GCE AS/A LEVEL

2400U20-1

THURSDAY, 9 JUNE 2022 – AFTERNOON

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.	12	
2.	12	
3.	14	
4.	15	
5.	18	
6.	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.

(Turn over)

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. If you run out of space, use the additional pages 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 6.

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

(Turn over)

ANSWER ALL QUESTIONS.

1. Look at IMAGE 1.1 for Question 1 in the separate Diagram Booklet. IMAGE 1.1 is a photograph of a transverse section through a mammalian heart.

(a) (i) Identify the chamber of the heart labelled X.

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[1 mark]

continued on the next page . . .

(Turn over)

Question 1 (a) continued

1. (a) (ii) Explain your answer to part (a) (i).

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[1 mark]

continued on the next page . . .

Question 1 continued

1. (b) Look at GRAPH 1.2 for Question 1 (b) in the separate Diagram Booklet.
GRAPH 1.2 shows pressure changes in the aorta,
left ventricle and left atrium of an adult individual at rest.

(i) On GRAPH 1.2
MARK WITH A
Y a point at which blood is flowing from the left ventricle into the aorta.

[1 mark]

continued on the next page . . .

(Turn over)

Question 1 (b) continued

1. (b) (ii) The numbers on GRAPH 1.2 indicate the points at which valves in the heart are either opening or closing.

Look at the table for Question 1 (b) (ii) in the separate Diagram Booklet.

Complete the table to show the name of the valve and state whether the valve is opening or closing.

[2 marks]

continued on the next page . . .

(Turn over)

Question 1 (b) continued

1. (b) (iii) Calculate the resting heart rate, in beats per minute, for this individual.

Space for working:

Heart rate

= ____________________ beats per minute

[1 mark]

(Turn over)

Question 1 continued

1. (c) Look at the equation for Question 1 (c) in the separate Diagram Booklet.
The volume of blood expelled from the left ventricle during each cardiac cycle is known as stroke volume. A person's cardiac output is calculated by multiplying the stroke volume by the heart rate, as shown in the equation.

continued on the next page . . .

(Turn over)

Question 1 (c) continued

Calculate the stroke volume for an individual whose heart rate was 75 bpm and cardiac output was $5.25\ dm^3\ min^{-1}$.

Space for working:

Stroke volume = ____________________ cm^3

[2 marks]

(Turn over)

Question 1 continued

1. (d) Look at IMAGE 1.3 for Question 1 (d) in the separate Diagram Booklet.

IMAGE 1.3 shows a transverse section through the aorta. The specimen has been stained to provide contrast.

(i) Name the tissue layers labelled A, B and C.

A = ______________________________

B = ______________________________

C = ______________________________

[2 marks]

(Turn over)

Question 1 (d) continued

1. (d) (ii) Although the pressure in the left ventricle drops almost to zero during diastole in the cardiac cycle, the pressure in the aorta remains relatively high.
With reference to IMAGE 1.3, explain how high pressure is maintained in the aorta.

(Turn over)

[2 marks]

(Total for Question 1 = 12 marks)

(Turn over)

2. Look at IMAGE 2.1 for Question 2 in the separate Diagram Booklet.

PLANARIA (a flatworm) and LUMBRICUS (an earthworm) are both multicellular animals that use their body surface for gas exchange. These are shown in IMAGE 2.1.

continued on the next page . . .

Question 2 continued

2. (a) (i) The body surface of both animals is adapted for gas exchange by being thin, moist, and permeable to gases. State ONE other feature of the body surface that these organisms have in common.

[1 mark]

continued on the next page . . .

(Turn over)

Question 2 (a) continued

2. (a) (ii) PLANARIA does not require a circulatory system. Explain why LUMBRICUS does require a circulatory system.

(Turn over)

[3 marks]

continued on the next page . . .

Question 2 (a) continued

2. (a) (iii) Locusts are large insects. Explain how they ensure an efficient supply of oxygen to their tissues.

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[2 marks]

(Turn over)

Question 2 continued

2. (b) Look at IMAGE 2.2 for Question 2 (b) in the separate Diagram Booklet.
IMAGE 2.2 shows an animal called NEREIS (a ragworm).

NEREIS also uses its body surface for gas exchange and, like LUMBRICUS, has a closed circulatory system and blood containing haemoglobin.

continued on the next page . . .

(Turn over)

Question 2 (b) continued

LUMBRICUS is slow – moving and burrows in damp soil feeding on decaying organic matter. NEREIS is a fast – moving, marine predator and uses its parapodia to crawl and swim.

continued on the next page . . .

Question 2 (b) continued

2. (b) (i) Suggest HOW parapodia are also adapted to increase the efficiency of gas exchange.

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[1 mark]

continued on the next page . . .

(Turn over)

Question 2 (b) continued

2. (b) (ii) Look at GRAPH 2.3 for Question 2 (b) (ii) in the separate Diagram Booklet. GRAPH 2.3 shows the oxygen haemoglobin dissociation curves for LUMBRICUS and NEREIS haemoglobin.

continued on the next page . . .

Question 2 (b) (ii) continued

Use the information provided to explain how the difference in the positions of the dissociation curves for LUMBRICUS and NEREIS haemoglobin reflects their method of feeding.

(Turn over)

(Turn over)

[5 marks]

(Total for Question 2 = 12 marks)

3. All mammals, including humans, are examples of holozoic heterotrophs. Once food has been ingested, it undergoes both mechanical and chemical digestion.

(a) Describe what is meant by the terms mechanical digestion and chemical digestion.

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(Turn over)

[2 marks]

continued on the next page . . .

(Turn over)

Question 3 continued

3. (b) Look at IMAGE 3.1 for Question 3 (b) in the separate Diagram Booklet.

IMAGE 3.1 shows the human alimentary canal and associated organs.

(i) Using the letters from IMAGE 3.1, identify the organs where lipase and bile are synthesised.

Lipase ________________________________

Bile ________________________________

[1 mark]

continued on the next page . . .

(Turn over)

Question 3 (b) continued

3. (b) (ii) Bile is composed of bile salts and HCO_3^- ions. Explain the importance of the HCO_3^- ions in the small intestine.

(Turn over)

[2 marks]

3. (c) Look at TABLE 3.2 for Question 3 (c) in the separate Diagram Booklet.

An experiment was carried out to determine the effect of bile salts on the digestion of lipids. The student used full fat milk as it contains a relatively high concentration of lipids.

continued on the next page . . .

(Turn over)

Question 3 (c) continued

Each test tube was set up as shown in TABLE 3.2; all solutions were maintained at 37°C throughout the investigation.

Phenolphthalein was used as an indicator. It is pink in solutions with a pH above 10 and colourless in solutions below pH 8.3

continued on the next page . . .

(Turn over)

Question 3 (c) continued

3. (c) (i) Explain why it was important that sodium carbonate solution was added to each of the test tubes.

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[1 mark]

continued on the next page . . .

Question 3 (c) continued

3. (c) (ii) Explain why it was important that different volumes of water were added to each of the test tubes.

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[1 mark]

continued on the next page . . .

Question 3 continued

3. (d) Look at TABLE 3.3 for Question 3 (d) in the separate Diagram Booklet.
The student recorded the time taken for the phenolphthalein to turn colourless. The results are shown in TABLE 3.3.

(i) Explain the results shown in test tubes A and B.

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(Turn over)

[4 marks]

(Turn over)

Question 3 (d) continued

3. (d) (ii) Explain why bile salts were included in test tube C but lipase was not.

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[1 mark]

continued on the next page . . .

Question 3 (d) continued

3. (d) (iii) Suggest ONE source of inaccuracy with this investigation and suggest ONE possible way in which it could be improved.

(Turn over)

[2 marks]

(Total for Question 3 = 14 marks)

(Turn over)

4. The Hawaiian archipelago is a group of tropical volcanic islands that formed within the last 30 million years. They are located in the middle of the Pacific Ocean, almost 2300 miles away from the closest continent, North America. There are 351 different bird species on the islands, of which 59 species are endemic (found only on the Hawaiian Islands). The UK has 635 different bird species, of which only one species is endemic.

continued on the next page . . .

(Turn over)

Question 4 continued

4. (a) (i) Calculate the percentage of bird species that are endemic to Hawaii.

Space for working:

________________________ **%**

[1 mark]

continued on the next page . . .

Question 4 (a) continued

4. (a) (ii) Less than 0.2% of UK bird species are endemic.

Suggest ONE reason for the difference in the percentage of endemic species between the UK and Hawaii.

[1 mark]

continued on the next page . . .

(Turn over)

Question 4 continued

4. (b) Hawaiian honeycreepers are a group of birds endemic to Hawaii. At least 56 species are known to have existed, however 38 species are now extinct.

Look at IMAGE 4.1 and TABLE 4.2 for Question 4 (b) in the separate Diagram Booklet.

IMAGE 4.1 shows one species, called apapane (HIMATIONE SANGUINEA), and TABLE 4.2 shows part of its classification.

continued on the next page . . .

(Turn over)

Question 4 (b) continued

Complete TABLE 4.2 to show the full classification of apapane.

[3 marks]

continued on the next page . . .

Question 4 continued

4. (c) Scientists have debated the identity of the ancestor of the honeycreepers. Morphological and behavioural data have suggested several possibilities. One group of scientists carried out DNA hybridisation to compare the DNA of apapane with other bird species.

continued on the next page . . .

Question 4 (c) continued

They include the orchard oriole (ICTERUS SPURIUS), the palm tanager (THRAUPIS PALMARUM) and the purple finch (CARPODACUS PURPUREUS).

This technique involves:

- **Heating the extracted DNA from apapane to break the hydrogen bonds, causing the two strands to separate.**
- **Mixing the separated strands with single DNA strands from a different species.**

continued on the next page . . .

(Turn over)

Question 4 (c) continued

- **Cooling the mixture to allow hydrogen bonds to form between complementary base pairs to produce hybrid DNA (with one strand from apapane and the other strand from the different species).**

When the hybrid DNA is then reheated the strands will separate at a lower temperature. This is because fewer hydrogen bonds will be present than in non – hybrid DNA from apapane.

continued on the next page . . .

(Turn over)

Question 4 (c) continued

The difference in temperature indicates how similar the DNA sequences are.

Look at TABLE 4.3 for Question 4 (c) in the separate Diagram Booklet. The results are shown in TABLE 4.3.

continued on the next page . . .

Question 4 (c) continued

4. (c) (i) Look at IMAGE 4.4 for Question 4 (c) (i) in the separate Diagram Booklet.

Use the results to COMPLETE THE PHYLOGENETIC TREE shown in TABLE 4.4.

[2 marks]

continued on the next page . . .

Question 4 (c) continued

4. (c) (ii) Use the information provided to explain how the technique allows the evolutionary relationships between the species to be determined.

(Turn over)

[3 marks]

continued on the next page . . .

Question 4 continued

4. (d) Look at IMAGE 4.5 for Question 4 (d) in the separate Diagram Booklet.

Since the arrival of the common ancestor in Hawaii, the honeycreepers have diversified into many different species. IMAGE 4.5 shows some of these with information regarding their food source.

continued on the next page . . .

Question 4 (d) continued

4. (d) (i) The apapane and iiwi are found in similar habitats and have similar diets. Explain why they are regarded as separate species.

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[1 mark]

continued on the next page . . .

(Turn over)

Question 4 (d) continued

4. (d) (ii) Using the information provided, describe and explain the evolutionary change illustrated by IMAGE 4.5.

(Turn over)

[4 marks]

(Total for Question 4 = 15 marks)

(Turn over)

5. Look at IMAGE 5.1 for Question 5 in the separate Diagram Booklet.

IMAGE 5.1 shows a longitudinal section through a vascular bundle of a marrow (CUCURBITA) stem.

(a) (i) State the main chemical found in the structures labelled X in IMAGE 5.1 and explain the importance of these structures in the functioning of xylem.

(Turn over)

[2 marks]

continued on the next page . . .

Question 5 (a) continued

5. (a) (ii) Calculate the length of the sieve tube element shown in IMAGE 5.1 in micrometres (µm). Show your working.

Space for working:

Length = ____________________ µm

[2 marks]

continued on the next page . . .

(Turn over)

Question 5 (a) continued

5. (a) (iii) Use your answer to part (ii) to calculate the length of time, in seconds, that it would take for a molecule of sucrose to travel between the sieve plates labelled in IMAGE 5.1, if the flow rate of phloem contents was $0.28\ \mathrm{mm\ s^{-1}}$.

Show your working.

Space for working:

continued on the next page . . .

Space for working continued

Time = ____________________ seconds

[3 marks]

continued on the next page . . .

(Turn over)

Question 5 continued

5. (b) Look at IMAGE 5.2 for Question 5 (b) in the separate Diagram Booklet.

In an investigation into the mechanisms of transport, fluid filled micropipettes were inserted into xylem vessels and sieve tube elements. IMAGE 5.2 shows the observations made.

Using your knowledge of plant transport, explain the observations shown in IMAGE 5.2.

(Turn over)

(Turn over)

[4 marks]

continued on the next page . . .

Question 5 continued

5. (c) Look at IMAGE 5.3 for Question 5 (c) in the separate Diagram Booklet.

In an experiment, some leaves of a plant were supplied with radioactively labelled carbon dioxide ($^{14}CO_2$) and allowed to photosynthesise, as shown in IMAGE 5.3. The leaves used $^{14}CO_2$ to produce sucrose. The sucrose was then transported from the leaves by the phloem.

continued on the next page . . .

(Turn over)

Question 5 (c) continued

After 24 hours exposure to $^{14}CO_2$ the plant was removed from the pot, dried, and then laid on photographic film in the dark. Radioactivity exposes the film turning it black.

Look at IMAGE 5.4 for Question 5 (c) in the separate Diagram Booklet.

IMAGE 5.4 represents an autoradiograph showing the location of compounds containing ^{14}C.

continued on the next page . . .

(Turn over)

Question 5 (c) continued

5. (c) (i) Other than sucrose, name ONE type of compound containing ^{14}C that may be transported in phloem.

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[1 mark]

continued on the next page . . .

(Turn over)

Question 5 (c) continued

5. (c) (ii) State the conclusions that can be drawn from the distribution of radioactivity in the LEAVES of the plant.

(Turn over)

[4 marks]

continued on the next page . . .

(Turn over)

Question 5 (c) continued

5. (c) (iii) The autoradiograph shows that radioactivity is also found in the roots. State the additional information that this provides about transport in phloem.

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[1 mark]

continued on the next page . . .

(Turn over)

Question 5 (c) continued

5. (c) (iv) Look at IMAGE 5.5 for Question 5 (c) (iv) in the separate Diagram Booklet. IMAGE 5.5 shows a transverse section of part of the stem of this plant.

USING A SINGLE ARROW, indicate ONE region on IMAGE 5.5 in which radioactivity would be found.

[1 mark]

(Total for Question 5 = 18 marks)

(Turn over)

6. Look at IMAGES 6.1A and 6.1B for Question 6 in the separate Diagram Booklet.

The images show two human parasites, the pork tapeworm (TAENIA SOLIUM) and a head louse (PEDICULUS CAPITUS).

The images illustrate the life cycles of these parasites.

continued on the next page . . .

(Turn over)

Question 6 continued

Using the information given in IMAGES 6.1A and 6.1B and your own knowledge, describe the general adaptations shown by BOTH organisms to a PARASITIC MODE OF LIFE and explain the SPECIFIC ADAPTATIONS of TAENIA and PEDICULUS.

(Turn over)

(Turn over)

(Turn over)

(Turn over)

(Turn over)

(Turn over)

(Turn over)

(Turn over)

(Turn over)

(Turn over)

(Turn over)

(Turn over)

[9 marks QER]

(Total for Question 6 = 9 marks)

END OF PAPER

TOTAL 80 MARKS

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

(Turn over)

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

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(Turn over)

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

GCE AS/A LEVEL

2400U20-1

THURSDAY, 9 JUNE 2022 – AFTERNOON

BIOLOGY – AS UNIT 2
BIODIVERSITY AND PHYSIOLOGY OF BODY SYSTEMS

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

Diagram Booklet

Surname: ____________________

First name(s): ____________________

Centre Number: ____________________

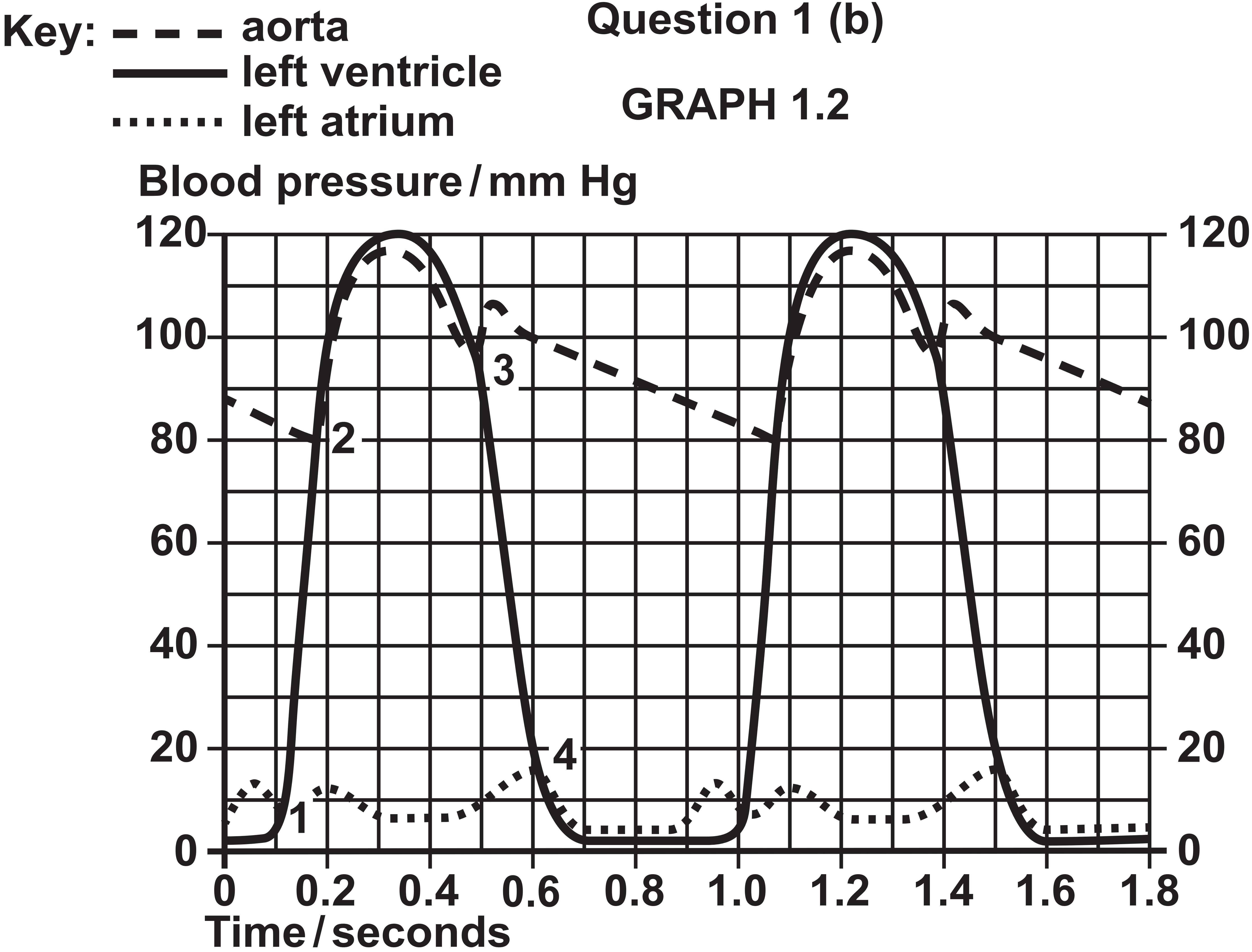
Candidate Number: 2 ____________________

Question 1

IMAGE 1.1

Question 1 (b)

GRAPH 1.2



Question 1 (b) (ii)

Table

Number	Name of valve	Opening or closing
1		
3		

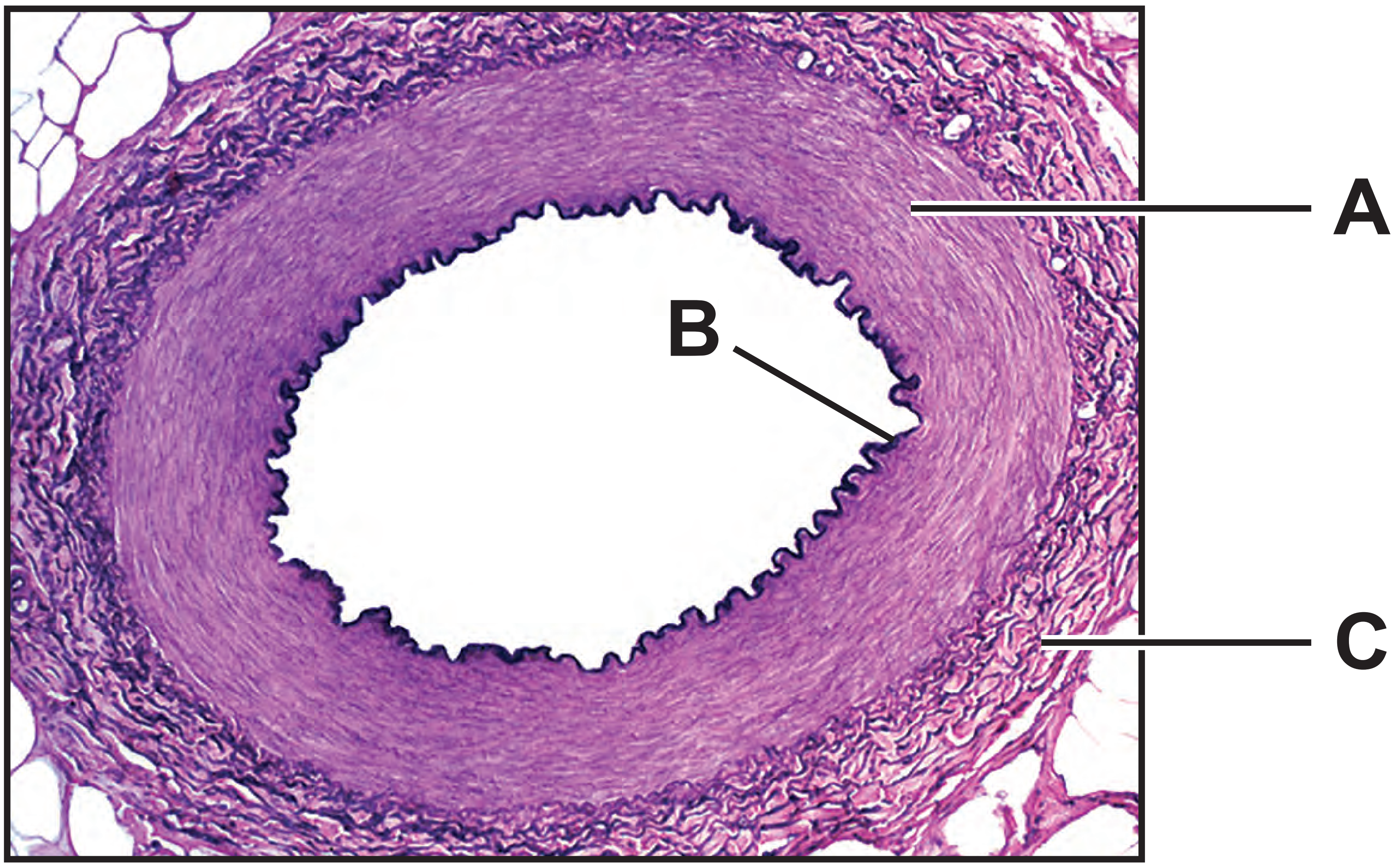
Question 1 (c)

Equation

$$\text{Cardiac output} = \text{heart rate} \times \text{stroke volume}$$

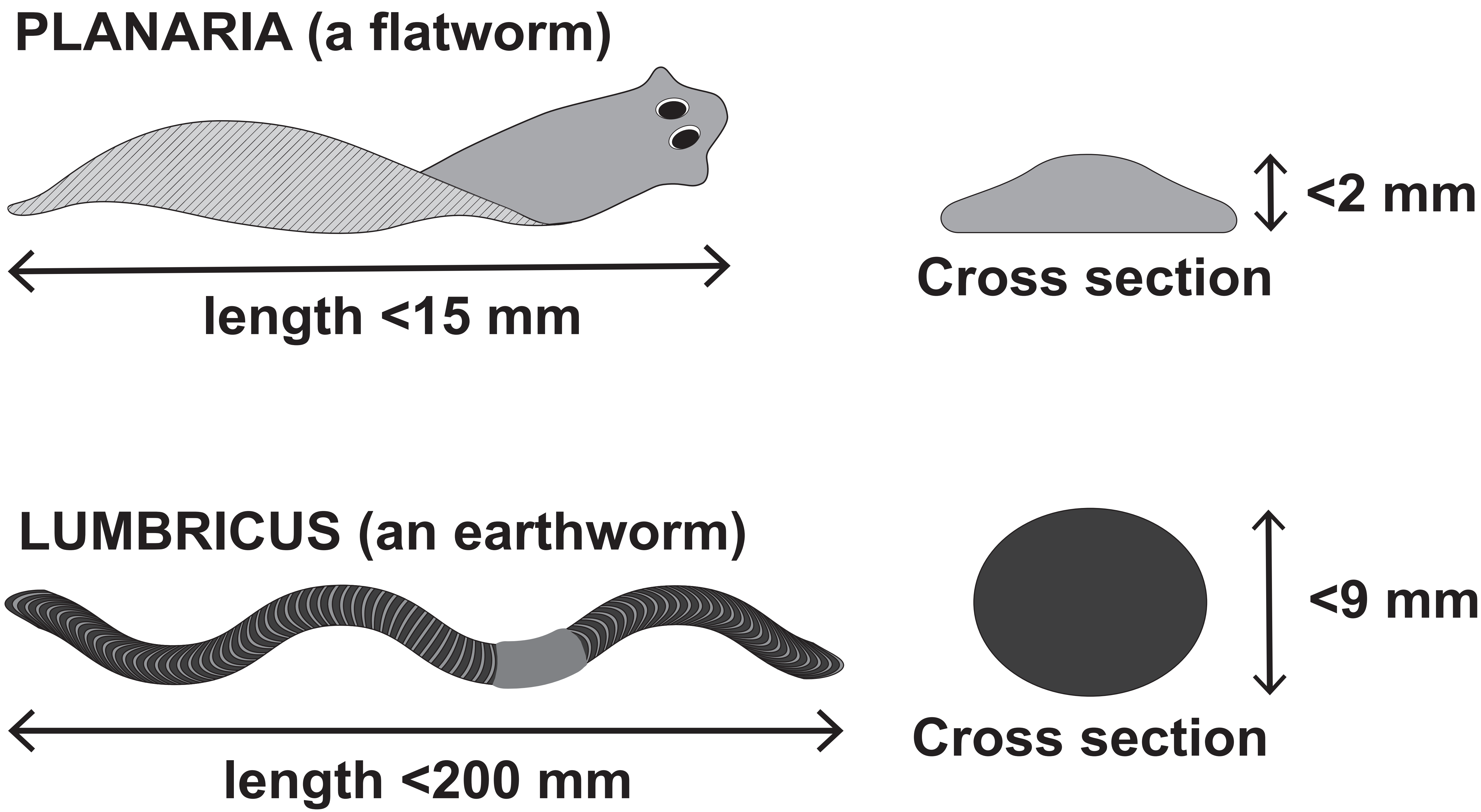
Question 1 (d)

IMAGE 1.3



Question 2

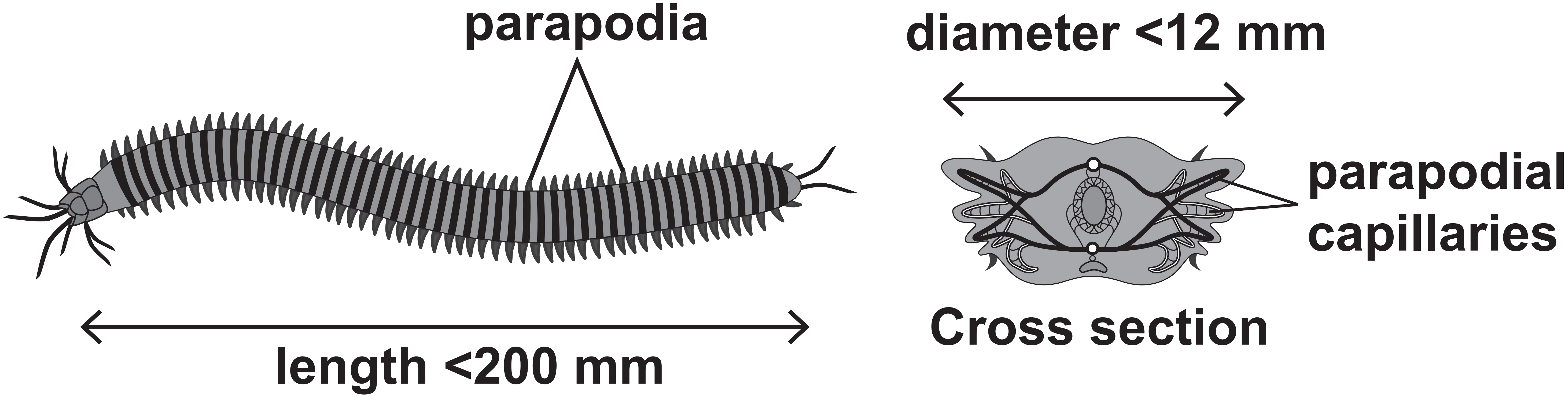
IMAGE 2.1



Question 2 (b)

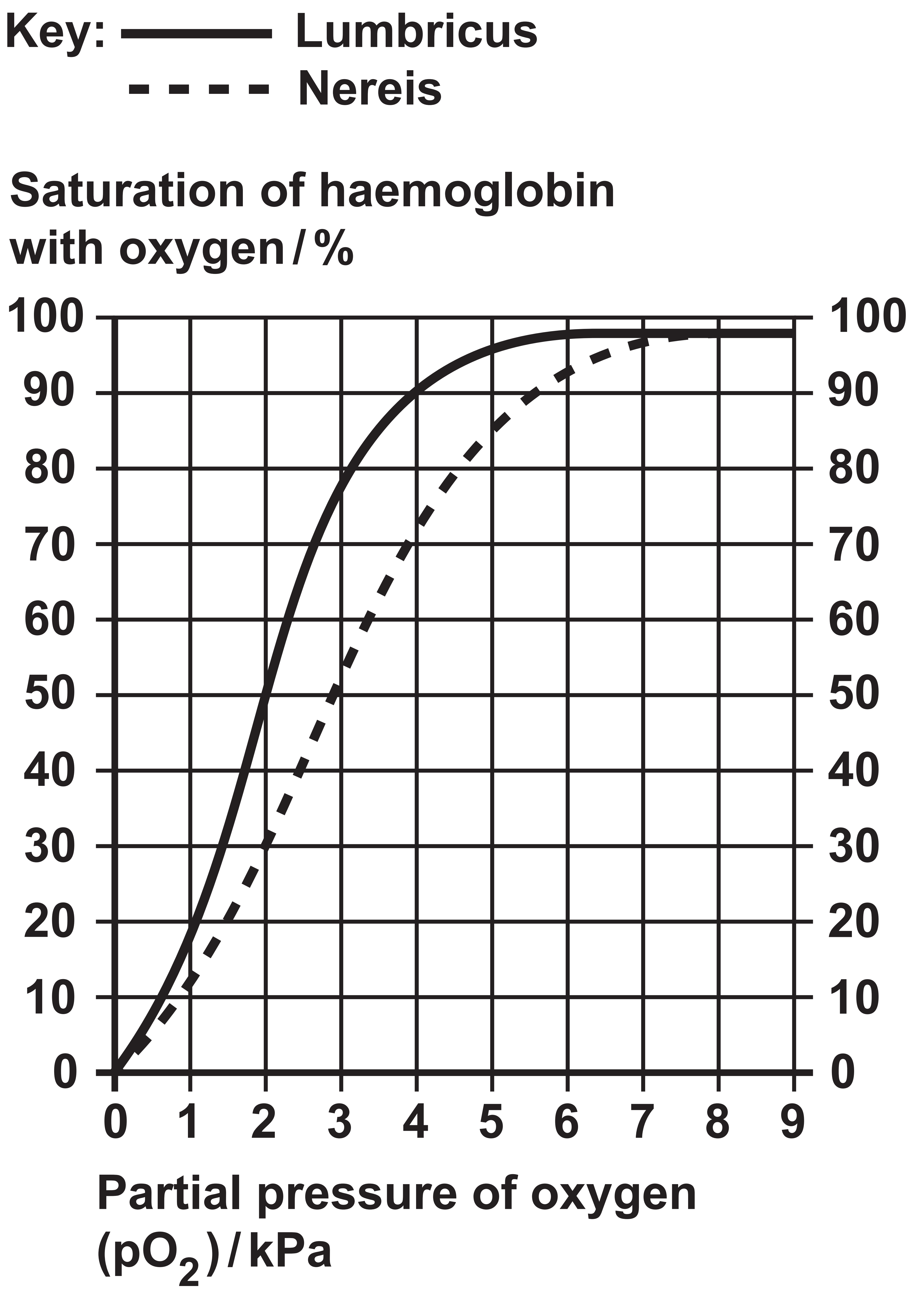
IMAGE 2.2

NEREIS (a ragworm)



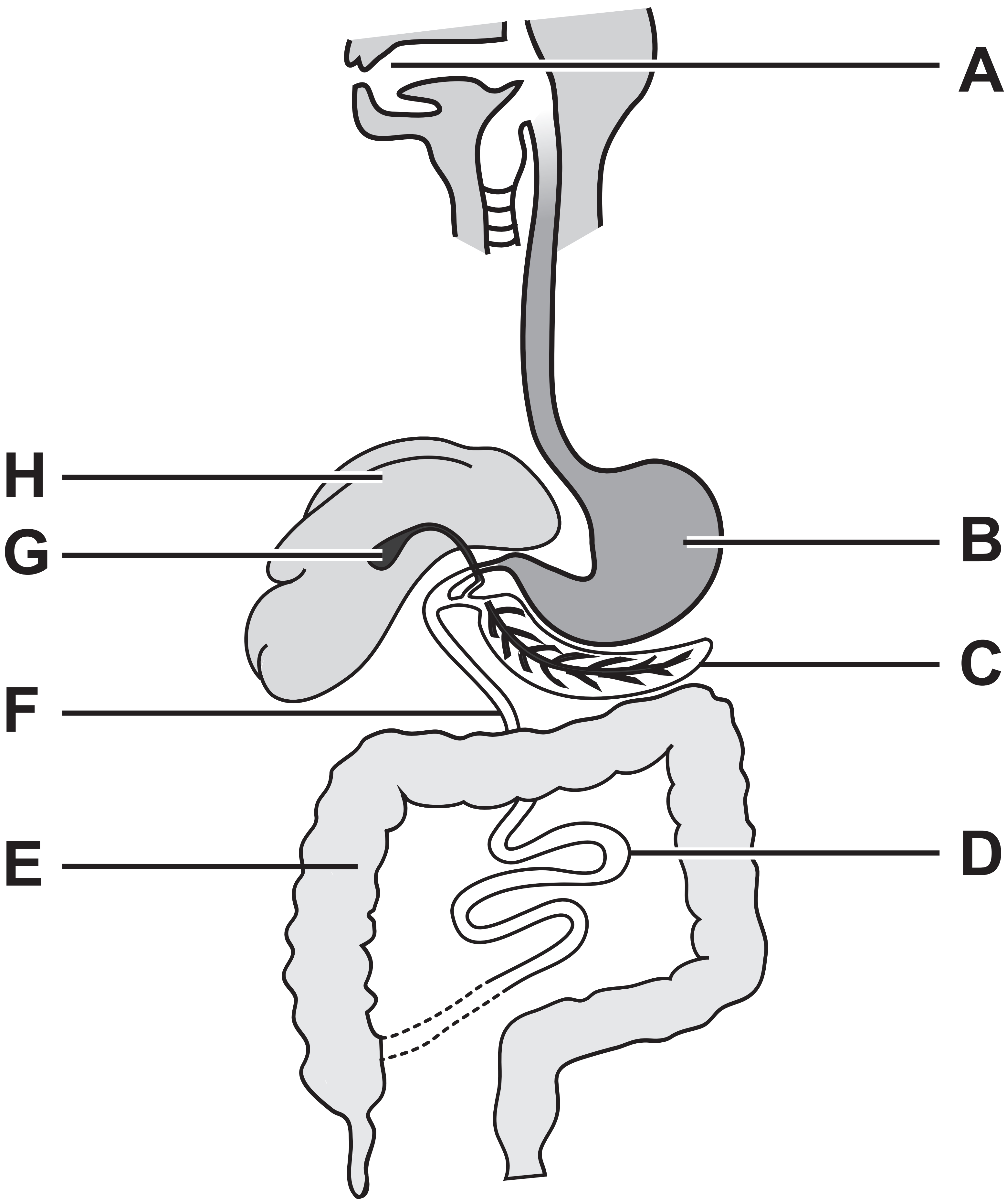
Question 2 (b) (ii)

GRAPH 2.3



Question 3 (b)

IMAGE 3.1



Question 3 (c)

TABLE 3.2

Tube	Volume / cm^3					
	Full fat milk (3.5% fat content)	Sodium carbonate solution (0.5 mol dm^{-3})	Lipase solution (5%)	Bile salt solution (3%)	Phenolphthalein (1%)	Distilled water
A	5.0	1.0	0.5	0.0	0.2	1.0
B	5.0	1.0	0.5	1.0	0.2	0.0
C	5.0	1.0	0.0	1.0	0.2	0.5

Question 3 (d)

TABLE 3.3

Tube	Time taken for phenolphthalein to turn colourless / s			
	Trial 1	Trial 2	Trial 3	Mean
A	247	283	266	265
B	111	87	109	102
C	*	*	*	*

*No colour change was recorded in test tube C even after 900 seconds.

Question 4 (b)

IMAGE 4.1

Question 4 (b)

TABLE 4.2

Domain	
Kingdom	Animalia
Phylum	Chordata
Class	Aves
	Passeriformes
	Fringillidae
Genus	
Species	

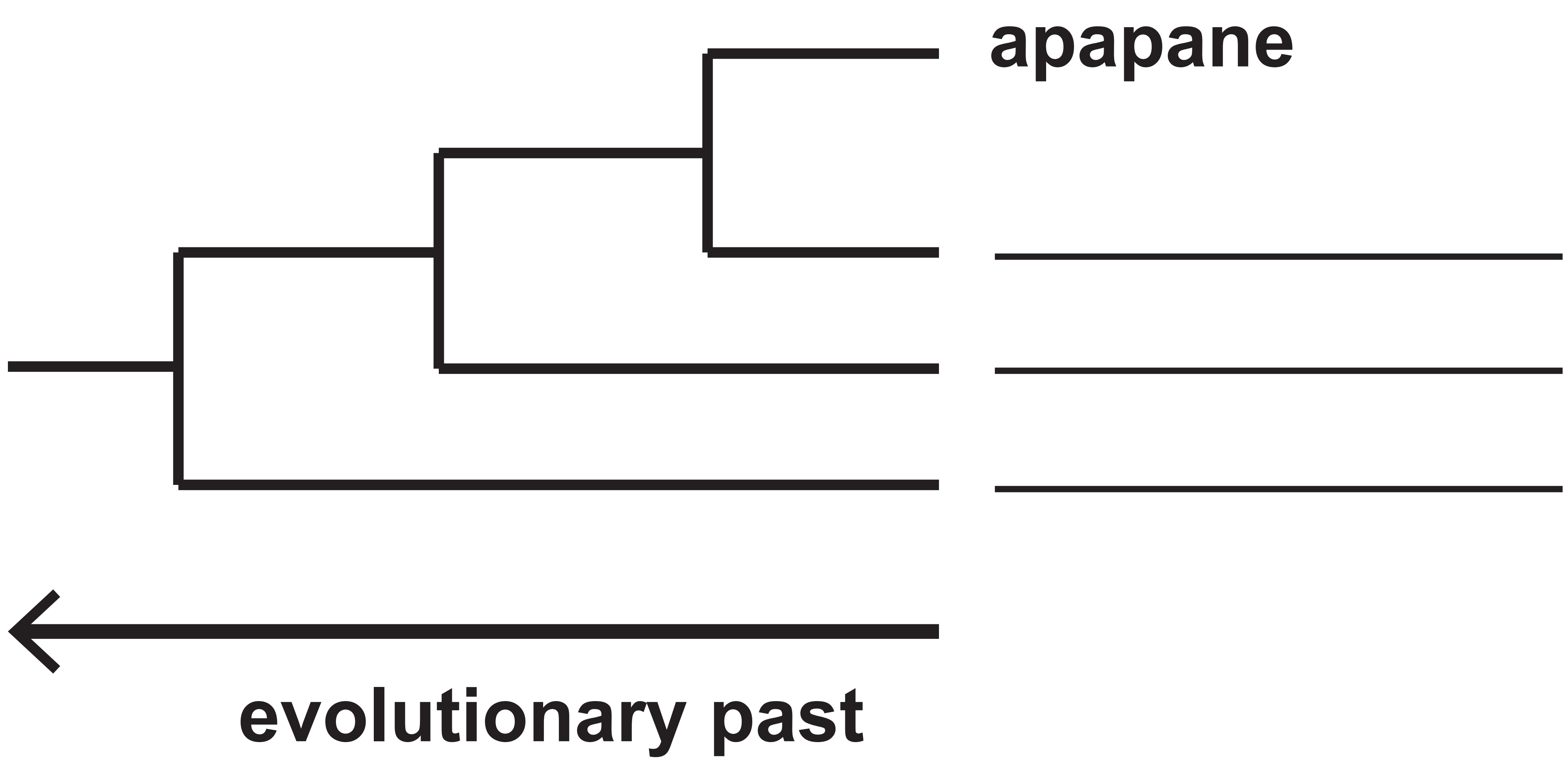
Question 4 (c)

TABLE 4.3

DNA	Temperature required to separate hybrid strands / °C
apapane – apapane	92.0
apapane – oriole	84.9
apapane – tanager	84.5
apapane – finch	87.8

Question 4 (c) (i)

IMAGE 4.4



Question 4 (d)

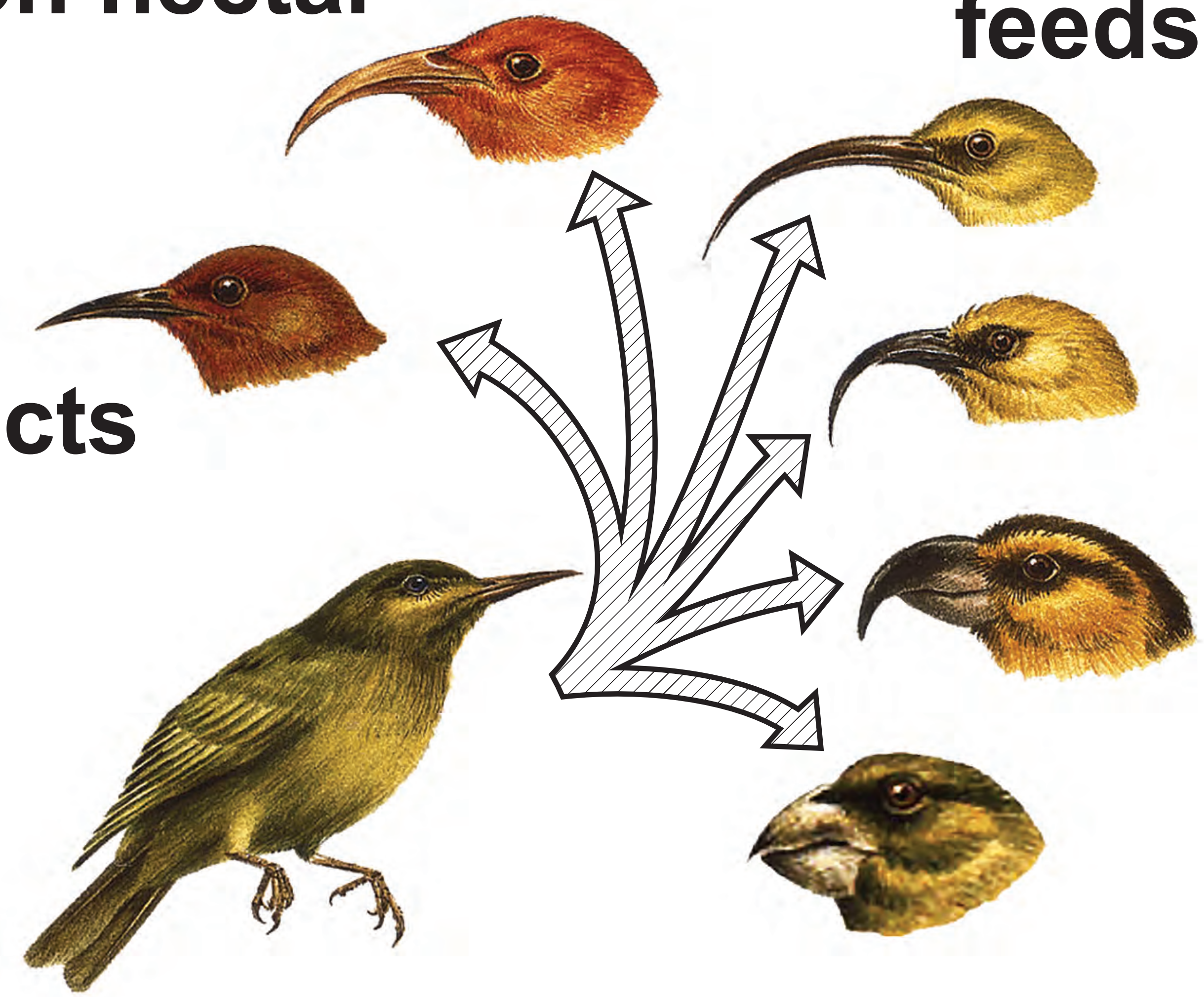
IMAGE 4.5

IIWI
feeds on nectar

AMAKIHI
feeds on nectar

APAPANE
feeds on insects and nectar

AKIAPOLA'AU
feeds on insects often under bark



MAUI PARROTBILL
feeds on insects under bark

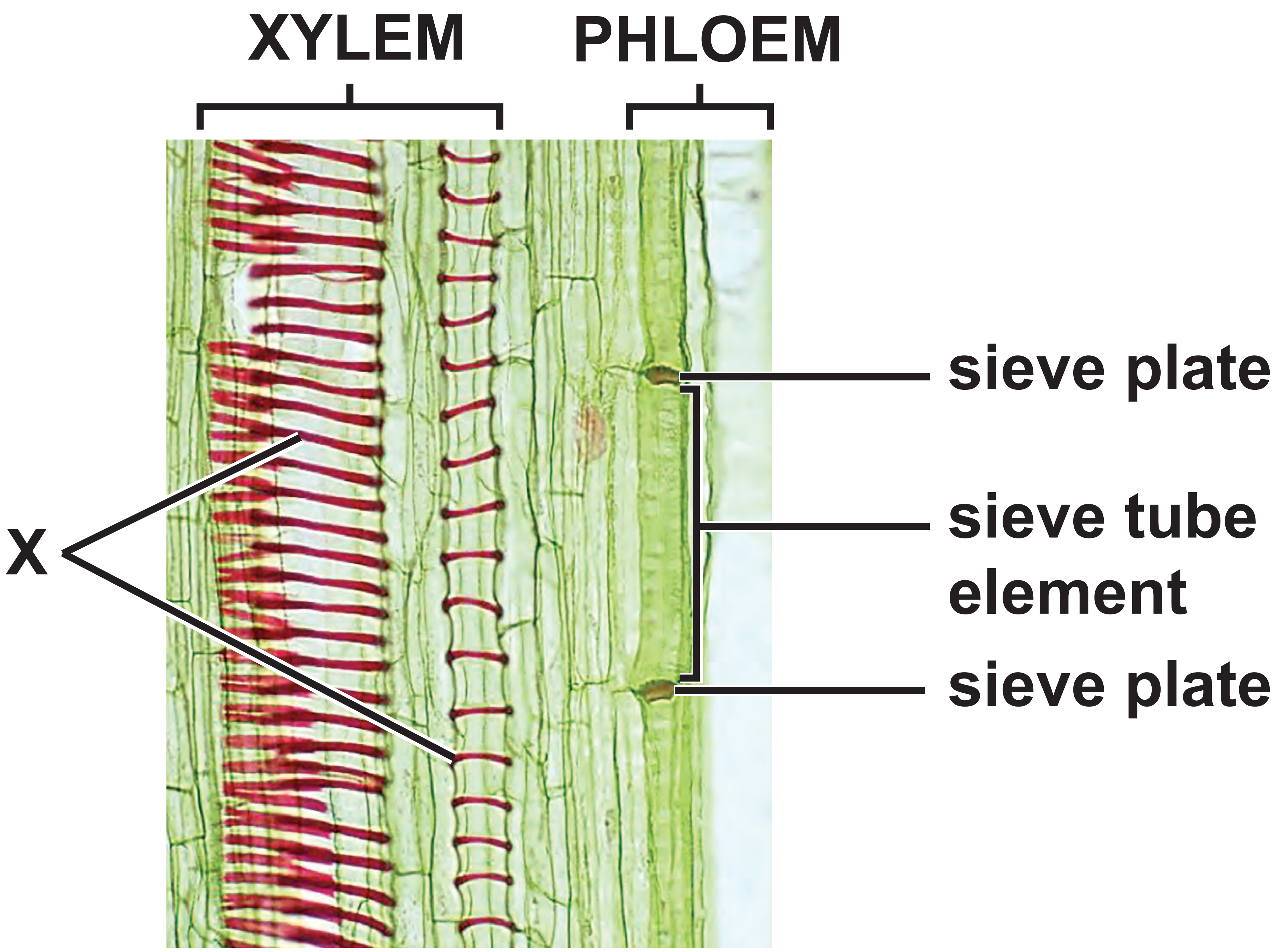
ORIGINAL SPECIES
now extinct, probably ate insects and nectar

NIHOA FINCH
feeds on seeds

Question 5

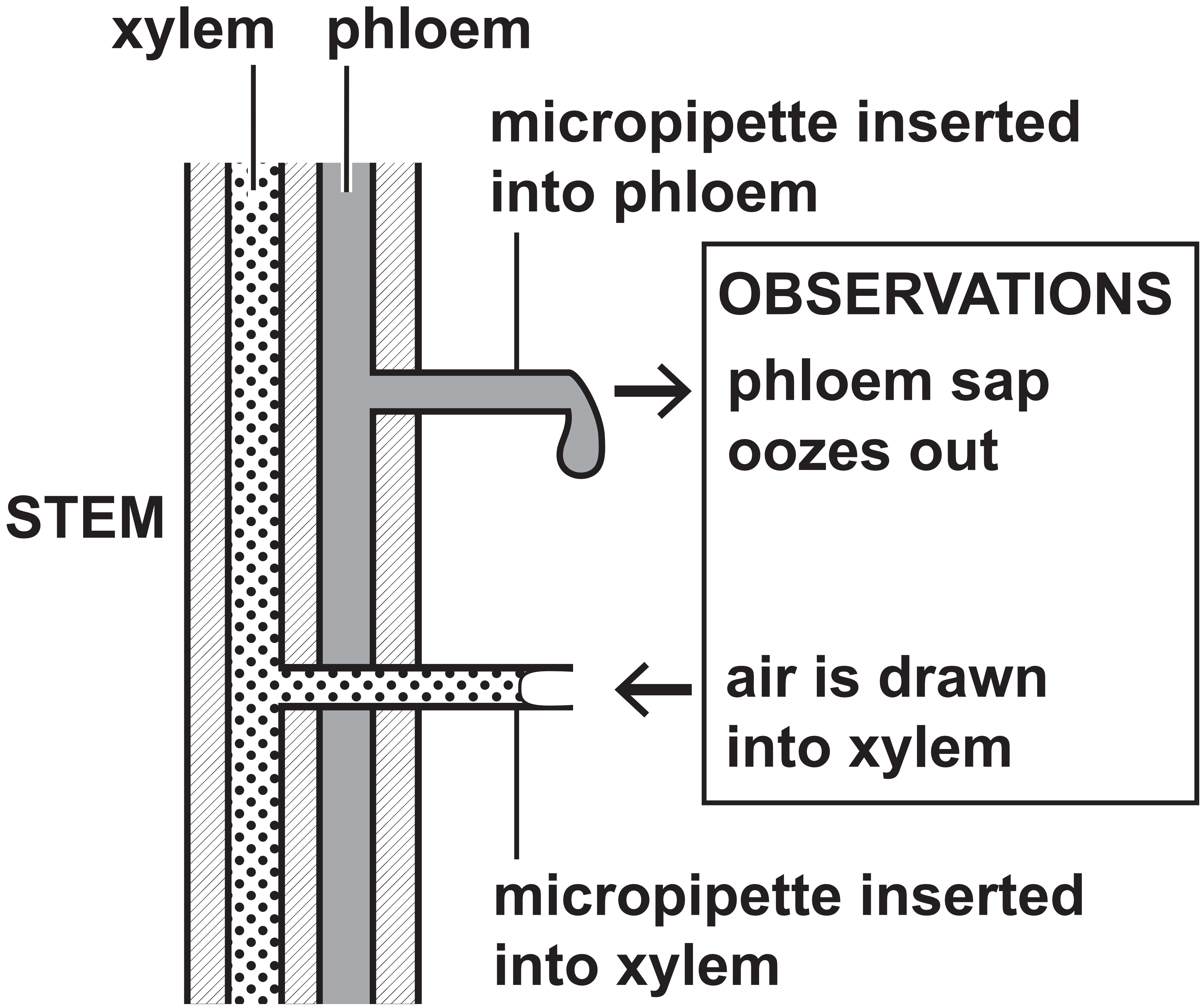
IMAGE 5.1

Magnification: 260×



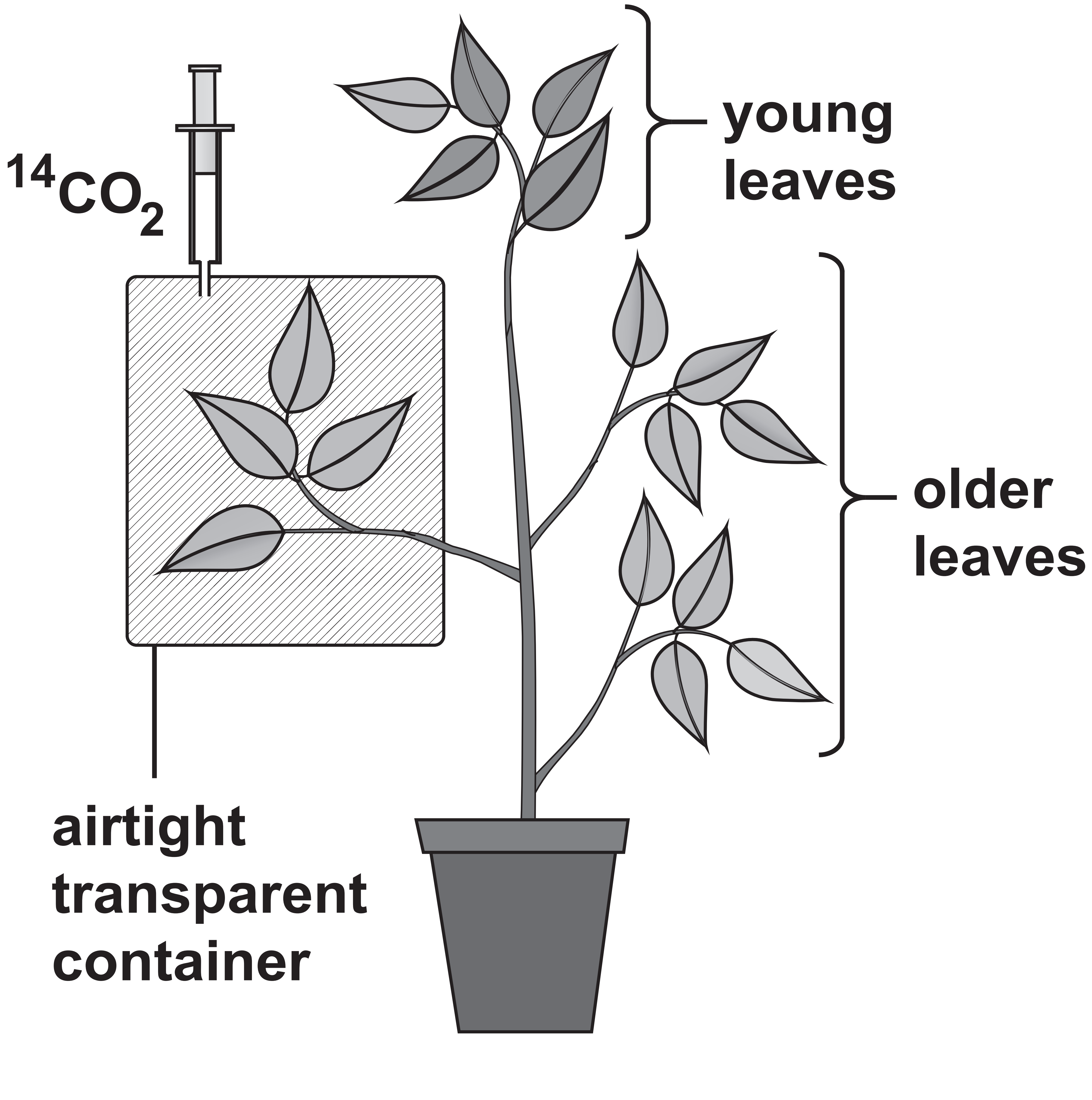
Question 5 (b)

IMAGE 5.2



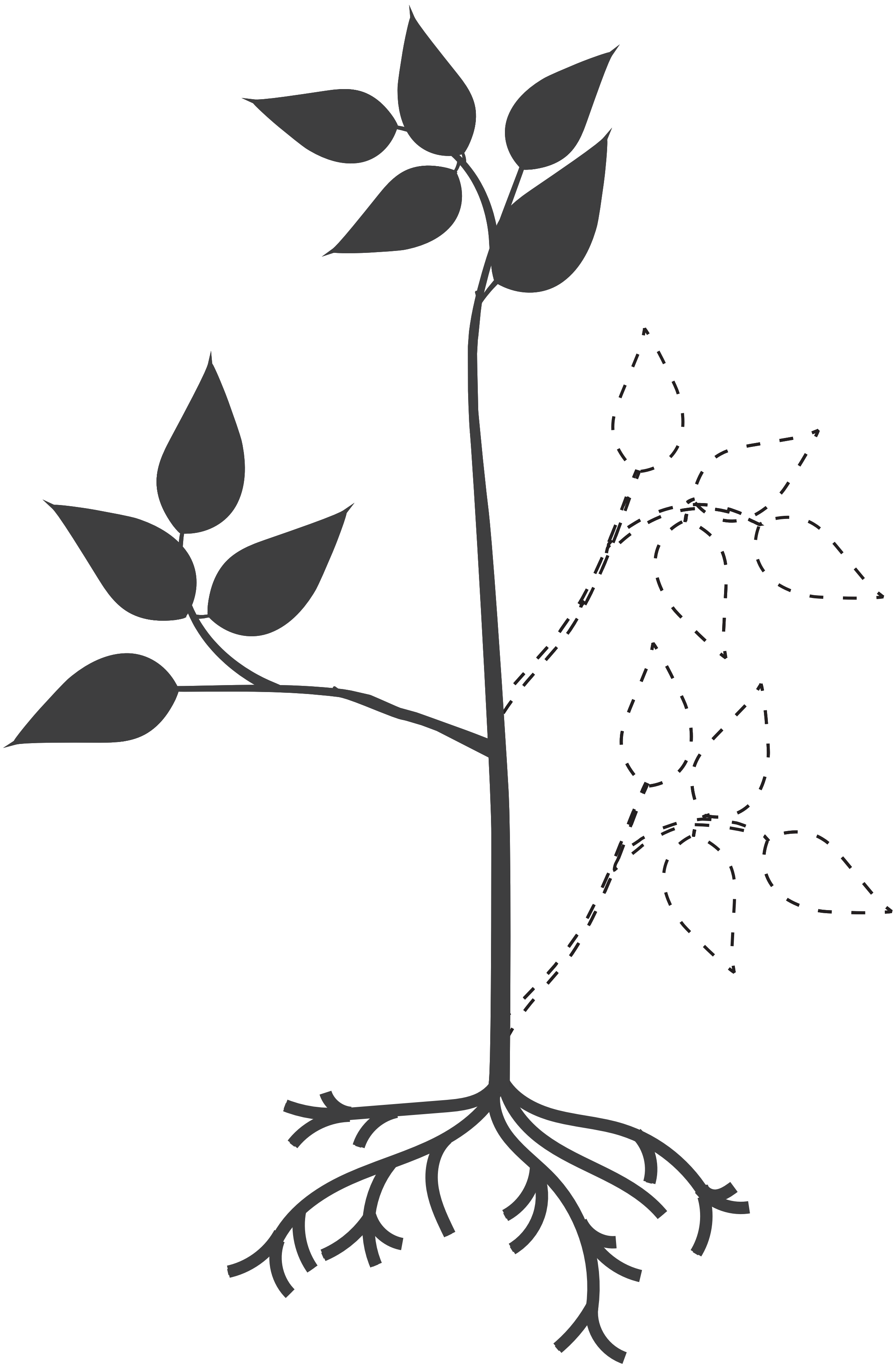
Question 5 (c)

IMAGE 5.3



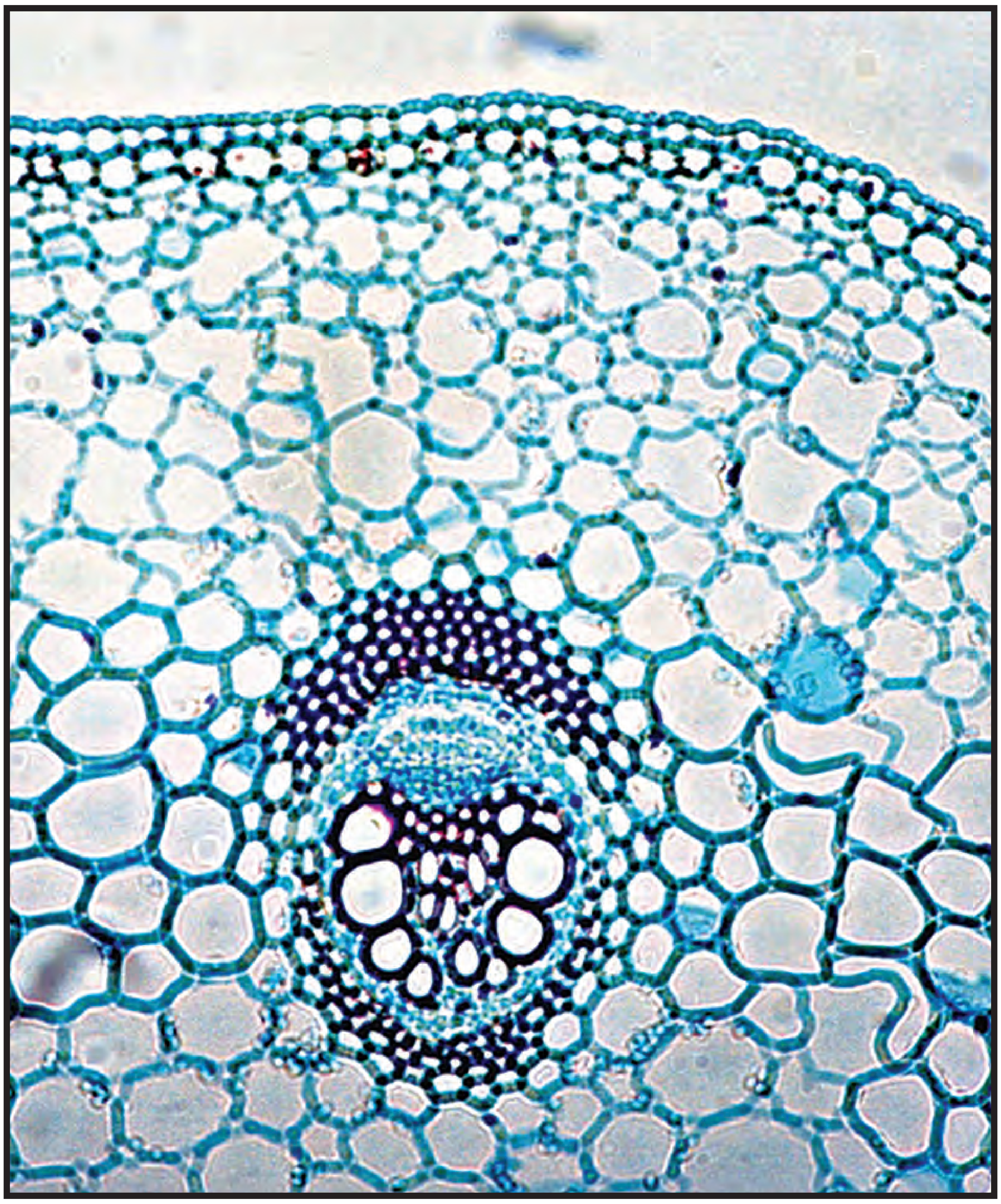
Question 5 (c)

IMAGE 5.4



Question 5 (c) (iv)

IMAGE 5.5

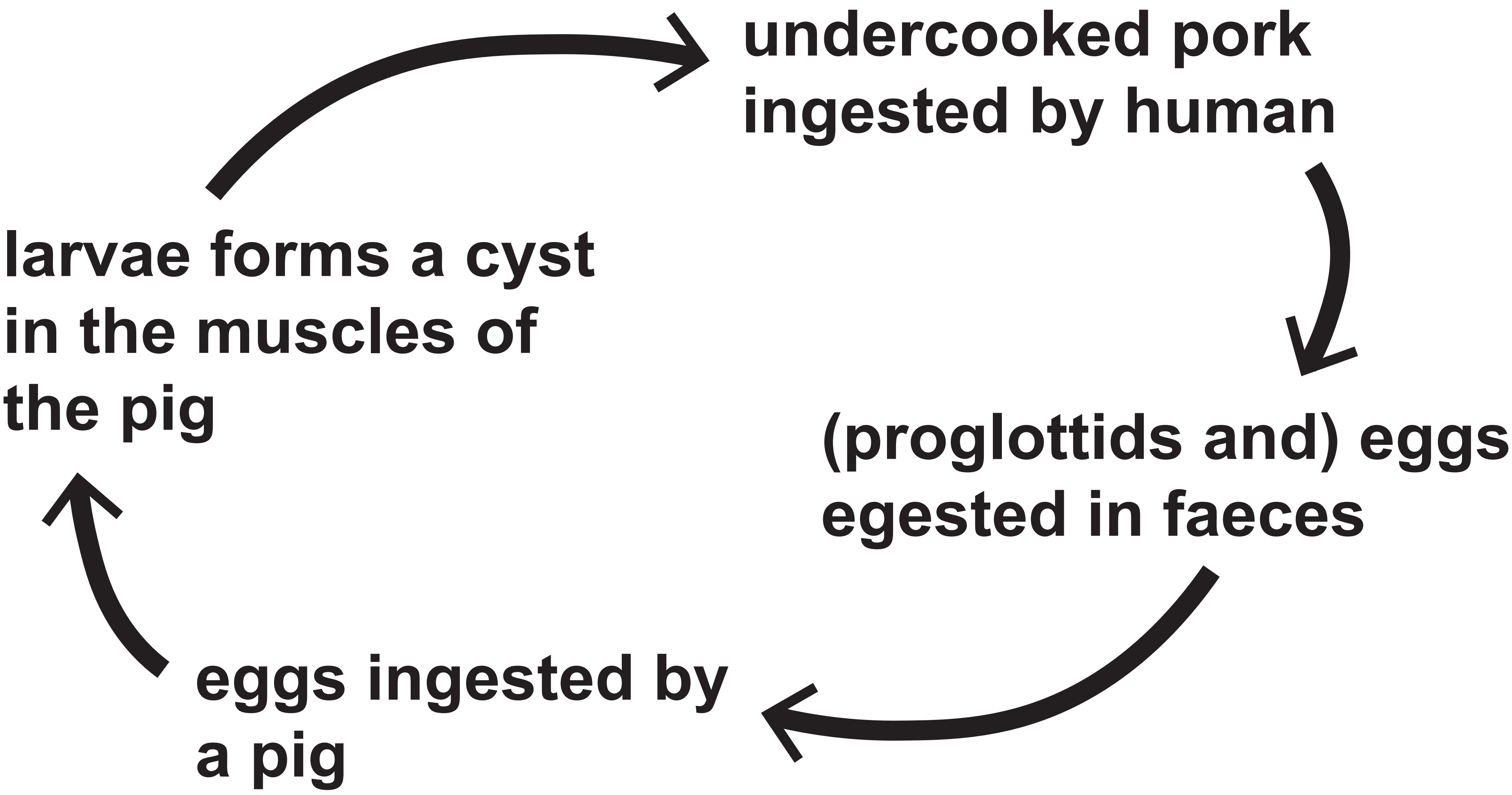


Question 6

IMAGE 6.1A

The pork tapeworm (TAENIA SOLIUM)

- **Life cycle of the pork tapeworm (TAENIA SOLIUM)**



Question 6

IMAGE 6.1B

The human head louse (PEDICULUS CAPITUS)

- **Life cycle of the human head louse (PEDICULUS CAPITUS)**

After mating has occured a female louse lays up to 10 eggs per day

eggs glued to the base of hair follicle

Nymph (offspring)

nymphs grow and mature

male and female adult lice adults can survive for 3 months