National Qualifications 2026

X840/76/12

Human Biology
Paper 1 — Multiple choice

TUESDAY, 28 APRIL

9:00 AM – 9:40 AM

Total marks — 25

Attempt ALL questions.

You may use a calculator.

Instructions for the completion of Paper 1 are given on *page 02* of your answer booklet X840/76/02.

Record your answers on the answer grid on *page 03* of your answer booklet.

Space for rough work is provided at the end of this booklet.

You must leave your answer booklet on your desk; if you do not, you could lose all the marks for this paper.

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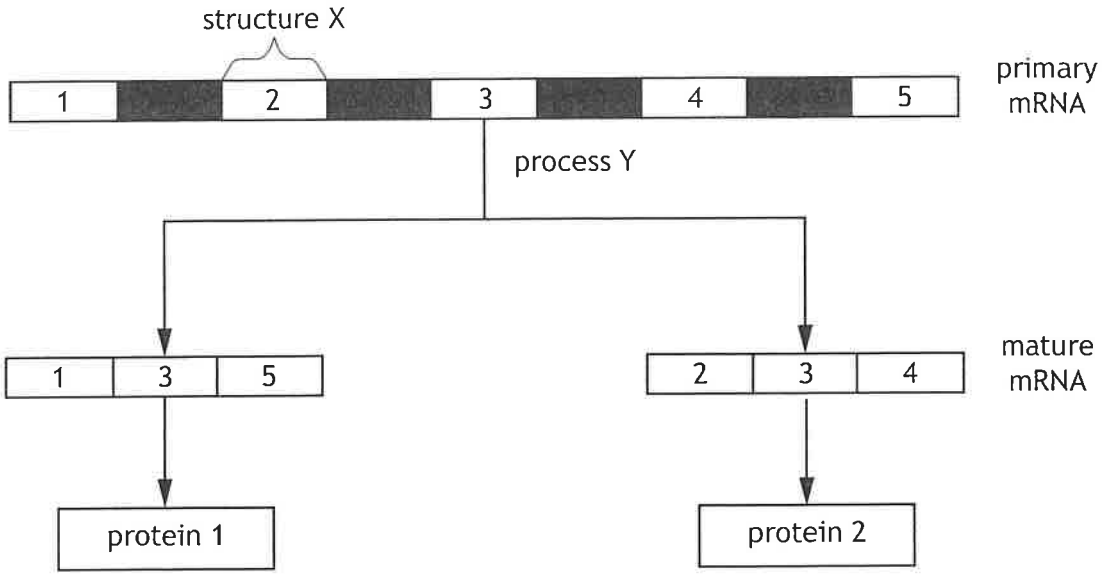
Total marks — 25

Attempt ALL questions

1. The diagram shows a stage during the synthesis of two different proteins.



Identify structure X and process Y.

	Structure X	Process Y
A	exon	translation
B	intron	alternative splicing
C	exon	alternative splicing
D	intron	translation

2. One cycle of PCR takes 2 minutes.

If the original sample contained one molecule of DNA, how many DNA molecules will be present after 20 minutes?

A 10

B 512

C 1024

D 2048

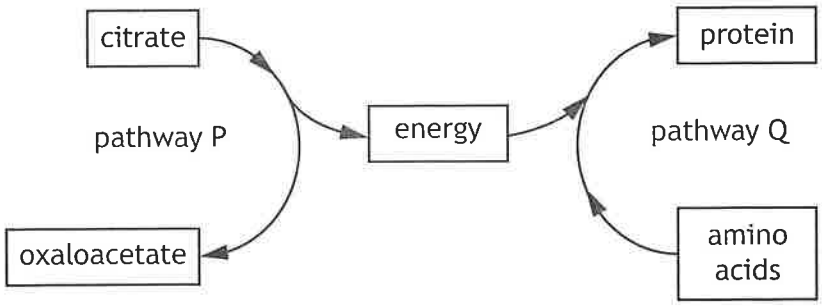
3. The following are descriptions of three chromosome structure mutations:

   1. A section of a chromosome is reversed.
   2. A section of a chromosome is added from its homologous partner.
   3. A section of a chromosome is added to a chromosome that is not its homologous partner.

   Which row in the table matches the description with the type of chromosome structure mutation?

	Chromosome structure mutation		
	Translocation	**Inversion**	**Duplication**
A	3	1	2
B	2	1	3
C	1	3	2
D	3	2	1

4. The diagram shows two linked metabolic pathways.



Which row in the table identifies the type of metabolic pathway and whether ATP is produced or required?

	Pathway	**Type of metabolic pathway**	**ATP**
A	P	anabolic	produced
B	P	catabolic	required
C	Q	anabolic	required
D	Q	catabolic	produced

[Turn over

5. An investigation was carried out into the effect of substrate concentration on enzyme activity.

Catalase is an enzyme that breaks down hydrogen peroxide to water and oxygen.

Test tubes were set up containing 5 cm^3 of hydrogen peroxide at different concentrations.

Catalase was added to each test tube and the volume of oxygen produced was measured.

Which row in the table identifies variables in this investigation?

	Independent variable	Dependent variable	Controlled variable
A	concentration of hydrogen peroxide	enzyme activity	volume of oxygen
B	concentration of hydrogen peroxide	enzyme activity	volume of hydrogen peroxide
C	enzyme activity	concentration of hydrogen peroxide	volume of hydrogen peroxide
D	enzyme activity	concentration of hydrogen peroxide	volume of oxygen

6. An investigation into the effect of substrate concentration on enzyme activity showed that enzyme activity levelled off at high substrate concentrations.

The explanation for this observation is that

A all the active sites are occupied

B no active sites are occupied

C the affinity of the active site has increased

D the affinity of the active site has decreased.

7. Three drops of iodine solution were added to a test tube containing 5 cm^3 of starch suspension, turning the starch suspension blue/black. When 1 cm^3 of enzyme amylase was added, the blue/black colour disappeared. It was concluded that the starch was broken down by the amylase.

To show that the starch was broken down by the amylase, a control test tube would contain

A 5 cm^3 of distilled water, 3 drops of amylase and 1 cm^3 of iodine solution

B 5 cm^3 of distilled water, 3 drops of iodine solution and 1 cm^3 of amylase

C 5 cm^3 of starch suspension, 3 drops of distilled water and 1 cm^3 of amylase

D 5 cm^3 of starch suspension, 3 drops of iodine solution and 1 cm^3 of distilled water.

8. The following list describes some effects of male hormones:

1. Stimulates sperm production.
2. Activates the prostate gland.
3. Inhibits the seminal vesicles.
4. Stimulates the interstitial cells.

Which of these are effects of testosterone?

A 1 only
B 1 and 2 only
C 1, 2 and 3 only
D 1, 2, 3 and 4

9. The onset of puberty is controlled by a hormone.

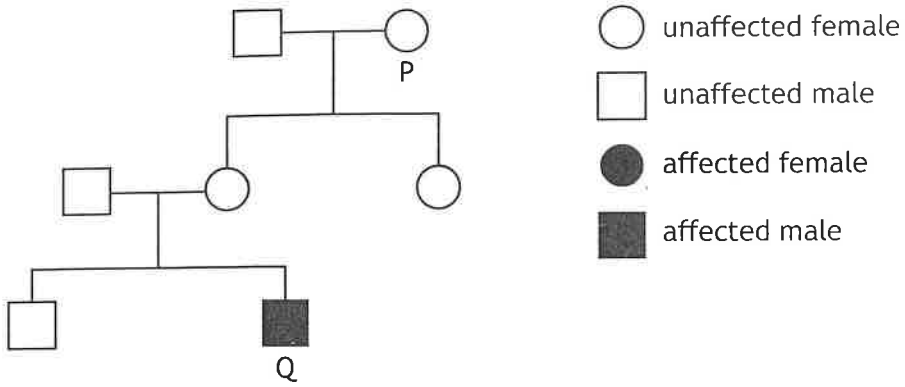
Which row in the table identifies this hormone and matches it with its site of production and target tissue?

	Hormone	Site of production	Target tissue
A	releaser hormone	pituitary gland	hypothalamus
B	FSH	hypothalamus	pituitary gland
C	releaser hormone	hypothalamus	pituitary gland
D	FSH	pituitary gland	hypothalamus

[Turn over

10. Haemophilia is a sex-linked recessive genetic disorder.

The diagram shows the pattern of inheritance of haemophilia in a family over three generations.



The allele for haemophilia is represented by 'h'.

Which row in the table shows the genotypes of individuals P and Q?

	Genotype of P	Genotype of Q
A	X^hX^h	X^HY
B	X^HX^h	X^HY
C	X^hX^h	X^hY
D	X^HX^h	X^hY

11. Compared to amniocentesis, chorionic villus sampling (CVS) can be carried out

A earlier in pregnancy and has a higher risk of miscarriage

B earlier in pregnancy and has a lower risk of miscarriage

C later in pregnancy and has a higher risk of miscarriage

D later in pregnancy and has a lower risk of miscarriage.

12. The table contains information about the rate of blood flow to parts of an individual's body at rest and during exercise.

	Rate of blood flow to body part (cm^3/min)				
	Heart muscle	Skin	Small intestine	Kidneys	Brain
At rest	250	500	700	1000	750
During exercise	750	1500	150	550	750

Which of the following statements describes the effect of exercise on blood flow?

A The rate of blood flow to all body parts changes.

B The decrease in blood flow to the small intestine is equal to the decrease in blood flow to the kidneys.

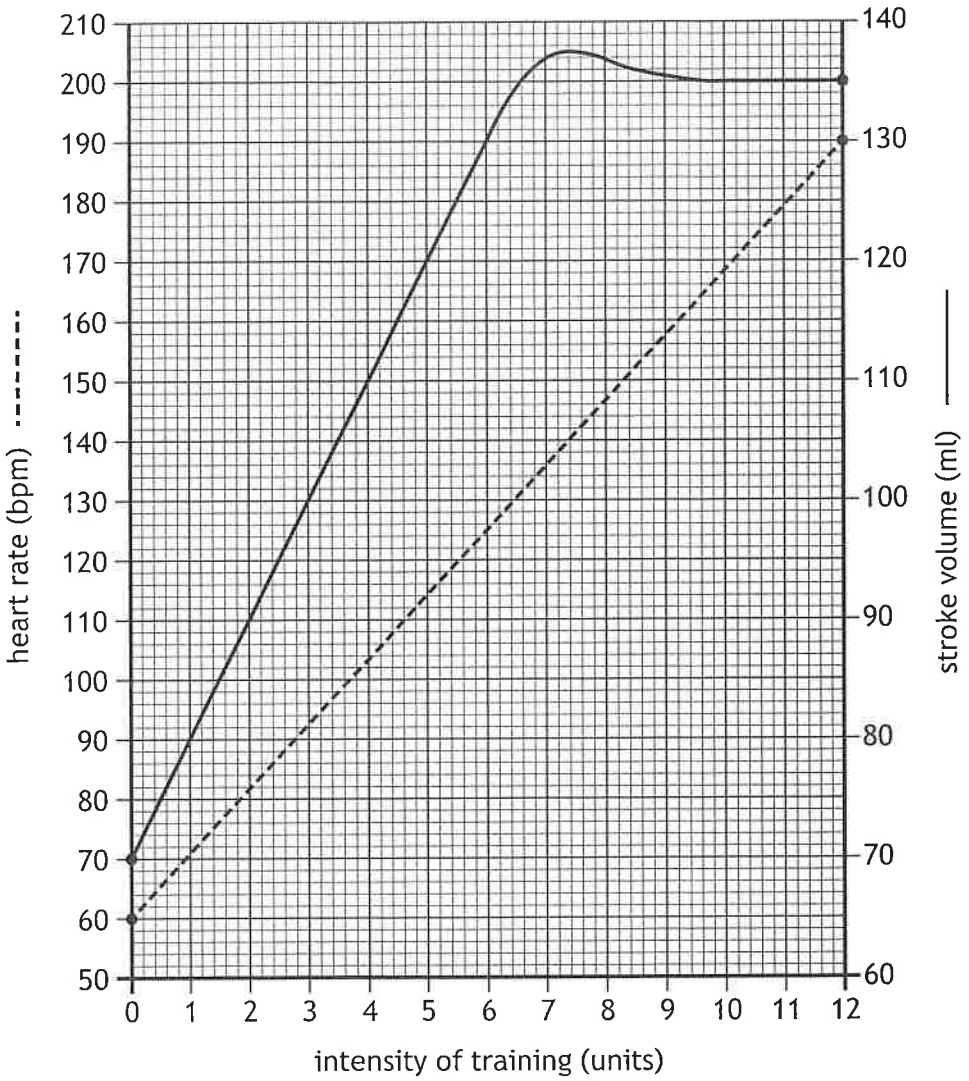
C The increase in blood flow to the skin is two times greater than the increase in blood flow to the heart muscle.

D The rate of blood flow to the heart muscle increases by 500 times.

[Turn over

13. The heart rate (HR) and stroke volume (SV) of an individual was measured throughout a training session.

The graph shows the results.



Calculate the increase in cardiac output as the intensity of training increased from 0–12 units.

A 21.45 l/min

B 21 450 l/min

C 25 650 l/min

D 510.7 l/min

14. A study was carried out to investigate the effect of a drug used to decrease blood pressure.

The following protocols were followed:

1. 50% of the participants were female.
2. Participant selection was randomised.
3. 300 000 participants completed the study.
4. The study included 20 repeated trials.

Identify the protocols that would make the study reliable.

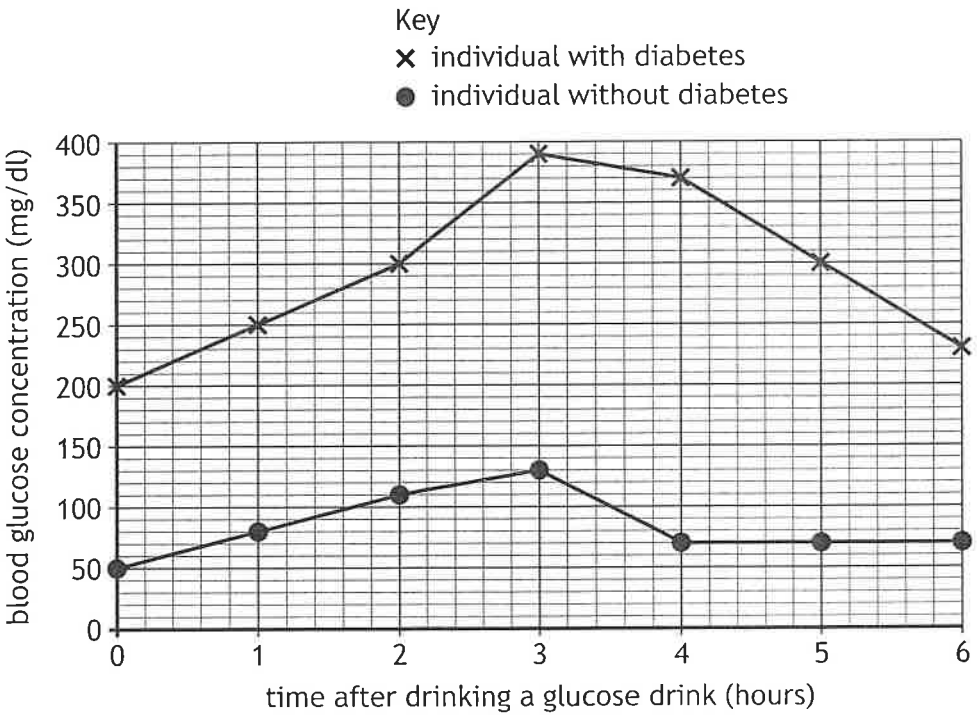
A 1 and 2

B 1 and 4

C 2 and 4

D 3 and 4

15. The graph shows the blood glucose concentrations of an individual with diabetes and an individual without diabetes, after a glucose drink.



Calculate the percentage increase in blood glucose concentration for the individual with diabetes three hours after the glucose drink.

A 49%

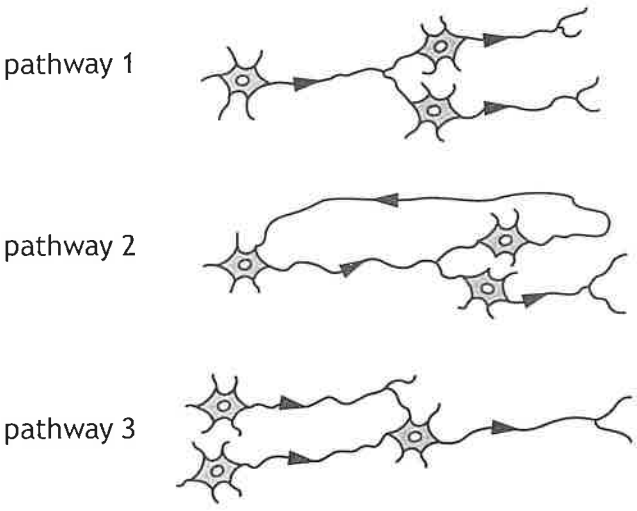
B 95%

C 160%

D 200%

[Turn over

16. The diagram shows three neural pathways. The arrowheads show the direction of impulse.



Which row in the table identifies the types of neural pathways shown?

	Neural pathway		
	Converging	Diverging	Reverberating
A	1	3	2
B	3	1	2
C	2	1	3
D	3	2	1

17. There is localisation of brain functions in the cerebral cortex.
Which of the following are functions controlled by the cerebral cortex?

A Language processing and breathing rate
B Heart rate and conscious thought
C Language processing and recall of memory
D Recall of memory and breathing rate

18. Identify the structure that transfers information between the cerebral hemispheres and the hemisphere that processes information from the right visual field.

	Structure	Hemisphere
A	corpus luteum	left
B	corpus callosum	left
C	corpus callosum	right
D	corpus luteum	right

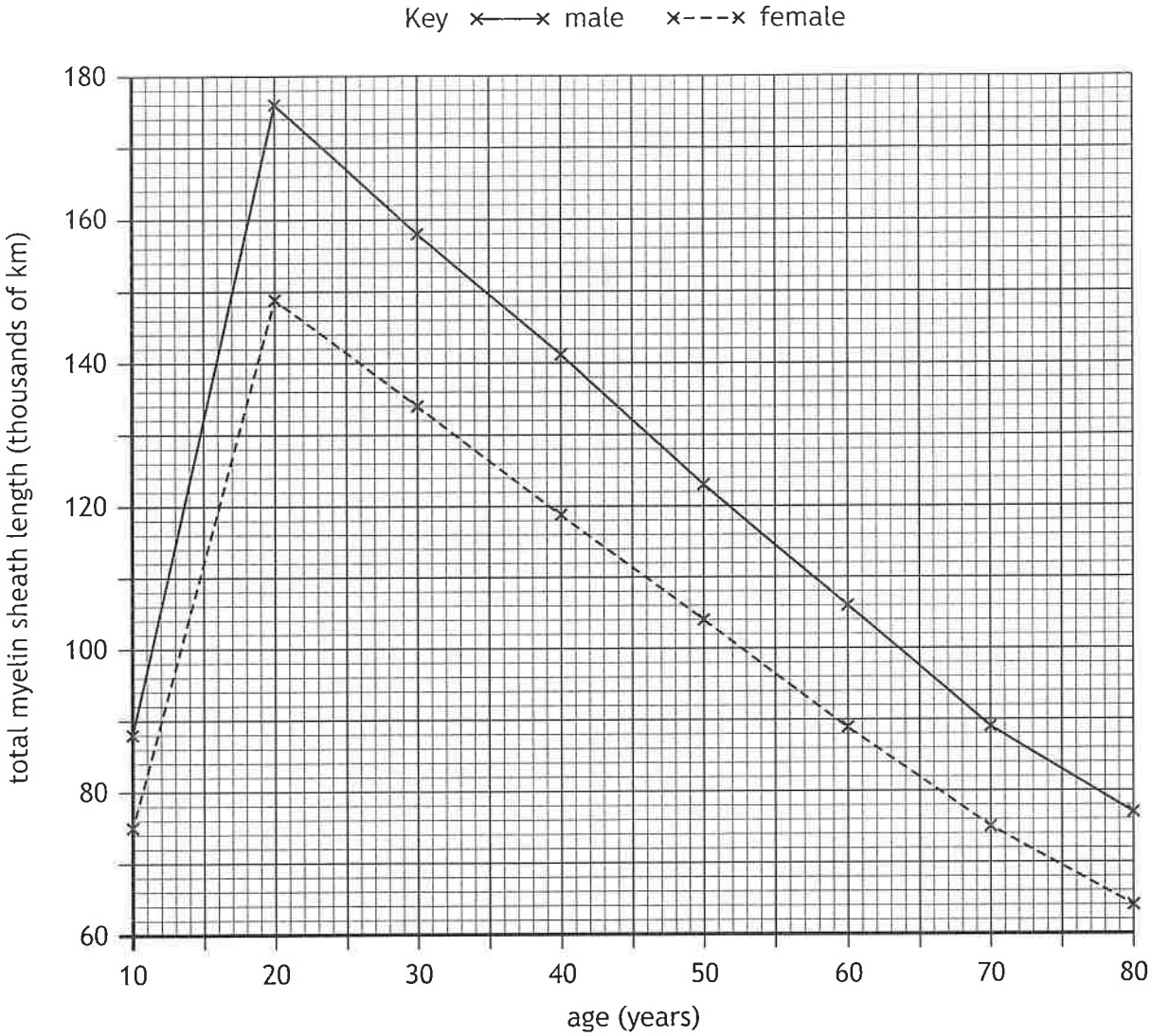
19. Which of the following stimulate neurons involved in the reduction of the intensity of pain?

A Dopamine
B Endorphins
C Noradrenaline
D Acetylcholine

[Turn over

20. Myelination occurs from birth to adolescence.

The graph shows the changes in total myelin sheath lengths for different ages in males and females. Fast impulse conduction occurs when the total myelin sheath length is greater than 100 000 km.

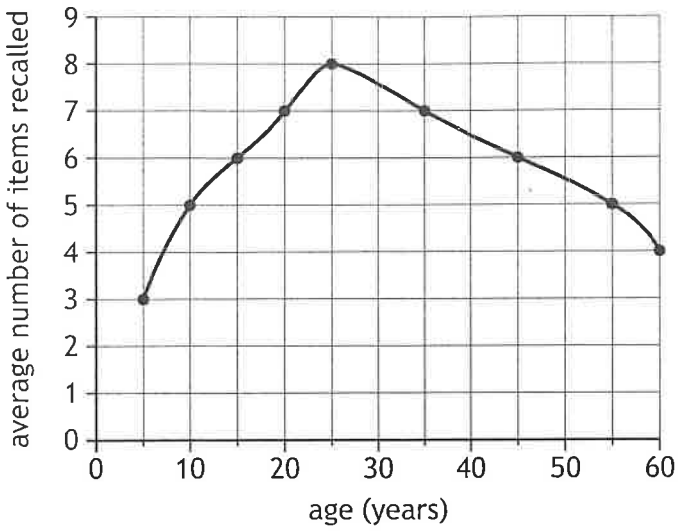


Which row in the table is correct for the data shown?

	Sex	Age (years)	Speed of impulse conduction	Response to stimuli
A	male	20	fast	slow
B	female	20	slow	fast
C	male	80	fast	fast
D	female	80	slow	slow

21. Individuals of various ages were shown 12 different items and then asked to recall as many as they could.

The graph shows how the average number of items recalled changed with age.



Which of the following statements is **not** supported by the data in the graph?

A The average number of items recalled was greatest at 25 years of age.

B The average percentage recall at age 60 is 33%.

C The average number of items recalled was the same at ages 10 and 55.

D The average percentage recall at age 25 is 66%.

[Turn over

22. The table shows the results of an experiment to demonstrate the serial position effect.

Position of item in the list	Percentage recall
1	93
2	81
3	64
4	54
5	42
6	27
7	31
8	51
9	54
10	72

Which row in the table shows the reason for the percentage recall of item 6 and the type of memory involved?

	Reason	Memory involved
A	displacement	long term
B	displacement	short term
C	decay	long term
D	decay	short term

23. An increase in sensitivity of neurotransmitter receptors causes

A drug tolerance due to repeated exposure to agonists

B drug addiction due to repeated exposure to agonists

C drug tolerance due to repeated exposure to antagonists

D drug addiction due to repeated exposure to antagonists.

24. The following events take place at the site of tissue damage:

P Increased blood flow

Q Phagocytes accumulate

R Mast cells release histamine

S Cytokines are released

The order of these events is

A P, Q, S, R

B R, Q, P, S

C R, P, Q, S

D S, Q, R, P.

25. Two groups of subjects volunteered for a clinical trial of a new vaccine.

One group was given the new vaccine and the second group was given a placebo.

The subjects were allocated to the two groups in a randomised way, taking account of age and gender, in order to

A reduce bias

B reduce experimental error

C establish significant differences

D ensure the comparison was reliable.

[END OF QUESTION PAPER]

FOR OFFICIAL USE

National Qualifications 2026

Mark

X840/76/01

Human Biology Paper 2

TUESDAY, 28 APRIL

10:10 AM – 12:30 PM

X8407601

Fill in these boxes and read what is printed below.

Full name of centre

Town

Forename(s)

Surname

Number of seat

Date of birth

Day Month Year

Scottish candidate number

Total marks — 95

Attempt ALL questions.

You may use a calculator.

Question 14 contains a choice.

Write your answers clearly in the spaces provided in this booklet. Additional space for answers and rough work is provided at the end of this booklet. If you use this space you must clearly identify the question number you are attempting. Any rough work must be written in this booklet. Score through your rough work when you have written your final copy.

Use **blue** or **black** ink.

Do not remove any exam materials. You must leave this booklet on your desk; if you do not, you could lose all the marks for this paper.

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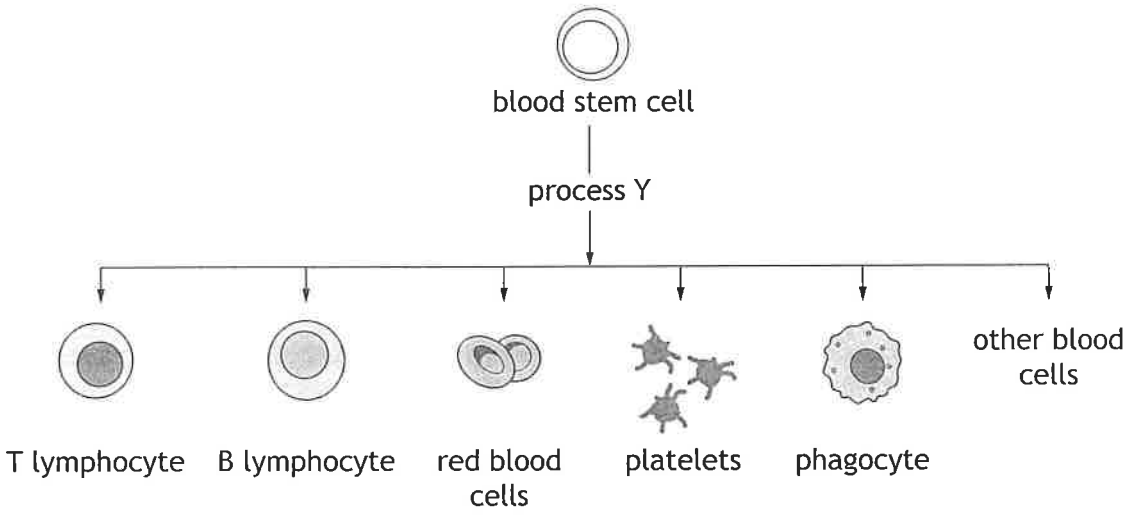
MARKS | DO NOT WRITE IN THIS MARGIN

Total marks — 95

Attempt ALL questions

Question 14 contains a choice

1. (a) The diagram shows the range of cells produced from blood stem cells found within the bone marrow.



(i) Name process Y. 1

_____

(ii) Using information from the diagram, explain why blood stem cells are described as multipotent. 1

_____

_____

(iii) Describe the process that results in phagocytes producing different proteins to lymphocytes. 1

_____

_____

(b) Leukaemia is a type of cancer that affects some blood cells.

(i) Explain why these cancer cells divide excessively. 1

_____

_____

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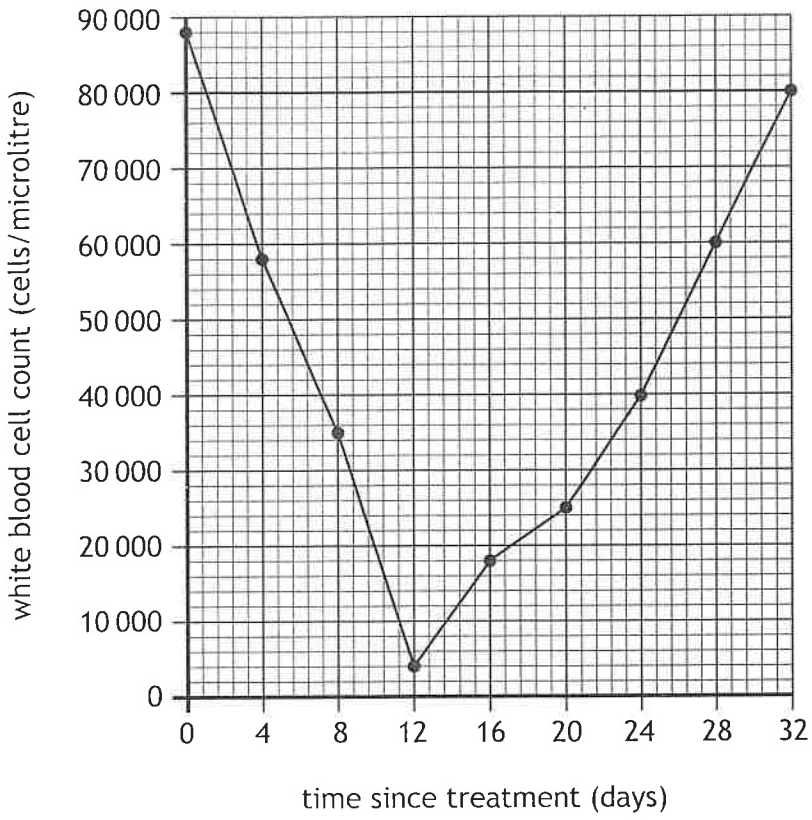
MARKS

A patient with cancer was treated with chemotherapy that affected their white blood cell count.

The graph shows the patient's white blood cell count over time following this treatment.



(ii) Use data from the graph to describe the changes that occur in the white blood cell count from days 0 to 32. 2

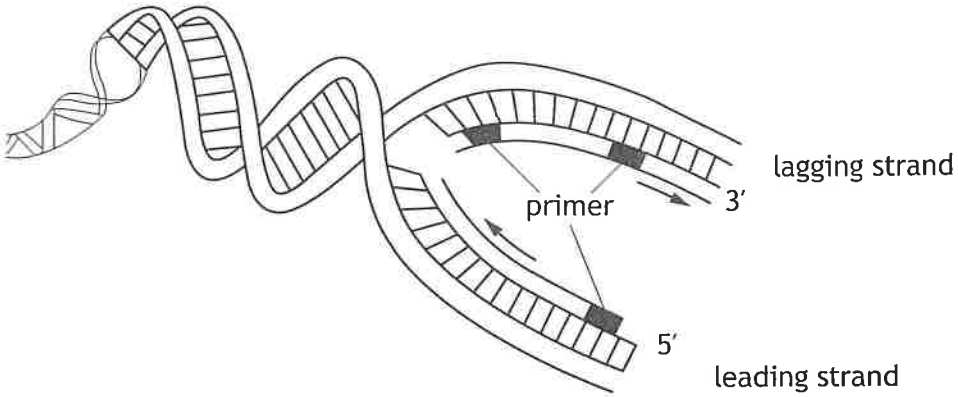
(iii) Use data from the graph to predict the white blood cell count on day 34. 1

_____ cells/microlitre

[Turn over

MARKS | DO NOT WRITE IN THIS MARGIN

2. (a) The diagram shows the replication of DNA in a cell.



(i) Suggest what the arrows on the diagram indicate. 1

(ii) Explain why the lagging strand is replicated in fragments. 1

(iii) Name the enzyme that joins fragments together in the lagging strand. 1

(b) DNA is involved in gene expression to allow cells to synthesise proteins.
The enzyme RNA polymerase is required in gene expression.
Describe the role of this enzyme in the synthesis of a protein. 2

2. (continued)

(c) Transfer RNA (tRNA) is involved in gene expression.

Describe the structure of tRNA. 3

[Turn over

MARKS | DO NOT WRITE IN THIS MARGIN

3. Haemoglobin is a protein that transports oxygen in the blood.

Individuals with sickle cell anaemia have two copies of a single gene mutation that results in the production of the protein haemoglobin S. Although haemoglobin S is the same length as haemoglobin it folds into a different shape.

DNA sequences from the same region of the gene for haemoglobin and haemoglobin S are shown.

haemoglobin	**T G A G G A C T C**
haemoglobin S	**T G A G C A C T C**

(a) State the sequence of bases in the mRNA transcript that would be formed from the haemoglobin S sequence shown. 1

_____

(b) (i) Using information from the diagram, name the type of single gene mutation that causes sickle cell anaemia. 1

_____

(ii) Explain why the changed sequence of bases in the gene for haemoglobin S codes for a different shaped protein. 1

_____

_____

(c) Suggest why individuals with sickle cell anaemia have increased blood lactate concentration and are more likely to experience muscle fatigue. 1

_____

_____

(d) In a country, 670 000 babies were born and tested for haemoglobin S.

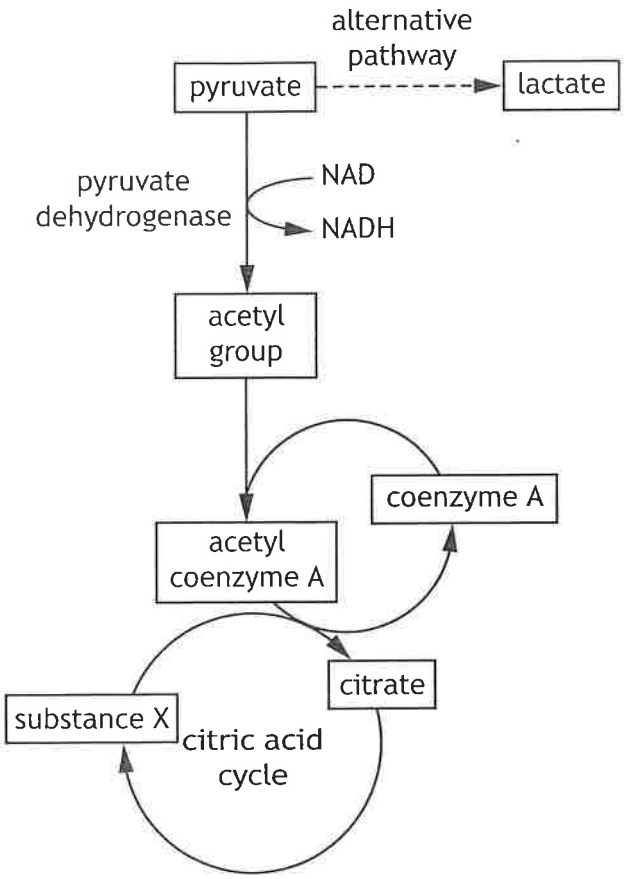
Calculate the number of babies with haemoglobin S, if 1 in every 80 babies tests positive. 1

Space for calculation

_____

4. The diagram shows part of the metabolic pathway of cellular respiration.

The pathway includes the enzyme pyruvate dehydrogenase, which catalyses the conversion of pyruvate to an acetyl group.



(a) State the location of the production of pyruvate in a cell. 1

_____

(b) Describe the role of pyruvate dehydrogenase in the production of NADH. 1

_____

_____

(c) Name substance X and describe its role in the synthesis of citrate. 2

Substance X _____

Role _____

[Turn over

4. **(continued)**

(d) Pyruvate dehydrogenase deficiency (PDHD) is caused by a mutation, which results in individuals with non-functional pyruvate dehydrogenase. This mutation affects cellular respiration.

Describe the effect of PDHD on ATP and lactate production. 2

ATP production _____

Lactate production _____

(e) One type of PDHD is caused by an autosomal recessive allele.

A couple who are both unaffected by the condition have a child with PDHD.

(i) Pharmacogenetics could be used in the treatment of this child.

Give an advantage of using pharmacogenetics. 1

_____

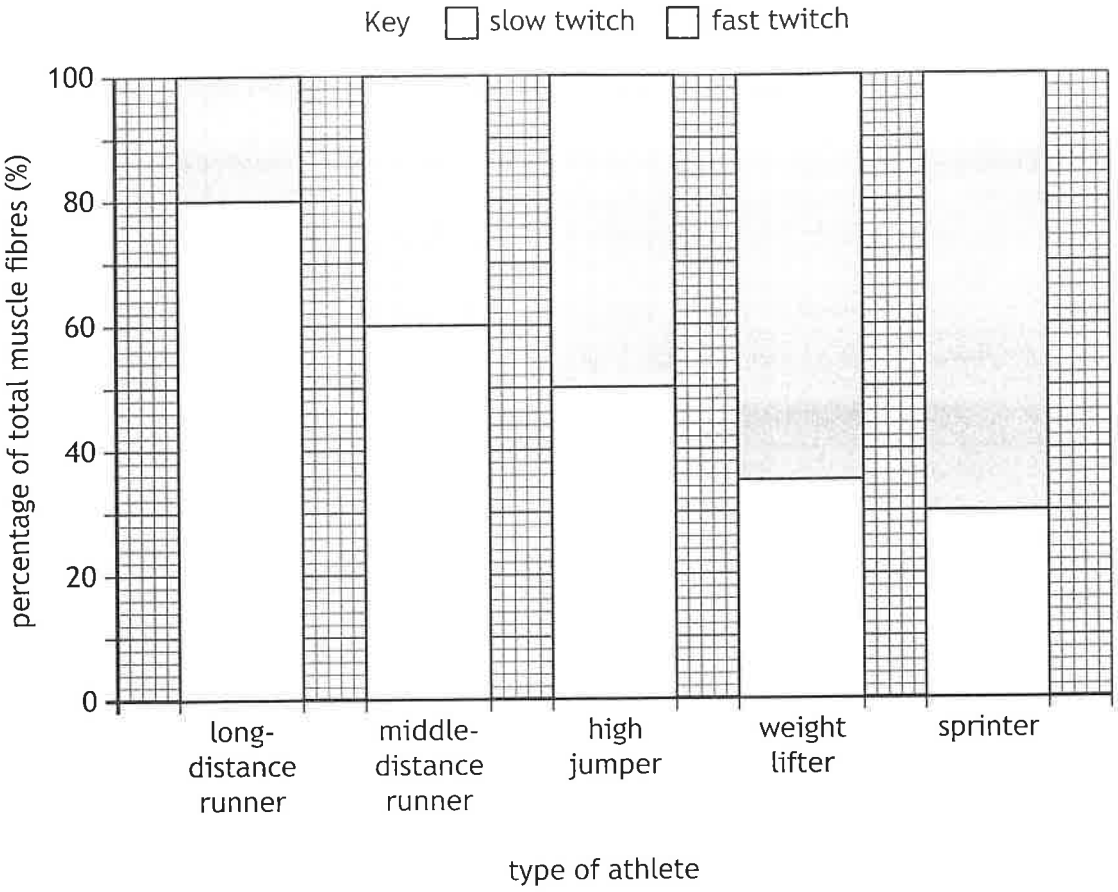
(ii) The couple are expecting a second child.

Calculate the percentage chance of this child having PDHD. 1

Space for calculation

_____ %

5. The graph shows the percentage of slow twitch and fast twitch muscle fibres in different types of athletes.



(a) (i) Express, as a simple whole number ratio, the percentage of fast twitch muscle fibres in the long-distance runner, high jumper and weightlifter. 1

Space for calculation

_____ : _____ : _____

long-distance runner | high jumper | weightlifter

5. (a) (continued)

(ii) Calculate how many times greater the percentage of fast twitch fibres in the muscles of the sprinter is compared to the muscles of the long-distance runner. 1

Space for calculation

_____ times greater

(b) (i) State a feature of fast twitch muscle fibres that makes them useful for sprinting. 1

_____

_____

(ii) Slow twitch muscle fibres have a higher concentration of myoglobin than fast twitch muscle fibres.

State the function of myoglobin and explain why slow twitch muscle fibres need to have a high concentration of myoglobin. 2

Function _____

Explanation _____

_____

(iii) Describe one other structural difference between slow twitch and fast twitch muscle fibres. 1

_____

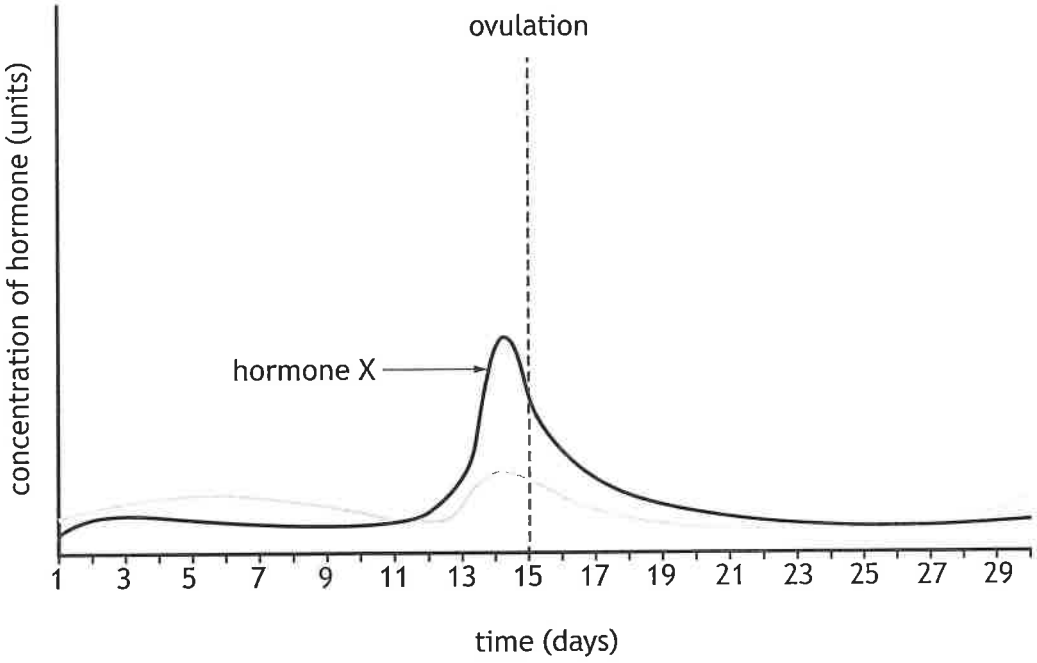
_____

[Turn over

6. The menstrual cycle is hormonally controlled.

(a) **Graph 1** shows the blood concentration of hormones produced by the pituitary gland in a female during one menstrual cycle.

Graph 1



(i) Name hormone X. 1

_____

(ii) Body temperature and cervical mucus consistency change throughout the menstrual cycle.

Describe the difference in a female's body temperature and cervical mucus consistency on day 16 compared to day 3. 2

Body temperature _____

_____

Cervical mucus consistency _____

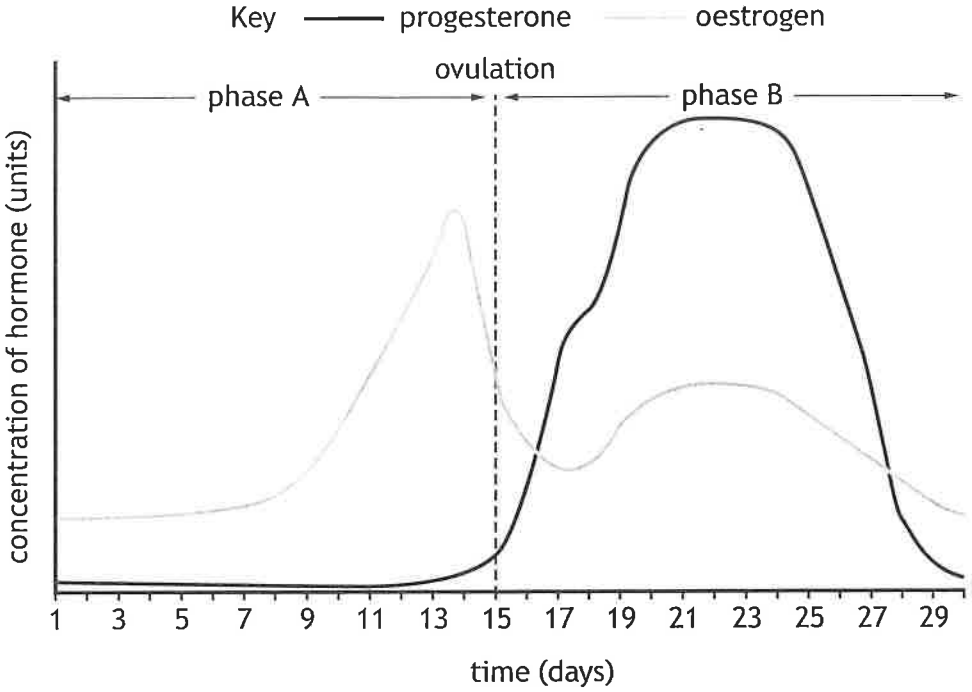
_____

6. (continued)

MARKS | DO NOT WRITE IN THIS MARGIN

(b) **Graph 2** shows the blood concentration of hormones produced by the ovaries in a female during one menstrual cycle.

Graph 2



(i) Name phase A and phase B. 2

Phase A _____

Phase B _____

(ii) Describe the events that lead to an increase in progesterone levels during phase B. 2

_____

_____

_____

(iii) In the next cycle, the female became pregnant.

Suggest one way in which the hormone concentration for this cycle would differ from Graph 2. 1

_____

_____

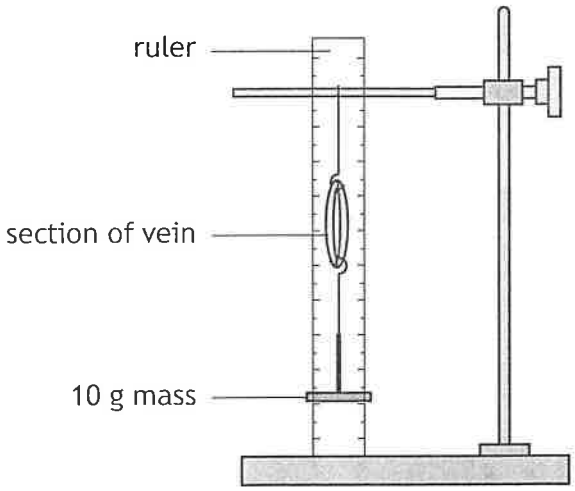
[Turn over

X8407601 13

MARKS | DO NOT WRITE IN THIS MARGIN

7. An investigation was set up to compare the elasticity of arteries and veins.

A section of vein was suspended from a clamp stand as shown in the diagram.



The length of the vein was measured.

A mass of 10 g was attached to the vein and the length of the vein was remeasured using the ruler.

This was repeated with masses of 20, 30 and 40 g. The investigation was then repeated with a section of artery.

The results are shown in **Table 1**.

Table 1

Mass (g)	Vein		Artery	
	Length (mm)	Change in length (%)	Length (mm)	Change in length (%)
0	25	0	20	0
10	27	8	22	10
20	29	16	24	20
30	31	24	27	
40	31	24	30	50

(a) Calculate the percentage change in length for the artery with a 30 g mass attached. 1

Space for calculation

_____ %

7. (continued)

MARKS | DO NOT WRITE IN THIS MARGIN

(b) (i) Explain why it was necessary to calculate the percentage change in the length of each blood vessel. 1

(ii) Describe how the reliability of these results could be improved. 1

(c) At the end of the investigation the masses were removed, and the lengths of the artery and vein were remeasured.

The values were recorded in **Table 2.**

Table 2

Blood vessel	Length (mm)	
	Start of investigation	End of investigation
Vein	25	30
Artery	20	20

(i) Suggest a difference between the structure of veins and arteries that leads to the difference in results shown in **Table 2.** 1

(ii) Explain why it is important that the walls of arteries can stretch and recoil. 1

(d) Describe a feature of artery walls that allows them to control blood flow. 1

[Turn over

8. Studies have shown that the percentage of infertile males in the UK is increasing. One of the main causes of male infertility is a low sperm count.

Mice were used as a model organism in an investigation into the effect of regular alcohol consumption on sperm count over a 120-day period.

140 mice were divided into two groups.

Group 1 received water.

Group 2 received water and a daily dose of alcohol.

Semen samples were collected from the mice throughout the investigation and sperm counts recorded.

The results of the investigation are shown in the table.

Day semen sample taken	Average sperm count (million/cm^3)	
	Group 1	Group 2
0	45.2	45.0
30	44.7	42.2
60	45.3	40.2
90	44.5	38.2
120	45.0	36.2

(a) (i) State the purpose of including group 1 in this investigation. 1

_____

(ii) Identify two variables, not already mentioned, that would need to be controlled to make the investigation valid. 2

1. _____

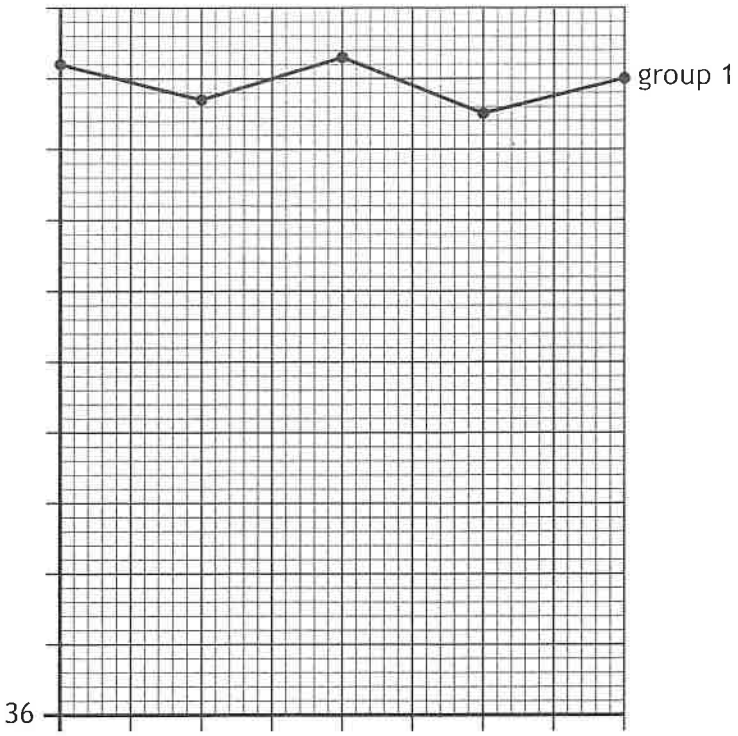
2. _____

8. (continued)

MARKS | DO NOT WRITE IN THIS MARGIN

(b) (i) On the grid, complete the line graph to show the results of the investigation for **group 2**. The results of group 1 are shown. 2

(Additional graph paper, if required, can be found on *page 28*.)



(ii) State the conclusion that can be made from these results. 1

_____

_____

(iii) If the study continued for another 15 days, predict the average sperm count of the mice in group 2. 1

_____ million/cm^3

(c) Artificial insemination can be used if a male has a low sperm count.

Describe a feature of artificial insemination that increases the chances of fertilisation. 1

_____

_____

[Turn over

9. Cholesterol is essential for myelin sheath regeneration and maintenance.

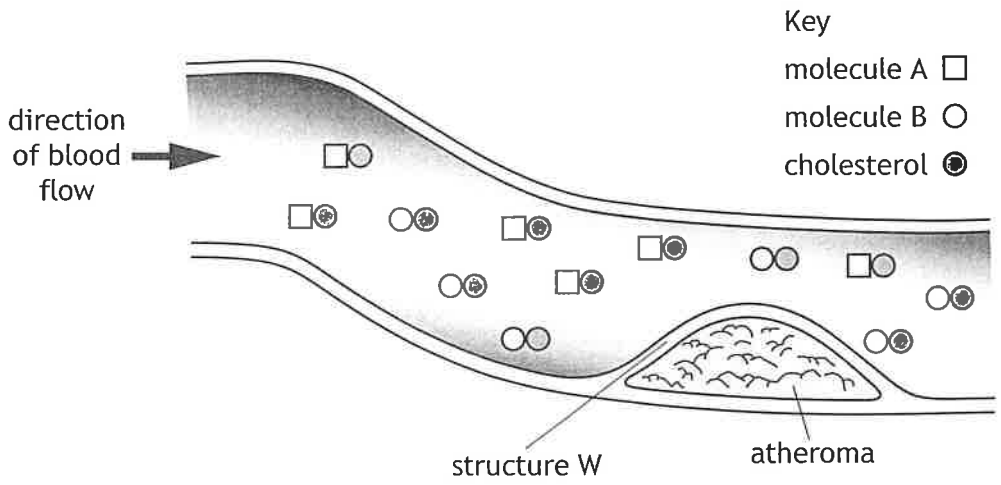
(a) (i) State another function of cholesterol in the body. 1

_____

(ii) Describe the importance of the myelin sheath. 1

_____

(b) The diagram shows the transport of cholesterol through an artery by molecules A and B.



Molecule A transports cholesterol to body cells.

Molecule B prevents accumulation of cholesterol in the blood.

(i) Identify molecule B and describe how it prevents accumulation of cholesterol in the body. 2

Molecule B _____

Description _____

_____

9. (b) (continued)

(ii) Describe how cholesterol uptake is limited in body cells with sufficient cholesterol. 1

_____

_____

(iii) Molecule A can also deposit cholesterol as part of the fatty material in an atheroma under structure W.

Name structure W and another substance that can be found in an atheroma. 2

Structure W _____

Other substance _____

(c) If an atheroma ruptures, clotting factors lead to the conversion of the enzyme prothrombin to its active form thrombin.

Hirudin is a molecule that acts as a competitive inhibitor of thrombin.

(i) Suggest how the inhibitor hirudin prevents the formation of a clot. 2

_____

_____

_____

(ii) Suggest how the effect of hirudin on the clotting process could be reversed. 1

_____

_____

[Turn over

10. Changes in an individual's heart rate and duration of stages in the cardiac cycle at rest and during exercise are shown in the table.

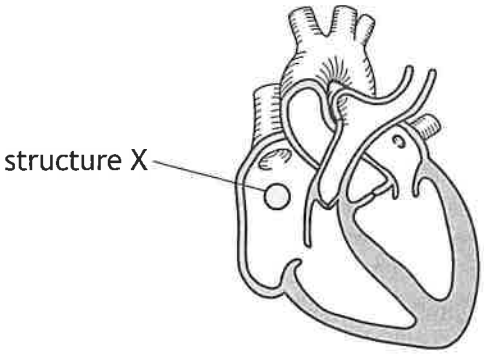
Activity	Heart rate (bpm)	Duration (s)		
		Atrial systole	Ventricular systole	Diastole
Rest	60	0.18	0.22	0.60
Exercise	120	0.10	0.14	

(a) Calculate the duration of diastole during exercise. 1

Space for calculation

_____ s

(b) Atrial systole is brought about by structure X.



(i) Name structure X. 1

_____

(ii) A stethoscope is used to listen to heart sounds during the cardiac cycle.

Describe the events during the cardiac cycle in the heart that are responsible for these sounds. 2

_____

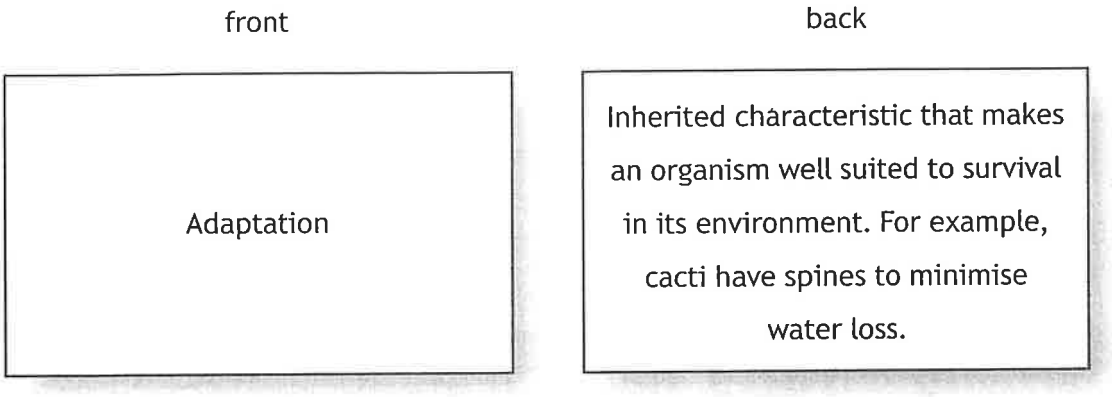
_____

_____

MARKS | DO NOT WRITE IN THIS MARGIN

11. Flashcards are often used in the rehearsal of information during revision.

A student created flashcards to revise for their N5 Biology exam. The flashcards had a biological term on the front and an explanation on the back. One of the flashcards is shown in the diagram.



(a) (i) The back of this flashcard shows another method that improves the transfer of information to the long-term memory.

Name this method. 1

_____

(ii) Explain why this method leads to improved information retention compared to rehearsal of the information. 1

_____

_____

(b) State what would happen to the information if it was not transferred from the short-term memory to long-term memory. 1

_____

(c) The short-term memory has a limited capacity.

Name the method that increases the capacity of short-term memory and suggest how this method can increase the capacity. 2

Name _____

Suggestion _____

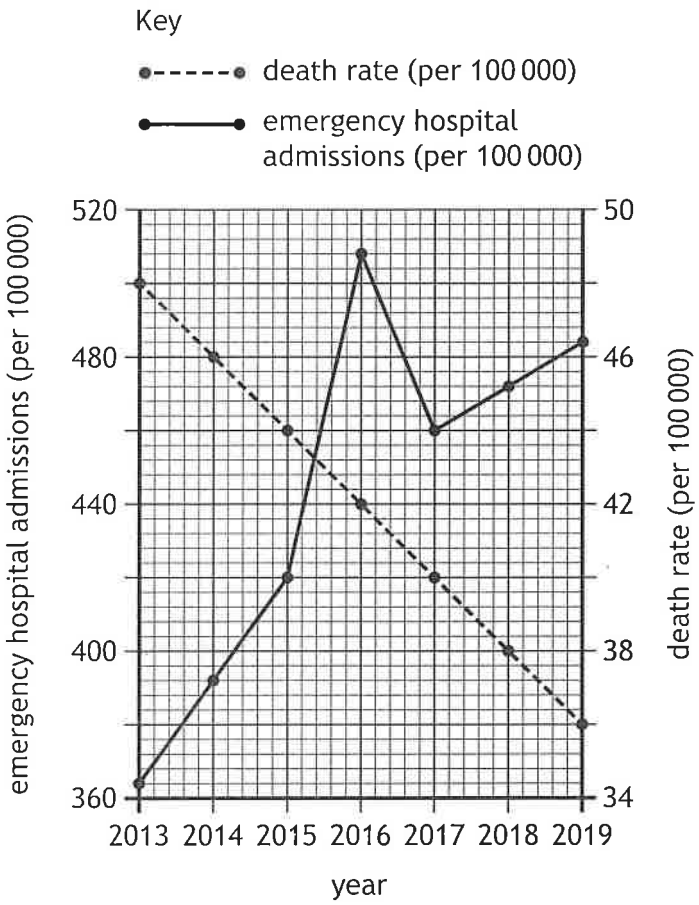
_____

[Turn over

12. A species of bacterium can be found in the upper respiratory tract of individuals where it is usually harmless and causes no symptoms.

If an individual contracts influenza, the normally harmless bacterium can move to the lower respiratory tract and cause pneumonia.

The graph shows the number of emergency hospital admissions and death rate for pneumonia in a country from 2013 to 2019.



(a) (i) Calculate the annual average increase in emergency hospital admissions for pneumonia over the six-year period from 2013 to 2019. 1

Space for calculation

_____ per 100 000/year

(ii) State the death rate from pneumonia when the number of emergency hospital admissions was 420 per 100 000. 1

_____ per 100 000

12 (a) (continued)

(iii) Calculate the difference between emergency hospital admissions and death rates for pneumonia in 2016. 1

Space for calculation

_____ per 100 000

(iv) Using the information provided, suggest a reason for the sharp increase in the number of emergency hospital admissions for pneumonia from 2015 to 2016. 1

_____

_____

(v) In 2017 the population of the country was 50 million and the total number of deaths in the country was 500 000.

Using data from the graph, calculate the percentage of the total number of deaths that were due to pneumonia. 1

Space for calculation

_____ %

(b) Individuals in this country are offered the influenza vaccine.

(i) Name a source of antigens that can be used to produce a vaccine. 1

_____

(ii) Explain why an adjuvant is added to a vaccine. 1

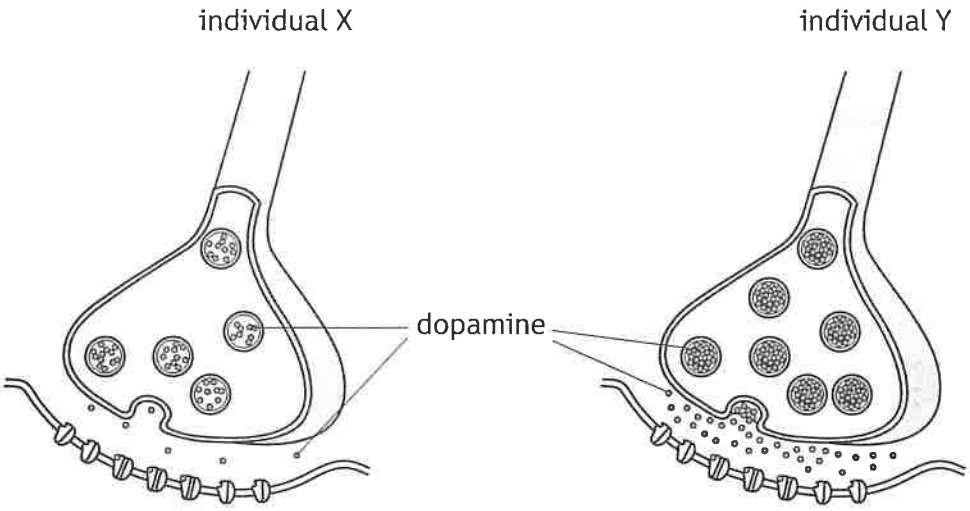
_____

_____

[Turn over

13. The diagram represents synapses from the brains of two individuals.

Individual X has Parkinson's disease and individual Y does not have Parkinson's disease.



(a) (i) Using information in the diagram, describe an effect of Parkinson's disease on the synapses of individual X. 1

(ii) State an effect of the neurotransmitter dopamine. 1

13. (continued)

(b) Parkinson's disease can be treated with a drug that mimics the action of dopamine at a synapse.

Name the type of drug that would mimic the action of dopamine. 1

_____

(c) Describe how the release of neurotransmitters at a synapse triggers an impulse in the postsynaptic neuron. 2

_____

_____

_____

_____

[Turn over

MARKS | DO NOT WRITE IN THIS MARGIN

14. Attempt **either** A **or** B.

Write your answer in the space below and on *page 27*.

A Write notes on the role of B and T lymphocytes in the specific immune response to a pathogen. 8

OR

B Write notes on the divisions of the nervous system to include the central nervous system and the peripheral nervous system. 8

You may use labelled diagrams where appropriate.