



GCE AS/A LEVEL

2400U20 – 1

THURSDAY, 22 MAY 2025 – 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.	8	
2.	14	
3.	11	
4.	17	
5.	9	
6.	12	
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.**

(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 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. Classification places organisms into hierarchical groups based on relatedness. Until recently organisms were classified into five Kingdoms based on morphological features.**
 - (a) Refer to IMAGE 1.1 in the separate Diagram Booklet. The pentadactyl limb demonstrates relatedness between different species as shown in IMAGE 1.1**

continued on the next page . . .

(Turn over)

Question 1 (a) continued

- 1. (a) (i) State the name given to structures such as the pentadactyl limb, that show relatedness.**

[1 mark]

continued on the next page . . .

(Turn over)

Question 1 (a) continued

- 1. (a) (ii) Explain the limitations of comparing the wings of birds and insects when considering morphological features to establish relatedness.**

(Turn over)

[2 marks]

continued on the next page . . .

(Turn over)

Question 1 continued

- 1. (b) Refer to IMAGE 1.2 in the separate Diagram Booklet. Comparison of the amino acid sequence of proteins can provide evidence for evolution. IMAGE 1.2 shows part of the amino acid sequence of a protein found in all organisms. Each capital letter indicates a different amino acid. The SHADED amino acids are THE SAME in all the organisms.**

continued on the next page . . .

(Turn over)

Question 1 (b) continued

Refer to TABLE 1.3 in the separate Diagram Booklet. TABLE 1.3 shows the number of differences in the amino acid sequence between the organisms shown in IMAGE 1.2

- 1. (b) (i) Complete TABLE 1.3 to indicate the number of differences in the amino acid sequence between the archaea and the other organisms shown in IMAGE 1.2**

[2 marks]

continued on the next page . . .

(Turn over)

Question 1 (b) continued

- 1. (b) (ii) Refer to IMAGE 1.4A and IMAGE 1.4B in the separate Diagram Booklet. Biochemical analysis has resulted in the classification of organisms into three Domains.**

IMAGE 1.4A shows a phylogenetic tree based on five Kingdoms and IMAGE 1.4B shows a phylogenetic tree based on three Domains.

continued on the next page . . .

(Turn over)

Question 1 (b) (ii) continued

Use IMAGE 1.4A, IMAGE 1.4B and the number of differences in TABLE 1.3 to explain why IMAGE 1.4B, which shows three Domains, is likely to be more accurate than IMAGE 1.4A which shows five Kingdoms.

(Turn over)

13

[3 marks]

(Total for Question 1 = 8 marks)

(Turn over)

2. Refer to IMAGE 2.1 in the separate Diagram Booklet. IMAGE 2.1 shows an amoeba, a single – celled eukaryotic organism that lives in an aquatic habitat.

(a) Explain how an amoeba carries out gas exchange.

(Turn over)

[2 marks]

continued on the next page . . .

(Turn over)

Question 2 continued

- 2. (b) Refer to IMAGE 2.2 in the separate Diagram Booklet. IMAGE 2.2 shows a flatworm and an earthworm.**

Refer to TABLE 2.3 in the separate Diagram Booklet. TABLE 2.3 shows some data on the surface area and volume of a flatworm and an earthworm.

continued on the next page . . .

(Turn over)

Question 2 (b) continued

- 2. (b) (i) Use the data provided to calculate the TWO missing values.**

**WRITE YOUR ANSWERS IN
TABLE 2.3**

Space for working

[2 marks]

continued on the next page . . .

(Turn over)

Question 2 (b) continued

2. (b) (ii) Explain why the body surface of both the flatworm and the earthworm is:

I. thin;

[1 mark]

II. moist.

[1 mark]

continued on the next page . . .

(Turn over)

Question 2 (b) continued

- 2. (b) (iii) Lugworms spend most of their lives in U – shaped burrows in tidal areas. Some species of lugworm can reach 25 cm in length. Refer to IMAGE 2.4A and IMAGE 2.4B in the separate Diagram Booklet. IMAGE 2.4A shows a lugworm in its burrow. IMAGE 2.4B shows its external gills and the direction of flow of blood and of water.**

continued on the next page . . .

(Turn over)

Question 2 (b) (iii) continued

The gas exchange surface of the lugworm is also thin and surrounded by water.

Use IMAGES 2.4A and B to explain THREE other adaptations that enable the lugworm to carry out efficient gas exchange.

I. _____

II. _____

(Turn over)

III.

[3 marks]

continued on the next page . . .

(Turn over)

Question 2 continued

- 2. (c) Refer to IMAGE 2.5 in the separate Diagram Booklet. Insects have a tracheal system to deliver oxygen to respiring tissues. IMAGE 2.5 shows this system in an insect.**

Refer to IMAGE 2.6 in the separate Diagram Booklet. IMAGE 2.6 shows insect tracheoles supplying the muscle fibres at rest and during flight.

continued on the next page . . .

(Turn over)

Question 2 (c) continued

- 2. (c) (i) Explain why the insect cannot carry out gas exchange through the body surface and needs a tracheal system to deliver oxygen to respiring tissues.**

(Turn over)

[2 marks]

2. (c) (ii) Suggest the role of the rings of chitin in the tracheoles.

[1 mark]

continued on the next page . . .

(Turn over)

Question 2 (c) continued

- 2. (c) (iii) Use IMAGE 2.6 to describe the change in fluid levels in the tracheoles during flight. Explain the advantage of this to the insect.**

(Turn over)

[2 marks]

(Total for Question 2 = 14 marks)

(Turn over)

- 3. Refer to IMAGE 3.1 in the separate Diagram Booklet. Erythrocytes (red blood cells) transport oxygen around the bodies of some animals. IMAGE 3.1 shows two views of an erythrocyte.**
- (a) Explain TWO ways in which the biconcave shape of the erythrocyte is an adaptation to its function.**

1. _____

(Turn over)

II.

[2 marks]

continued on the next page . . .

(Turn over)

Question 3 continued

- 3. (b) Refer to the fact file for Question 3 (b) in the separate Diagram booklet. The fact file is about blood in the average human.**
- (i) Use the information in the fact file to calculate the following for an average human:**
- I. The number of haemoglobin molecules in the body.**
- EXPRESS YOUR ANSWER IN STANDARD FORM.**

Use the space provided on the next page.

(Turn over)

Question 3 (b) (i) l. continued

Space for working

**Number of haemoglobin molecules in
the body = _____**

[3 marks]

continued on the next page . . .

(Turn over)

Question 3 (b) (i) continued

**3. (b) (i) II. The total mass of
haemoglobin in the body.**

**Total mass of haemoglobin in the body
= _____ g**

[1 mark]

continued on the next page . . .

(Turn over)

Question 3 (b) continued

3. (b) (ii) Describe how the values calculated in (i) I. and II. would change in an athlete who spends a month training at altitude.

Explain why this change would be of benefit to the athlete.

(Turn over)

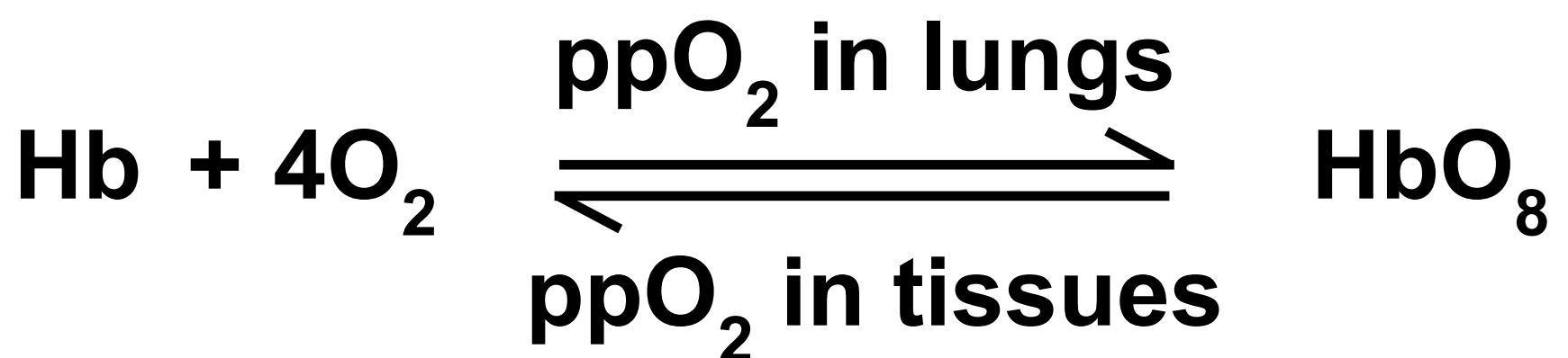
[2 marks]

continued on the next page . . .

(Turn over)

Question 3 continued

- 3. (c) (i) The association between haemoglobin and oxygen is reversible, as shown in the equation:**



State why the fact that this association is reversible is important to humans.

(Turn over)

[2 marks]

continued on the next page . . .

(Turn over)

Question 3 (c) continued

- 3. (c) (ii) Myoglobin is a protein found in muscle. It can reach 100% oxygen saturation and has a higher affinity for oxygen than haemoglobin.**

Explain why and when this would be beneficial to humans.

(Turn over)

[1 mark]

(Total for Question 3 = 11 marks)

(Turn over)

- 4. The vascular systems of flowering plants transport water, minerals and the products of photosynthesis.**
- (a) Refer to IMAGE 4.1 in the separate Diagram Booklet. IMAGE 4.1 shows a low power plan of a sector of a transverse section of a stem.**
- (i) On IMAGE 4.1, DRAW AN ARROW TO LABEL THE POSITION OF THE PHLOEM TISSUE in the vascular bundle.**

[1 mark]

continued on the next page . . .

(Turn over)

Question 4 (a) continued

4. (a) (ii) Refer to IMAGE 4.2 in the separate Diagram Booklet. IMAGE 4.2 shows a two – dimensional cross – section drawing of part of a vascular budle.

I. State the names of the cells labelled A and B in IMAGE 4.2

Cell A _____

Cell B _____

[1 mark]

continued on the next page . . .

(Turn over)

Question 4 (a) (ii) continued

4. (a) (ii) II. Explain how cell B supports the function of cell A.

[1 mark]

(b) (i) State the name of the material in the wall of the xylem vessel that provides strength.

[1 mark]

continued on the next page . . .

(Turn over)

Question 4 (b) continued

- 4. (b) (ii) Describe the movement of water across the root into the xylem. Include the role of the Casparian strip in your description.**

(Turn over)

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(Turn over)

[4 marks]

continued on the next page . . .

(Turn over)

Question 4 continued

- 4. (c) Scientists can investigate the rate of translocation in phloem using aphids. Aphids insert their mouthparts into phloem to feed on the organic molecules. Scientists can remove the bodies of the aphids, leaving the mouthparts in place. Sap will drip from the cut mouthparts and can be collected and analysed.**

Refer to IMAGE 4.3 in the separate Diagram Booklet. IMAGE 4.3 shows an experimental set-up.

continued on the next page . . .

(Turn over)

Question 4 (c) continued

In the experiment shown in IMAGE 4.3, the leaves of a plant were enclosed in a glass chamber containing radioactively labelled carbon dioxide ($^{14}\text{CO}_2$). The same number of aphids were placed at two different positions on the stem and the time taken for radioactive carbon compounds to be detected was recorded.

continued on the next page . . .

(Turn over)

Question 4 (c) continued

- 4. (c) (i) Name TWO radioactively labelled organic molecules that could be found in the phloem.**

_____ and _____

[1 mark]

- (ii) Suggest TWO factors that would need to be controlled throughout the investigation.**

[2 marks]

continued on the next page . . . (Turn over)

Question 4 (c) continued

**Refer to TABLE 4.4 in the
separate Diagram Booklet.**

**The results of the
investigation are shown in
TABLE 4.4**

- 4. (c) (iii) Calculate the rate of phloem
transport at position B.**

**WRITE YOUR ANSWER IN
TABLE 4.4**

Use the space provided on the next page.

(Turn over)

Question 4 (c) (iii) continued

Space for working

[2 marks]

continued on the next page . . .

(Turn over)

Question 4 (c) continued

- 4. (c) (iv) Refer to IMAGE 4.5 in the separate Diagram Booklet. The rate and direction of phloem transport varies during the year. Daffodils produce leaves and flowers in early spring. They store organic molecules in structures called bulbs which allow them to survive over winter.**

IMAGE 4.5 shows a daffodil in late winter and in spring.

continued on the next page . . .

(Turn over)

Question 4 (c) (iv) continued

Use IMAGE 4.5 and your knowledge of translocation to answer the following questions.

- 4. (c) (iv) I. Complete the table on the next page to identify the sources and sinks in the daffodil in late winter and spring.**

continued on the next page . . .

(Turn over)

Question 4 (c) (iv) I. continued

	Source(s)	Sink(s)
Late winter		
Spring		

[2 marks]**continued on the next page . . .****(Turn over)**

Question 4 (c) (iv) continued

4. (c) (iv) II. Explain why phloem transport needs to occur in BOTH DIRECTIONS in the same daffodil in SPRING.

[2 marks]

(Total for Question 4 = 17 marks)

(Turn over)

- 5. Students carried out a study of the biodiversity of invertebrate life in the leaf litter (dead leaves on the woodland floor) of two woodland habitats in Wales:**

Habitat A was a deciduous woodland. Deciduous trees lose their leaves in the autumn and regrow them in the spring.

Habitat B was a fast-growing coniferous woodland. The trees were tall and densely planted. Conifers do not shed all their leaves in autumn but do lose some leaves (needles) which fall to the ground throughout the year.

continued on the next page . . .

(Turn over)

Question 5 continued

**Both woodlands were approximately
1000 m²**

**The students investigated both sites
using the following method:**

- **A 400 m² area was marked using
two 20 m tape measures.**
- **Five pairs of co – ordinates
within the area were chosen by
generating random numbers
using 20 – sided dice.**
- **1 m² quadrats were placed at each
co – ordinate site and all the leaf
litter in the quadrat was collected.**

continued on the next page . . .

(Turn over)

Question 5 continued

- **The leaf litter was examined to find, identify and record the number of individuals of each invertebrate species.**

Refer to TABLE 5.1 in the separate Diagram Booklet. The total number of each invertebrate species found in the leaf litter at each site is shown in TABLE 5.1

continued on the next page . . .

(Turn over)

Question 5 continued

- 5. (a) The students concluded that they could be confident in their results because the data they gathered was representative of each woodland.**

Evaluate this conclusion.

(Turn over)

[3 marks]

continued on the next page . . .

(Turn over)

Question 5 continued

5. (b) Refer to TABLE 5.2 in the separate Diagram Booklet. The results for Habitat A, the deciduous woodland, are shown in TABLE 5.2

(i) Use TABLE 5.2 and the equation for Question 5 (b) (i) in the separate Diagram Booklet, to calculate the Simpson's Diversity Index for the deciduous woodland.

continued on the next page . . .

(Turn over)

Question 5 (b) (i) continued

**EXPRESS YOUR ANSWER
TO TWO DECIMAL PLACES.**

D = _____

[3 marks]

continued on the next page . . .

(Turn over)

Question 5 (b) continued

- 5. (b) (ii) The students calculated the Simpson's Diversity Index for Habitat B, the coniferous woodland, as 0.19**
- Use the information given to explain ONE reason why Habitat A has a higher biodiversity.**

(Turn over)

[3 marks]

(Total for Question 5 = 9 marks)

(Turn over)

6. Refer to IMAGE 6.1 in the separate Diagram Booklet. Mammalian digestive systems have structural differences based on their diet.

IMAGE 6.1 represents the digestive systems of a cow and a horse.

The cow and the horse have similar diets. However, there are differences in the way they digest food.

(a) (i) Identify the TWO main sites of protein digestion in the digestive system in a mammal.

[2 marks]

continued on the next page . . .

(Turn over)

Question 6 (a) continued

- 6. (a) (ii) Both horse and cow manure can be used to fertilise land for growing food crops.**

Use IMAGE 6.1 to explain why there are less nitrogen – containing compounds in cow manure compared to horse manure.

(Turn over)

[illegible]

[4 marks]

continued on the next page . . .

(Turn over)

Question 6 continued

6. (b) Refer to IMAGE 6.2 in the separate Diagram Booklet. IMAGE 6.2 is a micrograph of a longitudinal section of the ileum of a mammal.

**(i) Label tissues A and B on
IMAGE 6.2**

[1 mark]

continued on the next page . . .

(Turn over)

Question 6 (b) continued

- 6. (b) (ii) The villus indicated with the line Y–Y is 750 μm in length. Calculate the magnification of IMAGE 6.2**

Magnification = $\times$ _____

[2 marks]

continued on the next page . . .

(Turn over)

Question 6 (b) continued

6. (b) (iii) Nervous tissue at X in IMAGE 6.2 controls the activity of the two muscle layers.

Name and describe the process by which food is moved along the gut and explain why control of this process is necessary.

(Turn over)

[3 marks]

(Total for Question 6 = 12 marks)

- 7. Large complex animals require specialised transport systems. Some invertebrates have open circulatory systems whereas all vertebrates have a closed circulatory system with a heart to function as a pump.**

Refer to IMAGE 7 Diagram 1 and Diagram 2 in the separate Diagram Booklet. IMAGE 7 shows the closed circulatory systems of three different vertebrates.

Use IMAGE 7 and your own knowledge to compare the features of open and closed circulatory systems.

continued on the next page . . .

(Turn over)

Question 7 continued

Explain the benefits of the circulatory system of mammals compared to the circulatory system of fish.

Evaluate the effectiveness of the circulatory system of amphibians compared to fish and mammals.

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(Turn over)

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(Turn over)

[illegible]

(Turn over)

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(Turn over)

(Total for Question 7 = 9 marks)

TOTAL 80 MARKS

(Turn over)

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.

(Turn over)

[illegible]



GCE AS/A LEVEL

2400U20 – 1

THURSDAY, 22 MAY 2025 – MORNING

**BIOLOGY – AS UNIT 2
BIODIVERSITY AND PHYSIOLOGY
OF BODY SYSTEMS**

Diagram Booklet

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

Surname: _____

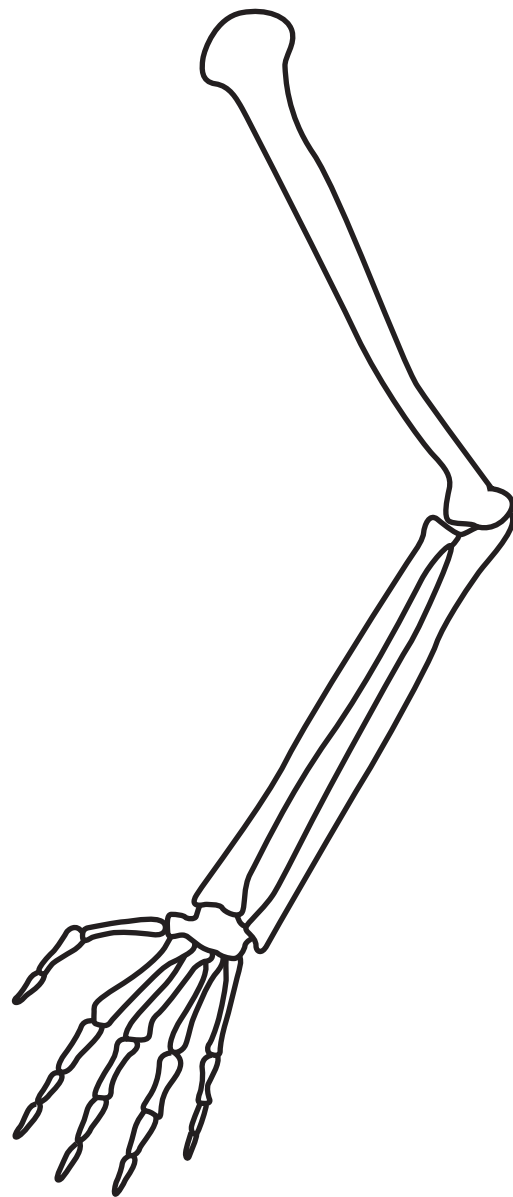
First name(s): _____

Centre Number: _____

Candidate Number: 2 _____

IMAGE 1.1

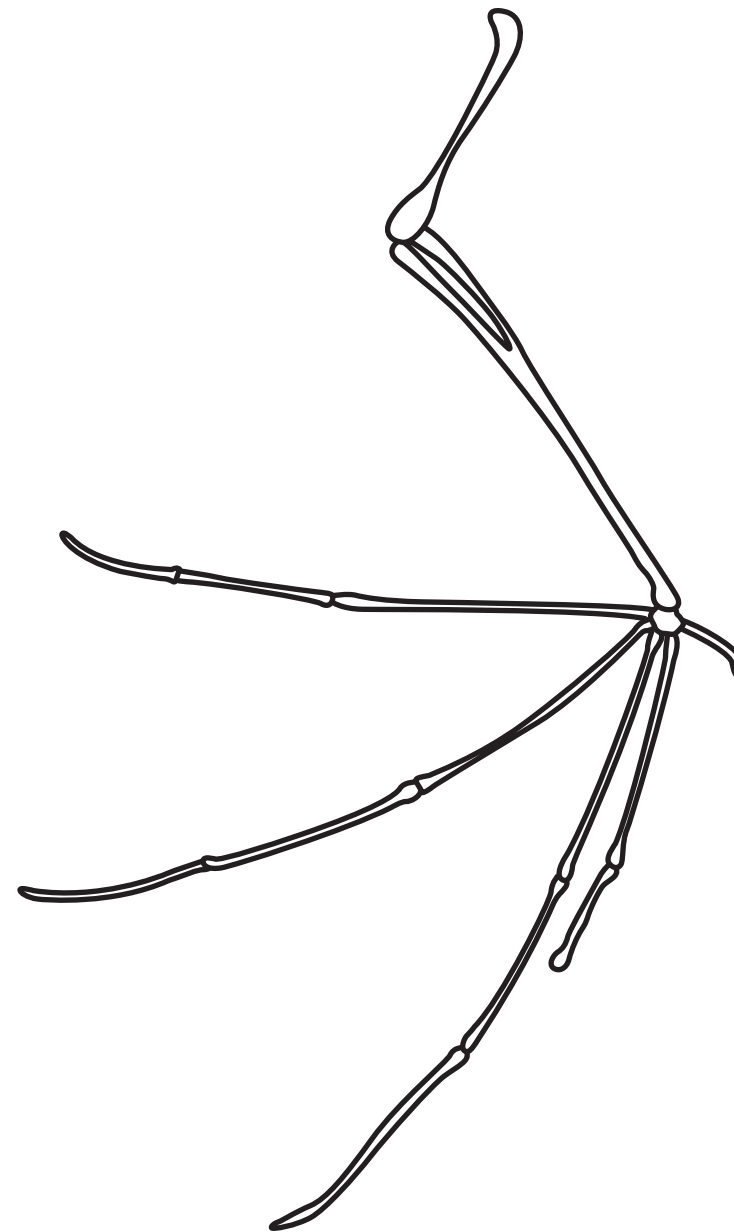
Human



Lizard



Bat



Bird

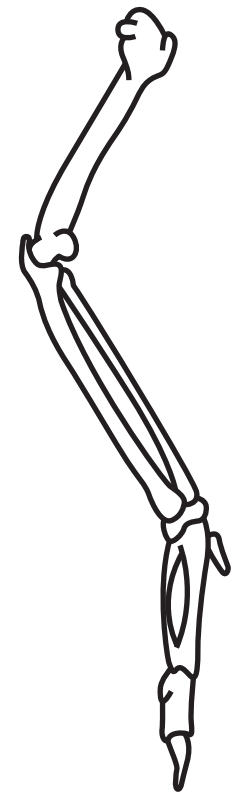


IMAGE 1.2

Key to first column: H.= Human
 T. = Tomato
 Y. = Yeast
 P. = Protoctista
 A. = Archaea
 E. = Eubacteria

H.	D	A	P	G	H	R	D	F	I	K	N	M	I	T	G	T	S	Q	A	D	C	A	V	L	I	V
T.	D	A	P	G	H	R	D	F	I	K	N	M	I	T	G	T	S	Q	A	D	C	A	V	L	I	I
Y.	D	A	P	G	H	R	D	F	I	K	N	M	I	T	G	T	S	Q	A	D	C	A	I	L	I	I
P.	D	A	P	G	H	R	D	F	V	K	N	M	I	T	G	T	S	Q	A	D	C	A	I	L	I	I
A.	D	A	P	G	H	R	D	F	V	K	N	M	I	T	G	A	S	Q	A	D	A	A	I	L	V	V
E.	D	C	P	G	H	A	D	Y	V	K	N	M	I	T	G	A	A	Q	M	D	G	A	I	L	V	V

TABLE 1.3

Key:

H = Human T = Tomato Y = Yeast P = Protocista
A = Archaea E = Eubacteria

	H	T	Y	P	A	E
H						
T	1					
Y	2	1				
P	3	2	1			
A	_____	_____	_____	_____		
E	10	11	10	10	6	

IMAGE 1.4A and IMAGE 1.4B

IMAGE 1.4A

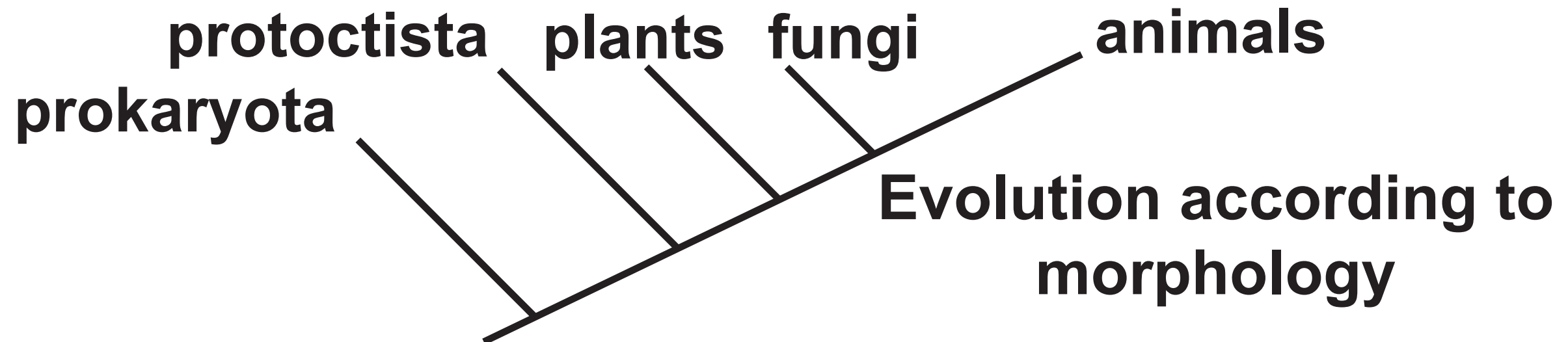


IMAGE 1.4B

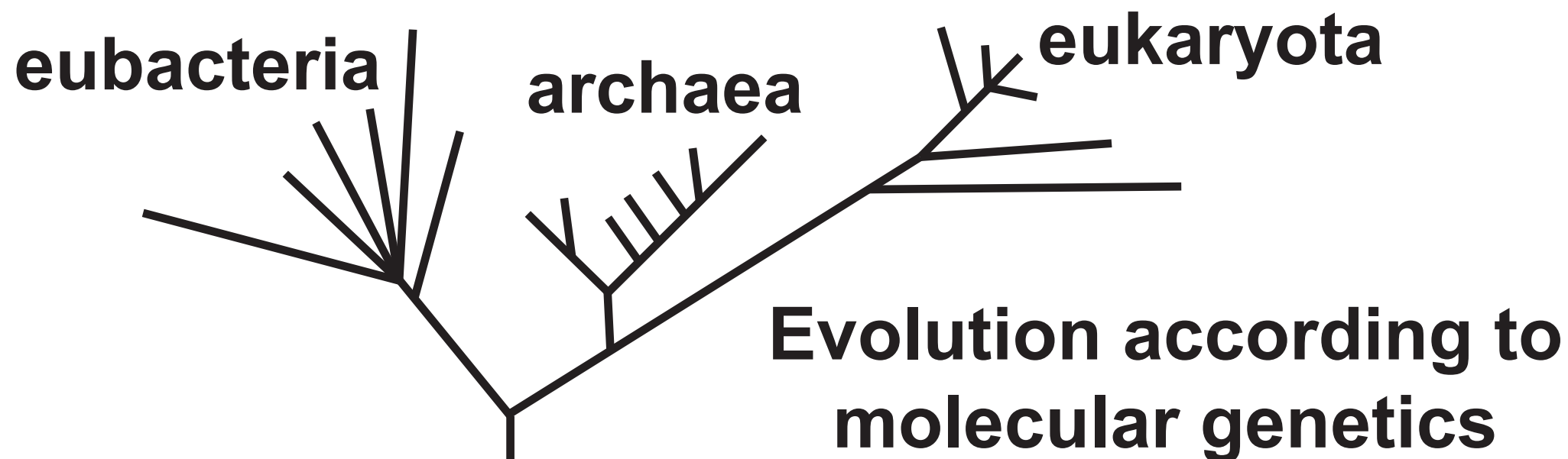


IMAGE 2.1

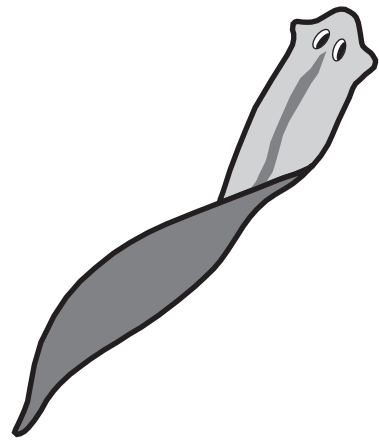


1 mm

IMAGE 2.2

Flatworm

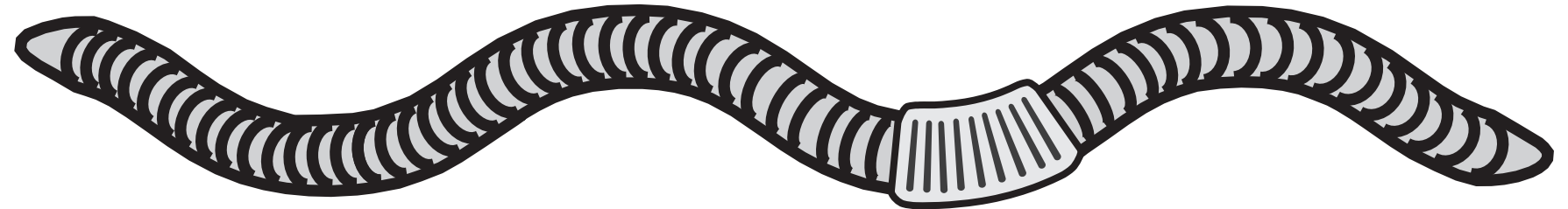
Habitat: freshwater



100 μm

Earthworm

Habitat: garden soil



20 mm

TABLE 2.3

Organism	Surface area / mm²	Volume / mm³	Surface area : Volume ratio
Flatworm	0•15	0•003	_____ : 1
Earthworm	_____	500	0•5 : 1

IMAGE 2.4A

Key: $\longrightarrow$ = flow of water

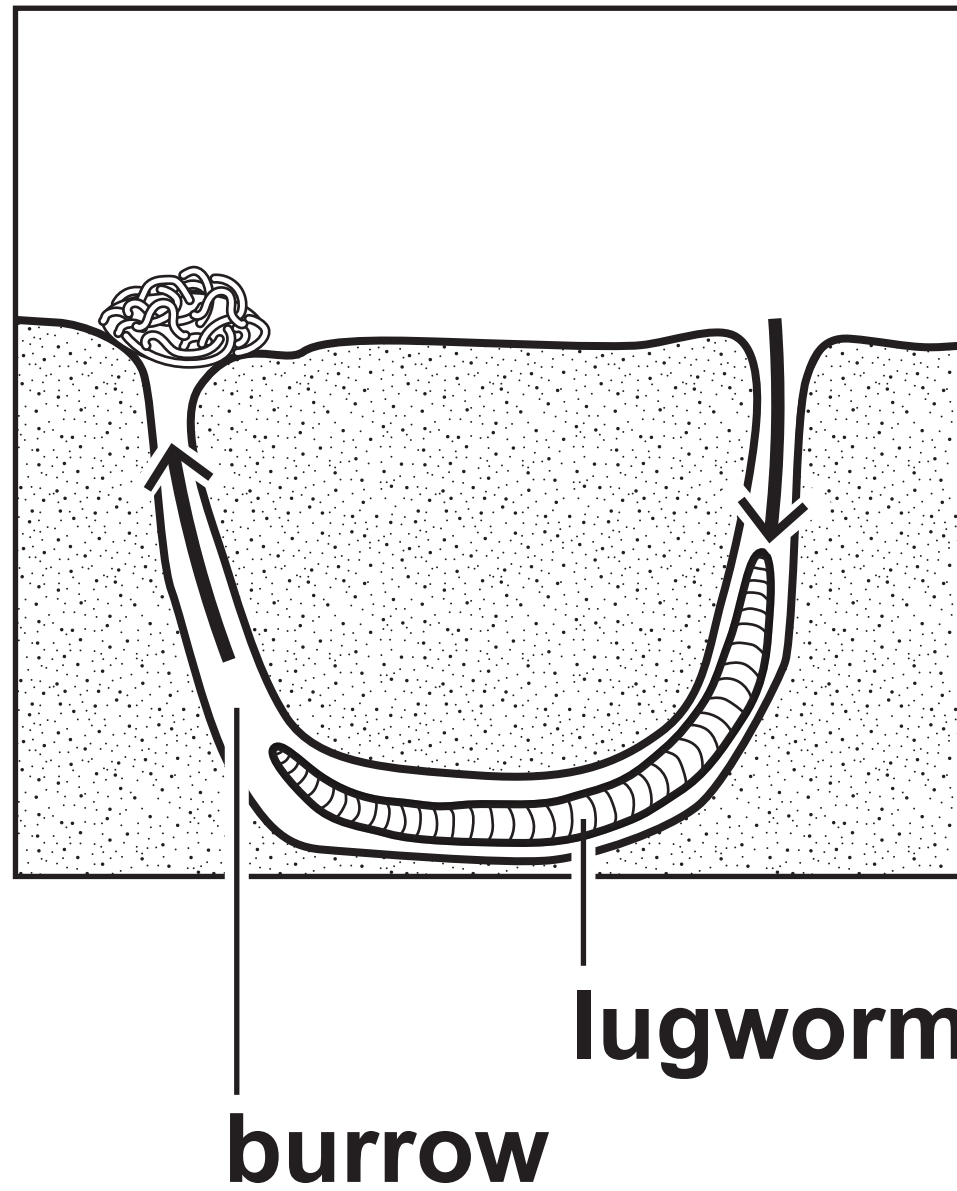


IMAGE 2.4B

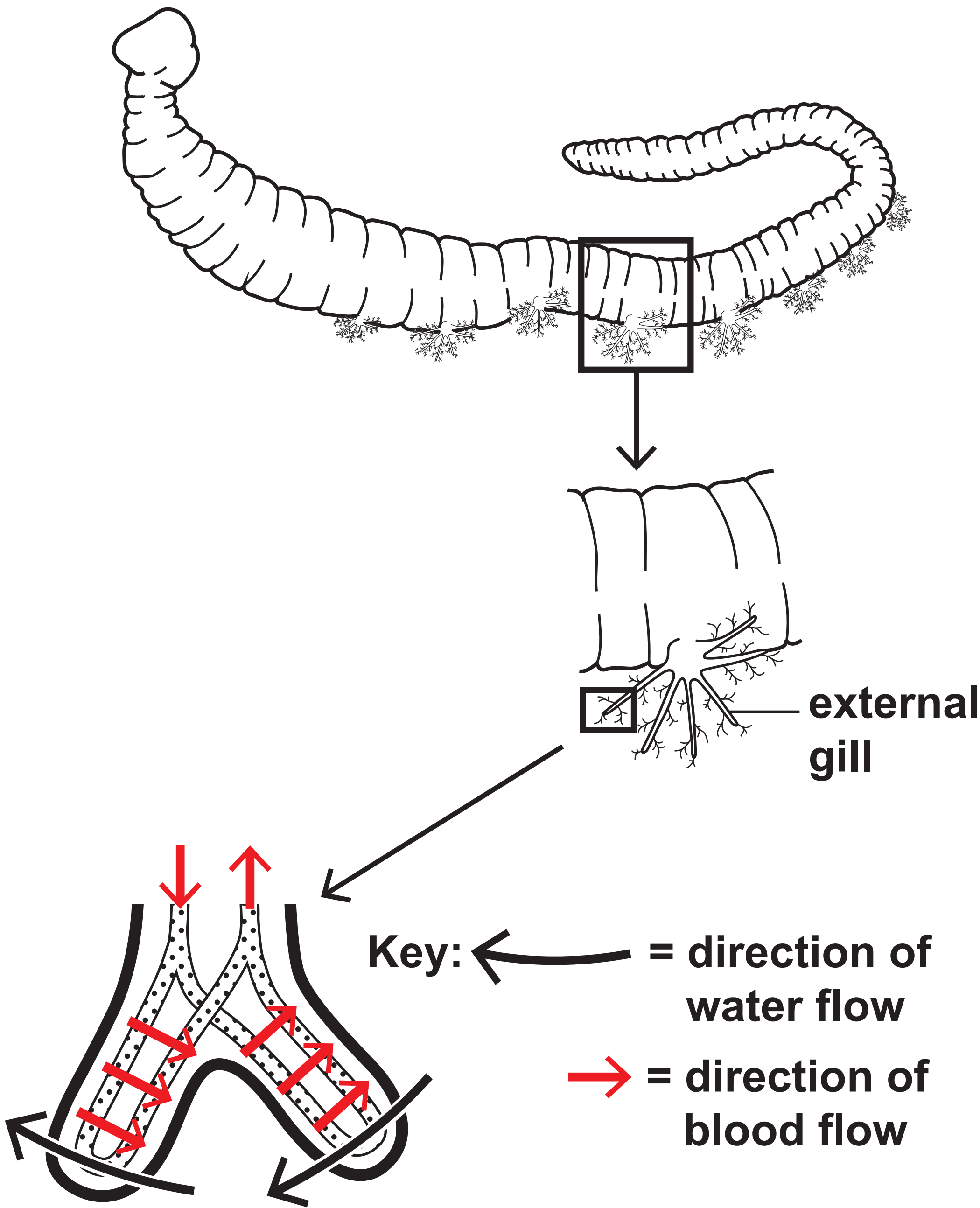


IMAGE 2.5

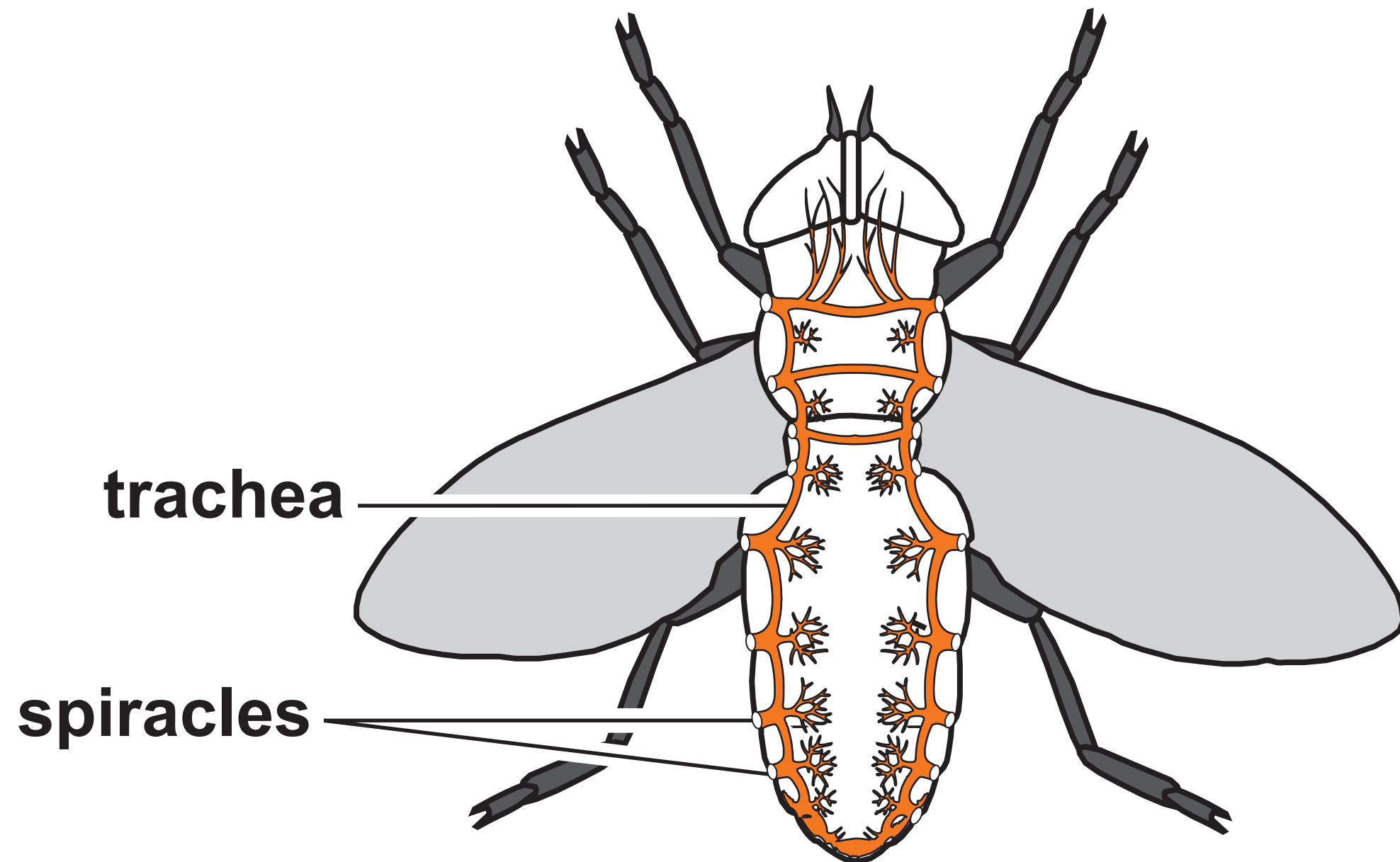
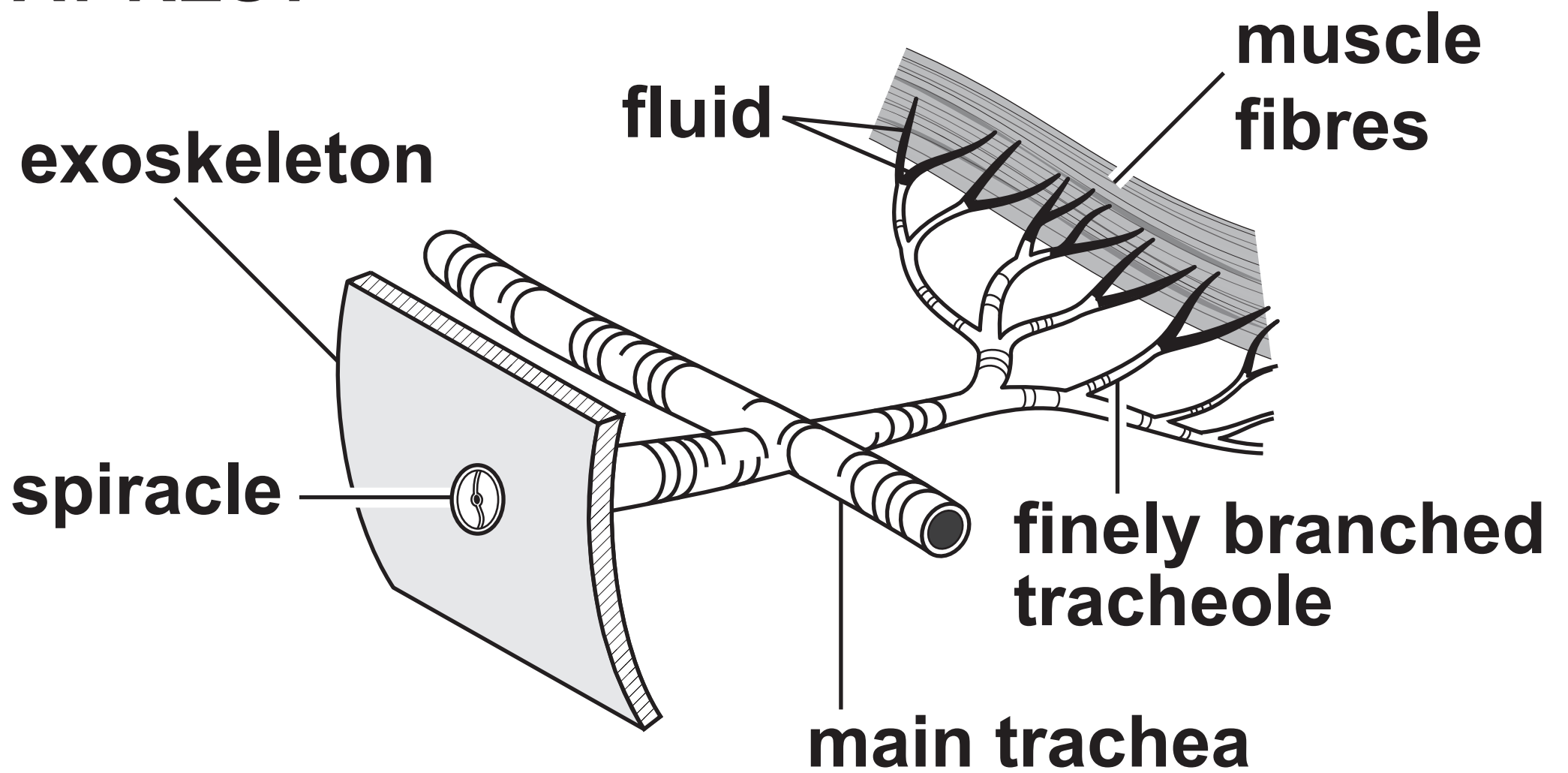


IMAGE 2.6

AT REST



DURING FLIGHT

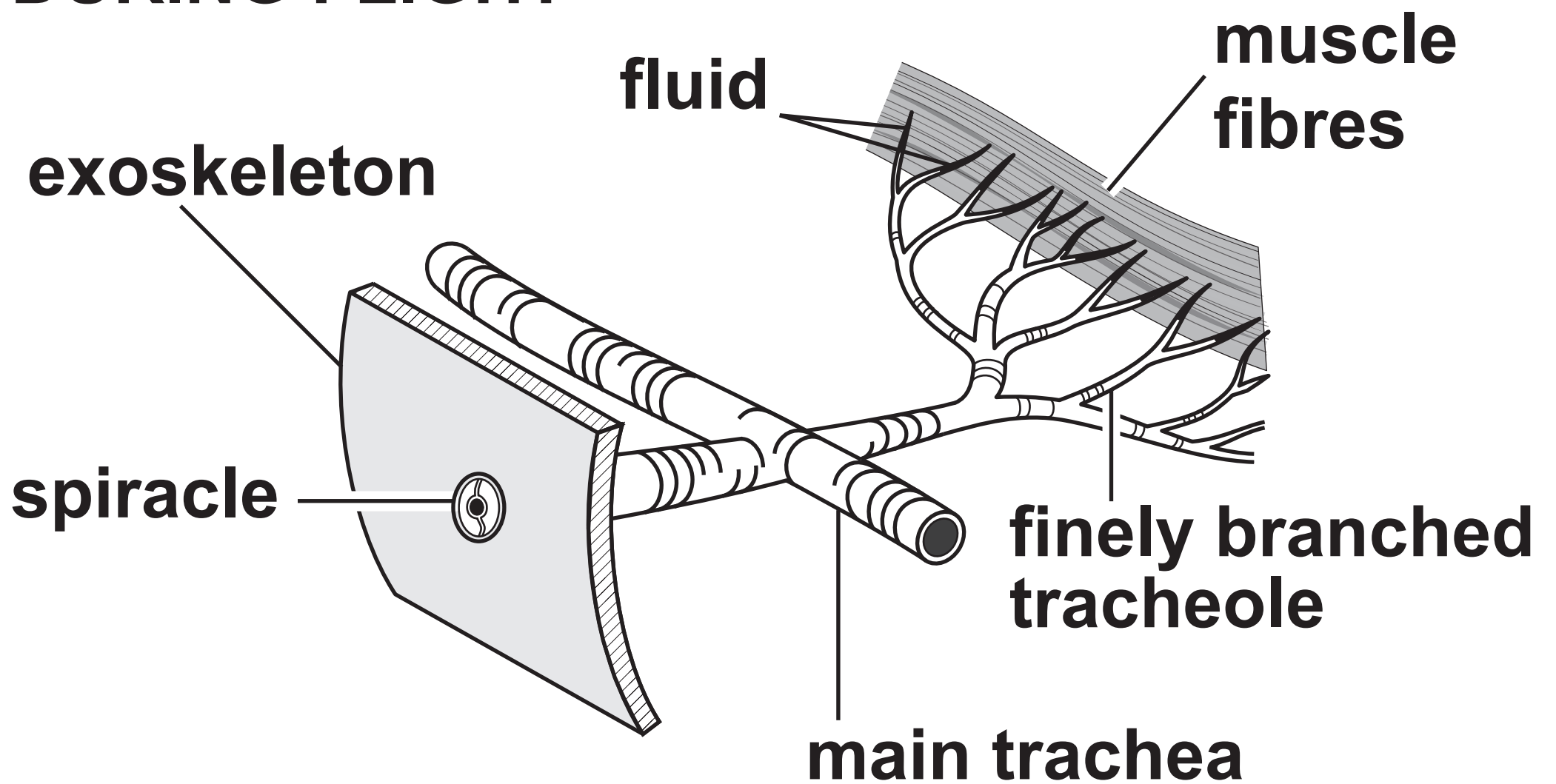
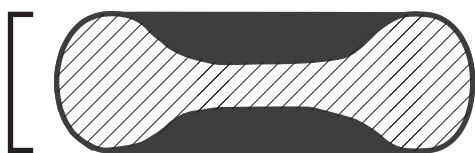


IMAGE 3.1

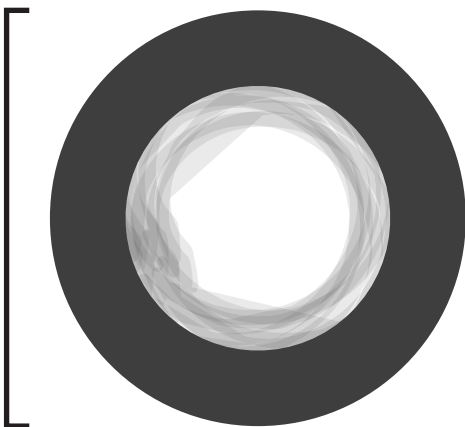
side view (cut)

top view

2•5 μm



7•5 μm



Question 3 (b)

- **5500 cm³ of blood in the body**
- **5 million erythrocytes per cm³ of blood**
- **2.7×10^8 haemoglobin molecules in one erythrocyte**
- **15 g of haemoglobin per 100 cm³ of blood.**

IMAGE 4.1

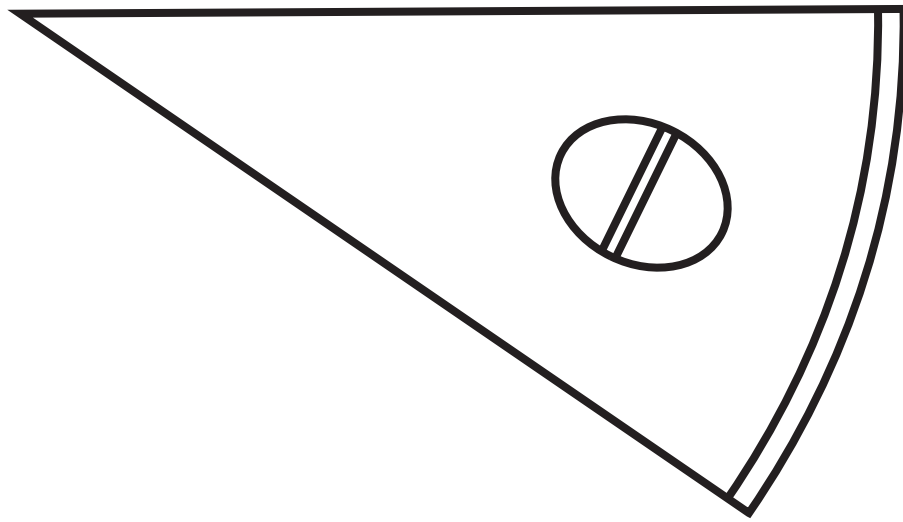


IMAGE 4.2

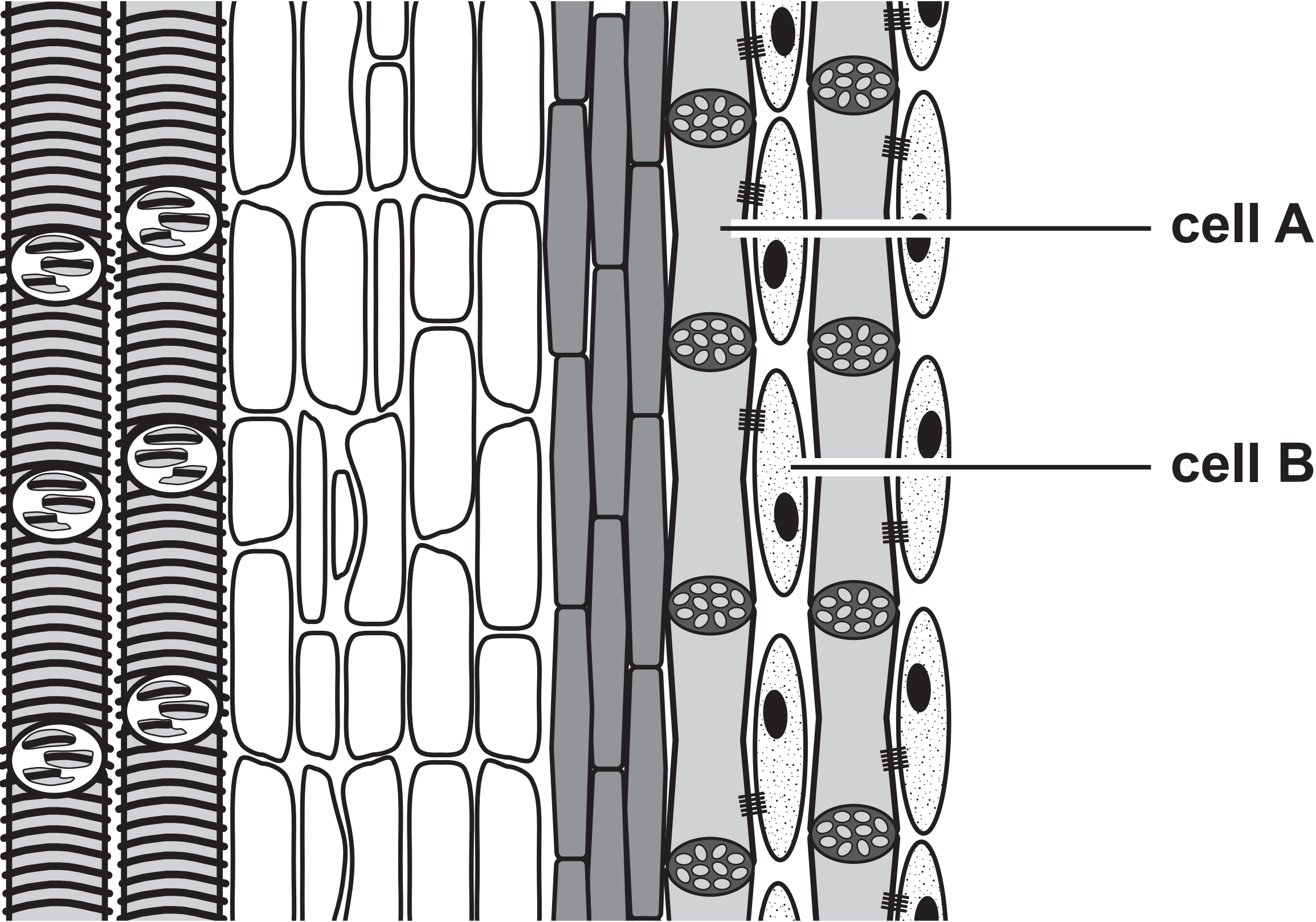


IMAGE 4.3

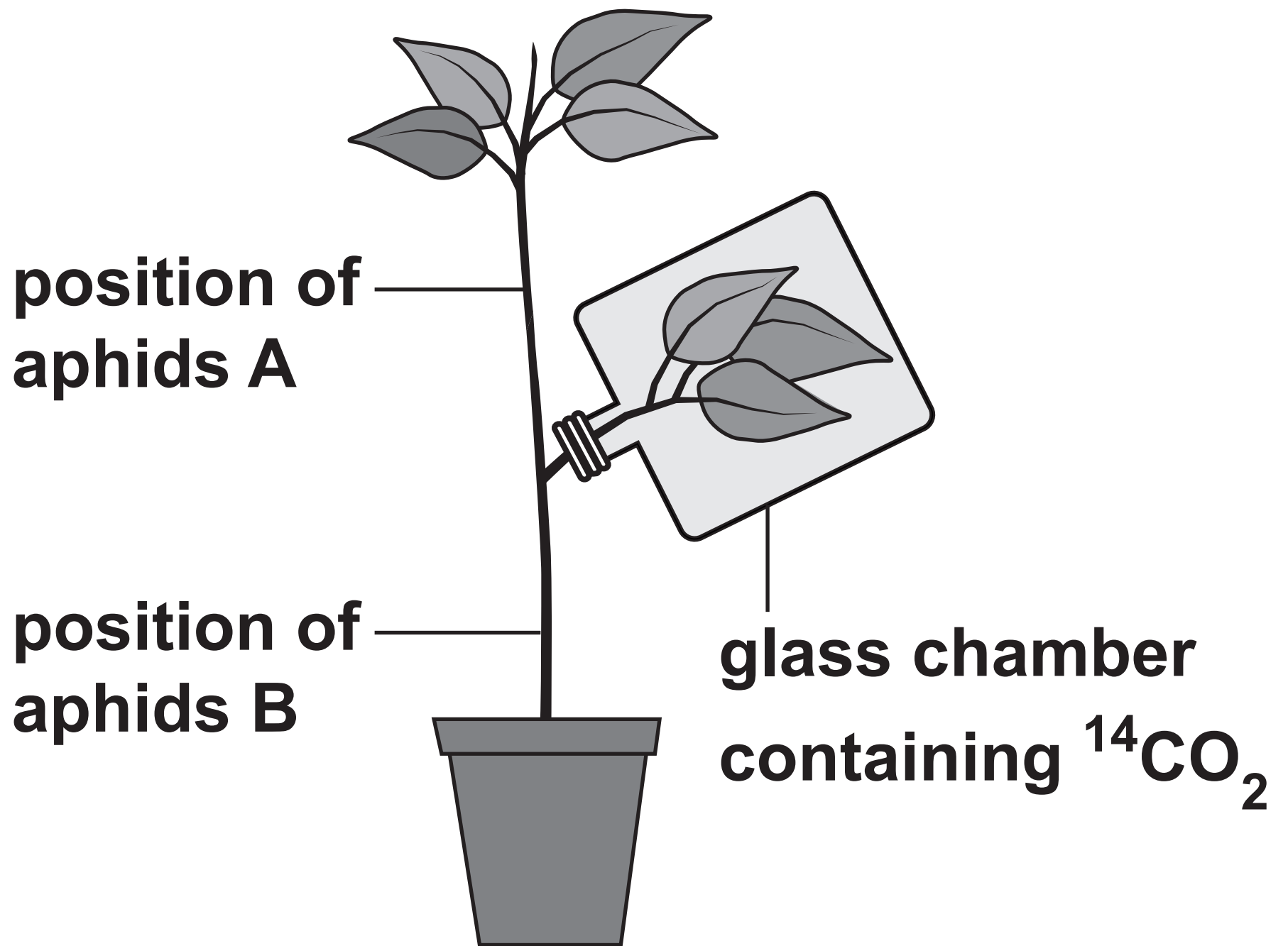


TABLE 4.4

Position of aphids	Distance of aphids from glass chamber / mm	Time taken for radioactivity to be detected / hours	Rate of phloem transport / mm hr⁻¹
A	15	1•1	13•6
B	15	1•9	_____

IMAGE 4.5

Late winter

Spring

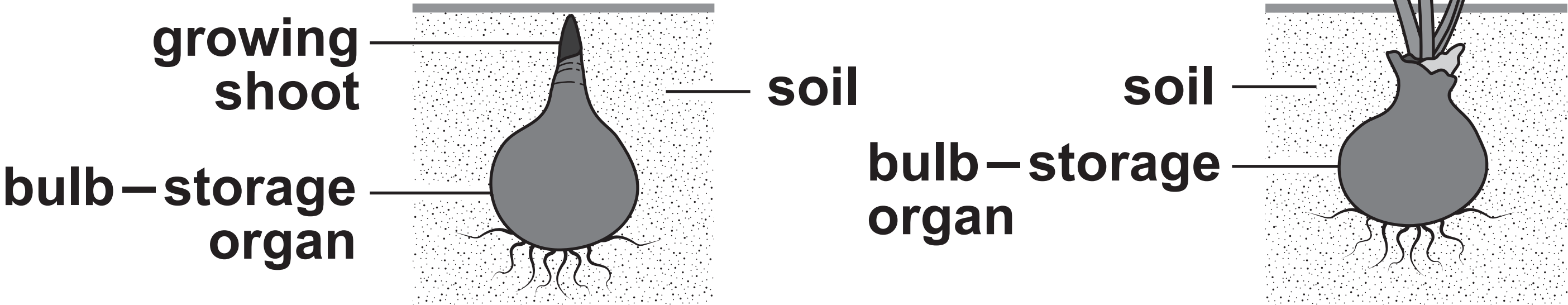


TABLE 5.1

Species	Number of organisms	
	Habitat A	Habitat B
Musk beetle	482	0
Shield bug	76	0
Wood ant	573	328
Flat – backed millipede	36	30
Harvestman spider	10	0
Fine – streaked bugkin	14	9

TABLE 5.2

Species	<i>n</i>	<i>(n – 1)</i>	<i>n(n – 1)</i>
Musk beetle	482	481	231 842
Shield bug	76	75	5700
Wood ant	573	572	327 756
Flat – backed millipede	36	35	1260
Harvestman spider	10	9	90
Fine – streaked bugkin	14	13	182
<i>N</i> =	_____	<i>Σn(n – 1)</i> =	_____
<i>N(N – 1)</i> =	_____		

Question 5 (b) (i)

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

Where;

n = the number of each organism found

N = the total number of organisms

Σ = sum of

D = _____

IMAGE 6.1

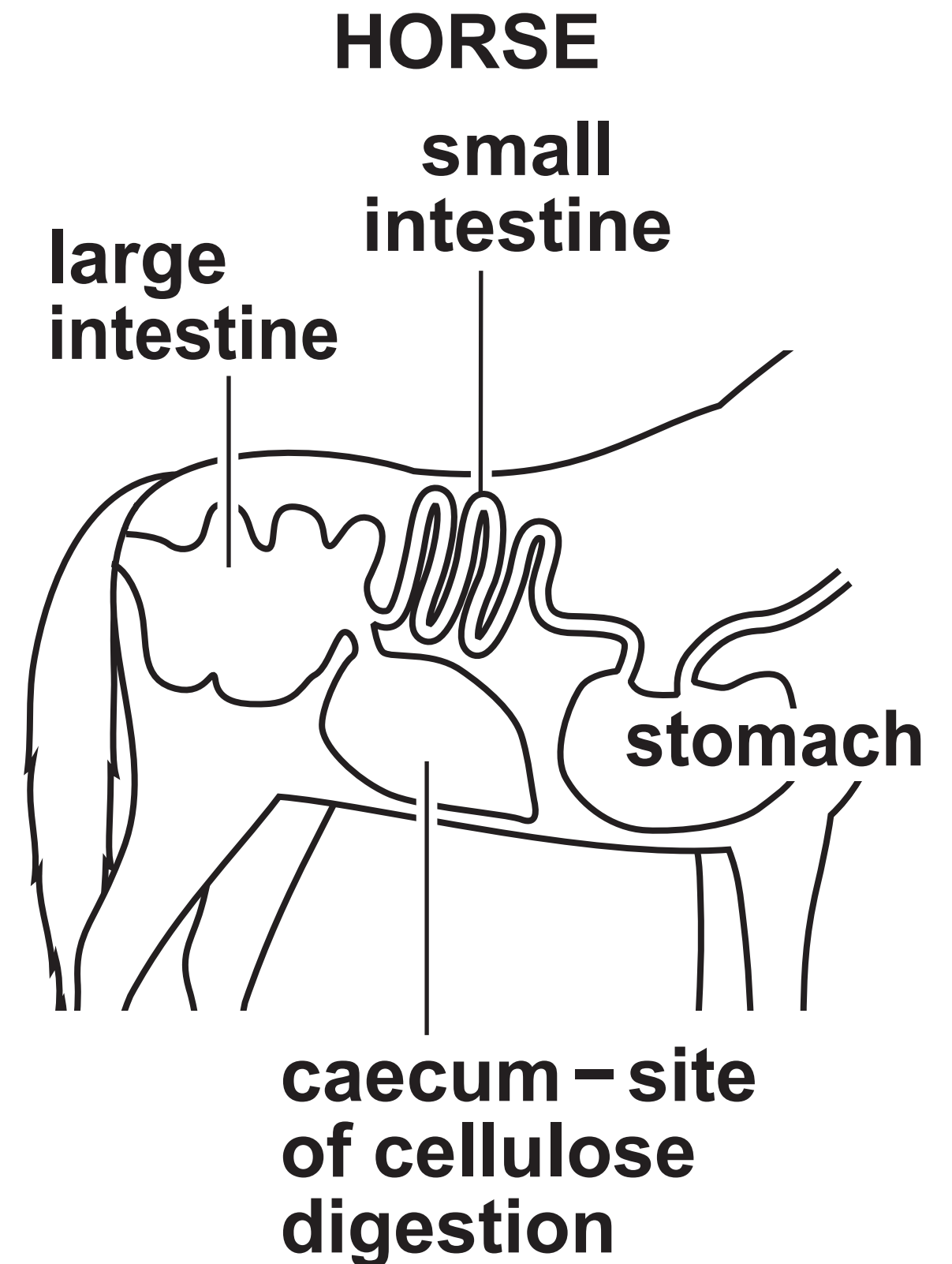
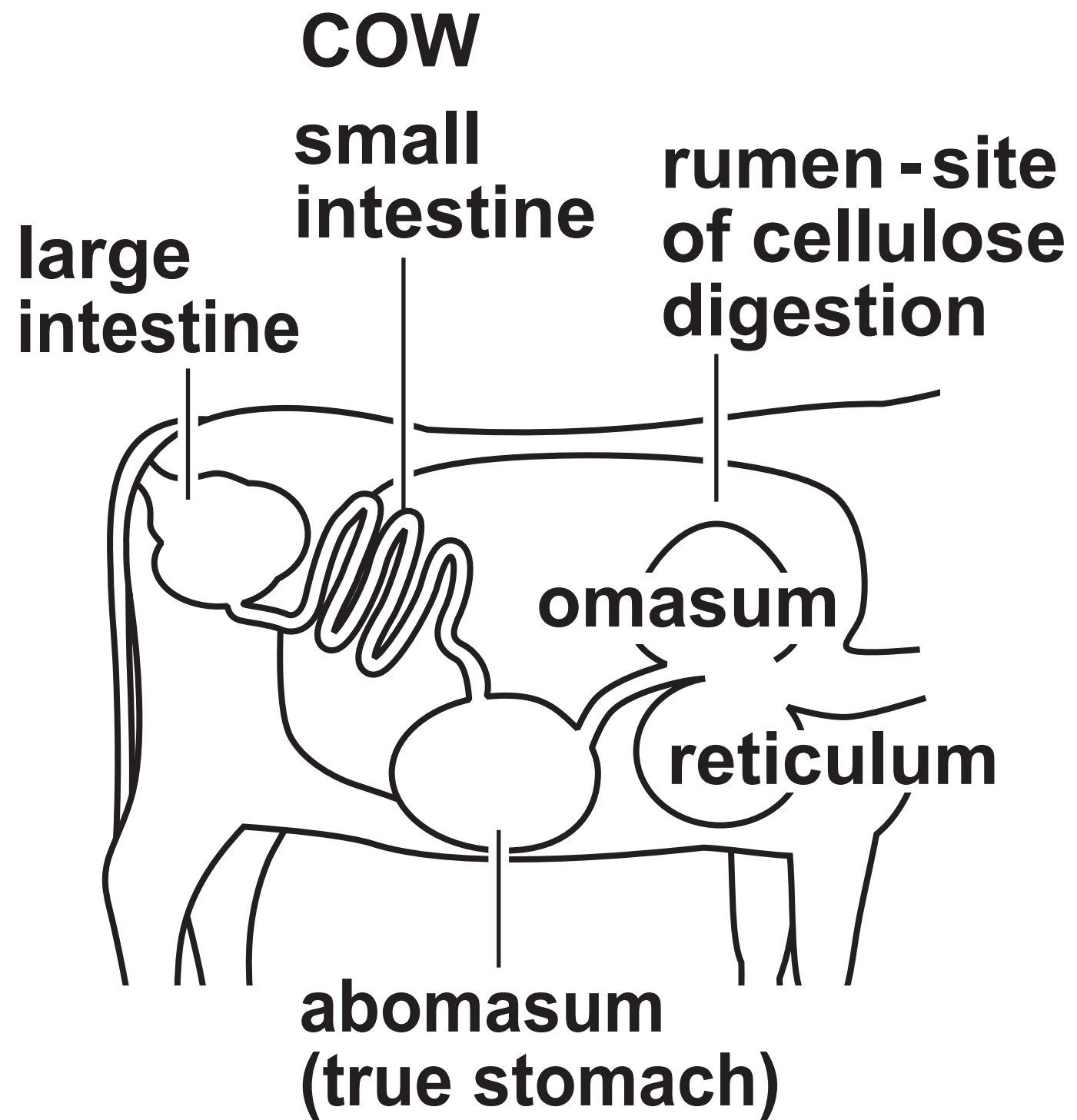


IMAGE 6.2

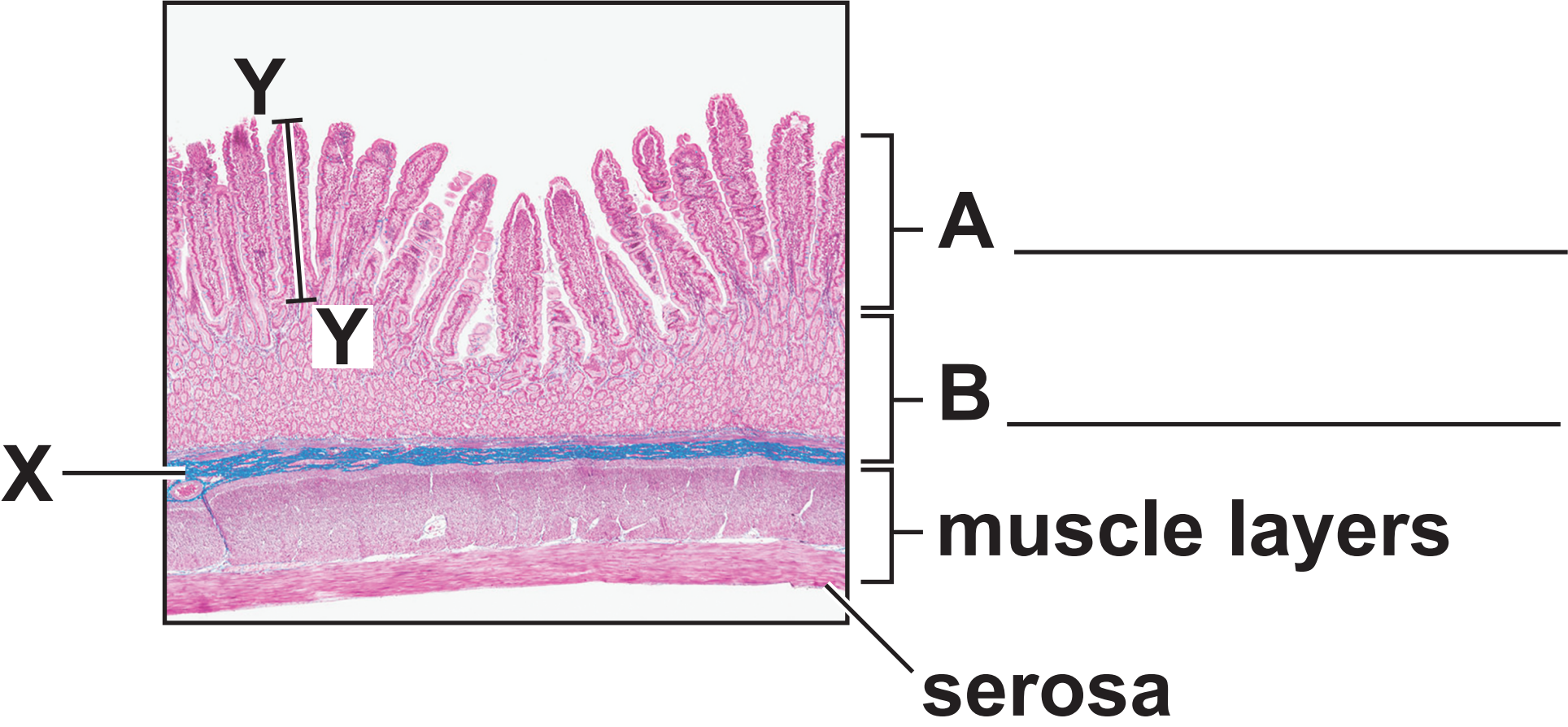
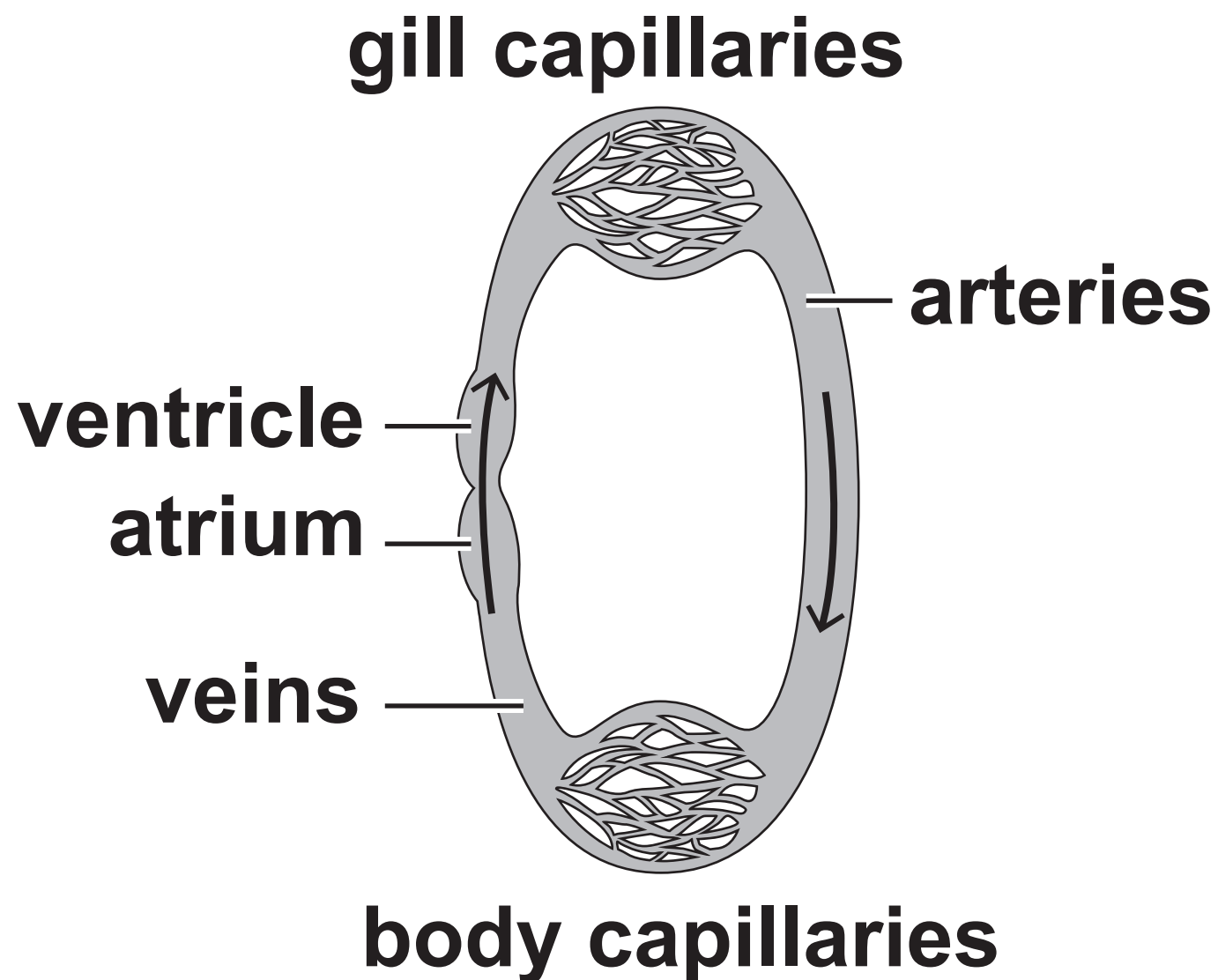


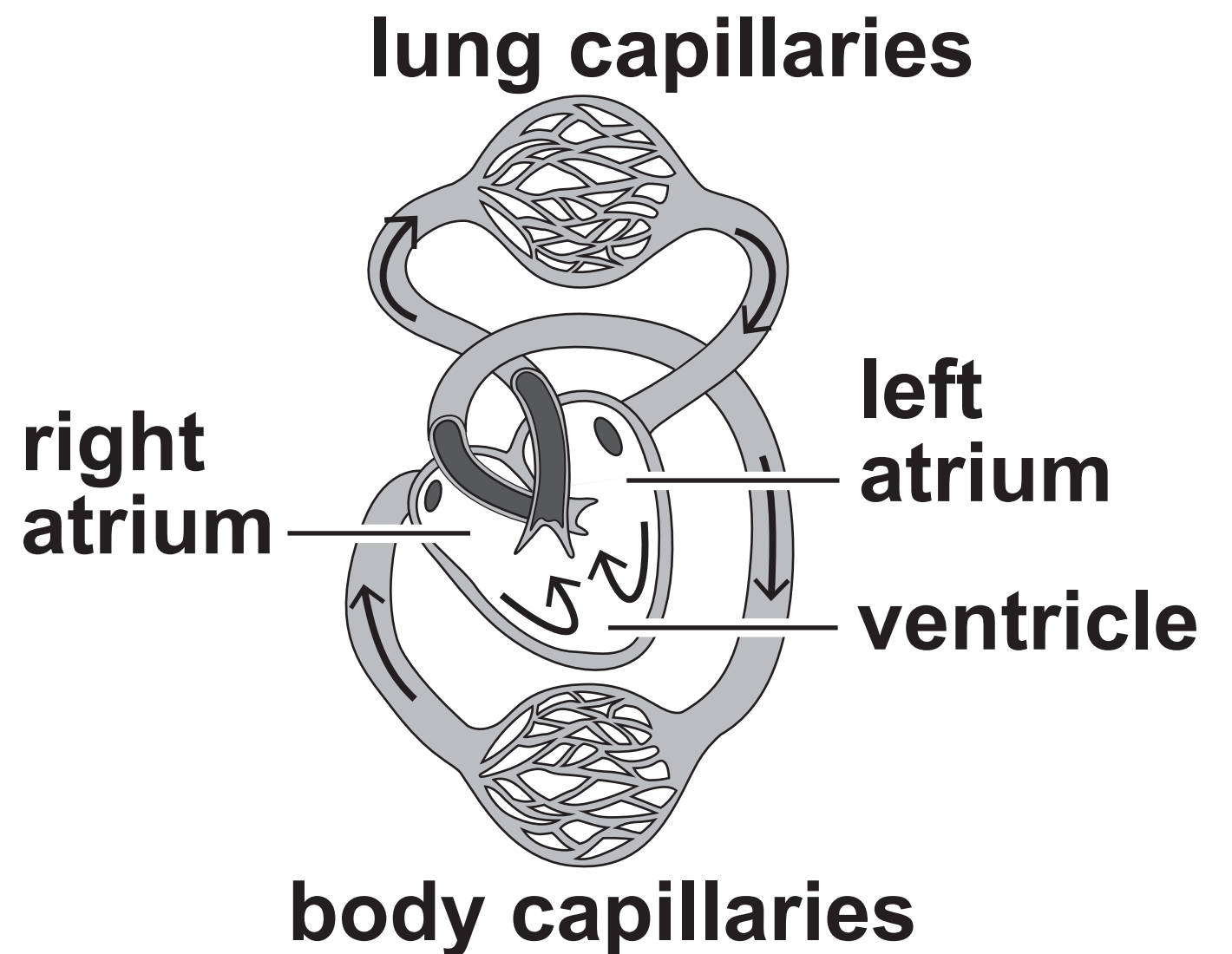
IMAGE 7
Diagram 1

Key: $\longrightarrow$ = direction of blood flow

A. FISH (2 chambers)



B. AMPHIBIANS (3 chambers)



continued on the next page . . .

IMAGE 7 continued

Diagram 2

Key: $\longrightarrow$ = direction of blood flow

C. MAMMALS (4 chambers)

lung capillaries

