FOR OFFICIAL USE

Total for Sections B & C

X009/301

NATIONAL QUALIFICATIONS 2001

MONDAY, 21 MAY
9.00 AM – 11.30 AM

HUMAN BIOLOGY
HIGHER

Fill in these boxes and read what is printed below.

Full name of centre

Town

Forename(s)

Surname

Date of birth
Day Month Year

Scottish candidate number

Number of seat

SECTION A—Questions 1–30

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

SECTIONS B AND C

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 and rough work 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.

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.

SCOTTISH QUALIFICATIONS AUTHORITY

SECTION A

All questions in this section should be attempted.

Answers should be given on the separate answer sheet provided.

1. In respiration, the sequence of reactions resulting in the conversion of glucose to pyruvic acid is called

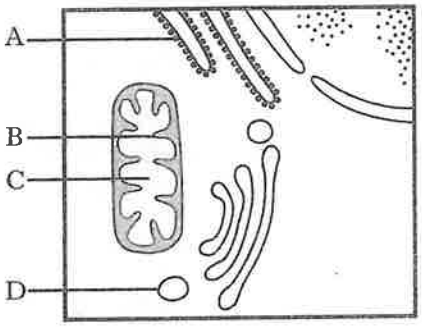
   A the cytochrome system

   B the TCA cycle

   C the Krebs cycle

   D glycolysis.

2. The diagram shows part of a liver cell with four parts labelled. In which part is most ATP produced?



3. A DNA nucleotide could be formed from a molecule of phosphate together with

   A ribose sugar and guanine

   B ribose sugar and uracil

   C deoxyribose sugar and guanine

   D deoxyribose sugar and uracil.

4. If a DNA molecule contains 8000 nucleotides of which 20% are adenine, then the number of guanine nucleotides present is

   A 1600

   B 2000

   C 2400

   D 3200.

5. If the mass of DNA in a human liver cell is $6{\cdot}6 \times 10^{-12}$ g, the mass of DNA in a human sperm is likely to be

   A $3{\cdot}3 \times 10^{-6}$ g

   B $3{\cdot}3 \times 10^{-12}$ g

   C $6{\cdot}6 \times 10^{-6}$ g

   D $6{\cdot}6 \times 10^{-12}$ g.

6. A section of DNA has the following base sequence.

   Identify the anti-codons of the three tRNA molecules which would align with the mRNA molecule transcribed from this section of DNA.

   A AAU CGC UUC

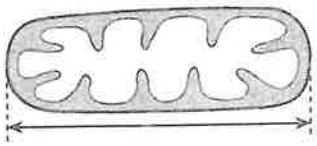
   B AAT CGC TTC

   C TTA GCG AAG

   D UUA GCG AAG

7. The cell organelle shown is magnified ten thousand times.

   What is the actual size of the organelle?



   A 0·04 µm

   B 0·4 µm

   C 4 µm

   D 40 µm

[Turn over

Questions 8 and 9 refer to the key shown below, used for the identification of carbohydrates.

1 { soluble 2
  { insoluble .....glycogen

2 { Benedict's test positive.....3
  { Benedict's test negative.....sucrose

3 { Barfoed's test positive.....4
  { Barfoed's test negative .....lactose

4 { Clinistix test positive .....glucose
  { Clinistix test negative .....fructose

8. Which line in the table of results below is **not** in agreement with the information contained in the key?

	Carbo-hydrate	*Clinistix test*	*Barfoed's test*	*Benedict's test*
A	sucrose	not tested	not tested	negative
B	glucose	positive	negative	positive
C	fructose	negative	positive	positive
D	lactose	not tested	negative	positive

9. Maltose is a soluble carbohydrate which gives a positive result with Benedict's but not with Barfoed's reagent. With which carbohydrate in the key could maltose be confused?

A Fructose

B Glucose

C Sucrose

D Lactose

10. The stages of infection of a host cell by a virus are listed below.

1 Host cell bursts, releasing new viruses.
2 Host cell DNA is inactivated.
3 Virus binds to host cell and injects DNA.
4 Virus DNA directs synthesis of new viruses.

The sequence in which these events occurs is

A 3,2,4,1

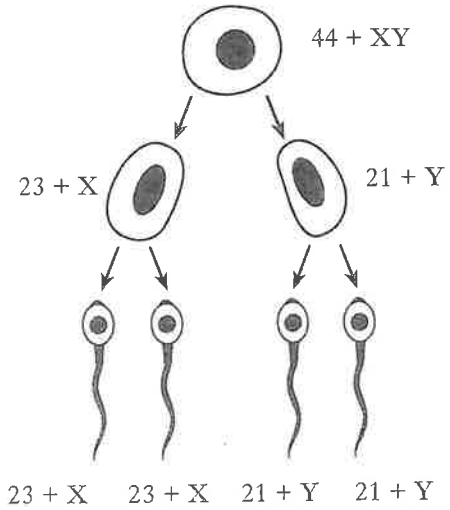
B 1,2,4,3

C 3,4,2,1

D 2,4,3,1.

Questions 11 and 12 refer to the information below.

The diagram shows the chromosome complement of cells during the development of abnormal sperm.



11. The diagram illustrates the effect of

A crossing over

B polygenic inheritance

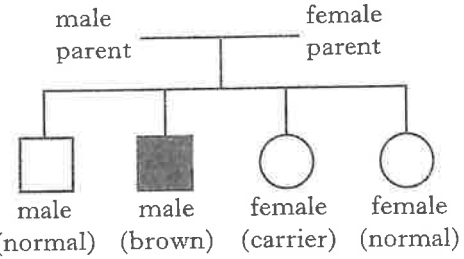
C non-disjunction

D independent assortment of chromosomes.

12. A sperm with chromosome complement 23+X fertilises a normal haploid egg. What is the chromosome number and sex of the resulting zygote?

	Chromosome number	*Sex of zygote*
A	24	female
B	46	female
C	46	male
D	47	female

13. The colour of tooth enamel is a sex-linked characteristic. The allele for brown tooth enamel (e) is recessive to the allele for normal tooth enamel (E). The following family tree refers to this condition.



What are the genotypes of the parents?

A X^EY and X^EX^e

B X^EY and X^eX^e

C X^eY and X^EX^E

D X^eY and X^EX^e

Questions 14 and 15 refer to the following list of hormones.

A Follicle Stimulating Hormone (FSH)

B Luteinising Hormone (LH)

C Oestrogen

D Progesterone

14. Which hormone stimulates the production of testosterone by the testes?

15. Which hormone is produced by the corpus luteum?

16. Which of the following will **not** normally pass through the placenta between the mother and fetus?

A Oxygen

B Minerals

C Glucose

D Red blood cells

17. Fertility drugs may be used in the treatment of fertility to

A correct hormone imbalances

B reduce the pH of the oviduct

C stimulate mitosis in an egg

D protect sperm cells in the oviduct.

18. The durations of ventricular diastole and systole are shown below.

Diastole 0·4 seconds

Systole 0·2 seconds

What is the heart rate for this individual?

A 60 beats per minute

B 72 beats per minute

C 100 beats per minute

D 120 beats per minute

19. In which of the following pairs of tissues/ organs, are red blood cells destroyed?

A Liver and lymph nodes

B Liver and spleen

C Bone marrow and duodenum

D Spleen and duodenum

20. Which of the following body fluids does **not** contain digestive enzymes?

A Saliva

B Gastric juice

C Pancreatic juice

D Bile

21. Which of the following results from an increase in the secretion of anti-diuretic hormone (ADH)?

A An increase in the permeability of the kidney tubules to water

B A decrease in the permeability of the kidney tubules to water

C An increase in the permeability of the glomerulus to water

D A decrease in the permeability of the glomerulus to water

22. Which of the following responses is caused by stimulation of the sympathetic nervous system?

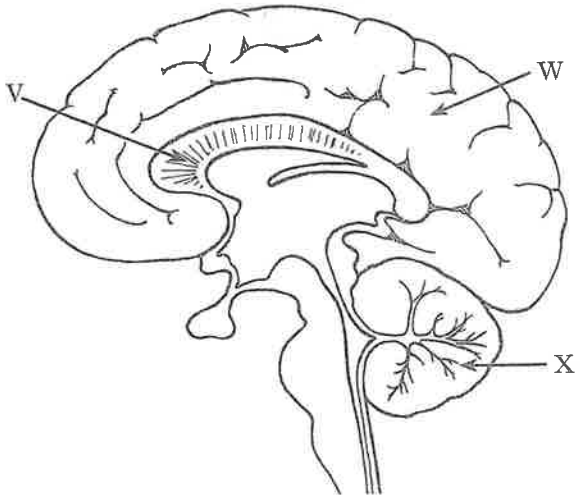
A Increase in insulin production

B Increase in heart rate

C Increase in the flow of saliva

D Increase in peristalsis

23. A vertical section of the brain is shown in the diagram below.



Which line of the table correctly labels the parts of the brain shown?

	V	*W*	*X*
A	corpus callosum	cerebellum	cerebrum
B	cerebellum	cerebrum	corpus callosum
C	corpus callosum	cerebrum	cerebellum
D	cerebrum	corpus callosum	cerebellum

24. Information is transferred between the two cerebral hemispheres by the

A corpus callosum

B medulla oblongata

C cerebellum

D hypothalamus.

25. A boy who is bitten by a large dog is subsequently frightened of all dogs. This behaviour pattern is an example of

A deindividuation

B extinction

C generalisation

D discrimination.

26. The development of phenotype is influenced by

A genetic factors only

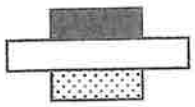
B genetic factors and nutrition only

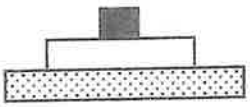
C the environment only

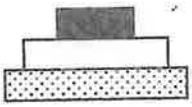
D the environment and genetic factors only.

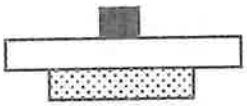
27. The age structure of four different human populations is represented in the diagrams below. The bars indicate the relative numbers in each group.

Which diagram shows the population with greatest scope for growth?

A 

B 

C 

D 

45 to 90 years

14 to 44 years

0 to 13 years

28. The interdependent biological and physical components in an area make up

A a habitat

B an ecosystem

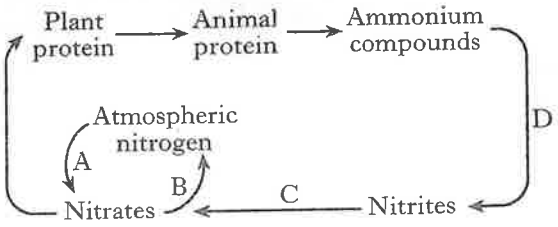
C a food web

D a community.

29. What would be the effect of the discharge of raw sewage on the oxygen and nitrate concentrations of the water in a loch?

	Oxygen concentration	*Nitrate concentration*
A	increase	increase
B	increase	decrease
C	decrease	increase
D	decrease	decrease

30. The diagram shows a nitrogen cycle associated with the soil.



Which arrow indicates the activity of denitrifying bacteria?

Candidates are reminded that the answer sheet MUST be returned INSIDE this answer booklet.

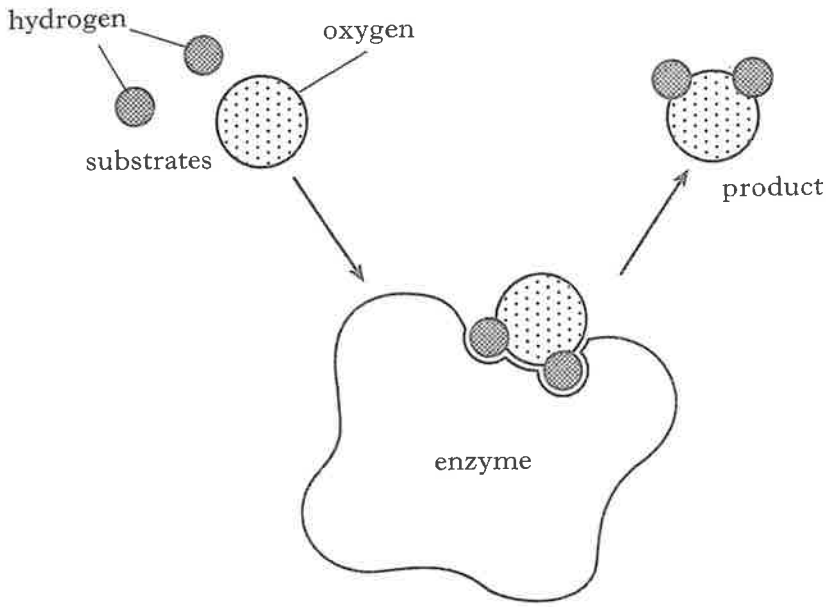
[Turn over for Section B on *Page eight*

Marks

SECTION B

All questions in this section should be attempted.

1. The diagram below represents a reaction catalysed by an enzyme in the cytochrome system.



(*a*) (i) What name is given to the part of the enzyme where this reaction occurs?

_____ 1

(ii) In which organelle would this reaction take place?

_____ 1

(iii) Name the product of this reaction.

_____ 1

(*b*) Cyanide is a poison which inhibits this enzyme.
Suggest how cyanide is able to do this.

_____

_____ 1

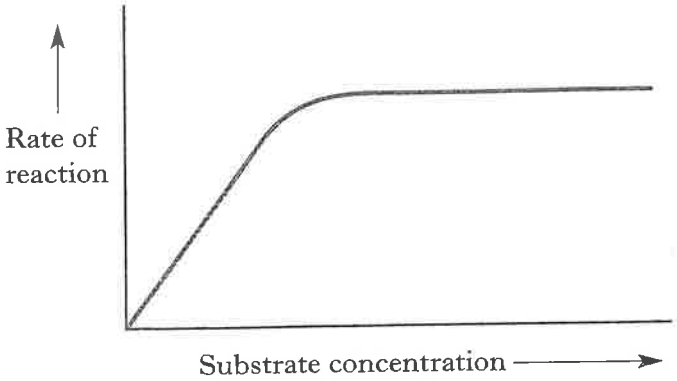
(*c*) Why do many enzyme-catalysed reactions require the presence of vitamins or minerals?

_____ 1

Marks

1. (continued)

(*d*) The graph shows the effect of increasing substrate concentration on the rate of this reaction.



(i) Explain why the graph levels out at high substrate concentration.

_____

_____ 1

(ii) Assuming that the enzyme is operating at its optimum pH and temperature, suggest how the rate of reaction could be increased at high substrate concentrations.

_____

_____ 1

[Turn over

Marks

2. (*a*) The table below shows the relative concentrations of sodium and potassium ions in red blood cells and plasma.

	Sodium (units/litre)	*Potassium* (units/litre)
red blood cells	24	150
plasma	144	5

(i) Express, as simple ratios, the concentrations of sodium ions and potassium ions in the red blood cells and the plasma.

Space for calculation

Red blood cells : plasma

(1) sodium _____ : _____

(2) potassium _____ : _____ **1**

(ii) Suggest how the red blood cells maintain the potassium concentration gradient.

_____

_____ **1**

(iii) When glucose is in short supply, the concentration of potassium in the red blood cells changes.

State whether the concentration will increase or decrease and give a reason for your answer.

Increase/decrease _____

Reason _____

_____

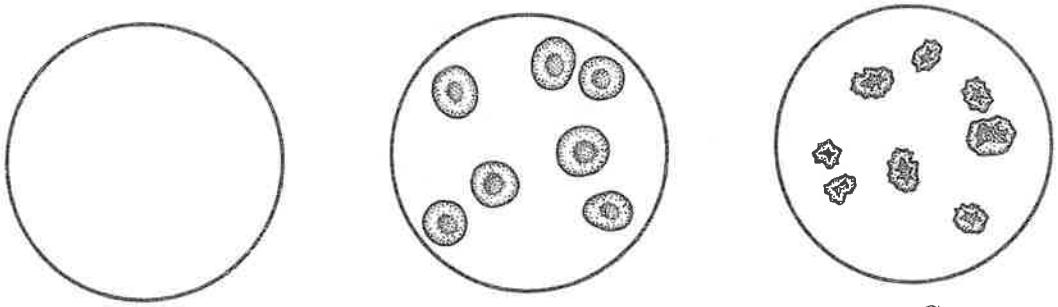
_____ **2**

DO NOT WRITE IN THIS MARGIN

Marks

2. (continued)

(*b*) Three samples of red blood cells were placed in different concentrations of sodium chloride solution for two minutes. The results of this treatment, when viewed under the microscope, are shown in the diagram below.



A
(no cells visible)

B

C

Using the information above, explain the appearance of the cells in each diagram.

A _____

_____

B _____

_____

C _____

_____ **3**

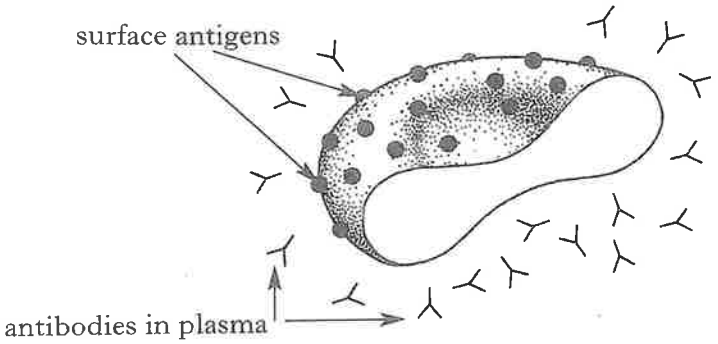
[Turn over

Marks

3. Antigens on the surface of red blood cells enable different blood groups to be identified.

Four types of blood group are A, B, AB and O.

The diagram shows antigens on a red blood cell and antibodies in the surrounding plasma.



(*a*) Complete the table below to show the types of antigen and antibody present in individuals of each blood group.

Blood group	*Antigens present on surface of red blood cells*	*Antibodies present in plasma*
A	A	
B		anti-A
AB		
O		

2

(*b*) Which blood group(s) could be transfused safely into a person of blood group A?

_____

1

Marks

3. (continued)

(*c*) The gene for this blood group has three alleles. Alleles A and B are co-dominant to allele O.

A man, heterozygous for blood group A, and a woman of blood group AB, have children.

(i) State the genotypes of the parents.

female _____ male _____ 1

(ii) Complete the Punnett square below to show the genotypes of their gametes and the genotypes of the children they may have.

male gametes \ female gametes		

2

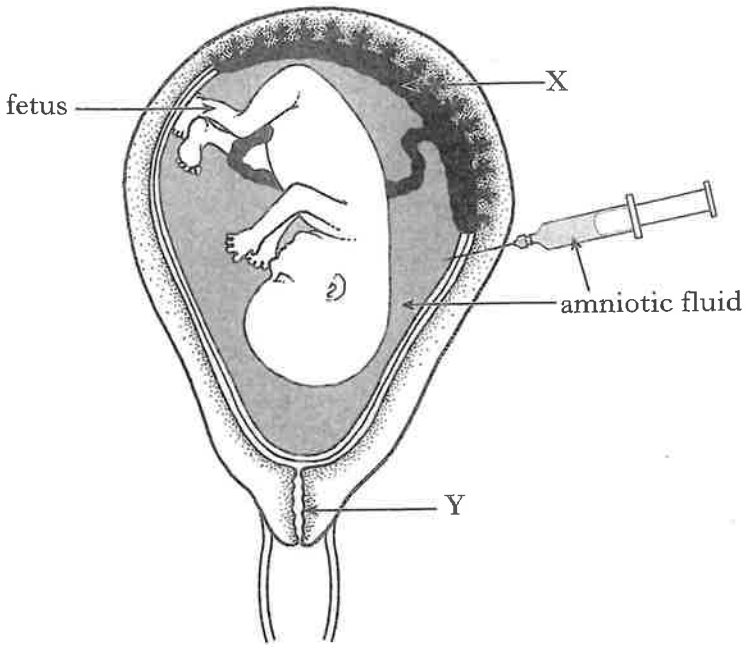
(iii) What is the percentage chance that a child of these parents would have blood group A?

_____ % 1

[Turn over

Marks

4. The diagram below illustrates the first stage of the process of amniocentesis. The fluid removed from the uterus contains fetal cells which can be grown, stained and examined.



(*a*) (i) Identify structure X.

_____ **1**

(ii) Name a hormone produced by structure X during pregnancy.

_____ **1**

(*b*) (i) Identify structure Y.

_____ **1**

(ii) Structure Y produces mucus. What change occurs to this mucus during the fertile period?

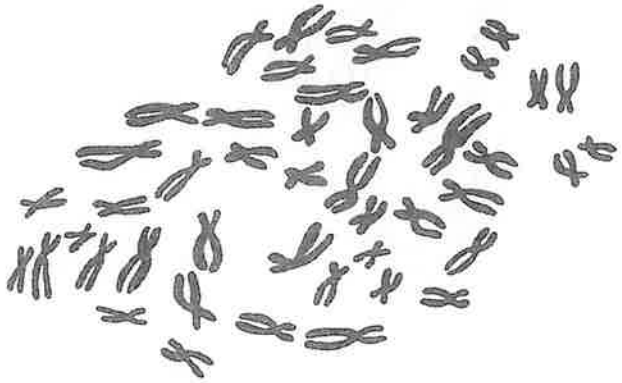
_____ **1**

DO NOT WRITE IN THIS MARGIN

Marks

4. **(continued)**

(c) The diagram represents a photograph of stained chromosomes from a fetal cell.



(i) The chromosomes may be cut out and arranged in homologous pairs.

Give **two** features of chromosomes which allow homologous pairs to be identified.

1 _____

2 _____ **1**

(ii) What name is given to a set of chromosomes arranged in pairs?

_____ **1**

(iii) How could the sex of the fetus be identified from this paired arrangement?

_____

_____ **1**

(iv) What other information could be obtained which would be of value in pre-natal screening?

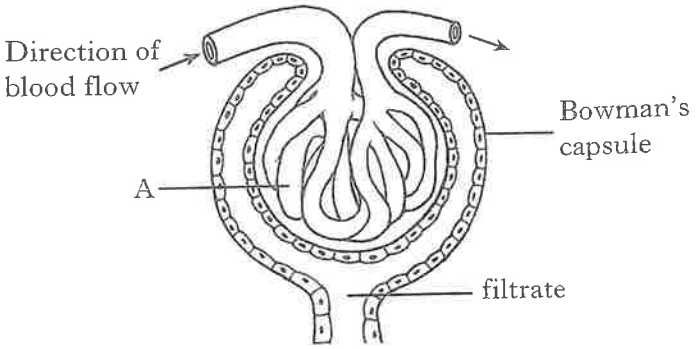
_____

_____ **1**

[Turn over

Marks

5. The diagram below shows the parts of a kidney nephron involved in ultrafiltration.



(*a*) (i) Part A consists of a bundle of capillaries. Name part A.

_____ 1

(ii) What feature, shown in the diagram, results in high blood pressure within structure A?

_____ 1

(iii) Into which part of the nephron does the filtrate flow immediately after leaving the Bowman's capsule?

_____ 1

(*b*) The table shows the composition of filtrate and urine.

Substance	*Mass in filtrate* (g/day)	*Mass in urine* (g/day)
Sodium ions	600	6
Potassium ions	35	2
Glucose	200	0
Urea	60	36
Water	180 000	1500

(i) Name the process which results in the differences between filtrate and urine, shown in the table.

_____ 1

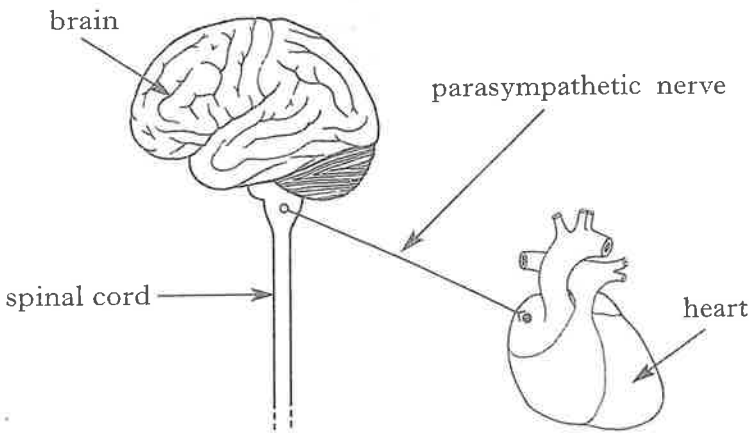
(ii) What percentage of urea returns to the blood as the filtrate flows through the nephron?

_____ % 1

(iii) Predict how the composition of urine would differ if the individual was an untreated diabetic.

_____ 1

6. The diagram below shows the parasympathetic nerve which runs between the central nervous system and the heart. *Marks*



(*a*) (i) Which subdivision of the peripheral nervous system contains parasympathetic nerves?

_____ 1

(ii) In which part of the brain does this parasympathetic nerve originate?

_____ 1

(*b*) (i) Name the part of the right atrium which is stimulated by the parasympathetic nerve.

_____ 1

(ii) State the effect of parasympathetic stimulation on the heart.

_____ 1

(*c*) Describe another effect which the parasympathetic nervous system has on the body.

_____

_____ 1

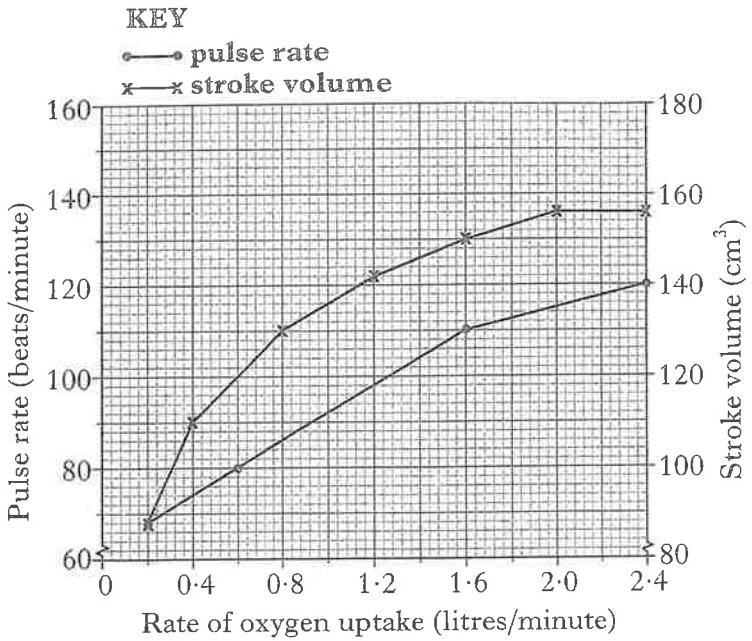
[Turn over

7. In humans, alterations in the level of exercise bring about changes in pulse rate, stroke volume and ventilation rate. The level of exercise is measured as rate of oxygen uptake.

Graph 1 gives information about the heart. It shows how pulse rate and stroke volume change with the level of exercise in an individual.

Stroke volume is the volume of blood pumped from the heart in one beat.

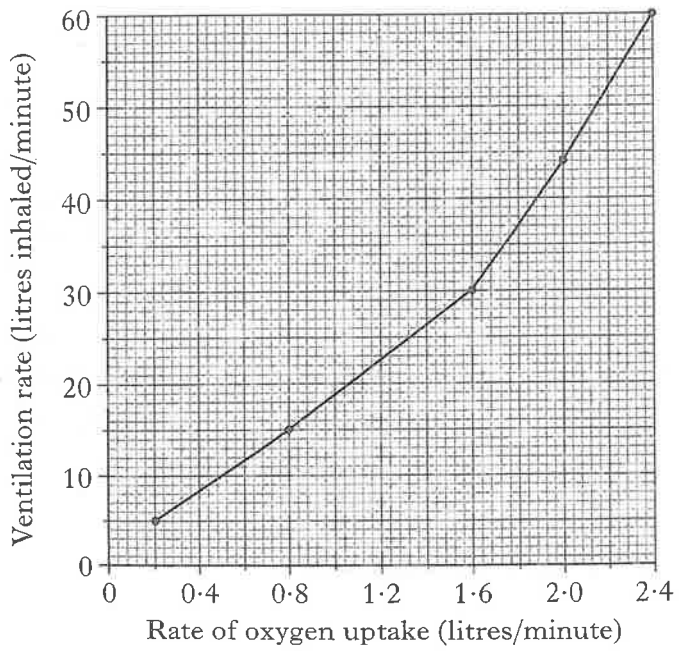
Graph 1



Graph 2 gives information about the lungs. It shows how the ventilation rate changes with the level of exercise in the same individual.

Ventilation rate is the volume of air inhaled during one minute.

Graph 2



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Marks

7. (continued)

(*a*) (i) With reference to **Graph 1**, what is the pulse rate and the stroke volume when the rate of oxygen uptake is 0·8 litres/minute?

Pulse rate _____ Stroke volume _____ **2**

(ii) What is the stroke volume when the pulse rate is 74 beats per minute?

_____ cm^3 **1**

(iii) What is the total volume of blood leaving the heart in one minute when the rate of oxygen uptake is 1·6 litres/minute?

Space for calculation

_____ litres/minute **1**

(iv) From **Graph 1**, compare the pattern of changes in pulse rate and stroke volume as oxygen uptake increases.

_____

_____

_____ **2**

(*b*) (i) Fresh air contains 20% oxygen. From **Graph 2**, what is the volume of oxygen inhaled per minute when the rate of oxygen uptake is 1·6 litres/minute?

Space for calculation

_____ litres **1**

(ii) What additional information would be required to calculate the average volume of air taken in during each breath at any time?

_____ **1**

(*c*) (i) With reference to **both graphs**, state the ventilation rate when this individual's pulse rate is 100 beats per minute.

_____ litres/minute **1**

(ii) Complete the table below by ticking the correct statement(s).

Statement	*Tick (✓)*
The rate at which pulse rate changes is highest at low rates of oxygen uptake.	
When ventilation rate doubles, the rate of oxygen uptake doubles.	

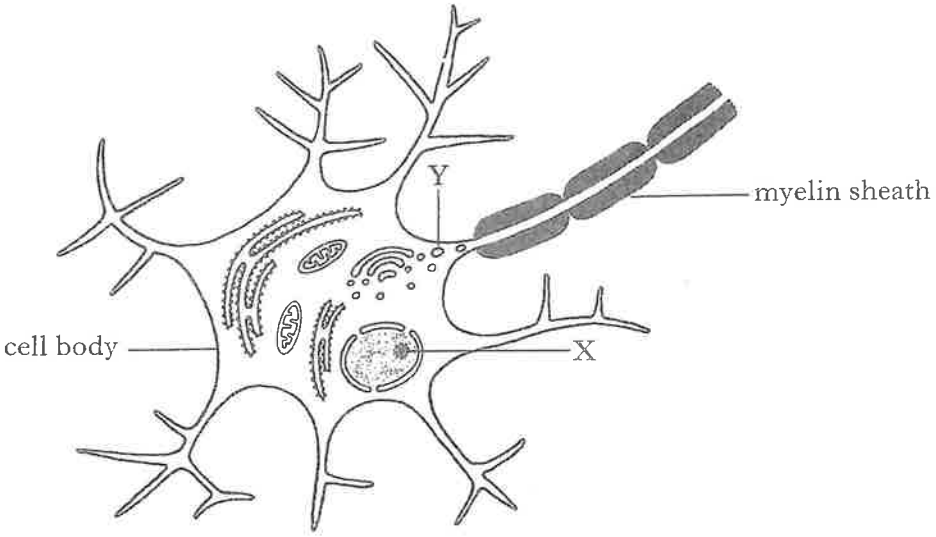
1

(*d*) Name the blood vessel which carries deoxygenated blood from the heart to the lungs.

_____ **1**

Marks

8. Part of a neurone is shown in the diagram below.



(*a*) State whether the neurone shown is a sensory or motor neurone and give a reason for your answer.

Type of neurone _____

Reason for answer _____

_____ 1

(*b*) Name structure X and state its function.

Name _____

Function _____ 2

(*c*) (i) Name structure Y.

_____ 1

(ii) Similar structures are found in the synaptic knob. What do they contain?

_____ 1

DO NOT WRITE IN THIS MARGIN

Marks

8. (continued)

(*d*) In the disorder Multiple Sclerosis, the myelin sheath is damaged by the body's own defence system.

(i) What effect does this have on the function of the nerve fibre?

_____

_____ 1

(ii) What term is used to describe a disorder where the body's defence system destroys its own cells?

_____ 1

(*e*) Draw an arrow on the diagram to show the direction of an impulse in a dendrite. 1

(*f*) Diverging neural pathways always contain the type of neurone shown opposite. Explain how diverging pathways allow humans to perform a task such as threading a needle.

_____

_____

_____

_____ 2

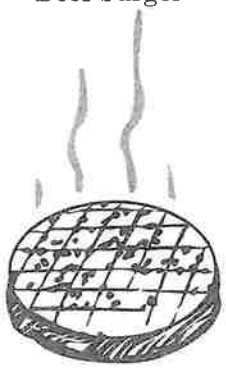
[Turn over

Marks

9. "Fast foods" are now very much part of the culture of the developed world.

The table below gives information about a beef burger.

Beef burger



Nutritional analysis/100 g	
Energy	1500 kJ
Protein	12 g
Carbohydrate	8 g
Fat	30 g
Fibre	1 g
Sodium	1 g

(*a*) A boy ate little else but beef burgers every day.

With reference to the table, explain why the boy might suffer from malnutrition but not starvation.

_____

_____

_____ 2

(*b*) Increased demand for cheap beef has had an impact on the natural ecosystems of developing countries.

Suggest how this demand affects natural ecosystems and local water supplies.

Natural ecosystems _____

_____

Local water supplies _____

_____ 2

(*c*) Why is the production of beef an inefficient use of land in a developing country where there is a large population to feed?

_____

_____ 1

DO NOT WRITE IN THIS MARGIN

Marks

9. (continued)

(*d*) The carbohydrate in the burger comes from wheat.

Modern varieties of wheat have been produced by selective breeding.

Describe an improvement brought about by selective breeding of crop plants such as wheat.

_____

_____

_____ **1**

(*e*) (i) Pesticides are frequently applied to growing crops. What is a pesticide?

_____ **1**

(ii) Describe **one** advantage of using pesticides.

_____

_____

_____ **1**

(*f*) Genetic manipulation is now used to produce new varieties of organisms.

Describe **one** advantage of this technique compared to selective breeding.

_____

_____

_____ **1**

[Turn over

Marks

10. The apparatus shown in **Figure 1** was used to investigate the effect of nitrates on the growth of grass. Grass seedlings were grown in seven different culture solutions. The experiment was repeated ten times.

Figure 2 shows the nitrate concentrations of the culture solutions and the results of the experiment.

Figure 1

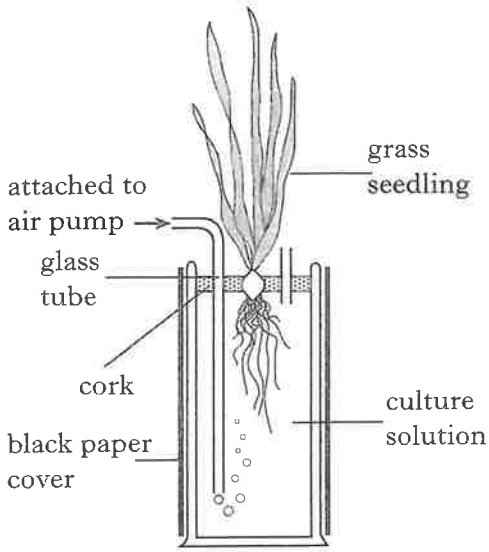
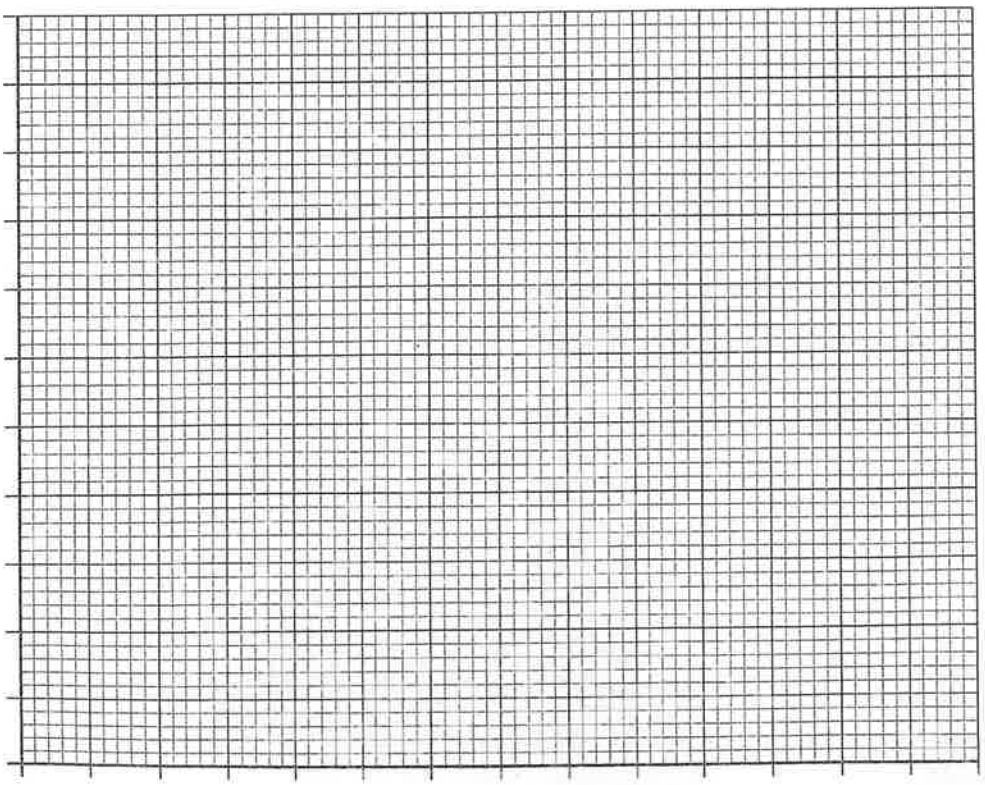


Figure 2

Culture solution	*Nitrate content* (g/litre)	*Average height of plants after 6 weeks of growth* (cm)
A	0	3
B	0·5	12
C	1·0	17
D	1·5	23
E	2·0	25
F	2·5	24
G	3·0	25

(*a*) Plot a line graph to illustrate the experimental results.

(Additional graph paper, if required, will be found on page 28.)



3

DO NOT WRITE IN THIS MARGIN

10. (continued)

Marks

(*b*) Name **two** variables which should be controlled in this experiment.

1 _____

2 _____ 1

(*c*) During the experiment air was pumped into the jars through the glass tubes. Suggest why this was necessary.

_____

_____ 1

(*d*) What feature of the experiment makes the results more reliable?

_____

_____ 1

(*e*) State **one** other feature of grass plants which could be observed or measured to assess the effects of nitrate.

_____ 1

(*f*) Predict how the results of this experiment would be different in culture solutions A, B and C if clover or pea plants had been used instead of grass plants. Give a reason for your answer.

Prediction _____ 1

Reason _____ 1

(*g*) A farmer wishes to purchase nitrate fertiliser. In what way could the information from this experiment be useful to the farmer?

_____

_____ 1

[Section C begins on *Page twenty-six*

Marks

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.

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

   A. Give an account of memory under the following headings:

   (i) encoding; **6**

   (ii) storage; **2**

   (iii) retrieval. **2**

   (10)

   OR

   B. Give an account of immunisation under the following headings:

   (i) artificial active immunity; **6**

   (ii) artificial passive immunity; **2**

   (iii) the impact of vaccination on childhood diseases. **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 the biological basis of contraception. **(10)**

   OR

   B. Outline the involuntary mechanisms involved in temperature control. **(10)**

[END OF QUESTION PAPER]