FOR OFFICIAL USE

National Qualifications 2025

Mark

X840/76/01

Human Biology Paper 2

TUESDAY, 27 MAY

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 15 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.

Before leaving the examination room you must give this booklet to the Invigilator; if you do not, you may lose all the marks for this paper.

SQA

X8407601 01

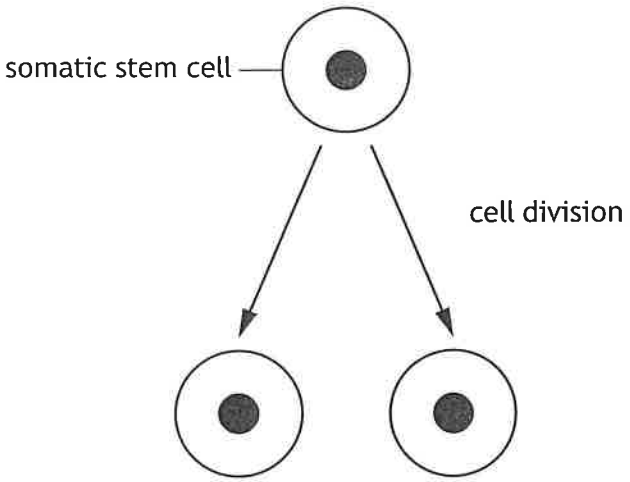
MARKS | DO NOT WRITE IN THIS MARGIN

Total marks — 95

Attempt ALL questions

Question 15 contains a choice

1. The diagram shows a somatic stem cell dividing.



(a) (i) Name the type of cell division shown in the diagram. 1

_____

(ii) Germline stem cells undergo a different type of cell division to produce gametes.

State one location of the production of gametes. 1

_____

(b) Somatic stem cells can be found in the cornea of the eye.

Describe how these stem cells could differentiate into specialised cells such as corneal cells. 1

_____

_____

_____

X8407601 02

1. (continued)

(c) Some conditions can cause severe damage to the cornea and somatic stem cells found in the eye. Stem cell transplants can be carried out to replace the damaged somatic stem cells with healthy stem cells.

The table shows the number of stem cell donors and the number of stem cell transplant recipients in one year.

Age group (years)	Number of stem cell donors	Number of stem cell transplant recipients
0–17	5	30
18–34	24	290
35–49	88	330
50–59	192	373
60–69	384	590
70–79	700	1021
80–99	394	656

(i) Use data from the table to describe the changes that occur in the number of stem cell donors as age increases from 0 to 99 years. **2**

(ii) Using information in the table, suggest a benefit of using a patient's own stem cells for this treatment. **1**

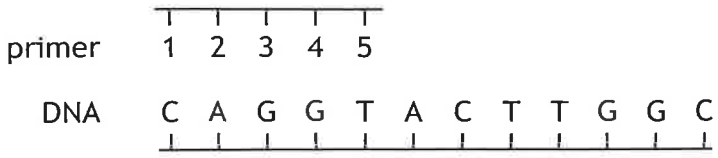
(d) Corneal repair is a therapeutic use of stem cells.

Describe one use of stem cells in research. **1**

MARKS | DO NOT WRITE IN THIS MARGIN

2. The polymerase chain reaction (PCR) is used to amplify DNA.

The diagram shows a primer attached to a single strand of DNA.



(a) Name base 3. 1

_____

(b) PCR requires two primers.

Explain why the two primers have different base sequences. 2

_____

_____

_____

_____

(c) State a temperature used to allow primers to bind during PCR. 1

_____ °C

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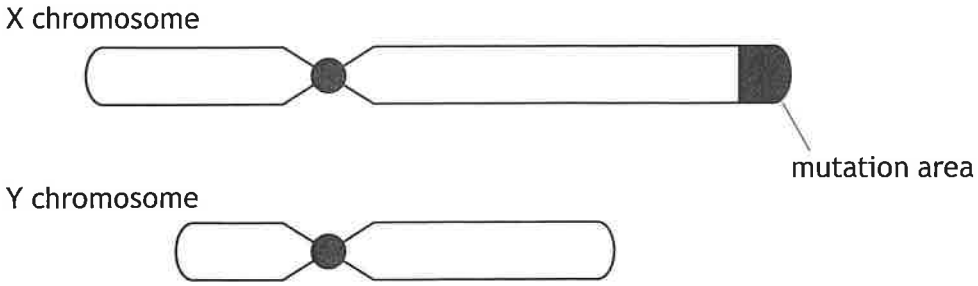
3. A chromosome mutation on the X chromosome can result in the blood clotting disorder haemophilia A.

The diagram shows two chromosomes from an individual with haemophilia A.



(a) (i) Name the type of inheritance for haemophilia A. 1

_____

(ii) In a population, 6300 males have haemophilia A. This represents 75% of the total number of individuals with this condition.

Calculate how many females have haemophilia A in this population. 1

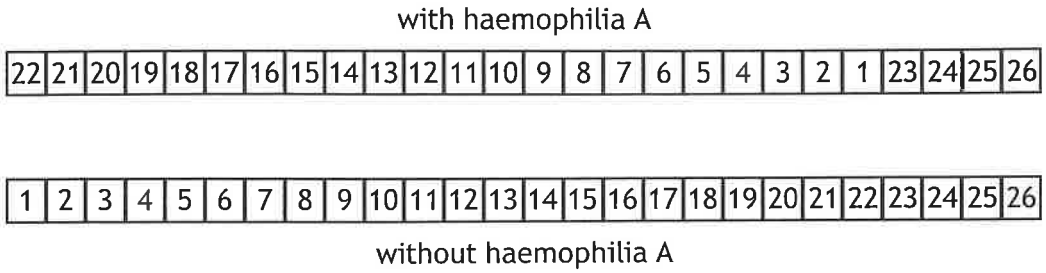
Space for calculation

_____

[Turn over

3. (continued)

(b) The diagram shows the order of exons in the mutation area of the X chromosome from an individual with haemophilia A and an individual without haemophilia A.



(i) Name the type of chromosome mutation that causes haemophilia A. 1

_____

(ii) State the function of an exon. 1

_____

(iii) During the expression of a gene for a blood clotting protein, mRNA is transcribed from exons 1 to 26.

Explain why this protein is non-functional in individuals with haemophilia A. 2

_____

_____

_____

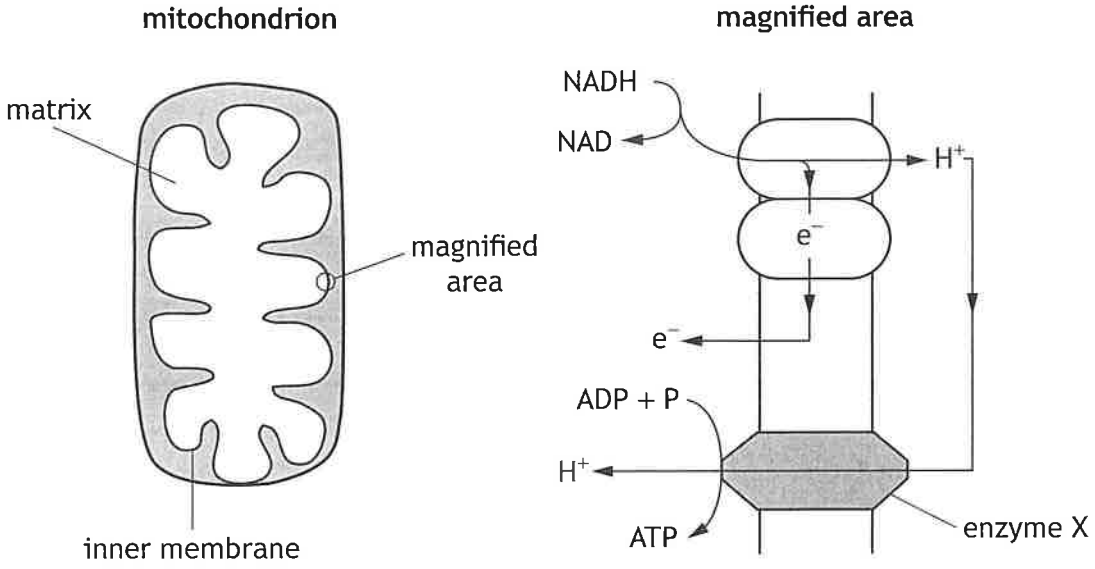
(c) Describe how alternative RNA splicing leads to different proteins being expressed from one gene. 1

_____

_____

4. The diagram shows a mitochondrion and a magnified area.

Some of the reactions involved in an electron transport chain are shown in the magnified area.



(a) Use the mitochondrion diagram to describe how the inner membrane is adapted to maximise ATP production. 1

(b) NADH is formed in the matrix of the mitochondrion.

State another location in the cell where NADH is formed. 1

(c) Describe one role of electrons (e^-) in the electron transport chain. 1

(d) Name enzyme X. 1

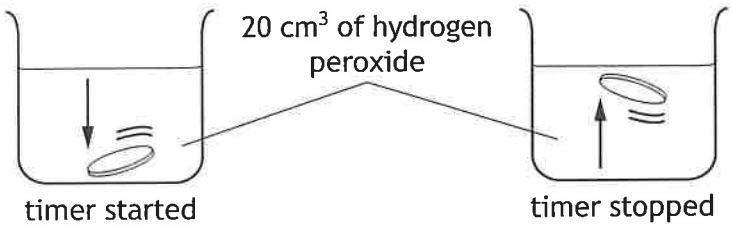
[Turn over

MARKS | DO NOT WRITE IN THIS MARGIN

5. An investigation was carried out into the effect of substrate concentration on the inhibition of catalase by copper nitrate. Catalase breaks down hydrogen peroxide into water and oxygen.

10 cm^3 of catalase solution was mixed with 10 cm^3 copper nitrate solution and a paper disc was placed in this solution for 10 seconds.

The disc was then dropped into hydrogen peroxide. When the disc reached the bottom of the beaker, a timer was started and the time taken for the disc to float to the surface was recorded. Oxygen produced during the reaction caused the paper disc to float.



This was repeated using different concentrations of hydrogen peroxide.

A control experiment was carried out where copper nitrate solution was replaced with water.

The results are shown in the table.

Concentration of hydrogen peroxide (%)	Time for disc to float to surface (seconds)	
	Catalase + copper nitrate solution	Catalase solution
0.5	192	120
1.0	136	84
2.0	72	36
3.0	52	28
5.0	28	28

(a) Name the type of metabolic reaction catalysed by catalase. 1

_____

(b) (i) State two variables, not already mentioned, that should be controlled to make the investigation valid. 2

1. _____

2. _____

(ii) State the purpose of the control in **this** investigation. 1

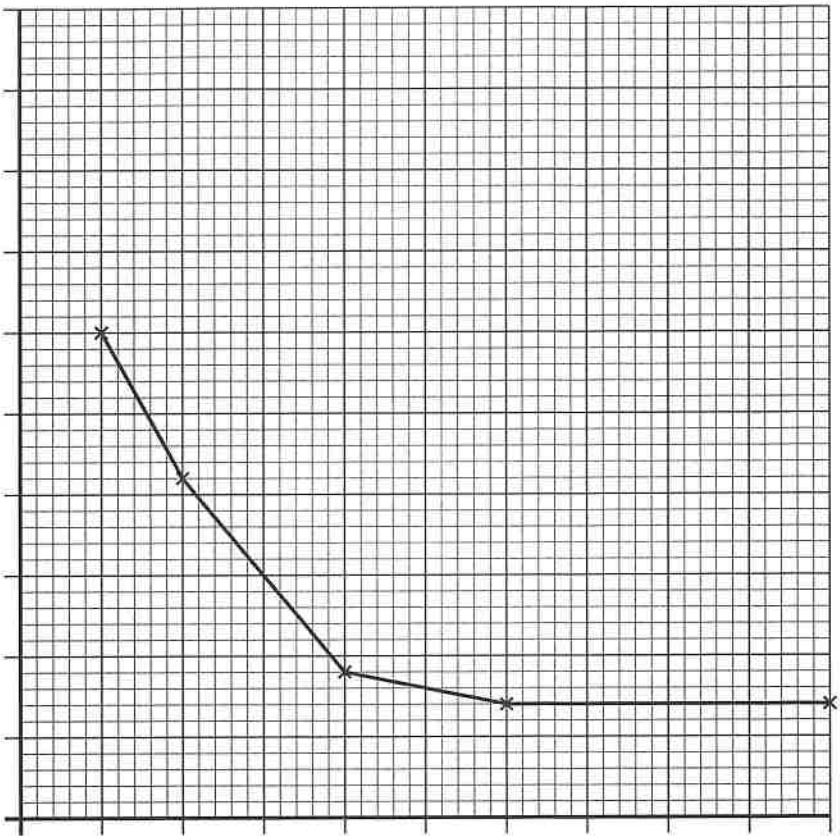
_____

_____

MARKS | DO NOT WRITE IN THIS MARGIN

(c) On the grid, complete the line graph to show the results of the investigation using **catalase and copper nitrate**. 2

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



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

_____

_____

(e) Another disc was placed in the solution of catalase and copper nitrate then dropped into a beaker of 6.0% hydrogen peroxide.

Predict the average time for the disc to float to the surface. 1

Space for calculation

_____ seconds

6. A study was carried out to determine if the physical activity and body mass of females affects fertility.

The results are shown in the table.

Physical activity category	Body mass category	Chance of fertility problems (%)
Low	healthy	14
	overweight	17
	obese	27
Moderate	healthy	13
	overweight	16
	obese	18
High	healthy	11
	overweight	15
	obese	17

(a) State the physical activity and body mass category that resulted in the greatest chance of fertility problems in females. 1

_____

(b) (i) BMI is used to determine body mass category.

Calculate the BMI of a female with a body mass of 77 kg and a height of 1.7 m. 1

Space for calculation

_____

(ii) A female has a moderate level of physical activity and a BMI of 33.

State the chance that this female will have fertility problems. 1

_____ %

6. (b) (continued)

(iii) The female and her partner are undergoing treatment for infertility because the partner has a low sperm count.

Name and describe a suitable treatment for this couple. 2

Treatment _____

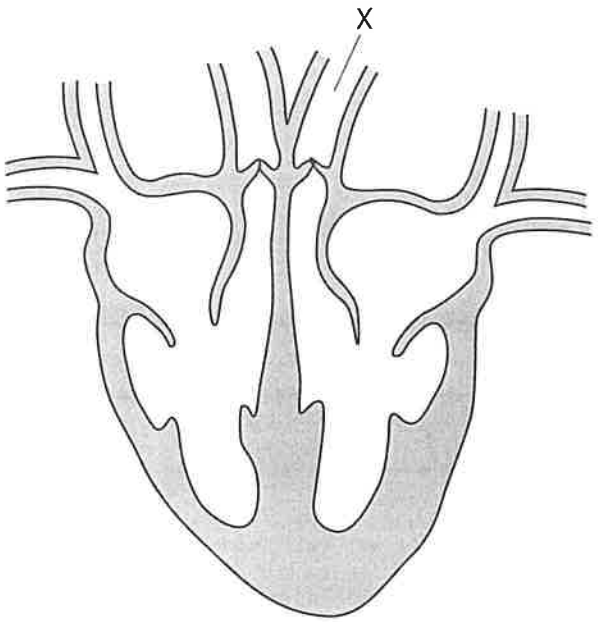
Description _____

_____

_____

[Turn over

7. The diagram shows a section through a human heart.



(a) (i) Name blood vessel X. 1

_____

(ii) Describe the evidence shown in the diagram that suggests the heart is in atrial systole. 1

_____

_____

(b) Describe how impulses from the sino-atrial node (SAN) cause ventricular systole. 2

_____

_____

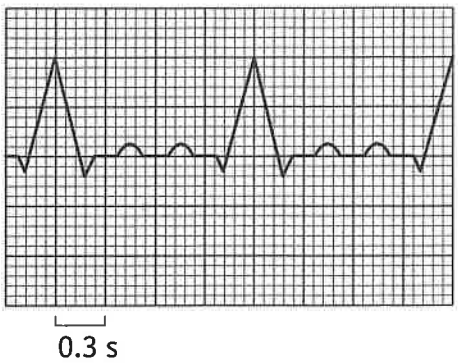
_____

_____

7. **(continued)**

(c) The diagrams show ECG traces from an individual before and after strenuous exercise.

before exercise



after exercise

Calculate the increase in heart rate during exercise. **1**

Space for calculation

_____ beats per minute

(d) Describe how the medulla lowers the heart rate following a period of exercise. **2**

_____

_____

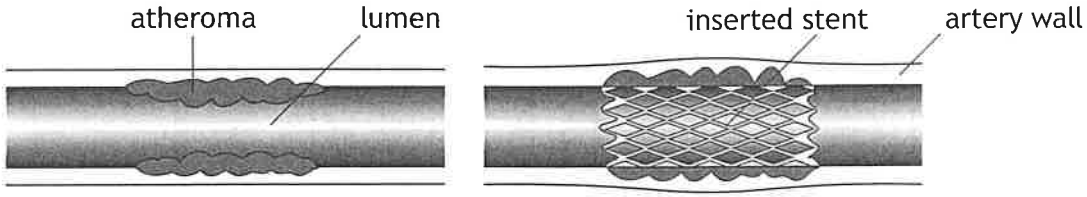
_____

_____

[Turn over

8. When an atheroma develops in an artery it can be treated by inserting a mesh tube called a stent.

The diagrams show an artery before and after a stent has been inserted.



(a) (i) Describe the formation of an atheroma within an artery. 2

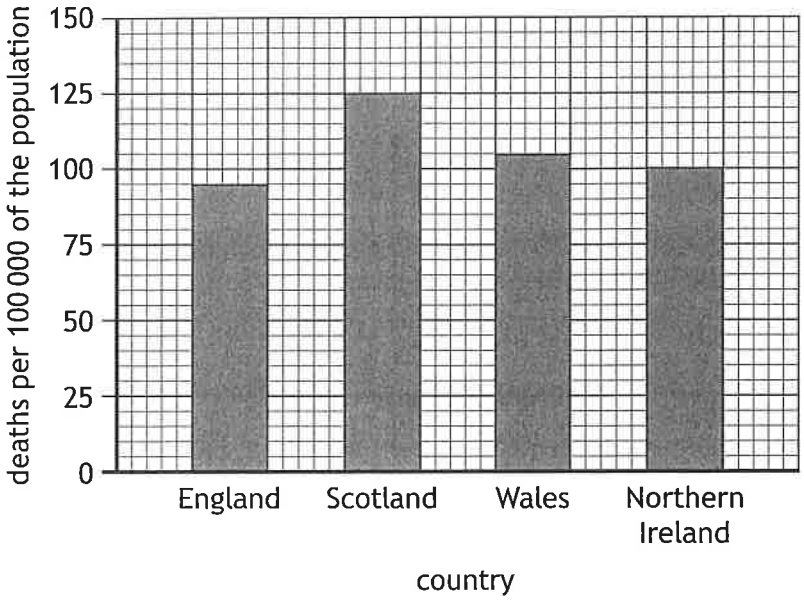
(ii) Use the diagrams to suggest how the insertion of a stent leads to increased blood flow in an artery. 1

(b) A ruptured atheroma in an artery may lead to thrombosis.

Describe how thrombosis can cause a myocardial infarction (heart attack). 2

8. (continued)

(c) The graph shows deaths from coronary heart disease in four countries.



(i) Using data from the graph, the risk of an individual dying from coronary heart disease in Northern Ireland was calculated to be 1 in 1000.

Use data from the graph to calculate the risk of an individual dying from coronary heart disease in Scotland. 1

Space for calculation

1 in _____

(ii) Explain why deaths from coronary heart disease are expressed as per 100 000 of the population. 1

_____

_____

[Turn over

9. High density lipoproteins (HDLs) and low density lipoproteins (LDLs) transport cholesterol around the body.

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

_____

(ii) Name the organ to which HDL transports excess cholesterol for elimination. 1

_____

(b) Familial hypercholesterolaemia (FH) is an inherited condition.

Individuals with FH have high levels of LDLs in their bloodstream.

(i) Statins are drugs, and can be prescribed to individuals with FH.

Statins act as competitive inhibitors of an enzyme involved in the synthesis of cholesterol.

Describe the mode of action of competitive inhibitors such as statins. 1

_____

_____

(ii) FH is caused by an autosomal dominant allele.

Describe two ways in which the patterns of inheritance in a family history would indicate autosomal dominance. 2

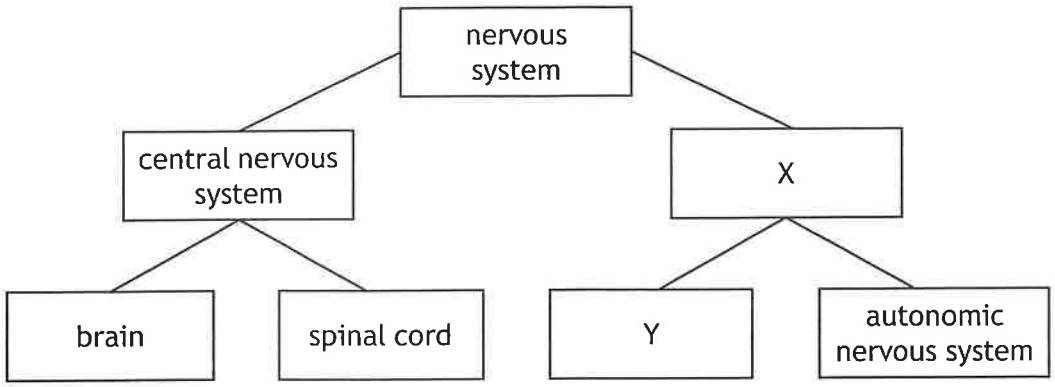
1. _____

_____

2. _____

_____

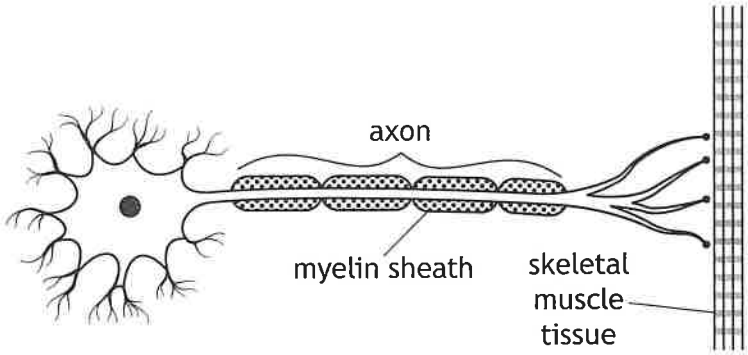
10. The diagram shows divisions of the nervous system.



(a) Identify X and Y. 2

X _____ Y _____

(b) The diagram represents a neuron and its junction with skeletal muscle tissue.



Name the type of neuron shown in the diagram. 1

_____

(c) Describe myelination and its importance in child development. 3

_____

_____

_____

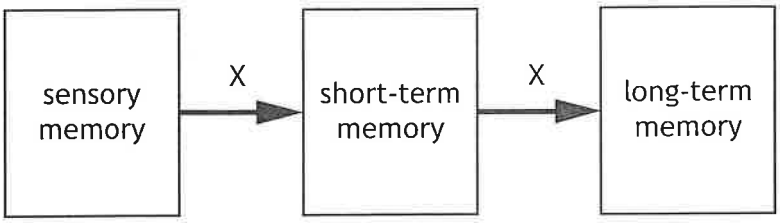
_____

_____

_____

11. The diagram represents a flow of information through memory.

MARKS | DO NOT WRITE IN THIS MARGIN



(a) (i) Name process X. 1

_____

(ii) Name two methods that enable the transfer of information from short-term to long-term memory. 2

1. _____

2. _____

(b) State the location in the brain where memories are stored. 1

_____

(c) An investigation into the serial position effect on recall was carried out.

A list of words was read out to a group of students. Each student then wrote down the words that they could recall.

The table shows the position of the words in the list and the number of students who recalled each word.

Position of word in list	Number of students who recalled each word
1	18
2	17
3	16
4	14
5	10
6	8
7	7
8	8
9	16
10	17

11. (c) (continued)

(i) It was observed that more students recalled the words at the start and the end of the list compared to those in the middle.

Explain this observation. 2

(ii) The investigation was evaluated as being unreliable.

State how the investigation could be made reliable. 1

[Turn over

MARKS | DO NOT WRITE IN THIS MARGIN

12. Dopamine is a neurotransmitter that activates the reward pathway in the brain.

(a) State one effect of activating the reward pathway. 1

_____

(b) State one method of removal of dopamine from a synapse. 1

_____

(c) (i) A dopamine agonist can be used in the treatment of Parkinson's disease.

State the effect of prolonged use of an agonist. 1

_____

(ii) In a clinical trial of a potential new drug for the treatment of Parkinson's disease, individuals were divided into groups in a randomised way.

Name one other protocol that could be used during this clinical trial and explain its importance to the results. 2

Protocol _____

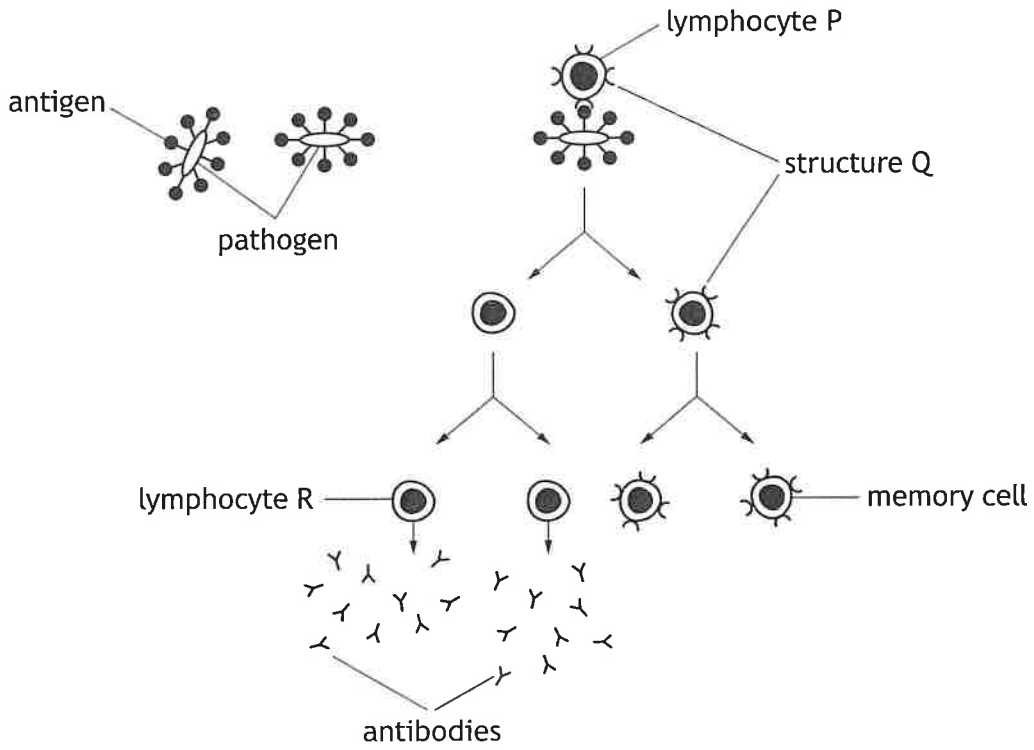
Importance _____

_____

(iii) State one other design factor that would allow the results of the clinical trial to have statistical significance. 1

_____

13. The diagram represents lymphocyte responses to infection by a pathogen.



(a) (i) Structure Q is found on the surface of lymphocytes to allow them to bind with antigens.

Name structure Q. **1**

_____

(ii) Give evidence from the diagram that shows lymphocyte R is a B lymphocyte. **1**

_____

(b) Antibodies attach to and inactivate a pathogen, so the pathogen cannot spread through the body.

Describe the role of phagocytes following the inactivation of the pathogen. **1**

_____

_____

[Turn over

13. (continued)

(c) An individual contracted chicken pox during childhood. A few years later they were exposed to the same chicken pox antigen.

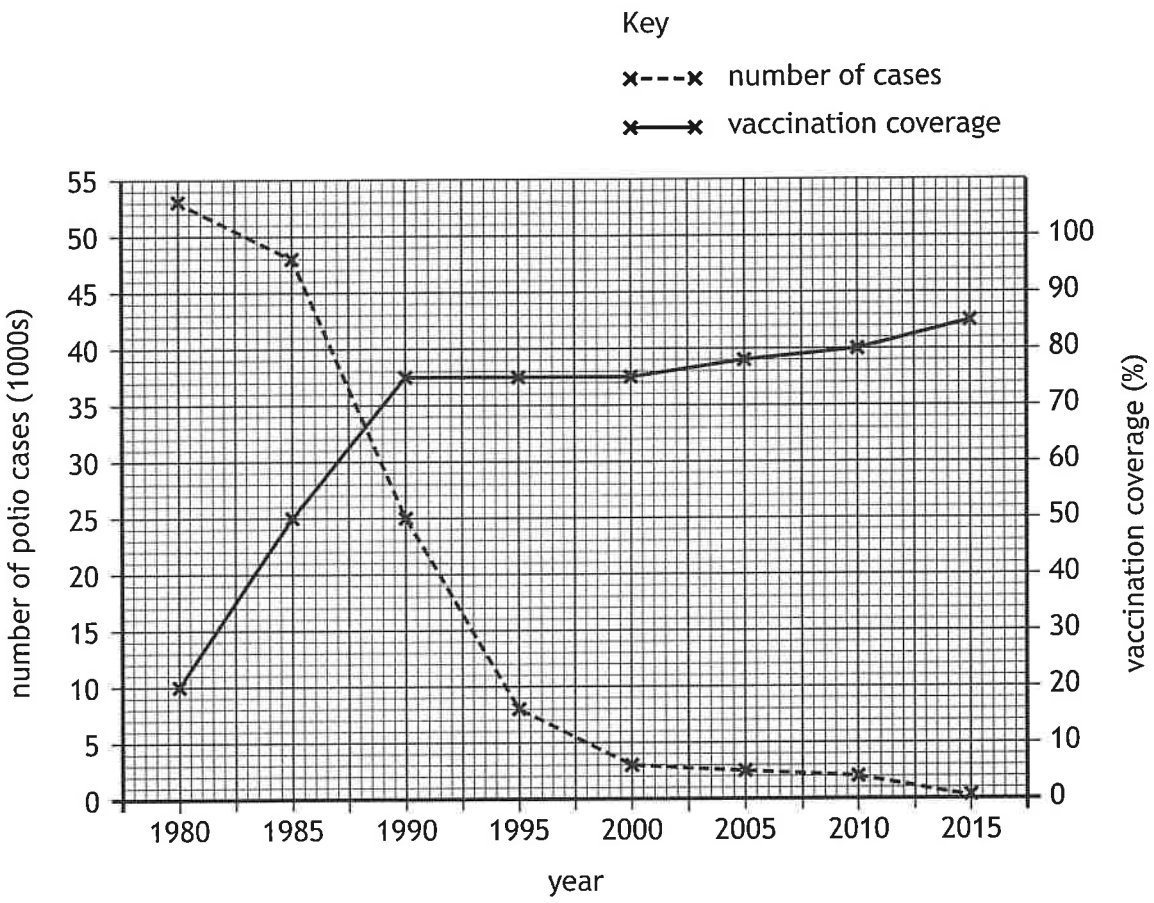
Describe the role of memory cells in protecting this individual from developing symptoms of chicken pox during this second exposure. **2**

(d) T lymphocytes are another type of lymphocyte that protect the body from infection.

Explain how T lymphocytes destroy infected cells. **1**

14. Polio is a viral disease that has been eradicated in most countries due to mass vaccination programmes.

The **graph** shows changes in the global number of polio cases and the percentage of the world population vaccinated between 1980 and 2015.



(a) (i) State the vaccination coverage achieved when the number of polio cases was 8000. 1

_____ %

(ii) Calculate the percentage decrease in polio cases in the 30-year period from 1980 to 2010. 1

Space for calculation

_____ %

14. (a) (continued)

MARKS | DO NOT WRITE IN THIS MARGIN

(iii) Use data from the graph to describe the changes in vaccination coverage between 1980 and 2000. 2

(b) Polio is still present in some developing countries.

The **table** shows the number of polio cases in one of these countries between 2000 and 2010.

Year	2000	2002	2004	2006	2008	2010
Number of polio cases	90	50	20	15	10	15

(i) **Using data in the table and graph**, calculate the simple whole number ratio of the global number of cases of polio to the number of cases in this country in 2000. 1

Space for calculation

_____ : _____

global country

(ii) In order to establish herd immunity for polio, there has to be at least 85% vaccination coverage.

If the population of this country is 2 million people, calculate the number of individuals that must be vaccinated to establish herd immunity for polio in this country. 1

Space for calculation

_____

(iii) Suggest why the herd immunity threshold may not be reached in this developing country despite a 10-year mass vaccination programme. 1

_____

_____

MARKS | DO NOT WRITE IN THIS MARGIN

15. Attempt **either** A **or** B.

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

A Write notes on the follicular and luteal phases of the menstrual cycle. 9

OR

B Write notes on the biology of controlling fertility and the methods of contraception. 9

You may use labelled diagrams where appropriate.