



GCE A LEVEL



A400U30-1

WEDNESDAY, 21 JUNE 2023 – MORNING

BIOLOGY – A LEVEL COMPONENT 3

REQUIREMENTS FOR LIFE

2 hours plus your additional time allowance

Surname: _____

First name(s): _____

Centre Number: _____

Candidate Number: 2 _____

	For Examiner’s use only		
	Question	Maximum Mark	Mark Awarded
SECTION A	1.	9	
	2.	20	
	3.	19	
	4.	7	
	5.	16	
	6.	9	
SECTION B	Option	20	
	Total	100	

(Turn over)

ADDITIONAL MATERIALS

In addition to this paper, you will need 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.

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

This paper is in 2 sections, A and B.

Section A: 80 marks. Answer ALL questions.

You are advised to spend about 1 hour 35 minutes, plus your additional time allowance, on this section.

Section B: 20 marks. Options.

Answer ONE OPTION ONLY.

You are advised to spend about 25 minutes, plus your additional time allowance, on this section.

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.

SECTION A

ANSWER ALL QUESTIONS

- 1. (a) The mammalian kidney is an organ which is involved in homeostasis.**

Define the following terms.

(i) Organ

[1 mark]

(ii) Homeostasis

[1 mark]

continued on the next page . . .

(Turn over)

Question 1 continued

1. (b) Look at IMAGE 1.1 for Question 1 (b) in the separate Diagram Booklet.

IMAGE 1.1 shows a section of kidney cortex that has been viewed using a $\times 40$ objective lens. The microscope used was fitted with an eyepiece graticule.

Identify cell type **A**, structure **B** and structure **C** on IMAGE 1.1

cell type **A** _____

structure **B** _____

structure **C** _____

[3 marks]

continued on the next page . . .

(Turn over)

Question 1 continued

1. (c) Look at IMAGE 1.2 for Question 1 (c) in the separate Diagram Booklet.

A stage micrometer can be used to calibrate an eyepiece graticule.

IMAGE 1.2 shows part of a stage micrometer viewed using a $\times 40$ objective.

- (i) Calibrate the microscope using IMAGE 1.2 (1 stage micrometer division = 0.01 mm).

SHOW ALL YOUR WORKING.

GIVE YOUR ANSWER IN μm .

Space for working:

One eyepiece unit = _____ μm

[2 marks]

continued on the next page . . .

(Turn over)

Question 1 (c) continued

1. (c) (ii) I. Use the eyepiece graticule in
IMAGE 1.1 to determine the
diameter of the glomerulus in
EYEPIECE UNITS.

Space for working:

Diameter = _____ eyepiece units
[1 mark]

continued on the next page . . .

(Turn over)

Question 1 (c) (ii) continued

1. (c) (ii) II. Use your calibration of the microscope to calculate the actual diameter of the glomerulus in μm .

Space for working:

Diameter of glomerulus = _____ μm

[1 mark]

(Total for Question 1 = 9 marks)

(Turn over)

2. A student investigated the numbers of stomata in ivy leaves (*HEDERA HELIX*). Leaves of a similar size were taken from ivy plants growing on two different trees, one grown in full sun and another in shade. Clear nail varnish was used to make a lower epidermal impression from the leaf.

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

IMAGE 2.1 shows an ivy leaf and an impression of the lower epidermis viewed using a microscope with a $\times 40$ objective lens.

continued on the next page . . .

Question 2 continued

Nail varnish impressions from ten ivy leaves grown in full sun and ten ivy leaves grown in shade were used to estimate the number of stomata in a field of view for plants grown in each condition.

Look at TABLE 2.2 for Question 2 in the separate Diagram Booklet.

TABLE 2.2 shows the number of stomata in a field of view for each leaf.

(a) (i) State the following for this investigation:

the independent variable;

the dependent variable;

[1 mark]

continued on the next page . . .

(Turn over)

Question 2 (a) continued

- 2. (a) (ii) State TWO variables that were controlled in this investigation.**

[2 marks]

- (iii) State TWO ways in which the student could improve the reliability of the results.**

[2 marks]

continued on the next page . . .

(Turn over)

Question 2 continued

- 2. (b) Student's t – test was used to compare the means of the two samples. The null hypothesis was stated as:**

‘there was no significant difference between the mean numbers of stomata per field of view found in ivy leaves grown in the shade and in full sun’.

Look at TABLE 2.3 and the key for Question 2 (b) in the separate Diagram Booklet.

TABLE 2.3 shows the calculation of the variance for these data.

continued on the next page . . .

Question 2 (b) continued

2. (b) (i) Calculate the value of t for these data using the formula:

$$t = \frac{(\bar{x}_1 - \bar{x}_2)}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

$t =$ _____

[3 marks]

continued on the next page . . .

(Turn over)

Question 2 (b) continued

2. (b) (ii) Look at TABLE 2.4 for Question 2 (b) (ii) in the separate Diagram Booklet.

Compare your calculated value for t with the figures in TABLE 2.4 at the 5% level of probability, where the degrees of freedom $= (n_1 - 1) + (n_2 - 1)$

Explain whether you would accept or reject the null hypothesis and give your final conclusion.

[4 marks]

continued on the next page . . .

(Turn over)

Question 2 continued

- 2. (c) Global atmospheric carbon dioxide concentrations have increased by approximately $60 \mu\text{mol mol}^{-1}$ over the past 200 years. Studies on eight species of plants collected over this period have shown that the increase in carbon dioxide concentrations has resulted in a 40% reduction in stomatal density.**

- (i) Suggest why the increased carbon dioxide concentration resulted in a reduction in stomatal density.**

[3 marks]

2. (c) (ii) Look at IMAGE 2.5 for
Question 2 (c) (ii) in the separate
Diagram Booklet.

A diagram of a stomata from a leaf
of grass is shown in IMAGE 2.5

Use your knowledge of stomatal
opening mechanisms to explain how
the stomata in IMAGE 2.5 are opened.

(Turn over)

[5 marks]

(Total for Question 2 = 20 marks)

(Turn over)

3. (a) Major changes take place in the circulatory system in humans at birth.

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

A diagram of the foetal heart and associated blood vessels is shown in IMAGE 3.1

- (i) During foetal development there is a hole between the right and left sides of the heart as shown by X in IMAGE 3.1

Suggest why this hole is open during foetal development.

[3 marks]

3. (a) (ii) Shortly after birth, this hole closes.
If this hole does not close after birth
the individual would have symptoms
of fatigue.
Suggest why these symptoms occur.

[2 marks]

continued on the next page . . .

(Turn over)

Question 3 continued

3. (b) Vessel Y in IMAGE 3.1 is called the ductus arteriosus. It is open in the foetus but closes at birth.

(i) Give the names of vessels A and B shown in IMAGE 3.1 which are connected by the ductus arteriosus.

A _____

B _____

[1 mark]

continued on the next page . . .

(Turn over)

Question 3 (b) continued

- 3. (b) (ii) In some humans the ductus arteriosus is not closed after birth.**

Explain why this condition can result in the production of excess fluid in the lung tissue.

[2 marks]

continued on the next page . . .

(Turn over)

Question 3 continued

- 3. (c) A respiratory surface is defined as the part of the organism where gaseous exchange takes place between the external air or water and the internal tissues.**

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

Complete TABLE 3.2 to state the main respiratory surface of each organism.

[2 marks]

continued on the next page . . .

Question 3 continued

- 3. (d) Many organisms use haemoglobin to transport oxygen from the respiratory surface to the tissues.**

Look at TABLE 3.3 for Question 3 (d) in the separate Diagram Booklet.

There are three different types of haemoglobin molecules that can be found in normal adult humans. Each consists of a combination of polypeptide chains, α , β , γ and δ , as shown in TABLE 3.3

- (i) State the name given to the structure of a protein which is made from different polypeptide chains linked together.**

[1 mark]

continued on the next page . . .

(Turn over)

Question 3 (d) continued

- 3. (d) (ii) Use TABLE 3.3 to suggest the minimum number of genes that are involved in the production of haemoglobin.**

[1 mark]

- (e) Look at GRAPH 3.4 for Question 3 (e) in the separate Diagram Booklet.**

The oxygen dissociation curves for human foetal haemoglobin (HbF), adult haemoglobin (HbA) and the Tibetan wild yak (BOS MUTUS) are shown in GRAPH 3.4

continued on the next page . . .

(Turn over)

Question 3 (e) continued

- 3. (e) (i) Explain the position of the oxygen dissociation curve of foetal haemoglobin relative to that of adult haemoglobin.**

[2 marks]

continued on the next page . . .

(Turn over)

Question 3 (e) continued

- 3. (e) (ii) Look at IMAGE 3.5 for Question 3 (e) (ii) in the separate Diagram Booklet.**

The Tibetan wild yak shown in IMAGE 3.5 lives at high altitudes, between 4000 m – 6000 m.

Very few mammals can live at these altitudes.

Use GRAPH 3.4 to explain how Tibetan wild yak haemoglobin is an adaptation for living at high altitude.

[2 marks]

continued on the next page . . .

(Turn over)

Question 3 (e) continued

- 3. (e) (iii) Suggest ONE disadvantage of the position of the Tibetan wild yak dissociation curve.**

[1 mark]

continued on the next page . . .

(Turn over)

Question 3 (e) continued

- 3. (e) (iv) In their natural habitat the breathing rate of Tibetan wild yaks is much higher than that of humans living at sea level.**

Explain the difference in the rate of breathing.

[2 marks]

(Total for Question 3 = 19 marks)

(Turn over)

4. In an adult human, approximately 180 dm^3 of fluid is filtered from the glomeruli into the Bowman's capsules per day. As the filtrate moves along the proximal convoluted tubules (PCT) some substances are selectively reabsorbed. By the time the filtrate has reached the end of the proximal convoluted tubules 70% of the water has been reabsorbed.

Look at GRAPH 4.1 for Question 4 in the separate Diagram Booklet.

GRAPH 4.1 shows the change in the tubular filtrate to plasma ratio due to the reabsorption of water.

continued on the next page . . .

Question 4 continued

4. (a) Explain the change in tubular filtrate to plasma ratios for:

(i) glucose and amino acids;

[2 marks]

(ii) urea.

[2 marks]

continued on the next page . . .

(Turn over)

Question 4 continued

- 4. (b) Non – polar molecules, such as the insecticide DDT, are fat soluble and diffuse through the cell membranes of the cells in the PCT.**

Suggest why more of these molecules diffuse through the cells into the blood at the terminal end of the PCT.

[1 mark]

continued on the next page . . .

(Turn over)

Question 4 continued

- 4. (c) People with uncontrolled Type 1 diabetes have high concentrations of blood glucose. This results in high concentrations of glucose in the glomerular filtrate. Not all of the glucose can be reabsorbed, resulting in the loss of glucose in the urine.**

Use your knowledge of the transport of glucose to explain why not all the glucose can be reabsorbed.

[2 marks]

(Total for Question 4 = 7 marks)

(Turn over)

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

IMAGE 5.1 shows part of an axon and a synapse. The figures indicate the potential difference across the membrane between the cytoplasm of the axon and the extracellular fluid at intervals along the axon.

- (a) DRAW AN ARROW to indicate ONE region of the axon in IMAGE 5.1 where an action potential is taking place. Explain your choice.

[2 marks]

continued on the next page . . .

(Turn over)

Question 5 continued

- 5. (b) The nerve impulse is prevented from travelling in the opposite direction to that shown in IMAGE 5.1**

Use IMAGE 5.1 to give TWO pieces of evidence to explain this.

[2 marks]

continued on the next page . . .

(Turn over)

Question 5 continued

- 5. (c) Look at IMAGE 5.2 for Question 5 (c) in the separate Diagram Booklet.**

The electron micrograph in IMAGE 5.2 shows a transverse section along the line marked A – B on IMAGE 5.1

- (i) Identify cell P and structures Q and R.**

cell P _____

structure Q _____

structure R _____

[2 marks]

continued on the next page . . .

(Turn over)

Question 5 (c) continued

- 5. (c) (ii) Explain what would happen to the rate of transmission of the nerve impulse if structure **R** was not present.**

[2 marks]

continued on the next page . . .

(Turn over)

Question 5 (c) continued

- 5. (c) (iii) Look at the table for Question 5 (c) (iii) in the separate Diagram Booklet.**

COMPLETE THE TABLE to state and explain TWO other factors which affect the speed of conduction of the nerve impulse.

[2 marks]

continued on the next page . . .

Question 5 continued

- 5. (d) Look at IMAGE 5.3 for Question 5 (d) in the separate Diagram Booklet.**

Diagrams of two neurones X and Y, associated with the same postsynaptic neurone, are shown in IMAGE 5.3

In the diagram:

- An action potential passing along neurone X causes the impulse to pass across the synapse and an action potential to be generated in the postsynaptic neurone.**
- The neurotransmitter substance in the synaptic vesicles in neurone Y is gamma aminobutyric acid (GABA).**

continued on the next page . . .

Question 5 (d) continued

- When GABA is released it binds to receptors on the postsynaptic membrane. This causes chloride ions (Cl^-) to enter the post synaptic neurone and potassium ion (K^+) to leave the post synaptic neurone.
- This is an example of an inhibitory synapse.

If the inhibitory synapse of Y is activated first, neurone X does not generate an action potential in the postsynaptic neurone.

Use all the information given to suggest an explanation for this.

[4 marks]

continued on the next page . . .

(Turn over)

Question 5 continued

- 5. (e) Some organophosphates block the active site of the enzyme acetylcholinesterase that breaks down the neurotransmitter acetylcholine.**

Suggest why the presence of organophosphates in a synapse can result in continuous stimulation of the postsynaptic cell.

[2 marks]

(Total for Question 5 = 16 marks)

(Turn over)

6. AMOEBA is a unicellular organism, whilst HYDRA is an example of a multicellular organism that shows an increased level of adaptation for the digestion and absorption of food material.

Both AMOEBA and HYDRA show holozoic nutrition.

Look at IMAGE 6.1 for Question 6 in the separate Diagram Booklet.

IMAGE 6.1 shows the process of holozoic nutrition in AMOEBA.

Look at IMAGE 6.2A and IMAGE 6.2B for Question 6 in the separate Diagram Booklet.

IMAGE 6.2A shows HYDRA ingesting a worm and IMAGE 6.2B is a diagram of its body wall.

continued on the next page . . .

Question 6 continued

Use IMAGE 6.1 to describe how AMOEBA ingests, digests and egests food material.

Use IMAGE 6.2A AND IMAGE 6.2B to describe and explain how HYDRA is adapted for digestion and absorption.

Humans also show holozoic nutrition and have a tube gut. Describe how the presence of a tube gut enables humans to have a more efficient digestive system.

(Total for Question 6 = 9 marks)

(Turn over)

SECTION B: OPTIONAL TOPICS

Option A: IMMUNOLOGY AND DISEASE

☐

**Option B: HUMAN MUSCULOSKELETAL
ANATOMY**

☐

**Option C: NEUROBIOLOGY AND
BEHAVIOUR**

☐

Answer the question on ONE TOPIC ONLY.

Place a tick (✓) in one of the boxes above, to show which topic you are answering.

**YOU ARE ADVISED TO SPEND ABOUT 25 MINUTES
ON THIS SECTION.**

(Turn over)

Option A: IMMUNOLOGY AND DISEASE

- 7. Tuberculosis (TB) is an endemic disease in the UK.**

Look at GRAPH 7.1 for Question 7 in the separate Diagram Booklet.

GRAPH 7.1 shows the incidence of TB per 100 000 people in the UK between 1920 and 2020.

- (a) (i) State the meaning of the term endemic.**

[1 mark]

continued on the next page . . .

(Turn over)

Question 7 (a) continued

- 7. (a) (ii) The incidence is expressed as cases per 100 000 population and not as the total number of cases in the population. Explain why.**

[2 marks]

continued on the next page . . .

(Turn over)

Question 7 (a) continued

- 7. (a) (iii) Using GRAPH 7.1, calculate the percentage of the people diagnosed with TB who died from the disease in 2020.**

Space for working:

Percentage = _____

[2 marks]

continued on the next page . . .

(Turn over)

Question 7 (a) continued

- 7. (a) (iv) In 1920 approximately 40% of those diagnosed with TB died from the disease. It is thought that the actual percentage of deaths resulting from TB in 1920 may have been lower than 40%. Suggest why the actual percentage of deaths may have been lower.**

[1 mark]

continued on the next page . . .

(Turn over)

Question 7 continued

- 7. (b) Although TB can be treated with antibiotics, many strains of the bacterium are resistant to antibiotics which are water soluble.**

Rifampicin is one antibiotic which is effective against MYCOBACTERIUM TUBERCULOSIS. An investigation was carried out into the solubility of rifampicin in a range of different solvents.

The solvents used in the investigation included three non – polar solvents and three polar solvents.

Look at GRAPH for Question 7 (b) in the separate Diagram Booklet.

GRAPH 7.2 shows the results of the investigation.

continued on the next page . . .

Question 7 (b) continued

All strains of M. TUBERCULOSIS have a thick, hydrophobic envelope surrounding the cell which prevents water soluble compounds from entering the cell.

- (i) Use GRAPH 7.2 to explain why rifampicin is effective against M. TUBERCULOSIS.**

[2 marks]

continued on the next page . . .

(Turn over)

Question 7 (b) continued

- 7. (b) (ii) Rifampicin is a broad – spectrum, bactericidal antibiotic.**

State what is meant by the terms:

I. broad – spectrum;

[1 mark]

II. bactericidal.

[1 mark]

continued on the next page . . .

(Turn over)

Question 7 (b) continued

- 7. (b) (iii) Rifampicin works by inhibiting bacterial RNA polymerase enzyme, preventing transcription from taking place.**

Explain how rifampicin would affect M. TUBERCULOSIS.

[3 marks]

continued on the next page . . .

(Turn over)

Question 7 continued

- 7. (c) The most widely used vaccine against TB is the BCG vaccine. The vaccine is prepared with a live, attenuated form of MYCOBACTERIUM BOVIS. M. BOVIS is closely related to M. TUBERCULOSIS.**

Look at IMAGE 7.3 for Question 7 (c) in the separate Diagram Booklet.

IMAGE 7.3 shows a cross – section through the skin of a person receiving the vaccination.

The vaccine is administered by an injection below the epidermis of the skin (intradermal injection).

continued on the next page . . .

Question 7 (c) continued

- 7. (c) (i) To be effective the injection must penetrate the epidermis layer of the skin.
Explain why.**

[2 marks]

continued on the next page . . .

(Turn over)

Question 7 (c) continued

- 7. (c) (ii) Describe how injecting the vaccine would result in antibody production.**

[3 marks]

continued on the next page . . .

(Turn over)

Question 7 (c) continued

- 7. (c) (iii) There may be concerns regarding the use of a live vaccine. Suggest what these concerns may be and give a suitable alternative to a live vaccine.**

[2 marks]

(Total for Question 7 = 20 marks)

(Turn over)

Option B: HUMAN MUSCULOSKELETAL ANATOMY

- 8. Look at IMAGE 8.1 for Question 8
in the separate Diagram Booklet.**

**Osteoporosis is a progressive condition
where the bone mineral density reduces
over time. If it is not treated, osteoporosis
can lead to postural changes as shown in
IMAGE 8.1**

- (a) (i) The postural changes that can
occur in later life with osteoporosis
sometimes cause breathing
difficulties in sufferers.
Use IMAGE 8.1 to suggest why people
with these postural changes may
have difficulty breathing.**
-
-
-
-

[2 marks]

continued on the next page . . .

(Turn over)

Question 8 (a) continued

- 8. (a) (ii) Regular exercise is recommended as a precaution against the development of osteoporosis.**

Look at GRAPH 8.2 for Question 8 (a) (ii) in the separate Diagram Booklet.

GRAPH 8.2 shows how bone mineral density changes with age and level of activity.

A person is considered to have osteoporosis when bone mineral density falls below the fracture threshold. This means that the person is likely to suffer a fracture.

Use GRAPH 8.2 to conclude the effect of increased levels of activity on the development of osteoporosis by the age of 80 years.

[2 marks]

8. (a) (iii) Suggest TWO factors that should be kept constant when selecting candidates for the study.

[2 marks]

continued on the next page . . .

(Turn over)

Question 8 continued

- 8. (b) Look at IMAGE 8.3 for Question 8 (b) in the separate Diagram Booklet.**

A common fracture in osteoporosis sufferers is a fracture of the wrist as shown in IMAGE 8.3

Identify the type of fracture AND the bones involved in the wrist fracture shown in IMAGE 8.3

Describe ONE possible course of treatment required.

[3 marks]

(Turn over)

Question 8 continued

- 8. (c) Look at IMAGE 8.4 for Question 8 (c) in the separate Diagram Booklet.**

Studies have shown that load bearing exercises give the greatest benefit in preventing osteoporosis. Repetitively lifting an object by flexing the elbow as shown in IMAGE 8.4, is an effective load bearing exercise that can easily be performed at home.

- (i) Name the order of lever shown in IMAGE 8.4**

[1 mark]

continued on the next page . . .

(Turn over)

Question 8 (c) continued

8. (c) (ii) In IMAGE 8.4 the elbow to hand distance is **36 cm** and elbow to biceps is **4 cm**. Use this information and the formula below to calculate the force required to lift a weight with a mass of **1.2 kg**. **GIVE YOUR ANSWER IN NEWTONS.**

$$F_e = F_1 \times \frac{D1}{D2}$$

Where:

F_e = force exerted by the effort

F_1 = mass (kg) $\times$ 9.8 N

$D1$ = distance from load to fulcrum

$D2$ = distance from effort to fulcrum

Force = _____ Newtons

[2 marks]

(Turn over)

Question 8 (c) continued

- 8. (c) (iii) The flexion and extension of the elbow involves antagonistic pairs of muscles which alternately contract and relax to flex and extend the elbow.**

Explain why the muscles of the upper arm are arranged in this way and how they work to produce movement at the elbow.

[4 marks]

(Turn over)

Question 8 continued

- 8. (d) Look at IMAGE 8.5 for Question 8 (d) in the separate Diagram Booklet.**

IMAGE 8.5 shows an electron micrograph of a transverse section through a single cell from a biceps muscle.

- (i) Name the type of muscle cell shown in IMAGE 8.5**

[1 mark]

- (ii) Identify the molecules labelled A and B in IMAGE 8.5**

A: _____

B: _____

[2 marks]

continued on the next page . . .

(Turn over)

Question 8 (d) continued

- 8. (d) (iii) Look at IMAGE 8.6 for Question 8 (d) (iii) in the separate Diagram Booklet.**

IMAGE 8.6 shows a longitudinal view of a single sarcomere.

Identify which of the three lines A, B or C drawn on IMAGE 8.6 best represents the region from where the cross section in IMAGE 8.5 was taken.

[1 mark]

(Total for Question 8 = 20 marks)

(Turn over)

Option C: NEUROBIOLOGY AND BEHAVIOUR

- 9. Look at IMAGE 9.1 for Question 9
in the separate Diagram Booklet.**

**IMAGE 9.1 is a photograph of a section through
the brain showing the right hemisphere.**

- (a) (i) Identify the structures labelled
A, B and C on IMAGE 9.1**

Label	Name of structure
A	
B	
C	

[2 marks]

continued on the next page . . .

(Turn over)

Question 9 (a) continued

- 9. (a) (ii) The symptoms of a patient who had suffered a brain injury included partial paralysis of the right arm and hand and the right side of the face. Conclude which hemisphere of the brain is likely to have been damaged and explain your reasoning.**

[2 marks]

continued on the next page . . .

(Turn over)

Question 9 continued

- 9. (b) Studies have demonstrated that patients who receive therapy following brain injuries can recover some of the original function of their limbs over time.**

Look at GRAPH 9.2 for Question 9 (b) in the separate Diagram Booklet.

GRAPH 9.2 shows the percentage rate of recovery of original limb function in patients with brain injury depending on how soon after the injury they received therapy.

continued on the next page . . .

Question 9 (b) continued

- 9. (b) (i) Use the data in GRAPH 9.2 to conclude how the number of months after injury before therapy started affected the improvement. Explain how the range bars increase confidence in the conclusions made.**

[2 marks]

continued on the next page . . .

(Turn over)

Question 9 (b) continued

- 9. (b) (ii) Explain how the brain can recover following a brain injury that destroys neural pathways.**

[2 marks]

continued on the next page . . .

(Turn over)

Question 9 (b) continued

- 9. (b) (iii) The data shown in GRAPH 9.2 were obtained by studying the recovery of many patients over an extended period.**

Suggest TWO factors that would have to be controlled when carrying out such a study.

[2 marks]

continued on the next page . . .

(Turn over)

Question 9 (b) continued

- 9. (b) (iv) During early childhood, the rate of formation of new synapses between neurones in the central nervous system in the healthy developing brain reaches its maximum.**

Look at GRAPH 9.3 for Question 9 (b) (iv) in the separate Diagram Booklet.

GRAPH 9.3 shows the rate of formation of synapses involved in sensory pathways and language development in early childhood.

Use GRAPH 9.3 to suggest why children who are not exposed to language between birth and four years of age are less likely to develop language skills.

[4 marks]

continued on the next page . . .

Question 9 continued

- 9. (c) Woodlice are common invertebrates which are often found under rotting wood in damp locations in gardens and woodland.**

Look at IMAGE 9.4 for Question 9 (c) in the separate Diagram Booklet.

IMAGE 9.4 shows an investigation into innate behaviour in woodlice.

Five woodlice were placed in separate Petri dishes on pieces of filter paper.

Each Petri dish was exposed to varying levels of light intensity. The distance travelled by each woodlouse in

20 seconds was recorded.

This distance was used to calculate the speed of movement.

continued on the next page . . .

Question 9 (c) continued

- 9. (c) (i) State the type of innate behaviour shown by the woodlice in this investigation.**

[1 mark]

- (ii) Look at TABLE 9.5 for Question 9 (c) (ii) in the separate Diagram Booklet.**

TABLE 9.5 shows the results of this investigation.

**Calculate the mean speed of the woodlice at 4 au light intensity
AND RECORD YOUR ANSWER IN
TABLE 9.5**

[1 mark]

continued on the next page . . .

(Turn over)

Question 9 (c) continued

- 9. (c) (iii) State the relationship between light intensity and mean speed of the woodlice in the investigation.**

[1 mark]

- (iv) Explain how this type of behaviour would benefit woodlice in their natural habitat.**

[1 mark]

continued on the next page . . .

(Turn over)

Question 9 (c) continued

- 9. (c) (v) Suggest how this method could be adapted to investigate the effect of humidity on the behaviour of the woodlice.**

[2 marks]

(Total for Question 9 = 20 marks)

END OF PAPER

TOTAL 100 MARKS

(Turn over)

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

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

[illegible]



GCE A LEVEL



A400U30-1

WEDNESDAY, 21 JUNE 2023 – MORNING

BIOLOGY – A LEVEL COMPONENT 3

REQUIREMENTS FOR LIFE

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

Diagram Booklet

Surname: _____

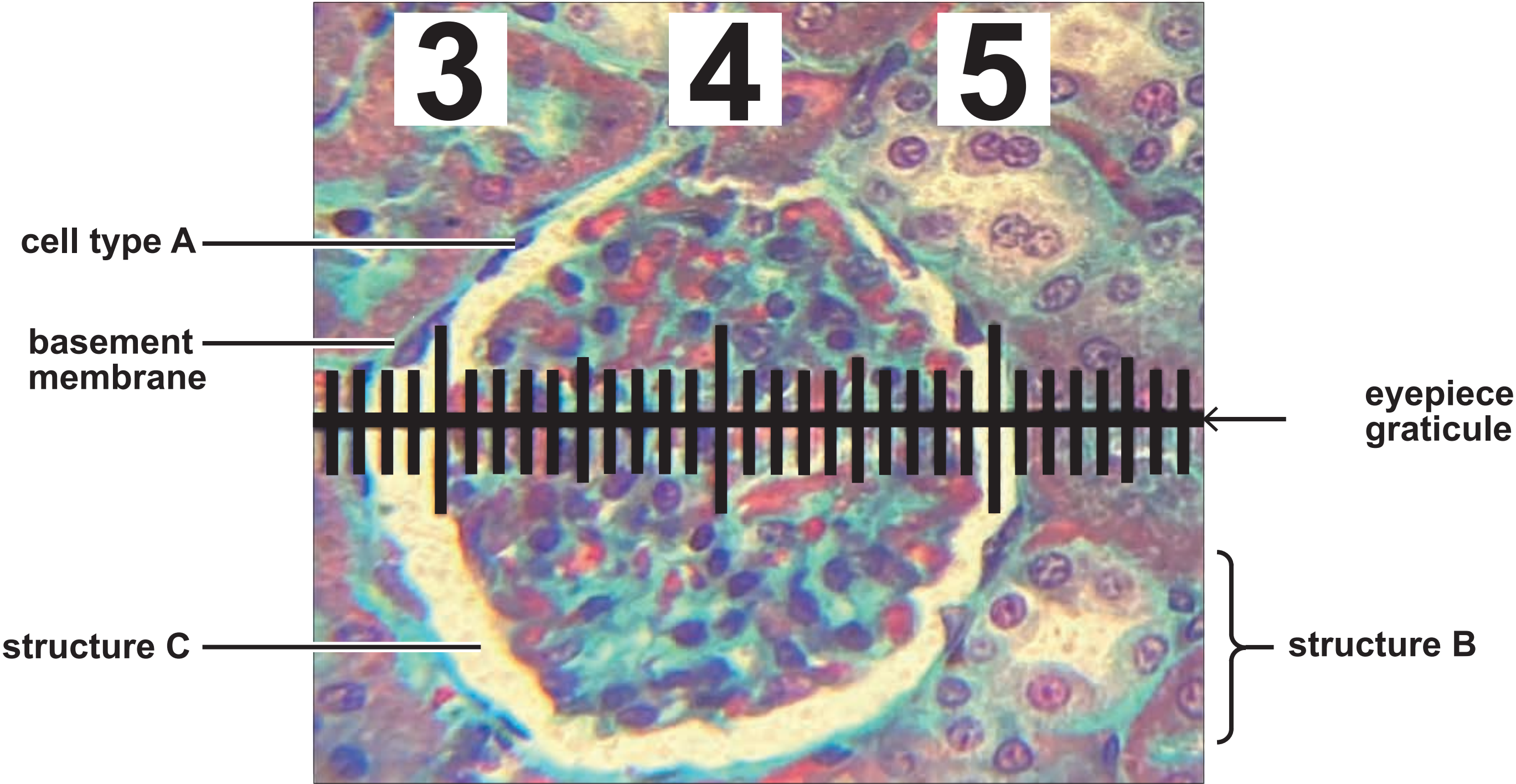
First name(s): _____

Centre Number: _____

Candidate Number: 2 _____

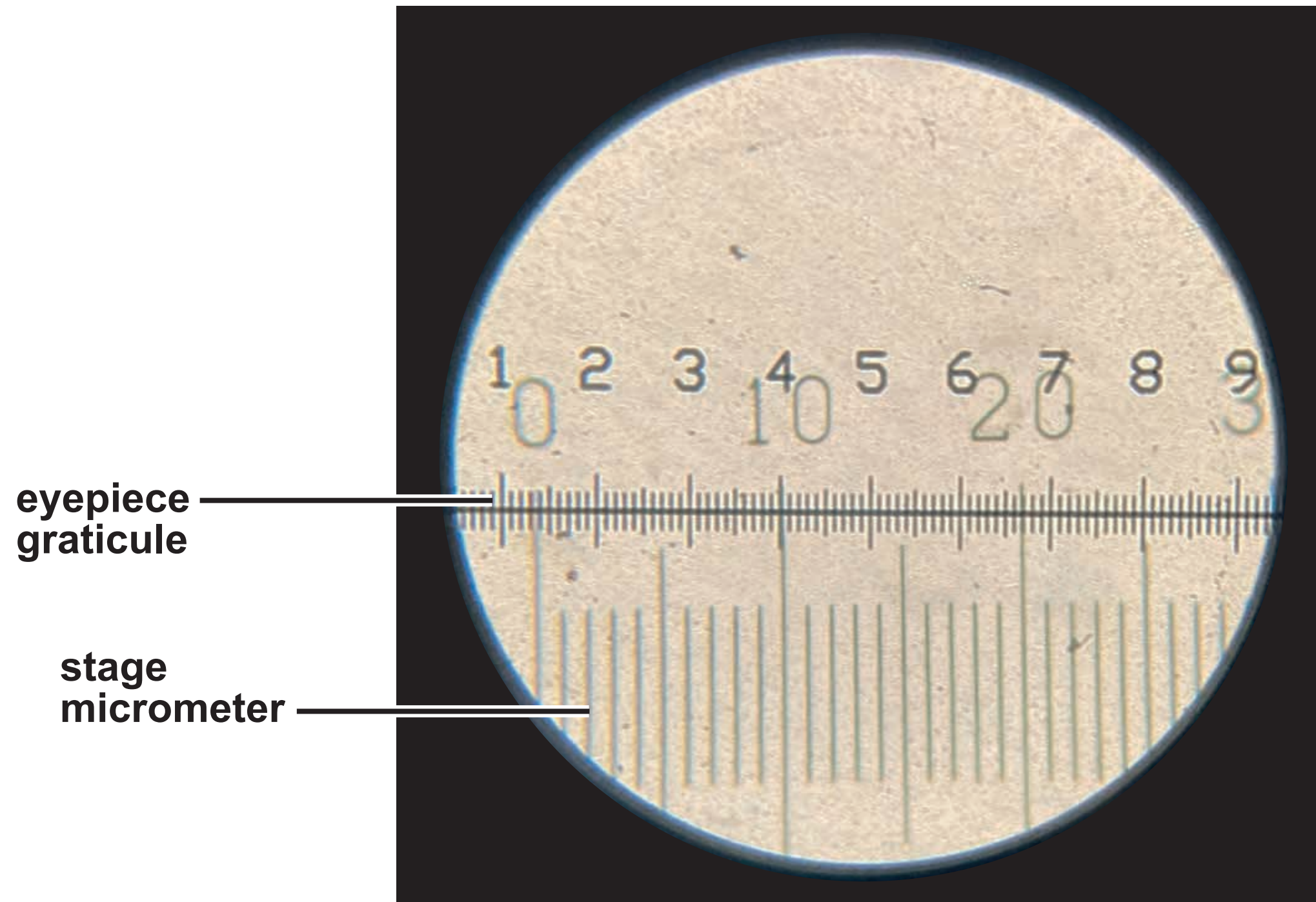
Question 1 (b)

IMAGE 1.1



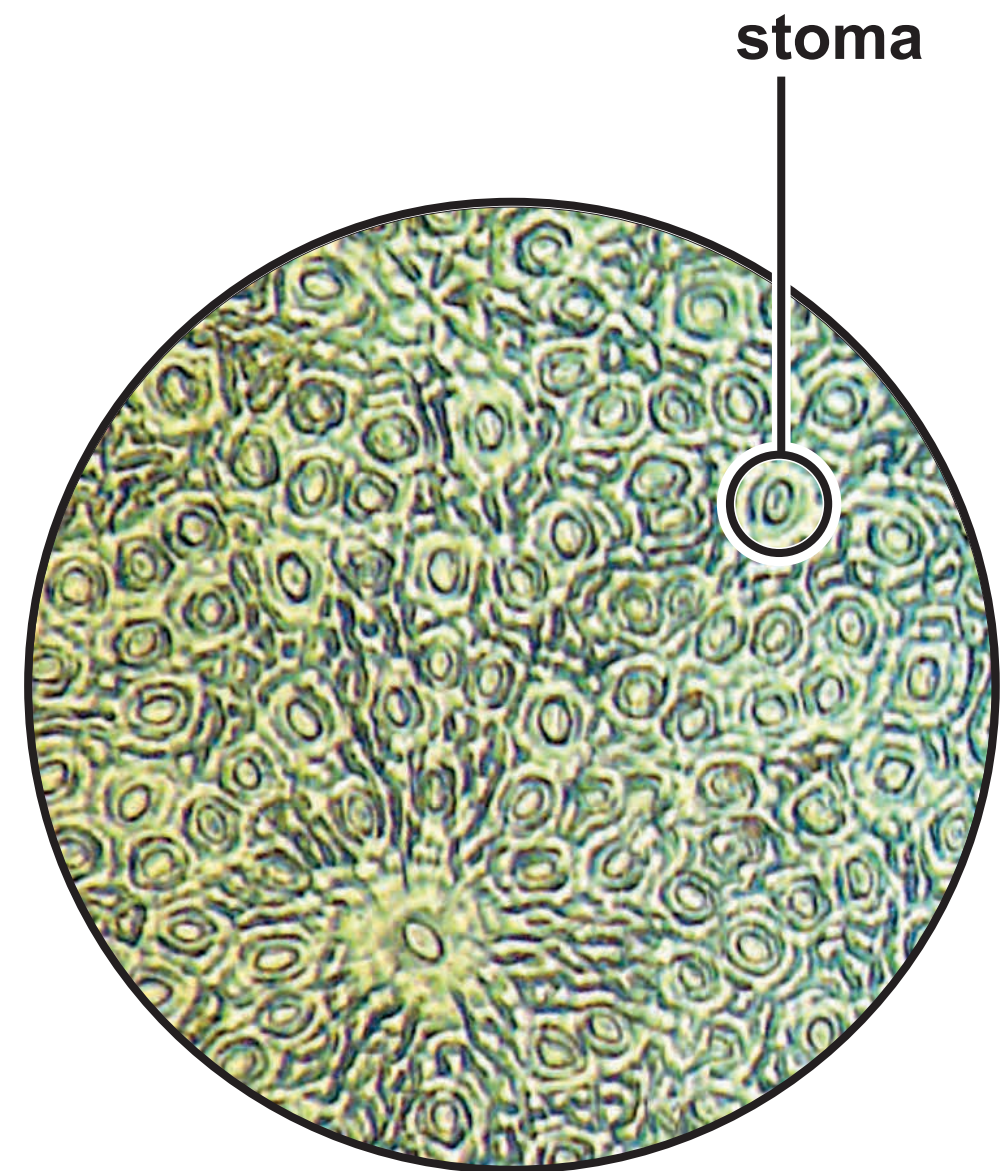
Question 1 (c)

IMAGE 1.2



Question 2

IMAGE 2.1



Question 2

TABLE 2.2

Number of stomata in a field of view from ivy leaves grown in full sun	Number of stomata in a field of view from ivy leaves grown in shade
45	23
40	24
42	30
38	32
36	27
38	28
40	32
35	28
45	22
41	24

Question 2 (b)

TABLE 2.3

Leaves grown in full sun			Leaves grown in shade		
Number of stomata in a field of view x_1	Deviation from mean $(\bar{x}_1 - x_1)$	Deviation from mean ² $(\bar{x}_1 - x_1)^2$	Number of stomata in a field of view x_2	Deviation from mean $(\bar{x}_2 - x_2)$	Deviation from mean ² $(\bar{x}_2 - x_2)^2$
45	- 5	25	23	4	16
40	0	0	24	3	9
42	- 2	4	30	- 3	9
38	2	4	32	- 5	25
36	4	16	27	0	0
38	2	4	28	- 1	1
40	0	0	32	- 5	25
35	5	25	28	- 1	1
45	- 5	25	22	5	25
41	- 1	1	24	3	9
$\bar{x}_1 = 40$		$\Sigma = 104$	$\bar{x}_2 = 27$		$\Sigma = 120$
		$s_1^2 = 11.6$			$s_2^2 = 13.3$

Question 2 (b)
Key for TABLE 2.3

For leaves grown in FULL SUN:

x_1 = the number of stomata in a field of view for each ivy leaf

$\bar{x}_1$ = mean number of stomata in a field of view for 10 ivy leaves

Σ = sum

s_1^2 = variance

n_1 = number of ivy leaves grown in full sun

For leaves grown in SHADE:

x_2 = the number of stomata in a field of view for each ivy leaf

$\bar{x}_2$ = mean number of stomata in a field of view for 10 ivy leaves

Σ = sum

s_2^2 = variance

n_2 = number of ivy leaves grown in shade

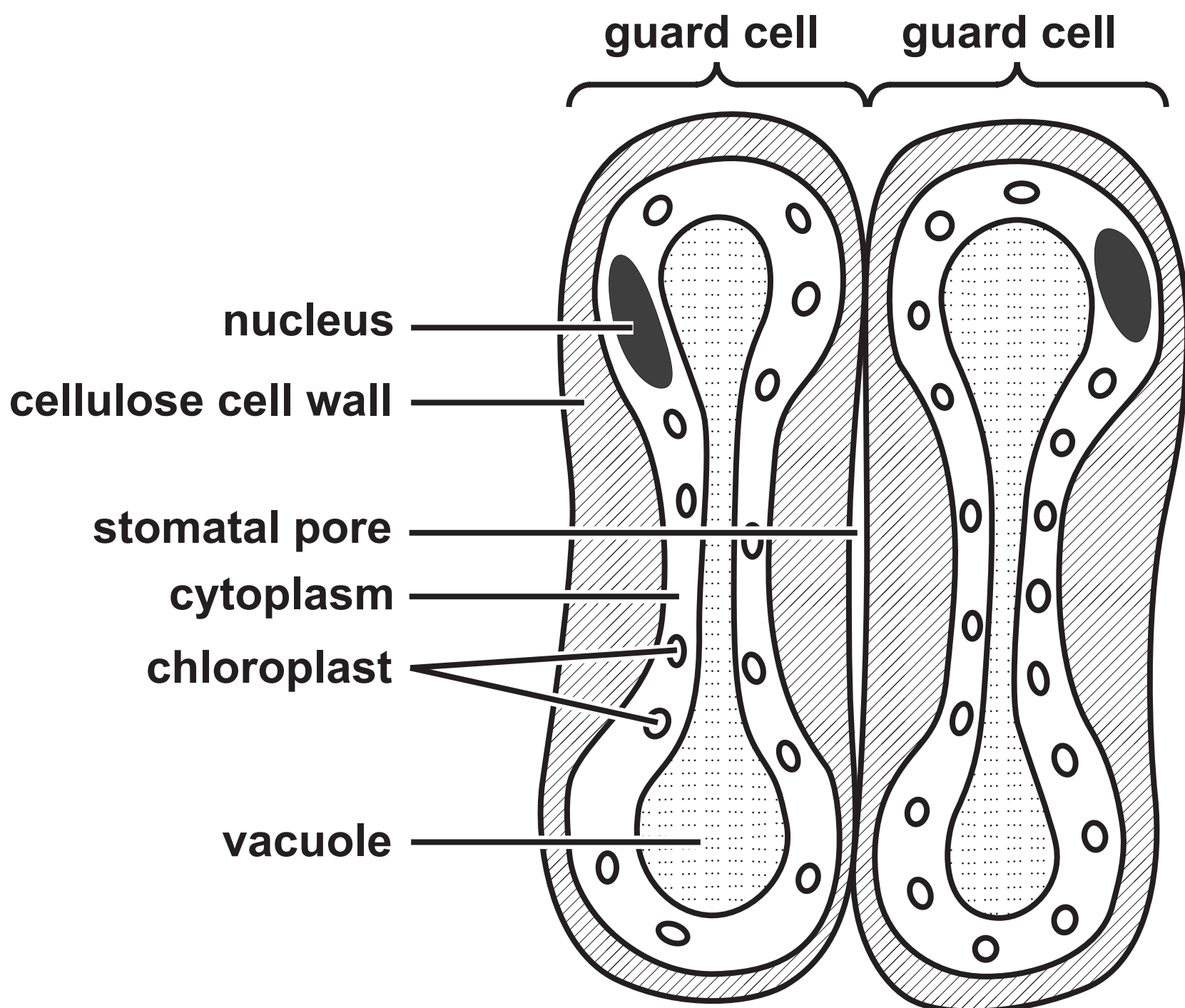
Question 2 (b) (ii)

TABLE 2.4

Degrees of freedom	Level of probability				
	1	0.5	0.1	0.05	0.02
15	0.000	0.691	1.753	2.131	2.602
16	0.000	0.690	1.748	2.120	2.583
17	0.000	0.689	1.740	2.110	2.567
18	0.000	0.688	1.734	2.101	2.552
19	0.000	0.688	1.729	2.093	2.539
20	0.000	0.687	1.725	2.086	2.528

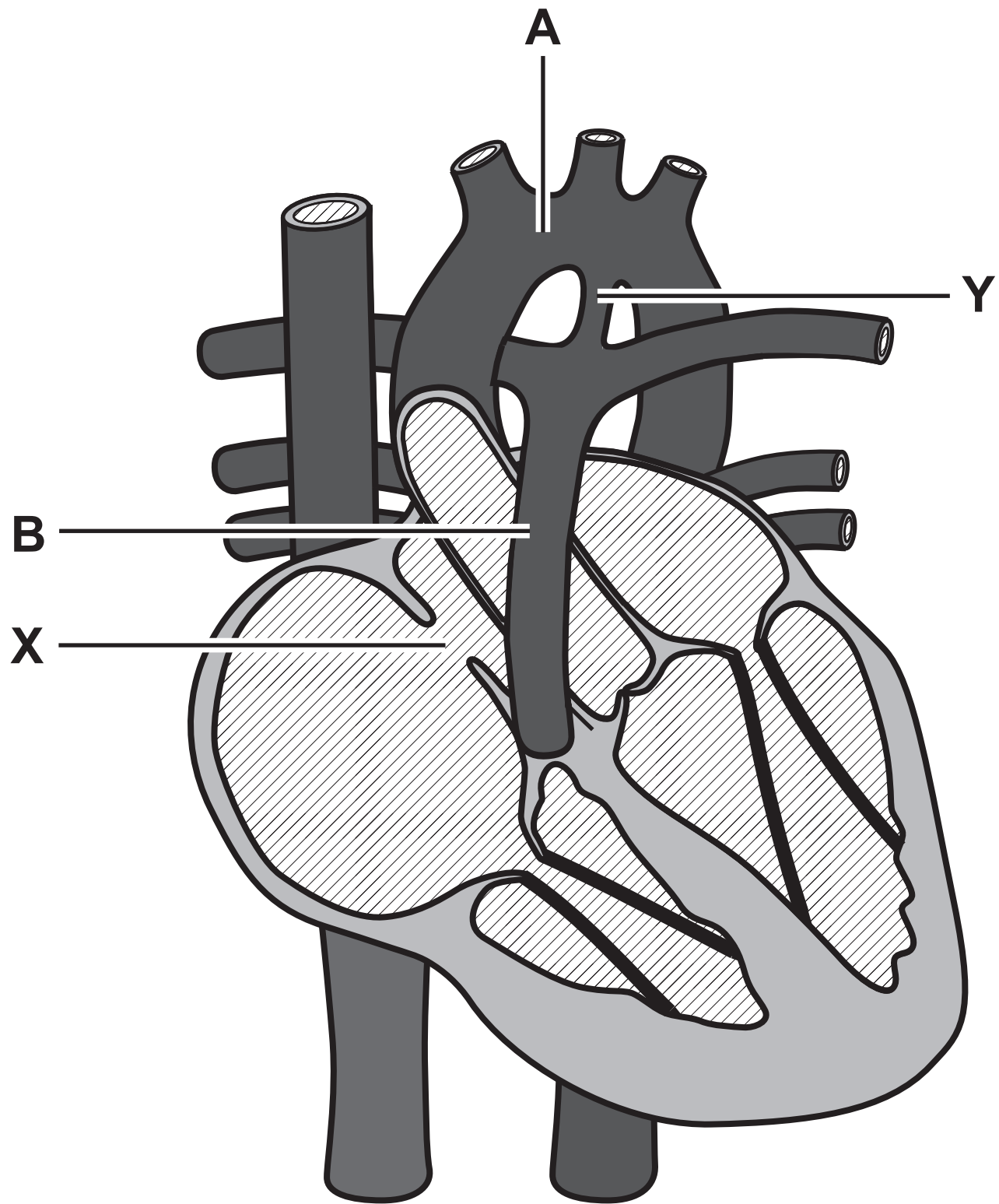
Question 2 (c) (ii)

IMAGE 2.5



Question 3 (a)

IMAGE 3.1



Question 3 (c)

TABLE 3.2

Organism	Main respiratory surface
Fish	
Mammal	
Earthworm	
Insect	

Question 3 (d)

TABLE 3.3

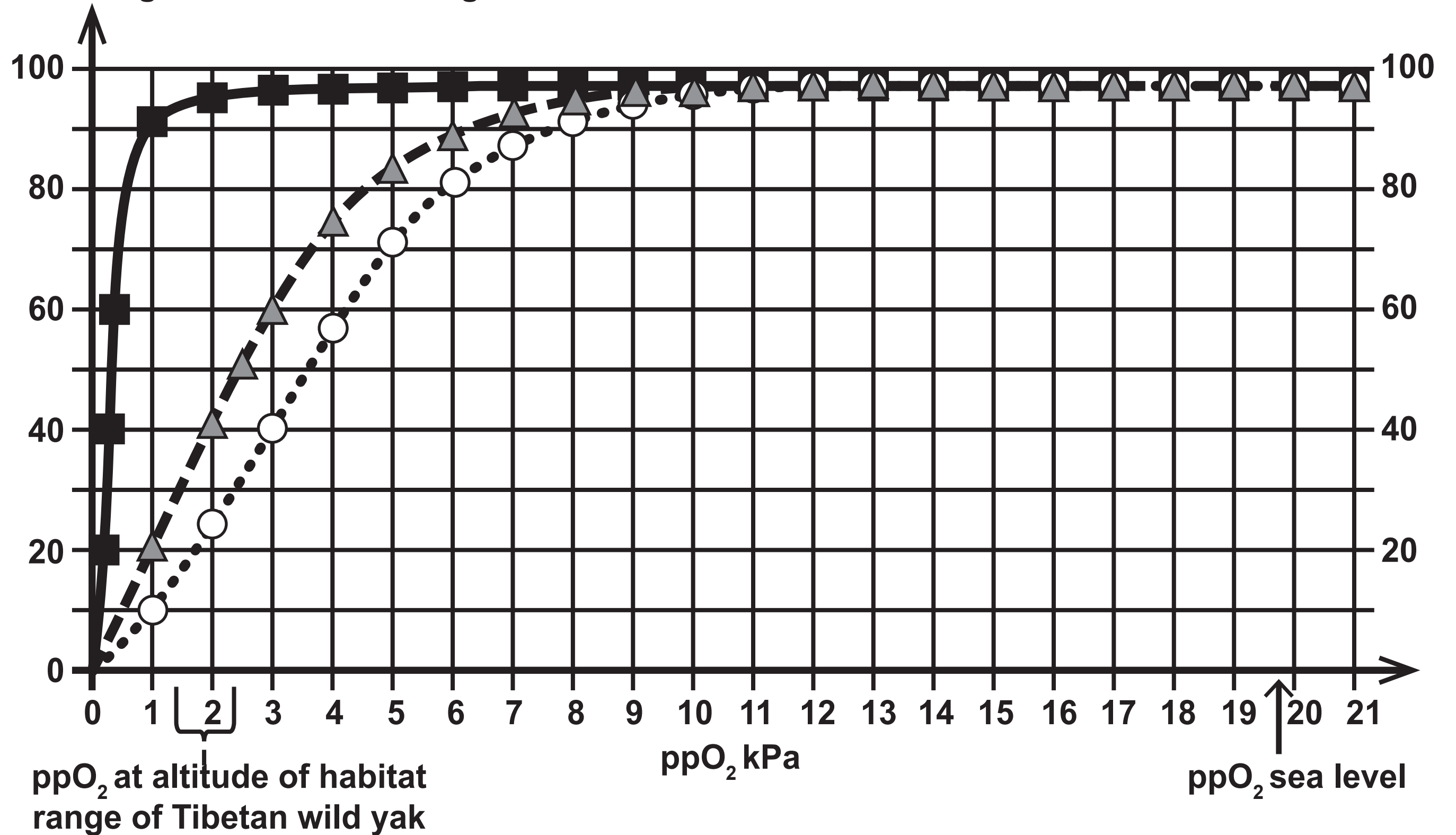
	Haemoglobin type		
	HbA	HbF	HbA ₂
Polypeptide type	2 α	2 α	2 α
	2 β	2 γ	2 δ

Question 3 (e)

GRAPH 3.4

Key:  = Tibetan wild yak  = human foetal  = adult human

Percentage saturation haemoglobin



Question 3 (e) (ii)

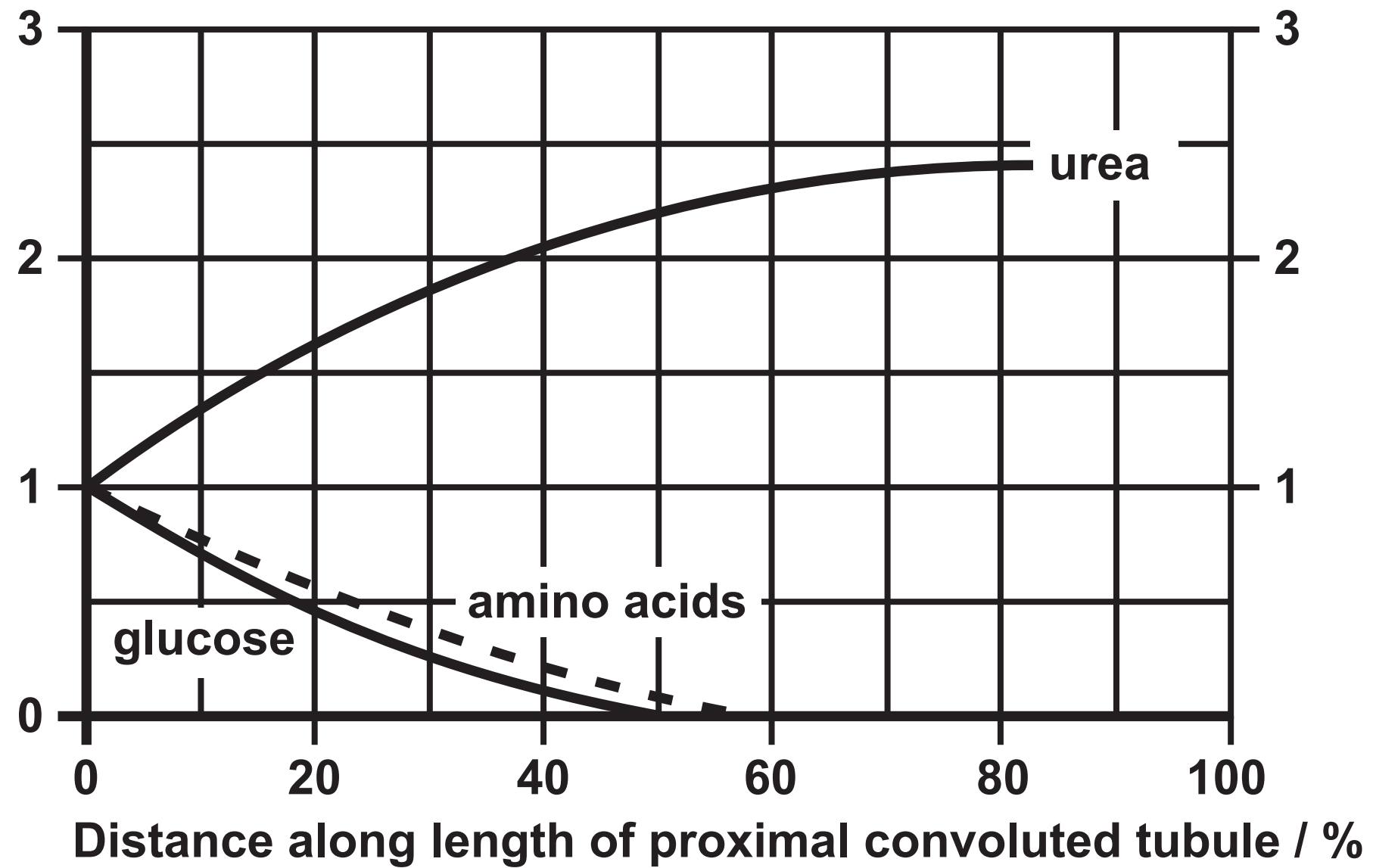
IMAGE 3.5



Question 4

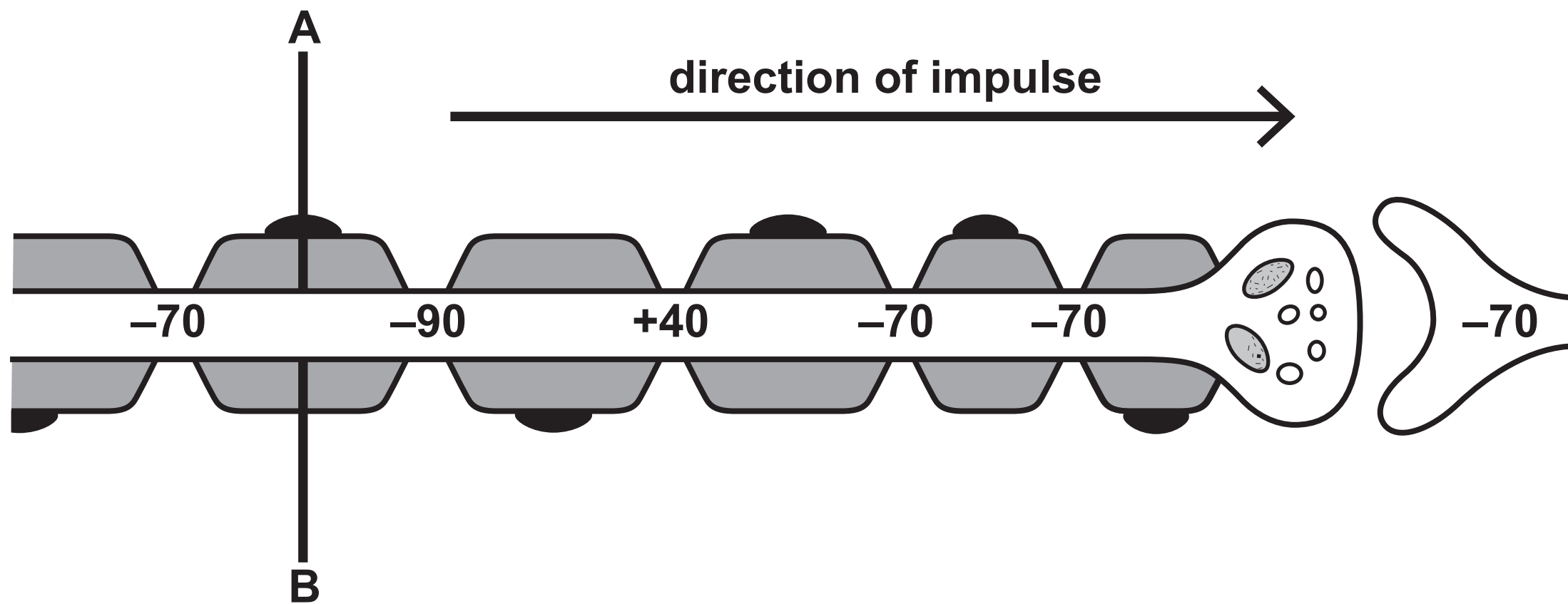
GRAPH 4.1

Tubular filtrate
to plasma ratio



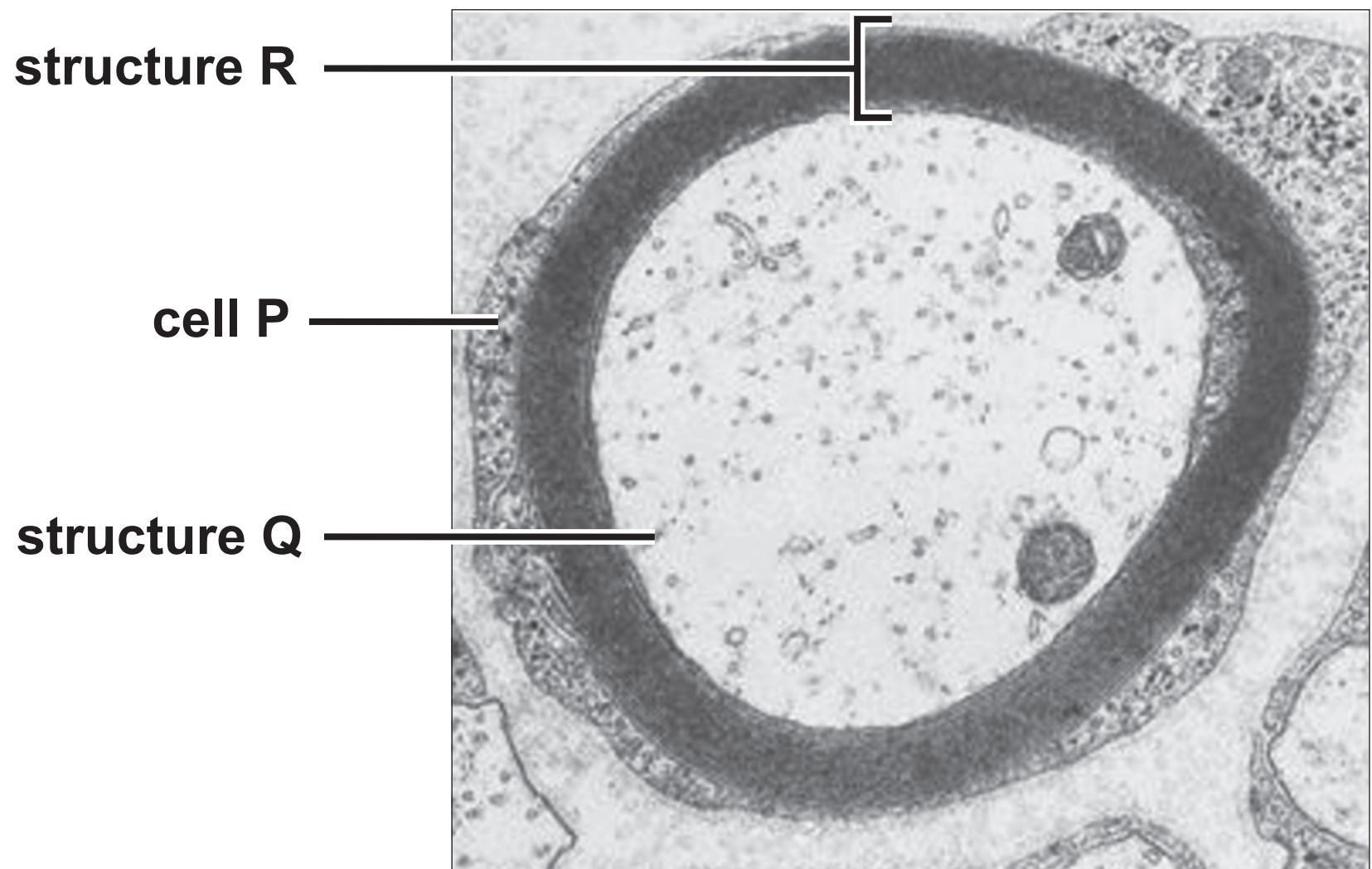
Question 5

IMAGE 5.1



Question 5 (c)

IMAGE 5.2



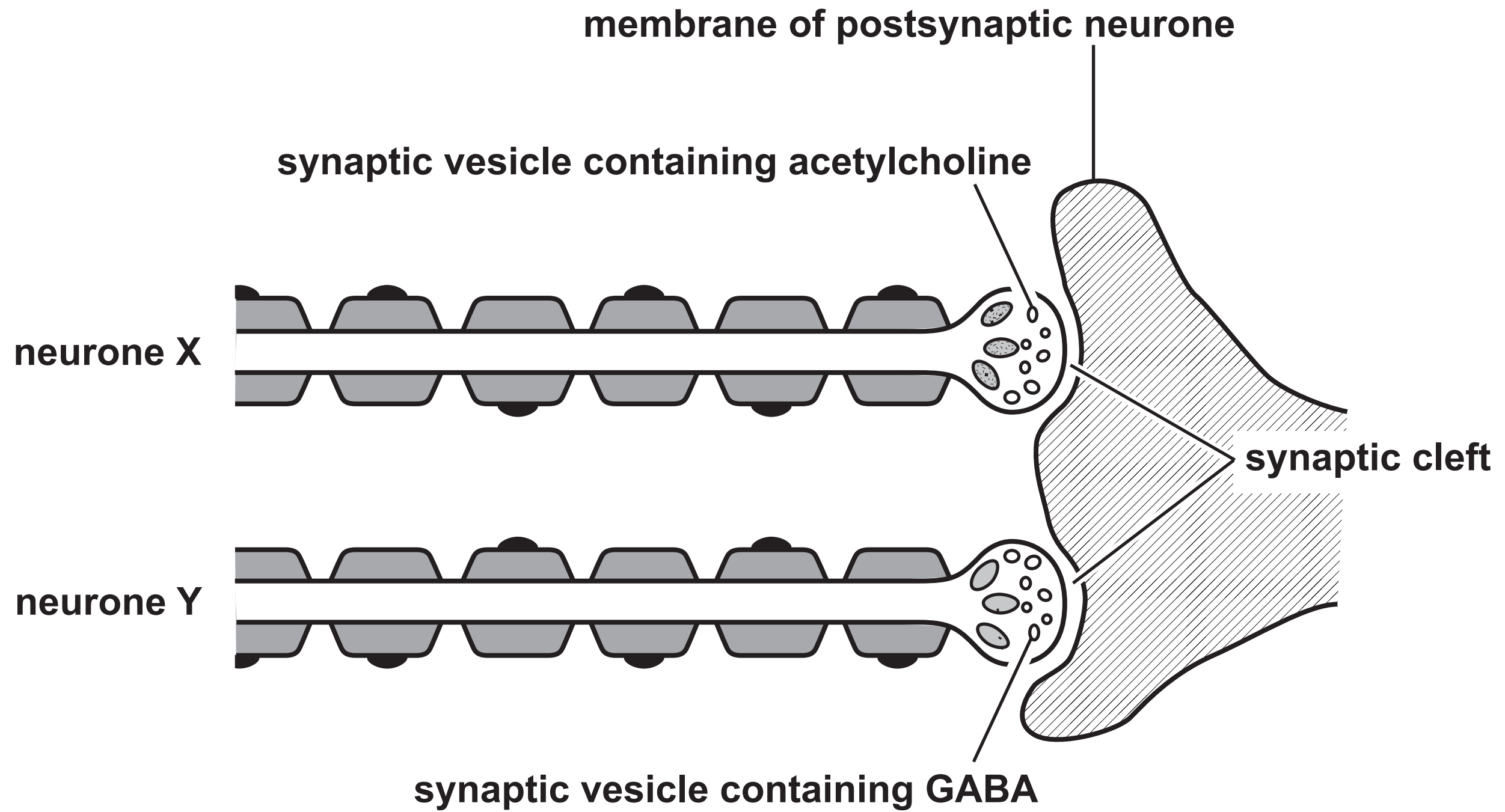
Question 5 (c) (iii)

Table

Factor	Explanation

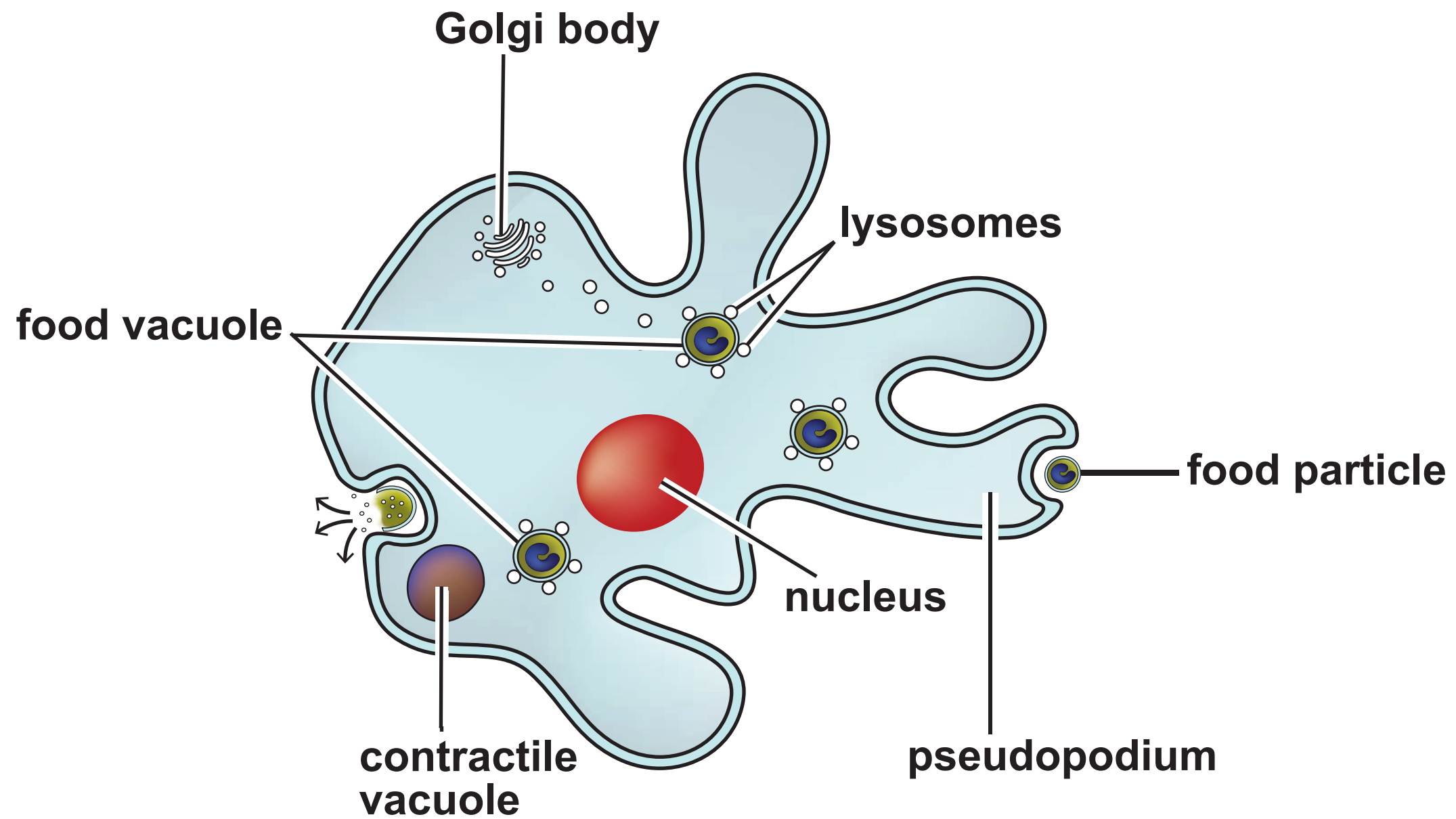
Question 5 (d)

IMAGE 5.3



Question 6

IMAGE 6.1



Question 6

IMAGE 6.2A

HYDRA ingesting a worm

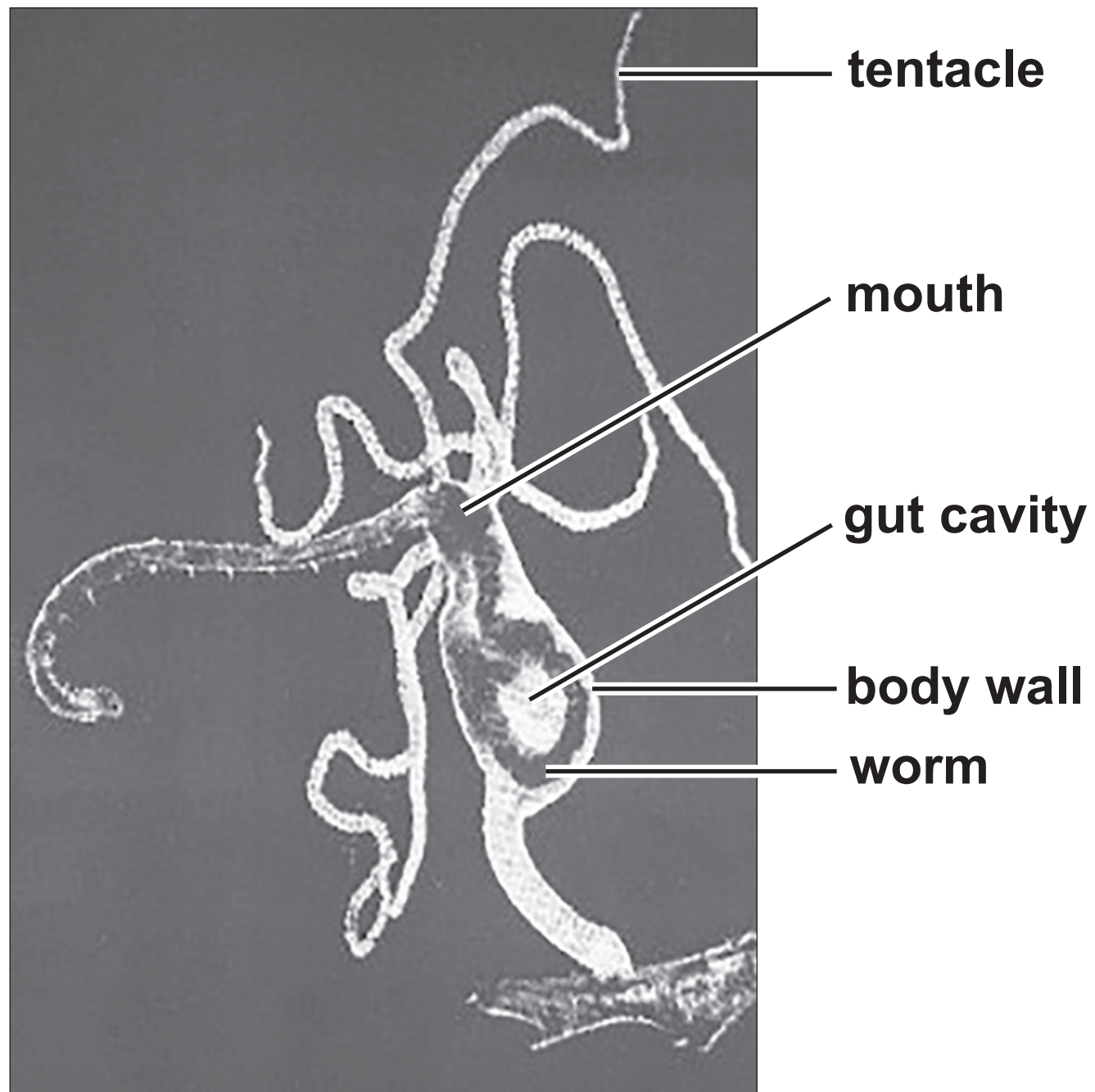
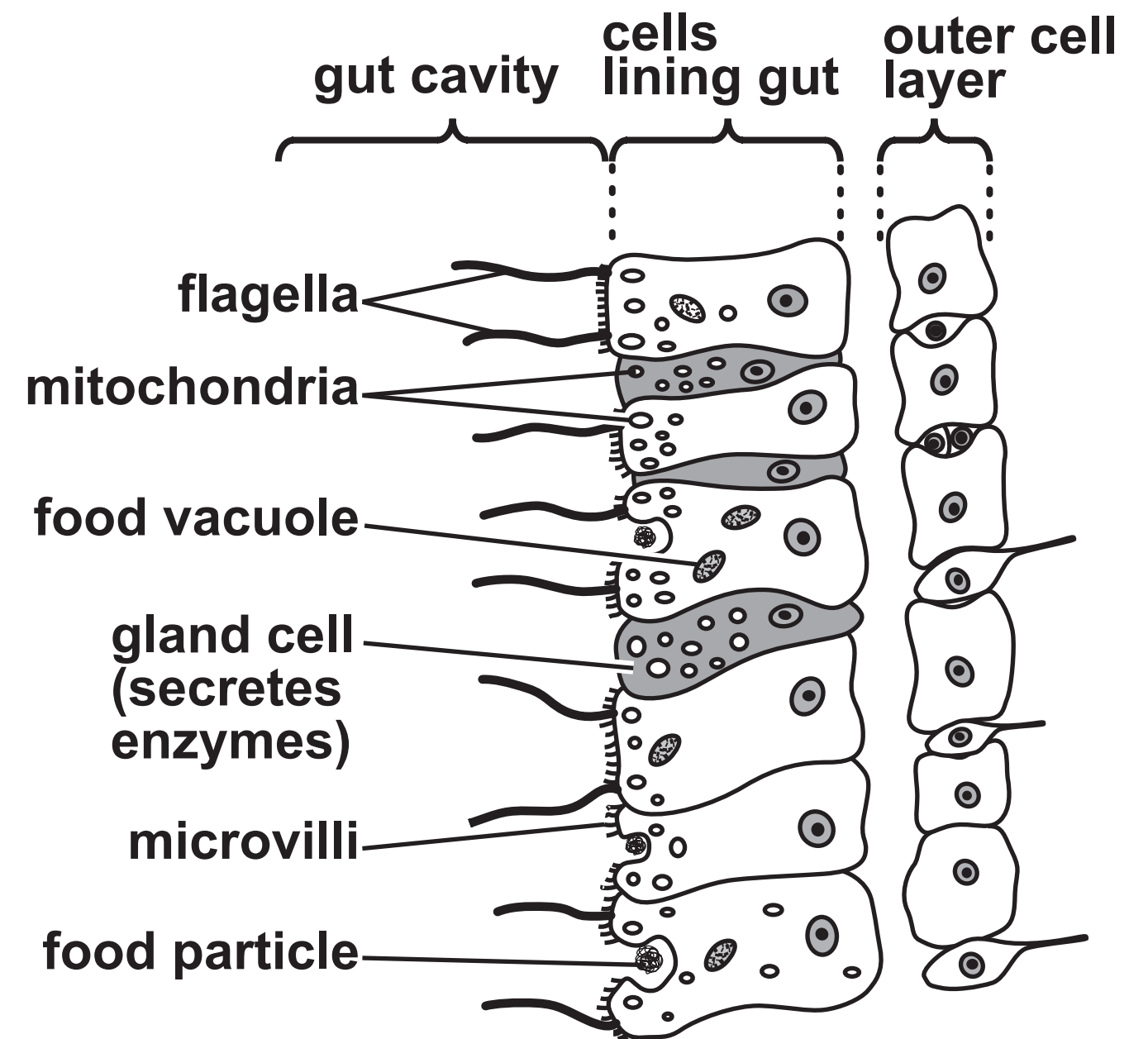


IMAGE 6.2B

Body wall of HYDRA



Question 7

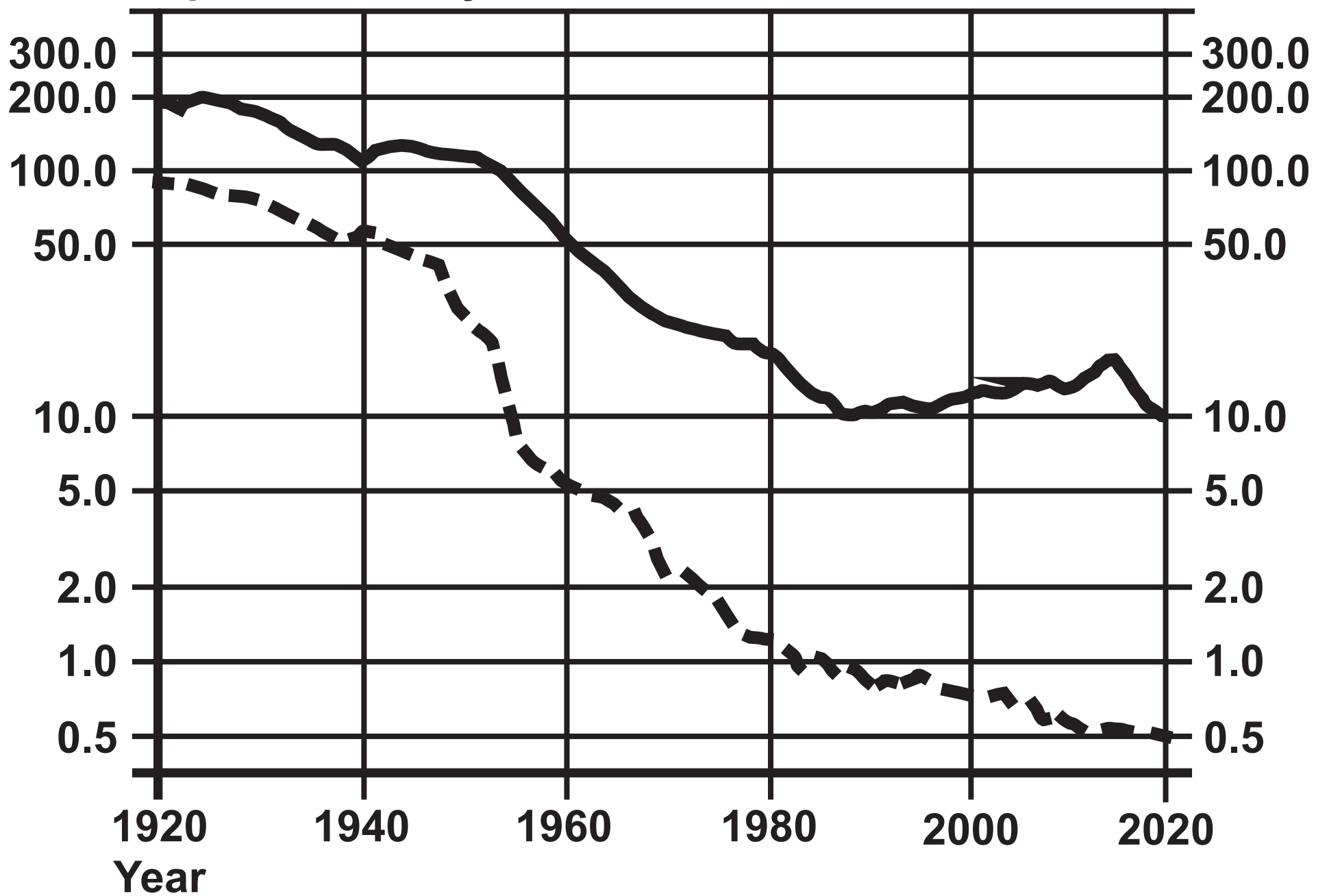
GRAPH 7.1

Key:

———— = TB cases diagnosed per 100 000 people

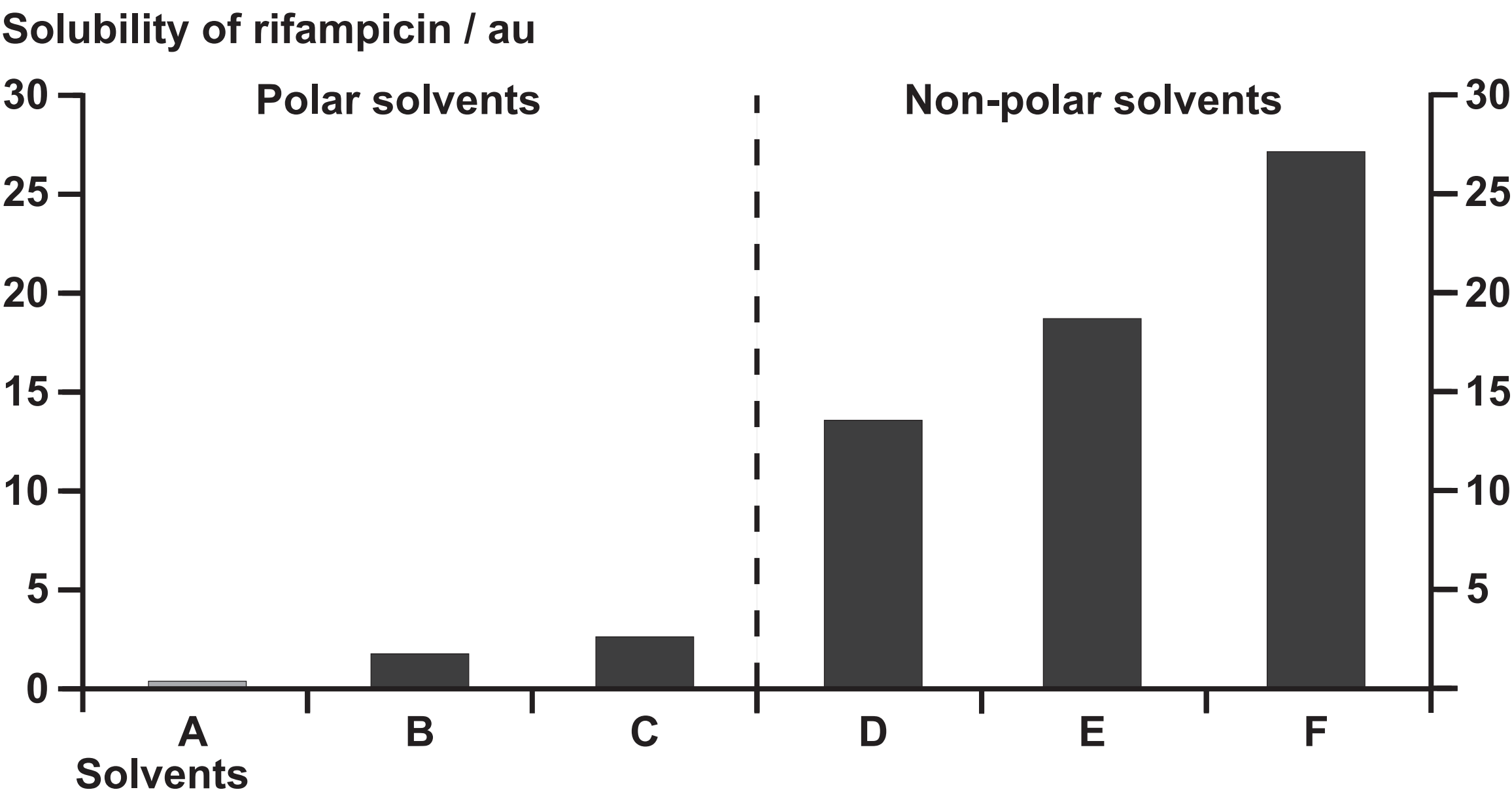
- - - - - = Deaths from TB per 100 000 people

Number per 100,000 / year



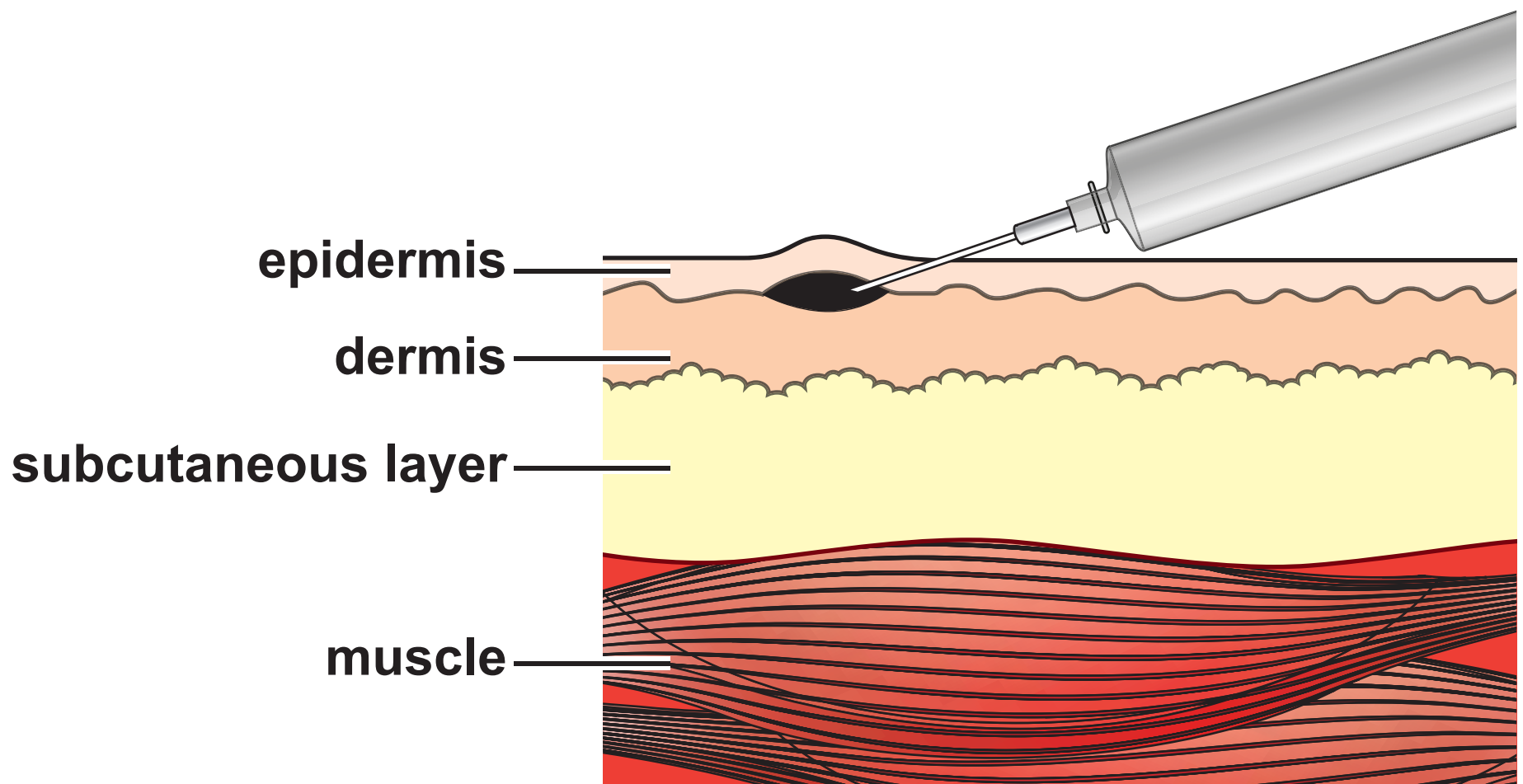
Question 7 (b)

GRAPH 7.2



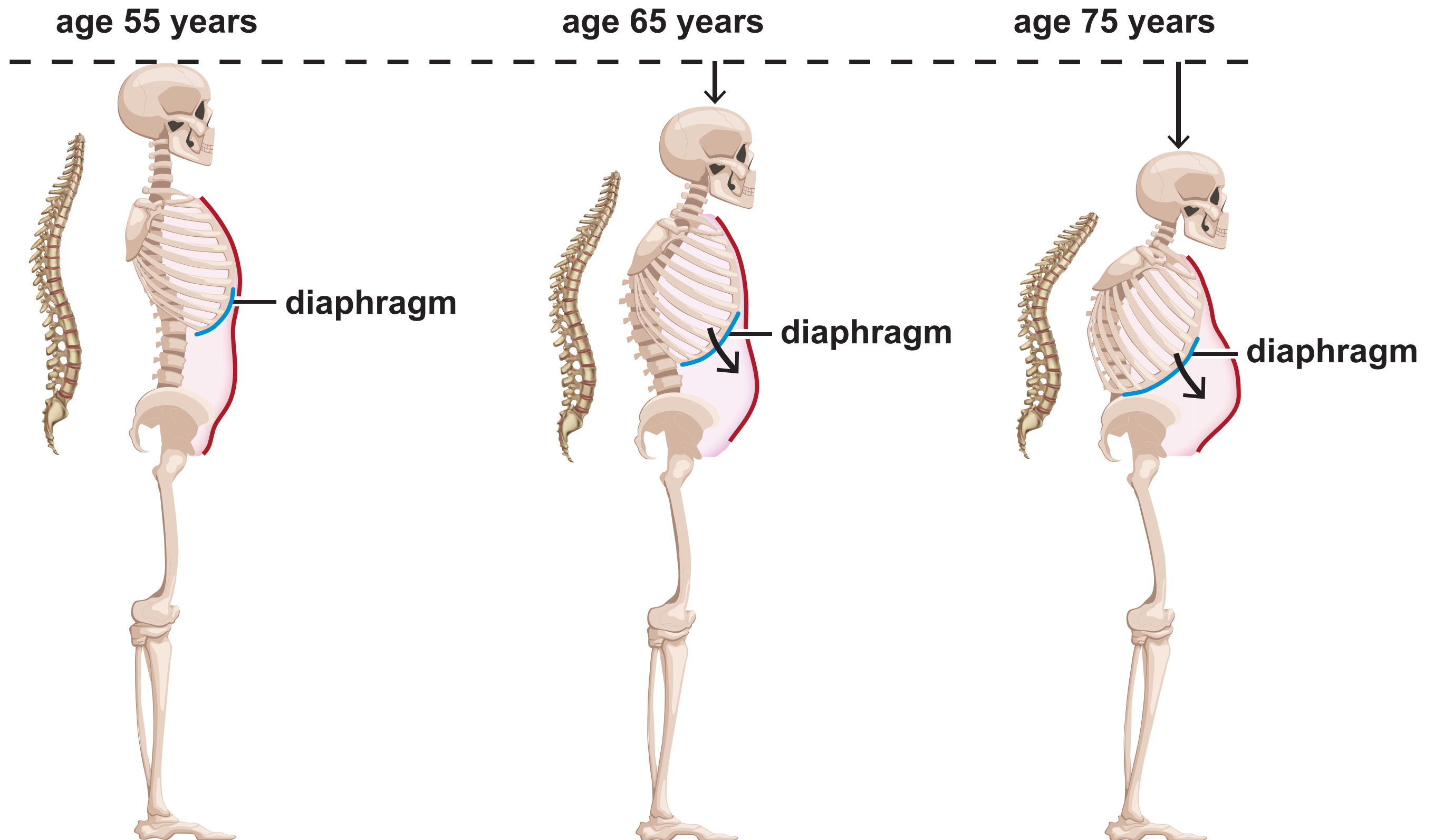
Question 7 (c)

GRAPH 7.3



Question 8

IMAGE 8.1



Question 8 (a) (ii)

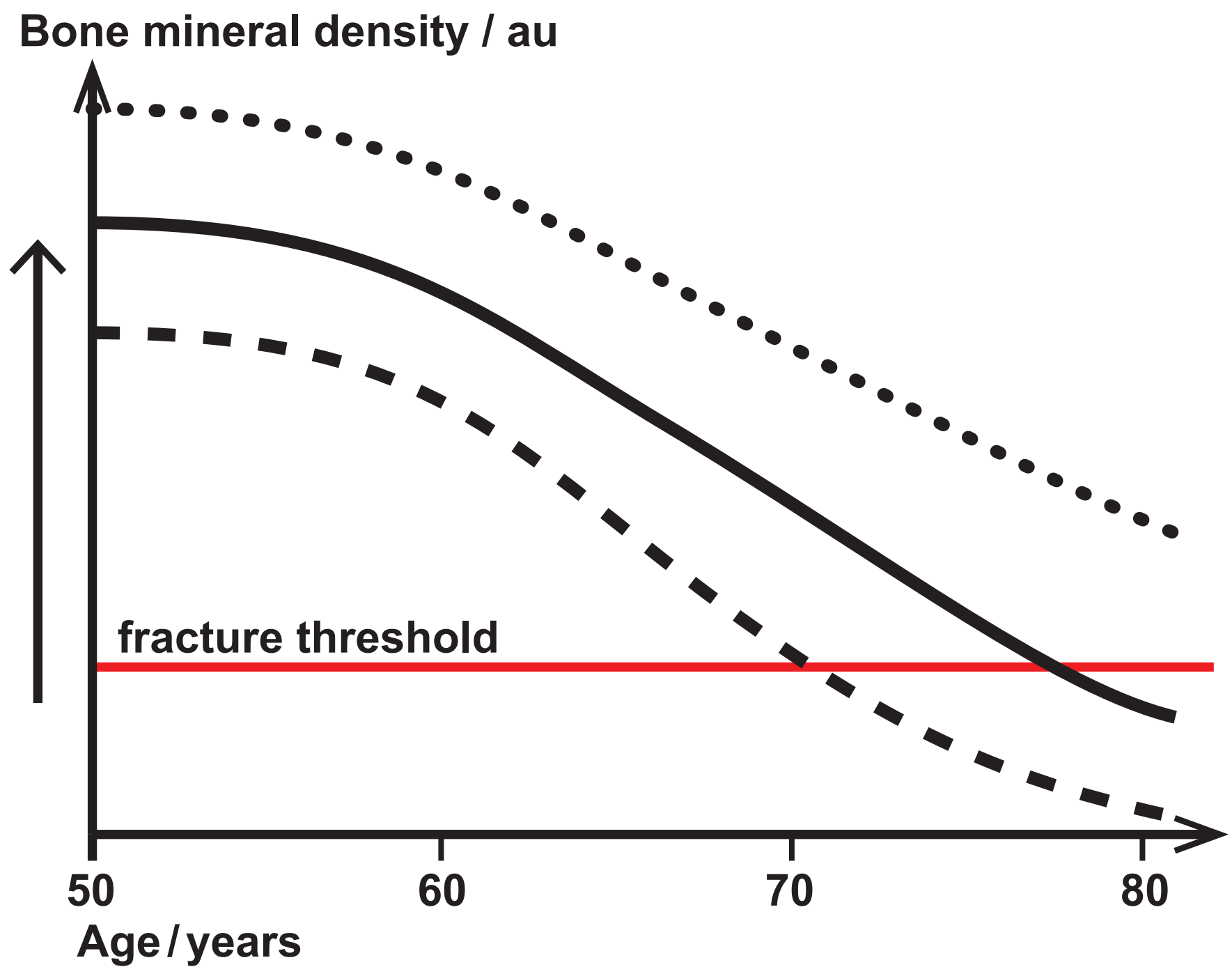
GRAPH 8.2

Key:

..... = highly active

———— = moderately active

- - - - = inactive



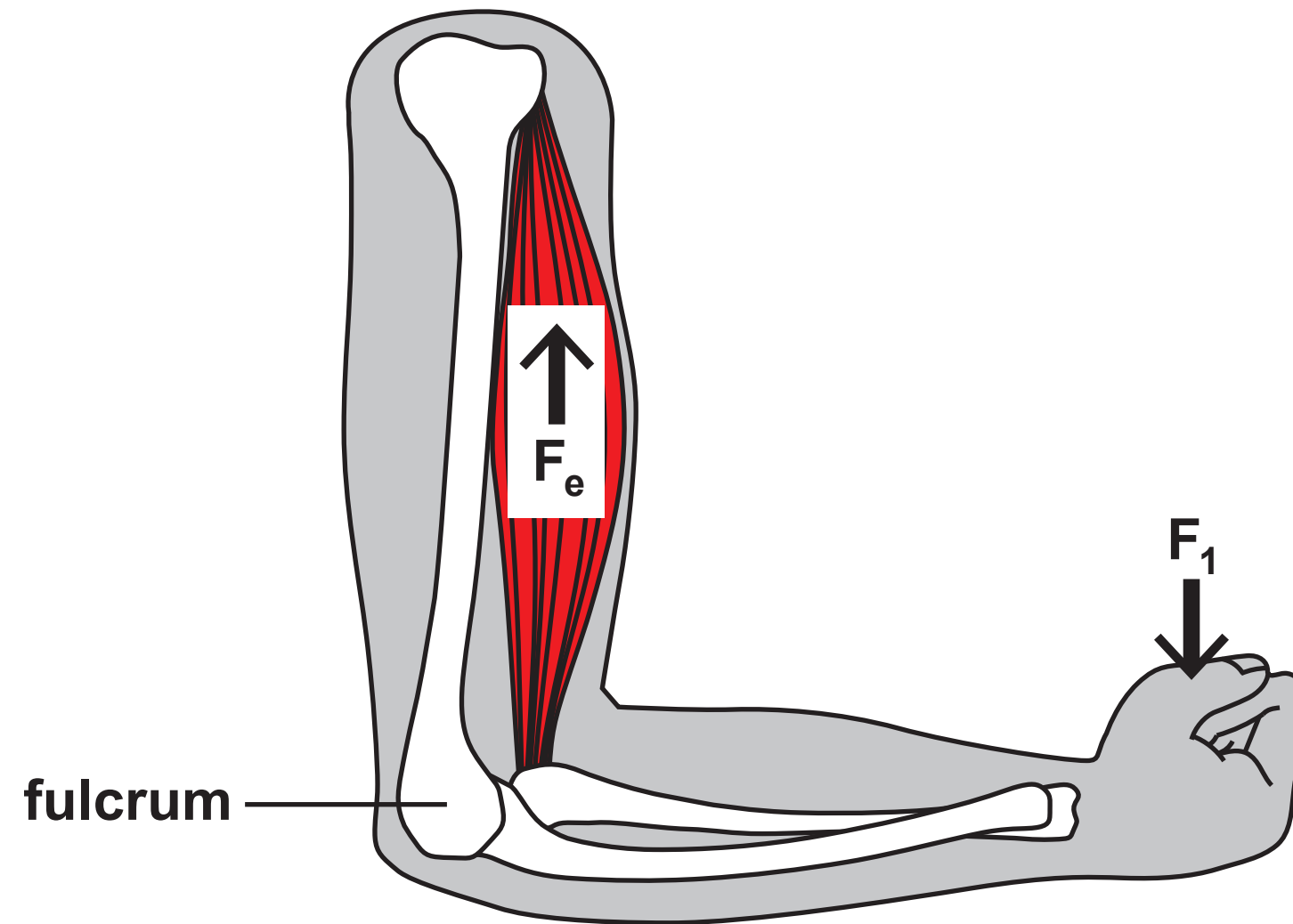
Question 8 (b)

IMAGE 8.3



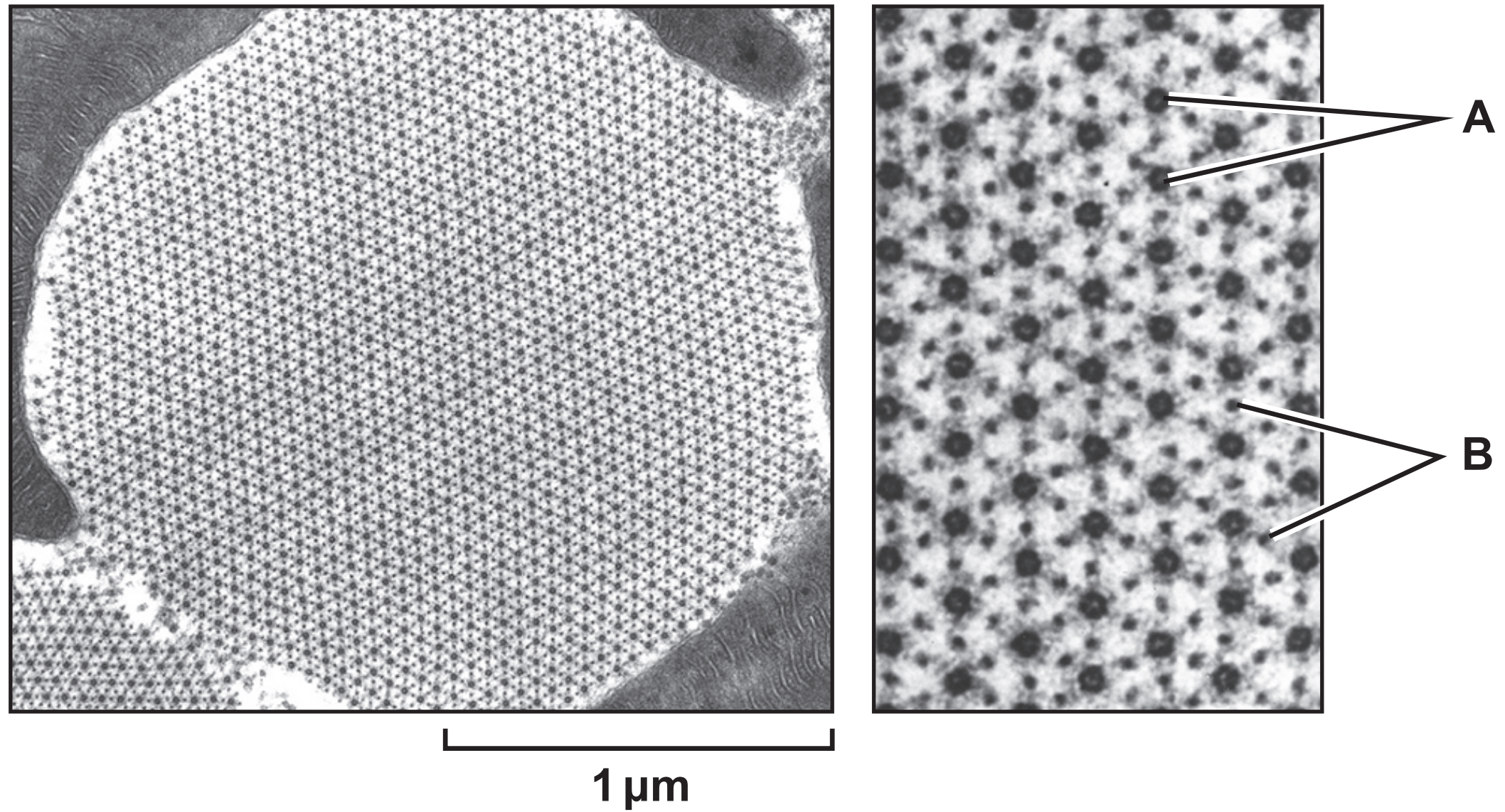
Question 8 (c)

IMAGE 8.4



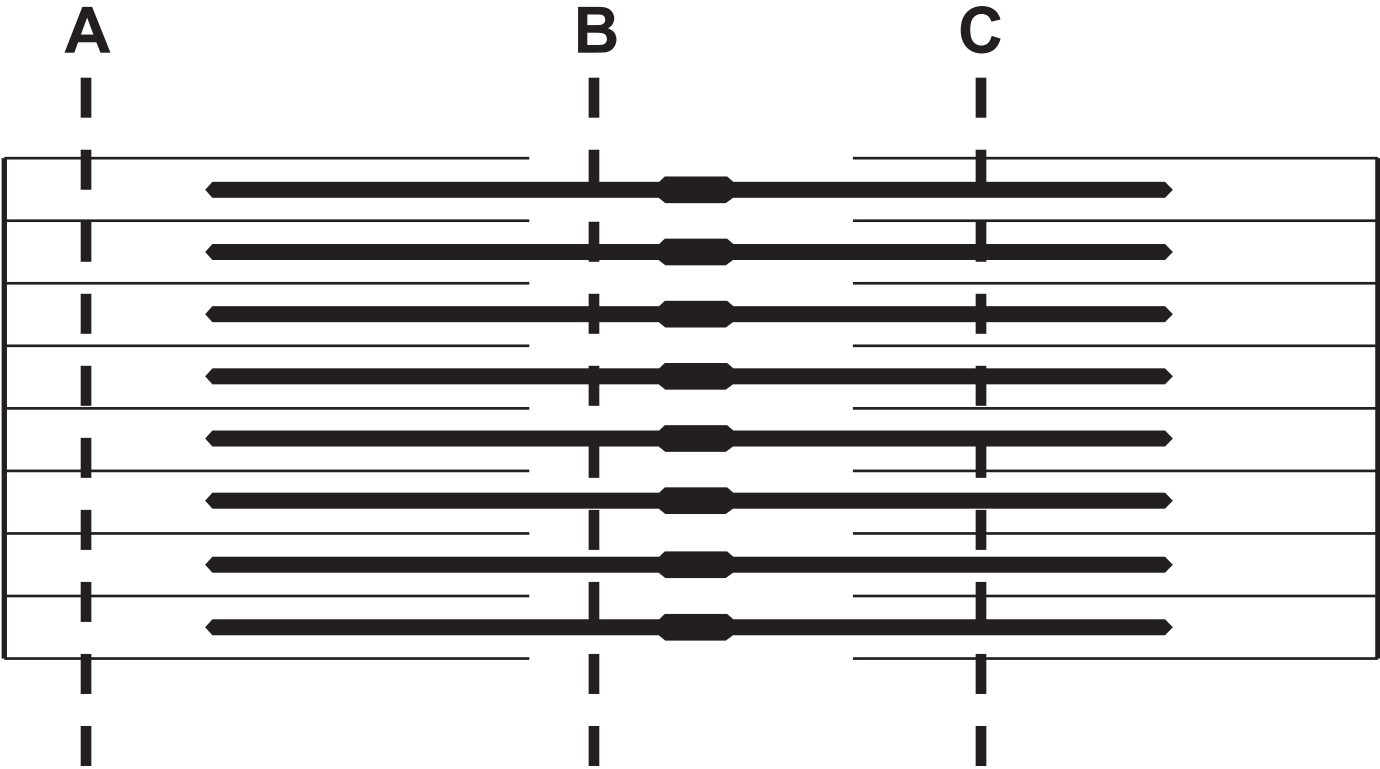
Question 8 (d)

IMAGE 8.5



Question 8 (d) (iii)

IMAGE 8.6



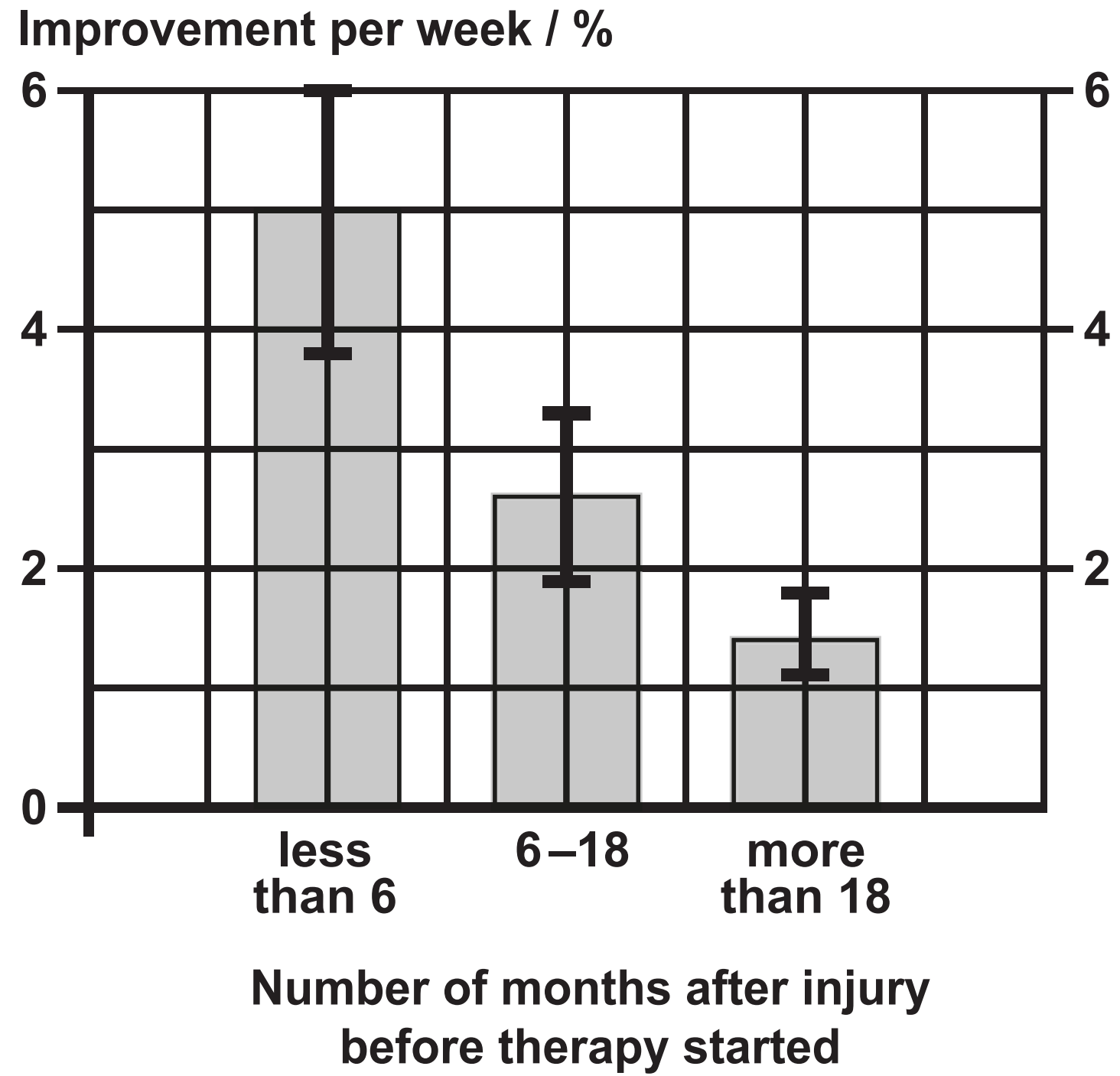
Question 9

IMAGE 9.1



Question 9 (b)

GRAPH 9.2

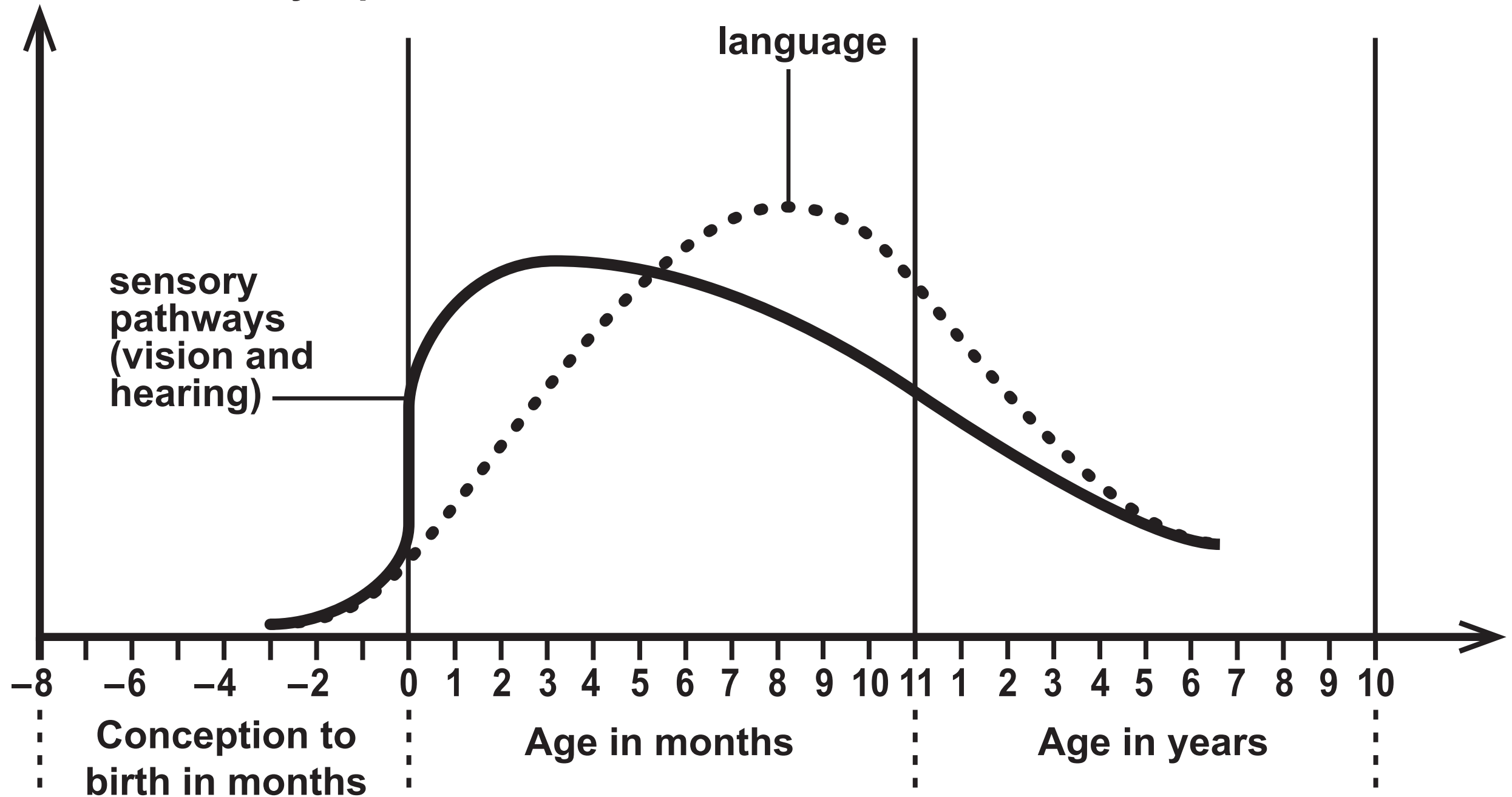


Question 9 (b) (iv)

GRAPH 9.3

Key: — = sensory pathways (vision and hearing)
..... = language

Rate of formation of synapses / au

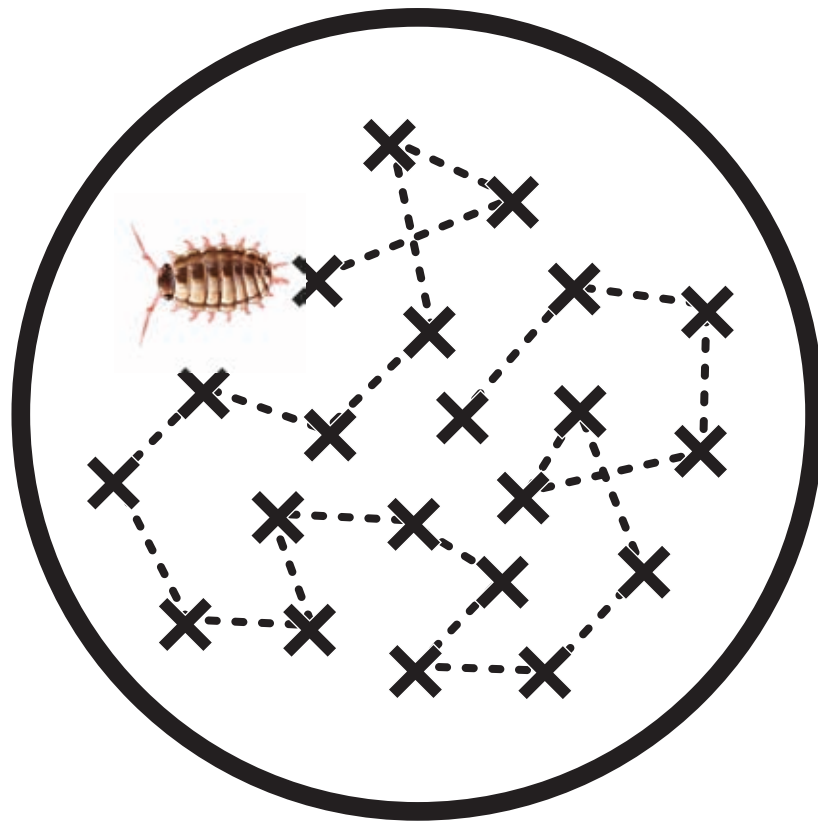


Question 9 (c)

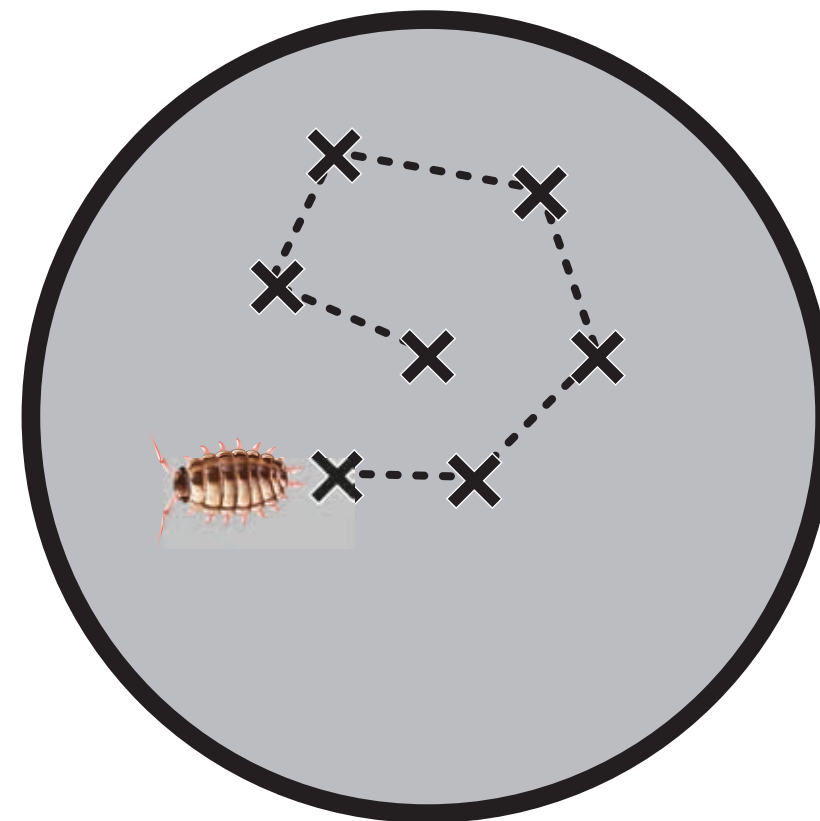
IMAGE 9.4

✕ = woodlouse changes direction

High light intensity



Low light intensity



Question 9 (c) (ii)

TABLE 9.5

Light intensity / au	Speed of woodlice / mm s ⁻¹					Mean speed / mm s ⁻¹
	Woodlouse 1	Woodlouse 2	Woodlouse 3	Woodlouse 4	Woodlouse 5	
2	1.0	1.0	1.2	0.9	1.3	1.1
4	4.4	5.1	4.1	4.3	4.2	
6	5.6	5.4	5.2	5.6	5.2	5.4
8	6.7	6.4	6.3	6.9	6.7	6.6
10	6.8	6.0	7.2	6.8	7.0	6.8