GCE A LEVEL

1400U40-1

FRIDAY, 16 JUNE 2023 – MORNING

BIOLOGY – A2 UNIT 4

VARIATION, INHERITANCE AND OPTIONS

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.	15	
	2.	9	
	3.	13	
	4.	11	
	5.	13	
	6.	9	
SECTION B	Option	20	
	Total	90	

ADDITIONAL MATERIALS

In addition to this paper, you will require 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.

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: 70 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. Look at IMAGE 1.1 for Question 1 in the separate Diagram Booklet.

IMAGE 1.1 shows a section of human ovary taken from a pregnant female.

Following ovulation, structure A performs an endocrine function, secreting a hormone which reaches a maximum concentration about 6 days later. Active growth of blood vessels occurs in the ovary after ovulation.

(a) (i) Name structure A and state its function.

_____

_____

_____

[2 marks]

continued on the next page . . .

Question 1 (a) continued

1. (a) (ii) Suggest ONE reason why it is important that the number of blood vessels in the ovary increase after ovulation.

_____

_____

_____

_____

_____

_____

[1 mark]

continued on the next page . . .

Question 1 continued

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

IMAGE 1.2 shows a single human spermatozoon.

(i) Calculate the actual length of the spermatozoon shown in IMAGE 1.2. GIVE YOUR ANSWER IN mm.

Space for working:

Length = _____ mm

[2 marks]

continued on the next page . . .

Question 1 (b) continued

1. (b) (ii) Structure A in IMAGE 1.1 has a mean diameter of 16 mm. Calculate the number of times larger structure A is than the human spermatozoon.

Space for working:

Structure A is _____ times larger than the human spermatozoon.

[1 mark]

continued on the next page . . .

Question 1 continued

1. (c) (i) Look at TABLE 1.3 for Question 1 (c) (i) in the separate Diagram Booklet.

Complete TABLE 1.3 by identifying structures X, Y and Z on IMAGE 1.2, describing their function during fertilisation.

[3 marks]

continued on the next page . . .

Question 1 (c) continued

1. (c) (ii) Humans normally have a diploid number $2n = 46$

Occasionally a secondary oocyte is fertilised by two sperm. The embryo formed develops abnormally and will not survive.

State the number of chromosomes this embryo would have and the term used to describe the number of sets of chromosomes.

Number of chromosomes =

_____

Term used

_____

_____

[2 marks]

continued on the next page . . .

Question 1 (c) continued

1. (c) (iii) This number of sets of chromosomes also occurs naturally in a certain plant tissue. State the name of this plant tissue and state its function.

_____

_____

_____

[2 marks]

continued on the next page . . .

Question 1 continued

1. (d) Look at IMAGE 1.4 for Question 1 (d) in the separate Diagram Booklet.

IMAGE 1.4 shows a human placenta, following delivery, after the baby is born.

Use IMAGE 1.4 to state TWO features of a placenta and describe how they are important to the survival of the embryo.

[2 marks]

(Total for Question 1 = 15 marks)

2. An investigation was carried out to determine the flower structure of a primrose.

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

The flower was dissected as shown in IMAGE 2.1

(a) The technician requested a materials list prior to the investigation.

Apart from safety glasses, list THREE items of apparatus which would be needed to carry out this investigation.

1. _____

2. _____

3. _____

[1 mark]

continued on the next page . . .

Question 2 continued

2. (b) Look at the table for Question 2 (b) in the separate Diagram Booklet.

Identify structures A to D on the flower in IMAGE 2.1 and describe their functions.

[4 marks]

continued on the next page . . .

Question 2 continued

2. (c) Look at IMAGE 2.2 for Question 2 (c) in the separate Diagram Booklet.

Further research was carried out to determine how pollen from different species varied. Photomicrographs of two types of pollen from different species are shown in IMAGE 2.2

Using your own knowledge of pollination and the photographs shown, conclude how each of the pollen samples, E and F, are transferred from one flower to another.

Explain how you came to your conclusions.

POLLEN E _____

_____

_____

_____

_____

_____

POLLEN F _____

_____

_____

_____

_____

_____

[4 marks]

(Total for Question 2 = 9 marks)

3. Co – dominance and certain homozygous genotypes can give unusual ratios in the resulting offspring.

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

IMAGE 3.1 shows some phenotypes of Camellia plants.

(a) Horticulturalists crossed plants which had red flowers and variegated leaves with plants which had red and white flowers and variegated leaves.

continued on the next page . . .

Question 3 (a) continued

3. (a) (i) Using the symbols provided for Question 3 (a) (i) in the separate Diagram Booklet, show this cross and the resulting offspring by:

- **completing the parental genotypes and gametes;**
- **drawing a genetic diagram.**

Space for GENETIC DIAGRAM

[2 marks]

continued on the next page . . .

Question 3 (a) continued

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

Use the genetic diagram drawn in part (a) (i) to complete TABLE 3.2

[3 marks]

continued on the next page . . .

Question 3 continued

3. (b) The resulting 420 seeds from the above cross were planted and the phenotypes of all the MATURE plants were counted and the following results observed.

56 red flowers, green leaves

102 red flowers, variegated leaves

49 red and white flowers, green leaves

110 red and white flowers, variegated leaves

The following observation was made:

'Of the 420 seeds produced in the above cross, all the seeds germinated but 103 did not grow and so a different phenotypic ratio was observed than expected.'

continued on the next page . . .

Question 3 (b) continued

Explain this observation. Your answer should include reference to:

- **germination;**
- **plant leaf cell structure;**
- **observed and expected phenotypic ratios.**

[5 marks]

continued on the next page . . .

Question 3 continued

3. (c) The production of seeds requires sexual reproduction which involves meiosis. One way for a plant grower to produce plants with the same phenotype as the parent plant is to take cuttings. Using your knowledge of cell division explain why the same phenotype would be retained.

[3 marks]

(Total for Question 3 = 13 marks)

4. A large research project was carried out to investigate the effect of the environment on the shell length of common European limpet shells (PATELLA VULGATA).

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

These molluscs live on rock surfaces and remain clamped to the rock with a muscular foot when they are exposed at low tide and only move for feeding when they are covered at high tide, as shown in IMAGE 4.1
They graze algae from the rock surface and always return to the same home position as the tide goes out.

Look at GRAPH 4.2A and GRAPH 4.2B for Question 4 in the separate Diagram Booklet.

The results from two sites, sheltered and exposed rocky shores, are shown on GRAPHS 4.2A and 4.2B. The same size area was investigated at both sites.

continued on the next page . . .

Question 4 continued

4. (a) (i) State TWO conclusions that you could draw from the data in GRAPH 4.2A and GRAPH 4.2B.

_____

_____

_____

_____

_____

_____

[2 marks]

(ii) State the modes for the two sets of data.

Sheltered rocky shore mode = _____

Exposed rocky shore mode = _____

[1 mark]

continued on the next page . . .

Question 4 continued

4. (b) Two groups of A level students carried out the same type of investigation on the two types of rocky shore. They measured the shell length in mm of 20 mature PATELLA VULGATA at each site.
They recorded their data in a results table and used an on – line calculator which calculated the t value.

GROUP 1: exposed rocky shore, Cemlyn Bay, Anglesey

GROUP 2: sheltered rocky shore, Menai Strait

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

continued on the next page . . .

Question 4 (b) continued

The t value was calculated as 2.6662

4. (b) (i) State the null hypothesis for this experiment.

_____

_____

_____

[1 mark]

(ii) State the degrees of freedom which should be used.

_____

_____

[1 mark]

continued on the next page . . .

Question 4 (b) continued

4. (b) (iii) Look at TABLE 4.4 for Question 4 (b) (iii) in the separate Diagram Booklet.

TABLE 4.4 shows the critical values for a two – tailed test.

Use TABLE 4.4 to determine whether you would accept or reject the null hypothesis. Explain how you have come to this conclusion.

[3 marks]

continued on the next page . . .

Question 4 continued

4. (c) Suggest ONE density – independent and TWO density – dependent factors which could account for the difference in shell length.

Density – independent factor

_____

_____

Density – dependent factor 1

_____

_____

Density – dependent factor 2

_____

_____

[3 marks]

(Total for Question 4 = 11 marks)

5. The international trade of ivory has been banned since 1989. However, as many as 50 000 African elephants are killed each year for their ivory tusks out of a population of less than 400 000

Researchers created a map of genetic profiles of different elephant populations across Africa using dung samples containing DNA from epithelial cells.

Polymerase Chain Reaction (PCR) was carried out to amplify the DNA and after 40 cycles over a billion copies of the target sequence was produced.

continued on the next page . . .

Question 5 continued

5. (a) (i) Explain the following processes during the PCR:

I. a single stranded DNA primer is added;

_____

_____

_____

II. the DNA is heated to $95^{\circ}C$ at the start of a cycle;

_____

_____

_____

III. the DNA is then cooled to $50 – 60^{\circ}C$.

_____

_____

_____

[3 marks]

Question 5 (a) continued

5. (a) (ii) Explain why a certain type of polymerase, called Taq polymerase, is necessary in the final extension stage of the cycle at $70^{\circ}C$.

_____

_____

_____

[1 mark]

continued on the next page . . .

Question 5 continued

5. (b) The researchers collected elephant dung samples from many locations to analyze the DNA.

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

IMAGE 5 shows the distribution of these locations. Each location was known to contain one population of elephants.

The different patterned dots on IMAGE 5 indicate where closely matching genetic profiles were found by the researchers.

Explain the distribution of the genetic profiles of the different elephant populations shown on IMAGE 5

_____

_____

_____

[2 marks]

continued on the next page . . .

Question 5 continued

5. (c) Most female African elephants have tusks, but typically about 6% of females in a population will never grow tusks.

However, in Gorongosa National Park in Mozambique:

- **elephants with large tusks are targeted and killed by poachers for the illegal ivory trade;**
- **33% of females between 10 and 20 years old do not have tusks;**
- **50% of females over 20 years old do not have tusks.**

Using your knowledge of evolution, explain the high incidence of elephants without tusks in the Gorongosa elephant population.

_____

_____

_____

[3 marks]

continued on the next page . . .

Question 5 continued

5. (d) Suggest how the trend toward INCREASED LACK OF TUSKS in a population with HEAVY POACHING will affect African elephant population sizes in the future. Explain your answer.

_____

_____

_____

_____

_____

_____

[2 marks]

continued on the next page . . .

Question 5 continued

5. (e) Ivory from elephant tusks contains DNA. Suggest how the data on the DNA profiles of populations could help with combatting poaching.

[2 marks]

(Total for Question 5 = 13 marks)

6. The Human Genome Project was completed in April 2003 when an accurate and complete human genome sequence was made available to scientists and researchers.

As a result of this research, more gene therapy drug trials have taken place.

Look at GRAPH 6 for Question 6
in the separate Diagram Booklet.

GRAPH 6 shows the number of gene therapy drug trials between 1997 and 2017.

Explain what is meant by gene therapy and outline ONE of the techniques involved.
Describe how the data in GRAPH 6 supports a link between the completion of the sequencing of the human genome and the number of gene therapy trials. Use your knowledge of the aims of the Human Genome Project to explain your answer.
Describe the use of exon skipping gene therapy for the treatment of muscular dystrophy.

[9 marks QER]

(Total for Question 6 = 9 marks)

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.

Option A: IMMUNOLOGY AND DISEASE

7. **Insect bites can cause infection of the deeper layers of the skin. This infection is called cellulitis and is caused by bacteria such as STREPTOCOCCUS and STAPHYLOCOCCUS that usually live harmlessly on the surface of the skin. These bacteria are introduced into the wound when the bite is scratched. Flucloxacillin is a bactericidal antibiotic, similar to penicillin, which is used to treat insect bite infections.**

(a) (i) State what is meant by the term bactericidal.

_____

_____

[1 mark]

continued on the next page . . .

Question 7 (a) continued

7. (a) (ii) STREPTOCOCCUS and STAPHYLOCOCCUS are types of Gram – positive bacteria. Suggest how and why flucloxacillin has a bactericidal effect on these types of bacteria.

[4 marks]

continued on the next page . . .

Question 7 (a) continued

7. (a) (iii) Flucloxacillin has become ineffective against some species of STAPHYLOCOCCUS. Suggest why.

[3 marks]

continued on the next page . . .

Question 7 (a) continued

7. (a) (iv) Suggest how infection following the insect bite could be prevented.

_____

_____

_____

[1 mark]

(b) Malaria is a disease spread by insect bites from some mosquitoes. They carry the protoctistan parasite PLASMODIUM, which causes the disease. Malaria is endemic in some sub – tropical areas, can become epidemic during wet seasons and could also be regarded as pandemic.

Look at IMAGE 7.1 for Question 7 (b) in the separate Diagram Booklet.

IMAGE 7.1 shows the distribution of malaria.

continued on the next page . . .

Question 7 (b) continued

7. (b) (i) Describe the difference between the terms endemic and epidemic. Suggest why malaria could be considered pandemic.

[2 marks]

continued on the next page . . .

Question 7 (b) continued

7. (b) (ii) State why there is no current effective vaccine against PLASMODIUM.

_____

_____

_____

_____

_____

_____

[2 marks]

continued on the next page . . .

Question 7 continued

7. (c) The aim of vaccination is to develop humoral and cell – mediated responses against a number of potentially fatal diseases. In 2019, the UK lost its World Health Organisation (WHO) measles – free status as the number of cases of measles was rising. The MMR vaccine provides immunity for measles, mumps and rubella.

Look at GRAPH 7.2 for Question 7 (c) in the separate Diagram Booklet.

GRAPH 7.2 shows the results of a study into the percentage uptake of the vaccine in children.

continued on the next page . . .

Question 7 (c) continued

7. (c) (i) Conclude why the number of cases of measles increased between 2016 and 2020.

_____

_____

_____

[1 mark]

continued on the next page . . .

Question 7 (c) continued

7. (c) (ii) In 2018 there were 700 000 children born. Calculate the number of children that had not been vaccinated by the time they were TWO YEARS OLD.

Space for working:

Number of children = _____

[2 marks]

continued on the next page . . .

Question 7 (c) continued

7. (c) (iii) The MMR vaccine contains antigens of the three pathogens. Explain why a child who is exposed to the measles virus after being vaccinated does not develop the measles disease.

[3 marks]

continued on the next page . . .

Question 7 (c) continued

7. (c) (iv) The MMR vaccine was linked to autism developing in children in a report that has since been disproven. However, some people still associate this condition with the combined MMR vaccine.

Use GRAPH 7.2 to suggest which year the report was published.

_____

_____

_____

[1 mark]

(Total for Question 7 = 20 marks)

Option B: HUMAN MUSCULOSKELETAL ANATOMY

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

IMAGE 8.1 shows a weight being lifted by a human forelimb.

(a) (i) With reference to the names of the muscles involved, state how the muscles work together to lift the weight.

_____

_____

_____

[1 mark]

continued on the next page . . .

Question 8 (a) continued

8. (a) (ii) IMAGE 8.1 represents a third order lever. Use IMAGE 8.1 and your knowledge of levers to identify the effort, load and fulcrum and explain why it is a third order lever.

_____

_____

_____

_____

_____

_____

[2 marks]

continued on the next page . . .

Question 8 continued

8. (b) Another experiment was carried out into the rate of muscle fatigue when the weight was held in the position as shown in IMAGE 8.1

(i) Suggest what causes the muscle to fatigue.

_____

_____

_____

_____

_____

_____

[2 marks]

continued on the next page . . .

Question 8 (b) continued

8. (b) (ii) Look at IMAGE 8.2 for Question 8 (b) (ii) in the separate Diagram Booklet.

IMAGE 8.2 shows an electromyogram (EMG) which is used to measure fatigue over time. The amplitude (mV) of the signal indicates the force the muscle is generating.

An EMG was produced for three males and three females. The total time they could hold the weight and the mean amplitude for the first 5 seconds and last 5 seconds of the trace was recorded for each person.

Look at TABLE 8.3 for Question 8 (b) (ii) in the separate Diagram Booklet.

The results are shown in TABLE 8.3

continued on the next page . . .

Question 8 (b) (ii) continued

Look at the equation for Question 8 (b) (ii) in the separate Diagram Booklet.

The rate of fatigue is measured using the equation shown.

Use the equation to calculate the rate of fatigue for GABRIEL. Suggest a unit for rate of fatigue.

Space for working:

Rate of fatigue = _____

Unit = _____

[3 marks]

continued on the next page . . .

Question 8 (b) continued

8. (b) (iii) It was concluded that females had better endurance than males. With reference to the data in TABLE 8.3 comment on the validity of this conclusion.

[3 marks]

continued on the next page . . .

Question 8 continued

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

IMAGE 8.4 shows a sarcomere.

(i) Use the letters X, Y and Z to label the following proteins on the sarcomere in IMAGE 8.4

X actin

Y myosin

Z tropomyosin

[1 mark]

continued on the next page . . .

Question 8 (c) continued

8. (c) (ii) Low blood calcium increased the rate of muscle fatigue. Use your knowledge of sliding filament theory to explain the reason for this.

[4 marks]

continued on the next page . . .

Question 8 continued

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

IMAGE 8.5 shows a vertebra.

(i) State what spinal region the vertebra in IMAGE 8.5 is from and explain your answer.

_____

_____

_____

_____

_____

_____

[2 marks]

continued on the next page . . .

Question 8 (d) continued

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

Scheuermann's kyphosis is a medical condition similar to scoliosis which causes curvature of the spine due to vertebrae being wedge – shaped as shown in IMAGE 8.6

Suggest which way the spine would curve in the body of a person with Scheuermann's kyphosis.

_____

_____

_____

[1 mark]

continued on the next page . . .

Question 8 (d) continued

8. (d) (iii) Suggest a possible treatment for Scheuermann's kyphosis.

_____

_____

_____

[1 mark]

(Total for Question 8 = 20 marks)

Option C: NEUROBIOLOGY AND BEHAVIOUR

9. Look at the photograph for Question 9 in the separate Diagram Booklet.
The photograph shows two baboons fighting.

Chacma baboons (PAPIO URSINUS) are the largest members of the monkey family and are a highly social species that live in groups of up to 200 individuals. Within a group, adult males form a dominance hierarchy that is established and maintained by fighting and aggressive displays.

(a) (i) State the meaning of the term 'dominance hierarchy'.

_____

_____

_____

[1 mark]

continued on the next page . . .

Question 9 (a) continued

9. (a) (ii) State and explain an advantage of dominance hierarchy in chacma baboons.

[2 marks]

(iii) Suggest an advantage of maintaining hierarchy by aggressive displays rather than fighting.

[1 mark]

continued on the next page . . .

Question 9 (a) continued

9. (a) (iv) With reference to the appropriate branches of the nervous system, explain how the hypothalamus prepares the baboons for the 'fight or flight response' during these aggressive displays.

_____

_____

_____

[4 marks]

continued on the next page . . .

Question 9 continued

9. (b) Male ranking is unstable and changes every 6 – 12 months. This is because young males tend to migrate between groups and high – ranking males frequently lose their status to younger, immigrant males.

Look at GRAPH 9.1 for Question 9 (b) in the separate Diagram Booklet.

Male testosterone levels were measured using faecal samples in a group of chacma baboons. GRAPH 9.1 shows the relationship between change in male ranking and mean testosterone levels.

continued on the next page . . .

Question 9 (b) continued

9. (b) (i) Calculate the percentage change in mean testosterone levels when the chacma baboon moves up one rank from 0 to 1

Space for working:

Percentage change = _____

[2 marks]

continued on the next page . . .

Question 9 (b) continued

9. (b) (ii) Suggest an advantage for the change in testosterone levels.

_____

_____

_____

[1 mark]

continued on the next page . . .

Question 9 continued

9. (c) Look at IMAGE 9.2 for Question 9 (c) in the separate Diagram Booklet.

Courtship behaviour, as shown by the Indian peafowl (PAVO CRISTATUS) in IMAGE 9.2, is an example of innate behaviour.

(i) State the meaning of the term innate behaviour.

_____

_____

_____

[1 mark]

continued on the next page . . .

Question 9 (c) continued

9. (c) (ii) Courtship behaviour, as seen in peafowl, is an example of the male handicap model. With reference to IMAGE 9.2, state the evidence that this is an example of the male handicap model and conclude how courtship behaviour provides both an advantage and a disadvantage in this species.

_____

_____

_____

[3 marks]

continued on the next page . . .

Question 9 continued

9. (d) Scientists carried out research into possible changes that occur in the brains of squirrels as a result of learning how to get nuts out of a bird feeder.

Look at the photograph for Question 9 (d) in the separate Diagram Booklet.
The photograph shows a squirrel on a bird feeder.

MRI images can be analysed to measure the volume of the different parts of the hippocampus.

continued on the next page . . .

Question 9 (d) continued

9. (d) (i) State TWO reasons why the scientists studied the hippocampus region of the brain in this research.

_____

_____

_____

_____

_____

[2 marks]

continued on the next page . . .

Question 9 (d) continued

9. (d) (ii) Look at GRAPH 9.3 for Question 9 (d) (ii) in the separate Diagram Booklet.

GRAPH 9.3 shows the percentage differences between the volumes of the posterior and anterior hippocampi against the duration of time spent with the bird feeder.

State the trend shown in GRAPH 9.3 and use your knowledge of brain structure and neuroplasticity to state TWO conclusions that can be drawn.

[3 marks]

(Total for Question 9 = 20 marks)

END OF PAPER

TOTAL 90 MARKS

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.

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

GCE A LEVEL

1400U40-1

FRIDAY, 16 JUNE 2023 – MORNING

BIOLOGY – A2 UNIT 4

VARIATION, INHERITANCE AND OPTIONS

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

Diagram Booklet

Surname: _____

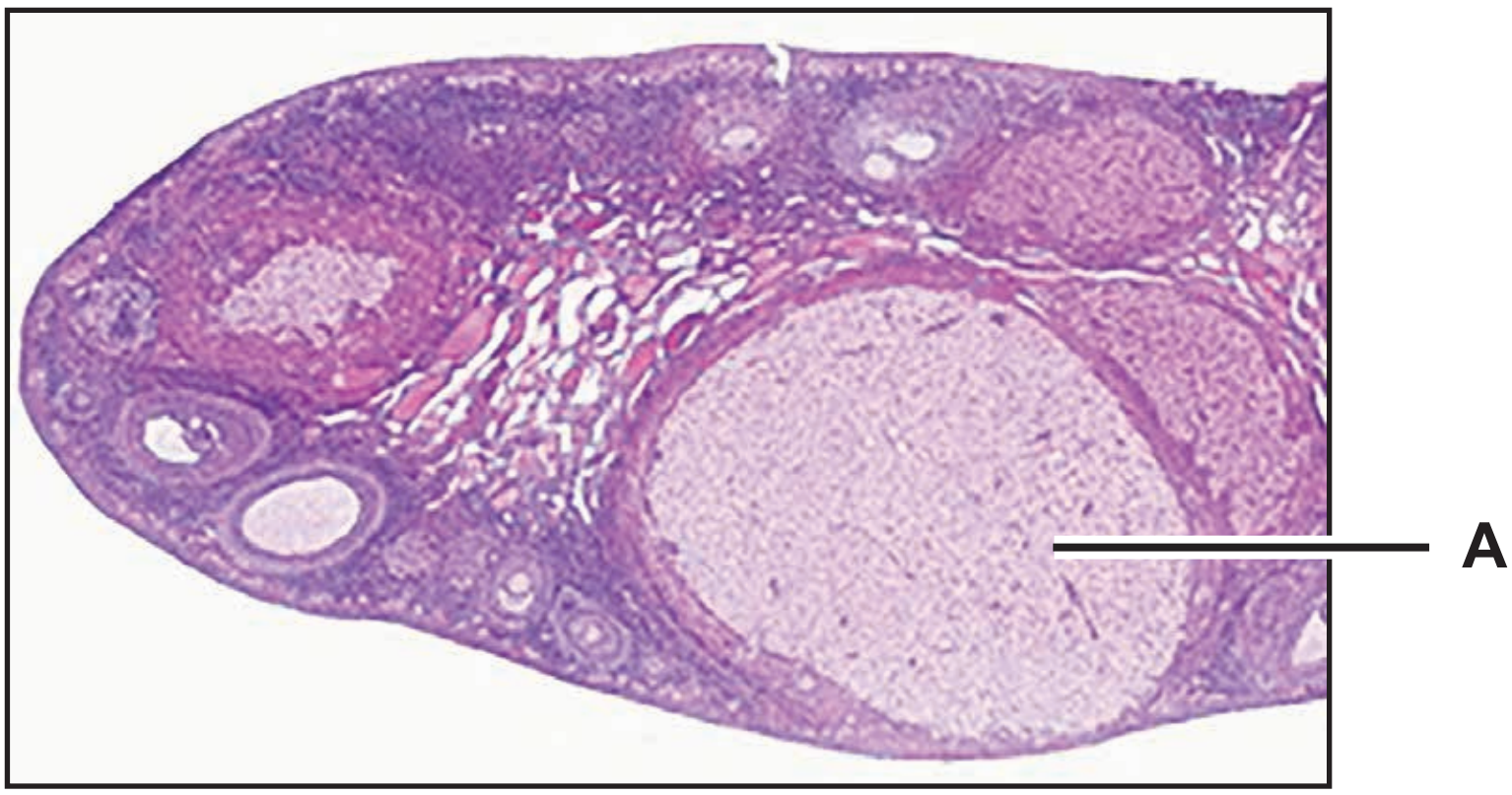
First name(s): _____

Centre Number: _____

Candidate Number: 2 _____

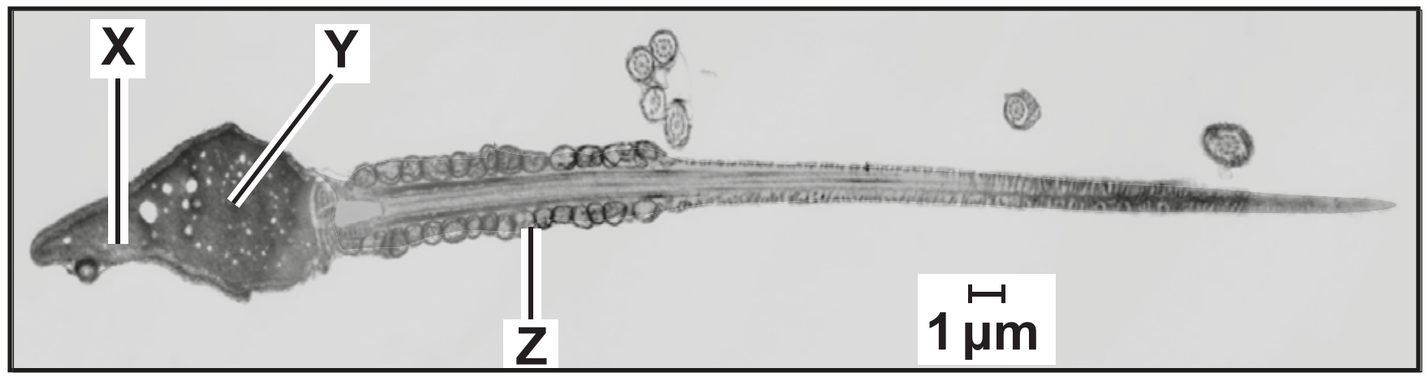
Question 1

IMAGE 1.1



Question 1 (b)

IMAGE 1.2



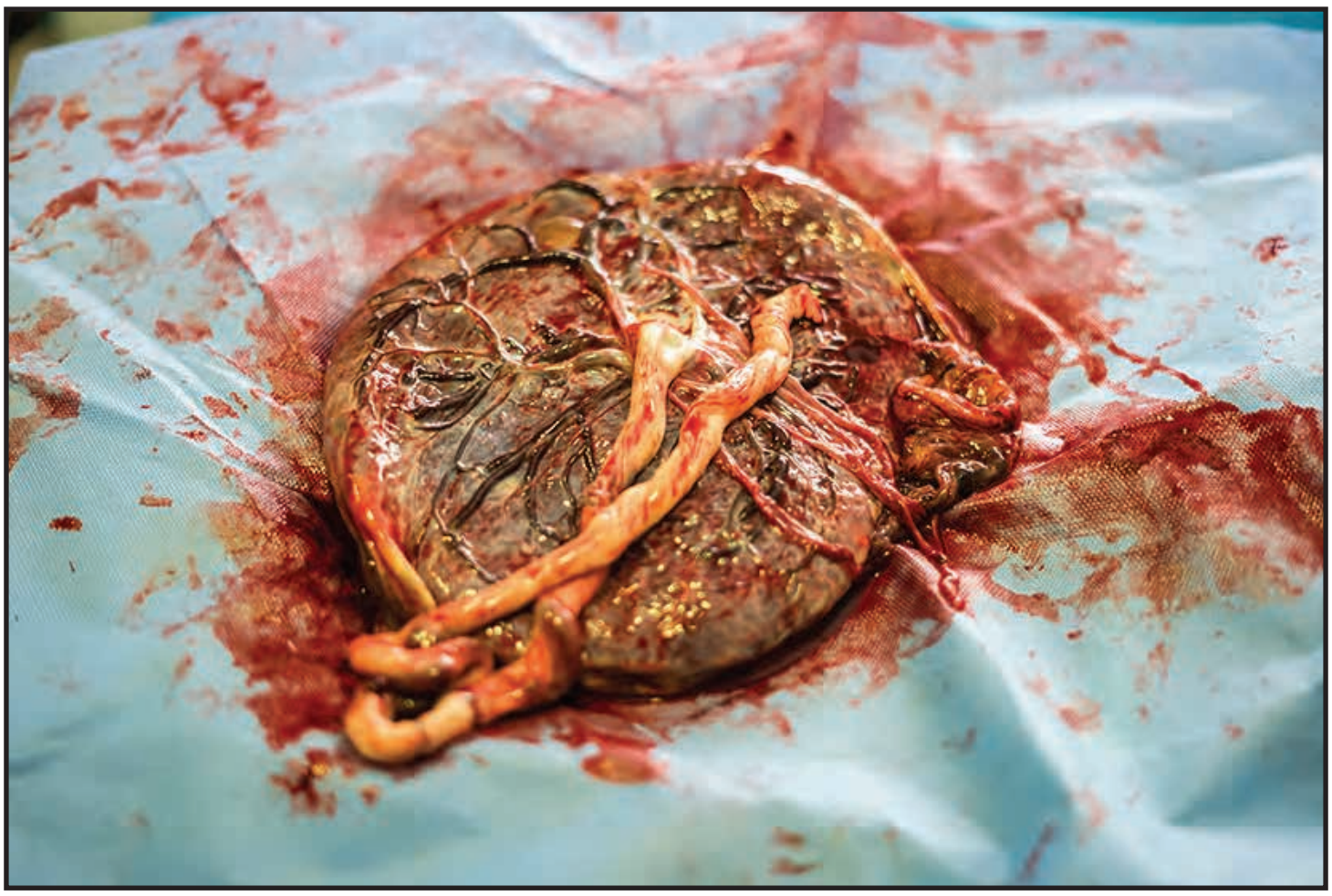
Question 1 (c) (i)

TABLE 1.3

Letter	Name of structure	Function during fertilisation
X	_____	_____ _____ _____
Y	_____	_____ _____ _____
Z	_____	_____ _____ _____

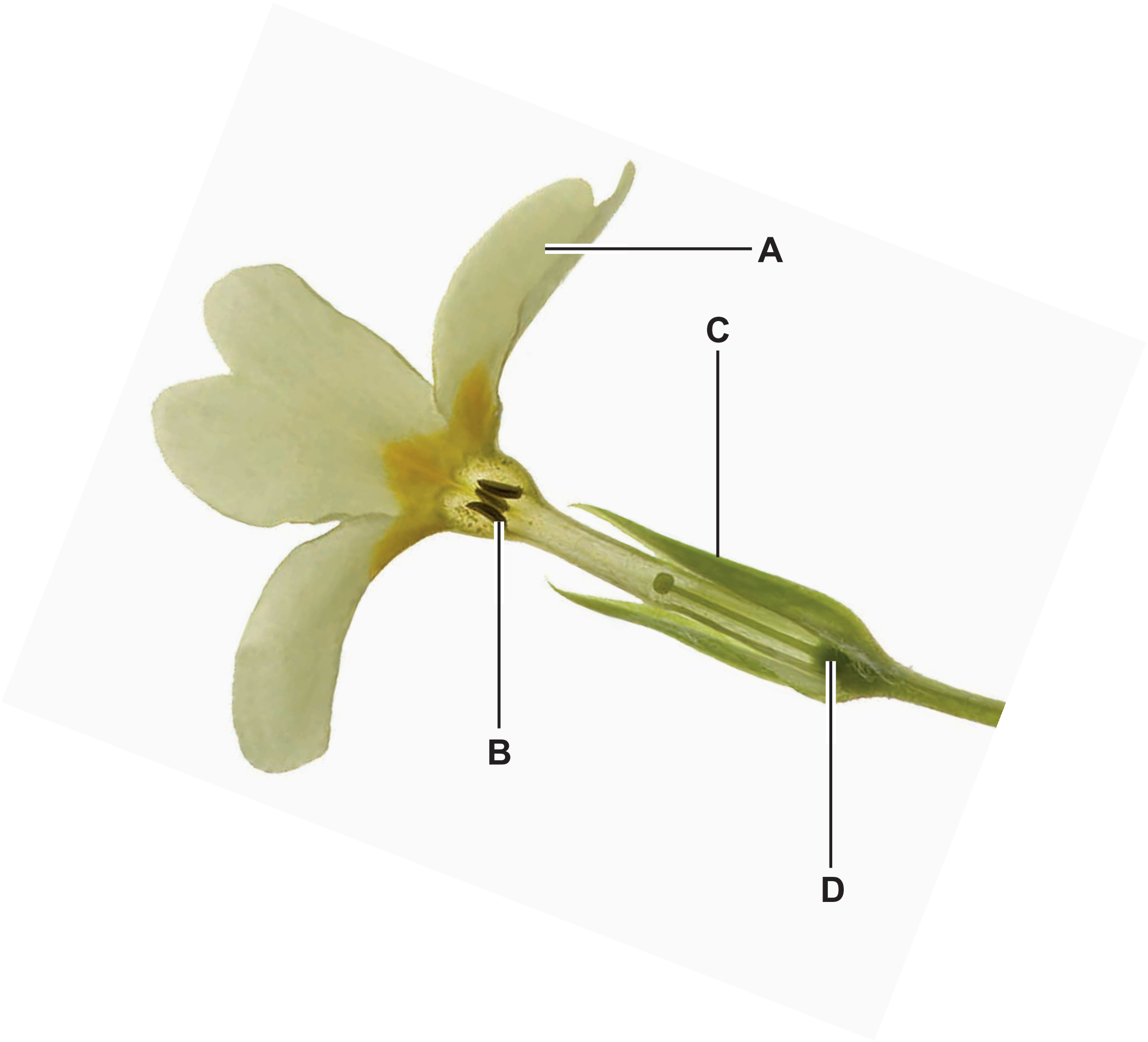
Question 1 (d)

IMAGE 1.4



Question 2

IMAGE 2.1



Question 2 (b)

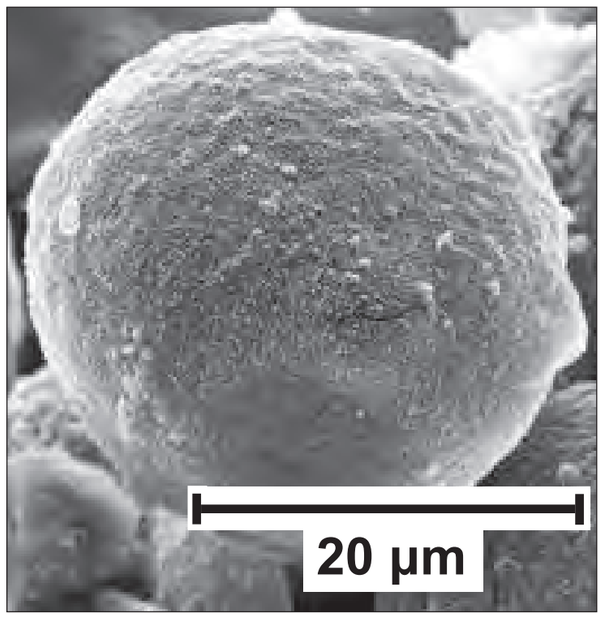
Table

	Structure	Function
A	_____	_____ _____ _____
B	_____	_____ _____ _____
C	_____	_____ _____ _____
D	_____	_____ _____ _____

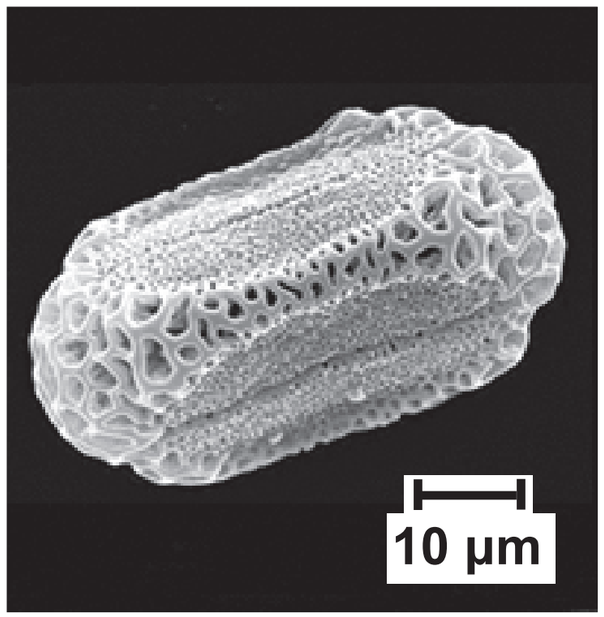
Question 2 (c)

IMAGE 2.2

POLLEN E



POLLEN F



Question 3

IMAGE 3.1

Variegated leaves (green and white)

Green leaves

Red flower

Red and white flower

Question 3 (a) (i)

Symbols

RR red flower

RW red and white flower

WW white flower

GG green leaves

GA variegated leaves

AA white leaves

Parental phenotype red flower, Variegated leaves

Parental genotype _____

Gametes _____

Parental phenotype red and white flower variegated leaves

Parental genotype _____

Gametes _____

Question 3 (a) (ii)

TABLE 3.2

Genotypes							
Expected phenotypes	Flower colour						
	Leaf type						
Expected ratio							

Question 4

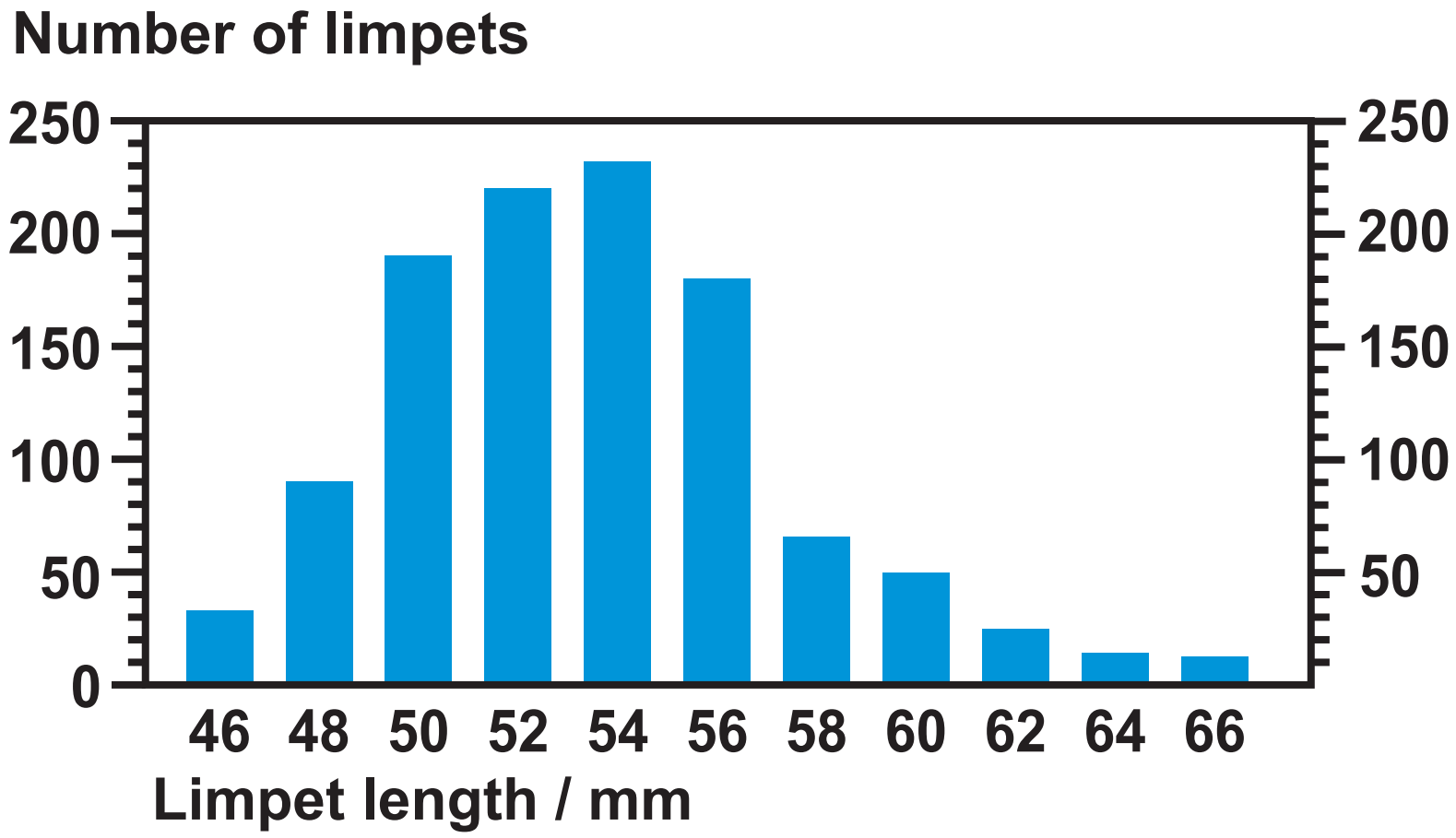
IMAGE 4.1

PATELLA VULGATA clamped to rock

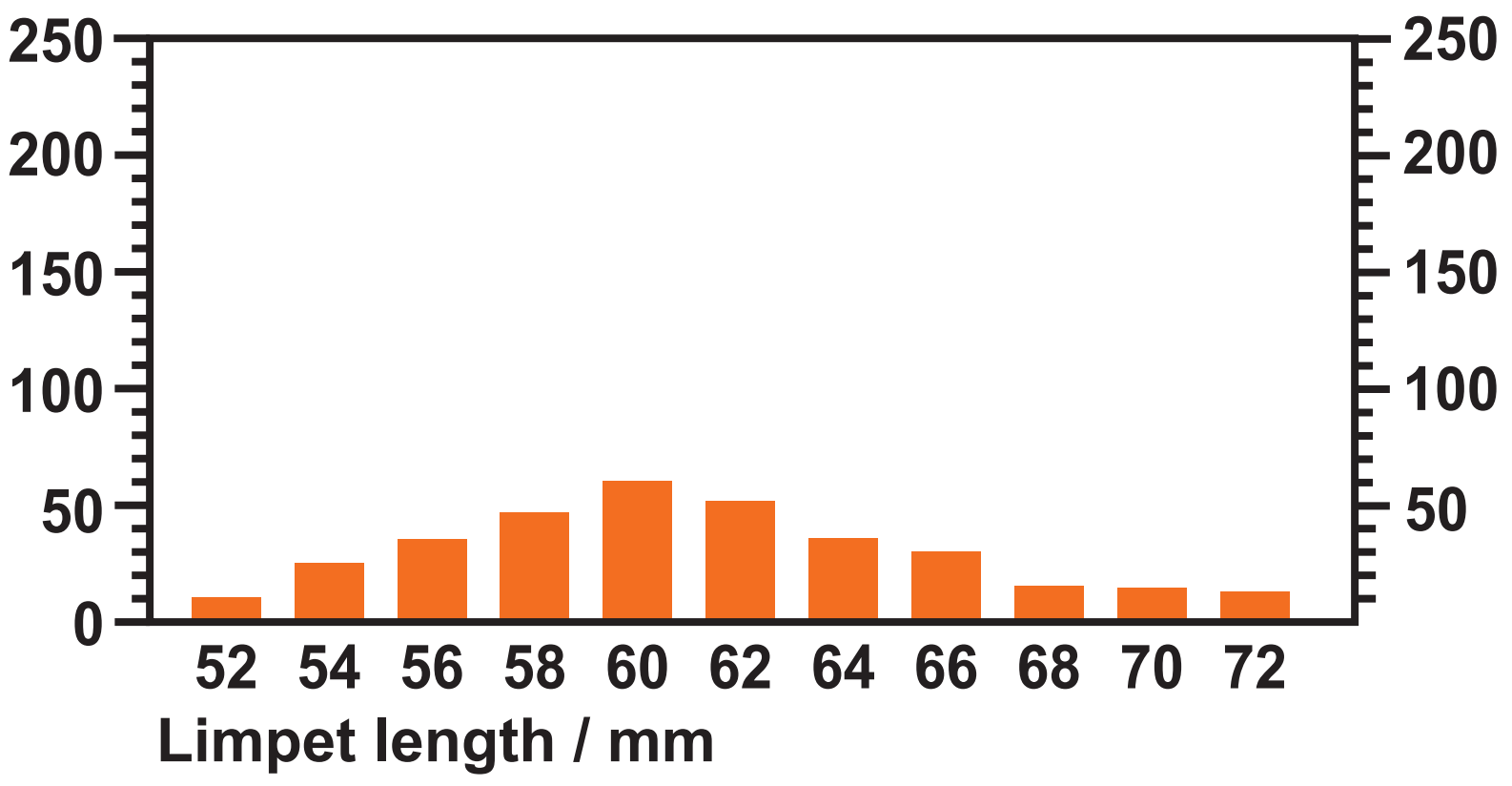
Showing muscular foot

Question 4

GRAPH 4.2A: Sheltered rocky shore



GRAPH 4.2B: Exposed rocky shore



Question 4 (b)

IMAGE 4.3

RESULT:
You entered the following data:

GROUP 1								GROUP 2							
72	68	59	69	58	58	49	59	68	47	45	60	59	49	51	67
61	69	75	80	49	68	70	71	58	59	49	67	63	66	61	58
67	58	60	71					55	60	59	62				

SUMMARY

	Group 1	Group 2
Mean	64.55	58.15
Variance	68.05	47.1868
Standard deviation	8.2492	6.8693
n	20	20
t	2.6662	

Question 4 (b) (iii)

TABLE 4.4

	PROBABILITY				
DEGREES OF FREEDOM	0.1	0.05	0.01	0.005	0.001
30	1.697	2.042	2.75	3.030	3.646
31	1.696	2.040	2.744	3.022	3.633
32	1.693	2.037	2.738	3.015	3.622
33	1.692	2.035	2.733	3.008	3.611
34	1.691	2.032	2.728	3.002	3.601
35	1.690	2.030	2.724	2.996	3.591
36	1.684	2.028	2.719	2.991	3.582
37	1.683	2.026	2.715	2.985	3.574
38	1.682	2.024	2.712	2.980	3.566
39	1.681	2.023	2.708	2.976	3.558
40	1.680	2.021	2.704	2.971	3.551

Question 5 (b)

IMAGE 5

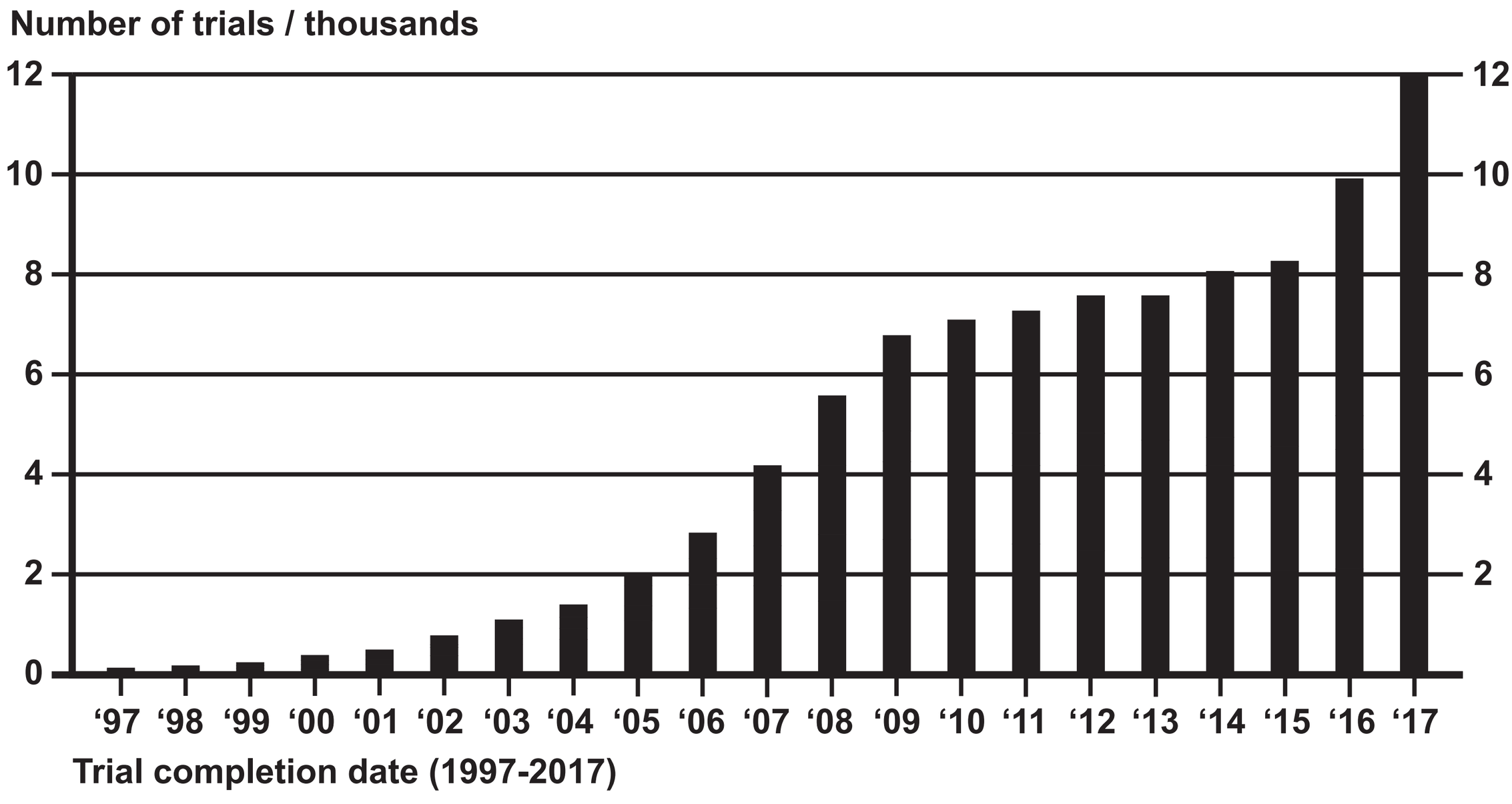
Key:

The symbols (patterned dots), ★ ■ ●, indicate where closely matching genetic profiles were found by the researchers.

Question 6

GRAPH 6

Number of trials over time



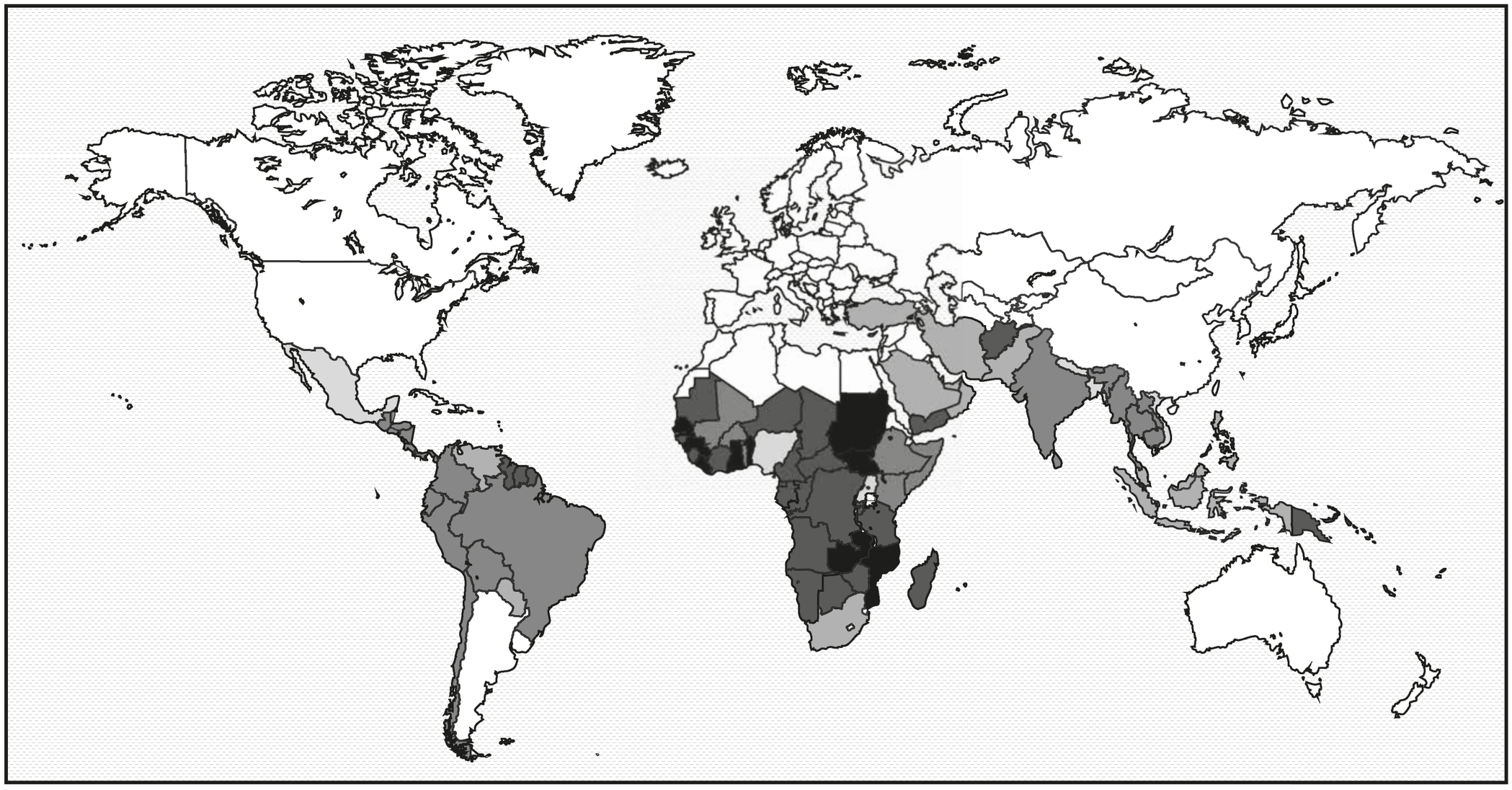
Question 7 (b)

IMAGE 7.1

Key: Malaria cases (per 100,000)

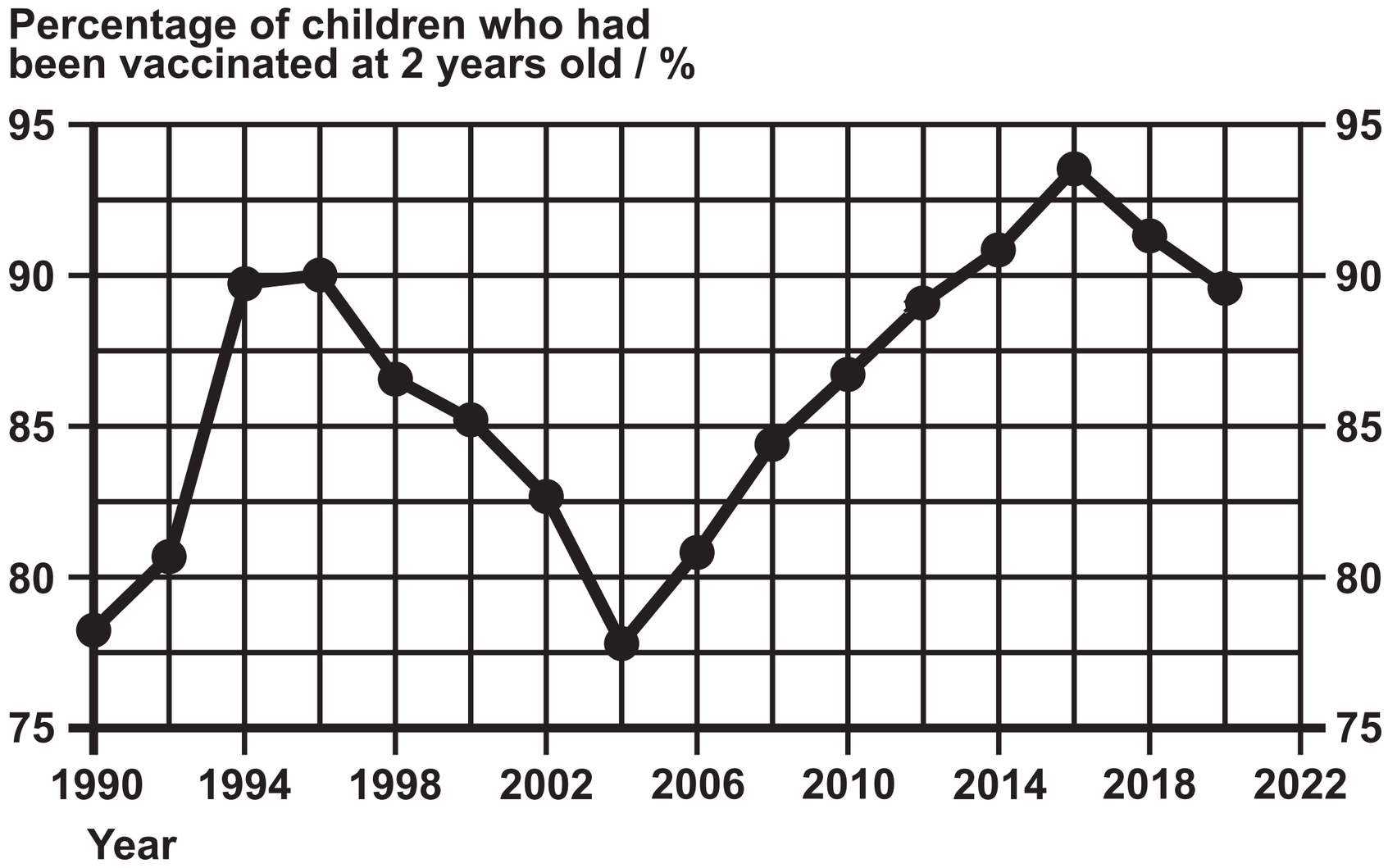
- <10
- ≥10 < 100
- ≥100 < 1000
- ≥1000 < 10,000
- ≥10,000 < 25,000
- ≥25,000

Malaria cases (per 100,000) by country



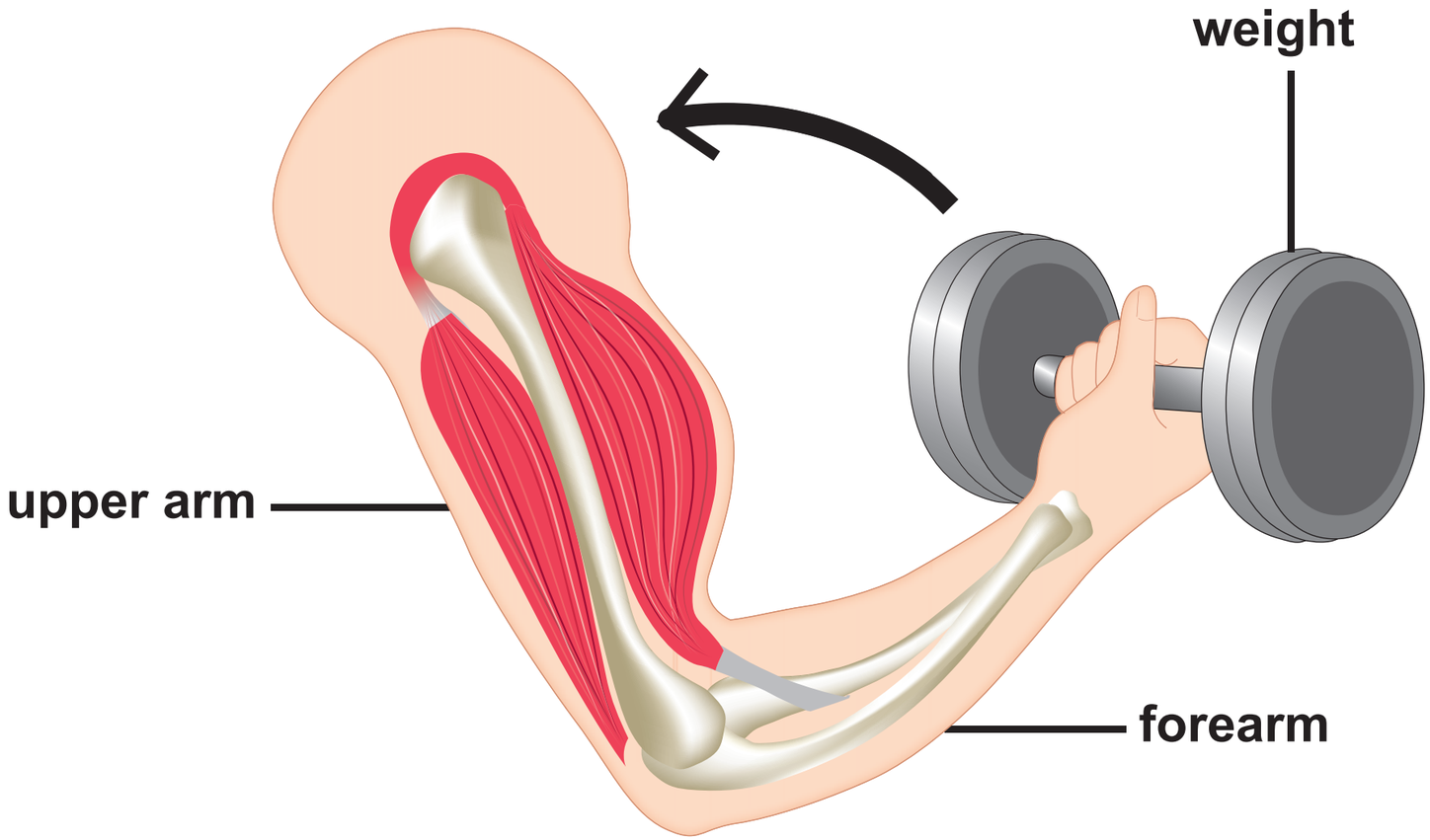
Question 7 (c)

IMAGE 7.2



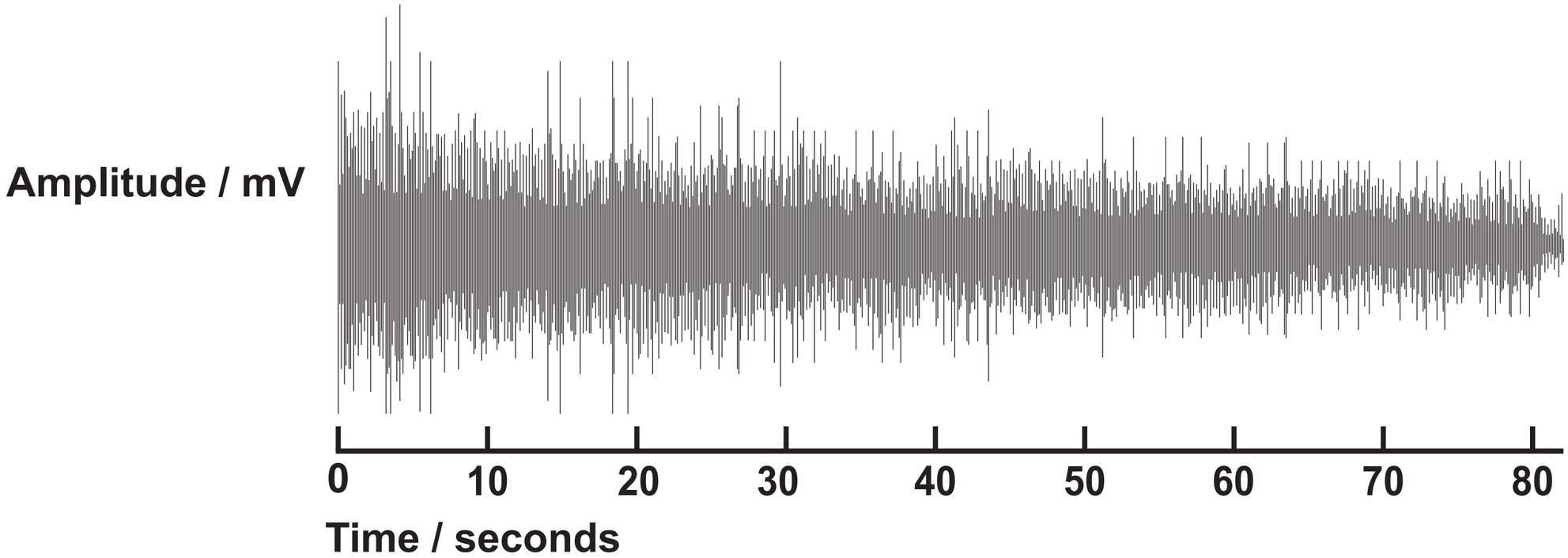
Question 8

IMAGE 8.1



Question 8 (b) (ii)

IMAGE 8.2



Question 8 (b) (ii)

TABLE 8.3

Gender	Name	Total time / s	Mean amplitude for first five seconds / mV	Mean amplitude for last five seconds / mV	Rate of fatigue
Male	Robert	85	26.85	17.20	– 0.11
	George	135	29.13	5.03	– 0.18
	Gabriel	90	6.83	2.10	
Female	Mary	230	9.32	3.48	– 0.03
	Elizabeth	120	14.31	4.09	– 0.09
	Alexandra	135	12.11	3.55	– 0.06

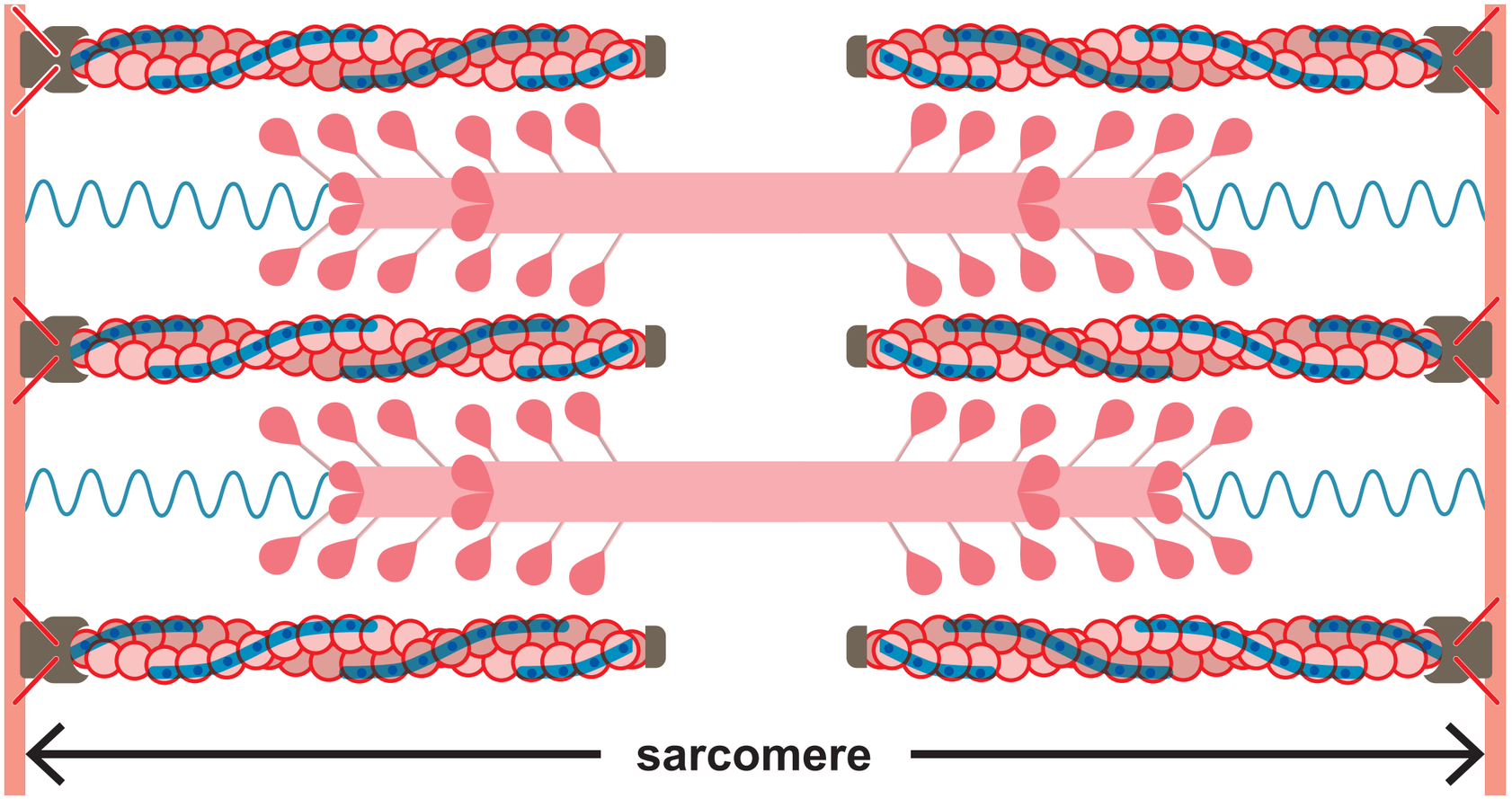
Question 8 (b) (ii)

Equation

$$\text{Rate of fatigue} = \frac{\text{mean amplitude for last five seconds} - \text{mean amplitude for first five seconds}}{\text{time}}$$

Question 8 (c)

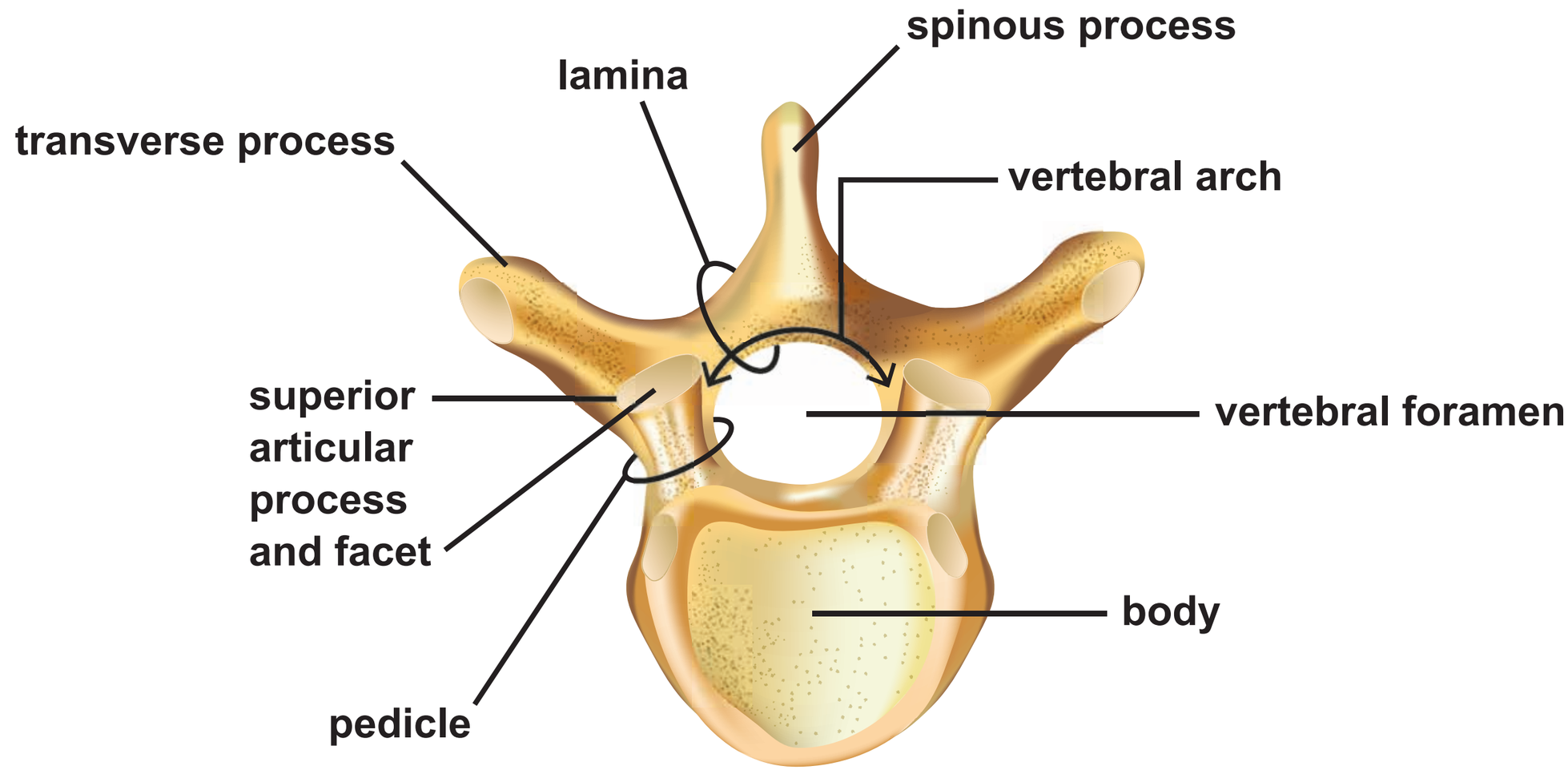
IMAGE 8.4



Question 8 (d)

IMAGE 8.5

POSTERIOR

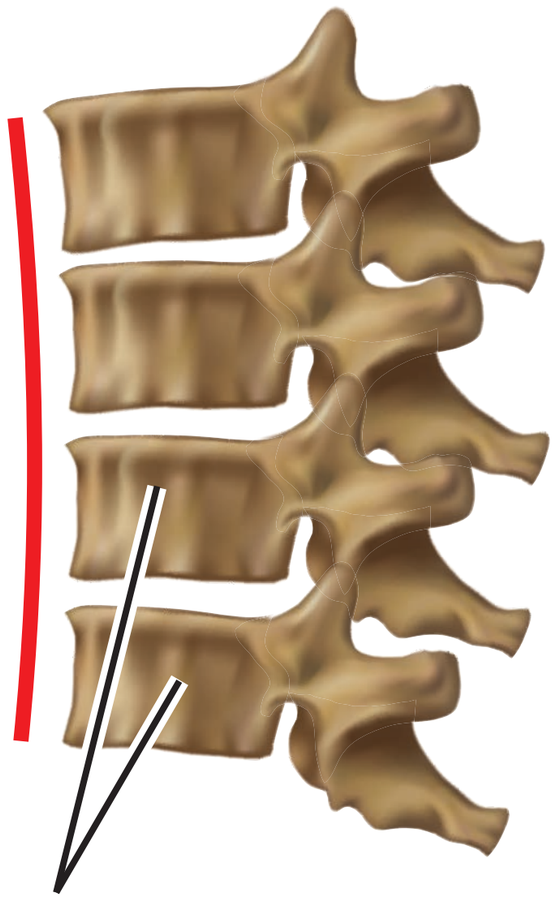


ANTERIOR

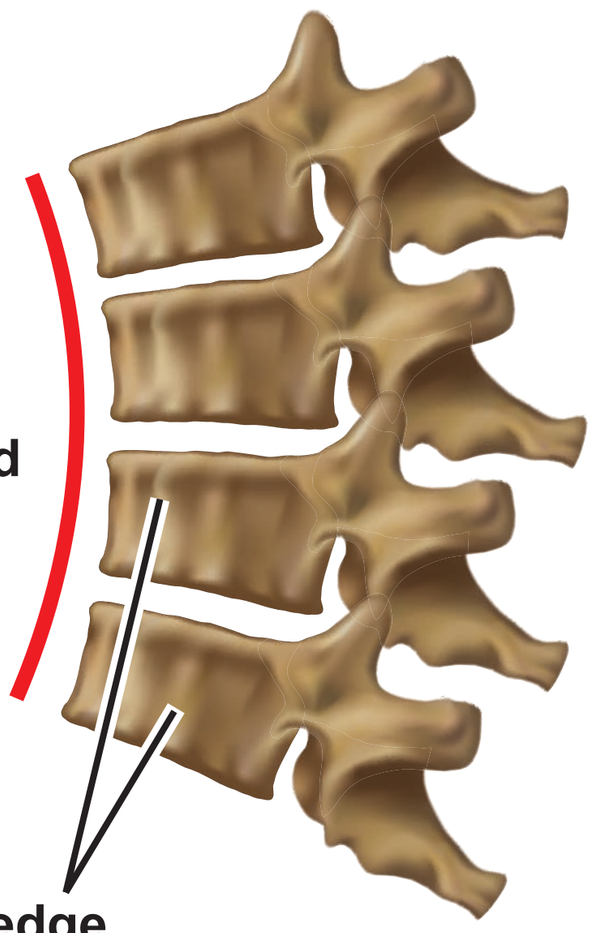
Question 8 (d) (ii)

IMAGE 8.6

Normal vertebrae



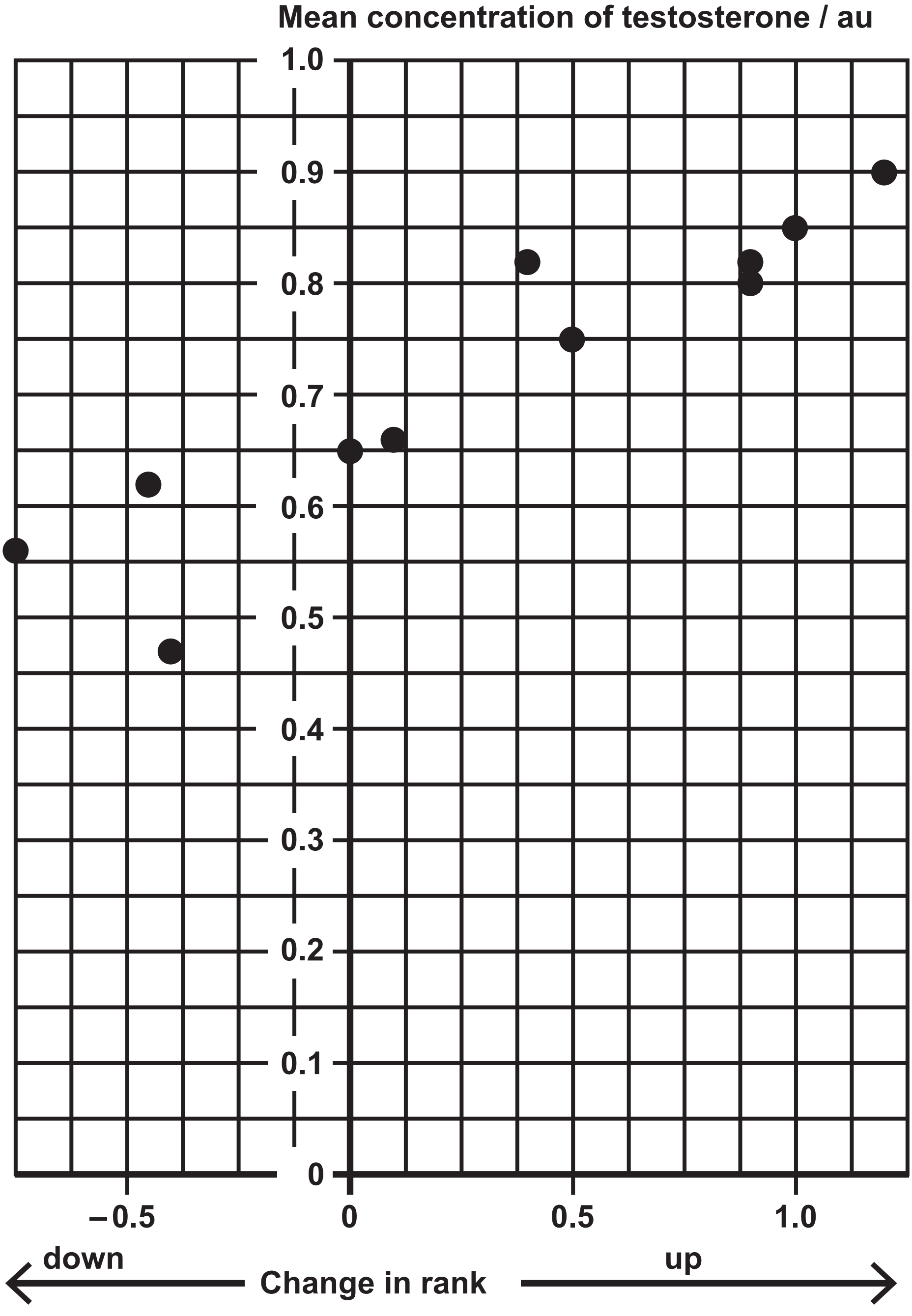
Vertebrae with Scheuermann's kyphosis



Question 9

Question 9 (b)

GRAPH 9.1



Question 9 (c)

IMAGE 9.2

Female (peahen)

Male (peacock)

Question 9 (d)

Question 9 (d) (ii)

GRAPH 9.3