FOR OFFICIAL USE

National Qualifications 2024

Mark

X840/76/01

Human Biology Paper 2

WEDNESDAY, 15 MAY
10:10 AM – 12:30 PM

* X 8 4 0 7 6 0 1 *

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 ©

* X 8 4 0 7 6 0 1 *

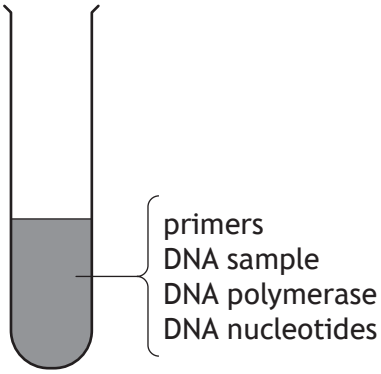
Total marks — 95

Attempt ALL questions

Question 15 contains a choice

1. To confirm an individual is infected with the herpes virus, a test to detect viral DNA can be carried out using the polymerase chain reaction (PCR) on a sample from the individual.

The diagram shows substances that are required to allow PCR to take place.



(a) Give the complementary DNA base sequence for the section of viral DNA shown. **1**

_____

(b) (i) State a temperature used to separate the DNA strands during PCR. **1**

_____ °C

(ii) State the role of primers and DNA polymerase in PCR. **2**

Primers _____

_____

DNA polymerase _____

_____

1. (continued)

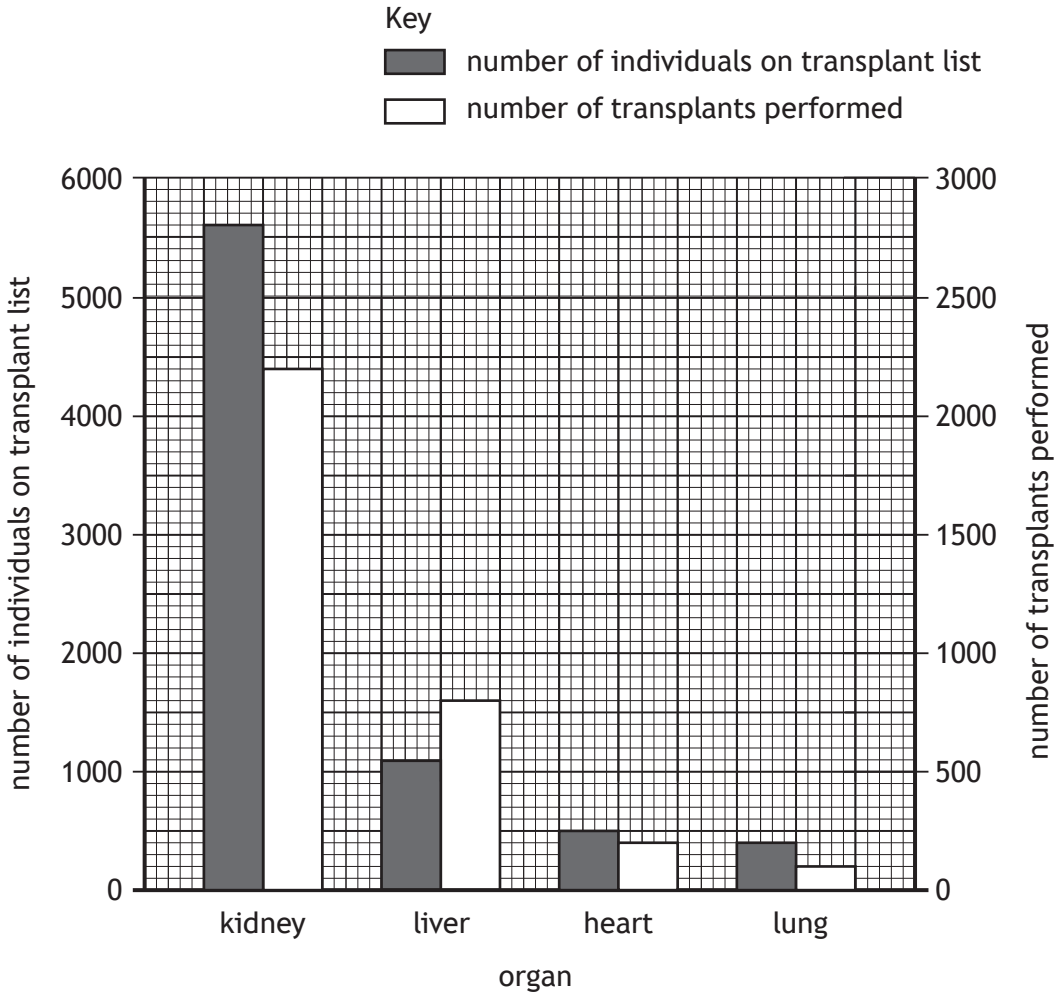
(c) State two uses of PCR, other than diagnosing viral infections. **2**

1. _____

2. _____

[Turn over

2. The graph contains information on some organ transplants performed during 2020 in the UK. It also shows the number of individuals waiting on the transplant list at the start of 2020.



(a) (i) State the number of lung transplants performed in 2020. **1**

_____

(ii) Use information from the graph to calculate the percentage of individuals who received a kidney transplant after being on the transplant list at the start of 2020. **1**

Space for calculation

_____%

2. (continued)

(b) The table shows the total number of transplants performed in three different countries in 2020.

Country	Number of transplants performed (per million of the population)
Scotland	72
England	47
Wales	40

(i) In 2020 the population of England was 57 million.

Calculate how many transplants were performed in England during 2020. **1**

Space for calculation

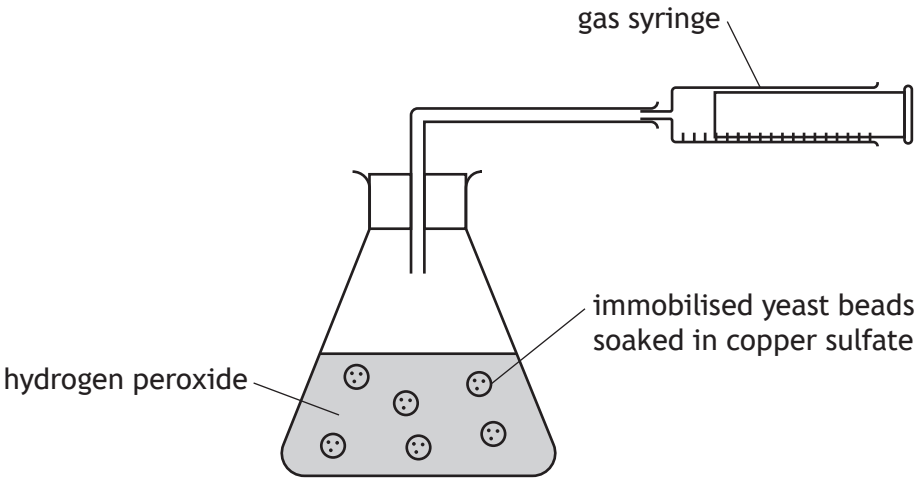
(ii) Explain why the data are presented as the number of transplants performed per million of the population. **1**

[Turn over

3. Catalase is an enzyme that breaks down hydrogen peroxide into oxygen and water. An investigation was carried out into the effect of inhibitor concentration on catalase activity.

Yeast cells containing catalase can be trapped in a gel substance to become 'immobilised' as gel beads. The catalase remains active within these beads.

Immobilised yeast beads were placed in different concentrations of the inhibitor copper sulfate for 24 hours. The beads were then added to a flask of hydrogen peroxide and the oxygen produced was collected in a gas syringe over a five-minute period.



The table shows the results of the investigation.

Concentration of copper sulfate (mmol/l)	Volume of oxygen collected (cm^3)		
	Experiment 1	Experiment 2	Average
0	80	84	82
5	65	71	68
10	45	45	45
25	26	24	25
50	15	17	16

(a) (i) State two variables, other than those shown above, that should be controlled so that a valid conclusion can be drawn. **2**

1. _____

2. _____

3. (a) (continued)

MARKS DO NOT WRITE IN THIS MARGIN

(ii) Suggest an advantage of using immobilised yeast beads rather than yeast in solution. **1**

_____

_____

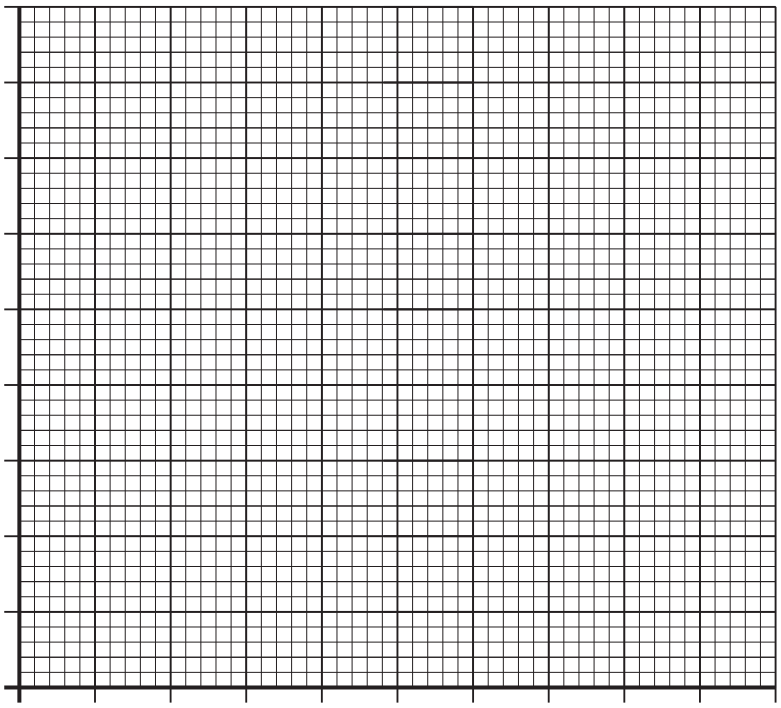
(iii) Suggest why the immobilised yeast beads were left in the copper sulfate solution for 24 hours before adding them to the hydrogen peroxide. **1**

_____

_____

(b) Using data from the table, draw a line graph to show the average volume of oxygen collected. **2**

(Additional graph paper, if required, can be found on *page 31*.)



(c) State the conclusion that can be drawn from this investigation. **1**

_____

_____

4. Cellular respiration takes place to generate ATP.

(a) The statements refer to events that occur during respiration in a muscle cell.

Letter	Statement
W	Carbon dioxide is released.
X	An acetyl group combines with coenzyme A.
Y	Glucose is broken down into pyruvate.
Z	Dehydrogenase enzymes remove hydrogen ions and electrons.

(i) Use letters from the table to identify the statements that apply to glycolysis. **1**

_____

(ii) Name the substance that is broken down to form the acetyl group that combines with coenzyme A. **1**

_____

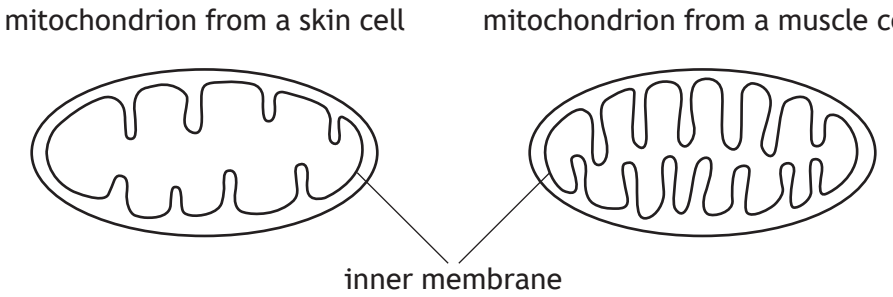
(iii) Oxaloacetate combines with an acetyl group to form another substance.

Name this substance. **1**

_____

4. (continued)

(b) The diagram shows the structure of mitochondria from a skin cell and a muscle cell.



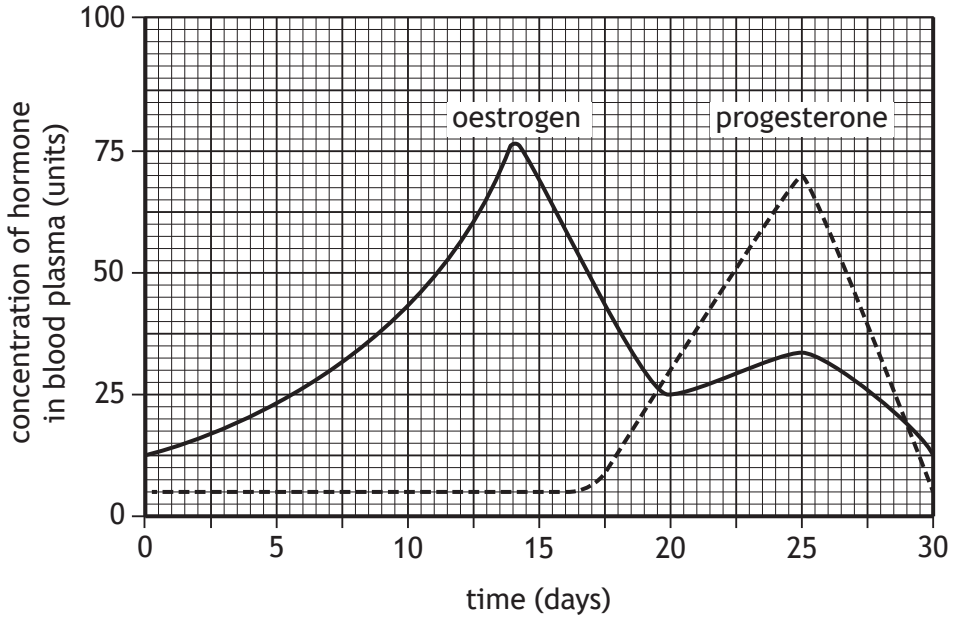
Use the diagram to suggest why mitochondria from muscle cells can generate more ATP than skin cells. **2**

(c) Slow-twitch muscle fibres are useful for endurance activities as they can sustain contractions for long periods of time.

Describe one structural feature of slow-twitch muscle fibres. **1**

[Turn over

5. The graph shows the concentrations of the ovarian hormones, oestrogen and progesterone, in a female's blood plasma during the menstrual cycle.



(a) During the first half of the cycle, the concentration of oestrogen in the blood plasma increases.

(i) Describe the role of follicle stimulating hormone (FSH) in causing this increase in oestrogen concentration. **2**

(ii) Describe how this increase in oestrogen concentration would affect the uterus. **1**

(iii) The high concentration of oestrogen at day 14 stimulates a surge in luteinising hormone (LH).

Describe the effect of this surge in LH on the ovary. **1**

5. (continued)

(b) During the second half of the cycle, the concentration of progesterone in the blood plasma increases.

(i) Calculate how many times greater the concentration of progesterone is on day 25 compared to its concentration on day 15. **1**

Space for calculation

_____ times greater

(ii) Name the structure within the ovary that produces progesterone. **1**

_____

(c) This female is receiving treatment for infertility.

(i) Describe evidence from the graph which indicates that she has **not** become pregnant during this menstrual cycle. **1**

_____

_____

(ii) It was discovered that her oviducts were blocked, reducing the chance of successful fertilisation.

Identify a suitable treatment and describe how the treatment would increase the chance of fertilisation. **2**

Treatment _____

Description _____

_____

[Turn over

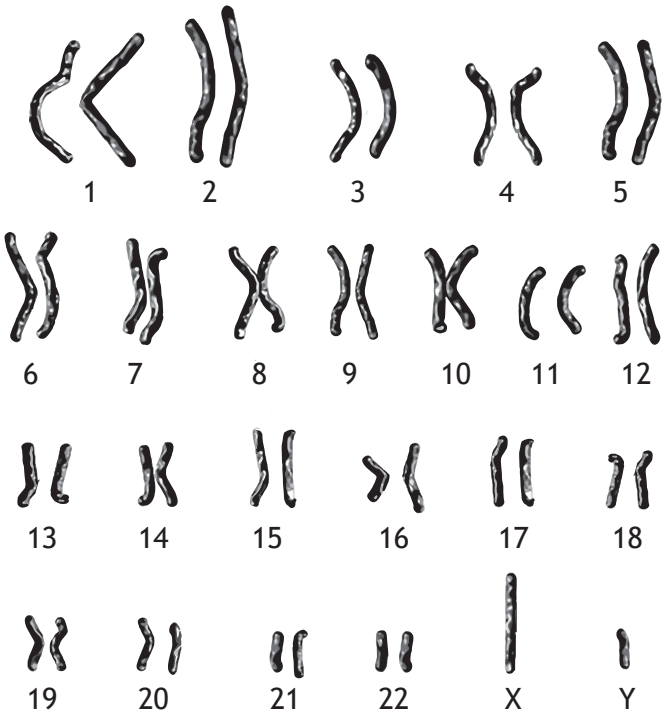
6. Routine blood tests are carried out throughout pregnancy to monitor the concentration of marker chemicals.

(a) Describe a problem with the results that could occur if a blood test is carried out at the wrong time during pregnancy. **1**

(b) A blood test showed unusually low levels of a protein in a pregnant female's blood. After medical advice, a diagnostic test called amniocentesis was carried out.

Suggest why amniocentesis was carried out instead of chorionic villus sampling (CVS). **1**

(c) Samples taken during amniocentesis were used to culture cells and the following image showing the fetal chromosomes was then produced.



(i) State the name given to an image of chromosomes arranged in this way. **1**

(ii) State the term used to describe chromosomes 1 to 22. **1**

[Turn over for next question

DO NOT WRITE ON THIS PAGE

7. The table shows an individual's blood flow rate to different parts of the body at rest and during exercise.

Part of body	Blood flow rate at rest (cm^3/min)	Blood flow rate during exercise (cm^3/min)
Brain	450	750
Heart muscle	250	1000
Skeletal muscles	1000	12 000
Intestines	1500	500

(a) (i) Calculate the percentage increase in the blood flow rate to the heart muscle from rest to exercise. **1**

Space for calculation

_____ %

(ii) Calculate the simple whole number ratio of the blood flow rate to the individual's intestines, skeletal muscles and brain during exercise. **1**

Space for calculation

_____ : _____ : _____

intestines skeletal muscles brain

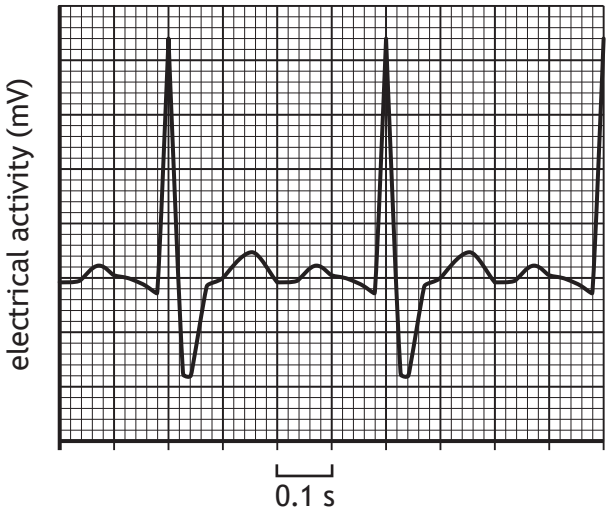
(iii) During exercise, blood flow to the intestines and skeletal muscles changes.

Complete the table to show how these changes would occur. **2**

Part of body	Change in blood flow rate	Process controlling blood flow
	decrease	
	increase	

7. (continued)

(b) (i) The graph shows part of an ECG trace taken when the individual was exercising.



Use information from the ECG trace to calculate their heart rate during exercise. **1**

Space for calculation

_____beats/minute

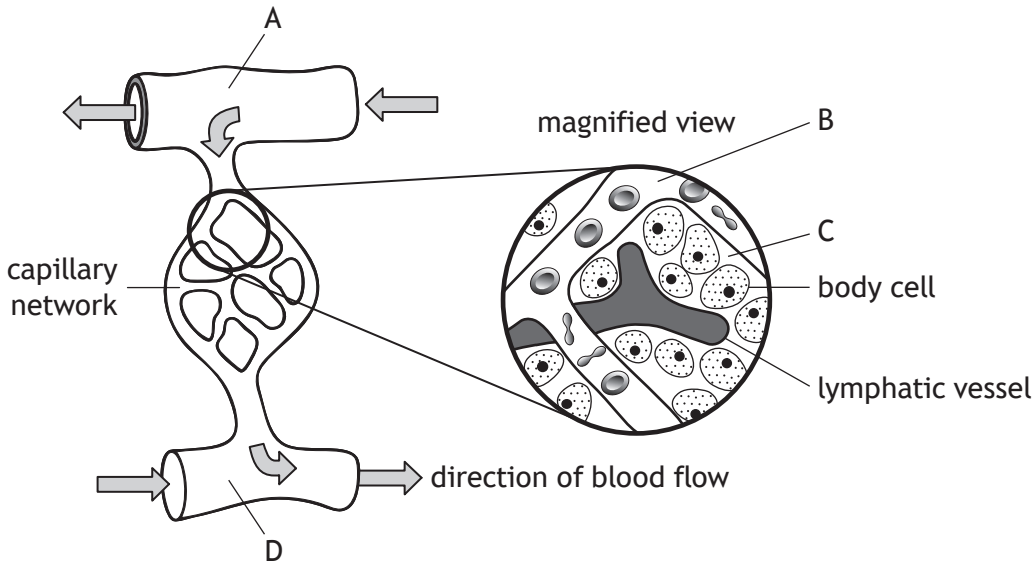
(ii) Describe the role of nerves in the autonomic nervous system to bring about an increase in heart rate. **1**

_____

_____

[Turn over

8. The diagram represents a capillary network and its associated blood vessels.



(a) (i) Name liquid B. **1**

_____

(ii) Name the process that forms liquid C. **1**

_____

(b) Explain why blood vessel A requires a thicker muscular wall than blood vessel D. **1**

_____

_____

(c) (i) Describe a feature of blood capillaries that allows the rapid diffusion of molecules into and out of the bloodstream to occur. **1**

_____

_____

(ii) Name a type of molecule that is normally unable to leave the bloodstream in a capillary network. **1**

_____

8. (continued)

(d) (i) Describe the function of the lymphatic vessel shown in the diagram. **1**

(ii) Suggest a reason why lymphatic vessels contain valves. **1**

[Turn over

9. A medical investigation was carried out into the effect of energy drinks on blood pressure. Energy drinks contain glucose and caffeine.

20 participants were divided into two groups.

Group 1 participants consumed 250 cm^3 of an energy drink.

Group 2 participants consumed 250 cm^3 of water.

Each participant's blood pressure was measured before consuming the drink and again three hours later.

(a) Describe how a sphygmomanometer is used to measure systolic blood pressure. **2**

(b) **Table 1** shows the average blood pressures of both groups.

Table 1

	Average blood pressure (mmHg)	
Group	**Before consuming drink**	**Three hours after consuming drink**
1	123/75	123/84
2	122/74	122/74

(i) Identify the dependent variable in this investigation. **1**

(ii) State one conclusion that can be drawn from these results. **1**

9. (b) (continued)

(iii) The mean arterial blood pressure (MAP) can be calculated using the formula:

$$\text{MAP} = \text{diastolic pressure} + \left(\frac{\text{pulse pressure}}{3}\right)$$

Pulse pressure is the difference between systolic and diastolic pressure.

Three calculated MAP values are shown in **Table 2**.

Table 2

	MAP (mmHg)	
Group	**Before consuming drink**	**Three hours after consuming drink**
1	91	
2	90	90

Use the information in **Table 1** to complete **Table 2** to show the MAP for group 1 after consuming the energy drink. **1**

Space for calculation

(c) Name the condition in which an individual has sustained high blood pressure. **1**

_____

[Turn over

10. A study was carried out to determine if there is a link between low levels of vitamin D and type 1 diabetes.

Vitamin D blood concentrations were measured in a group of individuals with type 1 diabetes and in a control group. There were equal numbers in both groups.

The results are shown in the table.

Group	Individuals with low concentrations of vitamin D (%)
Individuals with type 1 diabetes	91
Control	59

(a) (i) State one variable that would have to be taken into account when allocating individuals to the groups in this study. **1**

(ii) A student concluded from these results that low concentrations of vitamin D increases the risk of developing type 1 diabetes.

Suggest why this conclusion may be incorrect. **1**

(iii) The total number of individuals involved in the study was 400.

Calculate the number of individuals in the control group who had low concentrations of vitamin D. **1**

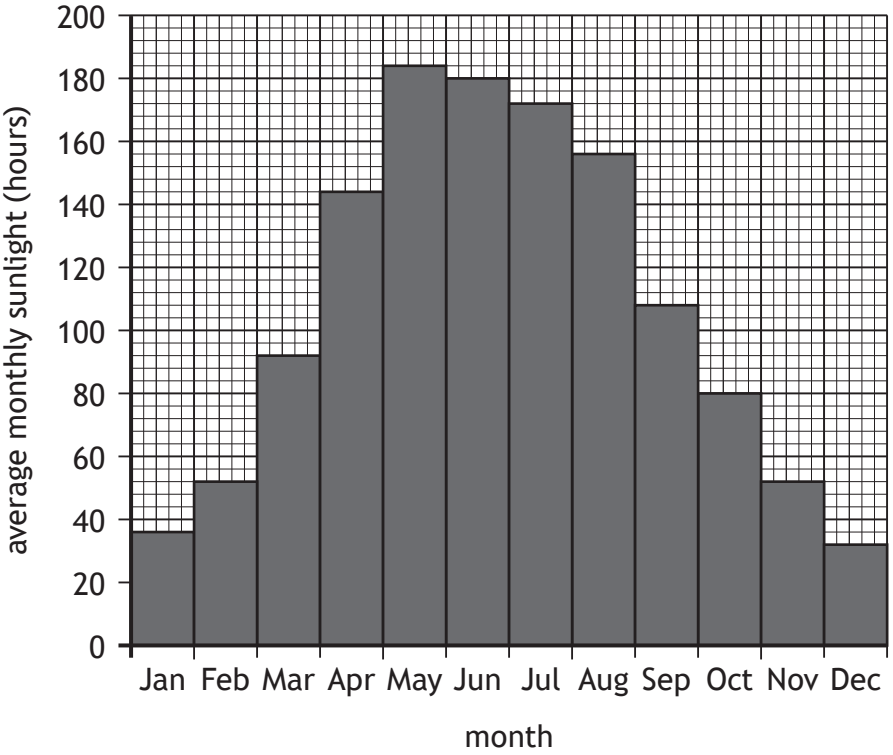
Space for calculation

(iv) Describe how the reliability of the study could be increased. **1**

10. (continued)

(b) When skin is exposed to sunlight the production of vitamin D increases.

The graph shows the average monthly hours of sunlight in a city in Scotland throughout the year.



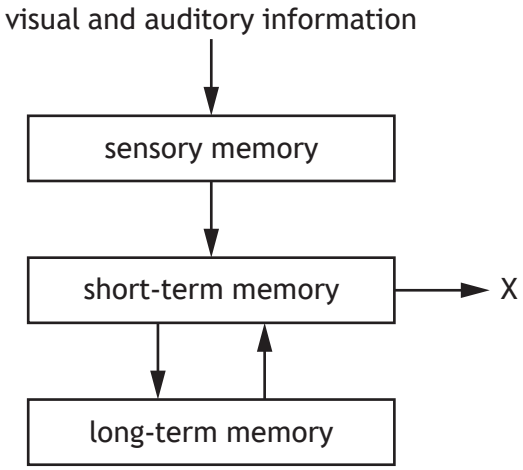
(i) Use data from the graph to describe the changes that occur in the average monthly hours of sunlight throughout the year. **2**

(ii) Most individuals produce enough vitamin D in their skin when the levels of sunlight are higher than 100 hours per month.

During which months would an individual living in this city need to obtain more of their vitamin D from their diet? **1**

[Turn over

11. The diagram represents the flow of information from the environment through memory.



(a) Name process X. **1**

_____

(b) Name the model that is used to explain the ability of the short-term memory to perform simple cognitive tasks. **1**

_____

(c) A mobile phone number typically consists of 11 numbers.

Explain why it is difficult to store a mobile phone number in the short-term memory. **1**

_____

_____

11. (continued)

(d) In an investigation into the recall of information from long term memory, a large group of students was divided into two sub-groups.

The students were then given a list of 20 words to memorise in one minute.

Group 1 was given a list of the words arranged into four different categories.

Group 2 was given a list that contained the same words but in a random order.

Five minutes later the students had to write down all the words they could recall from the list.

(i) Suggest a method that could be used to randomly allocate the students to each sub-group. **1**

_____

_____

(ii) Explain why students in group 1 recalled more words than students in group 2. **1**

_____

_____

_____

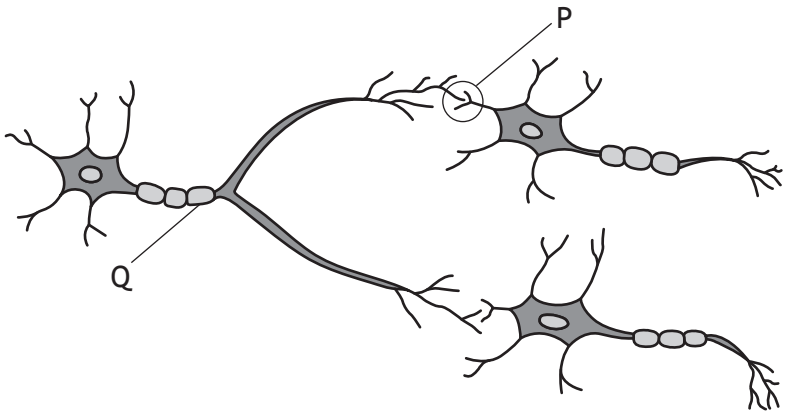
(e) Recalling the events that occurred when information was encoded into long term memory can help the later retrieval of the information.

Name the term that is used to describe these events. **1**

_____

[Turn over

12. The diagram shows the arrangement of some motor neurons.



(a) Name structure P. **1**

_____

(b) (i) Name the type of neural pathway shown in the diagram. **1**

_____

(ii) Explain how this arrangement of neurons helps with fine motor control when writing. **1**

_____

_____

(c) (i) Name structure Q. **1**

_____

(ii) Structure Q develops from birth to adolescence.

Describe why this development allows children to become more coordinated as they get older. **1**

_____

_____

12. (continued)

(d) (i) Myasthenia gravis is a disease where the neurotransmitter receptors on skeletal muscles are destroyed.

Suggest how this results in problems with movement. **1**

(ii) Myasthenia gravis is an autoimmune disease.

Describe the immune response that results in an autoimmune disease. **2**

(iii) The populations of three countries are shown in the table.

Country	Population (million)
Scotland	5.4
England	57.0
Wales	3.1

The incidence of Myasthenia gravis throughout the UK is 20 per 100 000.

Calculate how many more people suffer from the disease in England compared to Scotland. **1**

Space for calculation

[Turn over

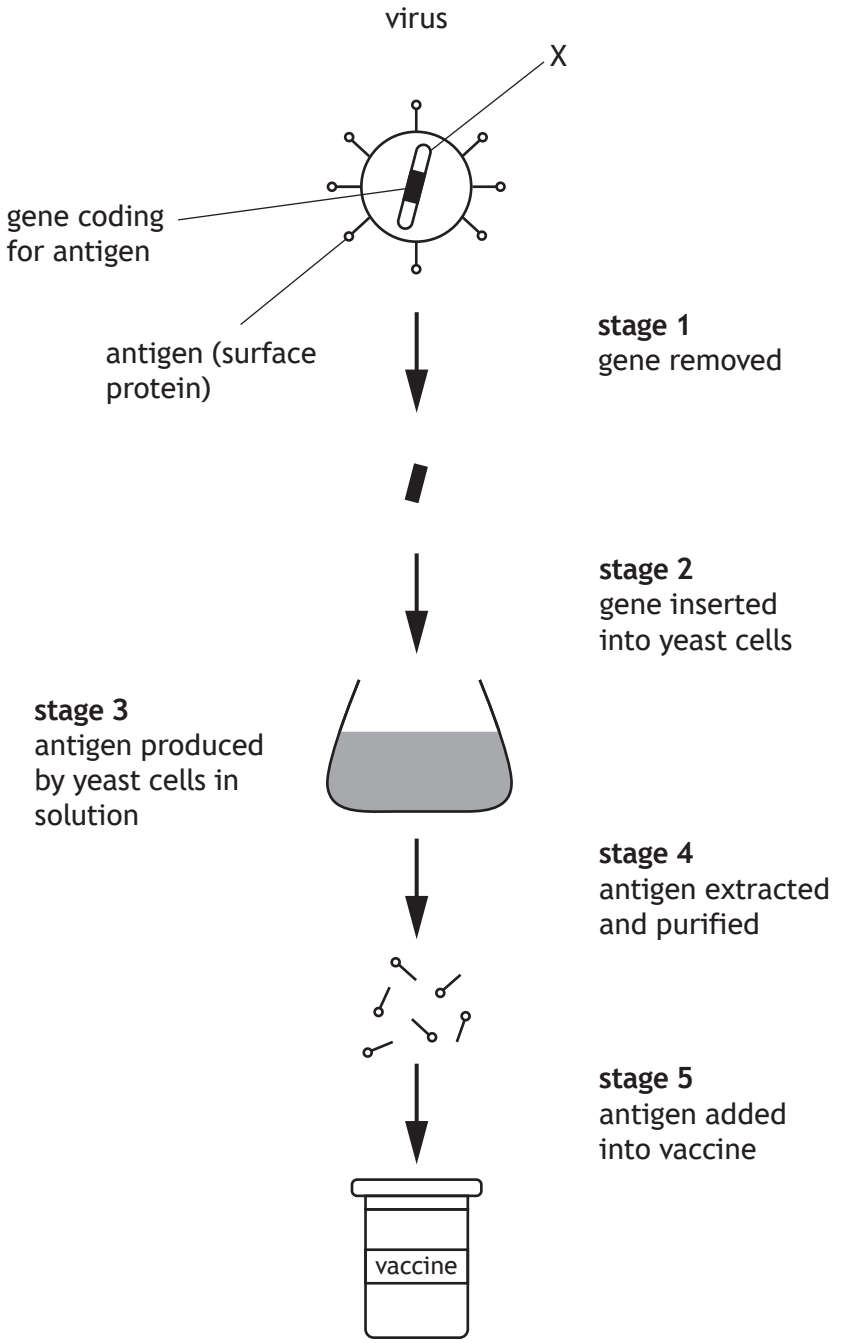
13. B lymphocytes form part of the specific immune system.

(a) Describe the mechanism of action of B lymphocytes against pathogens. **3**

(b) The specific immune system can respond to substances that are harmless to the body.

State the term used for this response. **1**

14. The diagram shows stages in the development of a vaccine against a virus.



(a) Suggest what structure X represents. **1**

_____

[Turn over

14. (continued)

(b) The development of this vaccine involves using part of the virus as an antigen.

State another source of antigens that can be used to produce vaccines. **1**

(c) (i) Explain why new vaccines must be subjected to clinical trials before being licensed for use. **1**

(ii) Describe how a double-blind procedure prevents a biased interpretation of the results from a clinical trial. **1**

(d) A new influenza vaccine is developed every year.

Explain why this is required to protect the body from the influenza virus. **2**

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

Write your answer in the space below and on *page 30*.

A Write notes on somatic and germline cells, including cell divison in both these cell types. **8**

OR

B Write notes on the production of the primary and mature mRNA transcripts. **8**

You may use labelled diagrams where appropriate.

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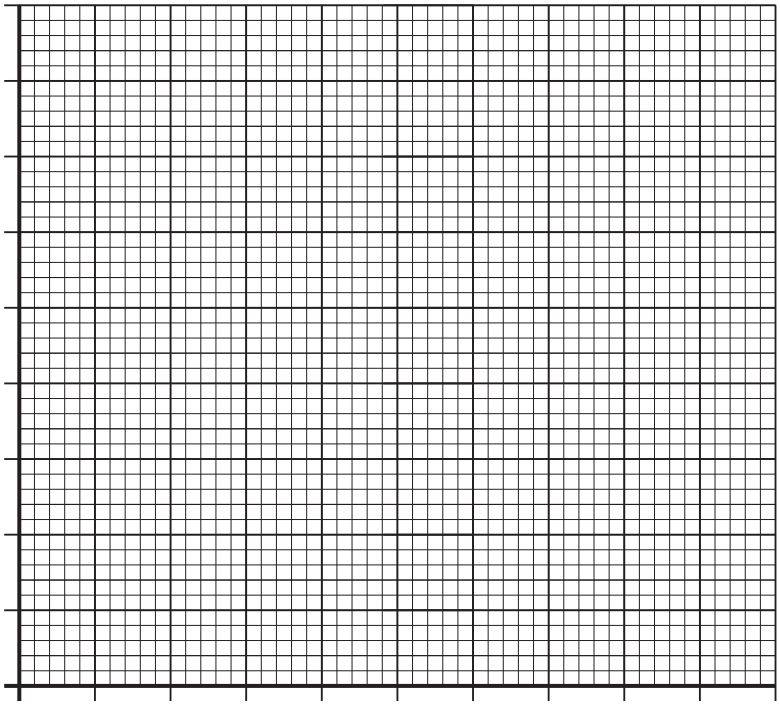
ADDITIONAL SPACE FOR ANSWER to question 15

[END OF QUESTION PAPER]

ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

Additional graph paper for question 3 (b)



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ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

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ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

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