

FOR OFFICIAL USE

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Total for
Sections B & C

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X009/12/02

NATIONAL FRIDAY, 16 MAY
QUALIFICATIONS 1.00 PM – 3.30 PM
2014

**HUMAN BIOLOGY
HIGHER**

Fill in these boxes and read what is printed below.

Full name of centre

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Town

--

Forename(s)

--

Surname

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Date of birth

Day Month Year

--	--	--	--	--	--	--

Scottish candidate number

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Number of seat

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SECTION A—Questions 1–30 (30 marks)

Instructions for completion of Section A are given on page two.

For this section of the examination you must use an **HB pencil**.

SECTIONS B AND C (100 marks)

- 1 (a) All questions should be attempted.
- (b) It should be noted that in **Section C** questions 1 and 2 each contain a choice.
- 2 The questions may be answered in any order but all answers are to be written in the spaces provided in this answer book, **and must be written clearly and legibly in ink**.
- 3 Additional space for answers will be found at the end of the book. If further space is required, supplementary sheets may be obtained from the Invigilator and should be inserted inside the **front** cover of this book.
- 4 The numbers of questions must be clearly inserted with any answers written in the additional space.
- 5 Rough work, if any should be necessary, should be written in this book and then scored through when the fair copy has been written. If further space is required a supplementary sheet for rough work may be obtained from the Invigilator.
- 6 Before leaving the examination room you must give this book to the Invigilator. If you do not, you may lose all the marks for this paper.



Read carefully

- 1 Check that the answer sheet provided is for **Human Biology Higher (Section A)**.
- 2 For this section of the examination you must use an **HB pencil**, and where necessary, an eraser.
- 3 Check that the answer sheet you have been given has **your name, date of birth, SCN** (Scottish Candidate Number) and **Centre Name** printed on it.
Do not change any of these details.
- 4 If any of this information is wrong, tell the Invigilator immediately.
- 5 If this information is correct, **print** your name and seat number in the boxes provided.
- 6 The answer to each question is **either** A, B, C or D. Decide what your answer is, then, using your pencil, put a horizontal line in the space provided (see sample question below).
- 7 There is **only one correct** answer to each question.
- 8 Any rough working should be done on the question paper or the rough working sheet, not on your answer sheet.
- 9 At the end of the examination, put the **answer sheet for Section A inside the front cover of this answer book**.

Sample Question

The digestive enzyme pepsin is most active in the

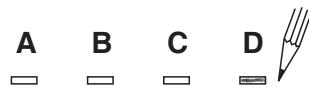
- A stomach
- B mouth
- C duodenum
- D pancreas.

The correct answer is **A**—stomach. The answer **A** has been clearly marked in **pencil** with a horizontal line (see below).



Changing an answer

If you decide to change your answer, carefully erase your first answer and, using your pencil, fill in the answer you want. The answer below has been changed to **D**.



SECTION A

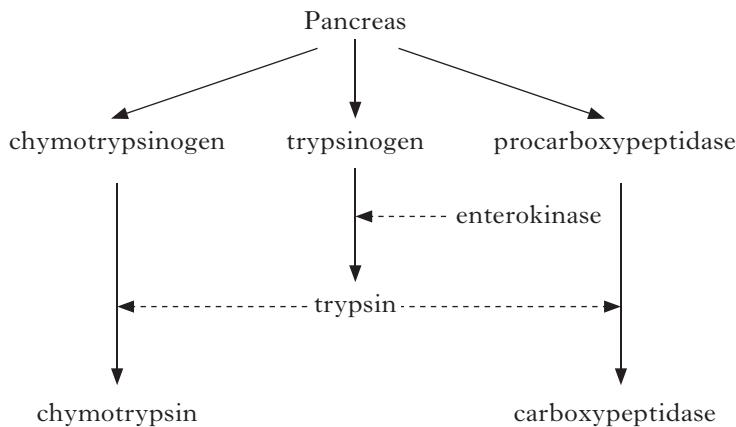
All questions in this section should be attempted.

Answers should be given on the separate answer sheet provided.

- 1.** Non-competitive inhibitors affect enzyme action by

- A altering the shape of the active site of the enzyme
- B altering the shape of the substrate molecule
- C competing for the active site of the enzyme
- D acting as a co-enzyme for enzyme action.

- 2.** The diagram below shows the activation of three inactive enzymes released into the small intestine by the pancreas.

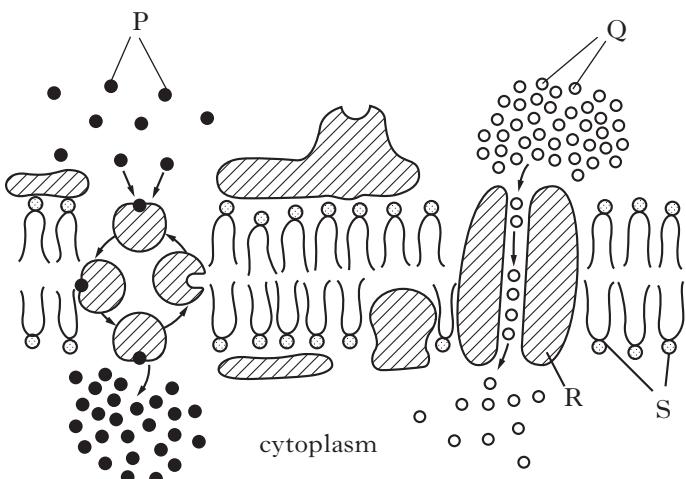


How many enzyme activators are shown in this diagram?

- A 4
 - B 3
 - C 2
 - D 1
- 3.** Which of the following substances contains nitrogen?

- A Glucagon
- B Glucose
- C Glycerol
- D Glycogen

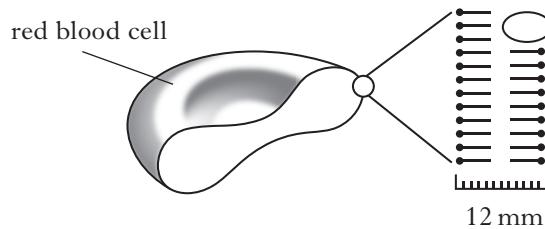
- 4.** The following diagram illustrates the fluid mosaic model of a cell membrane.



Which line in the table below describes correctly the uptake of substances P and Q and the nature of substances R and S?

	Uptake of substance		Nature of substance	
	P	Q	R	S
A	passive	active	protein	phospholipid
B	active	passive	phospholipid	protein
C	passive	active	phospholipid	protein
D	active	passive	protein	phospholipid

- 5.** The diagram below represents part of the plasma membrane of a red blood cell.



The membrane is shown magnified 2 million times.

What is the width of the membrane?
(1 nanometre = 1×10^{-6} mm)

- A 0.6 nanometres
- B 6 nanometres
- C 24 nanometres
- D 60 nanometres

6. A person with blood group AB can safely receive blood from
- A any blood group
 - B blood group O only
 - C blood groups A and B only
 - D blood group AB only.

7. Which substances must be provided by host cells for the synthesis of viruses?
- A Proteins and nucleotides
 - B Amino acids and DNA
 - C Proteins and DNA
 - D Amino acids and nucleotides

8. A DNA molecule replicates three times during three cell division processes.

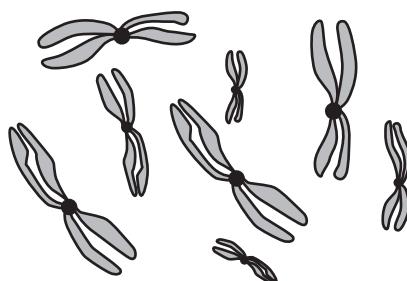
How many of the 8 resulting DNA molecules will contain the original DNA strands?

- A 0
- B 2
- C 4
- D 8

9. Which of the following are produced by meiosis?

- A Haploid cells of identical genetic composition
- B Diploid cells of different genetic composition
- C Diploid cells of identical genetic composition
- D Haploid cells of different genetic composition

10. The chromosomes of a gamete mother cell are shown in the diagram below.



How many chromosomes would be present in each gamete formed?

- A 2
- B 4
- C 8
- D 16

11. Huntington's chorea is caused by a single dominant gene which is not sex-linked.

A woman's father is heterozygous for this condition and her mother is unaffected.

What are the chances that this woman has inherited the condition?

- A 75%
- B 67%
- C 50%
- D 25%

12. Which of the following is **not** a function of the secretions from the prostate gland and seminal vesicles?

- A They add sperm to semen
- B They add sugar to semen
- C They add fluid to semen
- D They add enzymes to semen

13. How many days after ovulation is menstruation most likely to occur?

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

14. Which fertility treatment would be appropriate for a woman with blocked uterine tubes?

A Calculation of fertile period
 B Provision of fertility drugs
 C Artificial insemination
 D *In vitro* fertilisation

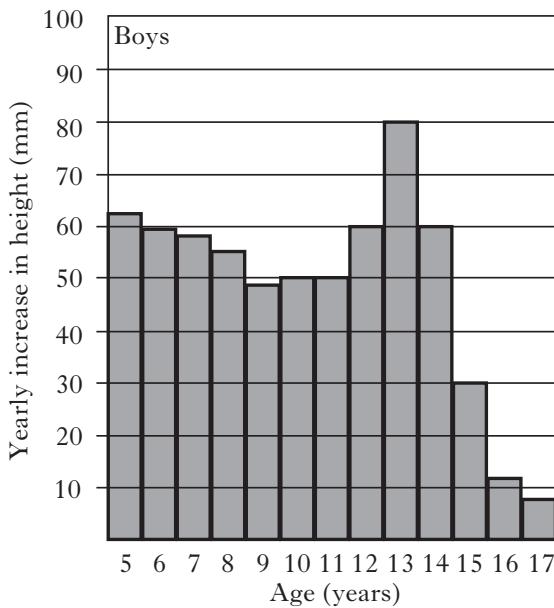
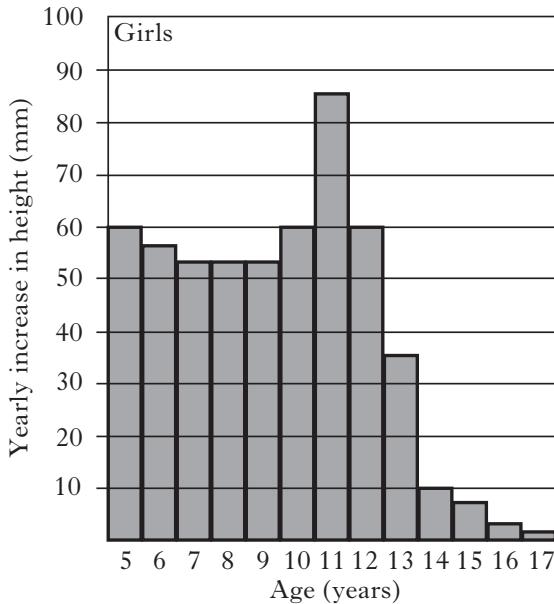
15. Which of the following processes describes how antibodies are exchanged between the maternal and fetal circulations?

A Active transport
 B Pinocytosis
 C Osmosis
 D Diffusion

16. Which line in the table below identifies correctly conditions which would increase the risk of the fetus being harmed by the mother's immune system?

	<i>Pregnancy</i>	<i>Blood type of Mother</i>	<i>Blood type of Fetus</i>
A	First	Rhesus negative	Rhesus positive
B	Second	Rhesus positive	Rhesus negative
C	First	Rhesus positive	Rhesus negative
D	Second	Rhesus negative	Rhesus positive

17. The graphs below show the average yearly increase in height of girls and boys.



Which of the following statements is correct?

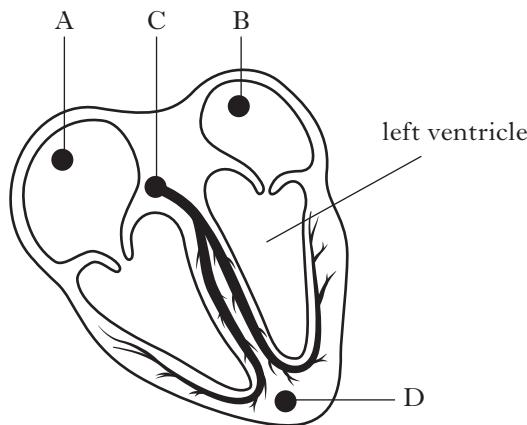
- A The greatest yearly increase for boys occurs one year later than the greatest yearly increase for girls.
 B Boys are still growing at seventeen but girls have stopped growing by this age.
 C Between the ages of five and eight boys grow more than girls.
 D There is no age when boys and girls show the same average yearly increase in height.

[Turn over]

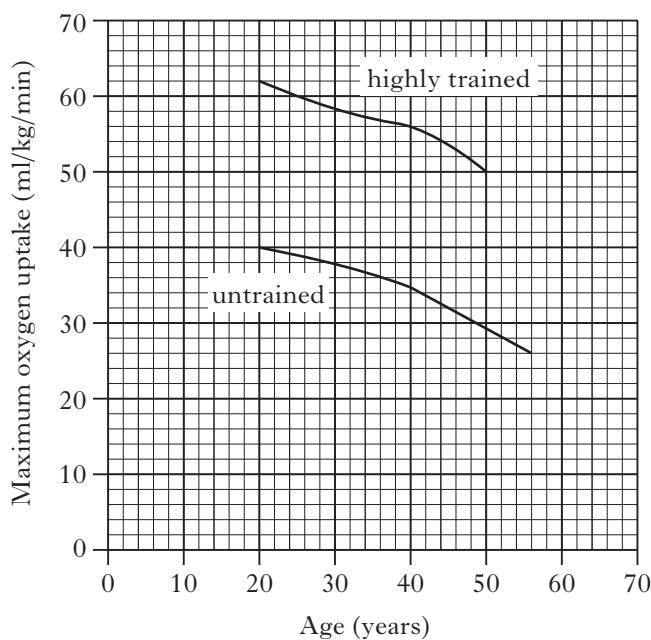
18. The main blood vessel supplying the heart muscle itself with oxygenated blood is the
- coronary vein
 - coronary artery
 - pulmonary artery
 - pulmonary vein.

19. The diagram below shows a section through the human heart.

Where is the sinoatrial node (SAN) located?



20. The graph below shows the effect of training and age on oxygen uptake.



What is the percentage increase in maximum oxygen uptake for a 20-year-old untrained person who becomes highly trained?

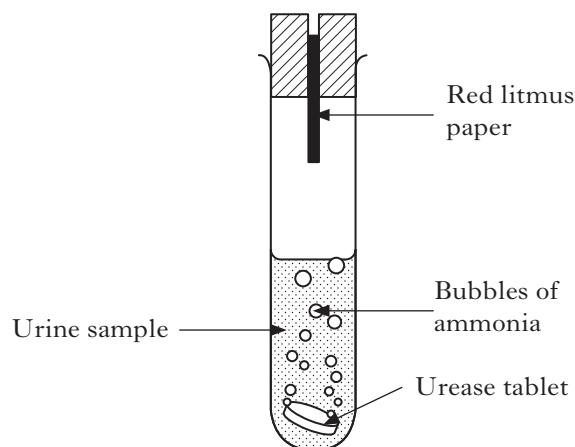
- 22.0%
- 55.0%
- 62.0%
- 64.5%

21. Which line in the table below identifies correctly the effect of increased secretion of anti-diuretic hormone (ADH) on the composition and volume of urine?

	Concentration of urea	Concentration of glucose	Volume of urine
A	no change	no change	increase
B	increase	increase	decrease
C	increase	no change	decrease
D	decrease	no change	increase

22. An experiment was carried out to estimate the concentration of urea present in urine samples.

The method involved adding tablets of the enzyme urease to the urine samples in a boiling tube and timing how long it takes for the litmus paper to turn blue.



Which two factors would have to be kept the same throughout the investigation?

- Size of tablet and concentration of urea
- Concentration of urea and time
- Size of tablet and volume of urine
- Volume of urine and time

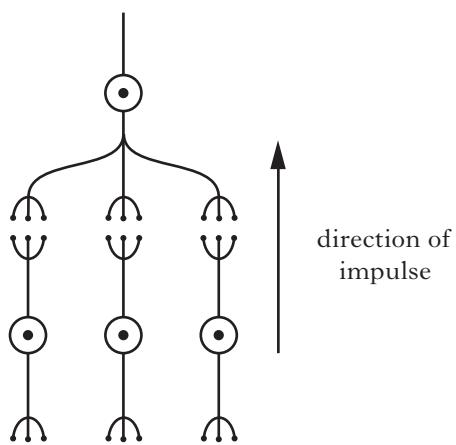
23. Which line in the table below describes correctly the control of body temperature?

	<i>Monitoring centre</i>	<i>Form of communication</i>	<i>Regulating organ</i>
A	skin	hormonal	liver
B	skin	nervous	brain
C	hypothalamus	hormonal	liver
D	hypothalamus	nervous	skin

24. Which parts of the body are controlled by the largest motor area of the cerebrum?

- A Hands and lips
- B Feet and hands
- C Ears and nose
- D Legs and arms

25. The following diagram represents four neurones in a nervous pathway.



Which line in the table below describes the pathway correctly?

<i>Type of pathway</i>		
A	motor	divergent
B	motor	convergent
C	sensory	divergent
D	sensory	convergent

26. Students were asked to recall twelve letters of the alphabet in any order, after hearing the list of letters read out slowly. An analysis of their performance is shown in the graph below.



On how many occasions was a letter recalled by more than 50% of the students?

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

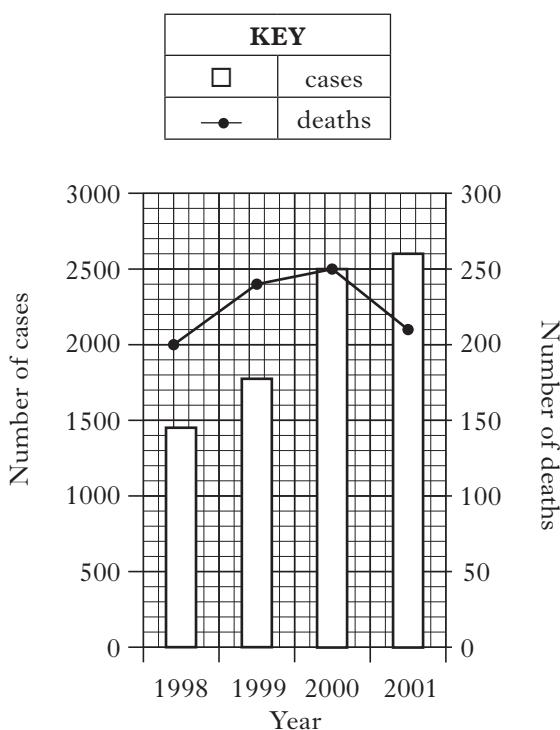
27. The table below shows the average yield in the years 1890 and 1990 for four crops grown in Scotland.

<i>Crop</i>	<i>Average yield</i> (tonnes per hectare)	
	<i>1890</i>	<i>1990</i>
A Barley	2.4	6.6
B Wheat	2.7	8.1
C Turnip	4.5	10.0
D Potato	15.0	37.5

Which crop has shown the greatest percentage increase in average yield?

[Turn over]

28. The graph below shows the number of cases of meningitis and deaths due to meningitis in the UK from 1998 to 2001.

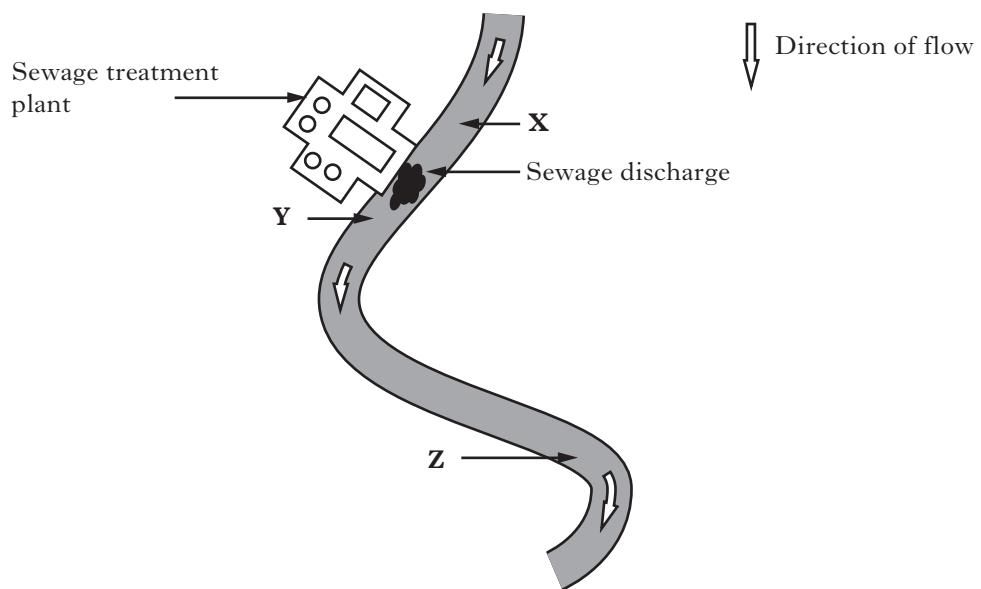


In which year was the number of deaths from meningitis less than 10% of the number of cases?

- A 1998
- B 1999
- C 2000
- D 2001

29. An algal bloom in a loch may result from
- A lack of oxygen
 - B lack of sunlight
 - C excess phosphates
 - D excess herbicide.

30. The map below represents a short length of a Scottish river.



There was an accidental discharge of untreated sewage into the river.

Which line in the table below shows the likely changes in the population of bacteria between points **X** and **Y**, and between points **Y** and **Z**?

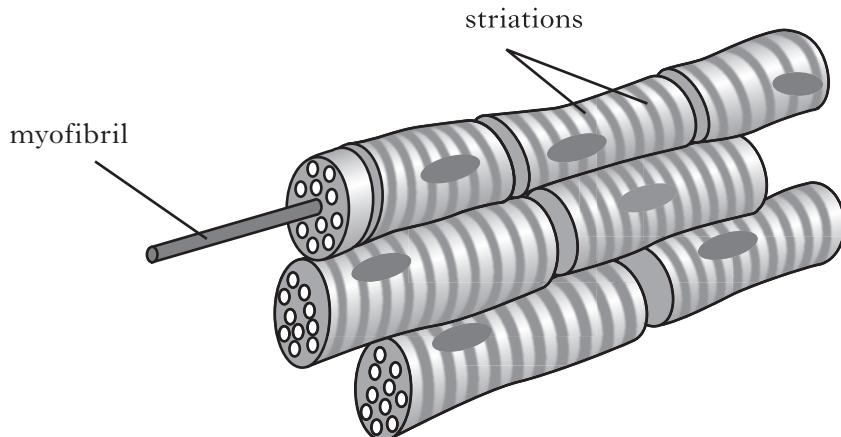
Change in the bacterial population		
	Between points X and Y	Between points Y and Z
A	increase	no change
B	increase	decrease
C	decrease	no change
D	decrease	decrease

**Candidates are reminded that the answer sheet MUST be returned
INSIDE the front cover of this answer booklet.**

[Turn over for Section B on page ten]

SECTION B*Marks***All questions in this section should be attempted.****All answers must be written clearly and legibly in ink.**

1. The diagram below shows some skeletal muscle cells.



- (a) Name the **two** proteins that give rise to the striations in the muscle cells.

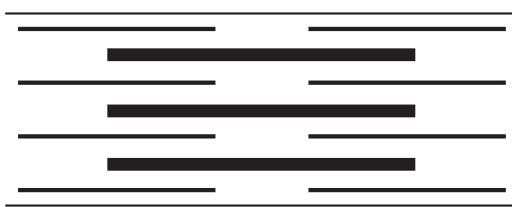
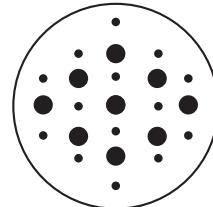
1 _____ 2 _____

1

- (b) The arrangement of the protein filaments in the muscle is shown in the two diagrams below.

Diagram A represents the arrangement of the filaments in the labelled myofibril.

Diagram B represents a cross section through this myofibril.

Diagram A**Diagram B**

- (i) **Draw a line on Diagram A** to show where the cross section was taken.

1

- (ii) Describe what happens to the arrangement of protein filaments when the muscle contracts.

1

1. (continued)	<i>Marks</i>
(c) Respiration produces the ATP required for muscle contraction. Explain why only small amounts of ATP are produced during anaerobic respiration.	_____ _____ _____ _____

2

[Turn over

Marks

2. Yeast is a single-celled fungus which produces enzymes, one of which catalyses the release of hydrogen during respiration.

An investigation was carried out to compare three sugars as respiratory substrates for yeast. Methylene blue dye was used to measure the rate of respiration because it turns clear in the presence of hydrogen.

A colorimeter was used to measure the colour intensity of the dye during the investigation.

The investigation setup is shown in **Figure 1**.

Table 1 shows the range of colorimeter readings recorded.

Figure 1

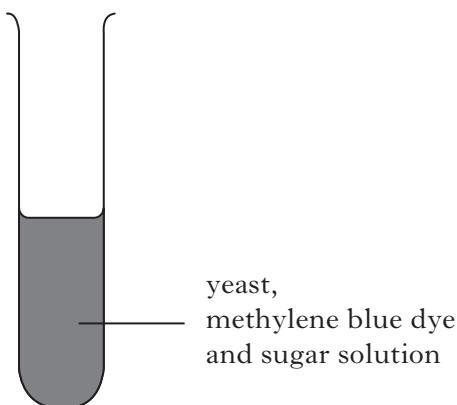


Table 1

<i>Colour intensity of dye</i>	<i>Colorimeter reading (units)</i>
maximum	63
minimum	0

Three test tubes were set up, each containing a different sugar. The colour intensity of the dye was measured at four-minute intervals for twenty minutes.

The results of the investigation are shown in **Table 2** below.

Table 2

<i>Time (min)</i>	<i>Colorimeter reading (units)</i>		
	<i>glucose sugar</i>	<i>maltose sugar</i>	<i>lactose sugar</i>
0	63	63	63
4	46	61	63
8	28	56	63
12	10	35	63
16	0	10	63
20	0	0	63

- (a) When setting up the test tubes as shown in **Figure 1**, state which substance should be added last.

Give a reason for your choice of substance.

Substance _____

Reason _____

2. (continued)

Marks

- (b) List **three** variables which would have to be kept constant during this investigation.

1 _____

2 _____

3 _____

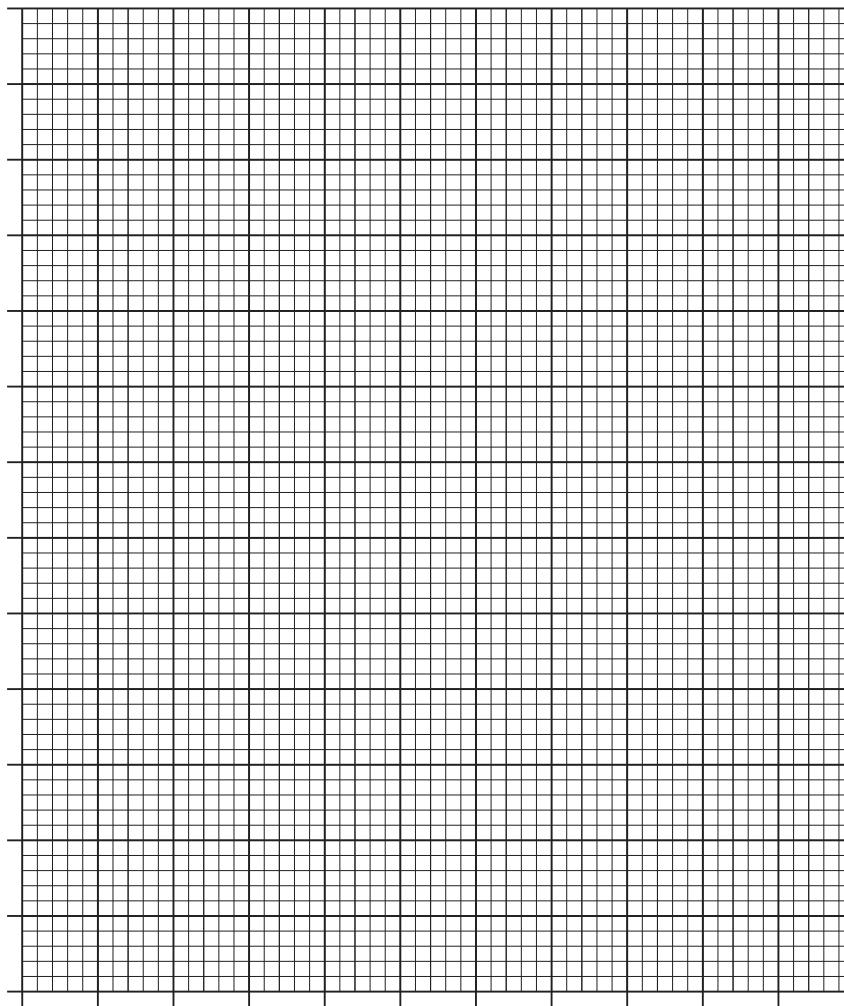
2

- (c) State how the reliability of the results from this investigation could be improved.

1

- (d) (i) Construct a line graph to show all the data in **Table 2**.

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



3

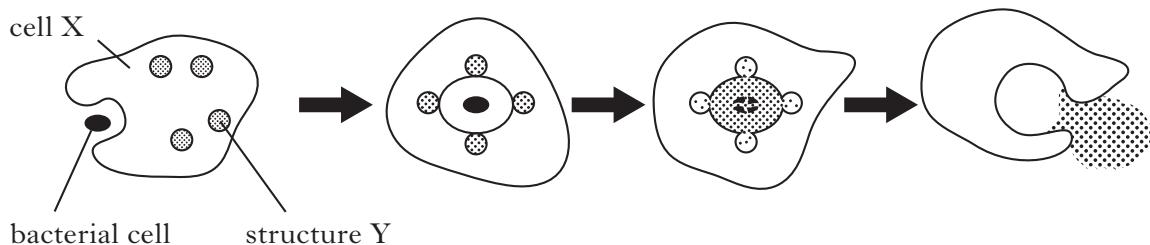
- (ii) State a conclusion that can be drawn from the results of this investigation.

1

Marks	
1	<p>2. (continued)</p> <p>(e) (i) Maltose is a disaccharide sugar which is composed of two glucose molecules joined together.</p> <p>Use this information to explain why the colour intensity of the dye in the test tube containing maltose decreased more slowly than the intensity of the dye in the test tube containing glucose.</p> <hr/> <hr/>
1	<p>(ii) Lactose is also a disaccharide sugar.</p> <p>Suggest why the colour intensity of the dye in the test tube containing lactose remained the same throughout the investigation.</p> <hr/> <hr/>

Marks

3. The diagram below illustrates the stages involved in the destruction of a bacterial cell by phagocytosis.



Stage: **A** **B** **C** **D**

- (a) (i) Name the type of phagocytic cell labelled X.

1

- (ii) Name structure Y and describe its function during stages B and C.

Structure Y _____

Function _____

2

- (iii) What term describes the secretory process shown in stage D?

1

- (b) Bacteria entering the body may also trigger the humoral response.

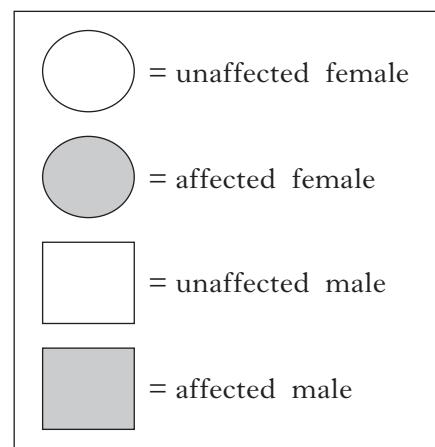
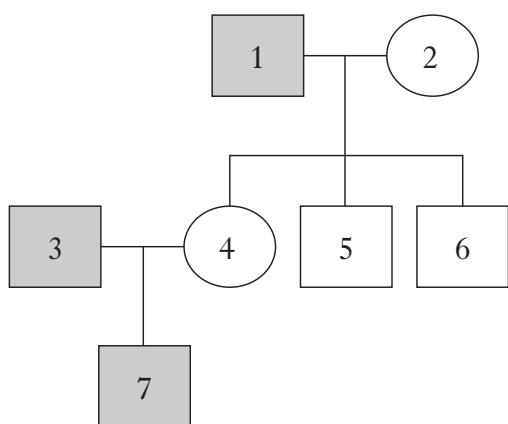
Describe what happens during the humoral response.

2

[Turn over

Marks

4. The diagram below shows the inheritance of a sex-linked condition in a family.



- (a) The condition is caused by a recessive sex-linked allele represented by the letter d.

- (i) State the genotypes of individuals 3 and 4.

Individual 3 _____

Individual 4 _____

1

- (ii) Explain why individual 1 could not pass the condition to his sons.

1

- (iii) Individual 6 has a son with a woman who is a carrier of the condition.

Calculate the percentage chance of their son having this condition.

Space for calculation

_____ % 1

4. (continued)

- (b) The condition is caused by a mutation in which an extra nucleotide is inserted into the gene that codes for an enzyme.

Explain the likely effect of this mutation on the structure of the enzyme.

2

- (c) The condition occurs with a frequency of 1 in 350 males.

Assuming an equal proportion of males and females, calculate how many males are likely to have the condition in a town with a population of 175 000.

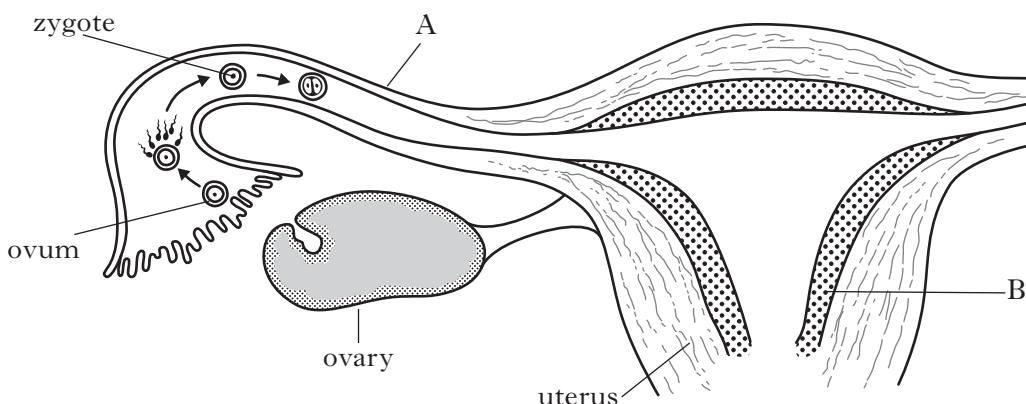
Space for calculation

1

[Turn over

Marks

5. The diagram below shows the fertilisation of an ovum and its subsequent early development.



- (a) Name structures A and B.

A _____

B _____

2

- (b) The ovum is released from the Graafian follicle which then becomes the corpus luteum. These structures are affected by pituitary hormones.

Complete the table below to describe the effect of these hormones on the structures.

Structure	Pituitary hormone	Effect on structure
Graafian follicle	FSH	
Corpus luteum	LH	

2

- (c) During its journey down structure A, the zygote undergoes repeated cell divisions.

What name is given to this series of early cell divisions?

1

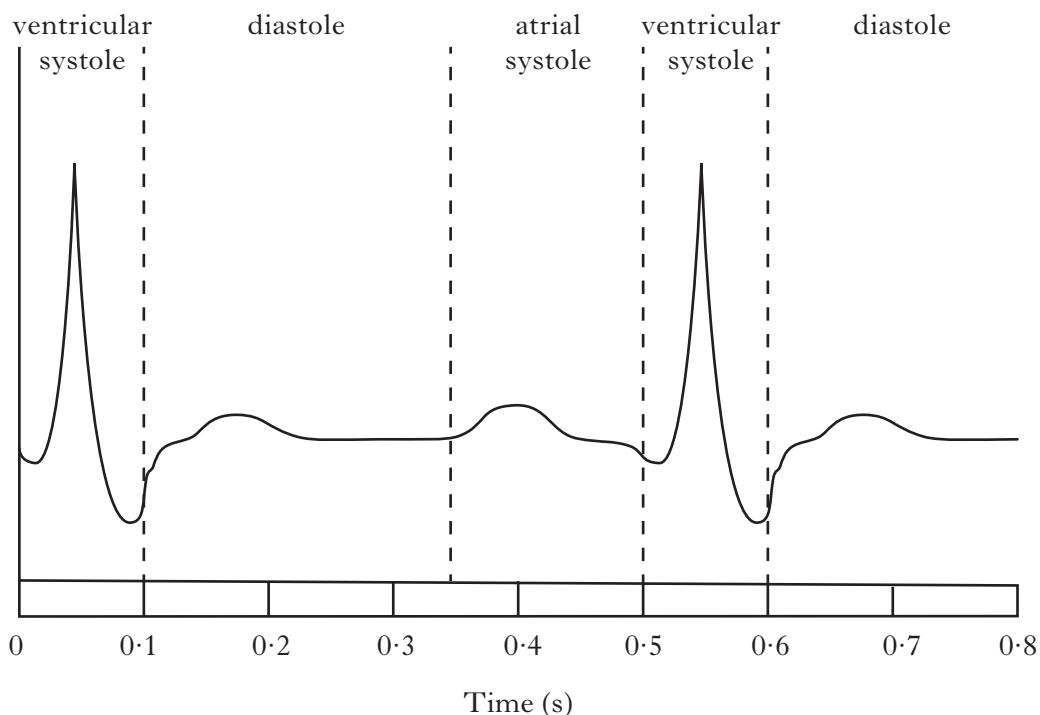
- (d) The further development of the zygote shown resulted in the birth of monozygotic twins.

Describe how this occurred.

1

Marks

6. The diagram below shows an electrocardiogram (ECG) trace of an individual's heartbeat.



- (a) Calculate the heart rate of this individual.

Space for calculation

_____ bpm 1

- (b) Complete the following sentence by underlining one option from each pair of options shown in **bold**.

During the diastole stage of the cardiac cycle, the atrial muscles are **contracted** / **relaxed** and the ventricular muscles are **contracted** / **relaxed**. 1

- (c) Name the valves which will be open and closed in the left side of the heart during ventricular systole.

Open _____ Closed _____ 1

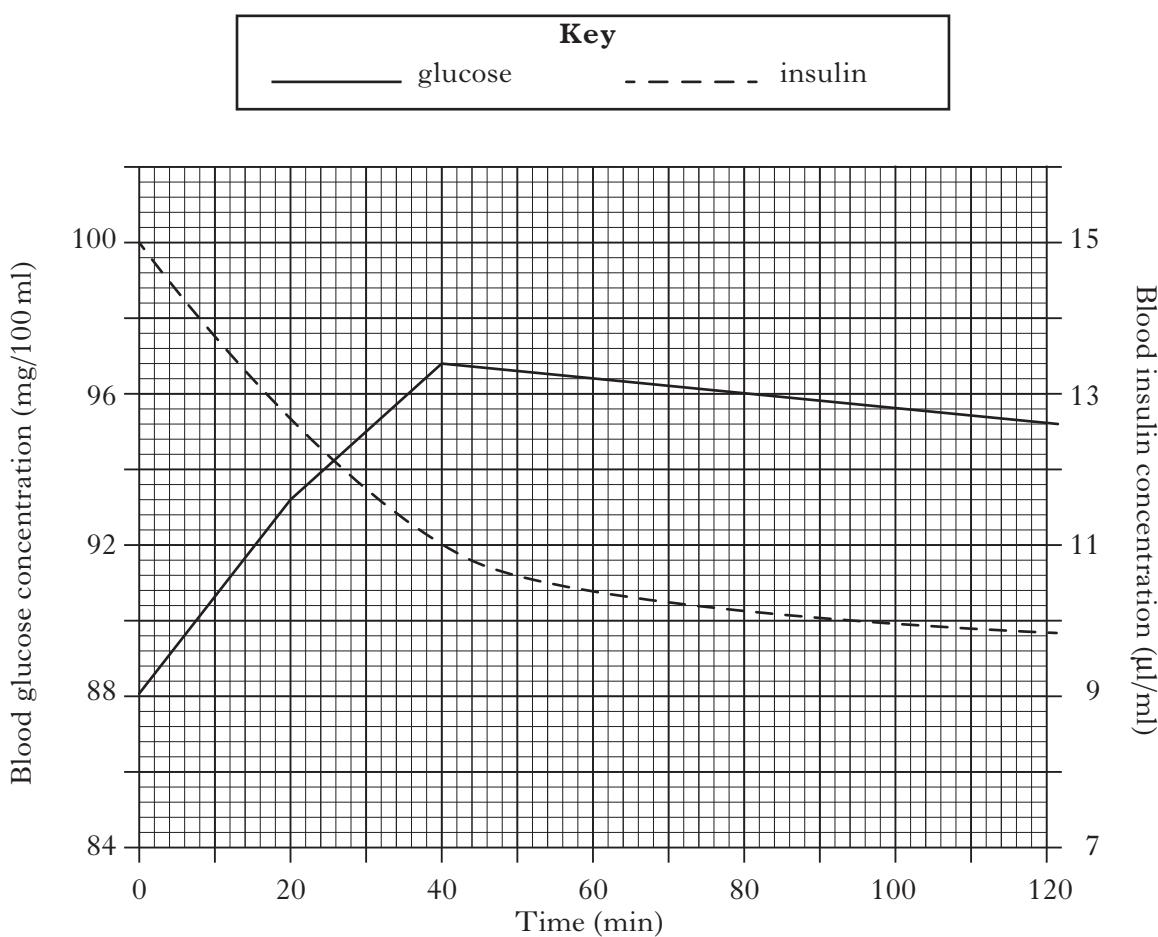
- (d) Predict how this individual's ECG trace would change under the influence of the parasympathetic nervous system.

1

[Turn over]

Marks

7. The graph below shows the changes in the concentration of glucose and insulin in a cyclist's blood while he cycled at a constant rate for two hours.



- (a) (i) State the cyclist's blood insulin concentration after he had been cycling for 10 minutes.

1

- (ii) State the cyclist's blood glucose concentration when his blood insulin concentration was 11 $\mu\text{l}/\text{ml}$.

1

- (b) During exercise, adrenaline is released which inhibits the production of insulin.

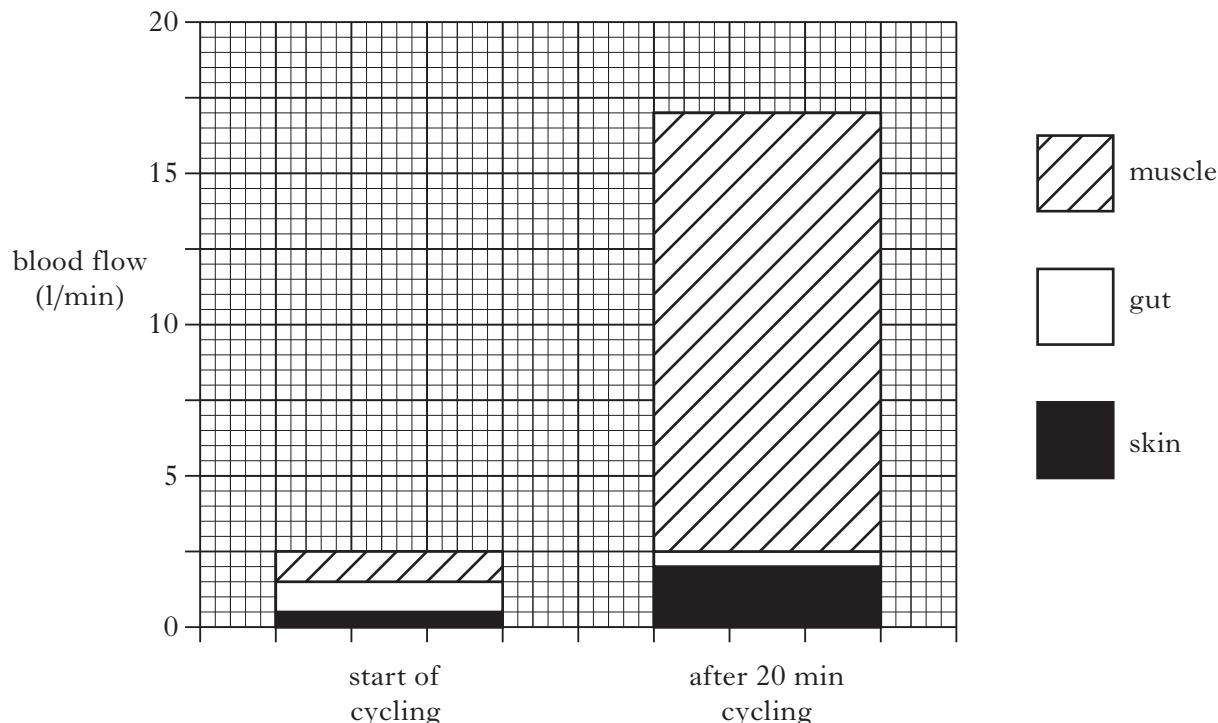
Explain why this is important to the cyclist.

2

7. (continued)

Marks

- (c) The graph below shows the changes that occurred in the distribution of blood to some parts of the cyclist's body after he had been cycling for 20 minutes.



- (i) Calculate the percentage increase that occurred in blood flow to his skin after he had been cycling for 20 minutes.

Space for calculation

_____ % 1

- (ii) Calculate the whole number ratio of muscle to gut blood flow after 20 minutes of cycling.

Space for calculation

_____ : _____ 1

- (iii) Describe how changes in the volume and distribution of blood to the muscles occur during cycling.

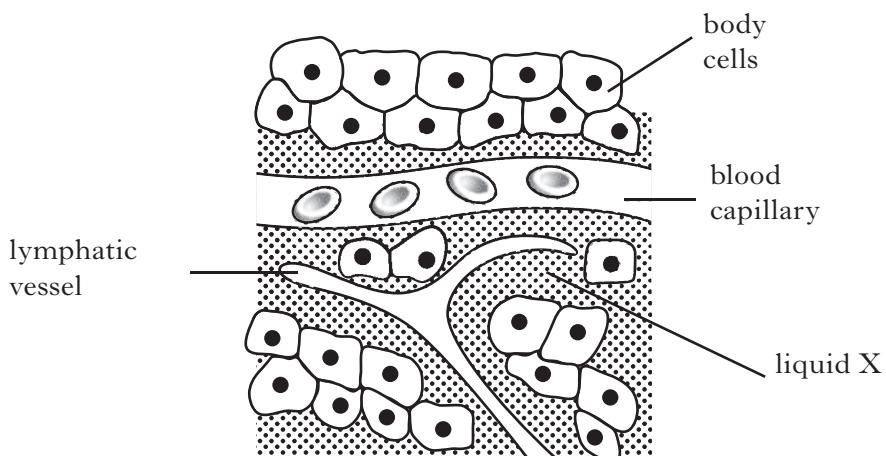
Volume _____

Distribution _____

2

Marks

8. The diagram below shows the relationship between a blood capillary, body cells and a lymphatic vessel.



- (a) (i) Name liquid X.

1

- (ii) State **one** way in which the composition of this liquid is different from blood plasma.

1

- (b) Complete the table below by naming **one** substance, apart from carbon dioxide and water, which is passed from the cells in each of the following tissues into blood capillaries.

Tissue	Substance
Interstitial cells	
Pancreas	
Leg muscle (after a sprint)	

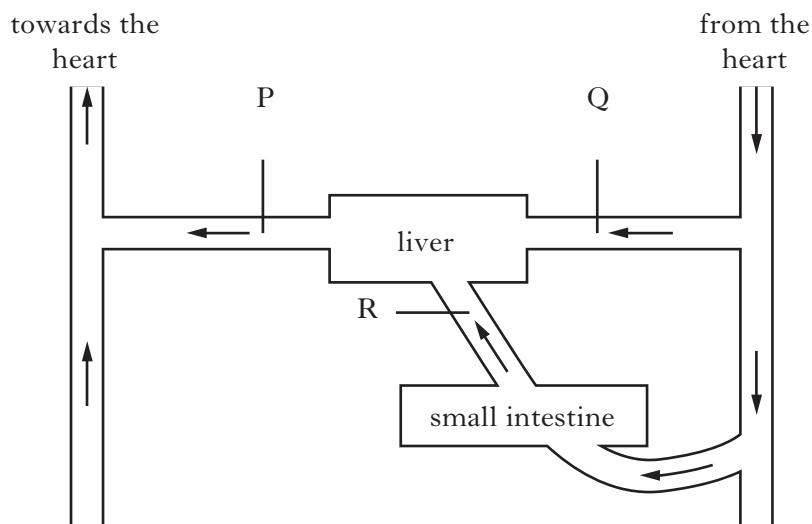
2

- (c) Explain how lymph is transported in lymphatic vessels.

2

9. The diagram below shows blood vessels associated with the liver.

The arrows show the direction of blood flow in these vessels.



- (a) (i) Identify the blood vessels labelled Q and R.

Q _____

R _____

2

- (ii) During the digestion of a meal, which of the three blood vessels would have the highest concentration of:

1 Glucose _____

2 Urea _____

1

- (b) The liver breaks down red blood cells.

Describe what happens to the products of haemoglobin breakdown.

2

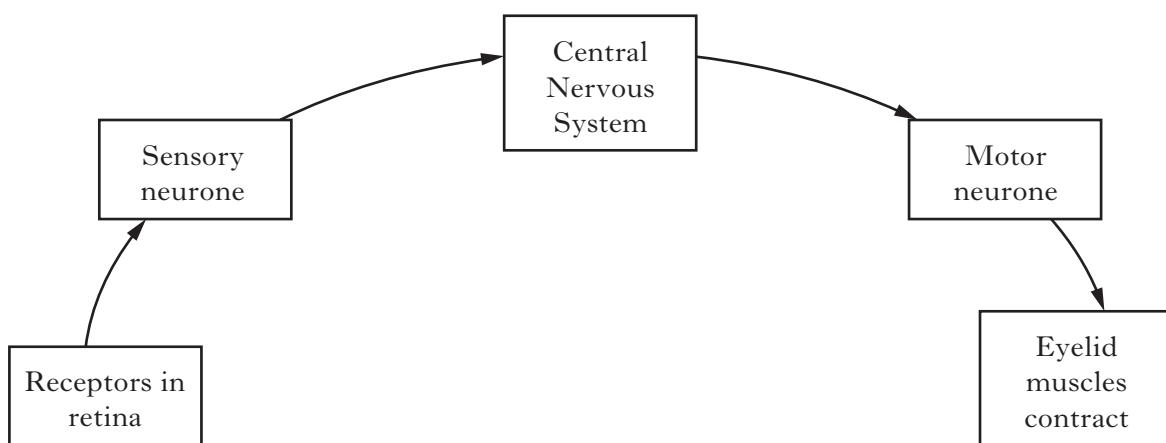
- (c) State the term which describes the action of the liver in the breakdown of alcohol.

1

[Turn over

Marks

10. The flow diagram below links the structures involved in the blinking reflex response.



- (a) The neural system can show plasticity of response.

Explain this statement with regard to the blinking reflex.

1

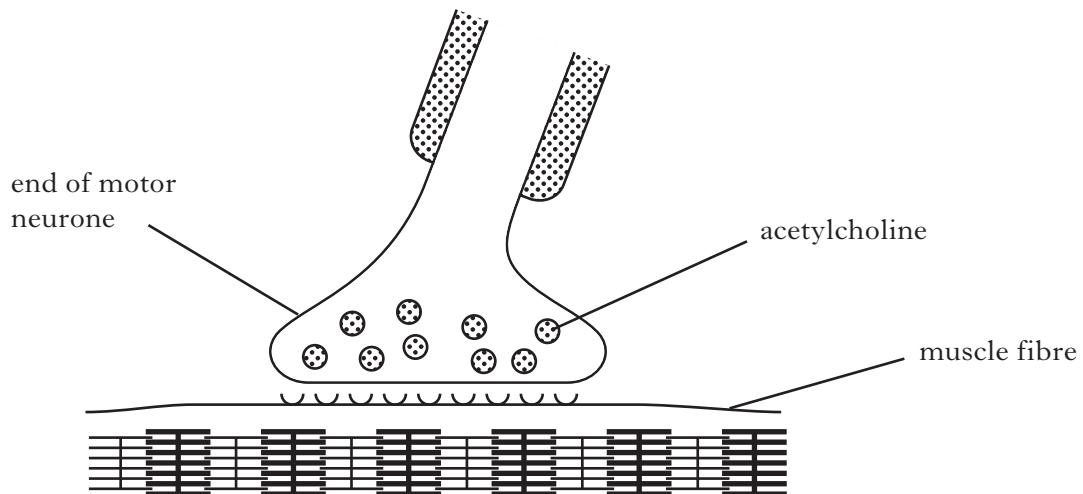
- (b) Describe how the structure of sensory and motor neurones ensures that transmission of impulses is rapid.

1

Marks

10. (continued)

- (c) The diagram below shows the junction between a motor neurone and a muscle fibre.



- (i) Describe how impulses pass between the motor neurone and the muscle fibre.

2

- (ii) State what happens to acetylcholine after it has carried out its function.

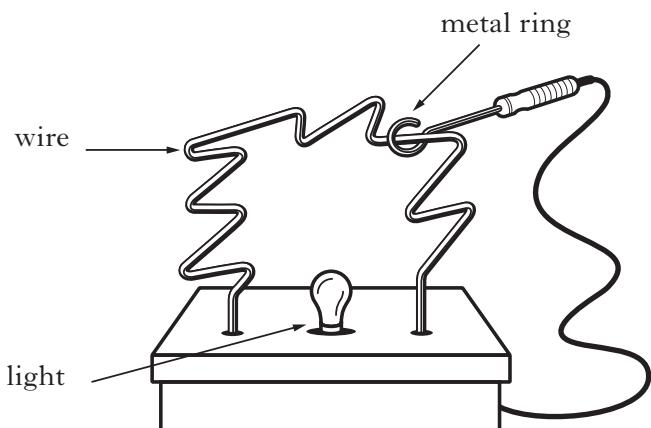
1

[Turn over

Marks

11. A student carried out an investigation to determine the effect an audience has on the performance of a task.

In the investigation, each individual had to move a metal ring along a curved wire, without touching the wire. Whenever the wire was touched a light would come on. The diagram below shows the apparatus used.



The student started by asking each individual to carry out the task without an audience.

She then asked them to repeat the task with an audience present.

The results of the investigation are shown in the table below.

Individual	Performance (Number of times the ring touched the wire when carrying out the task)	
	Without an audience	With an audience
1	3	3
2	5	2
3	6	3
4	5	0
5	2	3
6	1	1
7	5	3
8	3	1
9	5	0
10	3	2

- (a) Calculate the average improvement in performance caused by the presence of an audience.

Space for calculation

11. (continued)

<i>Marks</i>	
1	
1	
1	

- (b) State the term which describes the improvement in performance caused by the presence of an audience.

1

- (c) It is possible that the improvement in performance in this investigation resulted from practice and not the presence of the audience.

Without changing the apparatus, suggest how the design of the investigation could be improved to remove this possibility.

1

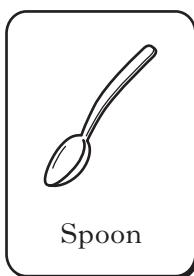
- (d) Describe how this investigation could be redesigned to investigate the effects of practice on performance.

1

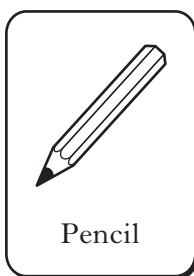
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Marks

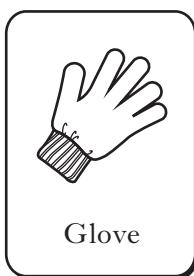
12. Three groups of children were shown cards of the following objects.



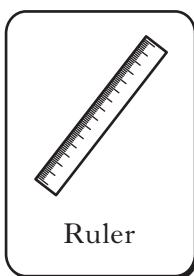
Spoon



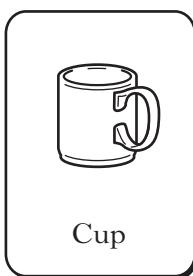
Pencil



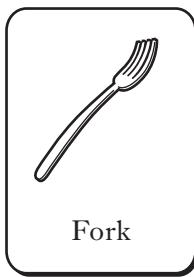
Glove



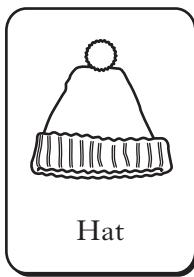
Ruler



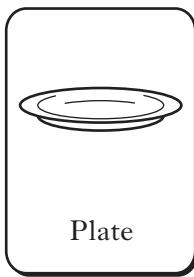
Cup



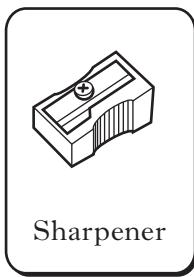
Fork



Hat



Plate



Sharpener



Shirt

- (a) Each group of children was given a different method to use in order to memorise the objects. The methods used by each group are shown below.

Group 1 — making up a story to include the objects

Group 2 — sorting the objects into related categories

Group 3 — saying the names of the objects to themselves several times

- (i) State the term that describes the method used by each group to transfer the objects into long-term memory.

Group 1 _____

Group 2 _____

Group 3 _____

2

- (ii) Several days later, the children were asked to recall the list of objects. Suggest an appropriate contextual cue that the children could use.

Explain how this cue would aid their recall.

Contextual cue _____

Explanation _____

1

- (b) Most people with Alzheimer's disease would not be able to recall all the objects.

State the area of their brain which is not able to form memories during this task.

1

Marks

13. Disease is a major regulatory factor of populations.

- (a) Human living conditions can influence the spread of disease.

In the table below, list **two** examples of poor living conditions and explain why they could increase the spread of disease.

<i>Example of poor living conditions</i>	<i>Why it increases the spread of disease</i>

2

- (b) Concerns about the MMR vaccine caused the percentage of children in the UK immunised against measles, mumps and rubella to fall below the critical level of 80% between 2000 and 2005. As a result, outbreaks of these viral diseases occurred in various parts of the country.

- (i) State what is present in an injection of vaccine.

1

- (ii) Explain how the process of vaccination prevents a child from showing symptoms of mumps during future outbreaks of the disease.

1

- (iii) Suggest why these diseases spread more rapidly when the vaccination level falls below 80%.

1

- (c) Another disease that affects humans is tetanus.

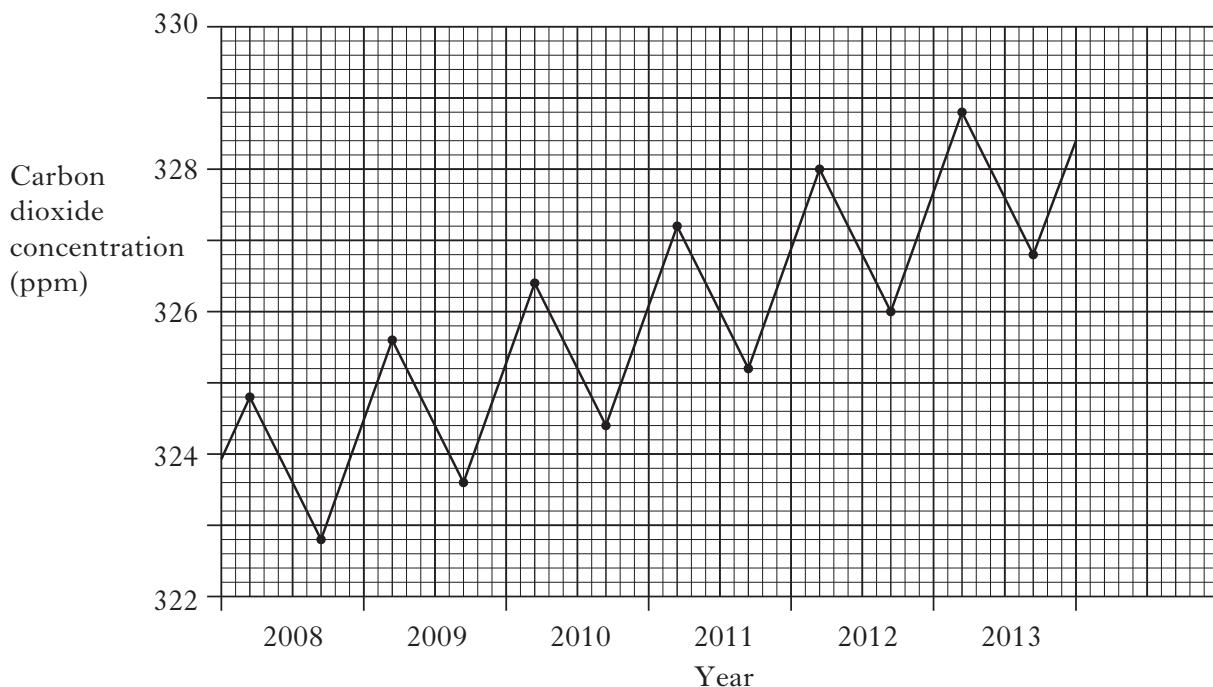
Protection against tetanus can be provided actively or passively.

Explain how an individual can be given passive immunity against tetanus.

1

Marks

14. The graph below shows the changes in atmospheric carbon dioxide measured in a European forest between 2008 and 2013.



- (a) (i) State the minimum carbon dioxide concentration recorded in 2010.

_____ ppm

1

- (ii) Predict the maximum carbon dioxide concentration that would be recorded in 2014.

_____ ppm

1

- (b) Suggest why there is a general upward trend in global atmospheric carbon dioxide concentration.

1

- (c) Carbon dioxide is a greenhouse gas.

Name another greenhouse gas and give a reason why its concentration is increasing in the atmosphere.

Gas _____

Reason _____

1

SECTION C

Both questions in this section should be attempted.

Note that each question contains a choice.

Questions 1 and 2 should be attempted on the blank pages which follow.

Supplementary sheets, if required, may be obtained from the Invigilator.

Labelled diagrams may be used where appropriate.

Marks

1. Answer **either A or B.**

A Describe protein synthesis under the following headings:

- | | |
|---------------------------------------|-------------|
| (i) events that occur in the nucleus; | 4 |
| (ii) events that occur at a ribosome. | 6 |
| | (10) |

OR

B Describe aerobic respiration under the following headings:

- | | |
|---|-------------|
| (i) events that occur in the matrix of a mitochondrion; | 5 |
| (ii) events that occur on the cristae of a mitochondrion. | 5 |
| | (10) |

In question 2, ONE mark is available for coherence and ONE mark is available for relevance.

2. Answer **either A or B.**

A Discuss the factors that influence the development of human behaviour. **(10)**

OR

B Discuss ways in which global food supply has been increased to provide for a growing human population. **(10)**

[END OF QUESTION PAPER]

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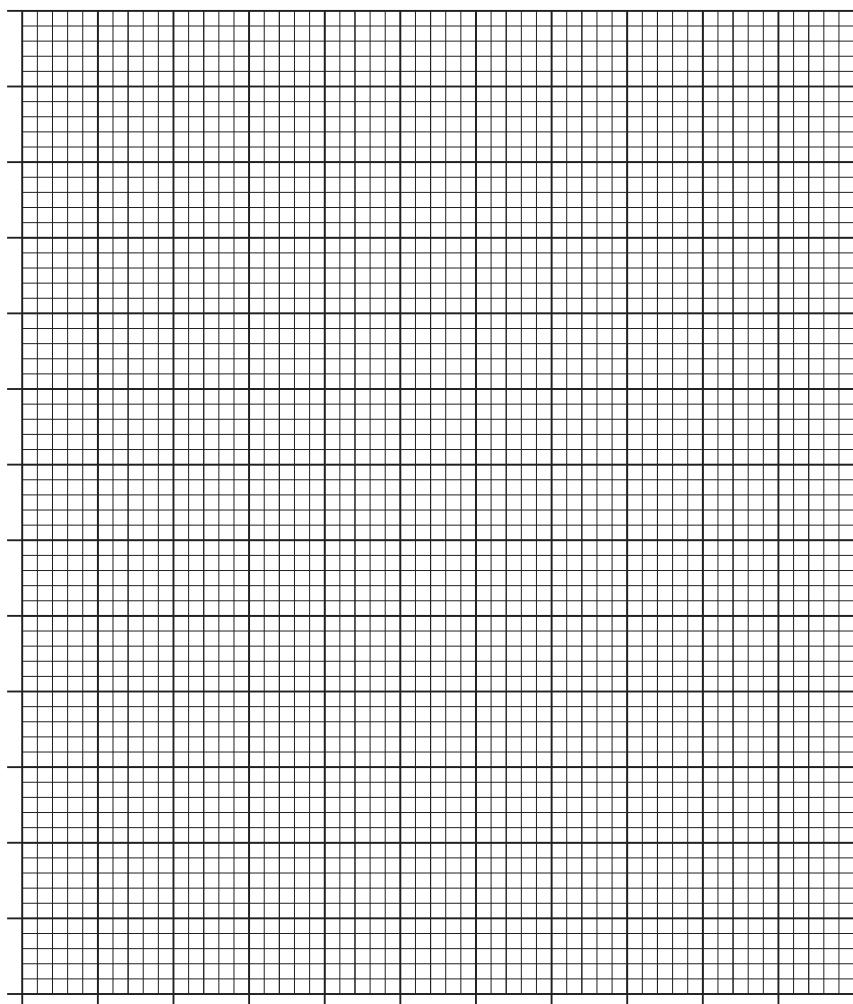
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ADDITIONAL GRAPH FOR QUESTION 2(d)(i)



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