

FOR OFFICIAL USE

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Total for
Sections B & C

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X009/12/02

NATIONAL
QUALIFICATIONS
2013

WEDNESDAY, 15 MAY
1.00 PM – 3.30 PM

HUMAN BIOLOGY
HIGHER

Fill in these boxes and read what is printed below.

Full name of centre

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Town

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Forename(s)

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Surname

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Date of birth

Day Month Year

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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)

- (a) All questions should be attempted.
(b) It should be noted that in **Section C** questions 1 and 2 each contain a choice.
- 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.**
- 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.
- The numbers of questions must be clearly inserted with any answers written in the additional space.
- 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.
- 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. Actin is a type of protein involved in

- A contraction of muscles
- B production of lactic acid
- C protection against infection
- D production of cell membranes.

2. Which line in the table below describes correctly the bonds that create the shape of a protein at a particular stage of its formation?

	<i>Stage of formation</i>	<i>Shape of protein</i>	<i>Bonds</i>
A	primary structure	chain	hydrogen
B	secondary structure	helix	hydrogen
C	primary structure	helix	peptide
D	secondary structure	chain	peptide

3. If ten percent of the bases in a molecule of DNA are adenine, what is the ratio of adenine to guanine in the same molecule?

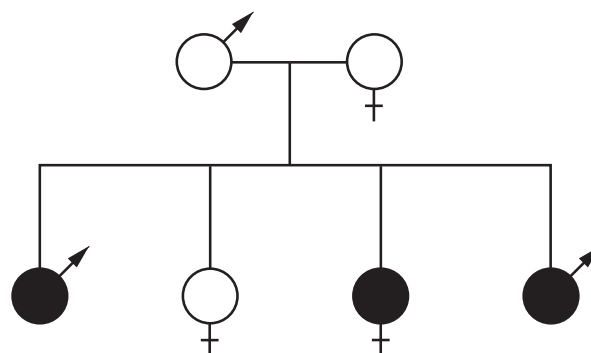
- A 1:1
- B 1:2
- C 1:3
- D 1:4

4. The table below contains statements which may be **True** or **False** with regard to DNA replication and mRNA synthesis.

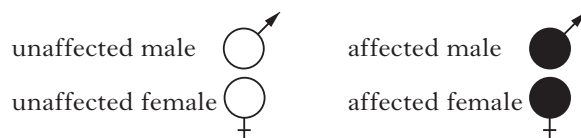
Which line in the table is correct?

	<i>Statement</i>	<i>DNA Replication</i>	<i>mRNA synthesis</i>
A	Occurs in the nucleus	True	False
B	Involved in protein synthesis	True	True
C	Requires free nucleotides	True	False
D	Involves specific base pairing	True	True

5. The diagram below shows the transmission of the gene for albinism.



KEY



This condition is inherited as a characteristic which is

- A dominant and not sex-linked
- B recessive and not sex-linked
- C dominant and sex-linked
- D recessive and sex-linked.

6. Two alleles of a gene code for different proteins. Both proteins are present in the heterozygote. This is an example of

- A co-dominance
- B sex-linkage
- C polygenic inheritance
- D complete dominance.

[Turn over

7. Which of the following are all examples of polygenic characteristics?

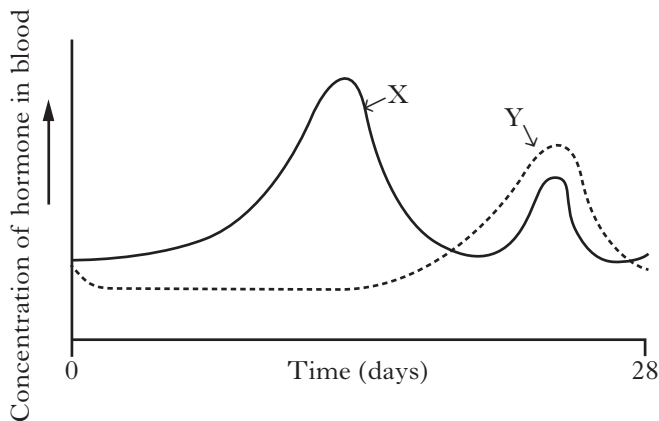
- A Hand span, height and skin colour
- B Blood group, height and foot size
- C Hand span, tongue rolling and weight
- D Blood group, foot size and skin colour

8. A substitution mutation results in a triplet of bases TTC being changed to TCC. The amino acid lysine is coded for by TTC and arginine by TCC.

The effect of such a mutation on the resultant protein would be that

- A arginine replaces lysine throughout the protein
- B arginine replaces lysine at one position in the protein
- C lysine replaces arginine throughout the protein
- D lysine replaces arginine at one position in the protein.

9. The graph below shows changes in the concentration of hormones X and Y in the blood during the menstrual cycle.



Which of the following correctly identifies hormones X and Y?

	<i>Hormone X</i>	<i>Hormone Y</i>
A	LH	Oestrogen
B	Oestrogen	FSH
C	Oestrogen	Progesterone
D	Progesterone	Oestrogen

10. Changes in the ovary during the menstrual cycle are described below.

- 1 Corpus luteum forms
- 2 Ovulation occurs
- 3 Progesterone is produced
- 4 Corpus luteum degenerates
- 5 Graafian follicle develops

The sequence in which these changes occur following menstruation is

- A 2, 3, 1, 5, 4
- B 2, 1, 3, 4, 5
- C 5, 3, 2, 1, 4
- D 5, 2, 1, 3, 4.

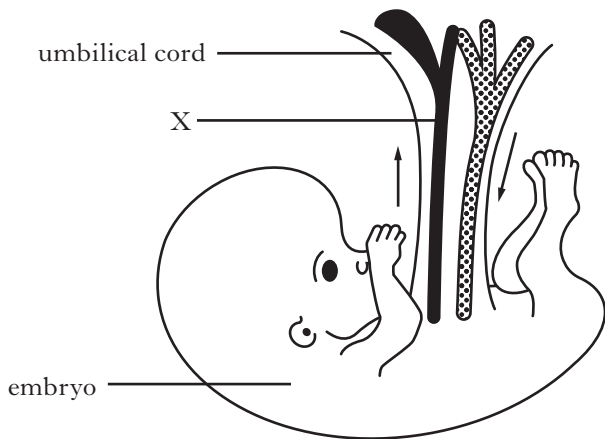
11. Which of the following changes indicate ovulation is likely to have taken place?

	<i>Cervical mucus</i>	<i>Body temperature</i>
A	becomes sticky	rises
B	becomes sticky	falls
C	becomes watery	rises
D	becomes watery	falls

12. Which of the following babies would be most likely to require a blood transfusion immediately after birth?

- A The first baby of a Rhesus negative mother and Rhesus positive father
- B The first baby of a Rhesus positive mother and Rhesus negative father
- C The second baby of a Rhesus negative mother and Rhesus positive father
- D The second baby of a Rhesus positive mother and Rhesus negative father

13. The diagram below shows the blood flow in the umbilical cord.



Which line in the table below identifies correctly blood vessel X and the blood it carries?

	<i>Blood vessel X</i>	<i>Blood carried in X</i>
A	vein	deoxygenated
B	vein	oxygenated
C	artery	deoxygenated
D	artery	oxygenated

14. Nicotine is a chemical which may affect pre-natal 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

		<i>Stage of development</i> (weeks after fertilisation)														
<i>Ball of cells</i>		<i>Embryo</i> (organ formation)						<i>Fetus</i> (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

15. Which of the following statements concerning the function of certain blood vessels is correct?

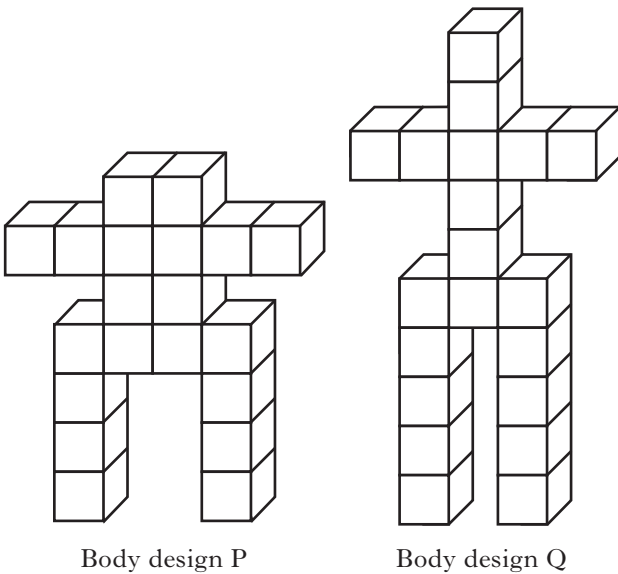
- A The vena cava carries oxygenated blood from the body to the right atrium.
- B The pulmonary artery carries deoxygenated blood to the lungs from the right ventricle.
- C The pulmonary vein carries oxygenated blood from the lungs to the left ventricle.
- D The aorta carries deoxygenated blood from the body to the left atrium.

[Turn over

16. Which line in the table below describes correctly the state of the heart valves during ventricular systole?

	<i>Atrio-ventricular</i>	<i>Semi-lunar</i>
A	open	open
B	closed	closed
C	open	closed
D	closed	open

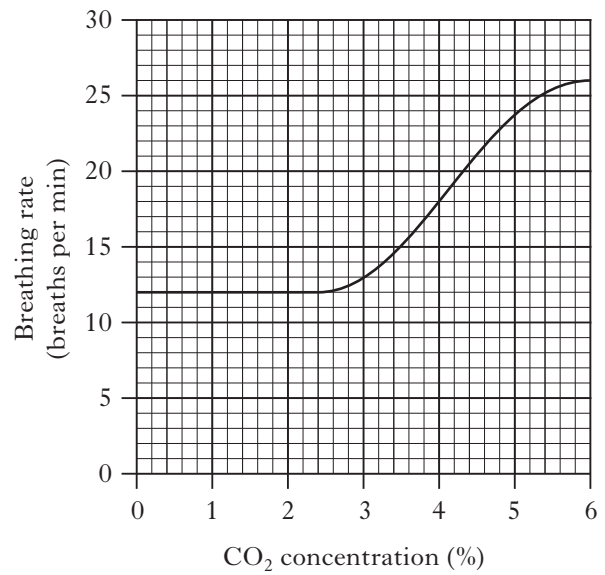
17. The diagrams below represent two different body designs.



Which of the following statements relating to these representations is correct?

- A Body P has the same volume as body Q.
- B Body P has a larger volume than body Q.
- C Body P has a larger surface area than body Q.
- D Body P has a larger surface area to volume ratio than body Q.

18. The graph below shows the effect of the carbon dioxide concentration of inhaled air on the breathing rate of an individual.



If the volume of one breath is 0.5 litre, what volume of air will be breathed in one minute when the CO₂ concentration is 4%?

- A 6 litres
- B 9 litres
- C 18 litres
- D 36 litres

19. The table below shows the changes in brain volume that have occurred during human evolution.

<i>Time</i> (million years ago)	<i>Brain volume</i> (cm ³)
3	500
2	600
1	800
0	1400

By how much has brain volume increased during the last three million years?

- A 36%
- B 64%
- C 180%
- D 280%

20. Which sequence shows the correct order of the early stages of human infant motor development?

- A Lifts head → rolls over → sits unsupported
- B Sits unsupported → lifts head → rolls over
- C Lifts head → sits unsupported → rolls over
- D Rolls over → sits unsupported → lifts head

21. Vision in dim light is improved by the rods connecting to

- A diverging neural pathways
- B converging neural pathways
- C reflex neural pathways
- D peripheral neural pathways.

22. The serial position effect shows that words in the middle of a list are usually poorly recalled because many of these words

- A have been displaced from short-term memory
- B have not been encoded into short-term memory
- C have been transferred into long-term memory
- D have been stored in long-term memory.

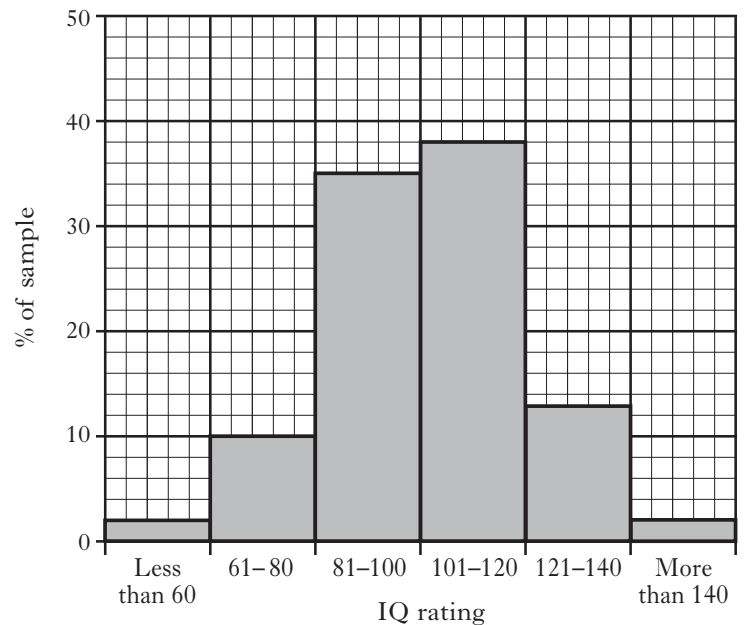
23. The following factors influence development of phenotype.

- 1 Environmental factors
- 2 Genetic factors
- 3 Maturation factors

In the study of monozygotic twins, which of these factors can be discounted?

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

24. The following histogram shows the percentage distribution of IQ rating in a sample of 1000 Scottish children.



How many children have an IQ of over 100?

- A 38
- B 53
- C 380
- D 530

25. Four groups of students were asked to make paper aeroplanes.

Each student had to make five aeroplanes.

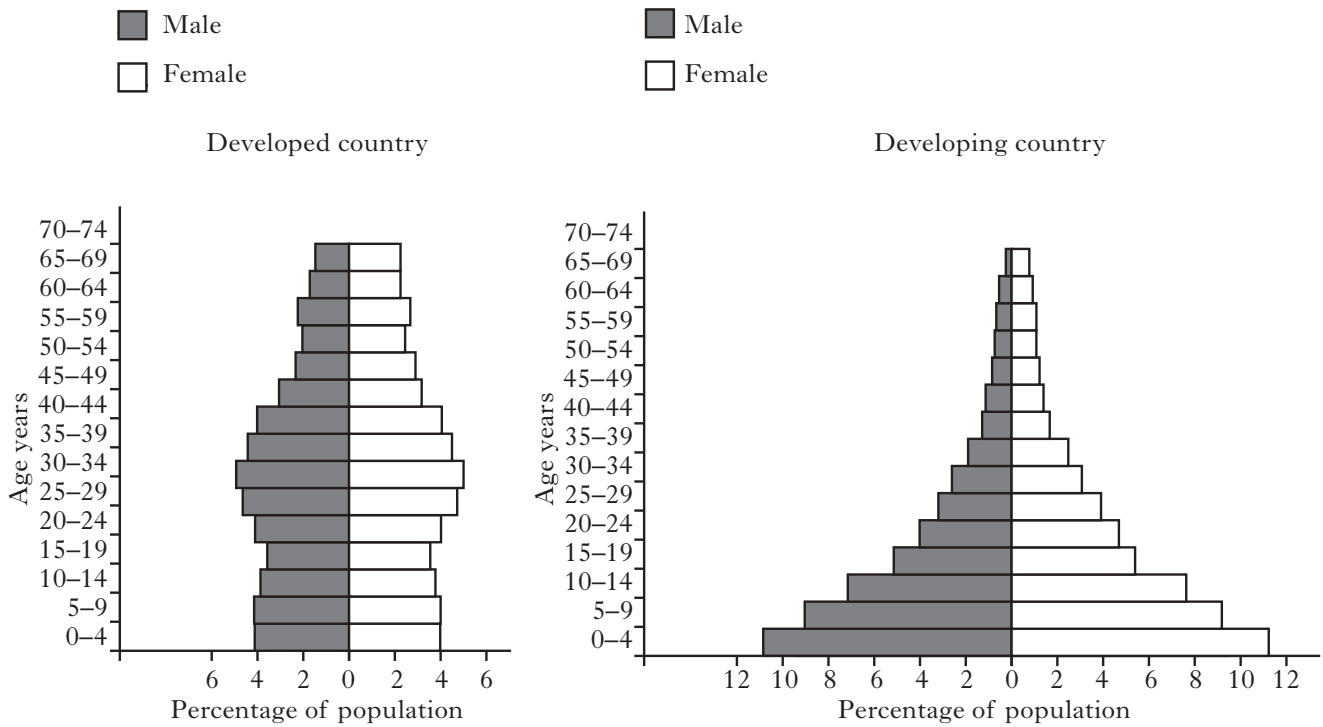
The table below shows the conditions under which each group worked.

	<i>Demonstration on how to fold the paper</i>	<i>Written set of instructions supplied</i>	<i>Prize for the first student finished</i>
Group 1	no	yes	no
Group 2	yes	no	no
Group 3	yes	no	yes
Group 4	yes	yes	yes

Which two groups are likely to be affected by social facilitation?

- A Groups 1 and 4
- B Groups 2 and 3
- C Groups 2 and 4
- D Groups 3 and 4

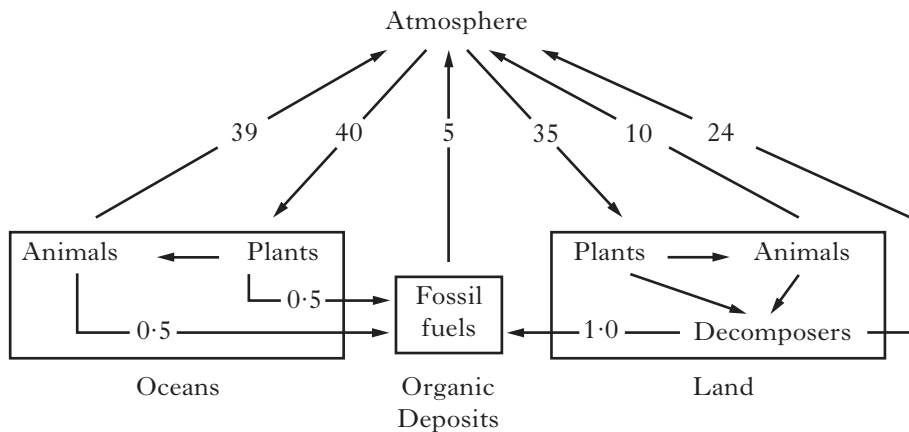
26. The figures below show the population structure of a developed and a developing country.



The percentage of the population under ten years of age in the developing country exceeds that of the developed country by

- A 12%
- B 14%
- C 24%
- D 32%.

27. The diagram below shows the relative movement of carbon within the carbon cycle. (Units are $kg \times 10^{12}$ carbon per year)



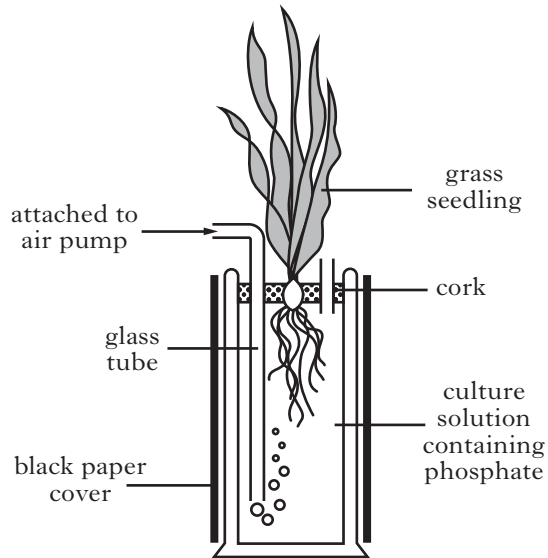
Which component of the carbon cycle shows a net loss of carbon?

- A Atmosphere
- B Oceans
- C Land
- D Organic deposits

28. The apparatus shown below was used to investigate the effect of concentration of phosphate on the growth of grass seedlings.

Grass seedlings were grown in seven different culture solutions.

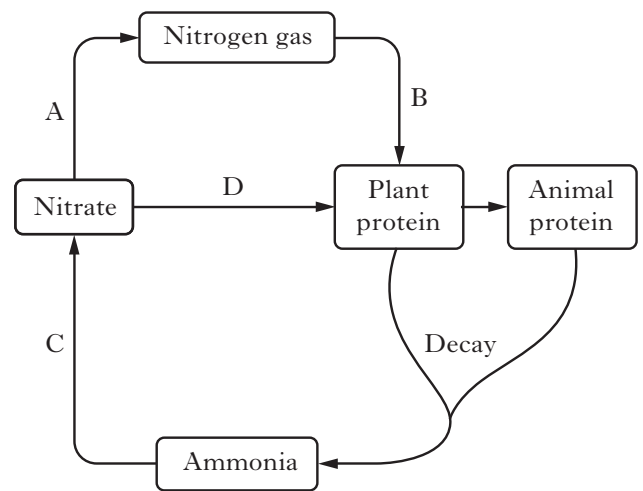
The height of the grass seedlings was measured after 6 weeks.



Two variables that must be the same throughout this investigation are

- A volume of culture solution and concentration of phosphate in the culture solution
- B concentration of phosphate in the culture solution and light intensity
- C light intensity and temperature
- D temperature and the height of the grass seedlings.

29. The diagram below shows a simplified outline of the nitrogen cycle.



Which stage does **not** involve micro-organisms?

30. Apple crop yields have been increased by plant breeders selecting for
- A disease resistance
 - B flavour
 - C resistance to bruising
 - D sugar content.

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

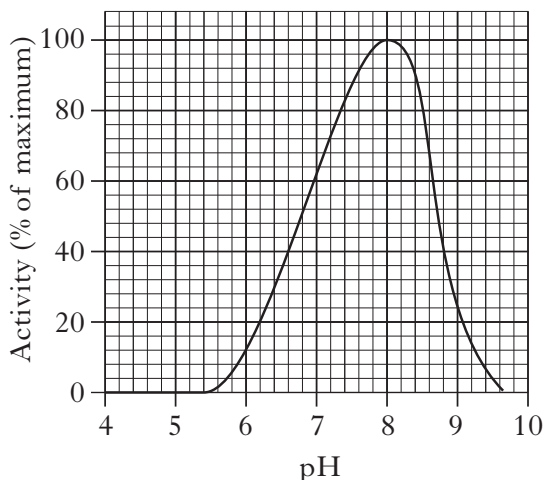
All questions in this section should be attempted.

All answers must be written clearly and legibly in ink.

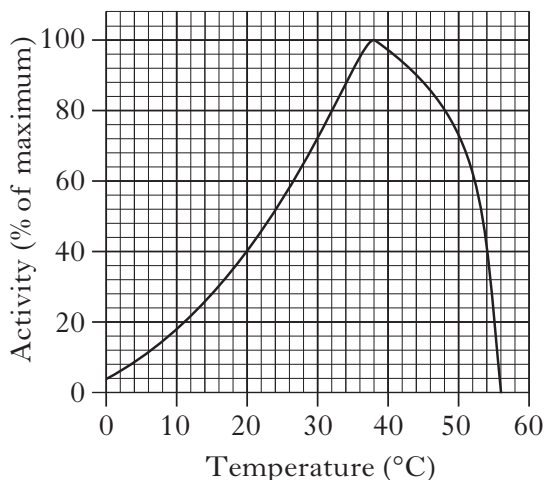
1. Trypsin is an enzyme which catalyses the breakdown of proteins in the small intestine.

The graphs below show how pH and temperature affect the activity of trypsin.

Graph 1—effect of pH on trypsin activity



Graph 2—effect of temperature on trypsin activity



- (a) (i) State the optimum conditions for trypsin activity.

pH _____ temperature _____ °C

1

- (ii) State the range of conditions over which trypsin shows at least 40% of its maximum activity.

1

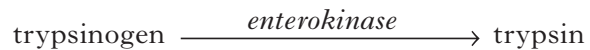
- (iii) Explain the rapid decrease in activity shown in Graph 2.

2

Marks

1. (continued)

- (b) The pancreas produces and releases trypsinogen which does not breakdown proteins. In the lumen of the small intestine, trypsinogen is converted to trypsin by the enzyme enterokinase.



- (i) What term describes the effect of enterokinase in this reaction?

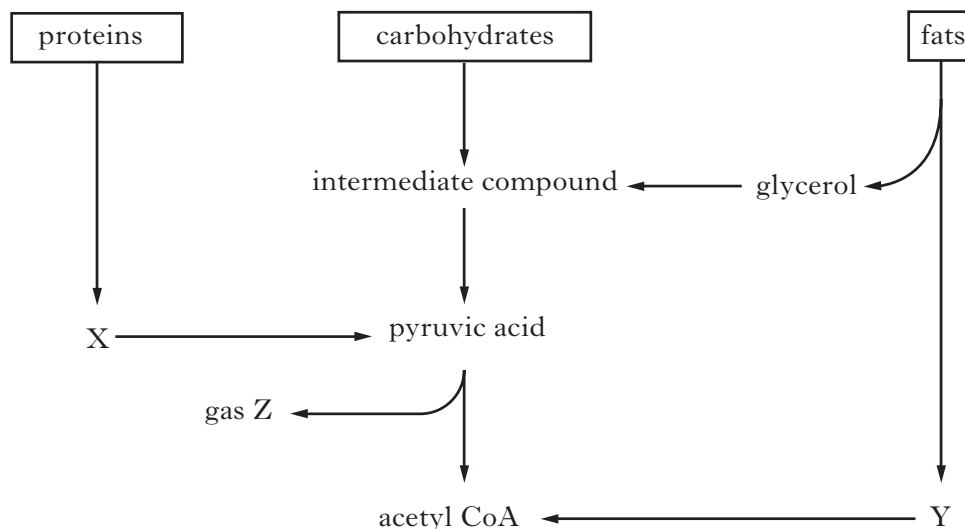
1

- (ii) Explain why trypsinogen is produced in the pancreas instead of trypsin.

1**[Turn over**

Marks

2. The diagram below shows the metabolism of three energy sources in a cell.



(a) Name X, Y and Z.

X _____

Y _____

Z _____

2

(b) What term describes the breakdown of carbohydrate into pyruvic acid during respiration?

1

(c) Describe what happens to acetyl CoA after it enters the Krebs Cycle.

1

(d) Under what circumstances would the body gain most of its energy from proteins?

1

(e) Carbohydrate is stored in the body as a polysaccharide.

Name this polysaccharide and state where it is stored.

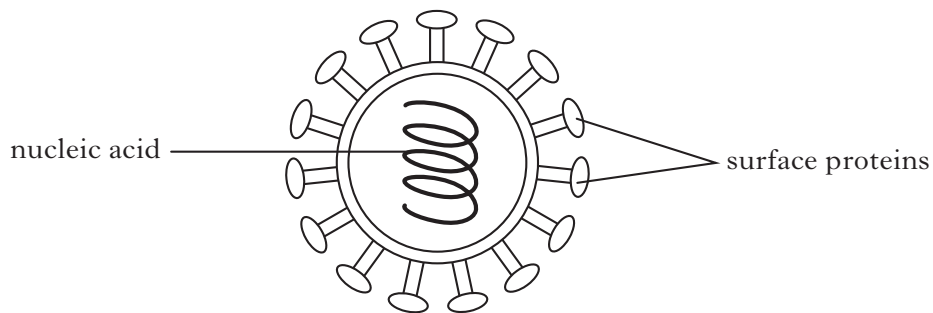
Name _____

Storage location _____

1

3. The diagram below shows the structure of one strain of the influenza virus.

Marks



(a) This virus can be used to prepare a flu vaccine. In order to do this the nucleic acid must be broken up but the surface proteins left intact.

Explain why it is necessary to:

(i) break up the nucleic acid _____

(ii) leave the surface proteins intact _____

2

(b) After a flu epidemic, two individuals, X and Y, were found to possess antibodies against this strain of influenza. X had recently recovered from flu while Y had been given a vaccine against it.

Complete the following sentences by underlining one option from each pair shown in **bold**.

The immunity gained by X is **active/passive** and **naturally/artificially** acquired.

The immunity gained by Y is **active/passive** and **naturally/artificially** acquired.

2

(c) A different vaccine is required against each strain of the influenza virus.

Suggest why different vaccines are required.

1

(d) Researchers are attempting to develop a new vaccine which will be effective against **all** strains of the influenza virus. Trials of this new vaccine have shown that it increases the activity of T-lymphocytes in the body.

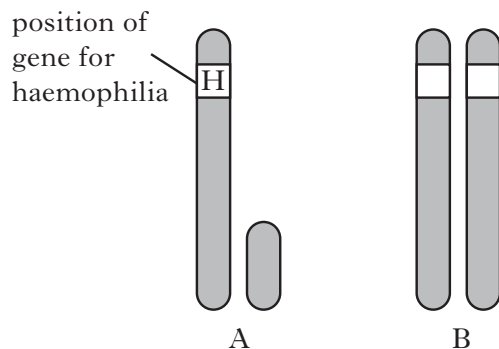
Describe the method by which T-lymphocytes combat infection.

1

Marks

4. Haemophilia is a sex-linked disorder caused by a recessive allele (h) which results in an individual producing a faulty blood-clotting protein.

The diagram below shows the sex chromosomes from two individuals.



- (a) Individual A is male while individual B is a female carrier of the allele for haemophilia.

(i) **Complete the diagram** by labelling the alleles on the sex chromosomes of individual B. 1

(ii) State the genotypes of individuals A and B.

A _____ B _____ 1

(iii) What is the chance that a daughter produced by this couple will have haemophilia?

Explain your answer.

Space for calculation

Chance _____%

Explanation _____

_____ 1

- (b) Karyotypes are images of fetal chromosomes arranged in homologous pairs.

(i) State **one** feature of chromosomes which allows them to be paired in this way.

_____ 1

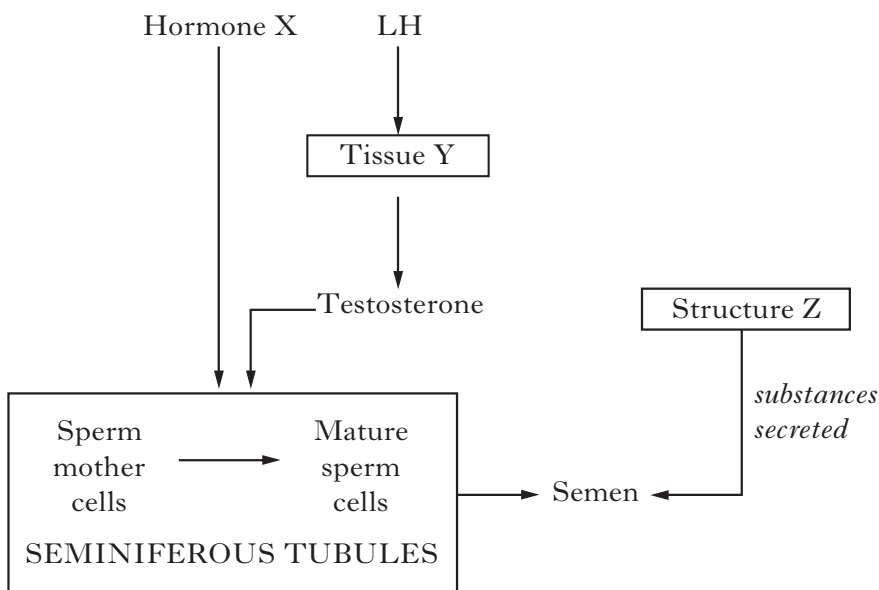
(ii) A mutation can occur during meiosis, in which chromosomes fail to separate. This results in an extra chromosome appearing in the karyotype.

What term is used to describe the failure of chromosomes to separate during meiosis?

_____ 1

Marks

5. The flowchart summarises the processes involved in the production of semen.



(a) Name hormone X and tissue Y.

Hormone X _____

Tissue Y _____

2

(b) Semen contains substances secreted by structure Z.

(i) Identify structure Z.

1

(ii) Describe how a named substance from structure Z aids fertilisation.

Substance _____

Description _____

1

(c) Complete the table to show the percentage of each type of cell which would contain a Y chromosome.

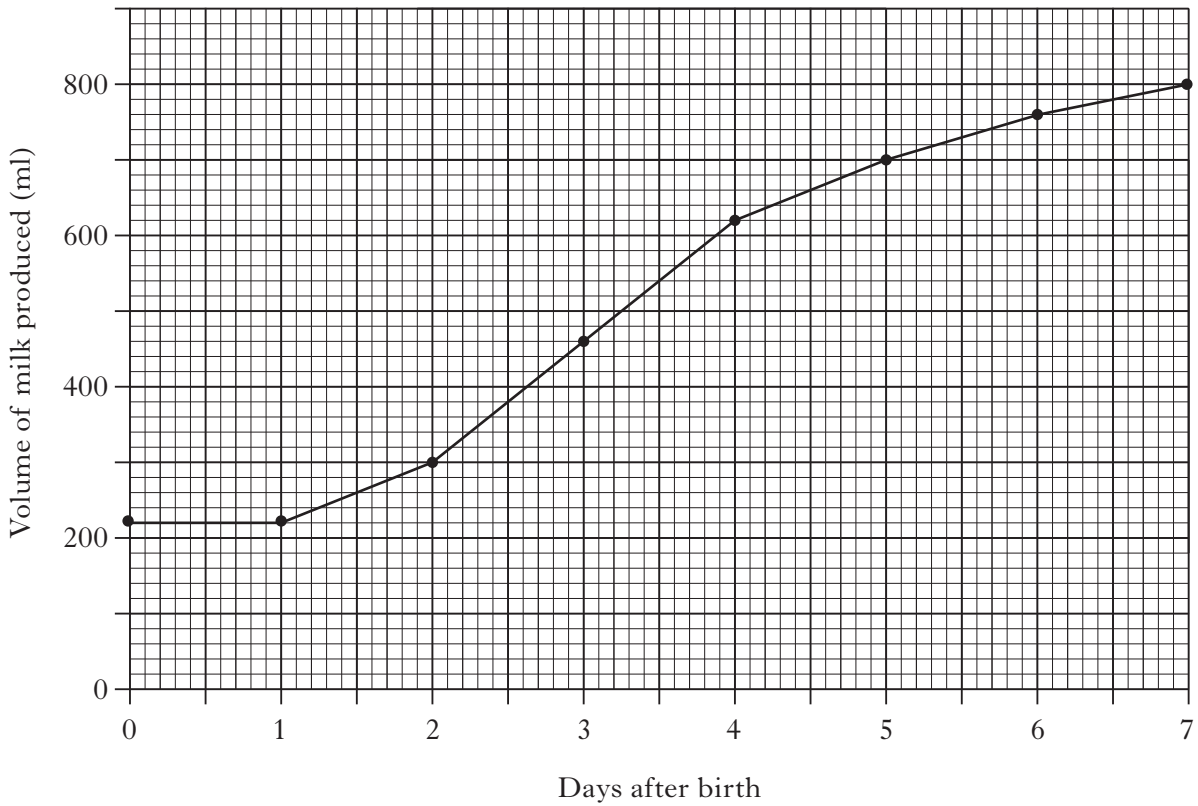
Cells	Percentage of cells containing a Y chromosome
Sperm mother cells	
Mature sperm cells	

1

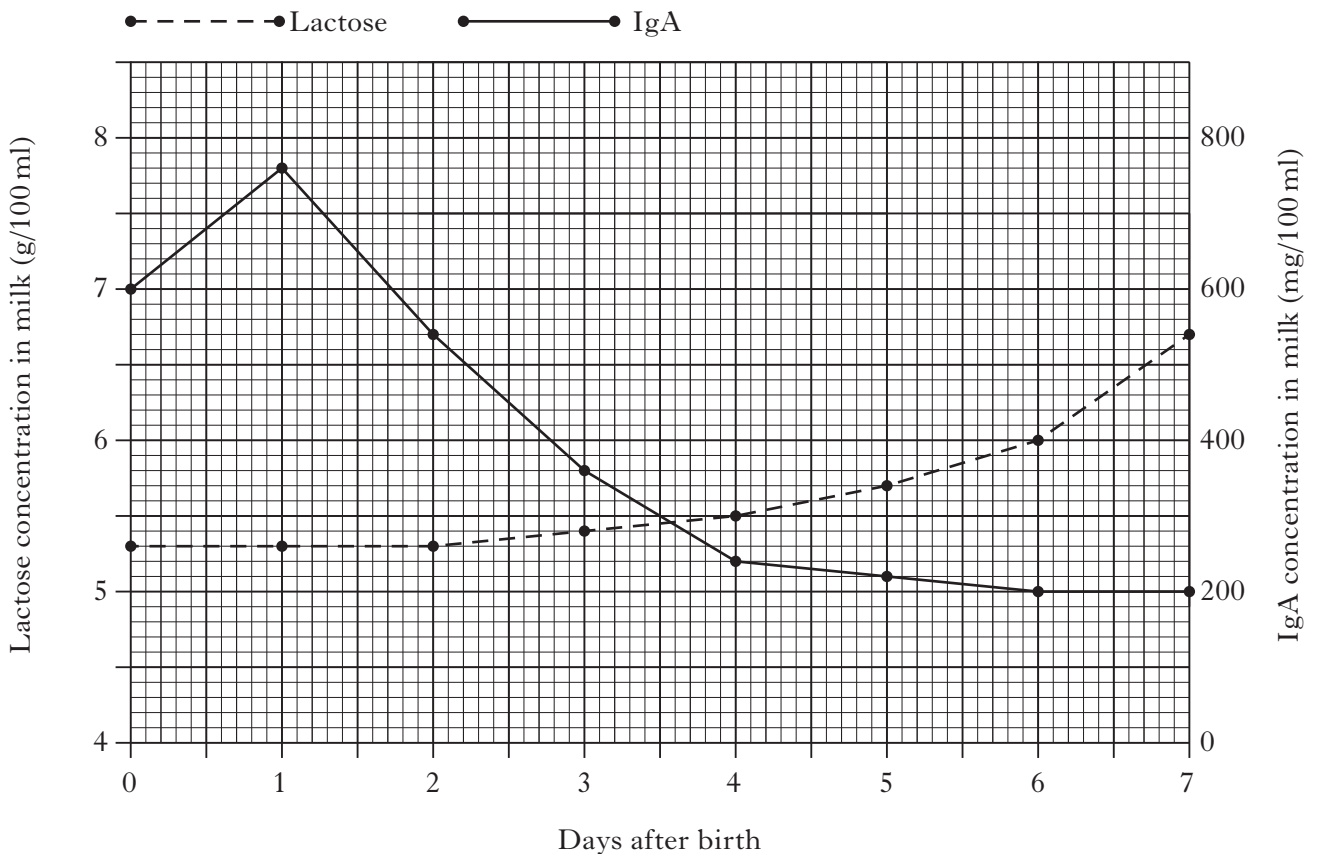
[Turn over

6. The graphs below show changes in the volume and composition of milk produced by a woman in the first week following the birth of her child.

Graph 1— changes in the volume of milk produced



Graph 2— changes in the concentration of lactose sugar and IgA antibody in milk



Marks

6. (continued)

- (a) (i) What name is given to milk produced in the first few days after birth?

1

- (ii) From **Graph 2**, describe **two** ways in which the composition of milk produced in the first three days after birth differs from milk produced later.

1 _____

2 _____

1

- (b) What was the volume of milk produced on day 3?

1

- (c) (i) Between days 2 and 3 this woman produced a constant mass of IgA.
Explain why the concentration of IgA in her milk decreased during this time.

1

- (ii) Express, as a simple whole number ratio, the concentration of IgA compared to the concentration of lactose produced on day 6.

(1 g = 1000 mg)

Space for calculation

_____ : _____
IgA Lactose

1

- (d) Using **Graphs 1** and **2**, calculate the mass of lactose produced on day 5.

Space for calculation

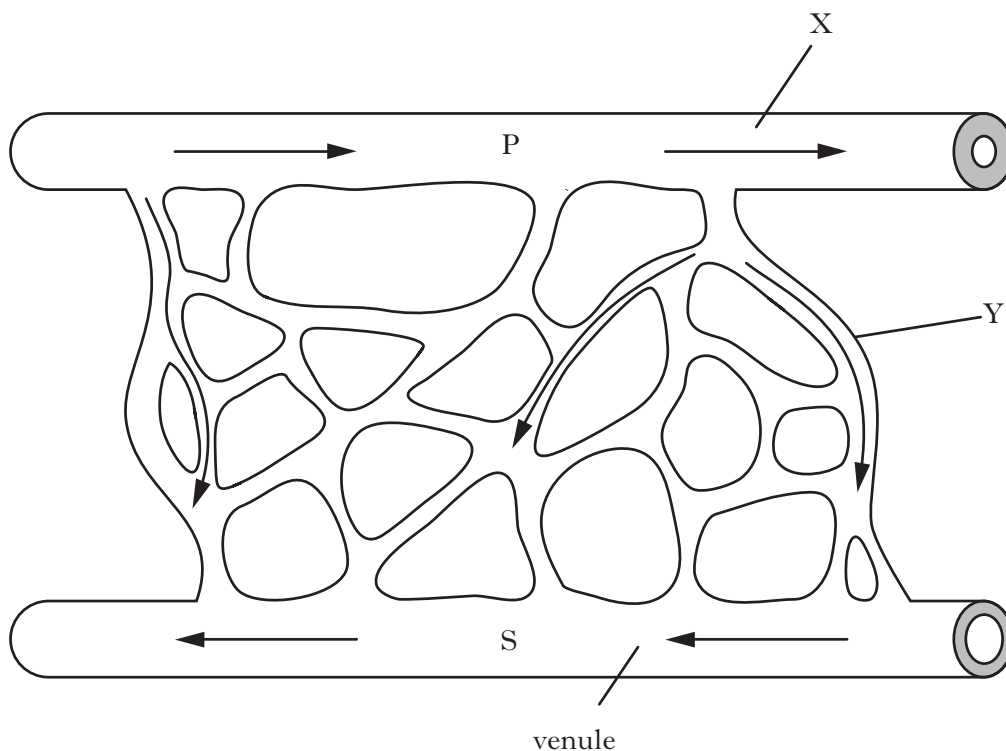
_____ g

1

[Turn over

Marks

7. The diagram below shows some blood vessels within muscle tissue of an athlete. The direction of blood flow is indicated by the arrows.



- (a) Name the type of blood vessels labelled X and Y.

X _____

Y _____

1

- (b) Name **two** substances which are at a higher concentration in the blood at point P than at point S.

1 _____

2 _____

1

- (c) The athlete ran on a treadmill at high speed for ten minutes.

Explain why the concentration of lactic acid in his blood increased during this time.

1

- (d) Tissue fluid surrounds the muscle cells.

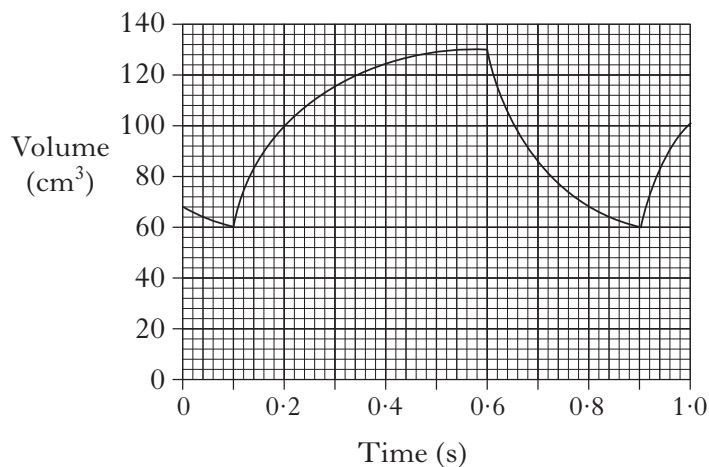
Some of this fluid is reabsorbed into the bloodstream.

How else is tissue fluid removed from around the muscle cells?

1

Marks

8. The graph below shows changes in the volume of blood in the left ventricle of a man's heart.



- (a) How long does ventricular systole last?

_____ s **1**

- (b) (i) What is the heart rate of this man?

_____ beats per minute **1**

- (ii) Calculate the volume of blood leaving this man's left ventricle every minute.

Space for calculation

_____ cm³ **1**

- (c) When this man exercises, the volume of blood leaving his heart increases significantly.

Describe how the nervous system and hormones cause this increase.

3

Marks

9. Infants and elderly people are especially vulnerable to hypothermia.



(a) (i) What is hypothermia?

1

(ii) State a **biological reason** why elderly people are particularly vulnerable to hypothermia.

1

(iii) Explain why an infant's small body size makes him more vulnerable to hypothermia than a teenager.

1

(b) (i) Name the body's temperature monitoring centre.

1

(ii) Explain how the following cause a decrease in body temperature.

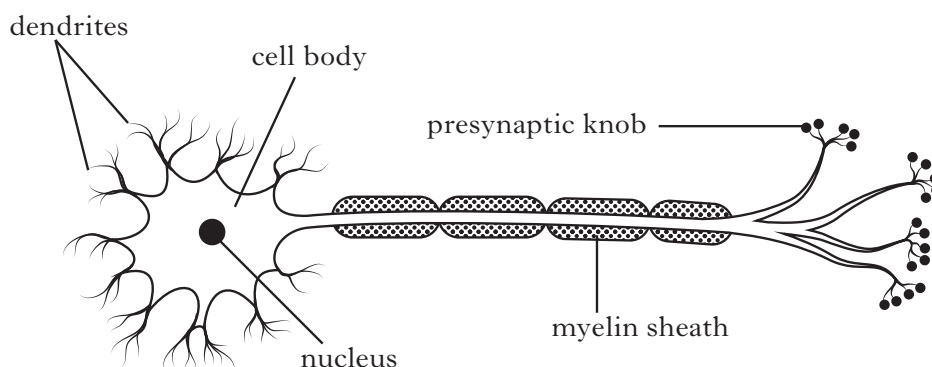
1 Increased sweating _____

2 Vasodilation _____

2

Marks

10. The diagram below shows a neurone from an adult.



(a) Draw an arrow **on the diagram** to show the direction in which an impulse would travel.

1

(b) Suggest a possible role of the nucleus in the transfer of information across a synapse.

1

(c) Complete the table below which contains information about organelles found in the presynaptic knob.

<i>Organelle</i>	<i>Function</i>
	Provides ATP for synthesis reactions
Vesicle	

1

(d) (i) How might a neurone in a newly-born child differ from the one in the diagram?

1

(ii) In what way would this affect how the neurone functions?

1

[Turn over

Marks

11. Split brain patients cannot transfer information between their left and right cerebral hemispheres because the band of nerve fibres connecting these areas of the brain has been cut.

(a) Name the band of fibres which connects the two hemispheres.

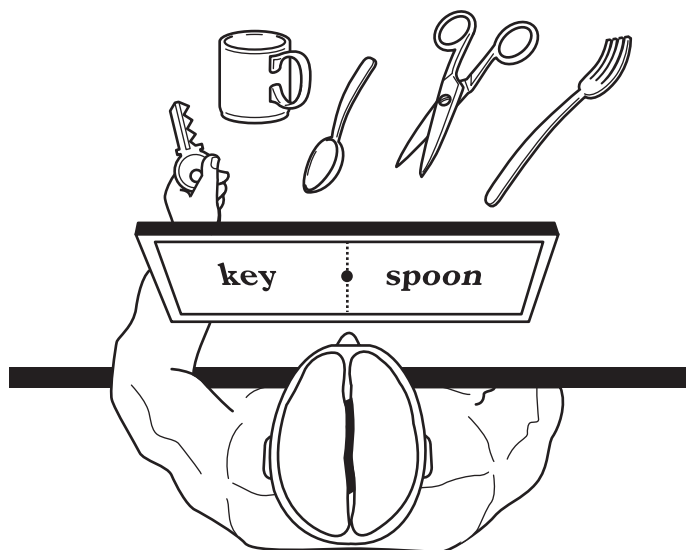
1

(b) Some of the functions of each hemisphere are described in the table below. These functions are unaffected in split brain patients.

<i>Left cerebral hemisphere</i>	<i>Right cerebral hemisphere</i>
processes information from right eye	processes information from left eye
controls language production	controls movements of left hand

The diagram below shows an experiment on a split brain patient.

The patient was asked to stare at a spot in the centre of a screen and the words “key” and “spoon” were flashed briefly onto the screen in the positions shown.



(i) The patient was then told to use his left hand to pick up the objects he saw named on the screen.

Explain why the patient picked up the key but not the spoon.

2

Marks

11. (continued)

- (ii) The patient was then asked to say what he saw written on the screen.
Predict what he would have said and give a reason for your answer.

Prediction _____

1

Reason _____

1

[Turn over

Marks

12. The following question relates to aspects of learning associated with guitar playing.



(a) What effect does practising a motor skill, such as repeatedly playing chords, have on the nervous system?

1

(b) Suggest how “shaping” might be used by a teacher to help students improve their guitar playing over the course of a year.

2

(c) (i) A teenager decides that she dislikes all of a band’s music after hearing just one song.

What form of learning is this?

1

(ii) As she grows older this teenager’s opinion about the band’s music could be altered by internalisation.

Explain how this may happen.

1

Marks

12. (continued)

(d) Anti-social behaviour can occur when people are together in a group such as at a music festival.

What is the name of this effect and why does it occur?

Name _____

1

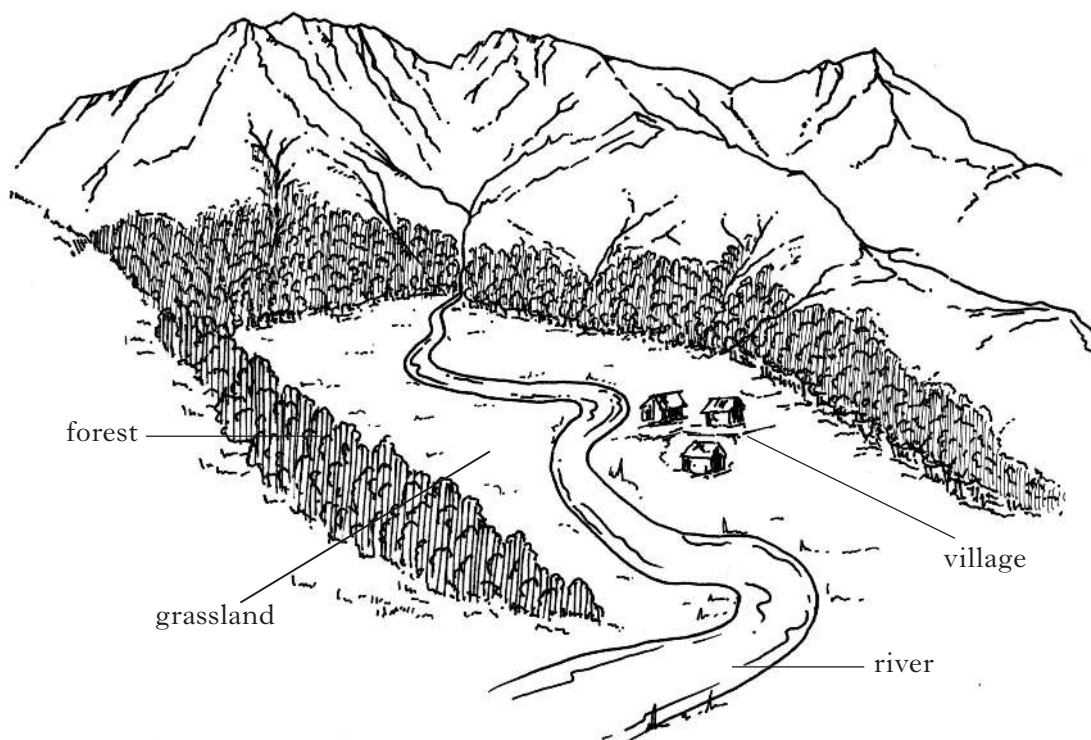
Cause _____

1

[Turn over

Marks

13. The diagram shows land use within a valley in a developing country.



(a) The population of the village near the river is increasing and the village is expanding.

(i) State **one** way in which the land around the village would change if this expansion continued.

Explain why this change would occur.

Change _____

Explanation _____

1

(ii) How might the resulting increase in the human population affect the river?

1

Marks

13. (continued)

- (b) Some changes in land use increase methane release into the atmosphere.
Give an example of such a change and state how methane release affects planet Earth.

Example _____

Effect _____

1

- (c) What name is given to the study of changes in the size of human populations?

1

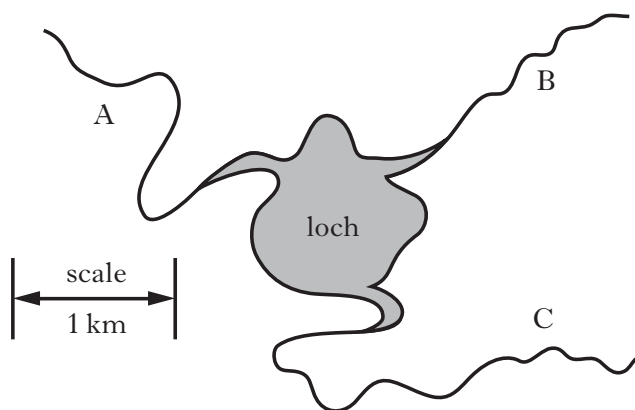
[Turn over

Marks

14. An investigation was carried out to find out where pollution was entering a loch. A student suspected that chemicals were entering the loch through one of the rivers that flowed into it (Figure 1).

She collected a water sample from each of the three rivers that entered the loch. She then measured the concentration of nitrates and phosphates present in each sample. Her results are shown in the table below.

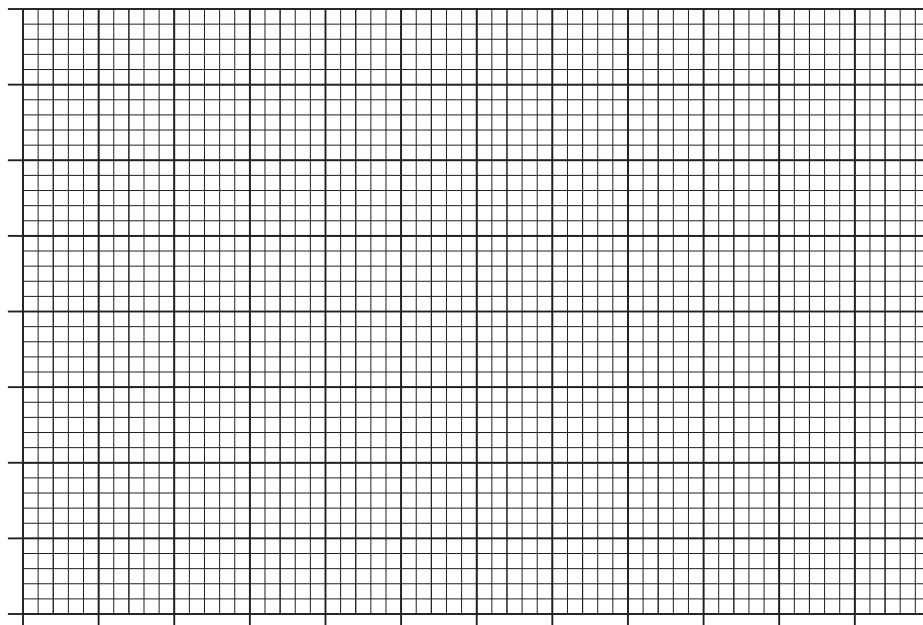
Figure 1—map showing loch and rivers that enter it. **Table**—analysis of water samples



River	Concentration of chemicals in water (mg/l)	
	Nitrate	Phosphate
A	2	0
B	35	10
C	5	1

(a) Construct a bar graph to show the data in the table.

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



3

Marks

14. (continued)

- (b) What conclusion can be drawn from the results of this investigation?

1

- (c) State **two** variables which would have to be kept constant when collecting the water samples from each river.

1 _____

2 _____

1

- (d) How could the student improve the reliability of her results?

1

- (e) Suggest how the student could extend her investigation to allow her to locate more accurately the source of the polluting chemicals.

1

- (f) The results of this investigation were obtained in the summer.

Suggest why there would be a lower concentration of nitrates in all of the rivers if the investigation had been carried out in the winter.

1

- (g) Describe the effects of excess nitrates entering a loch in summer.

1

[Turn over for Section C on Page thirty

SECTION C

Marks

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.

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

A Give an account of transport across the cell membrane under the following headings:

- | | |
|------------------------------------|-------------|
| (i) the structure of the membrane; | 3 |
| (ii) osmotic effects on cells; | 2 |
| (iii) endocytosis and exocytosis. | 5 |
| | (10) |

OR

B Give an account of the process of meiosis under the following headings:

- | | |
|------------------------------------|-------------|
| (i) first meiotic division; | 6 |
| (ii) second meiotic division; | 2 |
| (iii) significance of the process. | 2 |
| | (10) |

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

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

A Describe processes that occur in the liver which bring about changes in the composition of the blood. **(10)**

OR

B Describe processes that occur in the kidney which bring about changes in the composition of the blood. **(10)**

[END OF QUESTION PAPER]

SPACE FOR ANSWERS

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SPACE FOR ANSWERS

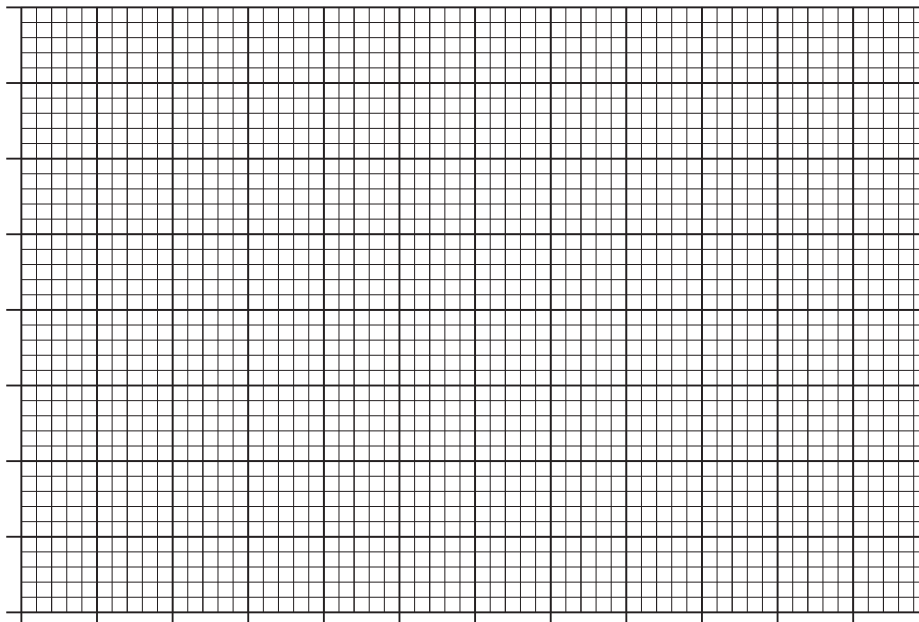
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ADDITIONAL GRAPH FOR QUESTION 14(a)



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