FOR OFFICIAL USE

National Qualifications 2019

Mark

X840/76/01

Human Biology Paper 2

TUESDAY, 30 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.

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 ©

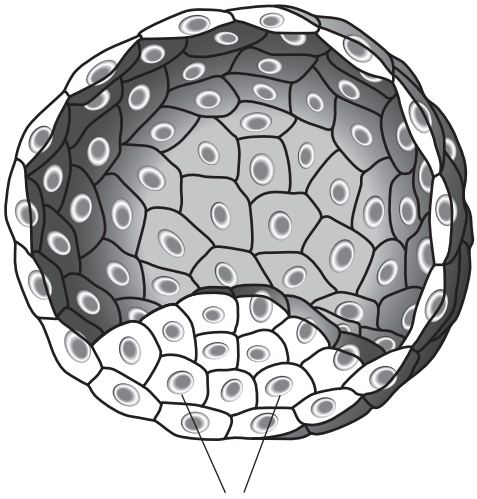
X840760101

Total marks — 95

Attempt ALL questions

Question 14 contains a choice

1. The diagram shows an early stage in the development of a human embryo.



(a) (i) The embryonic stem cells shown can differentiate into all body cell types.

State the term that describes this feature of these cells. **1**

_____

(ii) Explain why embryonic stem cells can differentiate into all cell types. **1**

_____

_____

(b) State the number of chromosomes in the nuclei of cells produced when germline stem cells divide by meiosis. **1**

_____

1. (continued)

(c) Stem cells can be cultured in the laboratory for research purposes.

State **one** way in which stem cells are used in research. **1**

_____

_____

(d) Scientists have recently found a way of converting skin cells into embryonic stem cells.

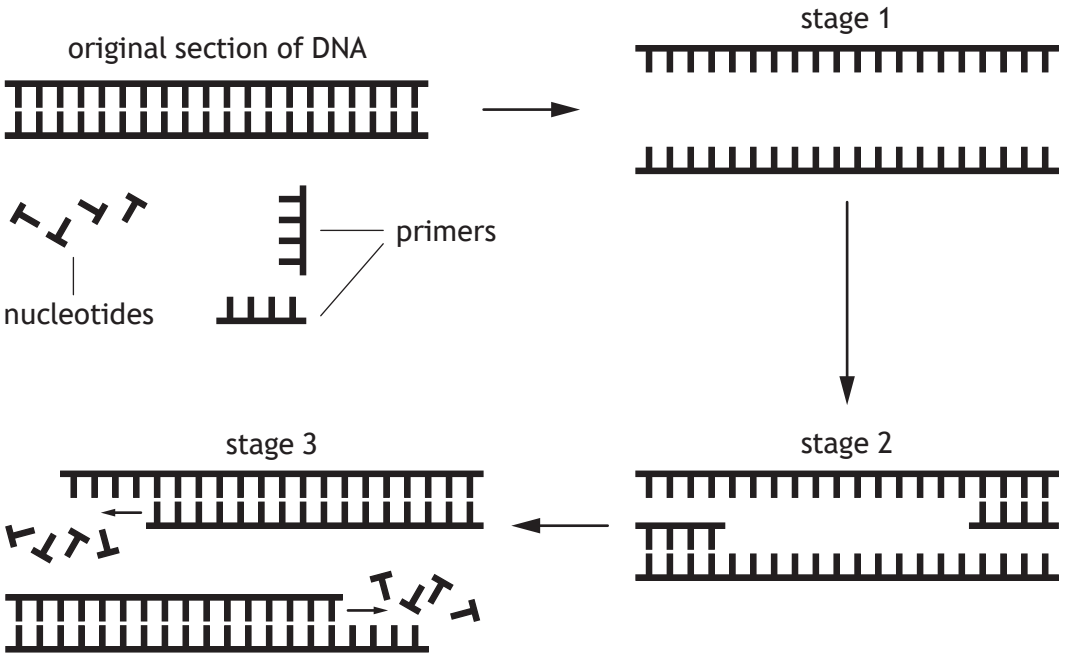
Suggest why this is an advantage from an ethical viewpoint. **1**

_____

_____

[Turn over

2. The polymerase chain reaction (PCR) is a process used to help solve crimes.
The diagram shows the stages in one PCR cycle.



(a) Each stage of PCR is temperature dependent.
Complete the table for stages 1 and 3. **2**

Stage	Temperature (°C)	Reason
1	95	
3		To allow replication of DNA

2. (continued)

(b) Each PCR cycle produces two copies of a section of DNA.

This PCR cycle takes 3 seconds.

Calculate how long it would take for at least 2000 copies of the original section to be produced. **1**

Space for calculation

_____ s

(c) Describe the role of primers in stage 2 and stage 3. **2**

Stage 2 _____

_____

Stage 3 _____

_____

(d) PCR was first used to help solve a crime in 1986.

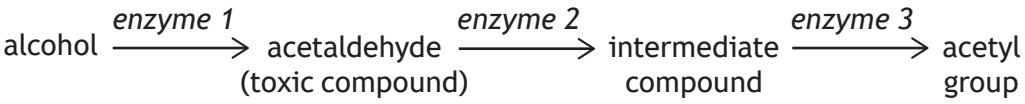
Suggest why PCR can now be used to help solve a crime committed in 1980, where only a small blood spot was found as evidence. **1**

_____

_____

[Turn over

3. The diagram shows some of the stages in the breakdown of alcohol by the liver.



(a) Use information from the diagram to explain how alcohol can be used as a substrate in respiration. **2**

(b) Some individuals cannot produce enough fully functioning enzyme 2.

(i) In these individuals an altered form of enzyme 2 is produced due to a missense mutation.

Suggest why this altered form of enzyme 2 works less well than the unaltered form. **1**

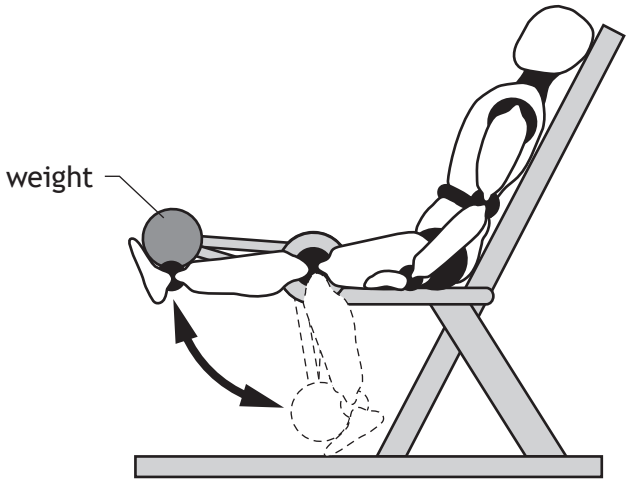
(ii) Explain why these individuals are less tolerant of alcohol. **1**

(c) A drug that acts as a competitive inhibitor of enzyme 2 can be prescribed to treat alcoholism.

Explain how this drug will affect the enzyme. **1**

4. A protein supplement is used by some people who take part in sport. They believe its use increases muscle mass and therefore improves performance in sporting activities such as weightlifting.

An investigation was carried out to test if protein supplements improved the ability of the upper leg muscles to raise weights.



A class of 20 students was divided into two groups, A and B. The groups were balanced for age, gender, fitness level and body mass.

Each student carried out 10 weeks of regular training on the apparatus.

Students in group A took a daily dose of a protein supplement.

Students in group B took a daily dose of a placebo.

All students had their results recorded every 2 weeks for 10 weeks, by measuring the maximum weight that could be raised using the apparatus shown in the diagram.

(a) State **two** additional variables, other than those described above, that would need to be controlled during this investigation. **2**

1 _____

2 _____

[Turn over

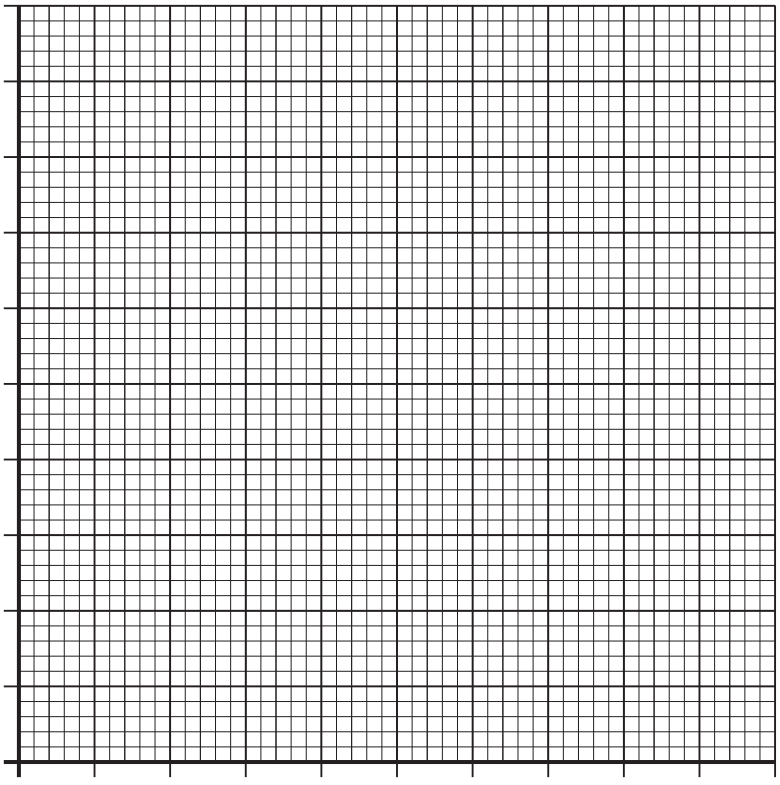
4. (continued)

(b) The results from the investigation are shown in **Table 1**.

Table 1

Time(weeks) / Group	Average maximum weight raised (kg)					
	0	**2**	**4**	**6**	**8**	**10**
A (protein supplement)	52	57	64	72	86	95
B (placebo)	50	55	60	68	74	80

(i) Draw a line graph to show **all** the data in **Table 1**.
(Additional graph paper, if required, can be found on *page 30*) **3**



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

_____

_____

4. (b) (continued)

(iii) Suggest a reason for the increase in performance of Group B. **1**

_____

_____

(c) The average body mass and percentage body fat of the students was measured at the start of the investigation and after 10 weeks.

The measurements for each group are shown in **Table 2**.

Table 2

Group	Measurement	Start (0 weeks)	After 10 weeks
A (protein supplement)	body mass (kg)	60·7	62·5
	body fat (%)	28·3	23·8
B (placebo)	body mass (kg)	60·5	61·3
	body fat (%)	27·9	25·8

Use the data to explain why taking protein supplements resulted in a greater increase in muscle mass. **2**

_____

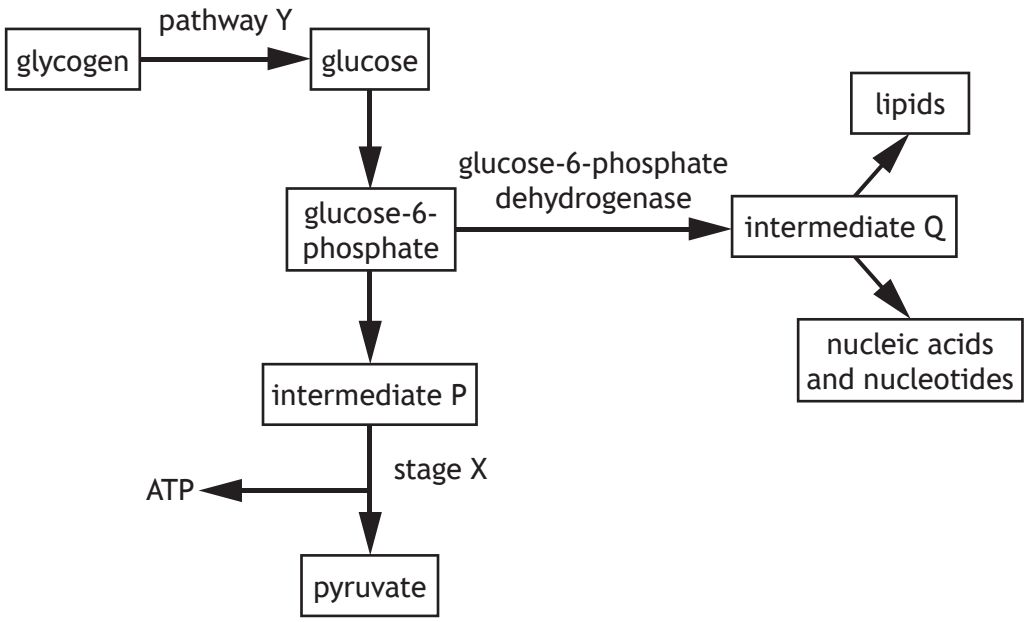
_____

_____

_____

[Turn over

5. The diagram is a summary of part of a respiratory pathway in a cell.



(a) Give evidence from the diagram that confirms stage X is the energy pay-off phase. **1**

_____

(b) State the function of dehydrogenase enzymes. **1**

_____

_____

(c) Name a hormone that is involved in pathway Y. **1**

_____

5. (continued)

(d) Some individuals are unable to produce the enzyme glucose-6-phosphate dehydrogenase.

Use information from the diagram to explain why this would reduce cell division in these individuals. **2**

_____

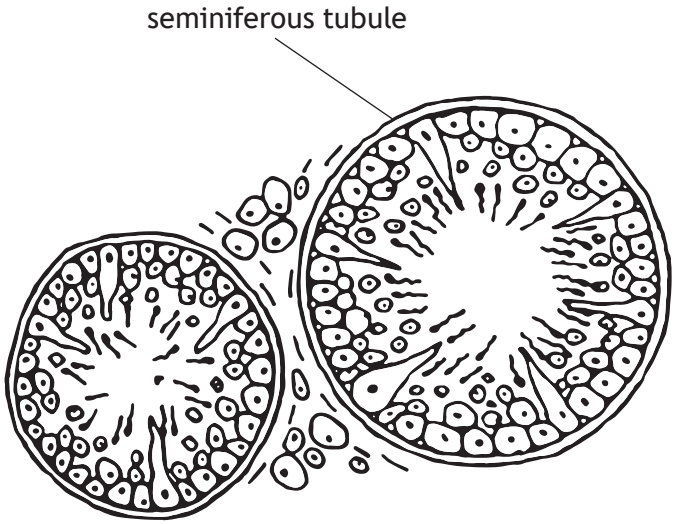
_____

_____

_____

[Turn over

6. (a) The diagram shows part of a testis.



(i) **Use the letter T** to label a cell in the diagram that produces testosterone. **1**

(ii) Describe two functions of testosterone. **2**

1 _____

_____

2 _____

_____

(iii) Describe how negative feedback control raises the concentration of testosterone in the blood if it has fallen to a low level. **2**

_____

_____

_____

_____

6. (continued)

(b) Artificial insemination (AI) and intra-cytoplasmic sperm injection (ICSI) are fertility treatments that may be used if a man has a low sperm count.

Describe how each of these treatments increases the chance of fertilisation. **2**

AI _____

_____

_____

ICSI _____

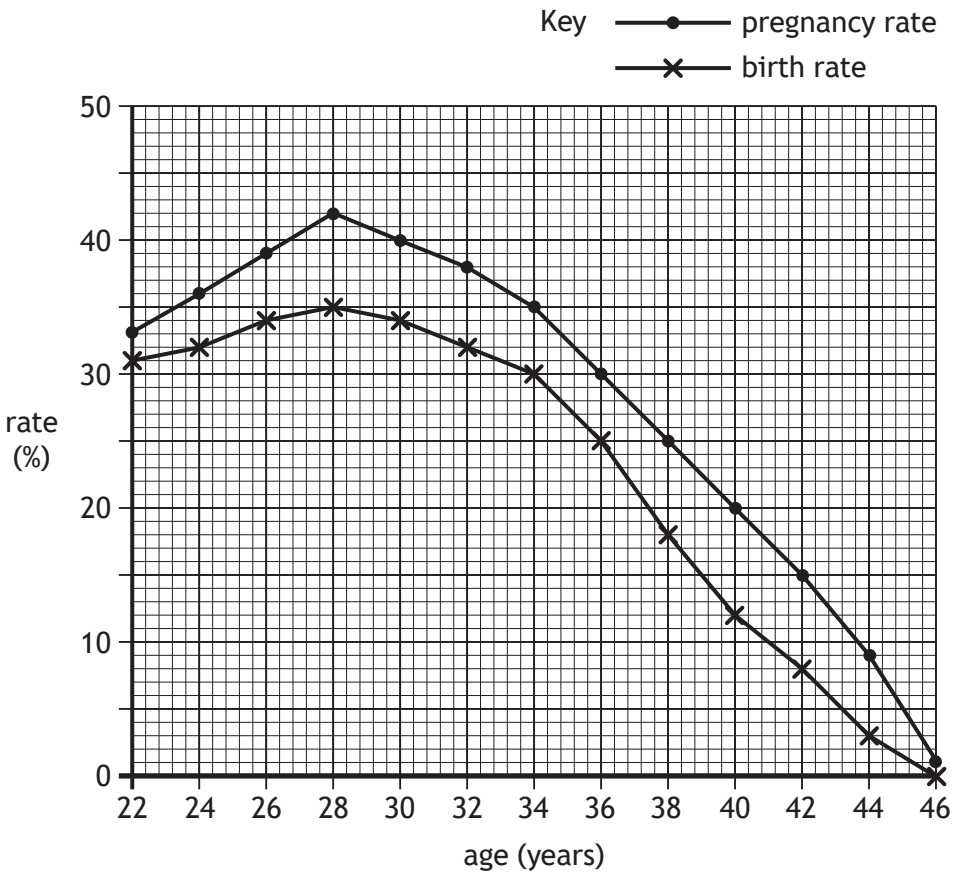
_____

_____

[Turn over

7. Data from *in vitro* fertilisation (IVF) clinics is used to indicate how a woman's age can affect the success rate of IVF.

(a) The graph shows the effect of age on pregnancy and birth rate after using IVF. The data refers to women using their own eggs.



(i) State **one** similarity and **one** difference in the trends for pregnancy and birth rate. **2**

Similarity _____

_____

_____

Difference _____

_____

_____

7. (a) (continued)

(ii) Calculate how many 34 year old women in a sample of 1000 would be predicted to get pregnant using IVF. **1**

Space for calculation

_____

(b) Some women are given the option to use eggs from a donor when undergoing IVF. This can increase their chances of becoming pregnant and giving birth.

(i) The table shows the birth rates for women of different ages after undergoing IVF using donor eggs.

Age (years)	22	26	30	34	38	42	46
Birth rate (%)	46	64	60	58	54	48	40

Using data in the table and graph, calculate the difference in birth rate for women aged 38 when using donor eggs rather than their own eggs. **1**

Space for calculation

_____ %

(ii) Suggest why older women undergoing IVF are more likely to produce a child when using donor eggs rather than their own eggs. **1**

_____

_____

(c) Some women undergoing IVF consent to pre-implantation genetic diagnosis (PGD) of their embryos.

Explain why PGD is offered to some women. **1**

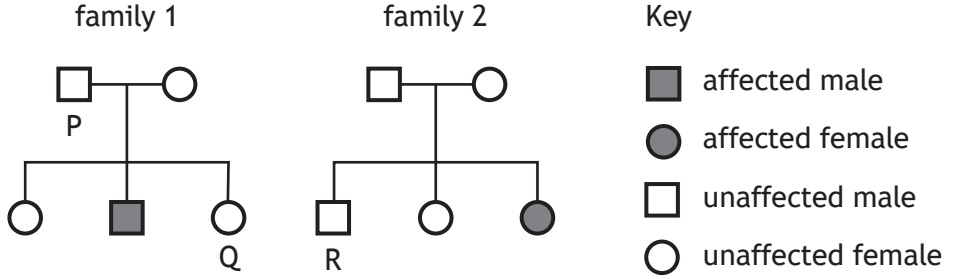
_____

_____

8. Adenosine deaminase (ADA) deficiency is an autosomal recessive disorder that affects the immune system. It is caused by a mutation in the gene that codes for this enzyme.

(a) Describe the difference between an autosomal disorder and a sex-linked disorder. **1**

(b) The chart shows the inheritance of ADA deficiency in two families.



(i) State the genotype of individual P using 'a' to represent the allele for ADA deficiency. **1**

(ii) Individuals Q and R plan to have a child together.

Use information from the chart to explain why it is difficult to predict the chances of their child having the disorder. **1**

8. (continued)

(c) Individuals with ADA deficiency have severely reduced numbers of lymphocytes. They can be treated by a bone marrow transplant.

Suggest how this treatment can help to restore a functional immune system. **1**

(d) Amniocentesis and chorionic villus sampling (CVS) are examples of antenatal tests that can be carried out.

Describe an advantage and a disadvantage of using amniocentesis rather than chorionic villus sampling (CVS). **2**

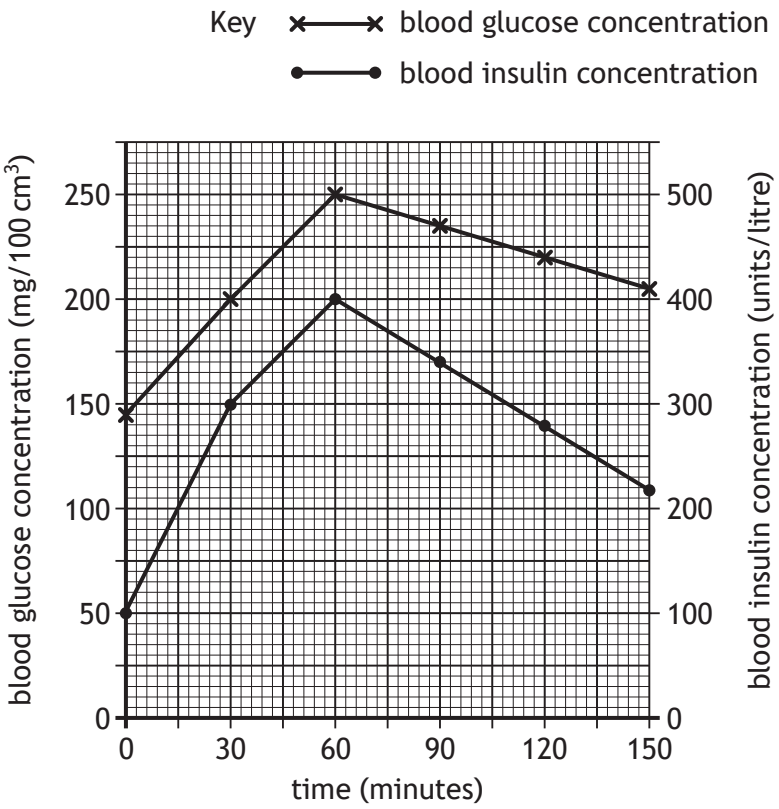
Advantage

Disadvantage

[Turn over

9. A man had a glucose tolerance test to indicate if he had type 2 diabetes.

The graph shows changes in the concentrations of glucose and insulin in his blood during 150 minutes, after drinking the glucose solution.



(a) State the man's blood insulin concentration when his blood glucose concentration was 200 mg/100 cm^3. **1**

_____ units/litre

(b) The man's blood glucose concentration will eventually return to its original value.

Predict how much longer this will take after 150 minutes. **1**

Space for calculation

_____ minutes

9. (continued)

(c) This man's body contains 5 litres of blood.

Calculate the total mass of glucose in his bloodstream at 60 minutes. **1**

Space for calculation

_____ mg

(d) (i) The glucose tolerance test indicated that this man had type 2 diabetes.

Explain why production of insulin did not lower his blood glucose concentration in the first hour of the test. **2**

_____

_____

_____

_____

(ii) Suggest **one** reason why this man's blood glucose concentration started to decrease after 60 minutes. **1**

_____

_____

(e) Describe evidence from the graph that indicates this man does **not** have type 1 diabetes. **1**

_____

_____

(f) Apart from reducing the sugar intake in his diet, suggest another way in which this man could control his blood glucose levels. **1**

_____

_____

[Turn over

10. (a) The table shows the death rate from cardiovascular disease (CVD) in groups of men and women in England and Scotland between 2001 and 2013.

	Death rate from CVD (per 100 000)			
	England		Scotland	
Year	Men	Women	Men	Women
2001	603	402	684	476
2005	490	337	577	406
2009	392	271	450	316
2013	324	221	396	275

(i) Identify the group that shows the greatest percentage decrease in death rate from CVD between 2001 and 2013. **1**

Space for calculation

Group _____

(ii) Death rates have decreased in all groups between 2001 and 2013.

State another conclusion that can be drawn from the data in the table. **1**

_____

_____

(iii) Express, as a simple whole number ratio, the death rate from CVD in English men compared to Scottish men in 2013. **1**

Space for calculation

_____ : _____

English men Scottish men

10. (a) (continued)

(iv) Explain how the data in the table allows a valid comparison of deaths from CVD between England and Scotland to be made, despite their populations being different sizes. **1**

(b) Three thousand men took part in a clinical trial to investigate the effect of a cholesterol reducing drug. Half the men were given the cholesterol reducing drug while half were given a placebo.

(i) Describe how a double-blind design could be achieved when setting up the clinical trial. **1**

(ii) State what aspect of the design of the study increased the reliability of the results. **1**

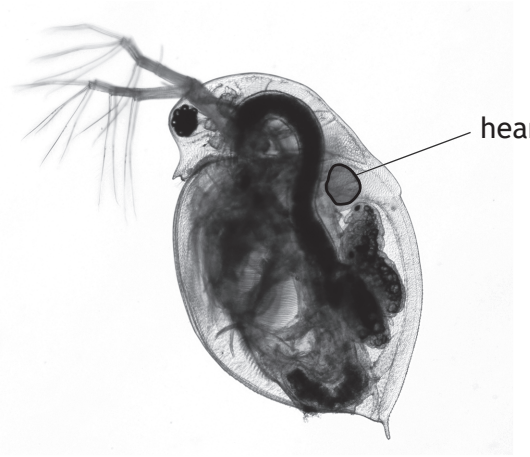
(iii) Researchers concluded that taking the cholesterol reducing drug decreased risk of death from CVD, as it lowered the concentration of LDLs in the blood.

Explain why having a lower LDL concentration in the blood decreases the risk of death from CVD. **2**

[Turn over

11. (a) The water flea, *Daphnia pulex*, is a small invertebrate animal that lives in ponds.

Water fleas can be used as model organisms to investigate the effect of chemicals on heart rate.



A student carried out an investigation to find out how caffeine concentration affects the heart rate of water fleas.

A water flea was placed in a small container of pond water and left for 5 minutes. The container was then placed under a microscope and the water flea videoed for a period of time. The video was analysed and the heart rate of the water flea calculated. This procedure was then repeated using different concentrations of caffeine solutions.

The results of the investigation are shown in the table.

Caffeine concentration (g/l)	Heart rate of water flea (bpm)
0	135
0·2	185
0·4	220
0·6	245
0·8	270
1·0	270

(i) Suggest why the student left the water flea in the solution for 5 minutes before videoing its heart rate. **1**

_____

_____

11. (a) (continued)

(ii) Suggest why the student videoed the water flea rather than simply counting its heart beat at the time. **1**

(iii) Use data from the table to describe the changes that occur in the heart rate as the caffeine concentration increases. **2**

(iv) State how the reliability of the results from this investigation could be improved. **1**

(b) In humans, describe how the autonomic nervous system increases the heart rate. **3**

12. Endorphins and dopamine are neurotransmitters that affect mood and behaviour.

(a) (i) State **one** activity that increases endorphin production. **1**

_____

_____

(ii) State **one** function of endorphins. **1**

_____

_____

(b) Parkinson's disease is associated with a loss of dopamine-producing neurons in the brain. It cannot be treated by taking dopamine.

Describe a possible mode of action of a drug that could be used to treat this disease. **1**

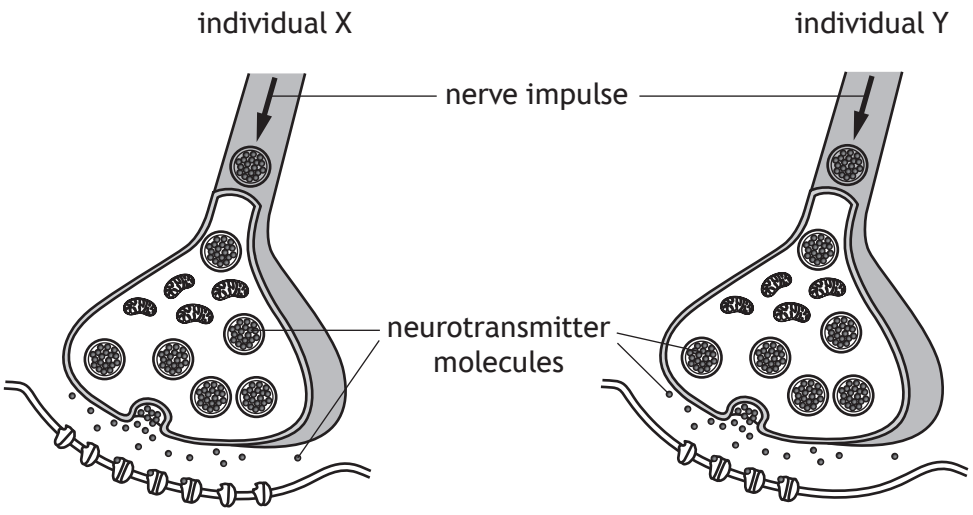
_____

_____

12. (continued)

(c) The diagram shows synapses from the brains of two individuals.

Individual X has never taken recreational drugs while individual Y has used a recreational drug for a long time.

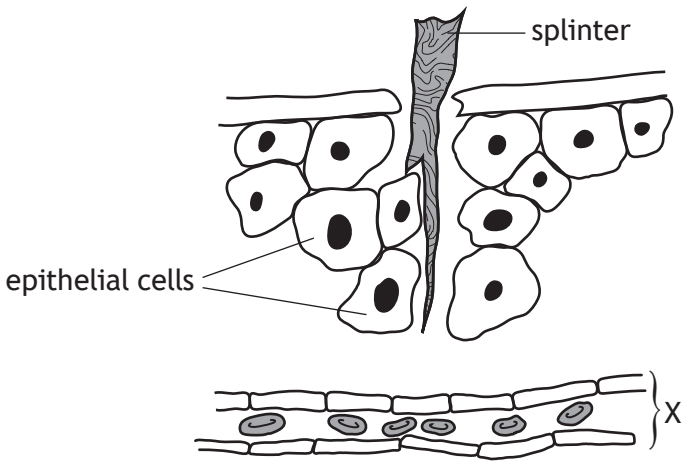


(i) Describe how the recreational drug has acted on the synapse of individual Y. **1**

(ii) Describe how changes to the synapses of individual Y will affect their drug-taking behaviour. **1**

[Turn over

13. The diagram represents a section of human skin punctured by a splinter of wood.



(a) (i) Describe **one** way in which these epithelial cells defend the body against pathogens. **1**

_____

_____

(ii) Name structure X. **1**

_____

(b) The inflammatory response involves the release of the chemical histamine.

(i) Name the cells that release histamine. **1**

_____

(ii) Explain why the skin around a puncture wound often becomes red and swollen. **1**

_____

_____

(c) Lymphocytes are part of the specific defence system of the body.

(i) Explain how a lymphocyte is able to recognise a particular pathogen. **1**

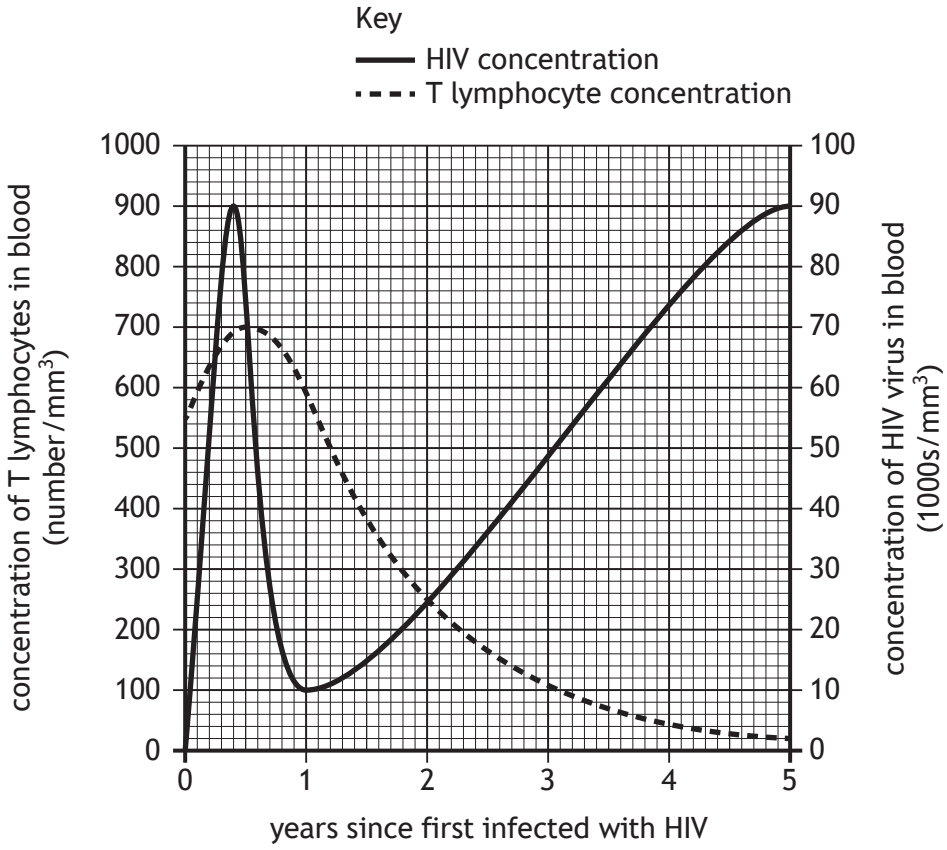
_____

_____

13. (c) (continued)

(ii) Describe how T lymphocytes destroy infected body cells. **1**

(d) The graph shows the concentrations of the HIV virus and T lymphocytes in the blood of an individual in the years following HIV infection.



(i) Suggest a reason for the decrease in HIV concentration during the first year after infection. **1**

(ii) Explain why the T lymphocyte concentration is decreasing between 1 and 5 years after infection. **1**

14. Attempt **either** A **or** B. Write your answer in the space below and on *page 29*.

A Discuss the encoding, storage and retrieval of information in memory. **9**

OR

B Describe vaccination and discuss its role in establishing herd immunity in a population. **9**

You may use labelled diagrams where appropriate.

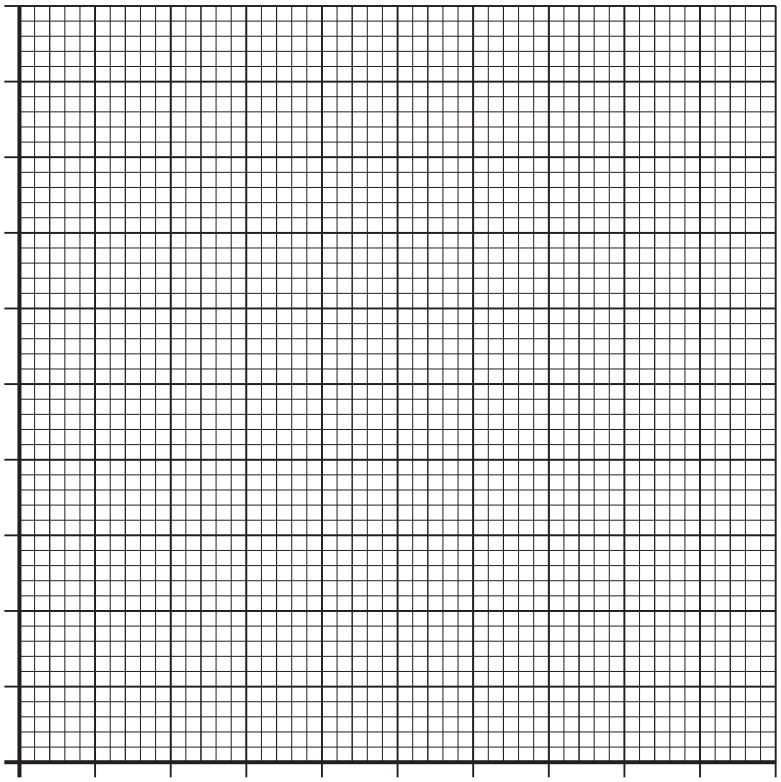
MARKS | DO NOT WRITE IN THIS MARGIN

ADDITIONAL SPACE FOR ANSWER to question 14

[END OF QUESTION PAPER]

ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

Additional graph paper for question 4 (b)(i)



MARKS | DO NOT WRITE IN THIS MARGIN

ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

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ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

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