



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.

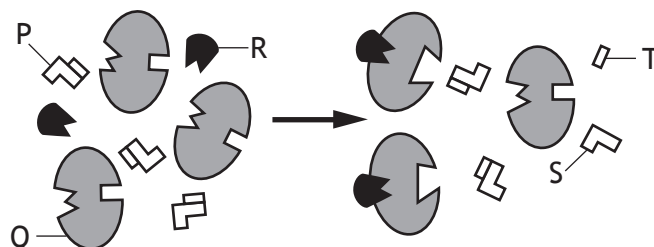
Before leaving the examination room you must give your question and answer booklet to the Invigilator; if you do not you may lose all the marks for this paper.



SECTION 1 — 20 marks

Attempt ALL questions

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

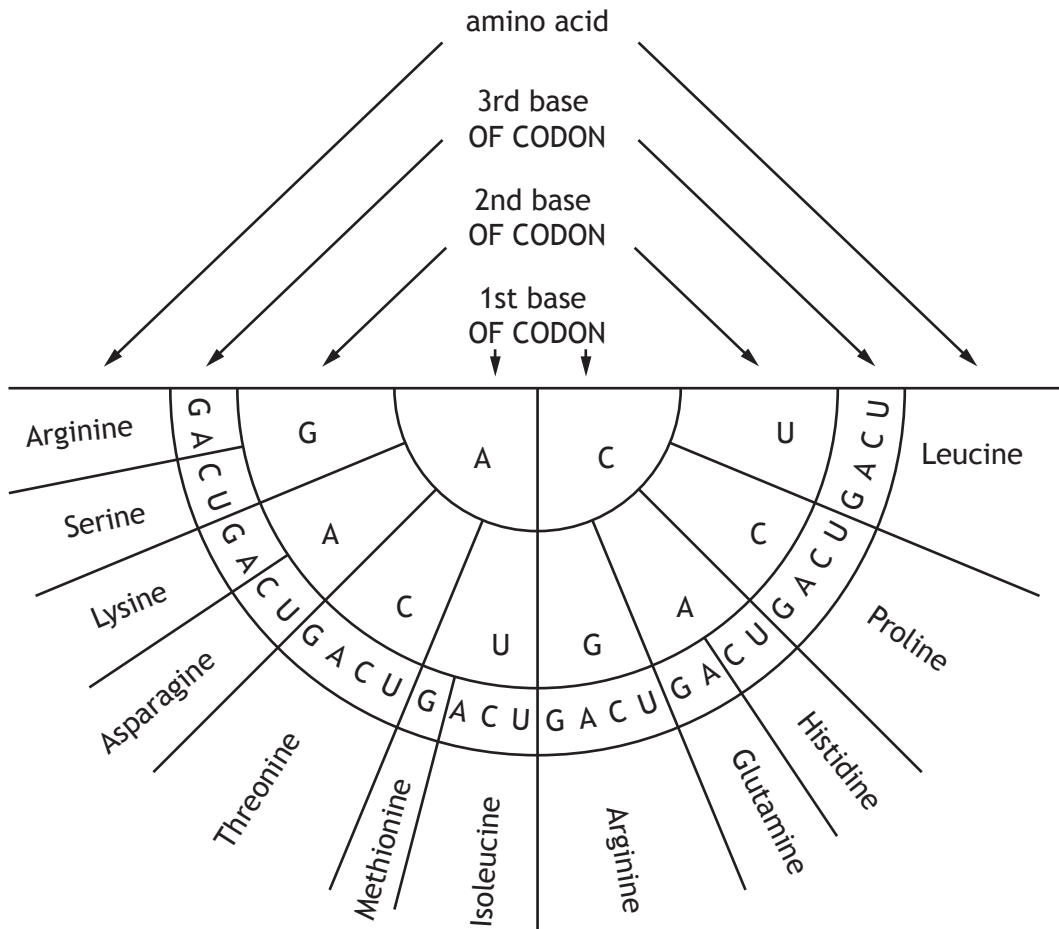


Which line in the table below identifies the molecules in the reaction?

	<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

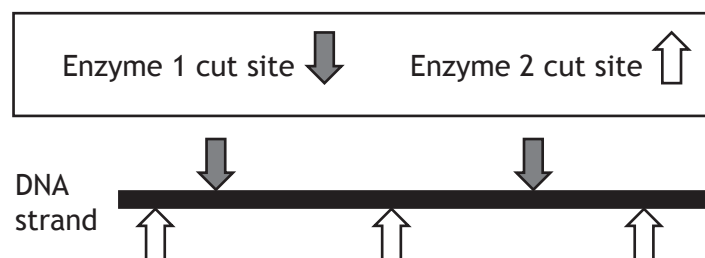
Description 3: one amino acid codon is replaced with a stop codon

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.

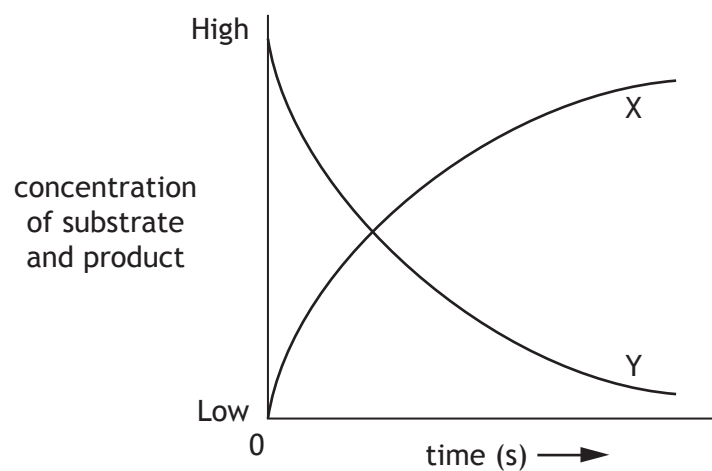
During this procedure DNA is cut into fragments by two different enzymes. Each enzyme cuts DNA at a specific point.



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.

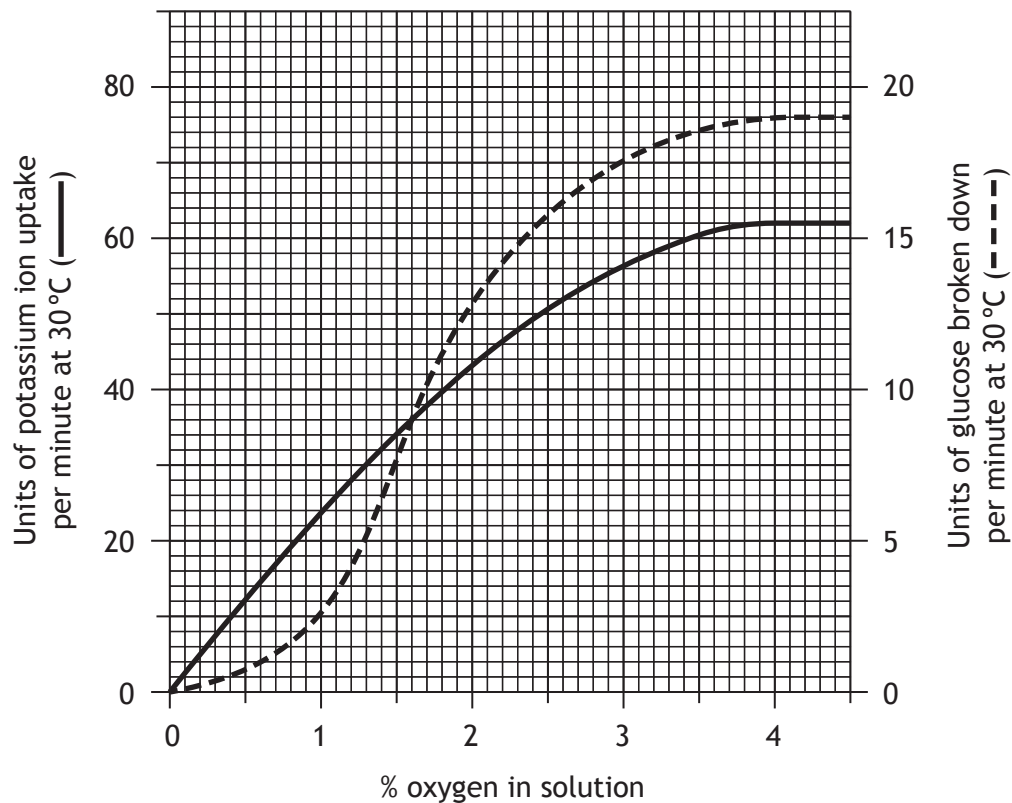


Which line in the table below identifies the substrate, product and the change in the rate of the reaction during the process?

	<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

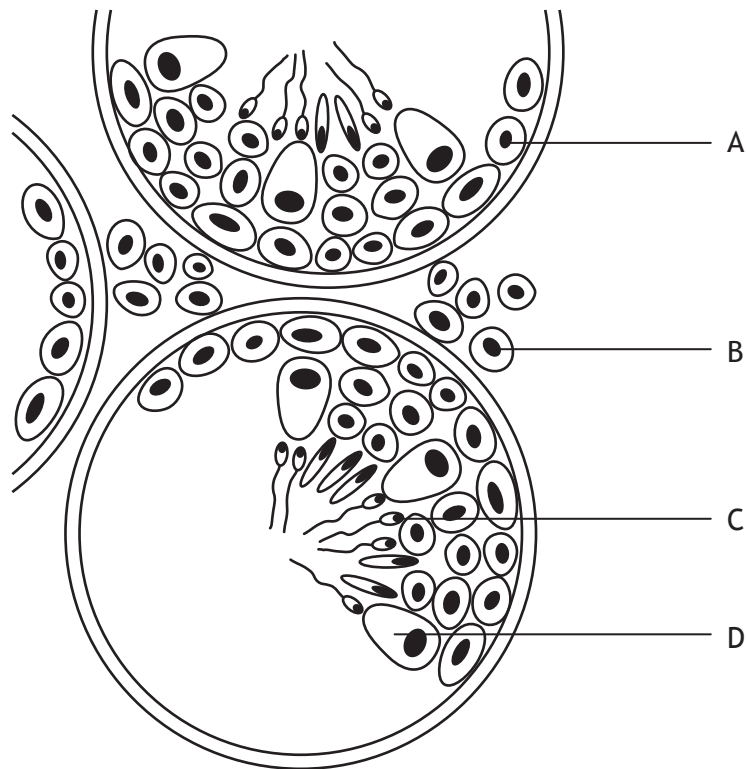
7. The graph below shows the rate of potassium uptake and glucose breakdown by muscle tissue in solutions of different oxygen concentrations.



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 40 g 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 ³)	<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 cm³.

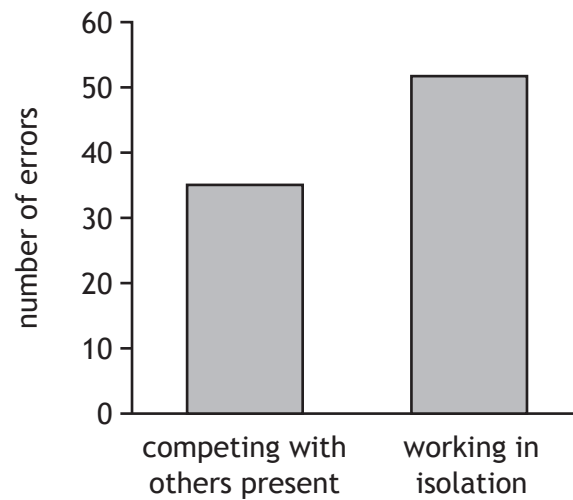
Predict how long it would take before a person with a blood alcohol concentration of 240 mg/100 cm³ would legally be able to drive in these regions.

- 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.

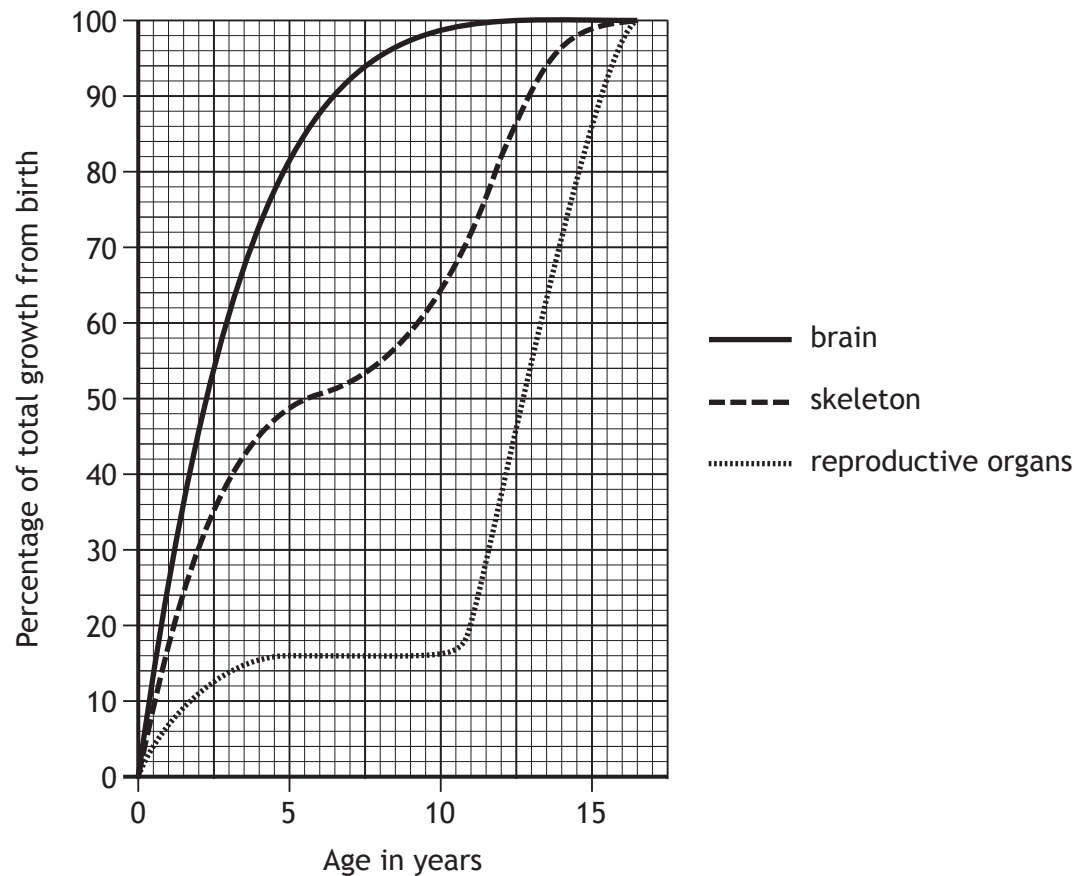
The graph below shows the number of errors recorded in the training process.



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

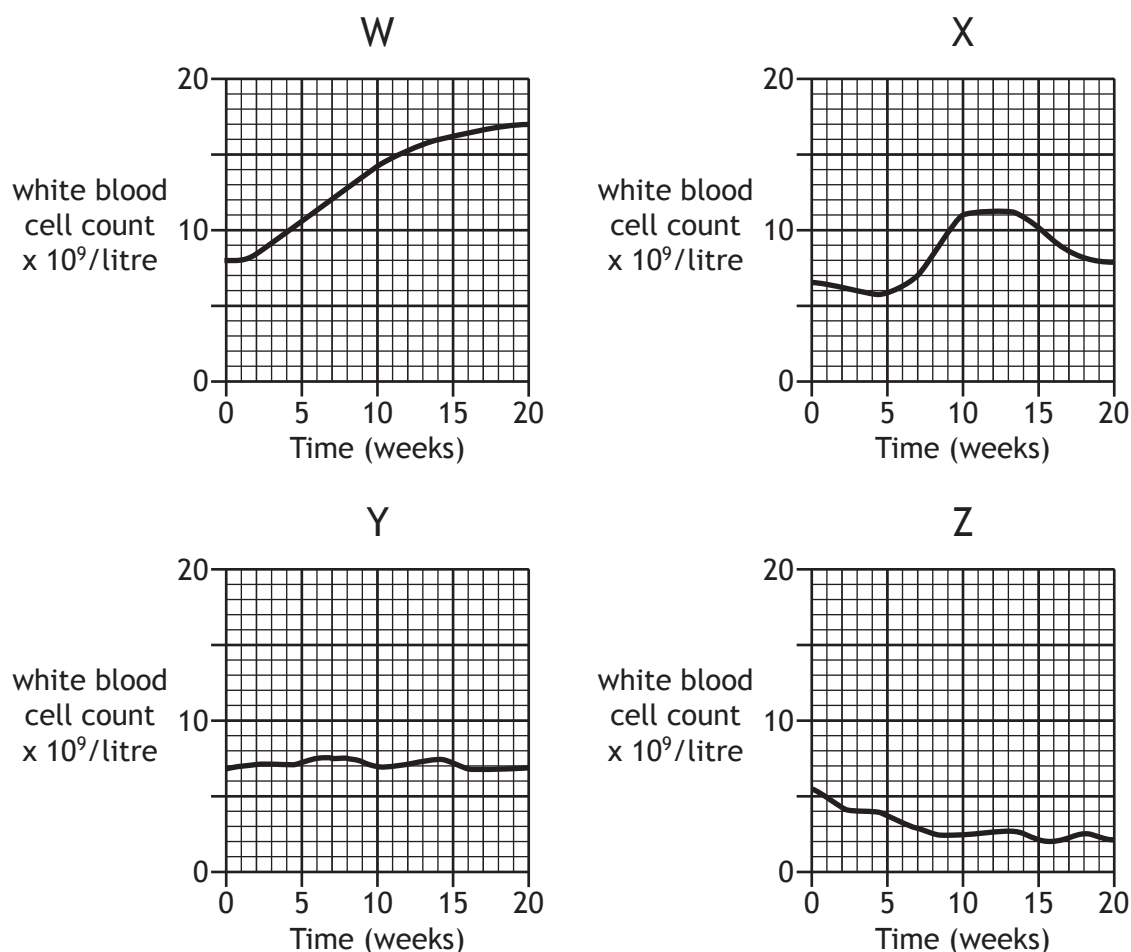
20. Blood tests to measure the number of white blood cells (leucocytes) are often used to indicate infection and/or illness.

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.]



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Mark

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X740/76/01

**Human Biology
Section 1 — Answer Grid
and Section 2**

WEDNESDAY, 13 MAY

1:00 PM – 3:30 PM



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 — 100

SECTION 1 — 20 marks

Attempt ALL questions.

Instructions for completion of Section 1 are given on *Page two*.

SECTION 2 — 80 marks

Attempt ALL questions.

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. You should 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.



The questions for Section 1 are contained in the question paper X740/76/02.
Read these and record your answers on the answer grid on *Page three* opposite.
Use **blue** or **black** ink. Do NOT use gel pens or pencil.

1. The answer to each question is **either** A, B, C or D. Decide what your answer is, then fill in the appropriate bubble (see sample question below).
2. There is **only one correct** answer to each question.
3. Any rough working should be done on the additional space for answers and rough work at the end of this booklet.

Sample Question

The digestive enzyme pepsin is most active in the

- A mouth
- B stomach
- C duodenum
- D pancreas.

The correct answer is **B**—stomach. The answer **B** bubble has been clearly filled in (see below).

A	B	C	D
☐	☒	☐	☐

Changing an answer

If you decide to change your answer, cancel your first answer by putting a cross through it (see below) and fill in the answer you want. The answer below has been changed to **D**.

A	B	C	D
☐	☒	☐	☒

If you then decide to change back to an answer you have already scored out, put a tick (✓) to the **right** of the answer you want, as shown below:

A	B	C	D		A	B	C	D
☐	☒	☐	☒	✓	☐	☒	☐	☐

or



SECTION 1 — Answer Grid



	A	B	C	D
1	☐	☐	☐	☐
2	☐	☐	☐	☐
3	☐	☐	☐	☐
4	☐	☐	☐	☐
5	☐	☐	☐	☐
6	☐	☐	☐	☐
7	☐	☐	☐	☐
8	☐	☐	☐	☐
9	☐	☐	☐	☐
10	☐	☐	☐	☐
11	☐	☐	☐	☐
12	☐	☐	☐	☐
13	☐	☐	☐	☐
14	☐	☐	☐	☐
15	☐	☐	☐	☐
16	☐	☐	☐	☐
17	☐	☐	☐	☐
18	☐	☐	☐	☐
19	☐	☐	☐	☐
20	☐	☐	☐	☐



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[Turn over for Section 2 on *Page six*

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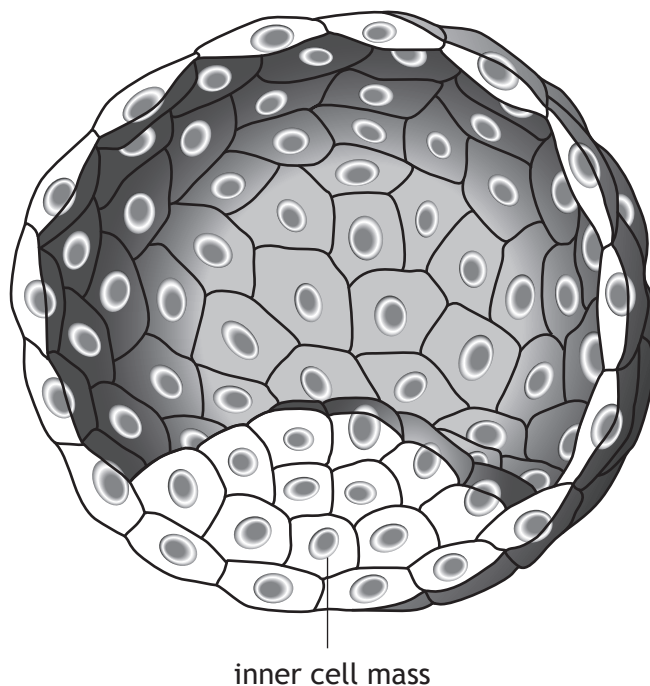
SECTION 2 — 80 marks

Attempt ALL questions

Note that Question 14 contains a choice

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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

- (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



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.

1

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

1

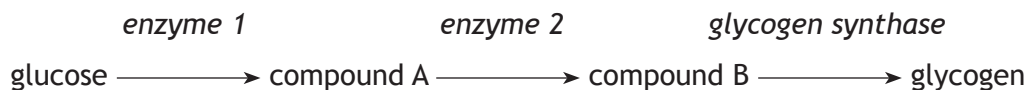
[Turn over



* 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

- (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.

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

2

recessive _____

 sex-linked _____

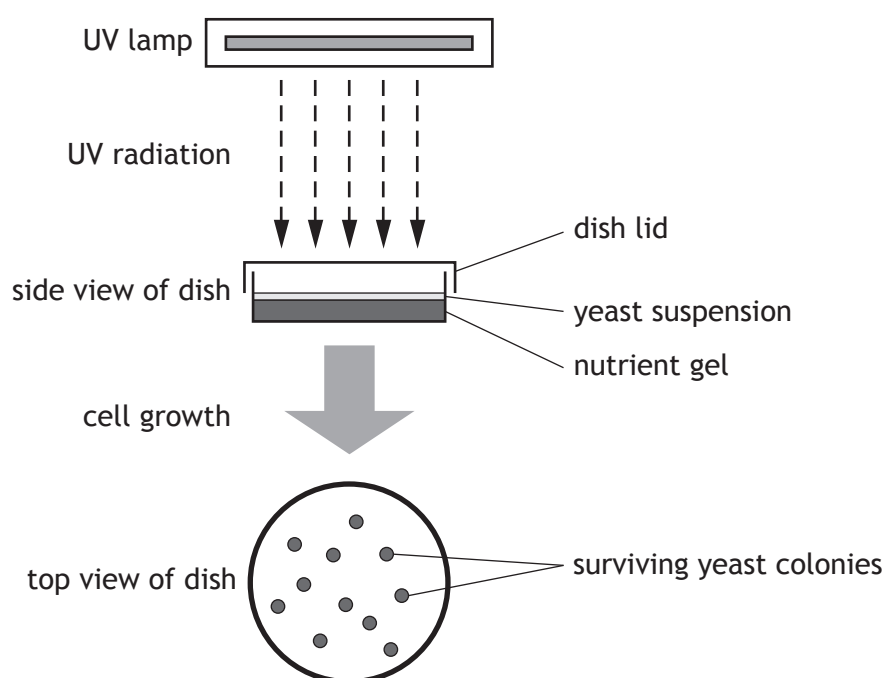


3. Most skin cancers are caused by overexposure to ultraviolet (UV) radiation from the sun or sunbeds. UV radiation damages the DNA in skin cells. Cells normally repair this damage but those which cannot may become cancerous.

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



* X 7 4 0 7 6 0 1 0 9 *

3. (continued)

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

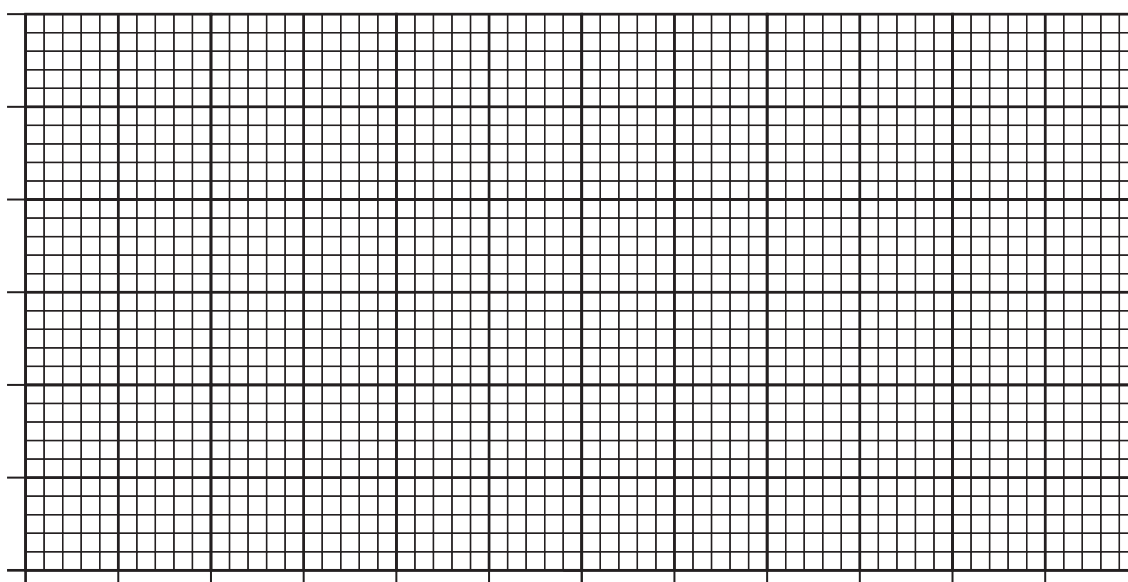
Table 1 — Yeast growth after exposure to UV radiation

<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

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

1



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

<i>Sunscreen used to coat lid (SPF)</i>	<i>Number of yeast colonies growing</i>
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

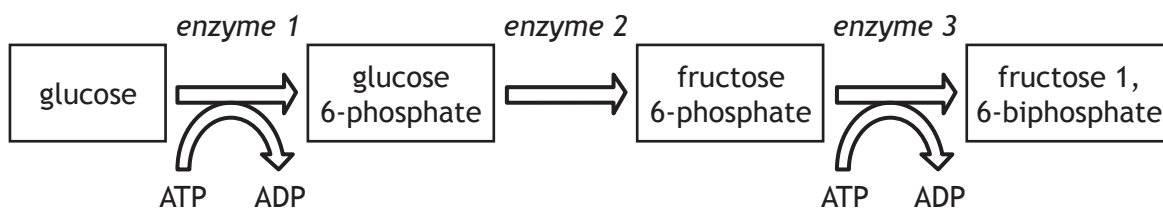


* X 7 4 0 7 6 0 1 1 1 *

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

- (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

- (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

- (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

- (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



* 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

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

1

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

1

(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 ☐

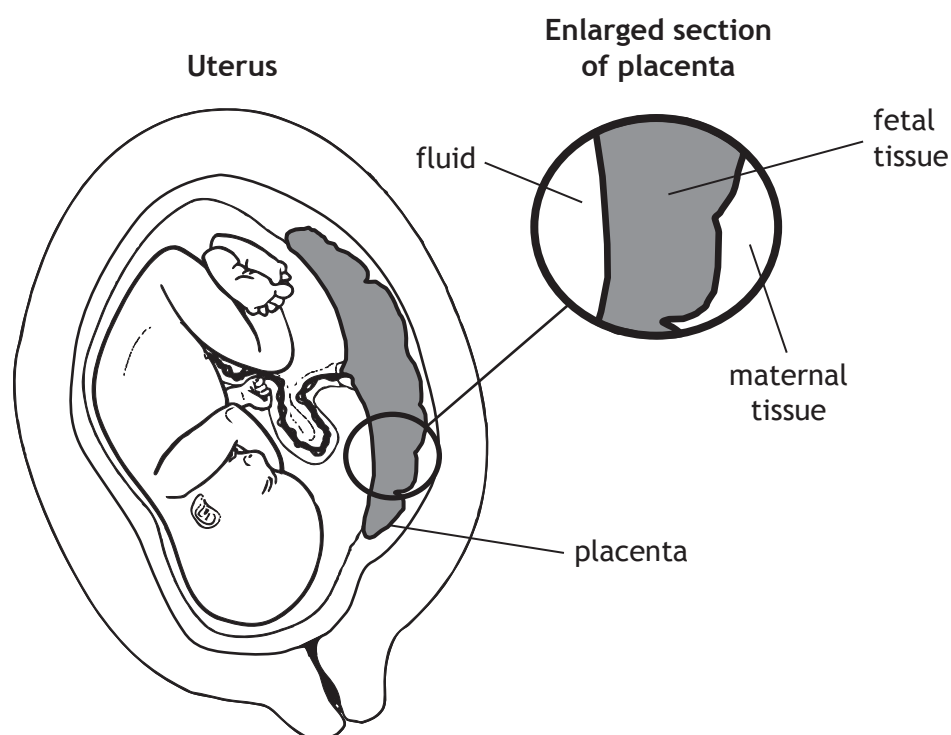
Give reasons to justify your choice of muscle fibre.

3



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

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

1



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.

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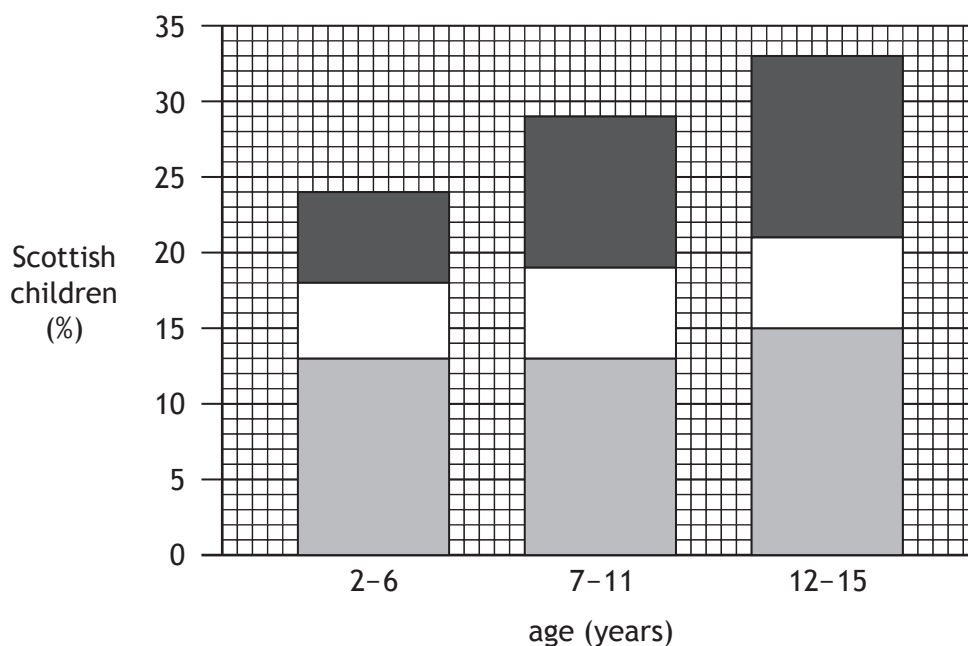
1

[Turn over



* 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



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



7. (continued)

MARKS

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- (c) Explain how BMI is calculated.

1

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

2

Identification _____

Internalisation _____

[Turn over

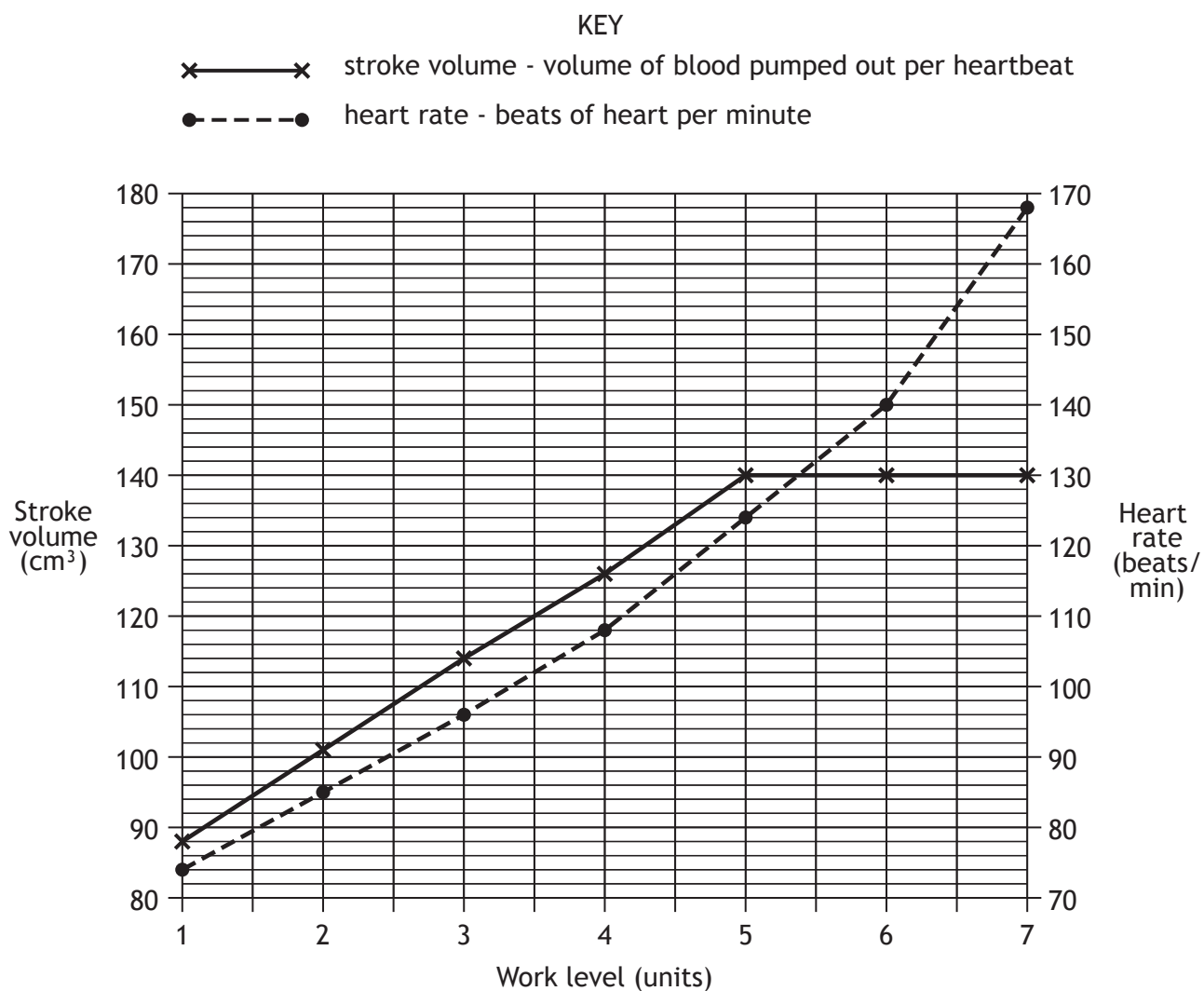


* X 7 4 0 7 6 0 1 1 7 *

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.



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

- (b) State what the cyclist's heart rate was when his stroke volume was 120cm^3 .

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^3/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

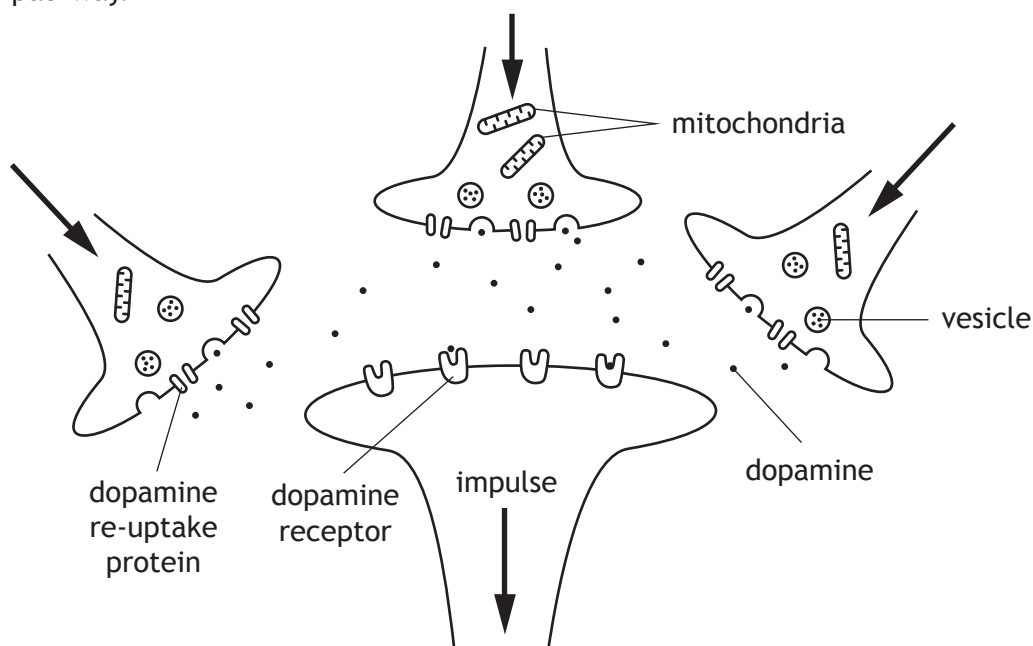
Space for calculation

_____ %



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

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

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

1

- (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.

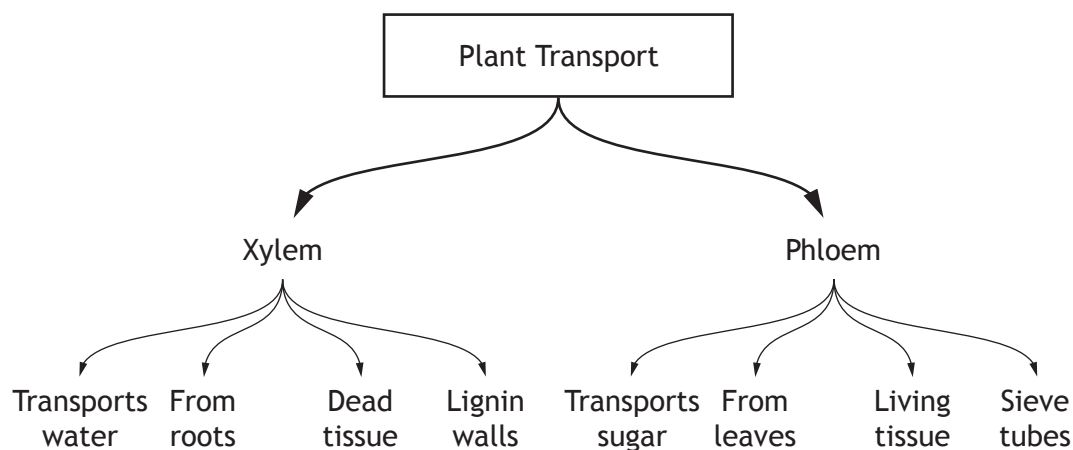
Suggest how cocaine produces this effect.

2



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

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



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

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

[Turn over

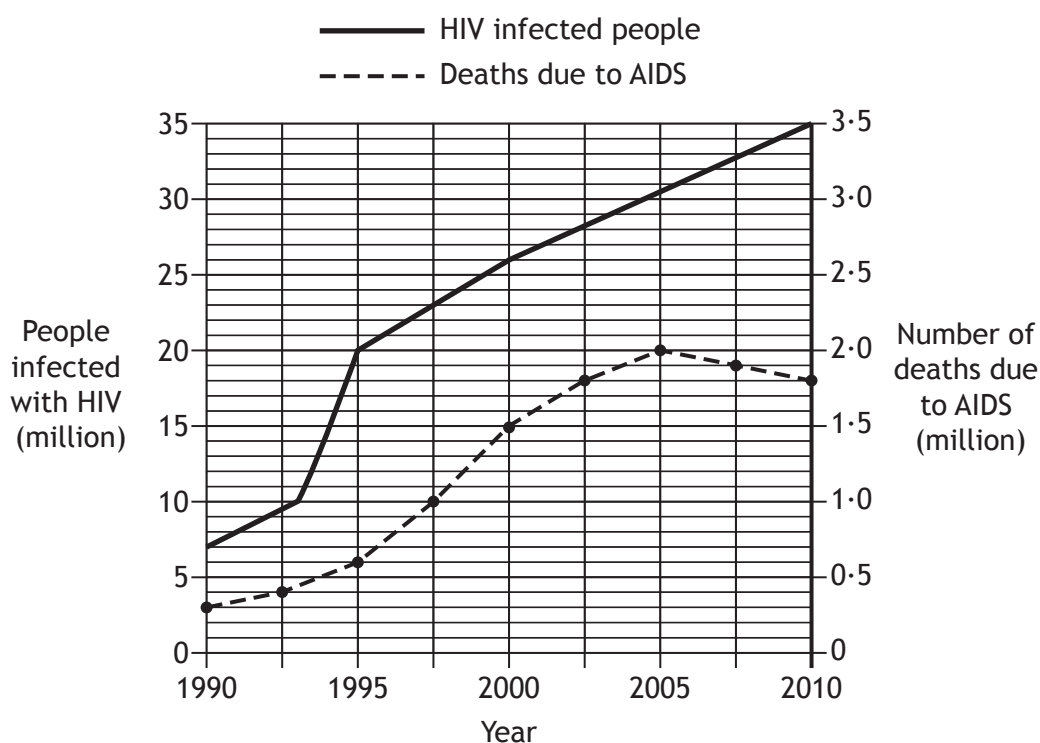


12. HIV is a virus which invades the cells of the immune system.

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

_____ %



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.

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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



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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

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ADDITIONAL SPACE FOR ANSWER TO QUESTION 14

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[END OF QUESTION PAPER]



ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

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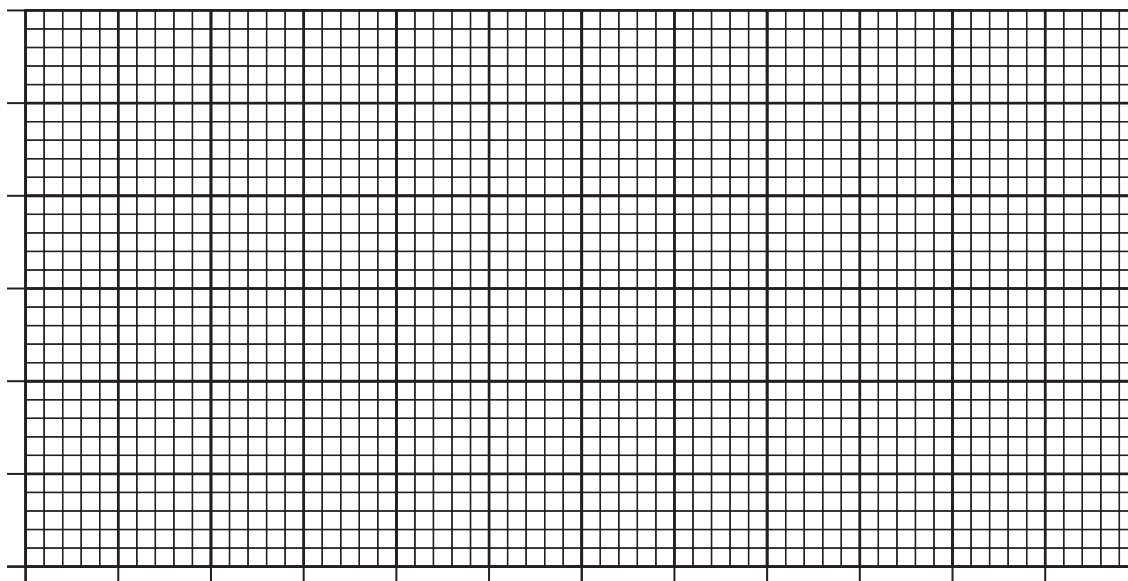


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ADDITIONAL GRAPH PAPER FOR QUESTION 3 (b) (i)

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