GCE A LEVEL

1400U40 – 1

FRIDAY, 14 JUNE 2024 – 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.**	**11**	
	2.	**15**	
	3.	**13**	
	4.	**10**	
	5.	**12**	
	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 or black ball – point pen 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 page(s) at the back of this 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 on this section.

Section B: 20 marks; Options. Answer ONE OPTION ONLY. You are advised to spend 25 minutes 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. **Refer to IMAGE 1.1 in the separate Diagram Booklet. The male reproductive system consists of a number of sex organs that play a role in the process of human reproduction. These organs are located on the outside of the body and within the pelvis as shown in IMAGE 1.1**

   (a) **Using the numbers in IMAGE 1.1, identify the following structures and briefly describe ONE function for each structure in TABLE 1.1 in separate Diagram Booklet.**

[5 marks]

continued on the next page . . .

Question 1 continued

1. (b) Compare the function of the urethra in males and females.

[2 marks]

continued on the next page . . .

Question 1 continued

1. (c) Refer to IMAGE 1.2 in the separate Diagram Booklet.

(i) Name the cells A, B, C and D in IMAGE 1.2

Cells	Name
A	
B	
C	
D	

[2 marks]

continued on the next page . . .

Question 1 (c) continued

1. (c) (ii) High numbers of spermatozoa must be constantly produced to ensure fertility. Use your knowledge of CELL DIVISION to explain why it is important that all type I spermatogonia do not become type II spermatogonia.

[2 marks]

(Total for Question 1 = 11 marks)

2. Refer to IMAGE 2.1 in the separate Diagram Booklet. Germination involves the rapid onset of biochemical activity and growth of a seedling until the plant can carry out photosynthesis and become independent of the food stores contained in the cotyledons. IMAGE 2.1 shows some stages of a germinating pea plant over a 15 – day period.

(a) (i) The germinating pea seed labelled **P** in IMAGE 2.1 was cut open. This is shown in IMAGE 2.2 in the separate Diagram Booklet.

ADD LABELS TO LINES A, B AND C to identify the COTYLEDON, PLUMULE AND RADICLE on IMAGE 2.2

[2 marks]

continued on the next page . . .

Question 2 (a) continued

2. (a) (ii) State TWO reasons why it is important that the radicle emerges prior to the plumule.

[2 marks]

continued on the next page . . .

Question 2 continued

2. (b) Briefly describe the stages of germination in a NON – ENDOSPERMIC seed such as the pea.

[3 marks]

continued on the next page . . .

Question 2 continued

2. (c) Refer to IMAGE 2.3 in the separate Diagram Booklet. Gibberellin is required for maize kernel (seed) germination. It is blocked by another plant hormone, abscisic acid (ABA) whilst the kernel is maturing on the cob. Mutant kernels which cannot produce ABA germinate whilst still on the cob. This is shown in IMAGE 2.3

With reference to the function of gibberellin, explain why the mutant kernels germinate causing the appearance of the corn cob in IMAGE 2.3

[3 marks]

2. (d) Refer to TABLE 2.4 in the separate Diagram Booklet. Field trials were carried out to investigate the effect of increasing soil temperature on the average number of wheat plants that grow. The results are shown in TABLE 2.4

In each field, the wheat grains were planted at a depth of 4 cm at a rate of 100 kg per hectare and the temperature was measured in each field at a depth of 5 cm.

continued on the next page . . .

Question 2 (d) continued

2. (d) (i) One simple conclusion from this data is that higher soil temperatures reduce the number of mature wheat plants per square metre. State FOUR other factors that could affect the growth and so your confidence in this conclusion.

I. _____

_____

II. _____

_____

III. _____

_____

IV. _____

_____

[2 marks]

continued on the next page . . .

Question 2 (d) continued

2. (d) (ii) Assuming that this was a valid conclusion, state why the results of this research are of serious significance to worldwide wheat production.

[3 marks]

(Total for Question 2 = 15 marks)

3. An artificial gene coding for human growth hormone (HGH), was synthesised in a laboratory.
The synthesised gene was used to genetically modify E. COLI bacteria, which then produced HGH.
The synthesised HGH was identical to natural HGH in size and biological activity.

(a) The human genome project determined the base pairs that make up human DNA.
Explain how the results from the human genome project have allowed the synthesis of the artificial gene to become possible.

[1 mark]

continued on the next page . . .

Question 3 continued

3. (b) State THREE advantages of using an artificially synthesised gene rather than extracting the gene from the human genome.

[3 marks]

continued on the next page . . .

Question 3 continued

3. (c) Refer to IMAGE 3.1 in the separate Diagram Booklet . The plasmid used to genetically modify the E. COLI is shown in IMAGE 3.1 It also shows the positions of two antibiotic resistance genes and the site of insertion of the HGH gene.

Name the TWO types of enzymes needed for the successful insertion of the human growth hormone gene and state their function in the process.

[2 marks]

continued on the next page . . .

Question 3 continued

3. (d) Refer to IMAGE 3.2 in the separate Diagram Booklet. To test that the plasmid has transferred successfully, the bacteria were grown on separate agar plates containing the two antibiotics. The bacteria were initially grown on agar containing tetracycline and the colonies were then transferred, using a replica pad, to agar containing ampicillin as shown in IMAGE 3.2

(i) Explain the need for PLATE A in the process.

[1 mark]

continued on the next page . . .

Question 3 (d) continued

3. (d) (ii) Explain the results shown on PLATE B.

[3 marks]

continued on the next page . . .

Question 3 (d) continued

3. (d) (iii) Suggest ONE vital property of the cells on PLATE C which would need to be confirmed prior to their use in the production of HGH.

_____

_____

_____

[1 mark]

continued on the next page . . .

Question 3 continued

3. (e) Each E. COLI cell transformed with this recombinant plasmid produced $2 \cdot 9 \times 10^6$ molecules of HGH. If there are 1×10^8 bacteria in the culture vessel, calculate the number of HGH molecules being produced by the cells. GIVE YOUR ANSWER IN STANDARD FORM.

Number of HGH molecules = _____

[2 marks]

(Total for Question 3 = 13 marks)

4. Refer to the IMAGE 4.1 in the separate Diagram Booklet. Bones can be preserved as fossils so research into evolutionary patterns and processes can include extinct vertebrates. IMAGE 4.1 shows how the leg bones of the modern horse have evolved from a horse – like mammal over the last 38 million years.

(a) Explain how the information in IMAGE 4.1 supports Darwin's theory of evolution.

[3 marks]

continued on the next page . . .

Question 4 continued

4. (b) Refer to IMAGES 4.2 and 4.3 in the separate Diagram Booklet. Ancient horses had many coat colours. One type of gene controlling depth of colour in horses is the dun allele (D).
For example the bay horse in Image 4.2 is homozygous for the d allele but a horse is a dun if it has at least one D allele (IMAGE 4.3).

continued on the next page . . .

Question 4 (b) continued

4. (b) (i) In a sample of 900 wild horses, 891 were dun and 9 were bay. Calculate the frequencies of the three genotypes within this population, assuming that the population is in Hardy–Weinberg equilibrium.

$$p + q = 1$$

$$p^2 + 2pq + q^2 = 1$$

where

p = frequency of the dominant allele (D)

q = frequency of the recessive allele (d)

Frequency of dd = _____

Frequency of DD = _____

Frequency of Dd = _____

[3 marks]

continued on the next page...

Question 4 (b) continued

4. (b) (ii) The population in (b) (i) consisted of randomly mating horses in semi – desert conditions.
Use all the information given to give TWO reasons why this population may not be in Hardy – Weinberg equilibrium.

[2 marks]

continued on the next page . . .

Question 4 continued

4. (c) Refer to IMAGES 4.4A and 4.4B in the separate Diagram Booklet. IMAGES 4.4A and 4.4B show photographs of a mule and a hinny.

Mules are considered more patient, hardy and long–lived than horses and are described as less obstinate and more intelligent than donkeys. They can carry heavy loads for long distances so are an ideal pack–animal.

A mule is a hybrid resulting from crossing a male donkey (E. ASINUS) with a female horse (E. CABALLUS).

(i) Explain why a breeder would need to use a donkey and a horse EACH TIME they wished to produce a mule.

[1 mark]

continued on the next page . . .

Question 4 (c) continued

4. (c) (ii) The opposite cross (a hinny) can also be carried out, but it is done very rarely. The mother is the much smaller donkey compared with the larger horse mother in a mule cross. Explain why the mule cross is more suitable for a load–bearing pack animal.

[1 mark]

(Total for Question 4 = 10 marks)

5. There are many sex – linked genetic diseases in humans which cause changes in phenotype.

   X – linked inheritance means that the gene is located on the X chromosome.

   X – linked severe combined immunodeficiency (X – SCID) is a recessive immunodeficiency disorder in which the body produces very few lymphocytes.

continued on the next page . . .

Question 5 continued

5. (a) (i) I. Use the symbols X^D for unaffected by X – SCID and X^d for affected by X – SCID to draw a genetic diagram to show how parents who are both unaffected can produce a son with X – SCID.

Parental phenotype	**unaffected male ×**	**unaffected female**
Parental genotypes	_____	_____
Gametes	_____	_____

Space for genetic diagram

[2 marks]

continued on the next page . . .

Question 5 (a) continued

5. (a) II. COMPLETE THE TABLE below linking the FOUR different genotypes from your genetic diagram with their correct phenotype.

Offspring genotype	Offspring phenotype

[2 marks]

continued on the next page . . .

Question 5 (a) continued

5. (a) (ii) The estimated UK incidence of X – SCID is 1 in 48933 The population of Wales in 2018 was 3139000

Calculate the number of cases of X – SCID that would have been expected in Wales in 2018

GIVE YOUR ANSWER TO AN APPROPRIATE NUMBER OF SIGNIFICANT FIGURES.

Number of cases = _____

[2 marks]

continued on the next page . . .

Question 5 continued

Refer to IMAGE 5.1 in the separate Diagram Booklet. There are other mechanisms, such as epigenetic changes, which can alter the phenotype of organisms. One example is DNA methylation, where a methylated promoter region decreases the expression of a gene and demethylation increases the expression of a gene. This is shown in IMAGE 5.1

Epigenetic control mechanisms can be seen in coat colour in mice which is influenced by the nutrition of the pregnant female.

When the pregnant females are fed compounds such as BPA (used in plastic production) with their normal diet, this can cause more yellow offspring to be born. When the pregnant females' normal diets are supplemented with high folic acid, more brown offspring are born. This is summarised in IMAGE 5.2 in the separate Diagram Booklet.

continued on the next page . . .

Question 5 continued

When mice were fed the two different diets, the following results were obtained, with ranges in coat colour as shown in IMAGE 5.3 in the separate Diagram Booklet. The number of each type of coat colour is shown in GRAPH 5.4, also in the separate Diagram Booklet.

5. (b) (i) Using IMAGES 5.1, 5.2, 5.3 and GRAPH 5.4, explain the effect of the TWO different supplements on gene expression and coat colour in mice.

[4 marks]

5. (b) (ii) Use all of the information to suggest how the results of this study might influence the use of BPA in the production of food containers and packaging.

[2 marks]

(Total for Question 5 = 12 marks)

6. **Mutations in the DNA of an organism may have a profound effect on the phenotype. There are two main types of mutations; gene and chromosome.**

Explain what is meant by the term mutation and describe some factors which increase the rate of mutations.

Describe the different types of gene and chromosome mutations and, using suitable examples, explain the different effects that gene and chromosome mutations may have on the phenotype.

[9 QER marks]

Total for Question 6 = 9 marks

TOTAL FOR SECTION A = 70 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. Tuberculosis (TB) is the leading cause of death by an infectious disease worldwide.

(a) (i) State why tuberculosis is called an infectious disease.

[1 mark]

(ii) To prevent the spread of TB, the BCG vaccination was introduced in 1953 for children aged 10–14 years old. Define the term vaccine.

[1 mark]

continued on the next page . . .

Question 7 (a) continued

7. (a) (iii) Refer to IMAGE 7.1 in the separate Diagram Booklet. The BCG vaccination is no longer part of childhood immunisations. It is only offered to those who are at higher risk of TB; for example, children under 5 who live in an area of the UK with a high rate of TB, as in some areas of London. IMAGE 7.1 shows the population density of different areas of London.

Using the map in IMAGE 7.1, suggest why the TB incidence is so high in some areas of London.

[2 marks]

7. (b) Refer to GRAPH 7.2 in the separate Diagram Booklet. GRAPH 7.2 shows the concentration of antibodies released by the body following a BCG vaccination and then after exposure to the live infectious micro–organism, MYCOBACTERIUM TUBERCULOSIS.

The BCG vaccine initiates an active immune response which leads to the production of antibodies by the patient.

(i) Describe and explain the shape of the part of GRAPH 7.2 which shows the primary immune response. Question 7 continued

[4 marks]

continued on the next page . . .

Question 7 (b) continued

7. (b) (ii) With reference to GRAPH 7.2, explain how vaccination prevents development of TB when exposed to M. TUBERCULOSIS.

[4 marks]

continued on the next page . . .

Question 7 continued

7. (c) Refer to GRAPH 7.3 in the separate Diagram Booklet. Since the 1940s, antibiotics have been used to treat TB. GRAPH 7.3 shows the change in the numbers of diagnosed TB cases in England and Wales from 1940 to 2015

continued on the next page . . .

Question 7 (c) continued

7. (c) (i) Calculate the percentage decrease in TB INCIDENCE between 1940 and 2015

Percentage decrease in incidence of TB =_____%

[2 marks]

continued on the next page . . .

Question 7 (c) continued

MYCOBACTERIUM TUBERCULOSIS can develop into a dormant state, referred to as latent TB. Whilst dormant, M. TUBERCULOSIS is resistant to antibiotics. Patients with TB receive a combination of antibiotics to kill active bacteria rapidly and to try to prevent latent TB.

Refer to IMAGE 7.4 in the separate Diagram Booklet. Two new treatments have been proposed to target dormant M. TUBERCULOSIS to prevent TB recurring in a patient.

TREATMENT 1
Use of DRUG A to activate the dormant bacteria as well as treating with high doses of antibiotics to kill all activated bacteria.

TREATMENT 2
Use of DRUG B that will inhibit the activation of any dormant bacteria while the drug is present.

These treatments have been trialled in mice as shown in IMAGE 7.4

continued on the next page . . .

Question 7 (c) continued

7. (c) (ii) Complete TABLE 7.5 in the separate Diagram Booklet by stating ONE advantage and ONE disadvantage for each of the treatments.

[4 marks]

(d) The methods of treating TB can also be used to treat malarial infections.
Explain why these methods are less effective when they are used in the treatment of malarial infections.

[2 marks]

Total for Question 7 = 20 marks

OPTION B: HUMAN MUSCULOSKELETAL ANATOMY

8. The human musculoskeletal system is comprised of a number of different tissues, including muscle, cartilage and bone.

Refer to IMAGE 8.1 in the separate Diagram Booklet. IMAGE 8.1 shows the structure and appearance of a sarcomere in relaxed, striated muscle. It also shows transverse sections of the actin and myosin filaments in the sarcomere.

(a) (i) COMPLETE THE APPEARANCE of transverse SECTION 3 shown on IMAGE 8.1

[1 mark]

continued on the next page . . .

Question 8 (a) continued

8. (a) (ii) During contraction of the muscle, the sarcomere shortens. Describe and explain what happens to the H zone and A band.

[4 marks]

continued on the next page . . .

Question 8 (a) continued

8. (a) (iii) When the sarcomere is contracted, its length is 1•5 µm long.
Use IMAGE 8.1 to calculate the percentage decrease in length when the sarcomere contracts.

Percentage decrease in length of sarcomere

= _____

[2 marks]

continued on the next page . . .

Question 8 (a) continued

8. (a) (iv) Describe how the structure of actin allows cross bridges to form during contraction of the muscle and explain why cross bridges are unable to form in a resting muscle.

[2 marks]

continued on the next page . . .

Question 8 continued

8. (b) Cartilage is connective tissue found in the skeleton. There are several forms of cartilage.

(i) Explain how the structure of hyaline cartilage relates to its function in the skeleton.

[2 marks]

continued on the next page . . .

Question 8 (b) continued

Refer to IMAGE 8.2 in the separate Diagram Booklet. IMAGE 8.2 shows a normal knee joint and a joint affected by rheumatoid arthritis.

8. (b) (ii) Describe what is meant by rheumatoid arthritis and name TWO types of tissues affected by rheumatoid arthritis as shown in IMAGE 8.2

[2 marks]

continued on the next page . . .

Question 8 continued

8. (c) Refer to IMAGE 8.3 in the separate Diagram Booklet. Osteoporosis is a form of brittle bone disease in humans. It is caused by the loss of calcium from the bones leading to decreased bone density. IMAGE 8.3 shows a cross section of bone from a healthy patient, and one from a patient suffering from osteoporosis.

(i) Using IMAGE 8.3 and your own knowledge, describe the effect of osteoporosis on the composition of the bones.

[2 marks]

continued on the next page . . .

Question 8 (c) continued

Refer to TABLE 8.4 in the separate Diagram Booklet. Amniotic fluid contains a form of stem cell that can differentiate into osteoblasts. Research has been carried out to assess the effectiveness of stem cells in treating osteogenesis imperfecta (OI) in mice. Three groups of mice were tested. The treatment received by each group is shown in TABLE 8.4

The results of the research are shown in GRAPHS 8.5 and 8.6 in the separate Diagram Booklet.

continued on the next page . . .

Question 8 (c) continued

8. (c) (ii) Summarise the effect of stem cell treatment in the experimental group C in comparison to the healthy mice (A) and the control group (B) shown in GRAPHS 8.5 AND 8.6

[3 marks]

continued on the next page . . .

Question 8 (c) continued

8. (c) (iii) The use of human stem cells is being considered for clinical trials in humans to treat osteoporosis. Using all of the information provided, suggest how stem cell treatment could improve the condition of bones in osteoporosis patients.

[2 marks]

Total for Question 8 = 20 marks

OPTION C: NEUROBIOLOGY AND BEHAVIOUR

9. Prairie dogs (CYNOMYS LUDOVICIANUS) are rodents, native to the grasslands of North America, which live in large colonies. Members of a family group interact through a variety of social behaviours such as kissing and grooming one another.
IMAGE 9.1 in the separate Diagram Booklet, shows prairie dogs sharing a greeting kiss.

(a) Prairie dogs are said to demonstrate social behaviour.

(i) Define the term social behaviour.

_____

_____

_____

[1 mark]

continued on the next page . . .

Question 9 (a) continued

Prairie dogs communicate with other members of the colony by making different sounding barks. When an intruder approaches, the first prairie dog gives a sharp bark, bobs up and down, barks again, and then plunges into a burrow. Other lookouts further away repeat this behaviour alerting other members of the colony along the route taken by the intruder.

9. (a) (ii) The social behaviour of 'barking and bobbing' is an example of a fixed action pattern. Explain how such a fixed action pattern is generated and why it may be advantageous to the animals within the social group.

[2 marks]

9. (a) (iii) State TWO differences between a fixed action pattern and a reflex action.

[2 marks]

continued on the next page . . .

Question 9 continued

9. (b) Social behaviour involves a large number of learnt responses.

Researchers investigated the behaviour of prairie dogs in colonies in Colorado. They were trying to find out if prairie dogs became habituated to the arrival of a human in their territory.

(i) Define the term habituation and explain why it is an advantage to the prairie dogs.

[2 marks]

continued on the next page . . .

Question 9 (b) continued

The researchers selected two colonies of prairie dogs:

Colony A **From a rural area, out of town, and not used to human presence.**

Colony B **From an urban area, close to city parks, where the prairie dogs would occasionally encounter humans.**

Humans slowly approached each colony 100 times over 200 days. They recorded the concealment distance – this is the distance from the lookout animal to the human when the prairie dogs went down into the burrows. The researchers expected that the prairie dogs would become habituated to the presence of humans. Refer to GRAPH 9.2 in the separate Diagram Booklet. The results are shown in GRAPH 9.2

continued on the next page . . .

Question 9 (b) continued

9. (b) (ii) Using GRAPH 9.2, calculate the percentage increase in concealment distance for the rural prairie dogs over the 200 days.

Percentage increase in concealment distance

= _____

[2 marks]

continued on the next page . . .

Question 9 (b) continued

9. (b) (iii) Use the evidence from GRAPH 9.2 to conclude whether the researchers' expectations were correct.

[3 marks]

continued on the next page . . .

Question 9 continued

9. (c) Refer to IMAGES 9.3 and 9.4 in the separate Diagram Booklet. IMAGES 9.3 and 9.4 show fMRI scans of two patients taken whilst carrying out language skill tasks.

(i) State why an fMRI scan was the most suitable form of brain scan to show where the patients were processing language.

[1 mark]

(ii) Suggest the area of the brain where the stroke took place and explain what has happened in the brain of the stroke patient in IMAGE 9.4 to account for the fMRI scan result.

[4 marks]

9. (c) (iii) The patient in IMAGE 9.4 regained all aspects of language. Refer to IMAGE 9.5 in the separate Diagram Booklet. IMAGE 9.5 shows an fMRI scan from a patient who had a stroke as a mature adult.

Using IMAGE 9.5 and your own knowledge, explain why it would be more difficult for this patient to fully regain all aspects of language.

[3 marks]

Total for Question 9 = 20 marks

TOTAL FOR SECTION B = 20 MARKS

END OF PAPER

TOTAL FOR PAPER = 90 MARKS

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

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GCE A LEVEL

1400U40–1

FRIDAY, 14 JUNE 2024 – 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 _____

IMAGE 1.1

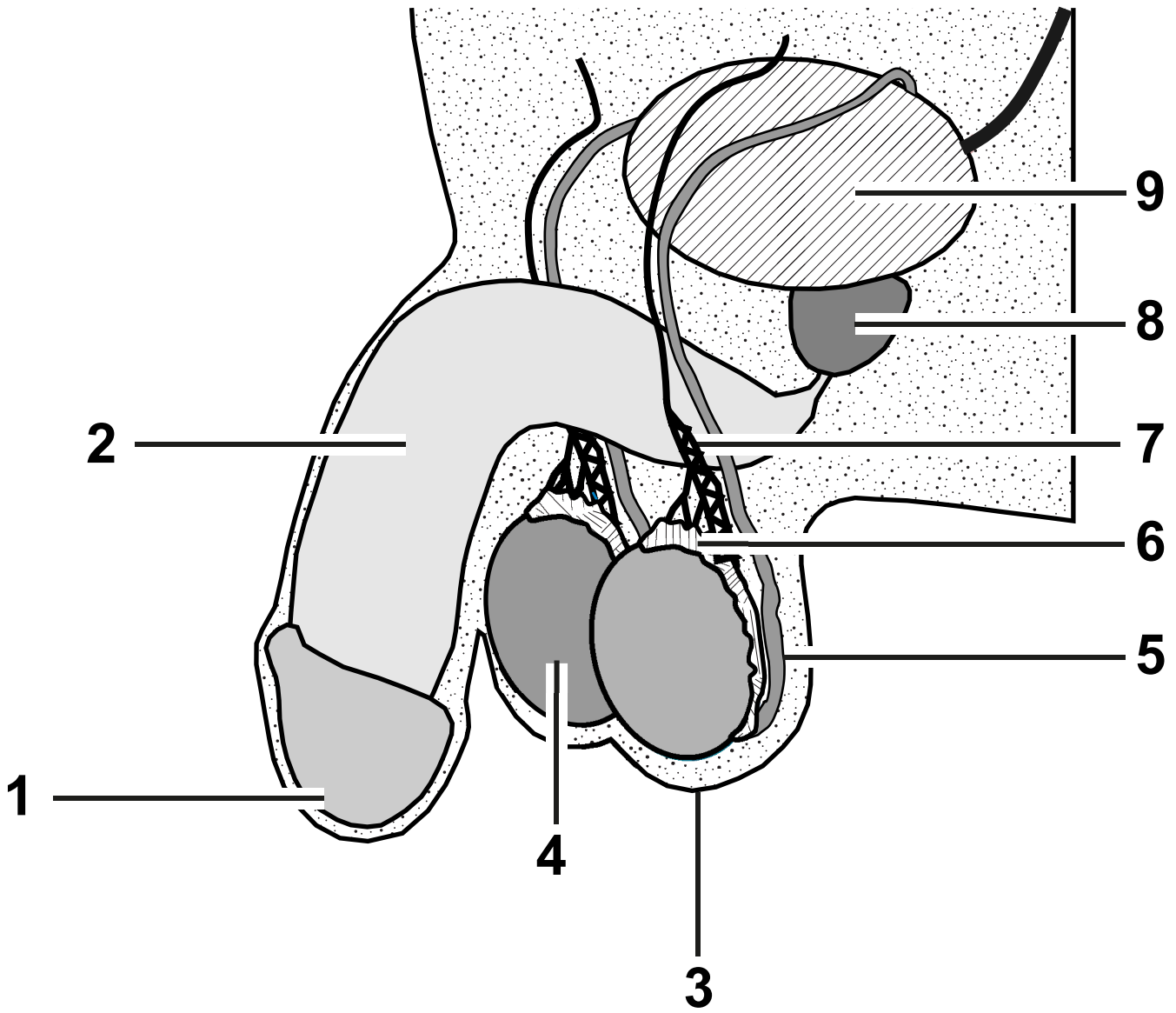


TABLE 1.1

Structure	Number from IMAGE 1.1	Function
vas deferens	_____	_____ _____
scrotum	_____	_____ _____
testes	_____	_____ _____
epididymis	_____	_____ _____
prostate gland	_____	_____ _____

IMAGE 1.2

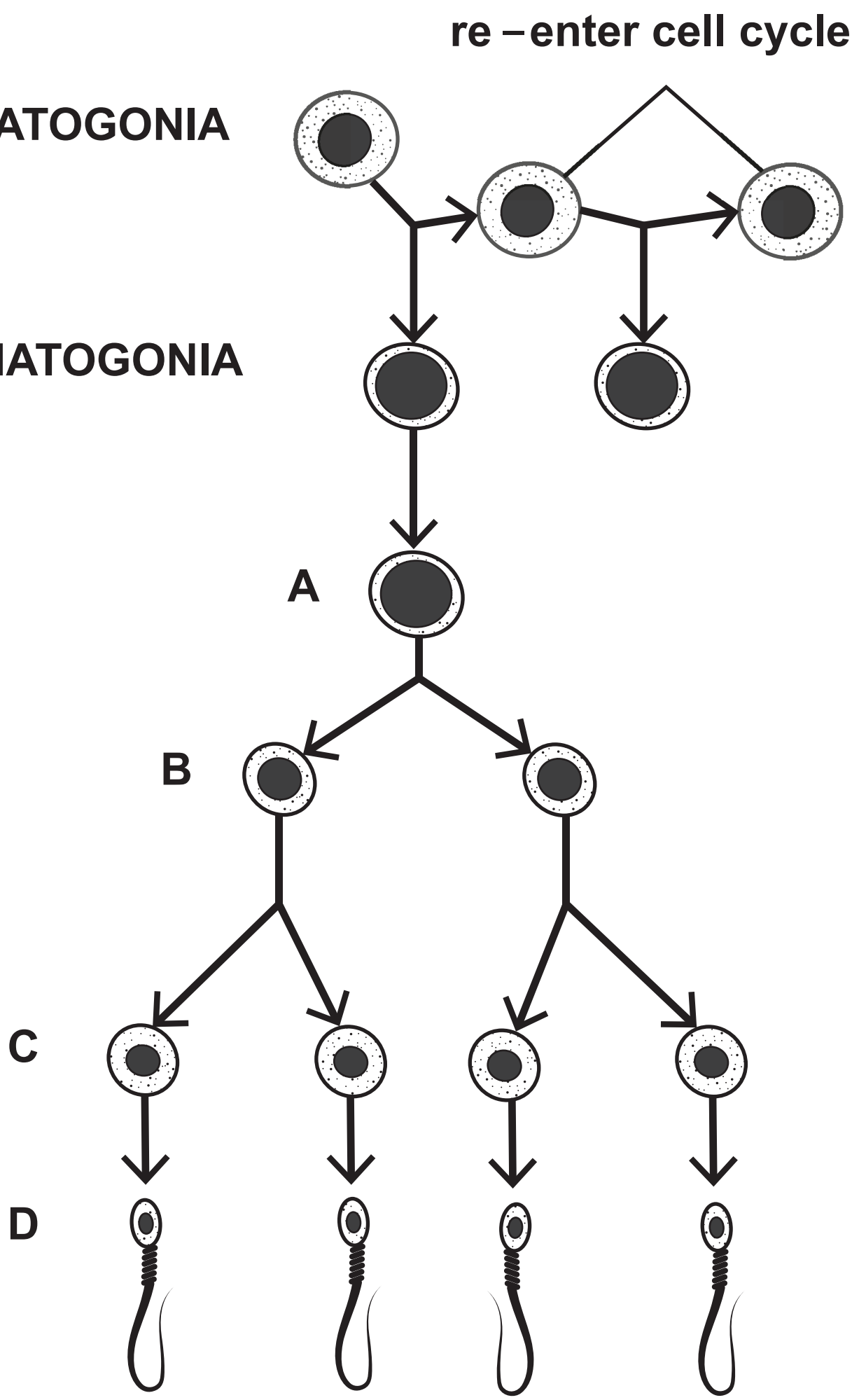

re – enter cell cycle
TYPE I SPERMATOGONIA
TYPE II SPERMATOGONIA
A
B
C
D

IMAGE 2.1

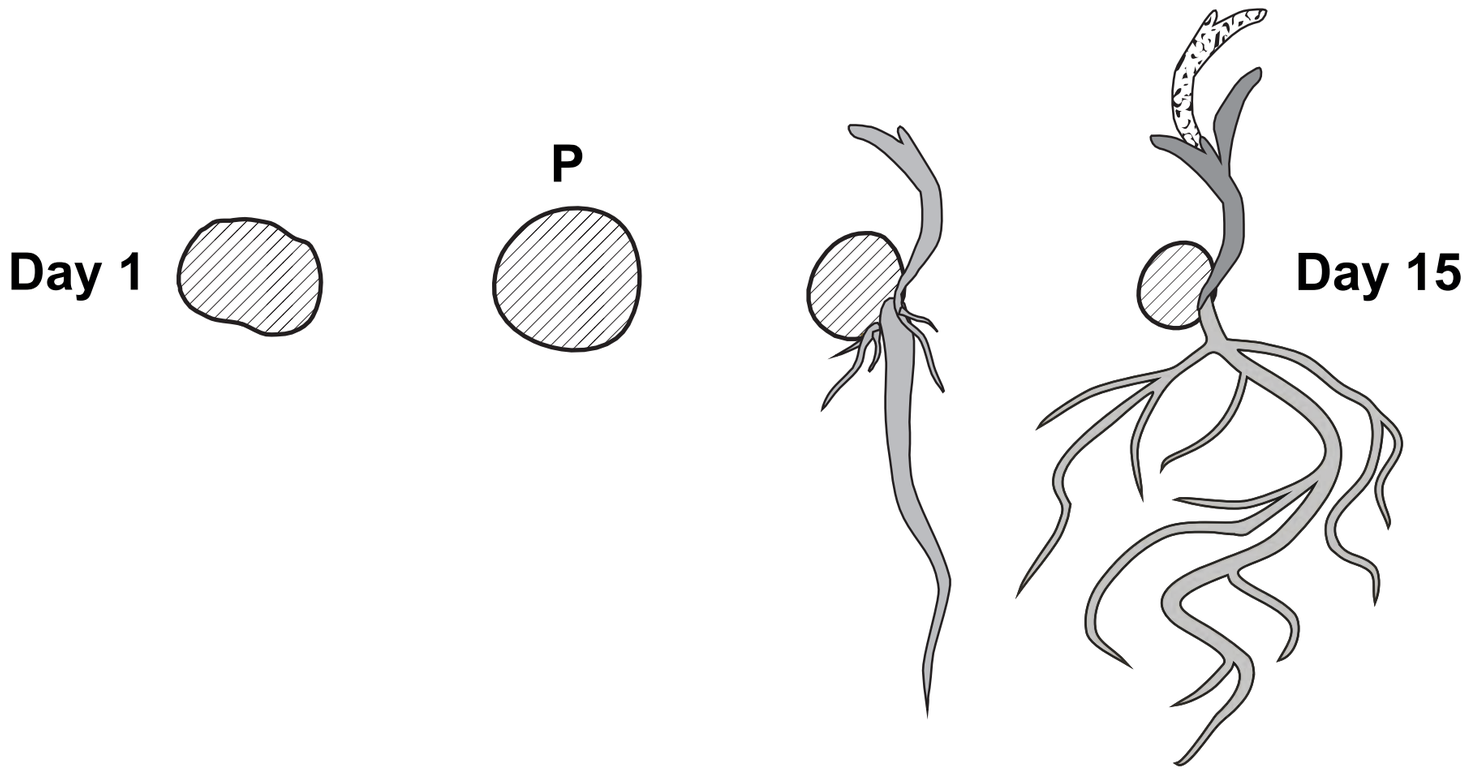


IMAGE 2.2

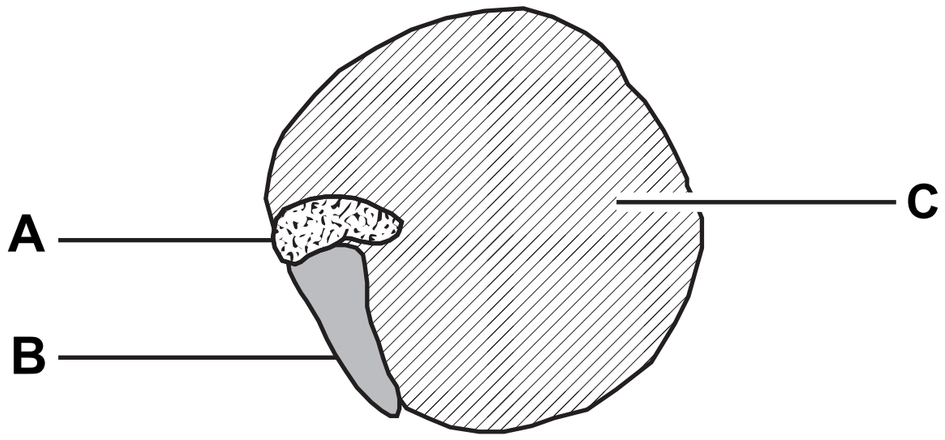


IMAGE 2.3

TABLE 2.4

Mean maximum soil temperature (°C)	Number of mature wheat plants per m^2
20•2	315•3
33•2	256•7
42•2	89•8

IMAGE 3.1

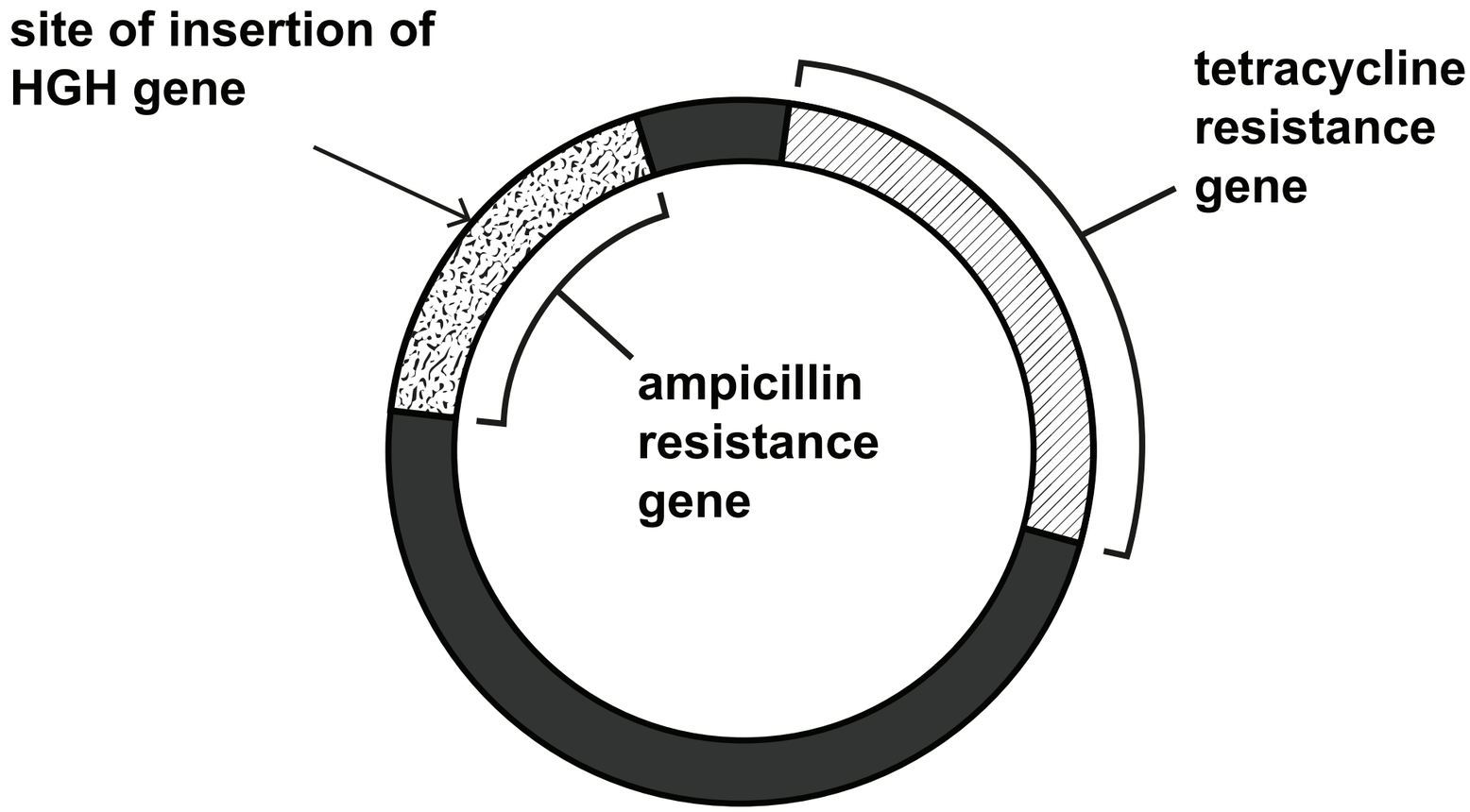

site of insertion of HGH gene
tetracycline resistance gene
ampicillin resistance gene

IMAGE 3.2

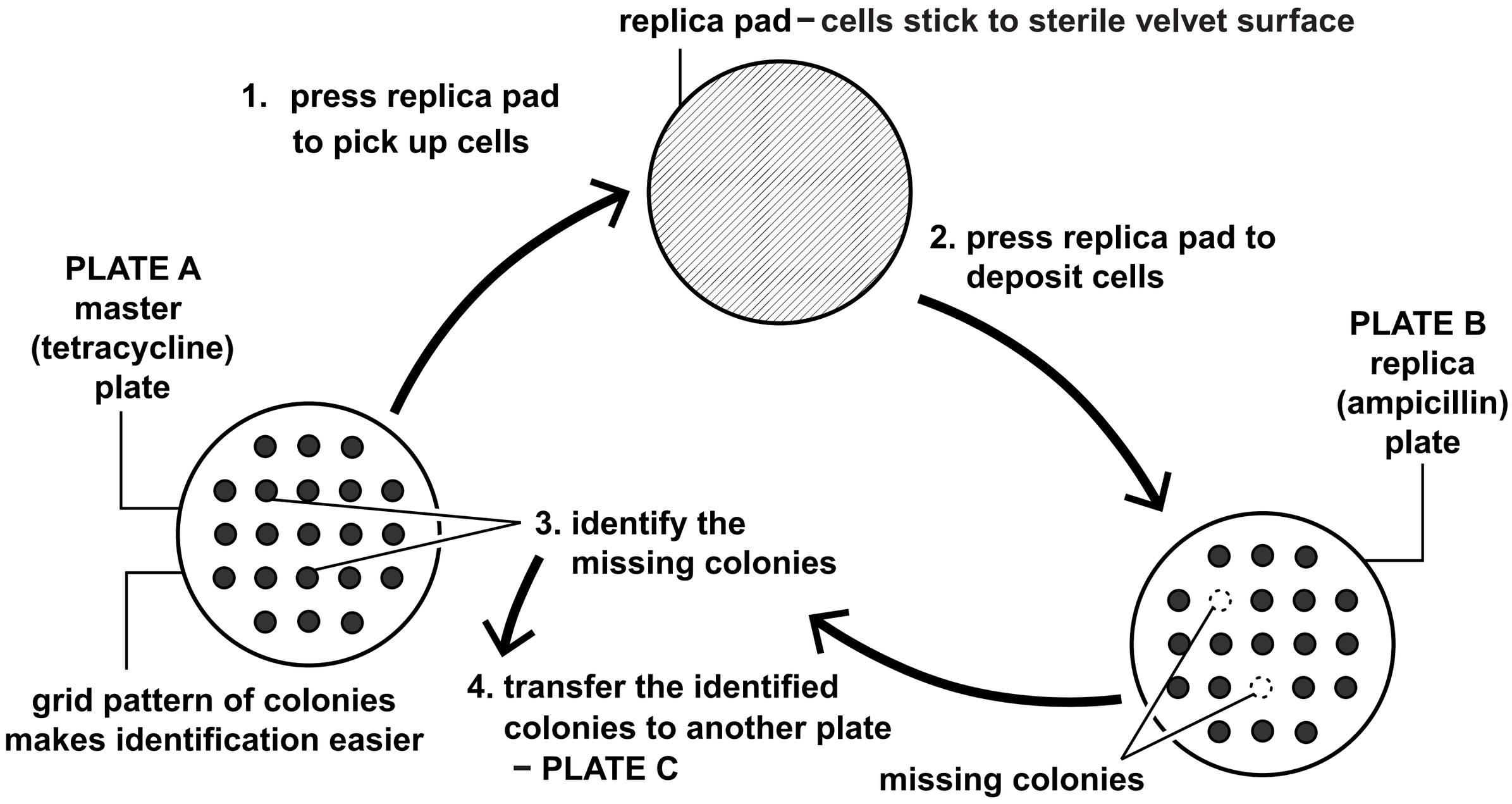

replica pad – cells stick to sterile velvet surface
1. press replica pad to pick up cells
2. press replica pad to deposit cells
PLATE A master (tetracycline) plate
PLATE B replica (ampicillin) plate
3. identify the missing colonies
4. transfer the identified colonies to another plate – PLATE C
grid pattern of colonies makes identification easier
missing colonies

IMAGE 4.1

MYA = Million Years ago

EQUUS
Recent

MERYCHIPPUS
Middle Miocene
11 MYA

MESOHIPPUS
Late Eocene
38 MYA

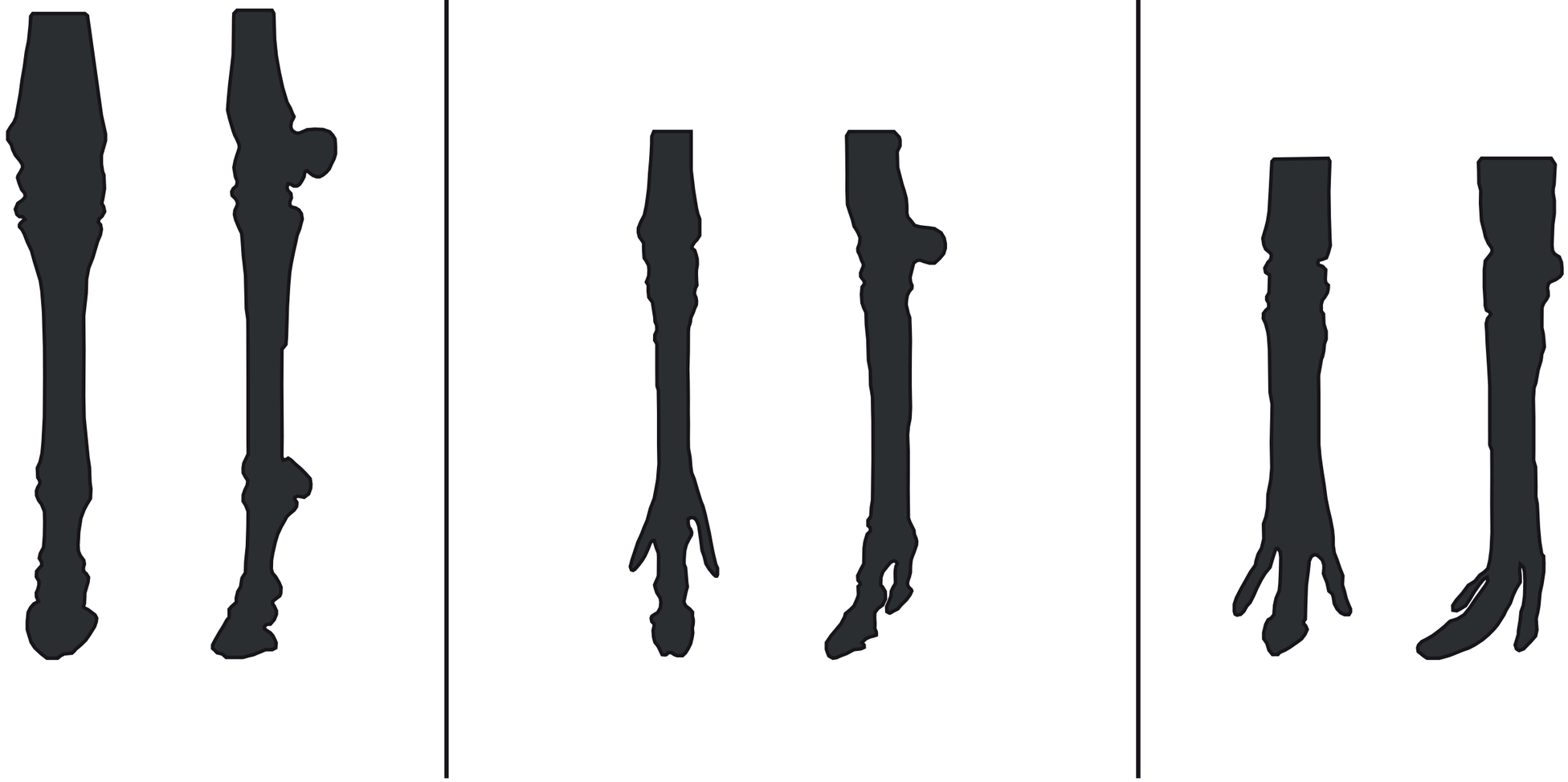


IMAGE 4.2 and IMAGE 4.3

IMAGE 4.2 Bay (dd)

IMAGE 4.3 Dun (DD or Dd)

IMAGE 4.4A and IMAGE 4.4B

IMAGE 4.4A – Mule

IMAGE 4.4B – Hinny

IMAGE 5.1

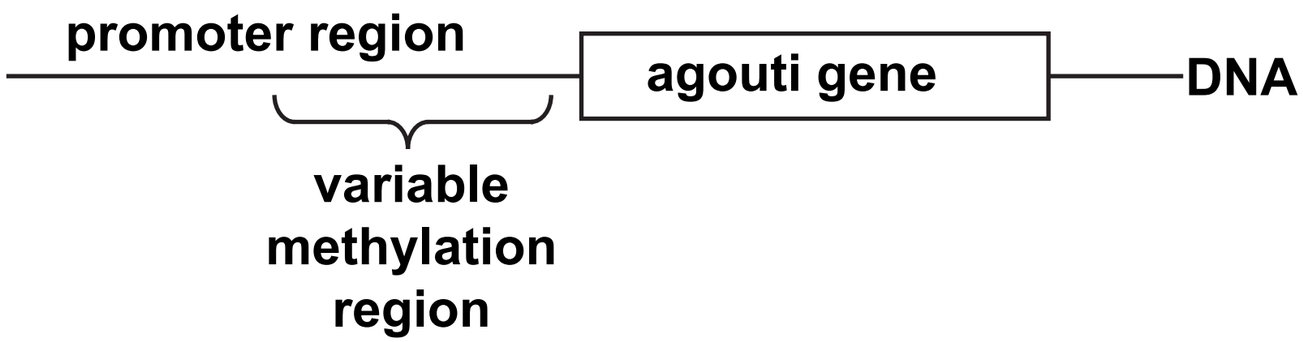
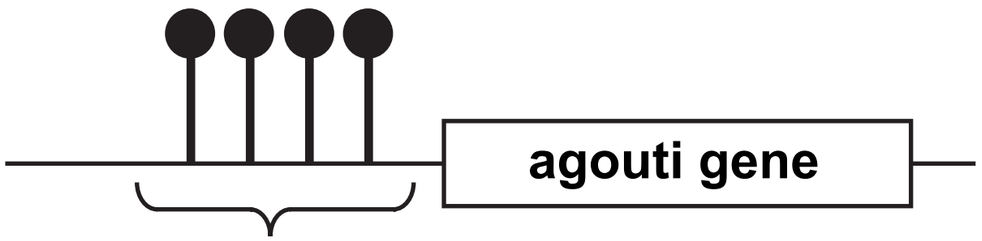

promoter region
agouti gene
DNA
variable
methylation
region

IMAGE 5.2

normal diet
+
folic acid



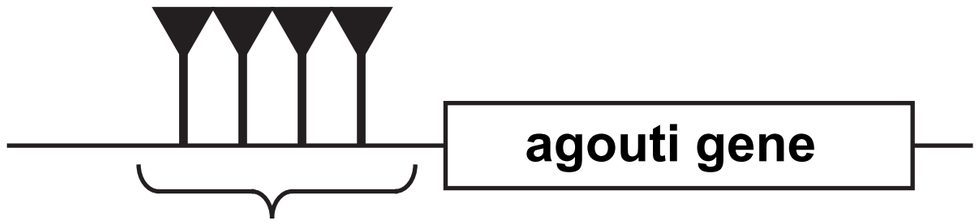
fully methylated

mRNA

agouti mRNA briefly made during development.
agouti gene silenced for the remainder
of the mouse ‘s life.

healthy mouse with brown fur.

normal diet
+
BPA



demethylated

mRNA

agouti gene is continually active, producing
mRNA across the mouse ‘s lifespan.

mouse with yellow fur;
develops obesity and diabetes during adulthood.

IMAGE 5.3

Coat colour

Key:

b = brown

hb = heavily mottled

m = mottled

sm = slightly mottled

y = yellow

GRAPH 5.4

Key:

normal diet + folic acid

normal diet + BPA

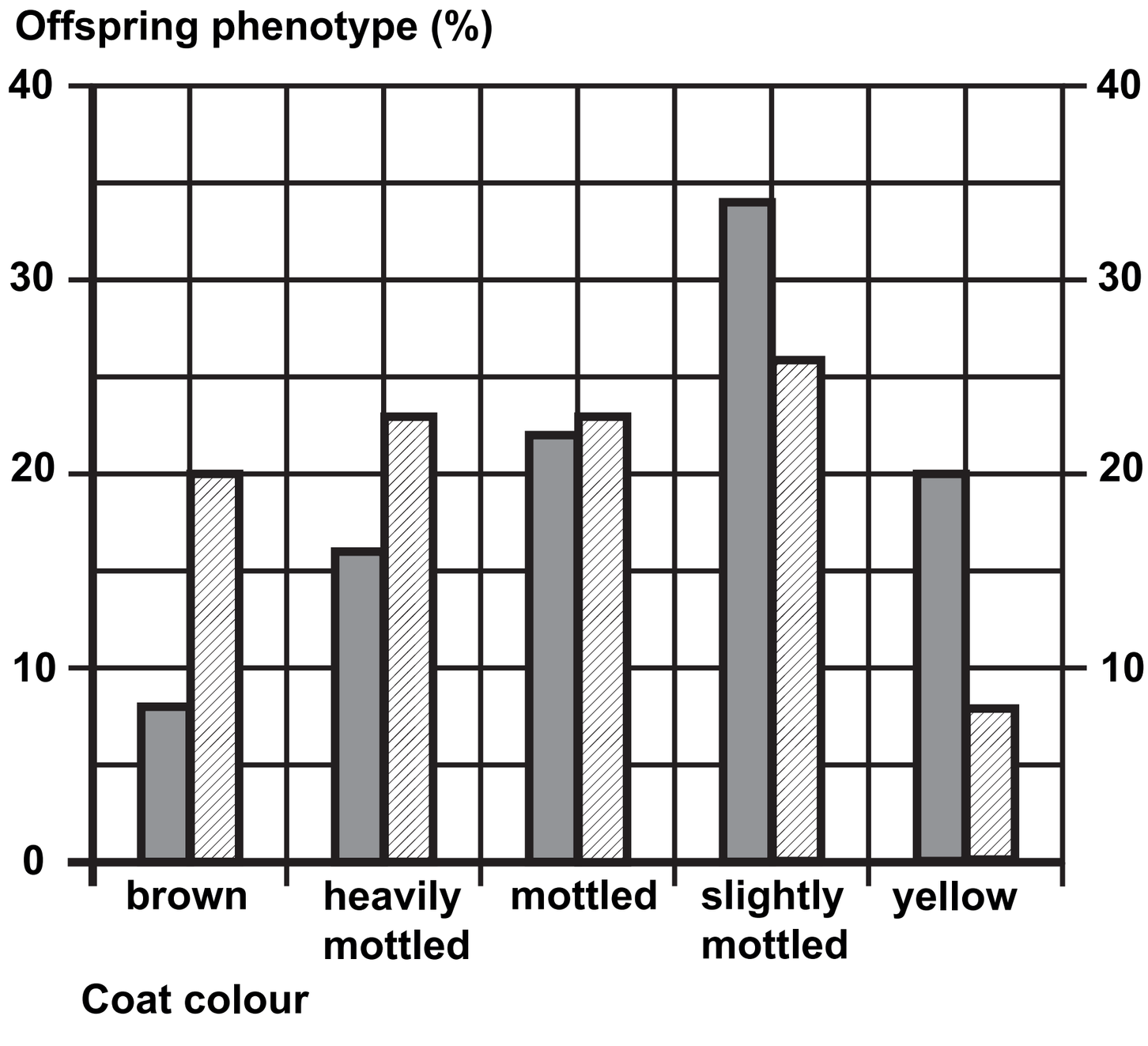


IMAGE 7.1

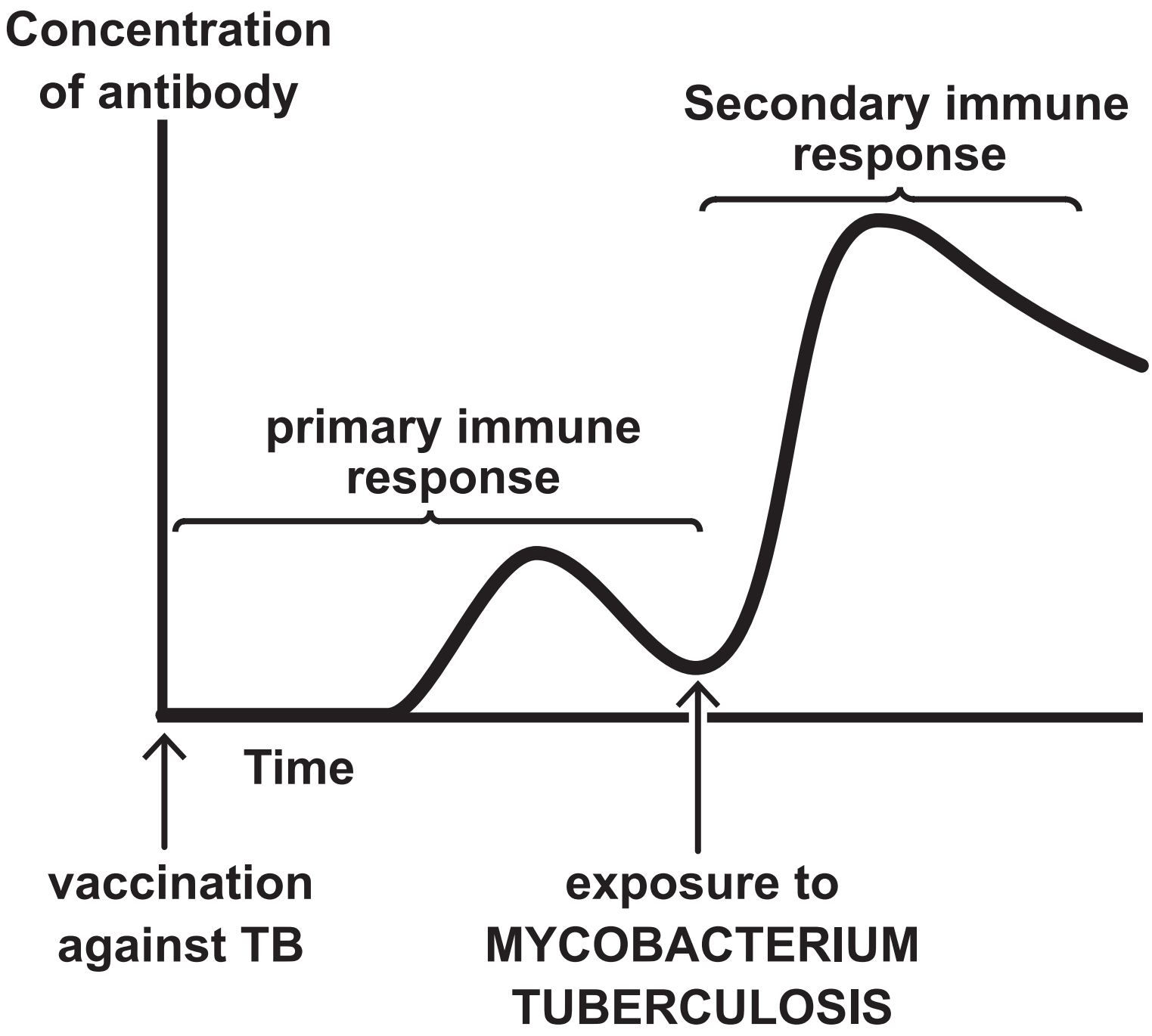
Population density
(people per sq km)

10 000 or over

5 000 – 9 999

4 999 or under

GRAPH 7.2


Concentration of antibody
Secondary immune response
primary immune response
Time
vaccination against TB
exposure to MYCOBACTERIUM TUBERCULOSIS

GRAPH 7.3

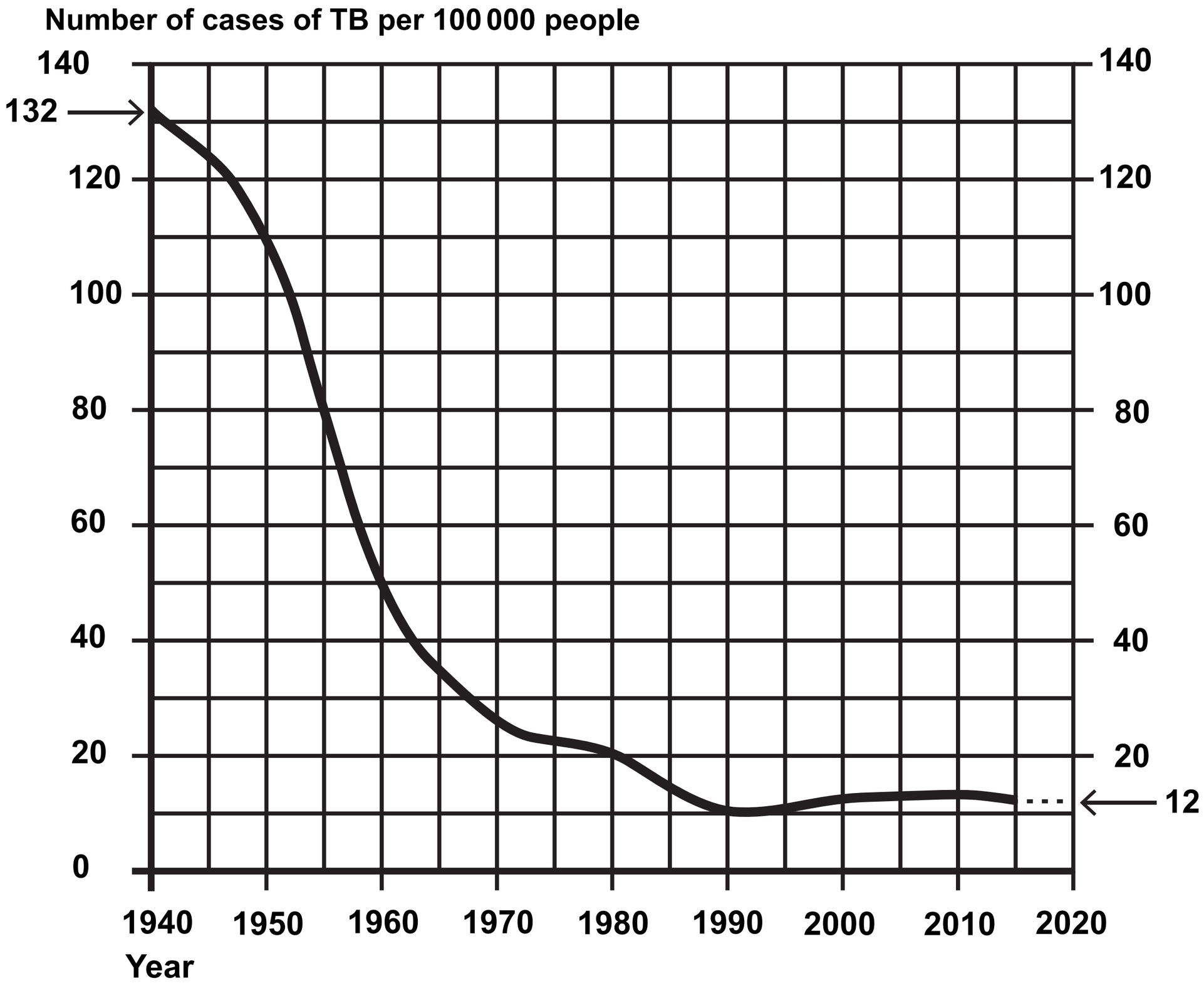

Number of cases of TB per 100 000 people
140
132
120
100
80
60
40
20
0
140
120
100
80
60
40
20
12
1940
1950
1960
1970
1980
1990
2000
2010
2020
Year

IMAGE 7.4

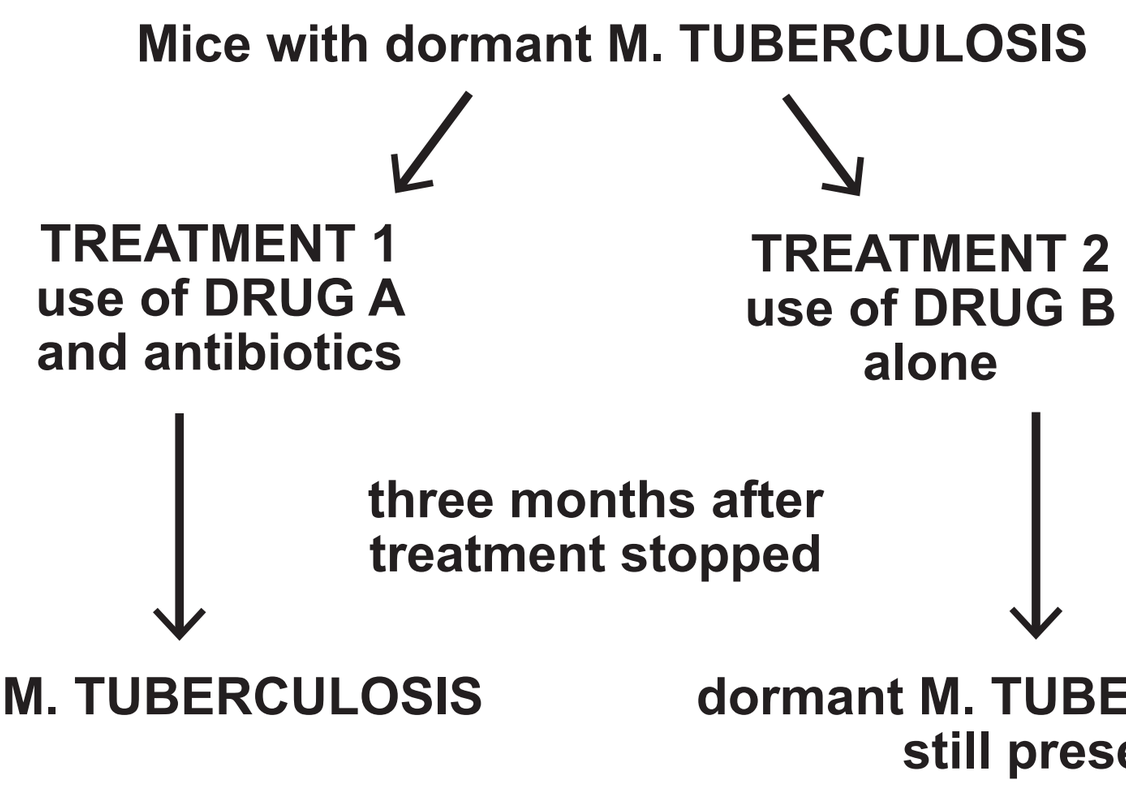

Mice with dormant M. TUBERCULOSIS
TREATMENT 1
use of DRUG A
and antibiotics
TREATMENT 2
use of DRUG B
alone
three months after
treatment stopped
no M. TUBERCULOSIS
dormant M. TUBERCULOSIS
still present

TABLE 7.5

Treatment	Advantage	Disadvantage
DRUG A and antibiotics		
DRUG B alone		

IMAGE 8.1

Transverse sections across sarcomere

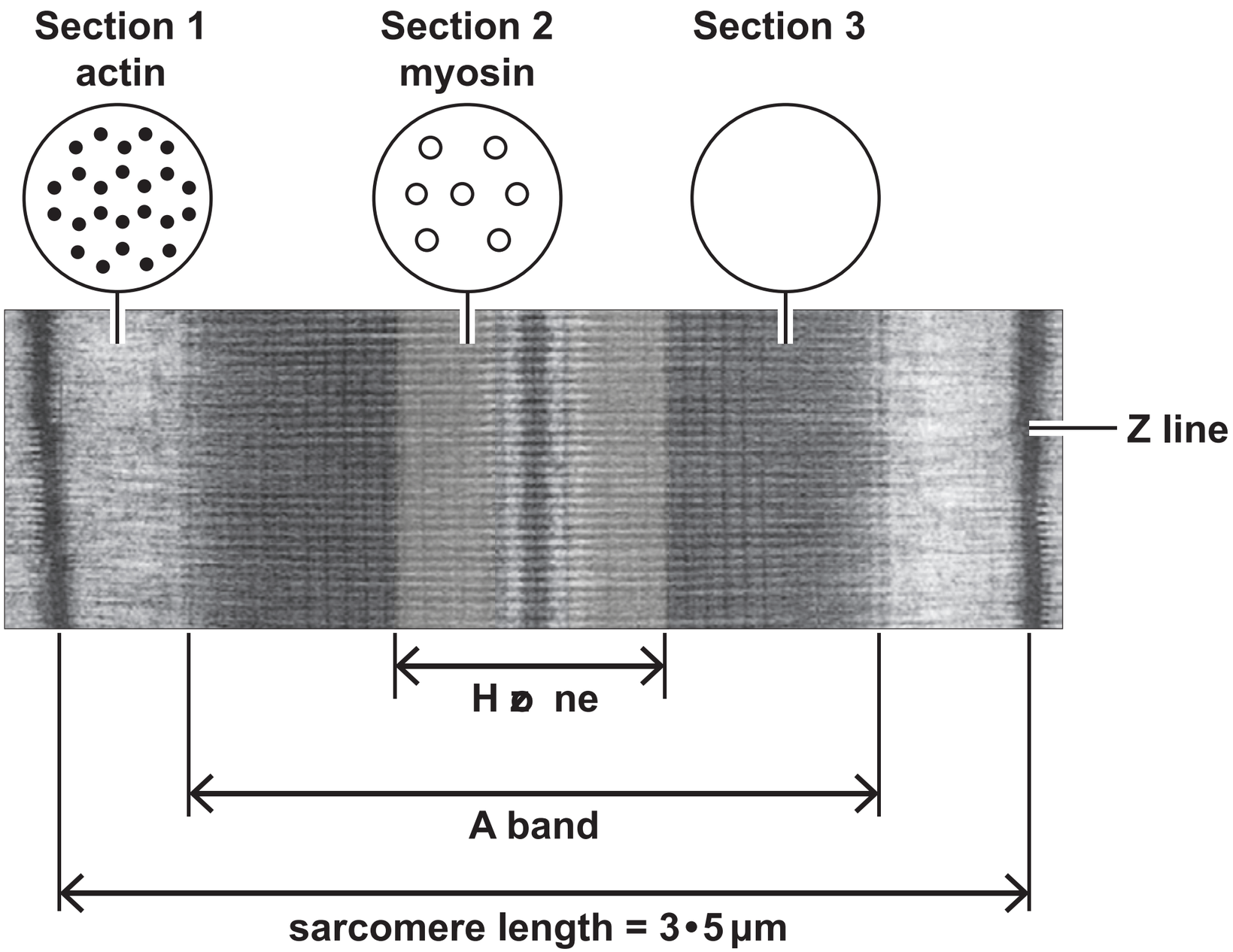
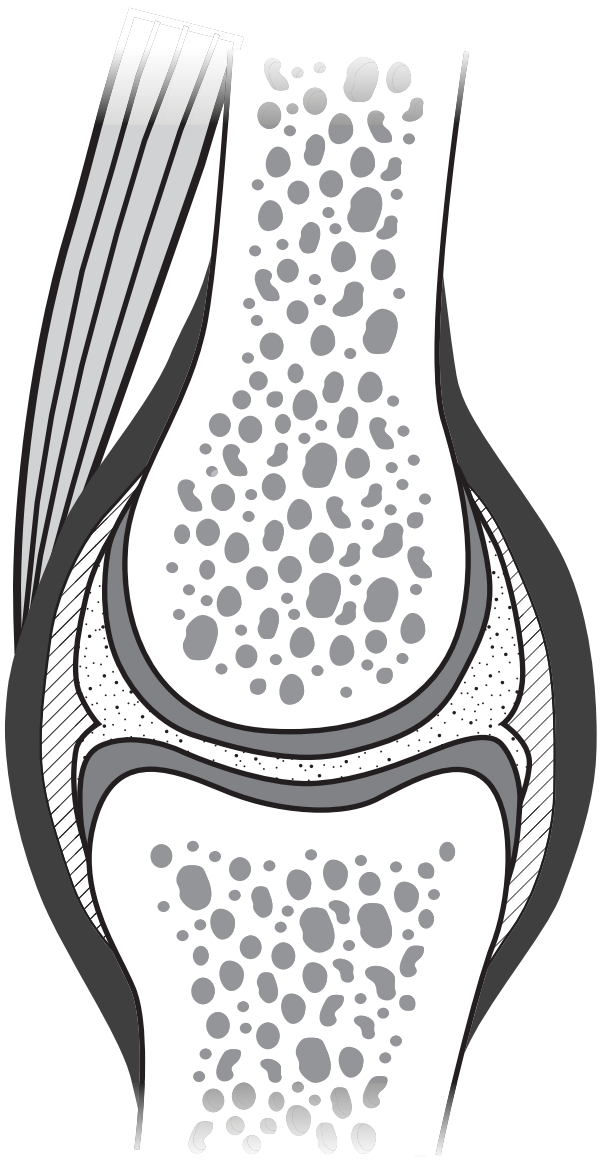


IMAGE 8.2

normal knee joint



knee joint with rheumatoid arthritis

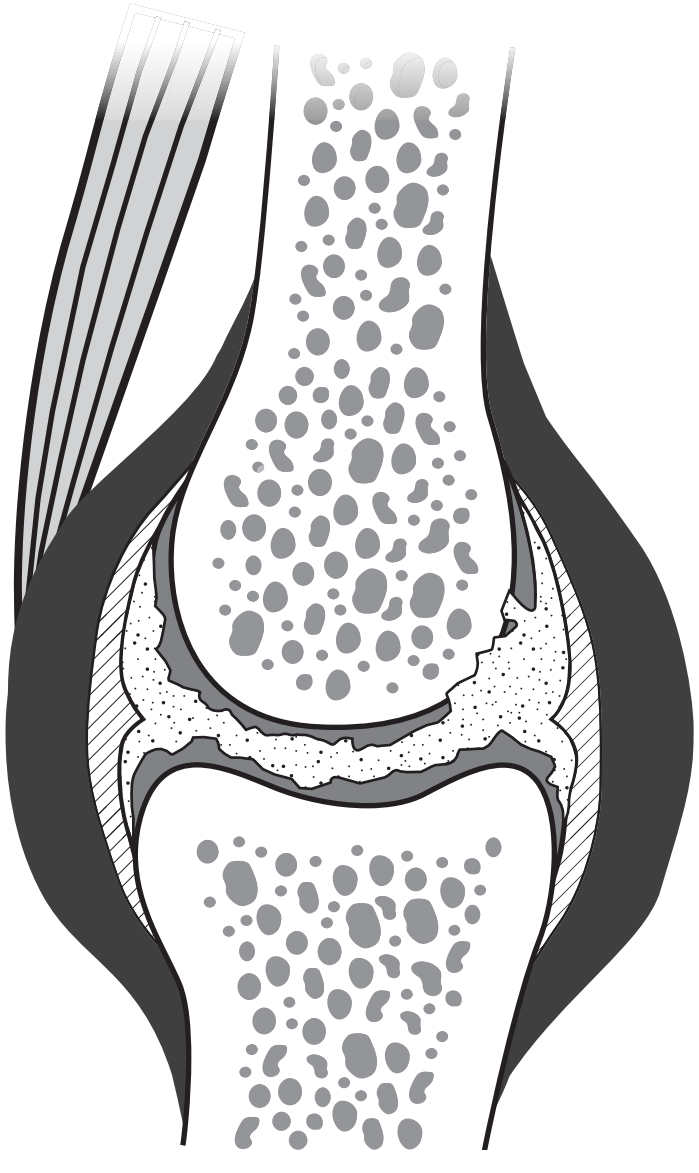
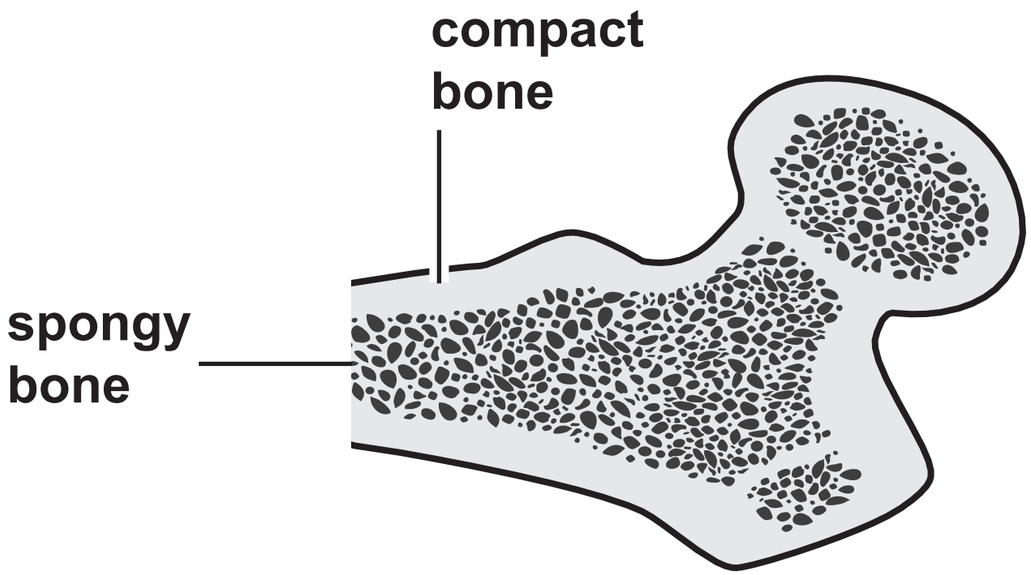


IMAGE 8.3

NORMAL BONE



BONE WITH OSTEOPOROSIS

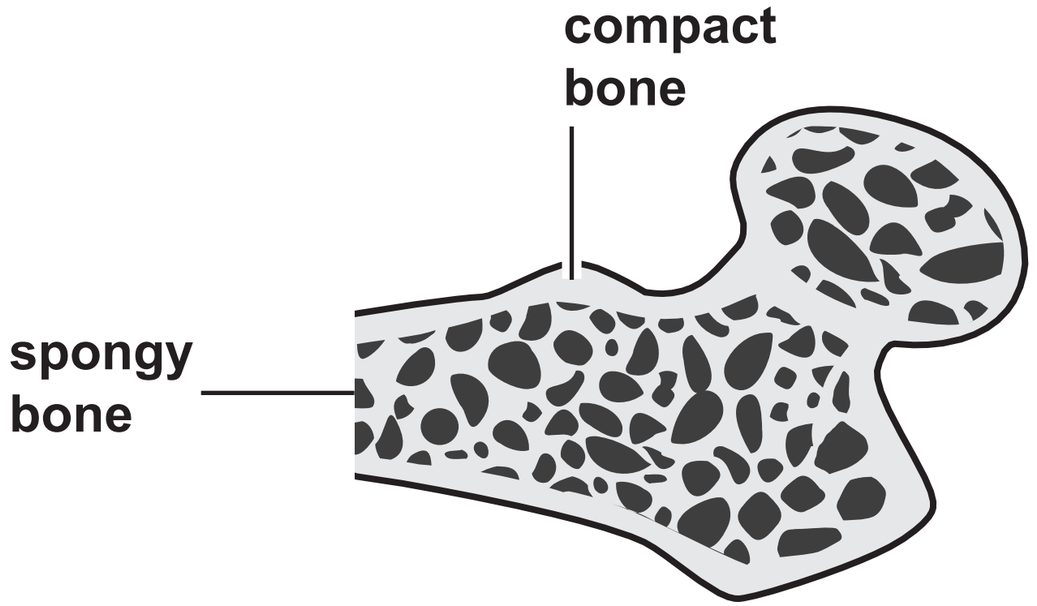


TABLE 8.4

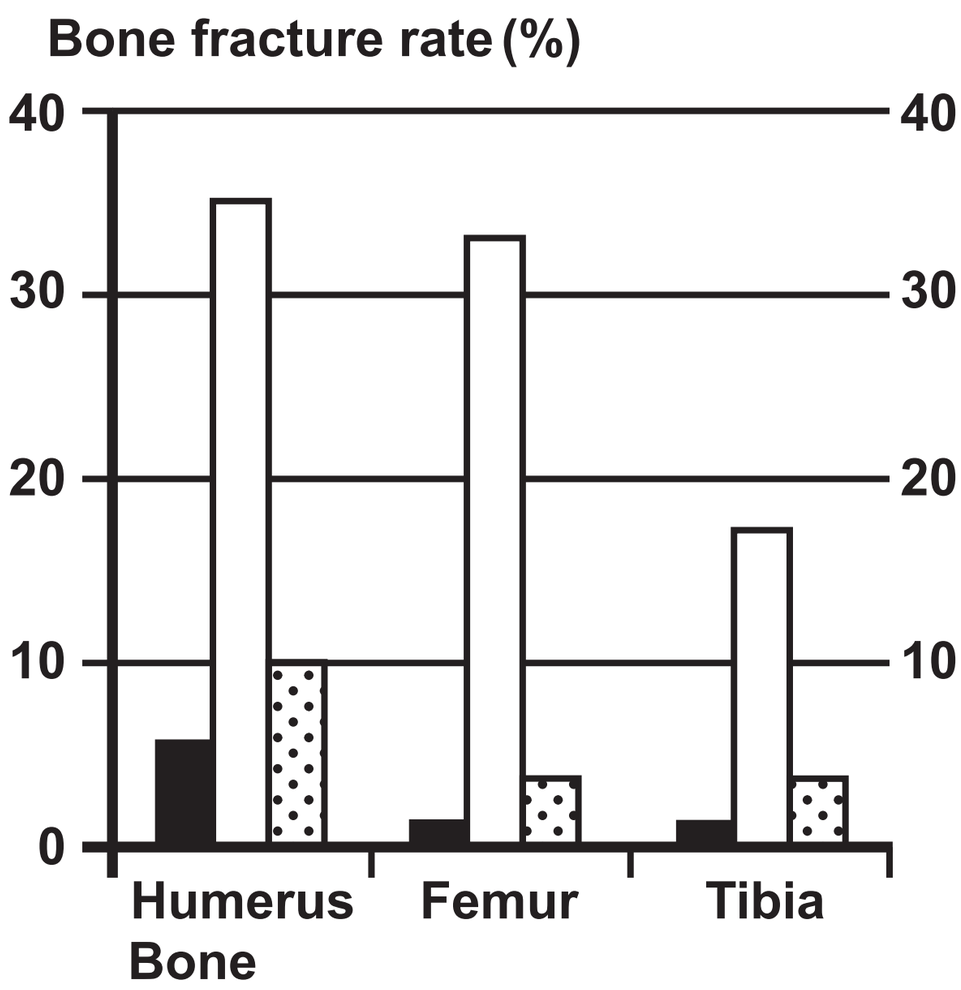
Group of mice	Osteogenesis imperfecta (OI) present	Received amniotic stem cells at birth
A – healthy mice	No	No
B – control group	Yes	No
C – experimental group	Yes	Yes

GRAPH 8.5 and GRAPH 8.6

Key:

- Group A
- Group B
- Group C

GRAPH 8.5



GRAPH 8.6

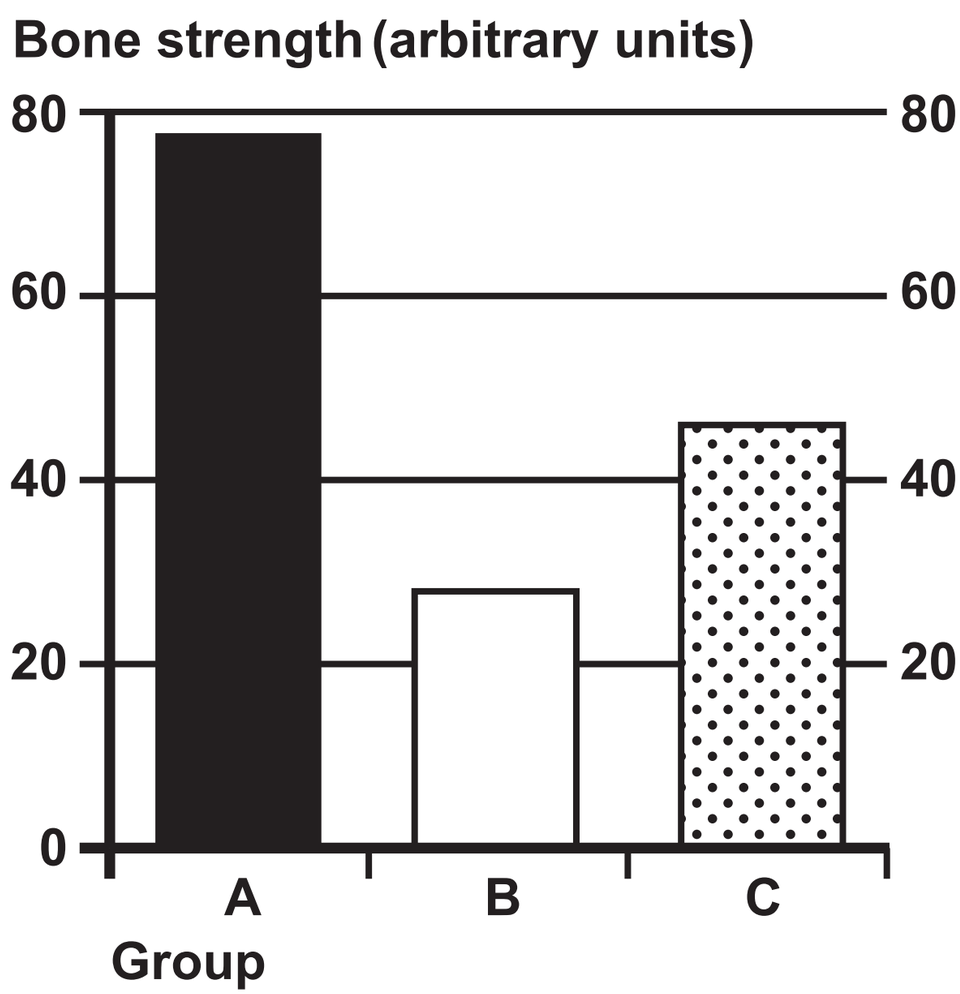


IMAGE 9.1

GRAPH 9.2

Key:

- colony A – rural
- colony B – urban

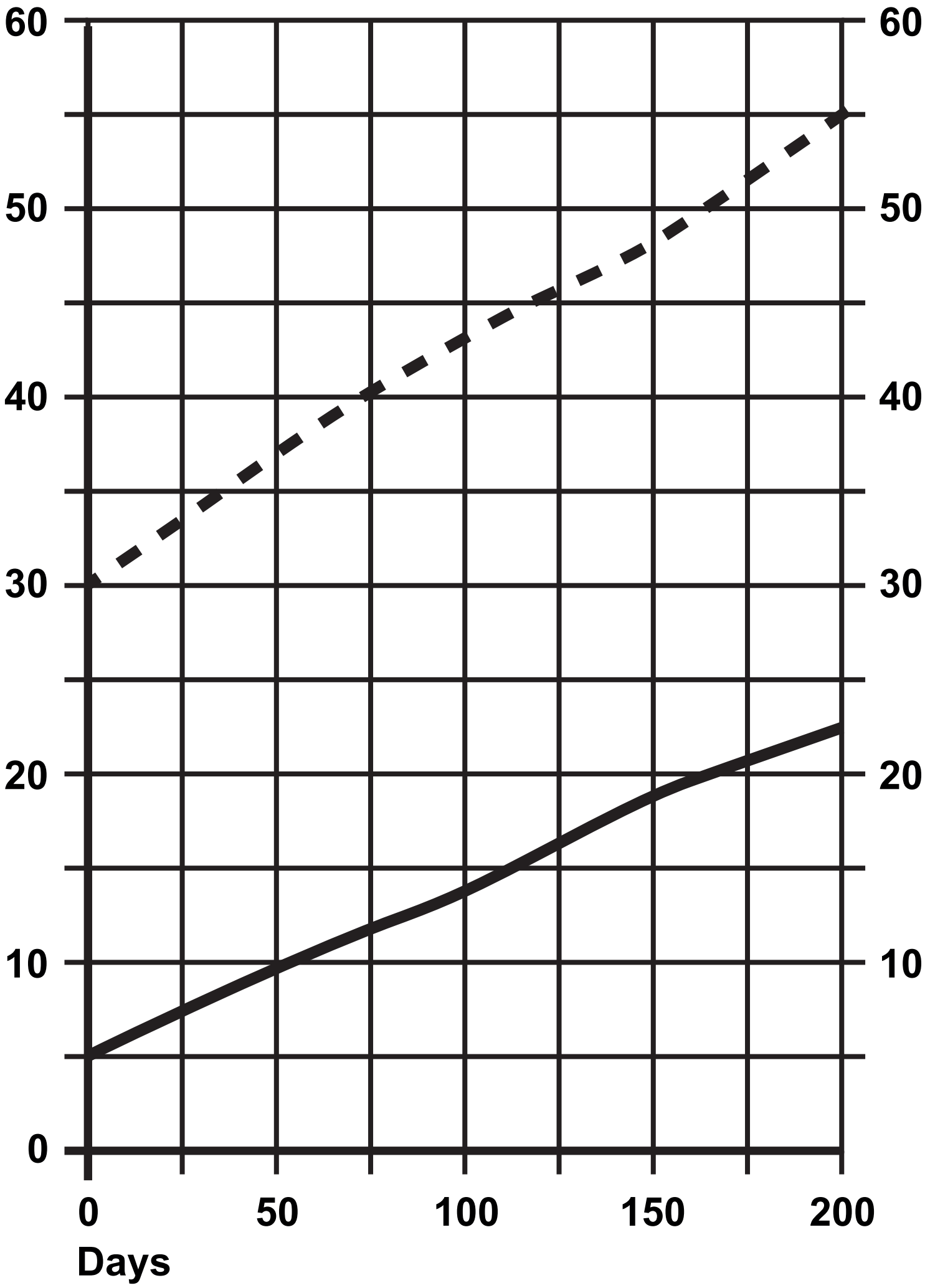


IMAGE 9.3 and IMAGE 9.4

IMAGE 9.3

fMRI taken from a healthy adult patient

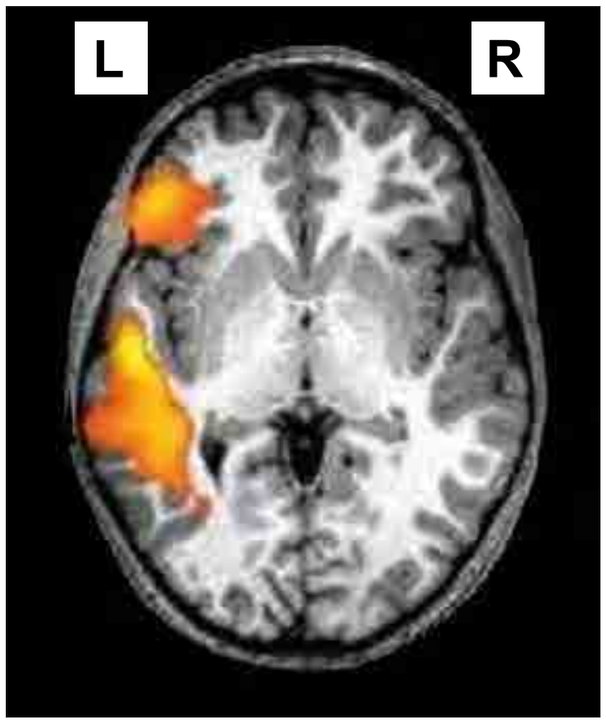


IMAGE 9.4

fMRI taken from an adult patient who had a stroke shortly after birth

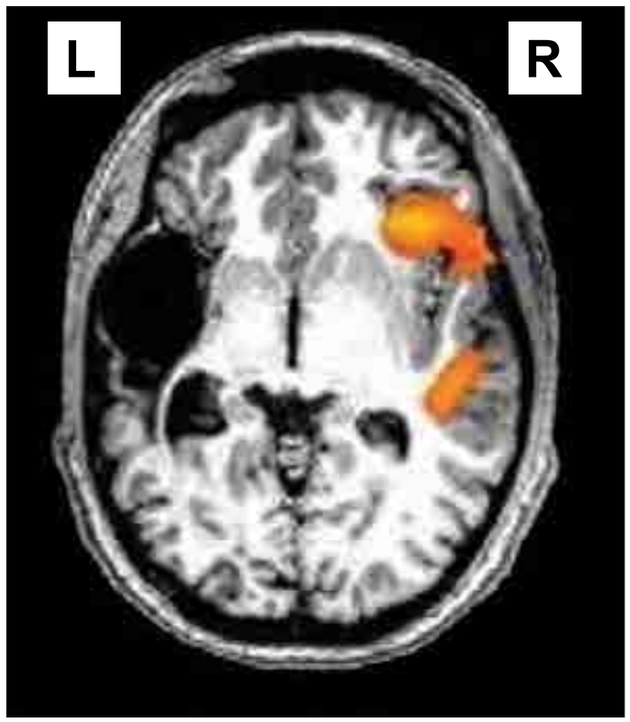


IMAGE 9.5