



# Higher Human Biology

## SQA past paper booklet B

2015, New specimen paper 1  
and paper 2



National  
Qualifications  
2015

**X740/76/02**

**Human Biology  
Section 1 — Questions**

WEDNESDAY, 13 MAY

1:00 PM – 3:30 PM

Instructions for the completion of Section 1 are given on *Page two* of your question and answer booklet.

Record your answers on the answer grid on *Page three* of your question and answer booklet.

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

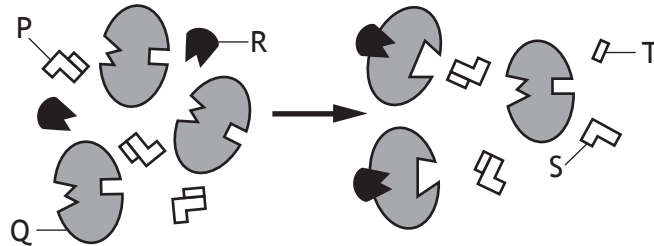


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SECTION 1 — 20 marks

Attempt ALL questions

1. The diagram below shows an enzyme-catalysed reaction taking place in the presence of an inhibitor.

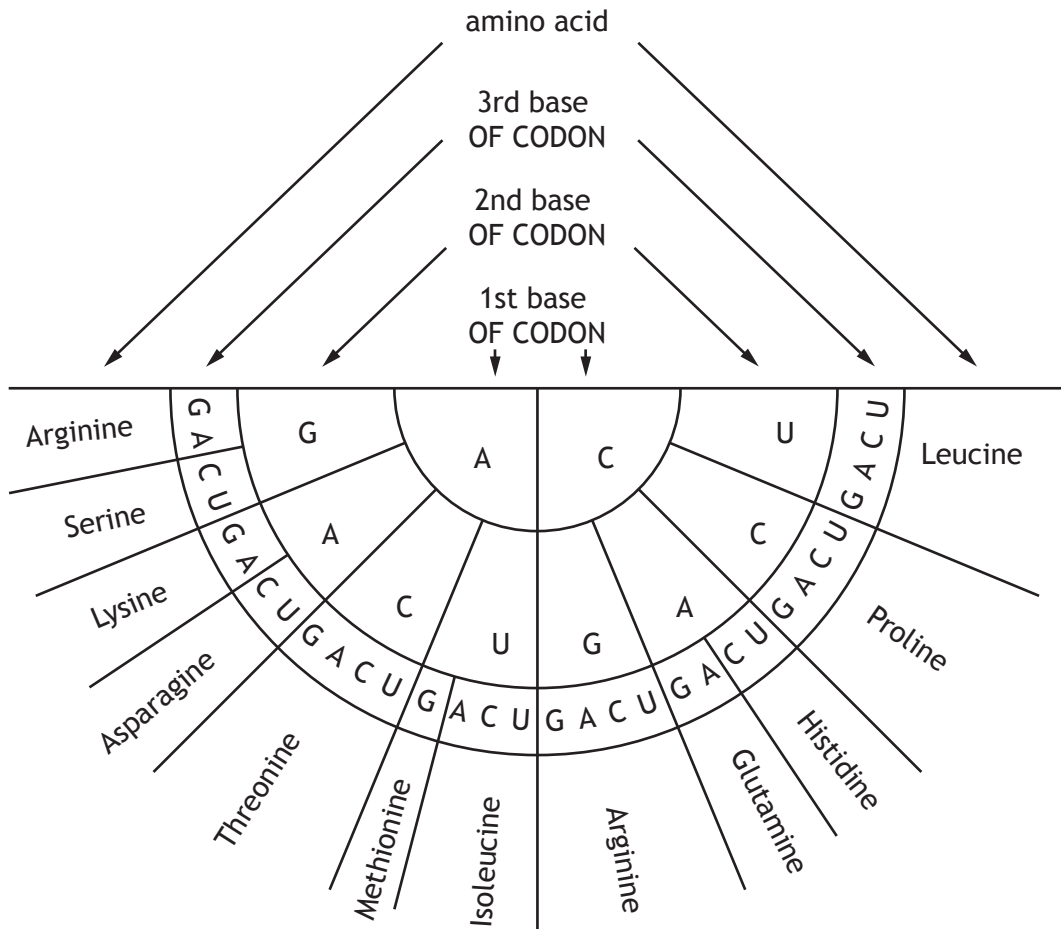


Which line in the table below identifies the molecules in the reaction?

	<i>Inhibitor</i>	<i>Substrate</i>	<i>Product</i>
A	P	R	S
B	Q	P	S
C	R	P	T
D	R	Q	T

2. A primary transcript is a strand of
- A RNA comprising just exons
  - B DNA comprising just exons
  - C RNA comprising introns and exons
  - D DNA comprising introns and exons.

3. The diagram below can be used to identify amino acids coded for by mRNA codons.



How many different amino acids are coded for by the following mRNA strand?

A U G C C A A C U C C U A G A C G A A U A

- A 4
- B 5
- C 6
- D 7

[Turn over

4. The following are descriptions of three single gene mutations.

Description 1: exon-intron codons are created or destroyed

Description 2: one amino acid codon is replaced with another

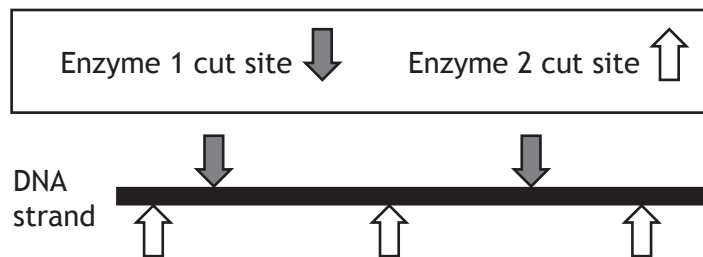
Description 3: one amino acid codon is replaced with a stop codon

Which line in the table below matches the descriptions with the correct gene mutation?

	<i>Gene mutation</i>		
	<i>Missense</i>	<i>Nonsense</i>	<i>Splice site</i>
A	1	2	3
B	1	3	2
C	2	1	3
D	2	3	1

5. DNA profiling may be used in criminal investigations.

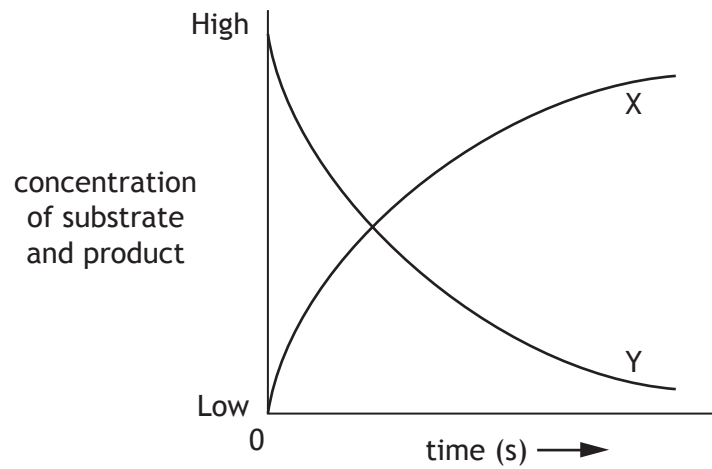
During this procedure DNA is cut into fragments by two different enzymes. Each enzyme cuts DNA at a specific point.



Which line in the table below gives the correct number of DNA fragments produced from this DNA strand?

	<i>Number of fragments produced using</i>		
	<i>enzyme 1 only</i>	<i>enzyme 2 only</i>	<i>enzymes 1 and 2</i>
A	2	3	5
B	2	3	6
C	3	4	7
D	3	4	6

6. The graph below shows the changes to the concentrations of substrate and product during an enzyme-controlled reaction.

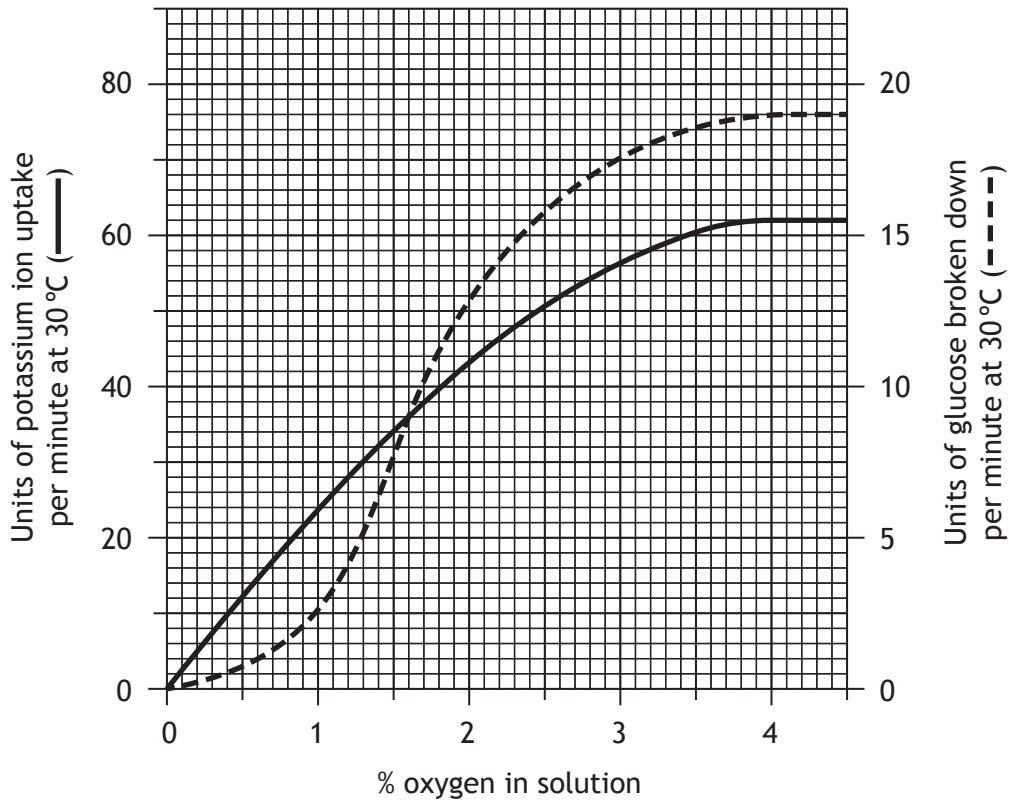


Which line in the table below identifies the substrate, product and the change in the rate of the reaction during the process?

	<i>Substrate</i>	<i>Product</i>	<i>Rate of reaction</i>
A	X	Y	increasing
B	X	Y	decreasing
C	Y	X	increasing
D	Y	X	decreasing

[Turn over

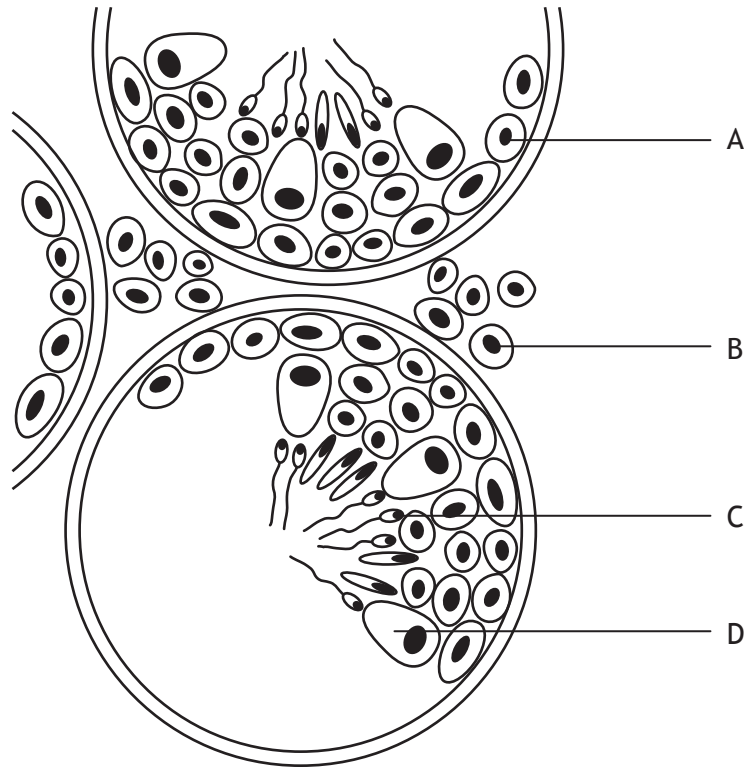
7. The graph below shows the rate of potassium uptake and glucose breakdown by muscle tissue in solutions of different oxygen concentrations.



How much glucose is broken down per minute when the oxygen concentration is 1%?

- A 2.5 units  
 B 6 units  
 C 10 units  
 D 24 units
8. A 40g serving of a breakfast cereal contains 2 mg of iron. Only 25% of this iron is absorbed into the bloodstream.
- If a pregnant woman requires a daily uptake of 6 mg of iron, how much cereal would she have to eat each day to meet this requirement?
- A 60 g  
 B 120 g  
 C 240 g  
 D 480 g

9. The diagram below shows a section through part of the testes.



Which cells produce testosterone?

10. The table below shows some genotypes and phenotypes associated with forms of sickle-cell anaemia.

<i>Genotype</i>	<i>Phenotype</i>
AA	unaffected
AS	sickle-cell trait
SS	acute sickle-cell anaemia

A woman with sickle-cell trait and an unaffected man have a child together. What are the chances that their child will have acute sickle-cell anaemia?

- A None
- B 1 in 1
- C 1 in 2
- D 1 in 4

[Turn over



11. The events leading to formation of a blood clot are listed below.
1. Clotting factors are released.
  2. An insoluble meshwork forms.
  3. Fibrinogen is converted to fibrin.
  4. Prothrombin is converted to thrombin.

The correct sequence of these events is

- A 4, 2, 3, 1  
 B 1, 4, 3, 2  
 C 1, 3, 4, 2  
 D 4, 3, 1, 2
12. Which of the following statements describes the role of lipoprotein in the transport and elimination of excess cholesterol?
- A Low density lipoprotein transports excess cholesterol from the liver to the body cells.  
 B Low density lipoprotein transports excess cholesterol from the body cells to the liver.  
 C High density lipoprotein transports excess cholesterol from the liver to the body cells.  
 D High density lipoprotein transports excess cholesterol from the body cells to the liver.
13. Which of the following describes typical features of Type 1 diabetes?

<i>Feature of Type 1 diabetes</i>		
A	occurs in childhood	cells unable to produce insulin
B	develops later in life	cells unable to produce insulin
C	occurs in childhood	cells less sensitive to insulin
D	develops later in life	cells less sensitive to insulin

14. The following are types of neural pathways.

1. Diverging
2. Converging
3. Reverberating

Which of these pathways involve nerve impulses being sent back through a circuit of neurons?

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

15. After drinking, alcohol is removed from the blood at a constant rate.

The table below shows the average time it takes to remove different alcohol concentrations from the blood.

<i>Blood alcohol concentration</i> (mg/100 cm <sup>3</sup> )	<i>Removal time</i> (hours)
16	1.0
50	3.125
80	5.0
100	6.25
160	10.0
200	12.5

The legal maximum blood alcohol concentration for driving in some regions of the UK is 80 mg/100 cm<sup>3</sup>.

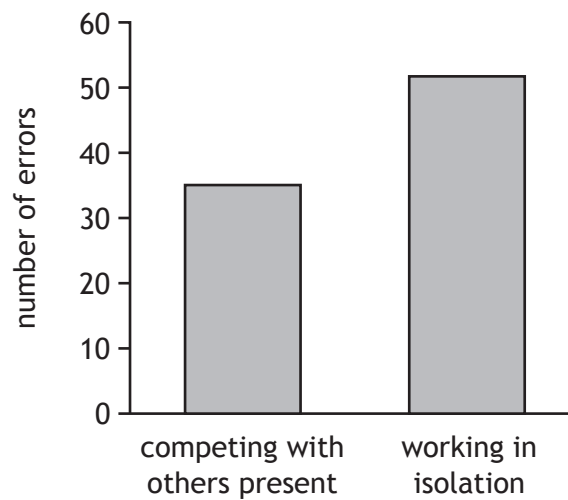
Predict how long it would take before a person with a blood alcohol concentration of 240 mg/100 cm<sup>3</sup> would legally be able to drive in these regions.

- A 5 hours  
B 10 hours  
C 15 hours  
D 20 hours

[Turn over

16. A number of students were trained to carry out a complex task. Some competed with one another, others worked in isolation.

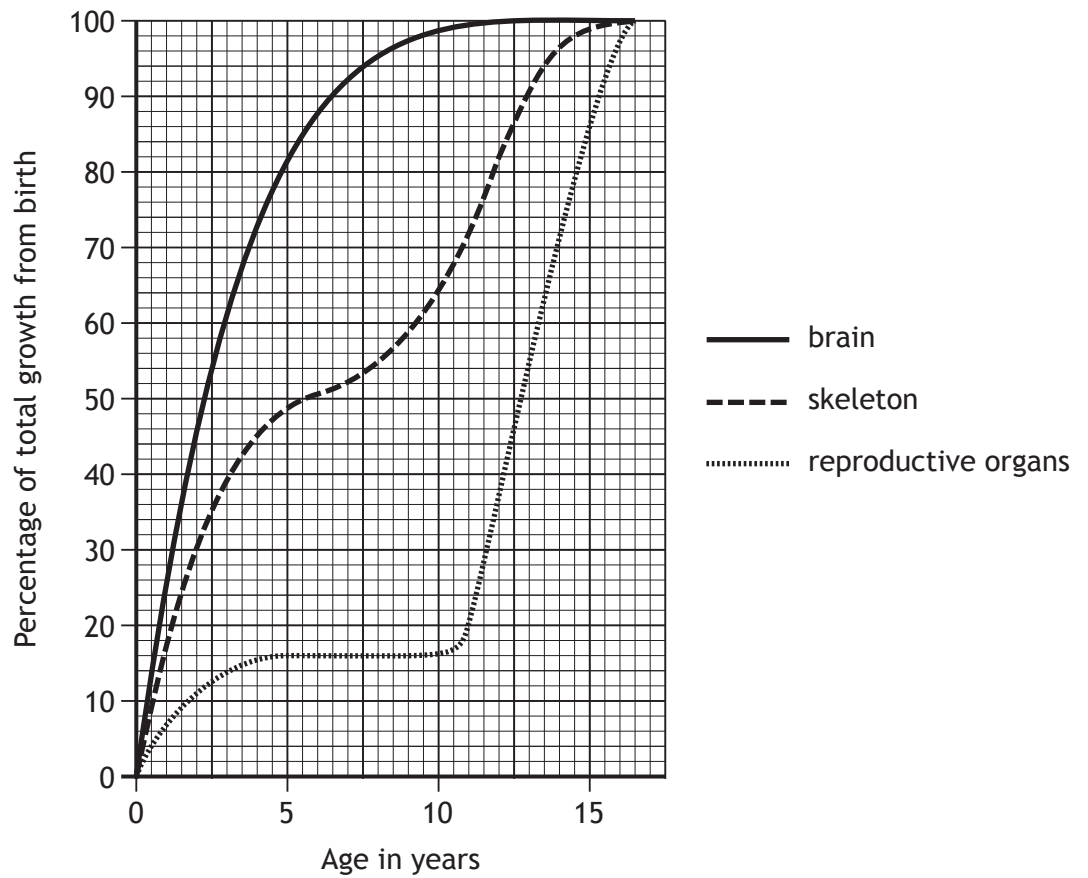
The graph below shows the number of errors recorded in the training process.



Which process is likely to have caused the difference in the results?

- A Deindividuation
  - B Social facilitation
  - C Shaping
  - D Internalisation
17. The pathogen for the disease tuberculosis (TB) evades the specific immune response by
- A surviving within phagocytes
  - B attacking lymphocytes
  - C attacking phagocytes
  - D antigenic variation.

18. The graph below shows the average growth rate of body organs in males.



What is the ratio of total growth of brain to skeleton in an 8 year old child?

- A 11 : 3
- B 3 : 11
- C 19 : 11
- D 11 : 19

19. Failure in regulation of the immune system leading to an autoimmune disease is caused by a

- A B lymphocyte immune response to self antigens.
- B T lymphocyte immune response to self antigens.
- C B lymphocyte immune response to foreign antigens.
- D T lymphocyte immune response to foreign antigens.

[Turn over for Question 20 on Page twelve

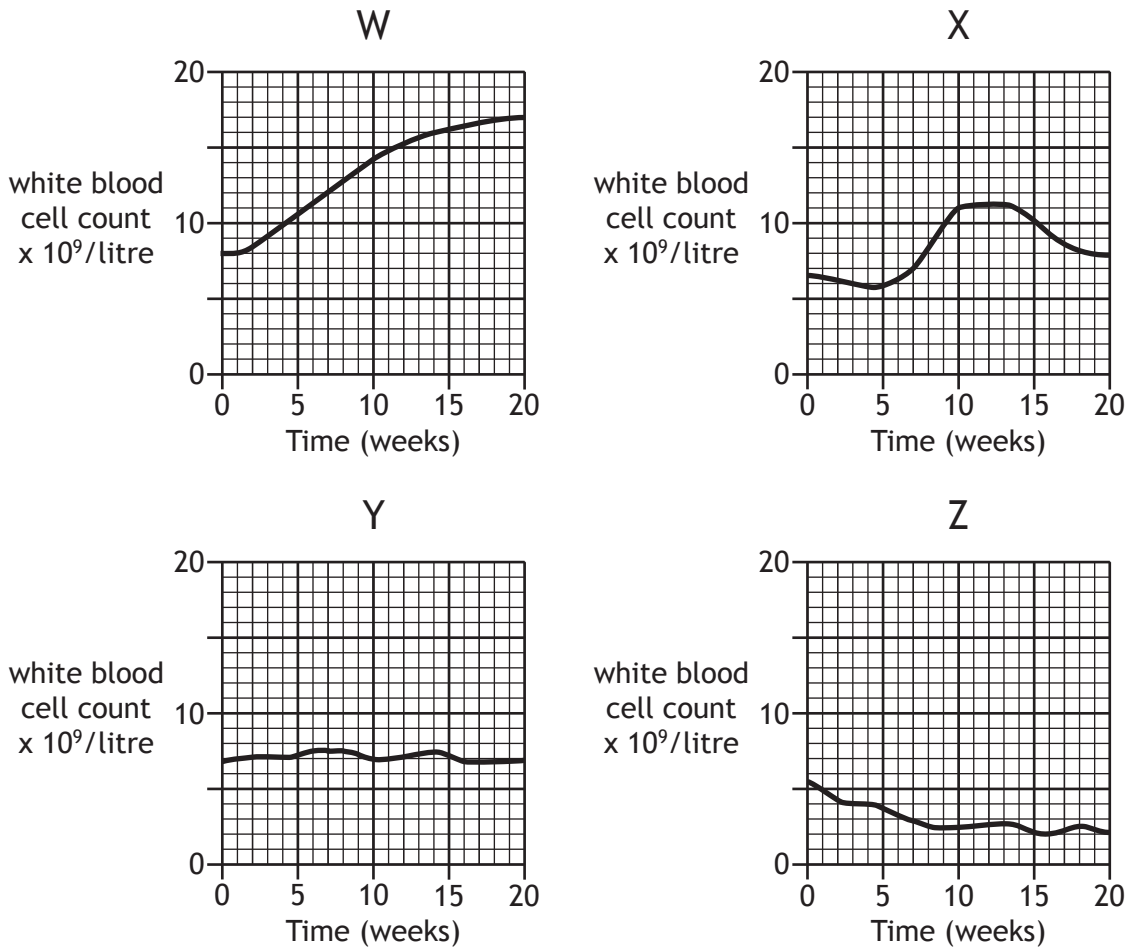
20. Blood tests to measure the number of white blood cells (leucocytes) are often used to indicate infection and/or illness.

Leucopenia, due to starvation or malnutrition, is indicated by white blood cell numbers dropping below  $4 \times 10^9/\text{litre}$ .

Leucocytosis, due to fever or tissue damage, is indicated by white blood cell numbers temporarily increasing to  $11 \times 10^9/\text{litre}$ .

Leukaemia, due to DNA damage and cell division, is indicated by white blood cell numbers permanently increasing.

The following graphs show the white blood cell count of four patients over 20 weeks.



From the graphs, identify the patients.

	<i>Leukaemia</i>	<i>Leucocytosis</i>	<i>Leucopenia</i>
A	Y	X	Z
B	Z	W	Y
C	W	X	Z
D	W	Y	X

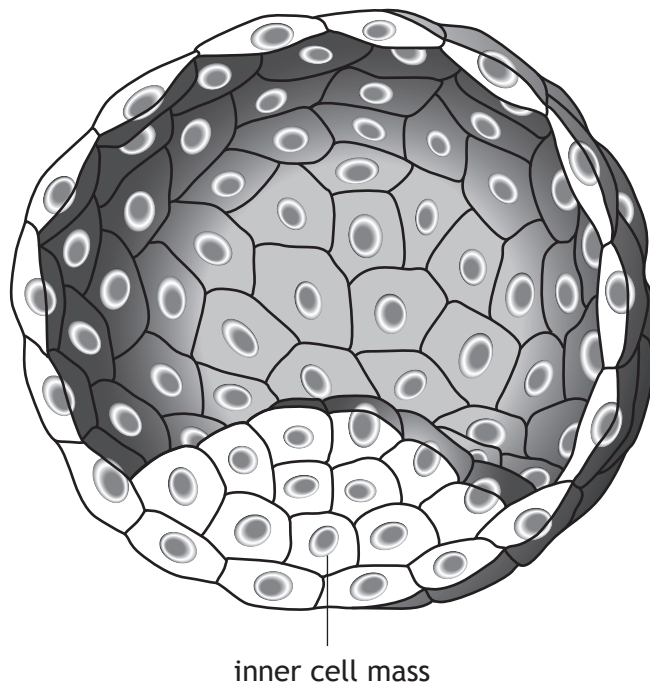
[END OF SECTION 1. NOW ATTEMPT THE QUESTIONS IN SECTION 2 OF YOUR QUESTION AND ANSWER BOOKLET.]

SECTION 2 — 80 marks

Attempt ALL questions

Note that Question 14 contains a choice

1. The diagram below represents an embryo in the early stages of development and identifies the inner cell mass which is made up of stem cells.



- (a) State one feature of stem cells.

1

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- (b) Stem cells are also found in tissues throughout the adult body.

Explain how the function of tissue stem cells differs from that of the stem cells found in the inner cell mass of an embryo.

1

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1. (continued)

(c) Stem cells have uses in both therapy and research.

(i) It has been proposed that tissue cells could be used to repair severely damaged muscle tissue.

Suggest how this might be done.

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(ii) State how stem cells can be used as model cells in medical research.

1

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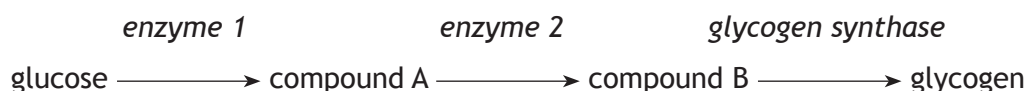
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\* X 7 4 0 7 6 0 1 0 7 \*

2. Glycogen storage disease is an inherited condition in which the enzyme glycogen synthase does not function.

This enzyme normally catalyses one step in the conversion of glucose to glycogen, for storage, as shown in the diagram below.



(a) State the term which describes a metabolic pathway in which simple molecules are built up into complex molecules. 1

\_\_\_\_\_

(b) (i) Describe how the genetic code for glycogen synthase might be altered in an individual with the disease. 1

\_\_\_\_\_  
 \_\_\_\_\_

(ii) Explain why this altered genetic code fails to produce glycogen synthase. 1

\_\_\_\_\_  
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(c) Suggest why individuals with glycogen storage disease might develop abnormally low blood glucose levels during exercise. 1

\_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

(d) One form of glycogen storage disease is caused by a gene which is recessive and sex-linked. 2

Describe a pattern of inheritance, shown by a family history, which would indicate that the condition is

recessive \_\_\_\_\_

\_\_\_\_\_

sex-linked \_\_\_\_\_

\_\_\_\_\_



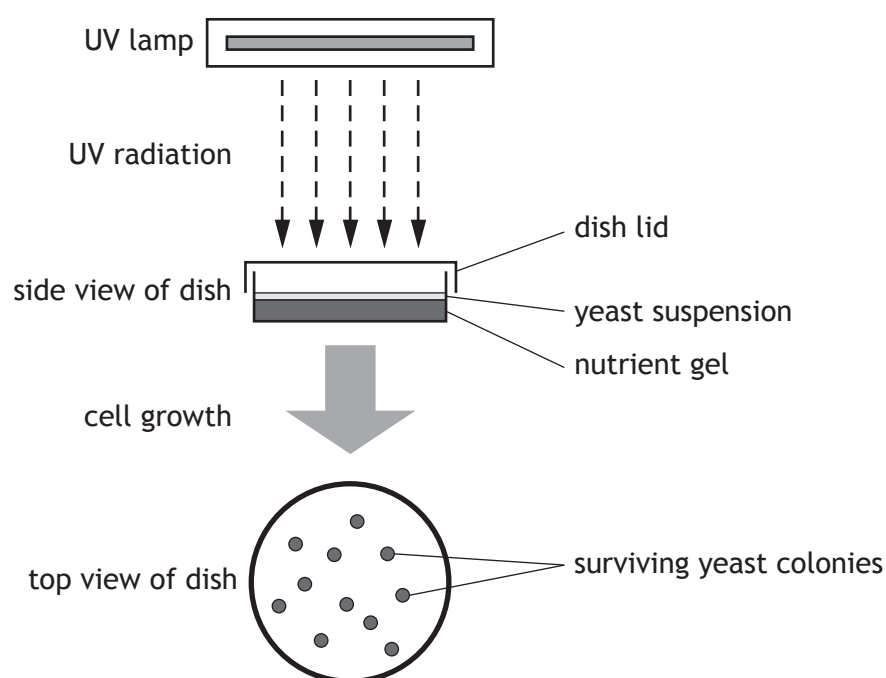


3. Most skin cancers are caused by overexposure to ultraviolet (UV) radiation from the sun or sunbeds. UV radiation damages the DNA in skin cells. Cells normally repair this damage but those which cannot may become cancerous.

A student designed an investigation which used UV-sensitive yeast cells to show the damaging effect of UV radiation. These yeast cells cannot repair DNA damage and die after exposure to UV radiation.

A suspension of UV-sensitive yeast cells was added to dishes which contained a gel that had all the nutrients the yeast needed to grow. The dishes were then exposed to UV radiation for different lengths of time. After exposure, the dishes were placed in an incubator and each of the surviving yeast cells left to grow into a colony on the gel. The number of these colonies was then counted.

The diagram below illustrates this procedure.



- (a) List **two** variables which should be kept constant during this investigation.

2

1 \_\_\_\_\_

2 \_\_\_\_\_

[Turn over



3. (continued)

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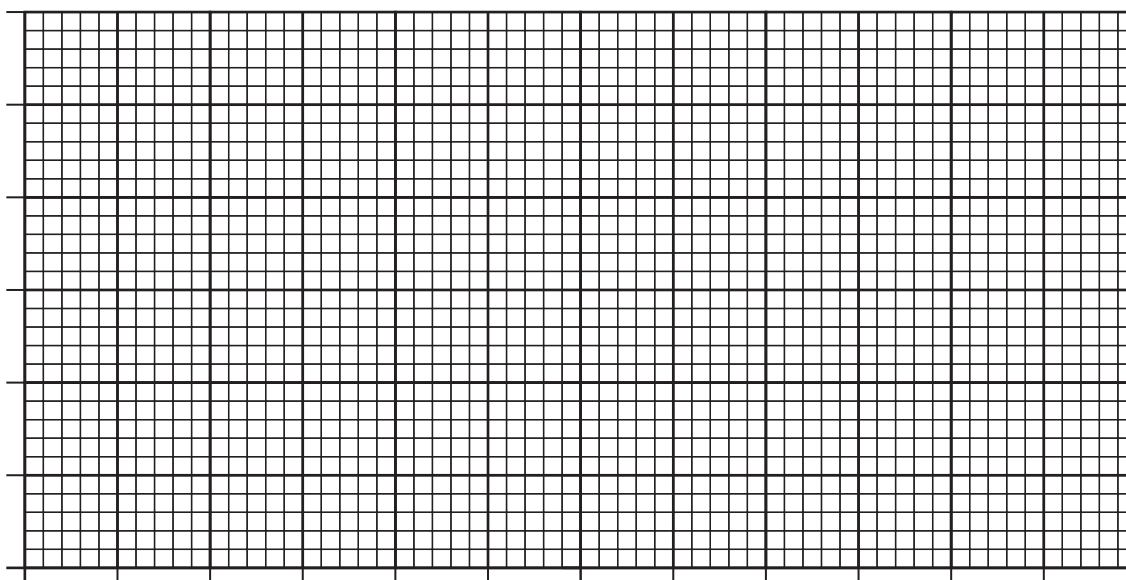
(b) The results of the investigation are shown in **Table 1** below.

**Table 1** — Yeast growth after exposure to UV radiation

<i>Length of time of exposure (minutes)</i>	<i>Number of yeast colonies growing</i>
10	58
20	32
30	15
40	4
50	1
60	0

(i) Plot a line graph to illustrate the results of the investigation. 2

(Additional graph paper, if required can be found on *Page thirty-one*)



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

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(iii) State how the reliability of the results in this investigation could be improved. 1

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3. (continued)

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- (c) Sunscreens work by blocking UV radiation, preventing it from entering skin cells and causing damage to the DNA, which results in sunburn.

Sunscreens are labelled with a Sun Protection Factor (SPF).

When a sunscreen of SPF 15 is applied to the skin, it will take 15 times longer to burn compared to having no sunscreen applied.

The student carried out a second investigation using UV-sensitive yeast.

The dishes were prepared as before but this time the lids of the dishes were coated with sunscreen of different SPFs. The dishes were then exposed to UV radiation for 30 minutes. After exposure, the dishes were placed in an incubator and the surviving yeast cells left to grow into colonies. The results are shown in **Table 2** below.

**Table 2** — Yeast growth after the use of sunscreen protection

Sunscreen used to coat lid (SPF)	Number of yeast colonies growing
6	20
15	72
35	74
50	75

- (i) Use the information from **Tables 1 and 2** to calculate the percentage increase in yeast cell survival when a sunscreen of SPF 50 is used to coat the lid. 1

*Space for calculation*

\_\_\_\_\_ %

- (ii) Official health advice recommends that people should use a sunscreen of SPF 15 when sunbathing for 30 minutes. 1

State how the results of this investigation support this recommendation.

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

- (iii) If skin starts to burn after 10 minutes in strong sunlight, calculate for how long a sunscreen of SPF 35 would protect the skin. 1

*Space for calculation*

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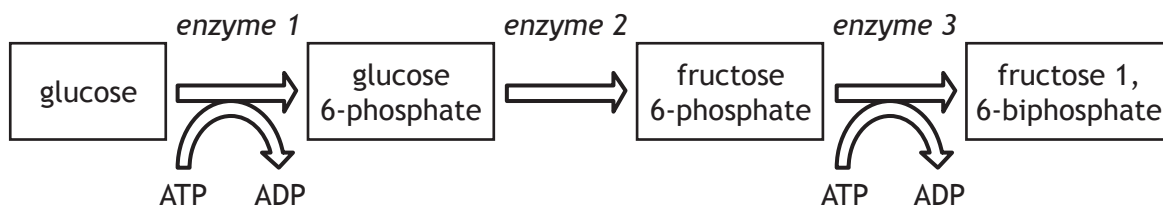


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4. The diagram below represents **three** chemical reactions in the energy investment phase of glycolysis.

MARKS

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(a) Identify the information, shown in the **diagram**, which confirms that this is the energy investment phase of glycolysis.

1

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(b) Enzyme 1 is activated by the binding of magnesium ions.

Suggest how the binding of these ions leads to an increase in enzyme activity.

1

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(c) Choose an enzyme shown in the **diagram** which is catalysing a phosphorylation reaction.

Circle one enzyme —      Enzyme 1      Enzyme 2      Enzyme 3

Explain what is meant by phosphorylation.

1

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(d) The conversion of glucose 6-phosphate to fructose 6-phosphate is a reversible reaction.

Describe the circumstances under which this reaction would go in the opposite direction to that shown in the diagram.

1

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(e) Following the energy investment phase, glycolysis enters the energy pay off stage, during which ATP is produced.

Enzyme 3 is phosphofructokinase which is inhibited by a build-up of ATP.

Explain how this feedback mechanism conserves the cell's resources.

1

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\* X 7 4 0 7 6 0 1 1 2 \*

5. Muscle cells utilise a variety of energy systems during strenuous activity.

(a) Creatine phosphate is found in muscle cells.

(i) Describe how creatine phosphate supports strenuous muscle activity.

2

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(ii) Explain why this support is not provided to strenuous activities beyond the first 10 seconds.

1

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(b) Name the substance which builds up in muscle cells as they become fatigued.

1

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(c) Choose a sporting activity and decide whether slow twitch or fast twitch muscle fibres would be best suited for the activity.

Sporting Activity \_\_\_\_\_

Slow twitch  Fast twitch

Give reasons to justify your choice of muscle fibre.

3

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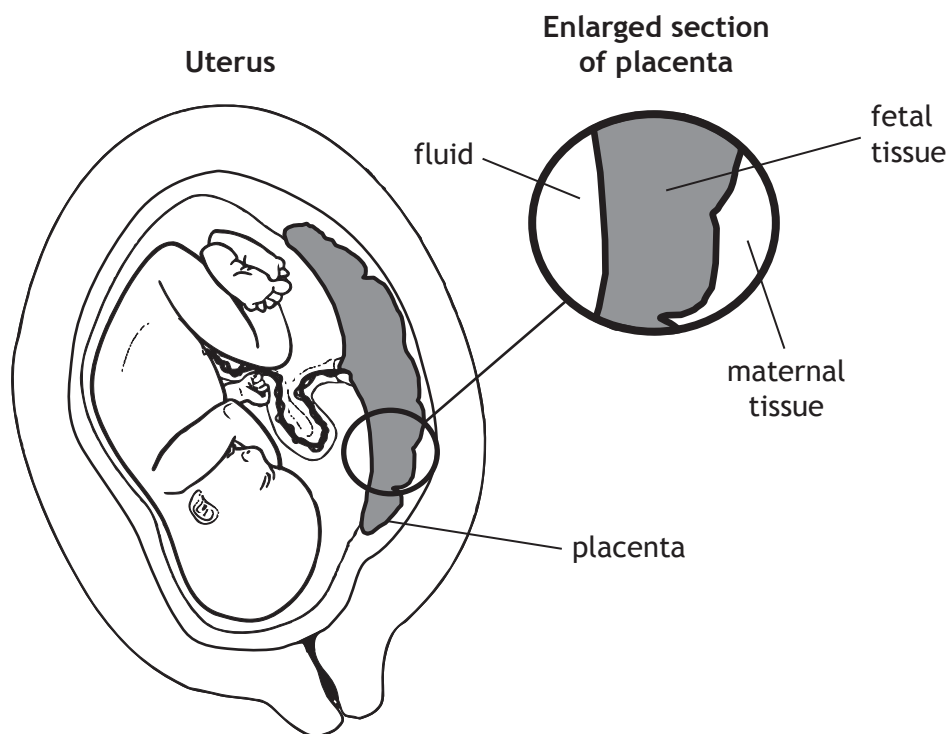
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6. Chorionic villus sampling (CVS) is a technique which can be used during antenatal screening. The cells obtained from CVS are used to prepare a karyotype.

(a) The diagram below shows the uterus of a pregnant woman with a section of the placenta enlarged.



(i) Place a cross (X) on the diagram of the **enlarged section of placenta** to indicate the area from which cells are removed during CVS.

1

(ii) Describe the process by which a karyotype is produced from cells removed during CVS.

2

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(iii) Suggest an advantage of using CVS rather than amniocentesis during antenatal screening.

1

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6. (continued)

- (b) Name the type of antenatal screening tests which are routinely carried out to monitor the concentration of certain substances, such as protein, in a pregnant woman's blood.

1

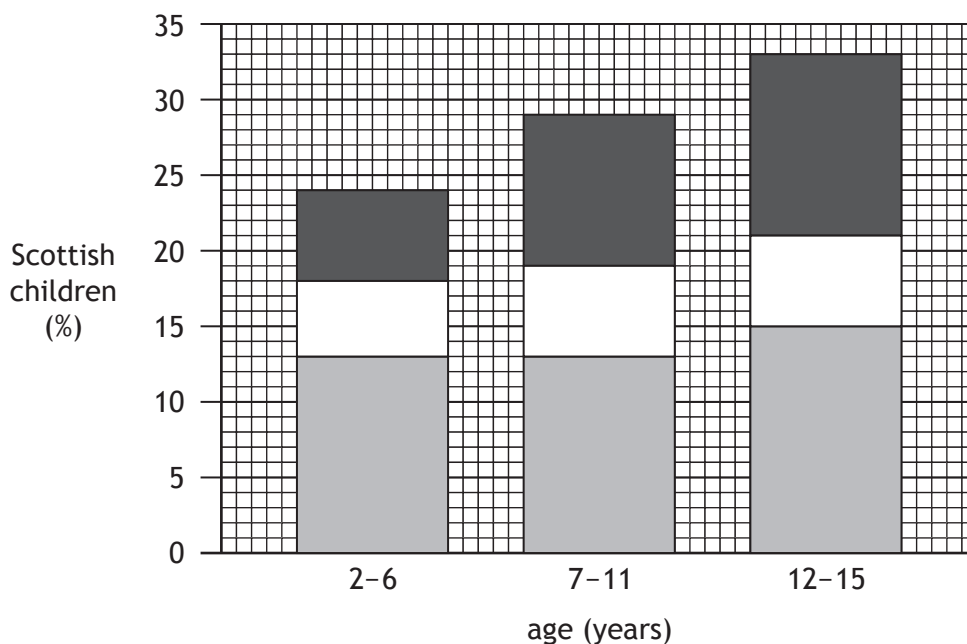
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\* X 7 4 0 7 6 0 1 1 5 \*

7. The graph below contains information about the body mass index (BMI) of Scottish children in 2009.



■	MORBIDLY OBESE BMI above 35
□	OBESE BMI 30 to 34.9
■	OVERWEIGHT BMI 25 to 29.9

(a) State the percentage of children aged 12 to 15 who had a BMI of more than 30 in 2009.

1

*Space for calculation*

\_\_\_\_\_ %

(b) Suggest reasons why the percentage of obese children increased between the ages of 2 and 15.

1

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\* X 7 4 0 7 6 0 1 1 6 \*



**MARKS**

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**7. (continued)**

(c) Explain how BMI is calculated.

**1**

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(d) Suggest how children could be encouraged to maintain a healthy BMI by use of the following processes.

**2**

Identification \_\_\_\_\_

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Internalisation \_\_\_\_\_

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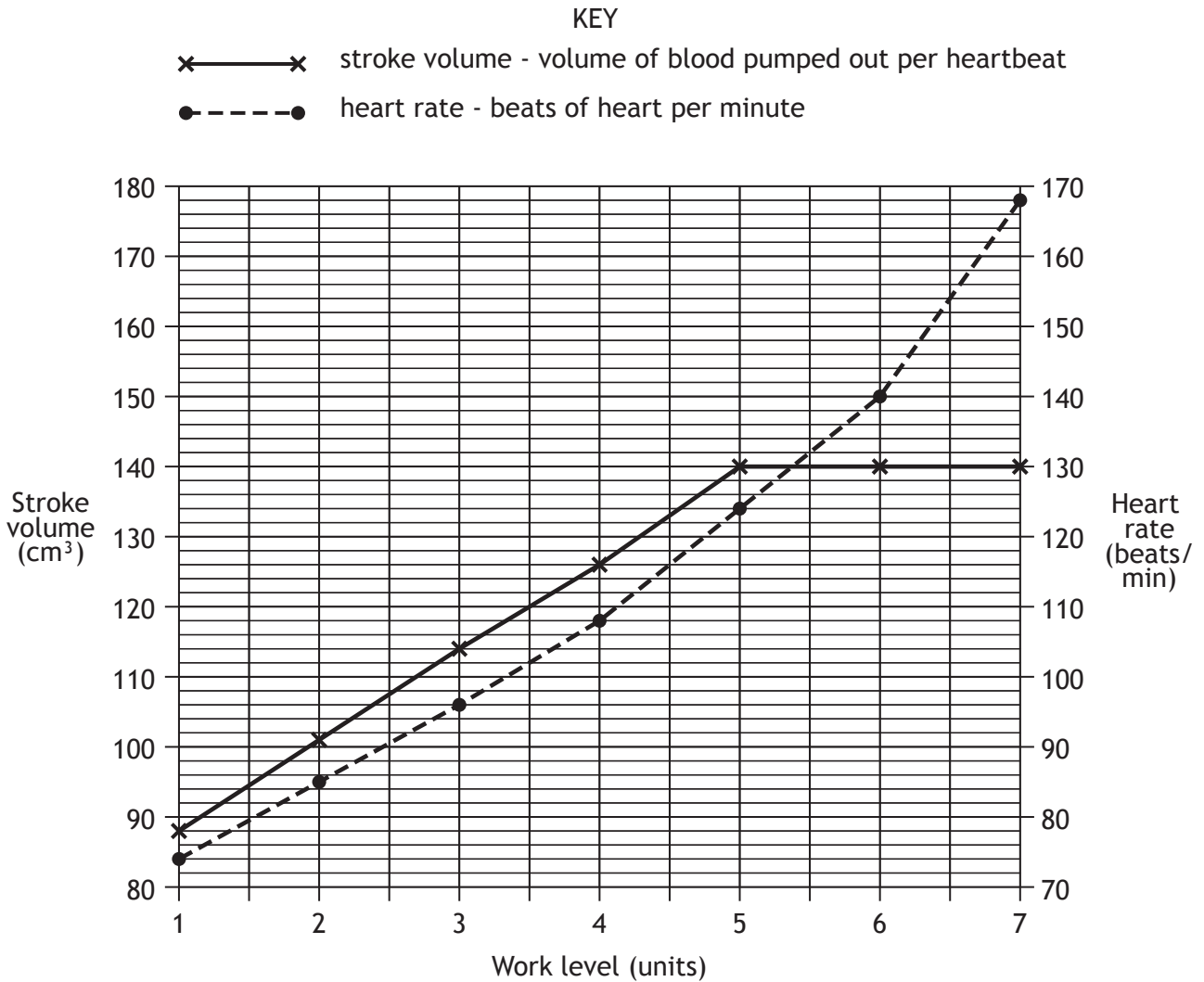


\* X 7 4 0 7 6 0 1 1 7 \*

8. The heart rate and stroke volume of a 40 year old cyclist were monitored as he used an exercise bike.

The cyclist was told to pedal at a constant rate as his work level was gradually raised by increasing the resistance to pedalling.

The graph below shows the changes that occurred in the cyclist's heart rate and stroke volume at seven different work levels.



\* X 7 4 0 7 6 0 1 1 8 \*

8. (continued)

- (a) Use **data from the graph** to describe the changes that occurred in the cyclist's stroke volume when the work level increased from 1 to 7 units. 2

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- (b) State what the cyclist's heart rate was when his stroke volume was 120 cm<sup>3</sup>. 1

*Space for calculation*

\_\_\_\_\_ beats/min

- (c) Cardiac output is the volume of blood leaving the heart in one minute. It is calculated using the formula shown below.

$$\text{cardiac output} = \text{heart rate} \times \text{stroke volume}$$

Calculate the cyclist's cardiac output when his work level was 6 units. 1

*Space for calculation*

\_\_\_\_\_ cm<sup>3</sup>/min

[Turn over



8. (continued)

- (d) The table below shows the recommended minimum heart rates that cyclists of different ages should maintain in order to either metabolise fat or improve their fitness.

Age	Minimum heart rate for metabolising fat (beats/min)	Minimum heart rate for improving fitness (beats/min)
10	136	168
20	130	160
30	123	152
40	116	144
50	110	136
60	104	128

- (i) Use information from the **table** and the **graph** to determine the work level that the cyclist should maintain in order to metabolise fat.

1

\_\_\_\_\_ units

- (ii) Use information from the **table** to predict the minimum heart rate for improving the fitness of a 70 year old.

1

\_\_\_\_\_

- (iii) As an individual gets older, their minimum heart rate for improving fitness decreases.

Use the information from the **table** to calculate the percentage decrease that occurs between the ages of 10 and 60 years.

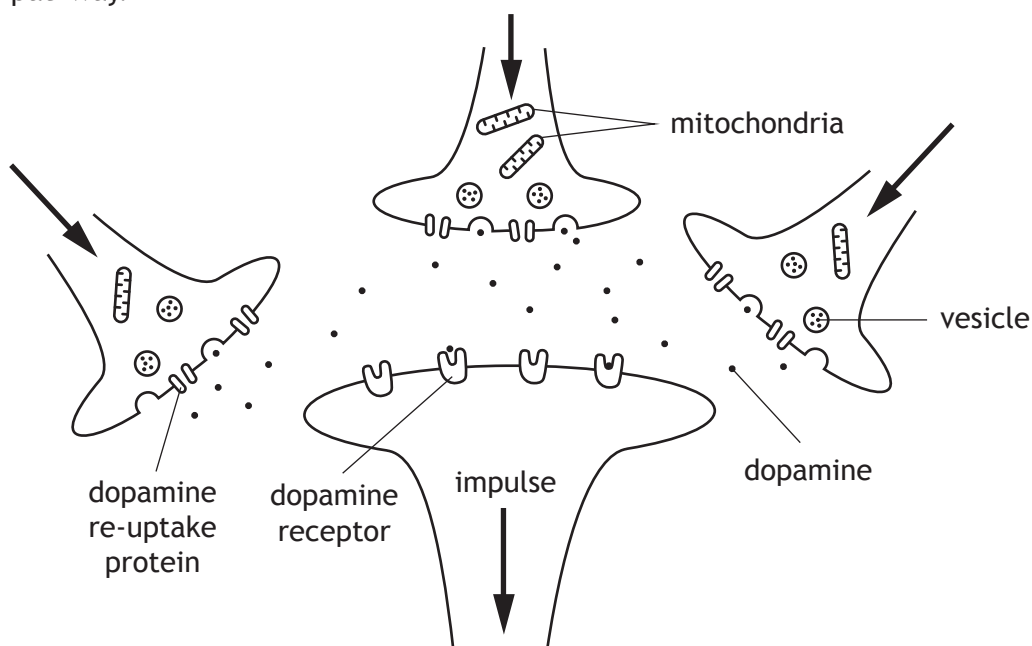
1

*Space for calculation*

\_\_\_\_\_ %



9. The diagram below shows some nerve cells involved in a neural reward pathway.



(a) Using information from the diagram, explain what is meant by the term “summation”.

1

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(b) Suggest a function for the mitochondria shown in the diagram.

1

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(c) Cocaine is a recreational drug that has an effect at this synapse. Cocaine binds to the dopamine re-uptake proteins. As a result, the reward pathway is stimulated for longer. Suggest how cocaine produces this effect.

2

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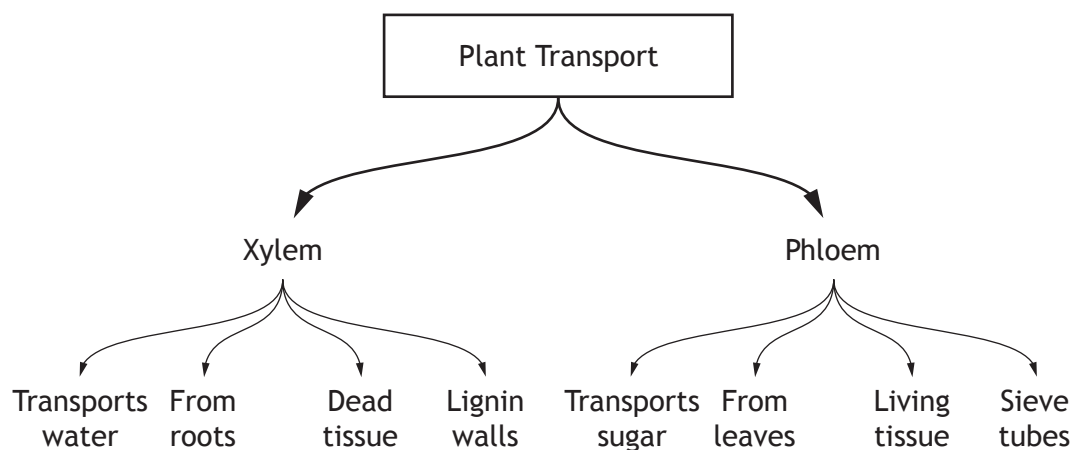
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10. A biology student produced the following diagram as a memory aid to help her learn about transport in plants.



(a) In producing this diagram the student used various methods to learn the information.

Other than rehearsal, name **two** methods that she used and describe how they helped her transfer the information into her long-term memory.

2

1 Method \_\_\_\_\_

Description \_\_\_\_\_

2 Method \_\_\_\_\_

Description \_\_\_\_\_

(b) Any information which is not transferred into long-term memory is displaced. Explain why displacement occurs.

1

\_\_\_\_\_

\_\_\_\_\_

(c) The student is storing a record of facts as she learns this information. State the part of the brain in which such memories are stored.

1

\_\_\_\_\_



11. Various types of white blood cell are involved in the non-specific immune response.

(a) Describe the role of each of the following cells in the non-specific defence of the body.

(i) Mast cells \_\_\_\_\_ 2

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

(ii) Natural killer (NK) cells \_\_\_\_\_ 1

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

(b) Explain how the presence of phagocytes is important in the activation of T lymphocytes. 2

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

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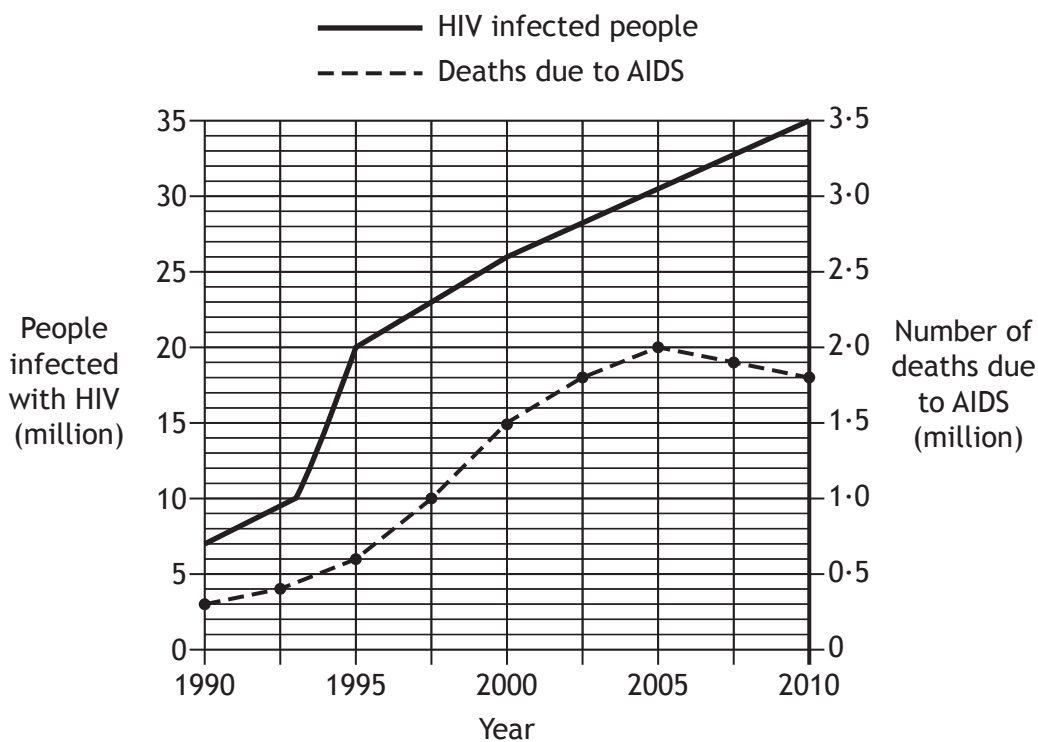


12. HIV is a virus which invades the cells of the immune system.

People infected with HIV may not show symptoms for many years.

AIDS is the condition which may develop from HIV infection, resulting in death.

The graph below shows the number of people in the world infected with HIV, from 1990 to 2010. It also shows the number of people who died from AIDS during this period.



(a) State how many people were infected with HIV in the year 2000.

1

\_\_\_\_\_

(b) State how many people died from AIDS when 20 million people in the world were infected with HIV.

1

\_\_\_\_\_

(c) Calculate the percentage of HIV-infected people who died from AIDS in 2010.

1

Space for calculation

\_\_\_\_\_ %





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12. (continued)

- (d) Describe the evidence from the graph which suggests that the rate of people becoming infected with HIV was greatest between 1993 and 1995.

1

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\* X 7 4 0 7 6 0 1 2 5 \*

13. A scientist investigated the effectiveness of four different types of influenza vaccine. A total of 2000 volunteers from a Scottish community were divided into four groups.

Each group was injected with a different vaccine.

The number who developed influenza during the following years was recorded.

The results are shown in the table below.

<i>Type of influenza vaccine</i>	<i>Developed influenza</i>	<i>Did not develop influenza</i>	<i>Total</i>
P	35	495	530
Q	25	455	480
R	24	496	520
S	17		

(a) (i) Suggest **one** way in which the scientist could minimise variation between the four groups of volunteers. 1

\_\_\_\_\_

\_\_\_\_\_

(ii) **Complete the table** for the volunteers who received type S vaccine. 1

(iii) State which of the vaccines P, Q or R was most effective in this investigation. 1

\_\_\_\_\_

(b) Explain why vaccines usually contain an adjuvant. 1

\_\_\_\_\_

\_\_\_\_\_

(c) In 1918 fifty million people died in a global outbreak of influenza. State the term used to describe such an outbreak. 1

\_\_\_\_\_



14. Answer either A or B in the space below.

Labelled diagrams may be used where appropriate.

A Describe hormonal control of the menstrual cycle under the following headings:

- (i) events leading to ovulation; 6
- (ii) events following ovulation. 4

OR

B Describe the cardiac cycle under the following headings:

- (i) the conducting system of the heart; 5
- (ii) nervous control of the cardiac cycle. 5

[Turn over



\* X 7 4 0 7 6 0 1 2 7 \*



National  
Qualifications  
SPECIMEN ONLY

**S840/76/12**

**Human Biology  
Paper 1 — Multiple choice**

Date — Not applicable

Duration — 40 minutes

**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 S840/76/02.

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.

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



\* S 8 4 0 7 6 1 2 \*

**Total marks — 25**  
**Attempt ALL questions**

1. If 10% of the bases in a molecule of DNA are adenine, what is the ratio of adenine to guanine in the same molecule?

- A 1:1
- B 1:2
- C 1:3
- D 1:4

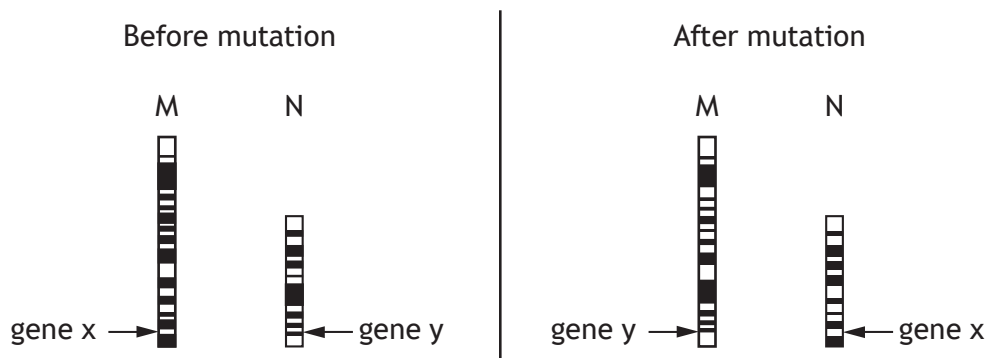
2. The following is a list of single gene mutations.

- 1 Nonsense
- 2 Missense
- 3 Frameshift

Which of these gene mutations is the result of a single-nucleotide substitution?

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

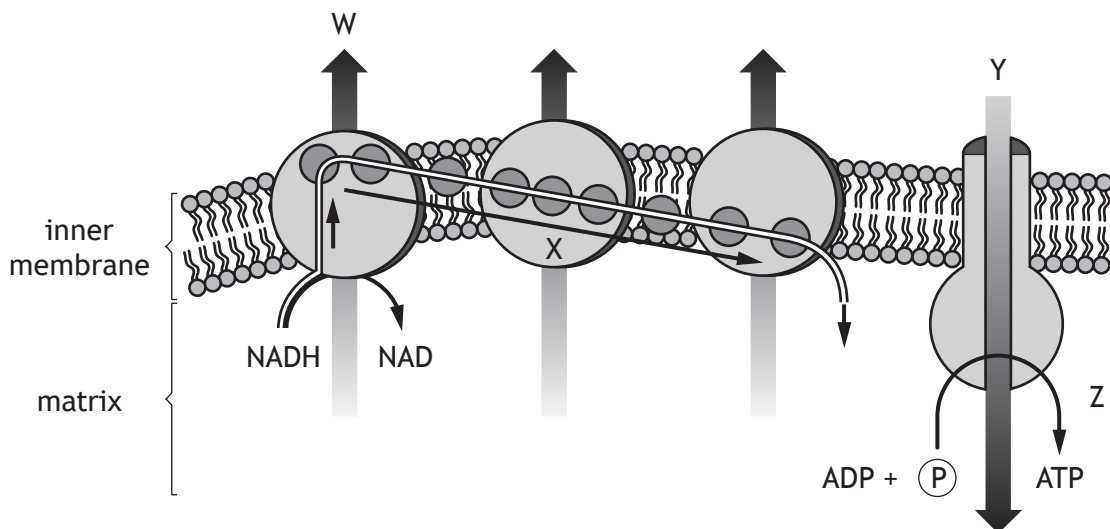
3. The diagram shows two chromosomes, M and N, before and after a chromosomal mutation.



What form of mutation has taken place?

- A Translocation
- B Duplication
- C Insertion
- D Deletion

4. Which of the following processes occurs during RNA splicing?
- A Introns are added
  - B Exons are added
  - C Exons are removed
  - D Introns are removed
5. Metabolic pathways can be controlled by feedback inhibition where
- A an end product binds to an enzyme found at the start of the pathway
  - B an end product binds to an enzyme found at the end of the pathway
  - C an enzyme binds to a substrate found at the start of the pathway
  - D an enzyme binds to a substrate found at the end of the pathway.
6. The diagram represents some of the processes that occur at the inner membrane of a mitochondrion.



Which letter represents the flow of hydrogen ions through ATP synthase?

- A W
- B X
- C Y
- D Z

[Turn over

7. A function of the interstitial cells in the testes is to produce

- A sperm
- B testosterone
- C seminal fluid
- D follicle stimulating hormone (FSH).

8. Nicotine is a chemical that may affect antenatal development.

The diagram shows the stages of development when major and minor malformations of organs may occur if there is exposure to nicotine.

Key

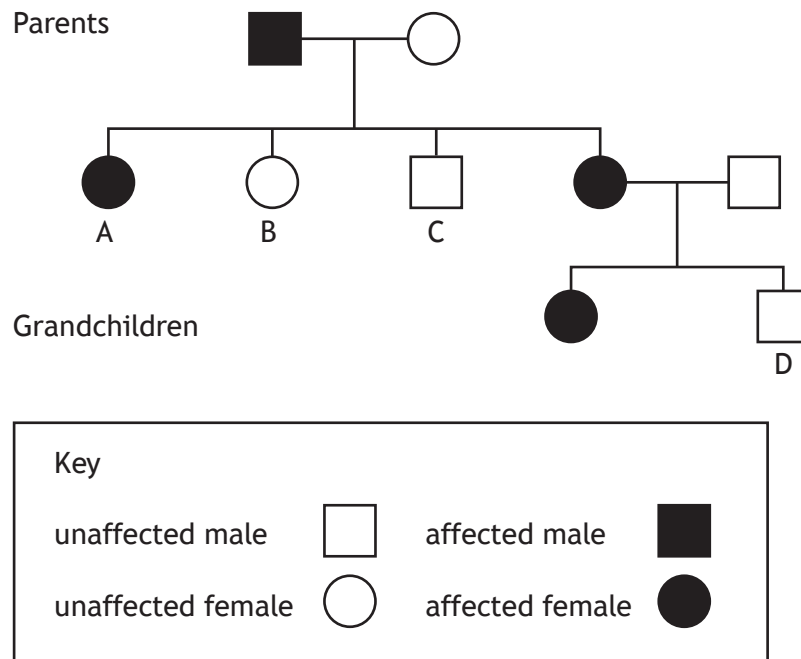
- major malformation
- minor malformation

	Stage of development (weeks after fertilisation)																
	Ball of cells		Embryo (organ formation)						Fetus (organ growth and development)								
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15		
brain																	
ear																	
limbs																	
genitalia																	

For how many weeks during pregnancy is there a possibility of major malformations to organs during development?

- A 6
- B 7
- C 9
- D 13

9. A genetic disorder is caused by an autosomal dominant allele. The diagram shows the inheritance of the disorder through three generations of a family. Which individual confirms that this disorder is autosomal?



10. The following procedures can be used in the treatment of infertility.
- 1 pre-implantation genetic diagnosis (PGD)
  - 2 intracytoplasmic sperm injection (ICSI)
  - 3 artificial insemination

Which of these procedures involve *in vitro* fertilisation (IVF)?

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

[Turn over



11. Which of the following forms of contraception causes thickening of the cervical mucus?

- A Mini-pill
- B Barrier methods
- C Morning-after pill
- D Intra-uterine device

12. The table contains information about four semen samples.  
Which semen sample has the lowest number of active sperm?

	Semen sample			
	A	B	C	D
Number of sperm in sample (millions/cm <sup>3</sup> )	40	30	20	60
Active sperm (%)	50	60	75	40
Abnormal sperm (%)	30	65	10	70

13. During antenatal screening, which two techniques can be used to obtain cells for production of a karyotype?

- A Chorionic villus sampling (CVS) and amniocentesis
- B Amniocentesis and pre-implantation genetic diagnosis (PGD)
- C Intra-cytoplasmic sperm injection (ICSI) and chorionic villus sampling (CVS)
- D Pre-implantation genetic diagnosis (PGD) and intra-cytoplasmic sperm injection (ICSI)

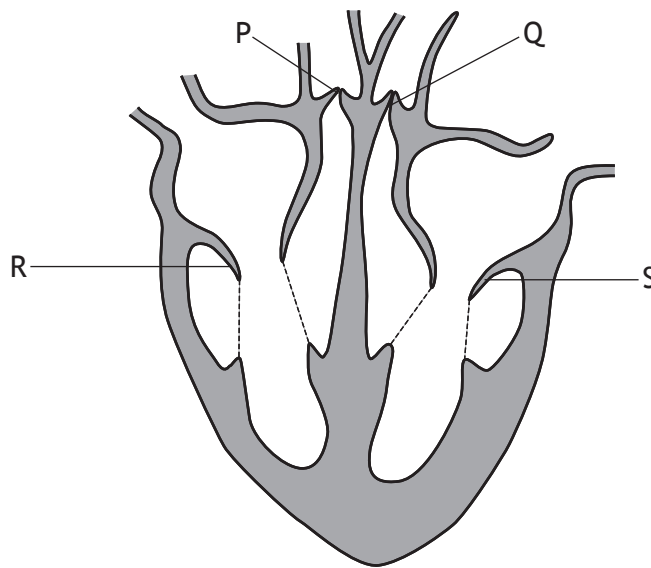
14. The duration of the stages in an individual's cardiac cycle are shown in the table.

Stage	Duration (s)
Diastole	0.4
Atrial systole	0.1
Ventricular systole	0.3

What is the heart rate of this individual?

- A 48 beats per minute
- B 75 beats per minute
- C 80 beats per minute
- D 150 beats per minute

15. The diagram shows a cross-section of the heart.



Which statement describes the movement of the valves during ventricular systole?

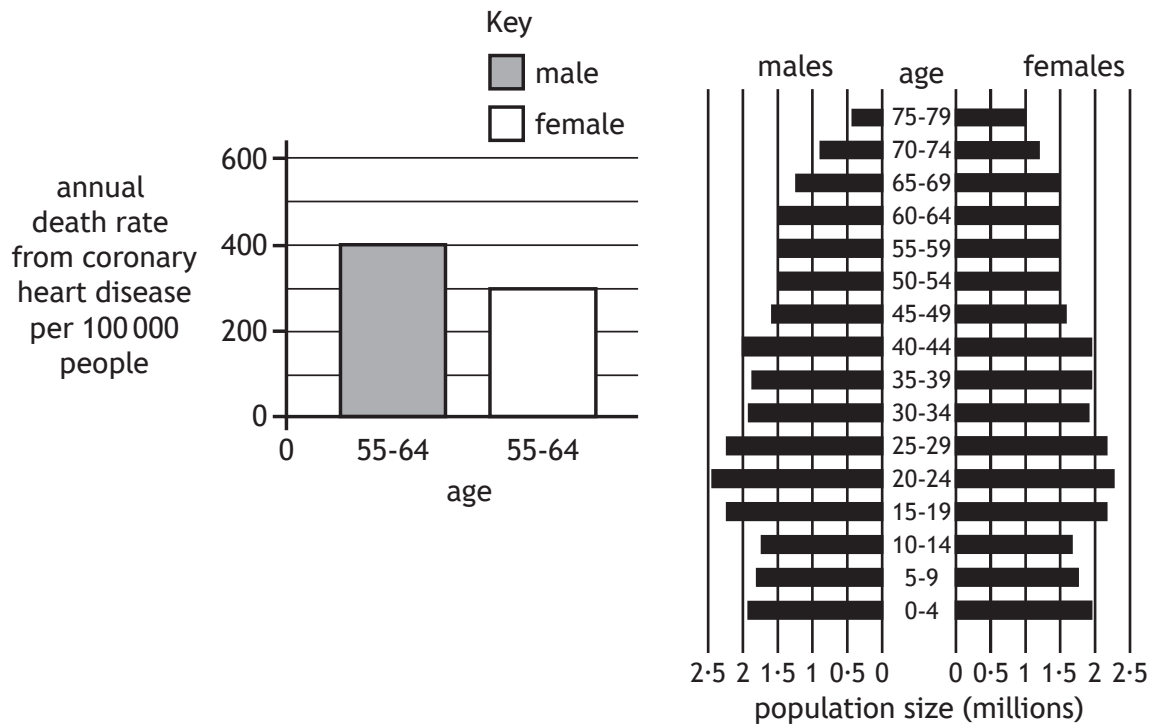
- A Valves P and Q open and valves R and S close.
- B Valves P and R open and valves Q and S close.
- C Valves P and Q close and valves R and S open.
- D Valves P and R close and valves Q and S open.

[Turn over

16. Which statement about lipoproteins is correct?

- A Low density lipoproteins (LDLs) transport cholesterol from body cells to the heart.
- B Low density lipoproteins (LDLs) transport cholesterol from body cells to the liver.
- C High density lipoproteins (HDLs) transport cholesterol from body cells to the heart.
- D High density lipoproteins (HDLs) transport cholesterol from body cells to the liver.

17. The graphs contain information about the population of Britain.



The number of British women between 55 and 64 years of age who die from coronary heart disease annually is

- A 300
- B 4500
- C 9000
- D 12 000.

18. The conversion of information into a form that memory can process is called

- A storage
- B encoding
- C retrieval
- D rehearsal.

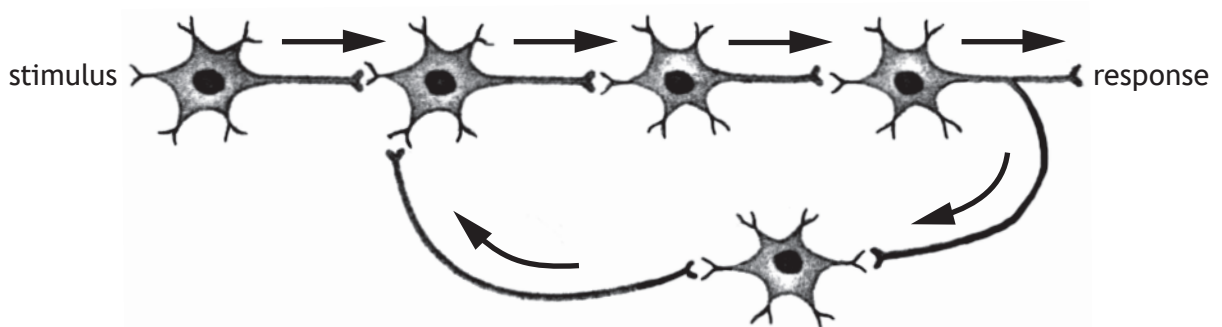
19. By calculating body mass index (BMI), it can be determined whether an individual is obese. The table contains information about four individuals.

Individual	Height (m)	Mass (kg)
1	1.60	90
2	2.10	130
3	1.80	100
4	1.30	56

Which of these individuals would be classified as obese?

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

20. The diagram represents a neural pathway.

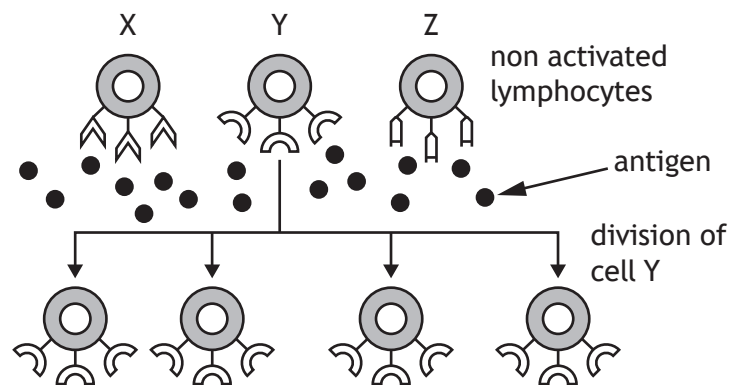


The type of pathway shown is a

- A sensory neural pathway
- B diverging neural pathway
- C converging neural pathway
- D reverberating neural pathway.

[Turn over

21. Which statement about the action of recreational drugs on brain neurochemistry is correct?
- A Desensitisation results from an increase in the number of neurotransmitter receptors due to the use of drugs that are agonists.
  - B Desensitisation results from an increase in the number of neurotransmitter receptors due to the use of drugs that are antagonists.
  - C Sensitisation results from an increase in the number of neurotransmitter receptors due to the use of drugs that are agonists.
  - D Sensitisation results from an increase in the number of neurotransmitter receptors due to the use of drugs that are antagonists.
22. Which of the following is **not** part of the inflammatory response?
- A Vasodilation
  - B Release of histamine
  - C Production of antibodies
  - D Increased capillary permeability
23. The diagram represents the production of a clonal population of lymphocytes.



The division of cell Y is stimulated by

- A the presence of lymphocytes X and Z
- B the presence of an antigen in the blood
- C the binding of antibodies to receptors on the cell membrane
- D the binding of antigens to receptors on the cell membrane.

24. Two groups of subjects were used when carrying out clinical trials of a vaccine. One group was given the vaccine, while the other group was given a placebo. The purpose of the placebo was to
- A reduce experimental error
  - B ensure a valid comparison
  - C allow a statistical analysis of the results
  - D ensure that researchers are unaware who has been vaccinated.
25. The table contains information about the number of influenza cases over five years.

Year	Number of influenza cases in January	Number of influenza cases in July
2001	580	120
2002	620	345
2003	1200	350
2004	120	145
2005	400	100

Which of the following conclusions can be drawn from the data in the table?

- A There are always more influenza cases in January than in July.
- B The number of influenza cases decreased by 75% between January and July of 2005.
- C The greatest percentage decrease in influenza cases occurred between January and July of 2003.
- D The greatest percentage increase in influenza cases occurred between July 2002 and January 2003.

[END OF SPECIMEN QUESTION PAPER]

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SPECIMEN ONLY

Mark

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**S840/76/01**

**Human Biology  
Paper 2**

Date — Not applicable

Duration — 2 hours 20 minutes



\* S 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 17 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.

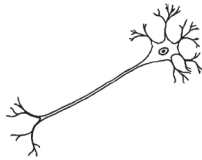
Before leaving the examination room you must give this booklet to the Invigilator; if you do not, you may lose all the marks for this paper.



\* S 8 4 0 7 6 0 1 0 1 \*

Total marks — 95  
 Attempt ALL questions  
 Question 17 contains a choice

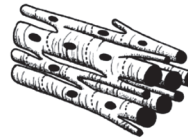
1. The human body contains many specialised cells, all of which have developed from embryonic stem cells.



nerve cells



liver cells



cardiac muscle cells

- (a) Name the process by which a stem cell develops into a specialised body cell and explain how this process occurs. 2

Process \_\_\_\_\_

Explanation \_\_\_\_\_

\_\_\_\_\_

- (b) The nucleus of a germline stem cell divides twice during meiosis. Describe what happens to chromosomes during each division. 2

First division \_\_\_\_\_

\_\_\_\_\_

Second division \_\_\_\_\_

\_\_\_\_\_

- (c) A company has developed a drug that could be used to treat the symptoms of an inherited disease. Before proceeding to clinical trials using volunteers, the company decides to carry out additional tests in the laboratory using embryonic stem cells.

Suggest **one** ethical consideration that might have influenced this decision to use embryonic stem cells. 1

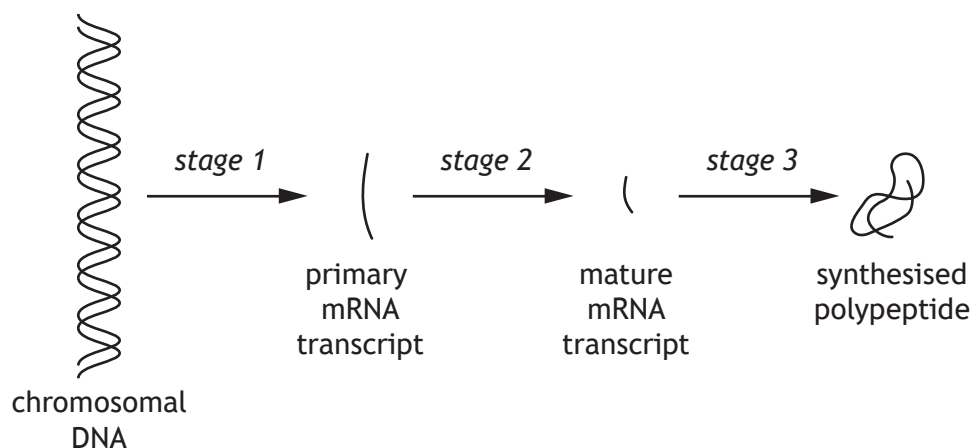
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2. The diagram shows stages in the synthesis of a polypeptide.



(a) Name the enzyme that catalyses stage 1 of this process. 1

\_\_\_\_\_

(b) State the exact location within the cell where stage 3 occurs. 1

\_\_\_\_\_

(c) (i) Explain why the primary mRNA transcript is so much shorter than chromosomal DNA. 1

\_\_\_\_\_  
\_\_\_\_\_

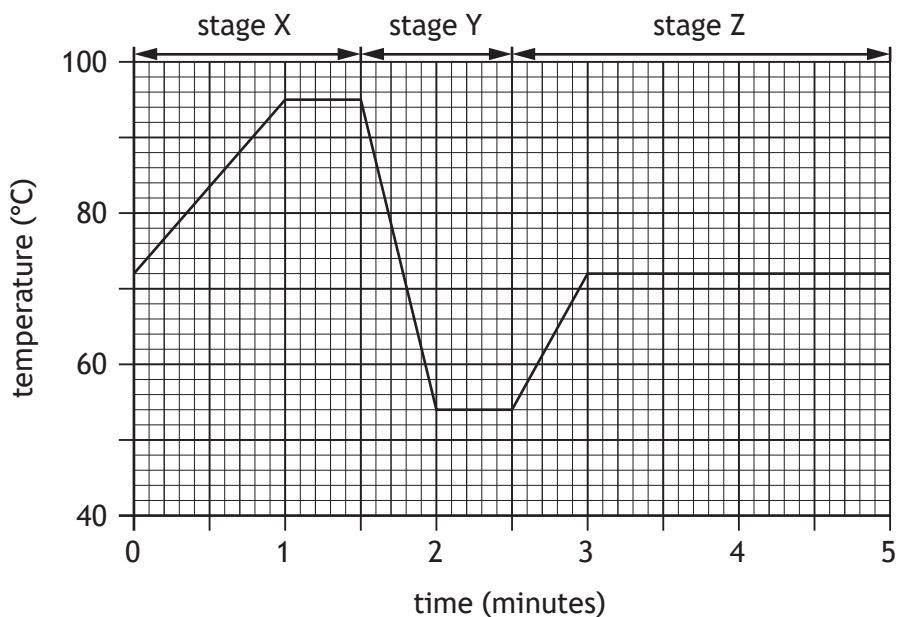
(ii) Explain why the mature mRNA transcript is shorter than the primary mRNA transcript. 1

\_\_\_\_\_  
\_\_\_\_\_

[Turn over



3. The graph shows how the temperature of a reaction tube is changed during one cycle of the polymerase chain reaction (PCR).



- (a) State the maximum change in temperature that the reaction tube experiences during one cycle of PCR. 1

\_\_\_\_\_ °C

- (b) State the function of PCR. 1

\_\_\_\_\_  
\_\_\_\_\_

- (c) Describe what happens to the DNA during stage X. 1

\_\_\_\_\_  
\_\_\_\_\_

- (d) Short sections of DNA called primers are involved in stage Y. Describe what happens to these primers during stage Y. 1

\_\_\_\_\_  
\_\_\_\_\_



## 3. (continued)

- (e) Suggest why the temperature is increased during stage Z.

1

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- (f) A forensic scientist discovered a tiny spot of blood at a crime scene.  
A sample taken from this spot contained 10 molecules of DNA.  
The sample underwent PCR cycles for 30 minutes.

Use data from the graph to calculate how many molecules of DNA would be present after this time.

1

*Space for calculation*

\_\_\_\_\_ molecules

[Turn over

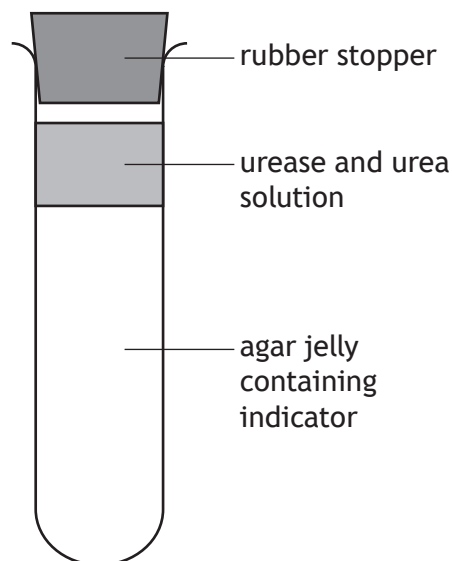


4. An experiment was carried out to investigate the effect of substrate concentration on the production of an end-product in an enzyme controlled reaction.

The enzyme urease was used, which breaks down urea into ammonia.



Urease and urea solutions were mixed together and added to test tubes containing agar jelly as shown in the diagram.



Five different concentrations of urea solution were added.

During the reaction the ammonia produced diffused through the agar jelly, changing the indicator from yellow to blue.

The length of the agar jelly stained blue was measured after the experiment had been allowed to run for 48 hours.

The results of the experiment are shown in the table.

Urea concentration added (moles)	Average length of agar stained blue (mm)
0.03	2
0.06	4
0.13	8
0.25	16
0.50	32

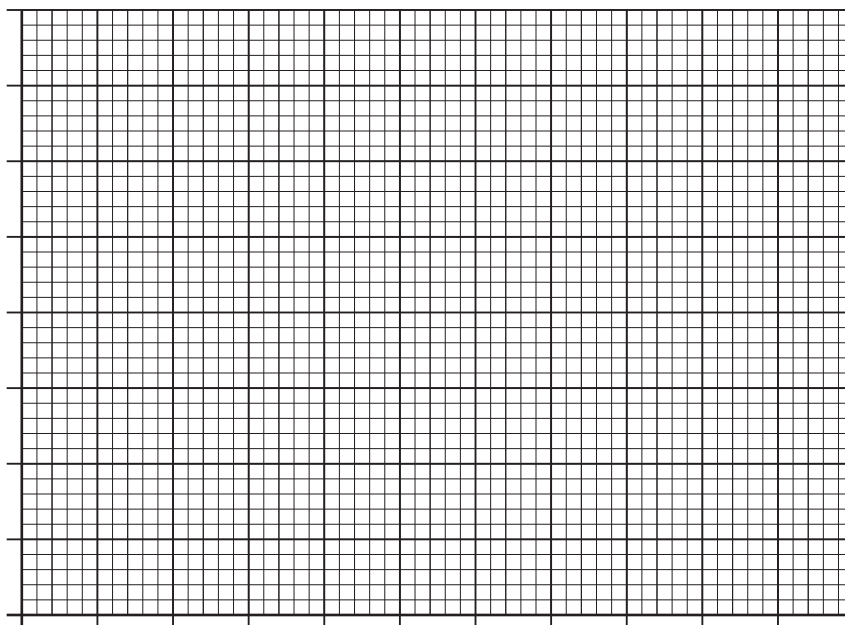


## 4. (continued)

- (a) Draw a line graph to show the results of the experiment.

2

(Additional graph paper, if required, can be found on *page 27*.)



- (b) (i) Name **one** variable that should be controlled when setting up this experiment.

1

\_\_\_\_\_

- (ii) Name **one** variable that should be kept constant during the 48 hours of this experiment.

1

\_\_\_\_\_

- (c) Give the feature of this experiment that makes the results reliable.

1

\_\_\_\_\_  
\_\_\_\_\_

- (d) Explain why the test tubes were left for 48 hours before the results were obtained.

1

\_\_\_\_\_  
\_\_\_\_\_



4. (continued)

- (e) State **one** conclusion that can be drawn from the results of this experiment. 1

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- (f) Using the **information in the table**, predict the length of agar jelly that would have been stained blue if a 0.75 molar urea solution had been used in the experiment. 1

*Space for calculation*

\_\_\_\_\_ mm

- (g) Thiourea is a competitive inhibitor of urease.

In another experiment, a test tube of agar jelly was set up containing the urease solution, 0.5 molar urea solution and thiourea.

After 48 hours, only 7 mm of agar jelly had turned blue.

- (i) Explain why less agar jelly turned blue in this experiment than in the first experiment, which also used a 0.5 molar urea solution. 1

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- (ii) Suggest why some agar jelly turned blue in this experiment. 1

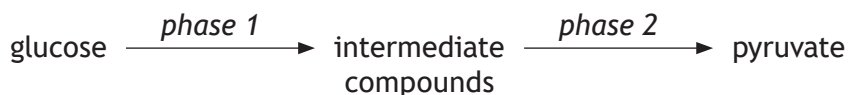
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5. The diagram represents the glycolysis stage of respiration in a muscle cell.



- (a) Phase 1 is the energy investment stage of glycolysis while phase 2 is the energy pay-off stage of glycolysis.

Describe what happens during the energy investment and energy pay-off phases of glycolysis.

2

Energy investment phase \_\_\_\_\_

\_\_\_\_\_

Energy pay-off phase \_\_\_\_\_

\_\_\_\_\_

- (b) Once pyruvate has been formed it can be converted into two different compounds, depending on the conditions.

Name **one** of these compounds and state under what conditions it would be produced.

2

Name \_\_\_\_\_

Conditions \_\_\_\_\_

\_\_\_\_\_

- (c) Most human muscle tissue contains a mixture of fast and slow twitch muscle fibres.

Complete the table to show differences between these two types of muscle fibre.

2

	Fast twitch	Slow twitch
Generation of ATP	from glycolysis	
Major storage fuel		fats

[Turn over

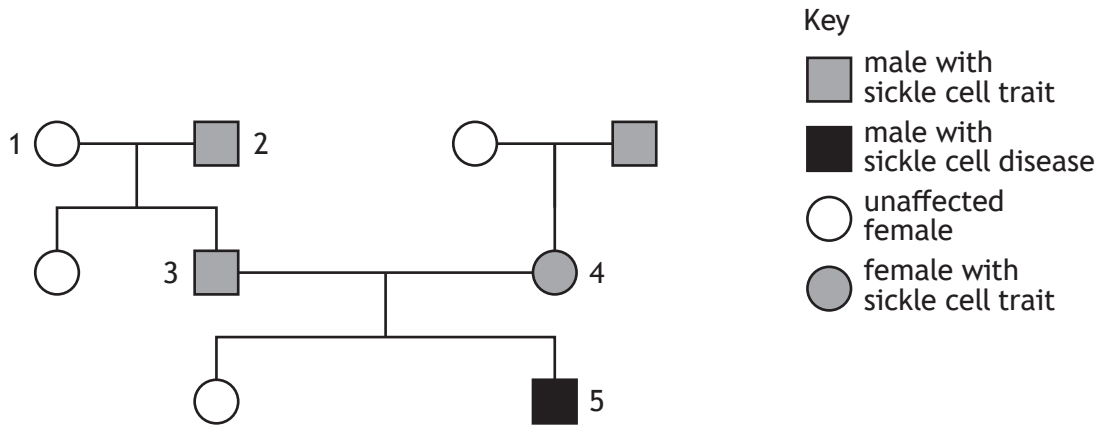


6. Sickle cell disease is an autosomal blood disorder in which a faulty form of haemoglobin, called haemoglobin S, is produced. This protein is an inefficient carrier of oxygen.

The allele for normal haemoglobin (H) is incompletely dominant to the allele for haemoglobin S (S).

Heterozygous individuals (HS) suffer from a milder condition called sickle cell trait.

The chart shows the incidence of these conditions in three generations of a family.



- (a) State the genotype of individual 5. 1

\_\_\_\_\_

- (b) Individuals 3 and 4 go on to have a third child.  
State the percentage chance that this child will have the same genotype as the parents. 1

*Space for working*

\_\_\_\_\_ %

- (c) Sickle cell disease is caused by a substitution mutation in the gene that codes for haemoglobin.  
(i) Describe how this form of mutation affects the structure of the gene. 1

\_\_\_\_\_  
\_\_\_\_\_

- (ii) Explain how this might change the structure of a protein such as haemoglobin. 1

\_\_\_\_\_  
\_\_\_\_\_





6. (continued)

- (d) During IVF treatment, it is possible to detect single gene disorders in fertilised eggs before they are implanted into the mother.

Give the term that describes this procedure.

1

\_\_\_\_\_

- (e) It has been discovered that the gene that codes for fetal haemoglobin is unaffected by the substitution mutation that causes sickle cell disease.

This gene is 'switched off' at birth.

**Use this information** to suggest how a drug designed to treat sickle cell disease in young children could function.

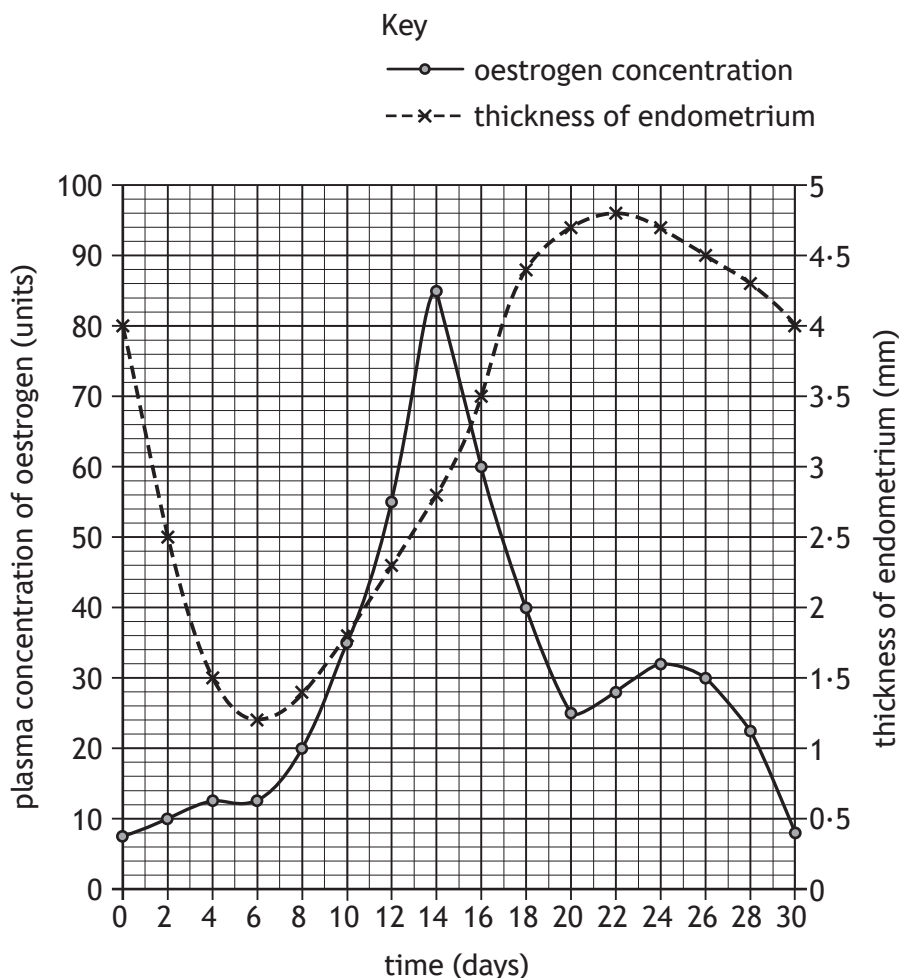
1

\_\_\_\_\_  
\_\_\_\_\_

[Turn over



7. The graph shows how the plasma concentration of oestrogen and the thickness of the endometrium vary during a woman's menstrual cycle.



(a) (i) State the plasma concentration of oestrogen on day 12 of this cycle. 1

\_\_\_\_\_ units

(ii) Describe how the pituitary gland stimulates the change in the plasma concentration of oestrogen between days 6 and 14. 2

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## 7. (continued)

- (b) Calculate the percentage increase in the thickness of the endometrium between day 6 and day 22.

1

*Space for calculation*

\_\_\_\_\_ %

- (c) Explain why the thickness of the endometrium decreases after day 22 of this cycle.

1

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- (d) Describe **one** way that ovulatory drugs stimulate ovulation.

1

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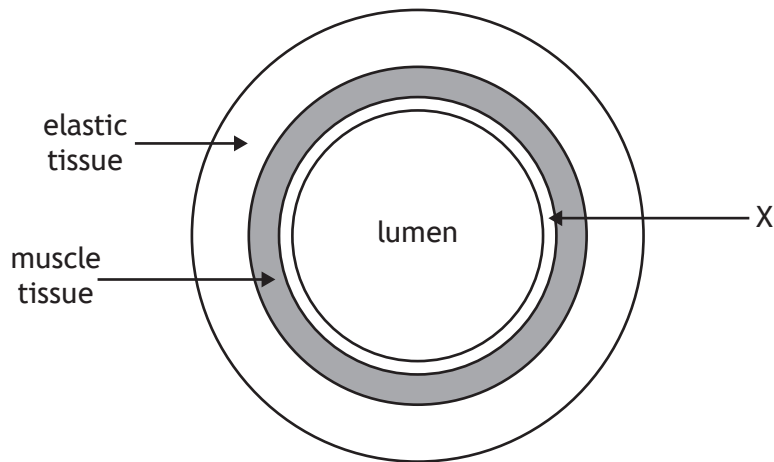
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[Turn over



\* S 8 4 0 7 6 0 1 1 3 \*

8. The diagram represents a section through an artery.



(a) Name layer X.

1

\_\_\_\_\_

(b) Describe how the presence of muscle tissue in the artery wall helps to control the flow of blood around the body.

1

\_\_\_\_\_  
\_\_\_\_\_

(c) Describe how an atheroma forming under layer X may lead to the formation of a blood clot and state the possible effects of this.

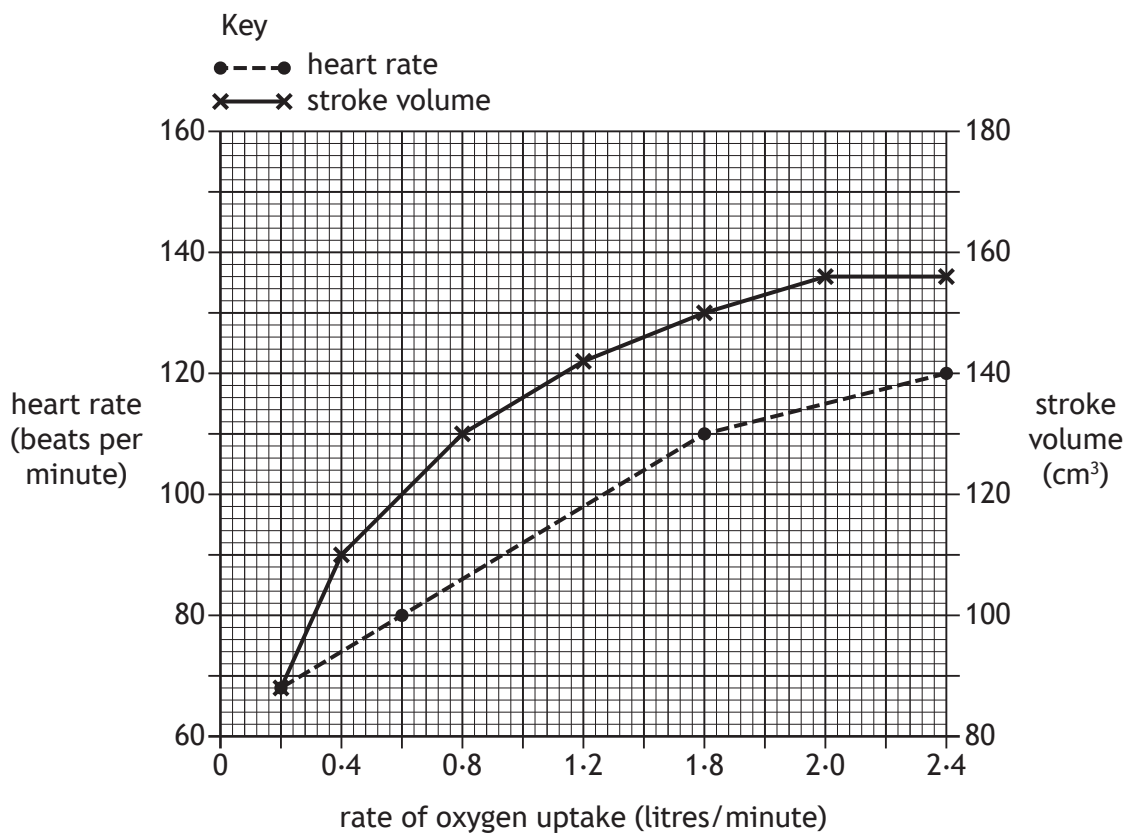
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\_\_\_\_\_  
\_\_\_\_\_



\* S 8 4 0 7 6 0 1 1 4 \*

9. The graph shows how an individual's heart rate and stroke volume changed as their oxygen uptake increased during exercise.



(a) (i) State the individual's heart rate when the rate of oxygen uptake was 1.2 litres/minute. 1

\_\_\_\_\_

(ii) Using data from the graph, describe how the stroke volume changed as oxygen uptake increased. 1

\_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

(iii) State the stroke volume when the heart rate was 110 beats per minute. 1

\_\_\_\_\_ cm<sup>3</sup>

[Turn over



9. (continued)

- (b) Calculate the cardiac output when the rate of oxygen uptake was 2.4 litres per minute.

1

*Space for calculation*

\_\_\_\_\_ litres/min

- (c) (i) When the individual's blood pressure was measured an hour after exercise, a reading of 140/90 mmHg was recorded.

1

Describe what the **first** figure in a blood pressure reading represents.

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- (ii) The individual was diagnosed as having high blood pressure.

One of the effects of this was that their ankles regularly swelled up due to a build-up of tissue fluid.

Suggest why there is a link between high blood pressure and the build-up of tissue fluid.

2

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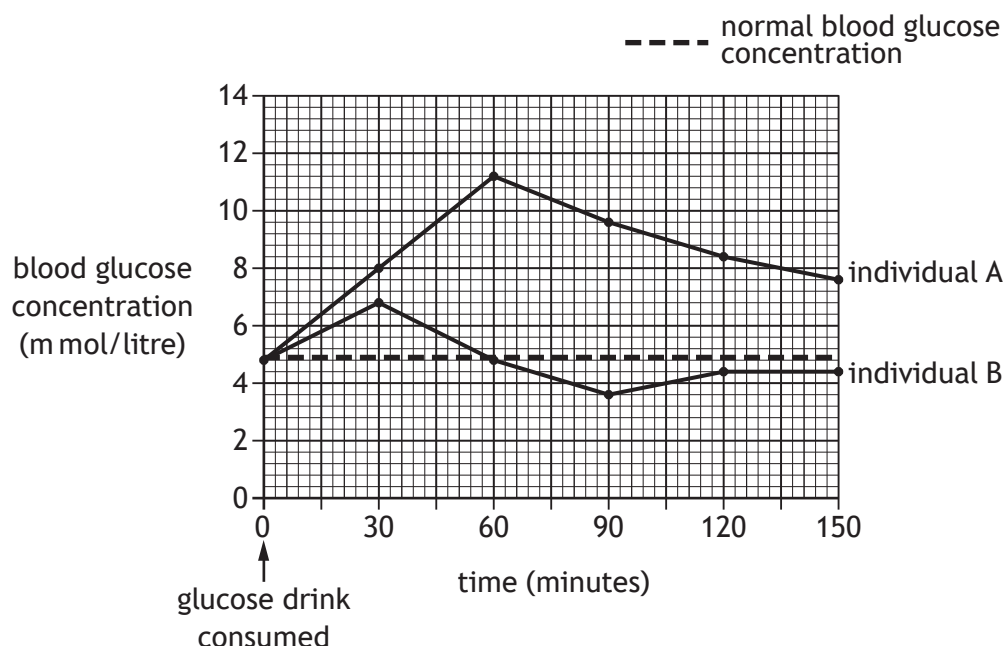
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10. The graph shows changes in blood glucose concentration in a diabetic and a non-diabetic individual after each had consumed a glucose drink.



- (a) (i) Describe how the graph indicates that individual B is **not** a diabetic. 1

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- (ii) Use data from the graph to describe the changes that occur in the blood glucose concentration of individual A after consuming the glucose drink. 2

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- (b) Describe the role of insulin in the development of type 1 and type 2 diabetes. 2

Type 1 \_\_\_\_\_

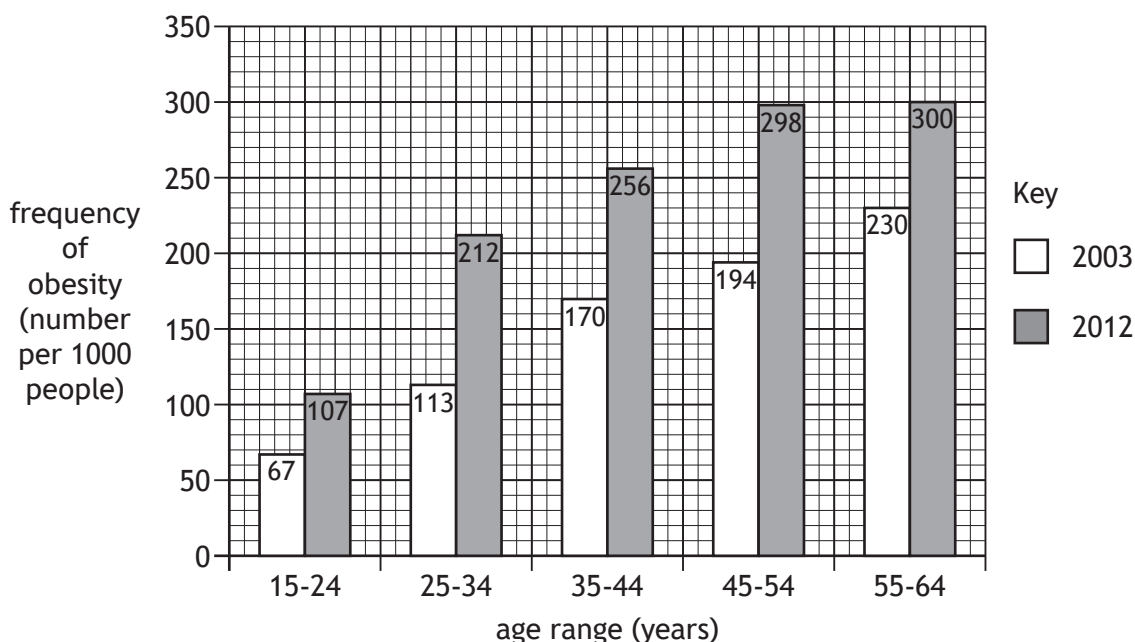
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Type 2 \_\_\_\_\_

\_\_\_\_\_



11. The graph shows data on obesity for a European country in 2003 and 2012.



(a) (i) Describe **two** general trends shown in the graph. 2

1 \_\_\_\_\_  
 \_\_\_\_\_  
 2 \_\_\_\_\_  
 \_\_\_\_\_

(ii) In 2012 the number of people in this country aged 35 to 44 was 6 million.  
 Calculate how many people aged 35 to 44 were obese. 1  
*Space for calculation*

Number of people \_\_\_\_\_

(b) State **one** piece of advice that an obese individual would be given to adapt their diet or lifestyle in order to avoid long-term health problems. 1

\_\_\_\_\_  
 \_\_\_\_\_





12. An investigation was carried out into how the meaning of words affects the recall of lists from long-term memory.

Two groups of 20 people were each shown a list of five words and asked to study them for 30 seconds.

Group 1 was shown words that all had a similar meaning, while group 2 was shown words that had different meanings.

Words shown to group 1 — *large, big, great, huge, wide.*

Words shown to group 2 — *late, cheap, rare, bright, rough.*

After reading a book for an hour, the groups were asked to write down the words that were on their list.

The results of the investigation are shown in the table.

Group	Meaning of words shown	Number of people who correctly recalled all the words
1	similar	11
2	different	17

- (a) Describe **two** ways that the investigators could minimise variation between the two groups of people. 2

1 \_\_\_\_\_  
\_\_\_\_\_

2 \_\_\_\_\_  
\_\_\_\_\_

- (b) Suggest why the groups were asked to read a book for an hour. 1

\_\_\_\_\_  
\_\_\_\_\_

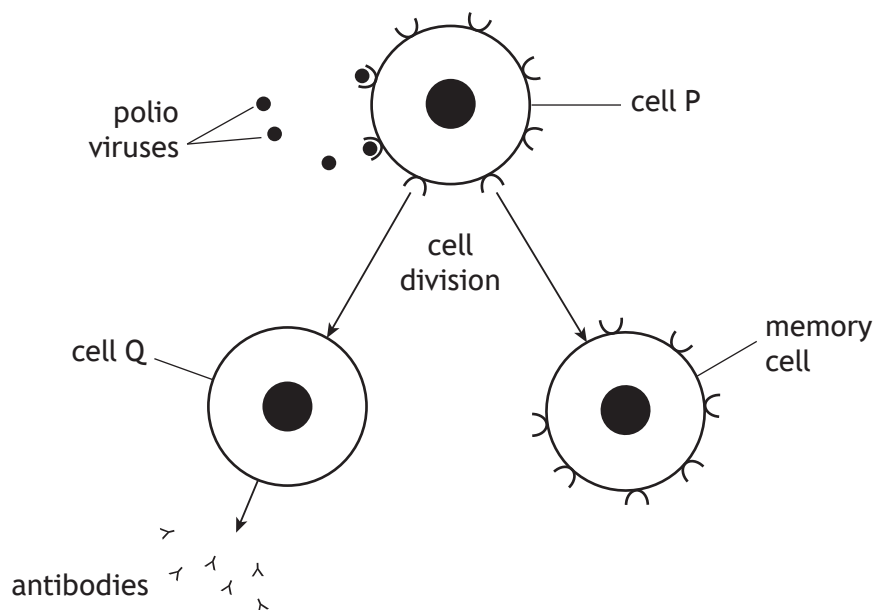
- (c) State a conclusion that can be drawn from the results of the investigation. 1

\_\_\_\_\_  
\_\_\_\_\_

[Turn over



13. The diagram shows how the immune system responds to polio viruses in a vaccine.



(a) Describe how a polio virus is able to attach to cell P. 1

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(b) Name cell Q. 1

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(c) Describe the role of memory cells in the immune system. 1

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(d) Explain why vaccination against polio would **not** provide immunity against the influenza virus. 1

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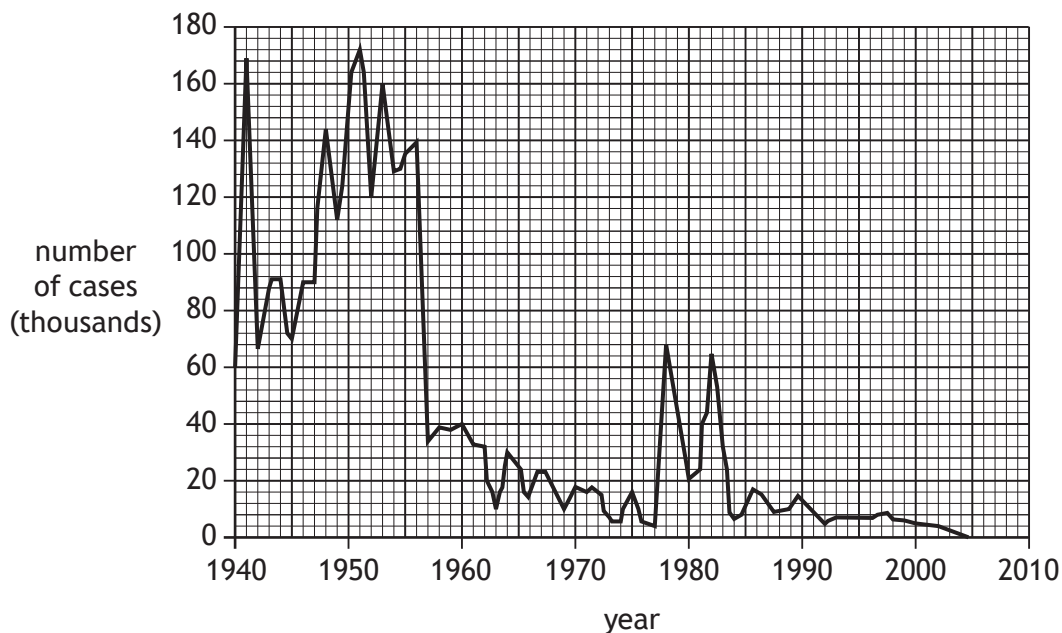
(e) Clinical trials of vaccines often use a double-blind protocol. Describe what is meant by the term double-blind. 1

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14. The graph shows the number of whooping cough cases over a 65 year period in a country.



(a) (i) Using information from the graph, state the year in which a vaccine for whooping cough was introduced. 1

\_\_\_\_\_

(ii) Suggest a reason for the unexpected increase in the number of cases of whooping cough in 1977. 1

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\_\_\_\_\_

(b) The number of cases of whooping cough decreases to a very low level after 2000 because of herd immunity. Explain what is meant by the term 'herd immunity'. 2

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[Turn over

15. The following figures contain information about the causes of death and survival rates in two countries, A and B, in 2010.

Figure 1 - Causes of death in countries A and B during 2010

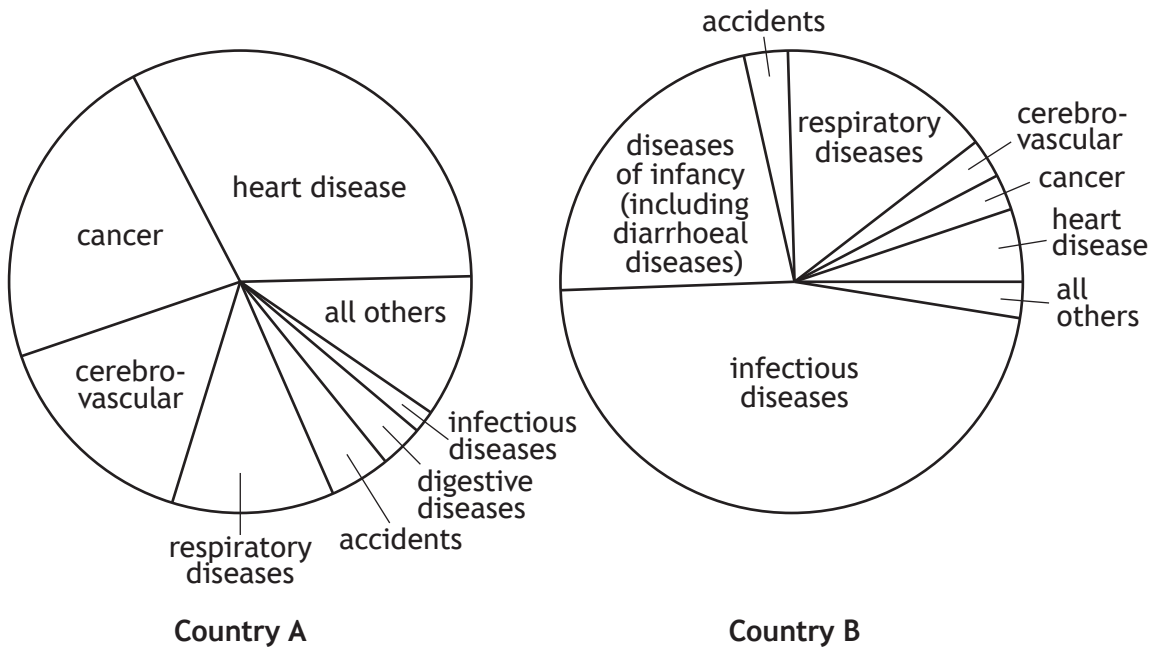
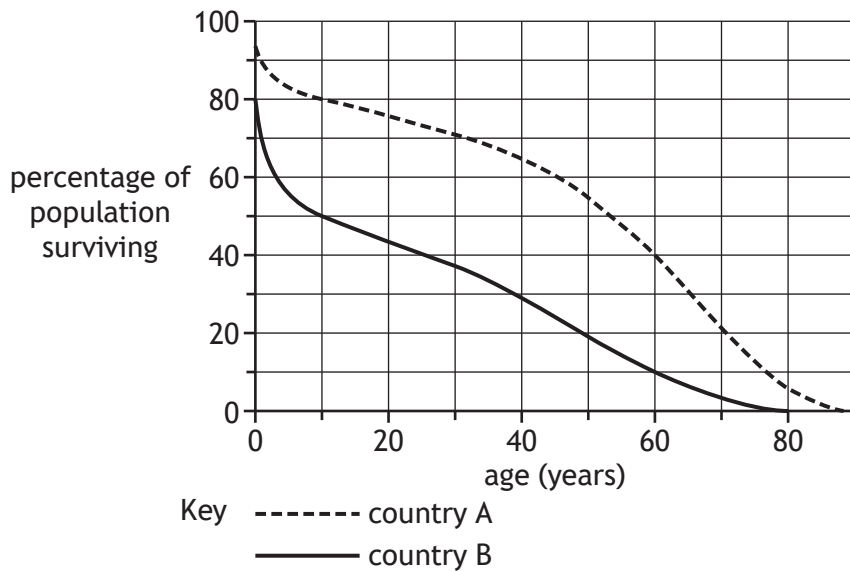


Figure 2 - Percentage survival rates in countries A and B in 2010



(a) Use information from Figure 2 to explain the lower incidence of heart disease in country B.

1

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## 15. (continued)

- (b) (i) Calculate the percentage of the population of country A that die before the age of 10.

1

*Space for calculation*

\_\_\_\_\_ %

- (ii) In 1950 three million babies were born in country B.

Calculate how many of these individuals were still alive in 2010, assuming no migration occurred.

1

*Space for calculation*

\_\_\_\_\_

- (c) Suggest **one** reason why a widespread vaccination programme against infectious diseases might **not** be possible in country B.

1

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[Turn over



16. Pulmonary tuberculosis (TB) is an infectious disease of the lungs caused by a bacterium.

This bacterium can also damage other organs in the body. When this happens it is called non-pulmonary TB.

The table shows the number of reported cases of pulmonary and non-pulmonary TB in Scotland between 1981 and 2006.

Year	Number of cases of pulmonary TB	Number of cases of non-pulmonary TB
1981	659	140
1986	500	178
1991	452	97
1996	408	102
2001	275	125
2006	255	153

(a) (i) Calculate in which five year period the greatest decrease in the total number of cases of TB occurred. 1

*Space for calculation*

(ii) Compare the trend in the number of cases of pulmonary TB with that of non-pulmonary TB between 1991 and 2006. 1

(iii) Calculate, as a simple whole number ratio, the number of cases of pulmonary TB compared to non-pulmonary TB in 2001. 1

*Space for calculation*

\_\_\_\_\_ : \_\_\_\_\_  
pulmonary TB                  non-pulmonary TB

(b) Non-pulmonary TB is often associated with HIV infection. 1

Suggest a reason for this association.

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MARKS

DO NOT  
WRITE IN  
THIS  
MARGIN

17. Attempt **either** A or B. Write your answer in the space below and on *page 26*.

A Describe the autonomic nervous system (ANS) and how it affects heart rate and digestive processes.

8

OR

B Describe how neurotransmitters relay impulses across the synapse.

8

You may use labelled diagrams where appropriate.



\* S 8 4 0 7 6 0 1 2 5 \*