FOR OFFICIAL USE

Total for Sections B and C

X007/301

NATIONAL QUALIFICATIONS 2008

TUESDAY, 27 MAY
1.00 PM – 3.30 PM

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 (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 **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 exam, put the **answer sheet for Section A inside the front cover of this answer book**.

Sample Question

The apparatus used to determine the energy stored in a foodstuff is a

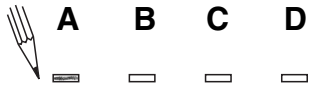
A calorimeter

B respirometer

C klinostat

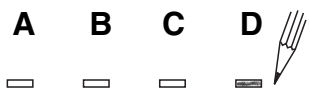
D gas burette.

The correct answer is **A—**calorimeter. 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. The following statements relate to respiration and the mitochondrion.

1 Glycolysis takes place in the mitochondrion.

2 The mitochondrion has two membranes.

3 The rate of respiration is affected by temperature.

Which of the above statements are correct?

A 1 and 2

B 1 and 3

C 2 and 3

D All of them

2. The anaerobic breakdown of glucose splits from the aerobic pathway of respiration

A after the formation of pyruvic acid

B after the formation of acetyl-CoA

C after the formation of citric acid

D at the start of glycolysis.

3. Phagocytes contain many lysosomes so that

A enzymes which destroy bacteria can be stored

B toxins from bacteria can be neutralised

C antibodies can be released in response to antigens

D bacteria can be engulfed into the cytoplasm.

4. After an animal cell is immersed in a hypotonic solution it will

A burst

B become turgid

C shrink

D become flaccid.

5. Which of the following proteins has a fibrous structure?

A Pepsin

B Amylase

C Insulin

D Collagen

6. The following cell components are involved in the synthesis and secretion of an enzyme.

1 Golgi apparatus

2 Ribosome

3 Cytoplasm

4 Endoplasmic reticulum

Which of the following identifies correctly the route taken by an amino acid molecule as it passes through these cell components?

A 3 2 1 4

B 2 4 3 1

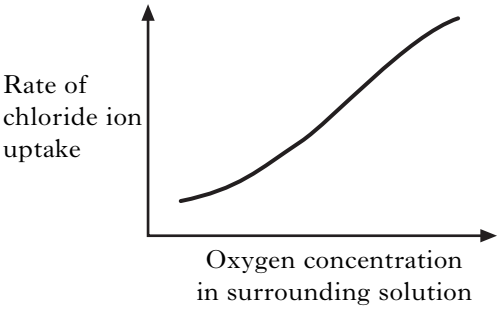
C 3 2 4 1

D 3 4 2 1

[Turn over

7. The graphs show the effect of various factors on the rate of uptake of chloride ions by discs of carrot tissue from their surrounding solution.

1



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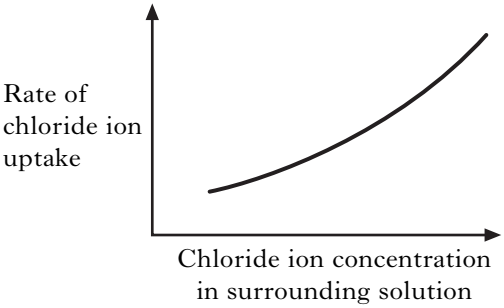
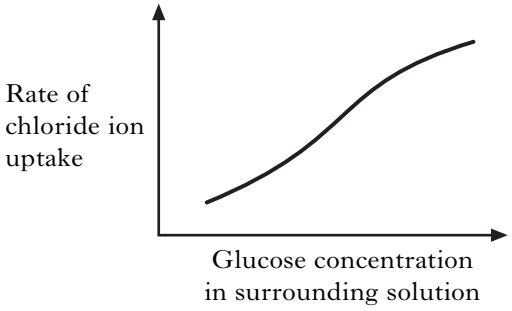


3



Which graphs support the hypothesis that chloride ion uptake by carrot tissue involves active transport?

A 1 and 2 only

B 1 and 3 only

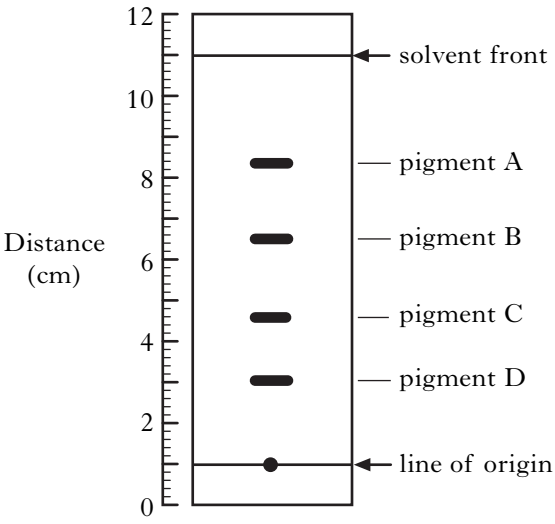
C 2 and 3 only

D 1, 2 and 3

8. The R_f value of a pigment can be calculated as follows:

$$R_f = \frac{\text{distance travelled by pigment from origin}}{\text{distance travelled by solvent from origin}}$$

The diagram shows a chromatogram in which four chlorophyll pigments have been separated.



Which pigment has an R_f value of 0·2?

9. The following steps occur during the replication of a virus.

1 alteration of host cell metabolism

2 production of viral protein coats

3 replication of viral nucleic acid

In which sequence do these events occur?

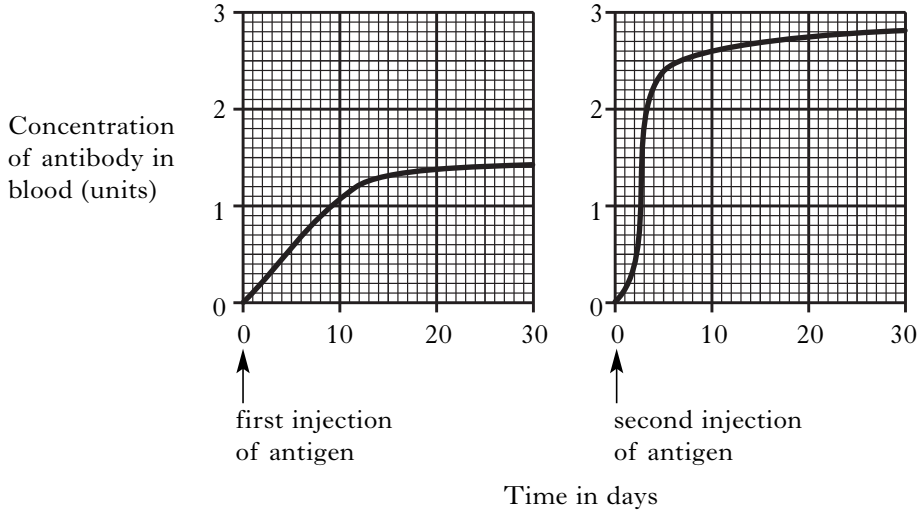
A 1, 3, 2

B 1, 2, 3

C 2, 1, 3

D 3, 1, 2

10. The graphs below show the effect of two injections of an antigen on the formation of an antibody.



The concentration of antibodies is measured 25 days after each injection. The effect of the second injection is to increase the concentration by

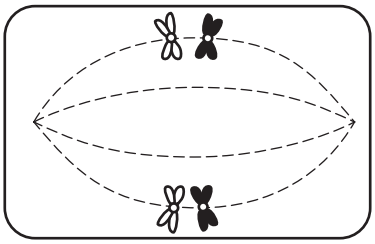
A 1%

B 25%

C 50%

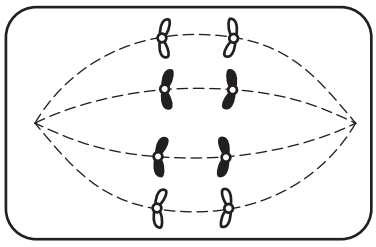
D 100%.

11. The diagram shows a stage of meiosis.

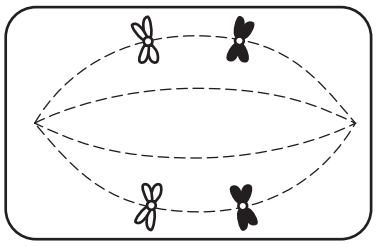


Which of the following diagrams shows the next stage in meiosis?

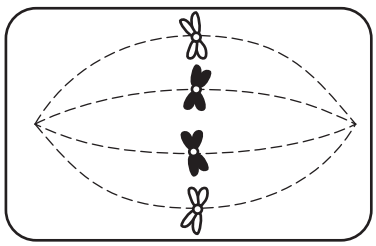
A



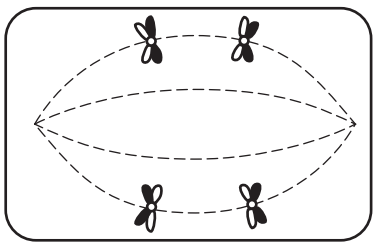
B



C



D



12. Cystic fibrosis is a genetic condition caused by an allele that is not sex-linked. A child is born with cystic fibrosis despite neither parent having the condition. The parents are going to have a second child.

What is the chance that the second child will have cystic fibrosis?

A 75%

B 67%

C 50%

D 25%

13. A sex-linked condition in humans is caused by a recessive allele.

An unaffected man and a carrier woman produce a son.

What is the chance that he will be unaffected?

A 1 in 1

B 1 in 2

C 1 in 3

D 1 in 4

14. A new species of organism is considered to have evolved when its population

A is isolated from the rest of the population by a geographical barrier

B shows increased variation due to mutations

C can no longer interbreed successfully with the rest of the population

D is subjected to increased selection pressure in its habitat.

15. The melanic variety of the peppered moth became common in industrial areas of Britain following the increase in the production of soot during the industrial revolution.

The increase in the melanic variety was due to

A melanic moths migrating to areas which gave the best camouflage

B a change in selection pressure

C an increase in the mutation rate

D a change in the prey species taken by birds.

16. Which of the following is true of freshwater fish?

A The kidneys contain few small glomeruli.

B The blood filtration rate is high.

C Concentrated urine is produced.

D The chloride secretory cells actively excrete excess salts.

17. Which of the following is a behavioural adaptation used by some mammals to survive in hot deserts?

A Dry mouth and nasal passages

B High levels of anti-diuretic hormone in the blood

C Very long kidney tubules

D Nocturnal habit

18. Which line in the table below correctly identifies the effect of the state of the guard cells on the opening and closing of stomata?

	State of guard cells	*Stomata open/closed*
A	flaccid	open
B	plasmolysed	open
C	flaccid	closed
D	turgid	closed

19. In an animal, habituation has taken place when a

A harmful stimulus ceases to produce a response

B harmful stimulus always produces an identical response

C harmless stimulus ceases to produce a response

D harmless stimulus always produces an identical response.

20. The table below shows the rate of production of urine by a salmon in both fresh and sea water.

	Rate of urine production (cm^3/kg of body mass/hour)
In fresh water	5·0
In sea water	0·5

After transfer from the sea to fresh water, the volume of urine produced by a 2·5 kg salmon over a one hour period would have increased by

A $4{\cdot}50\,cm^3$

B $5{\cdot}50\,cm^3$

C $11{\cdot}25\,cm^3$

D $12{\cdot}50\,cm^3$.

21. A 30 g serving of a breakfast cereal contains 1·5 mg of iron. Only 25% of this iron is absorbed into the bloodstream.

If a pregnant woman requires a daily uptake of 6 mg of iron, how much cereal would she have to eat each day to meet this requirement?

A 60 g

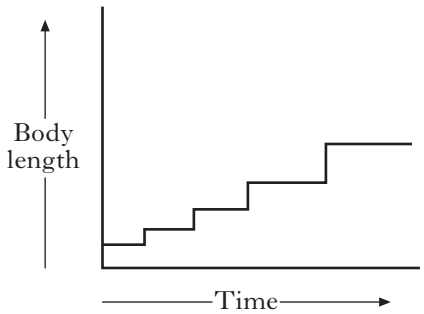
B 120 g

C 240 g

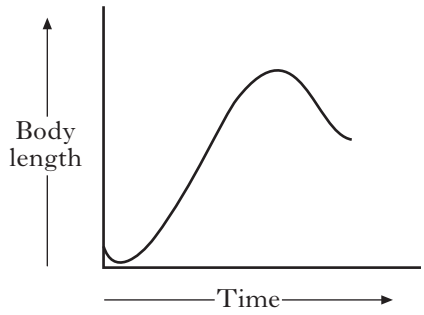
D 480 g

22. Which of the following graphs represents the growth pattern of a locust?

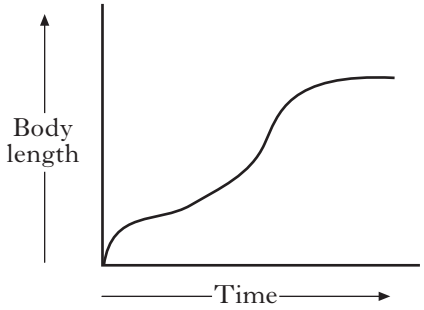
A



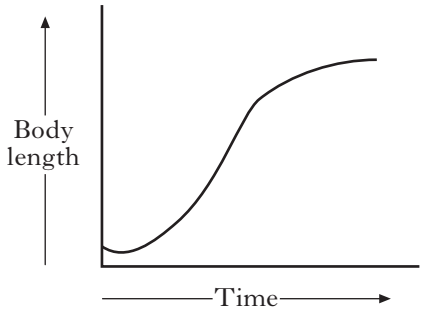
B



C



D



[Turn over

23. Gene expression in cells results in the synthesis of specific proteins. The process of transcription involved in the synthesis of a protein is the

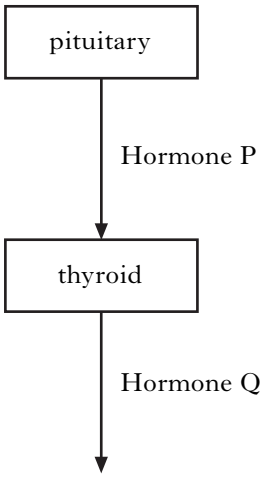
A production of a specific mRNA

B processing of a specific mRNA on the ribosomes

C replication of DNA in the nucleus

D transfer of amino acids to the ribosomes.

24. Hormones P and Q are involved in the control of growth and metabolism.



Control of growth and metabolism

Which line in the table below correctly identifies hormones P and Q?

	Hormone P	*Hormone Q*
A	TSH	growth hormone
B	thyroxine	TSH
C	TSH	thyroxine
D	growth hormone	TSH

25. Temperature control mechanisms in the skin of mammals are stimulated by

A nerve impulses from the pituitary gland

B nerve impulses from the hypothalamus

C hormonal messages from the hypothalamus

D hormonal messages from the pituitary gland.

26. Which of the following is **not** an effect of IAA?

A Increased stem elongation

B Fruit formation

C Inhibition of leaf abscission

D Initiation of germination

27. List P gives reasons why population monitoring may be carried out.

List Q gives three species whose populations are monitored by scientists.

List P

1 Valuable food resource
2 Endangered species
3 Indicator species

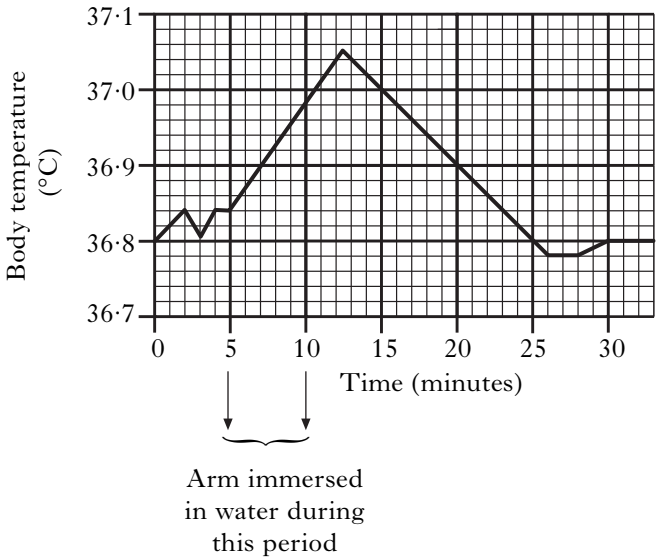
List Q

W Stonefly
X Humpback Whale
Y Haddock

Which line in the table below correctly matches reasons from **List P** with species from **List Q**?

	Reasons		
	1	2	3
A	W	X	Y
B	Y	W	X
C	X	Y	W
D	Y	X	W

28. The graph below records the body temperature of a woman during an investigation in which her arm was immersed in water.



By how much did the temperature of her body vary during the 30 minutes of the investigation?

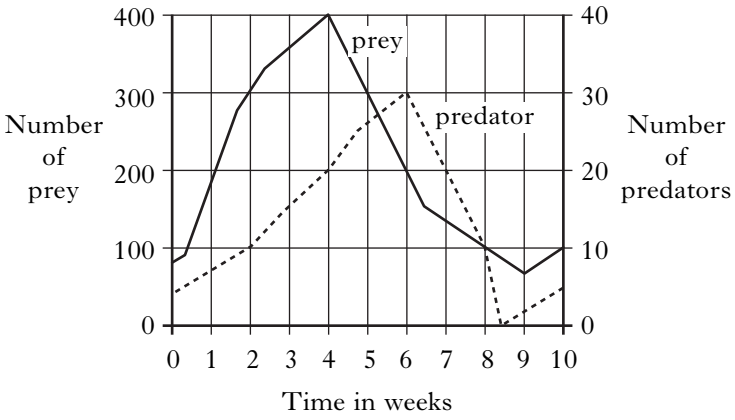
A 0·25 °C

B 0·27 °C

C 2·5 °C

D 2·7 °C

29. The graph below shows the variation in numbers of a predator and its prey recorded over a ten week period.



In which week is the prey to predator ratio the largest?

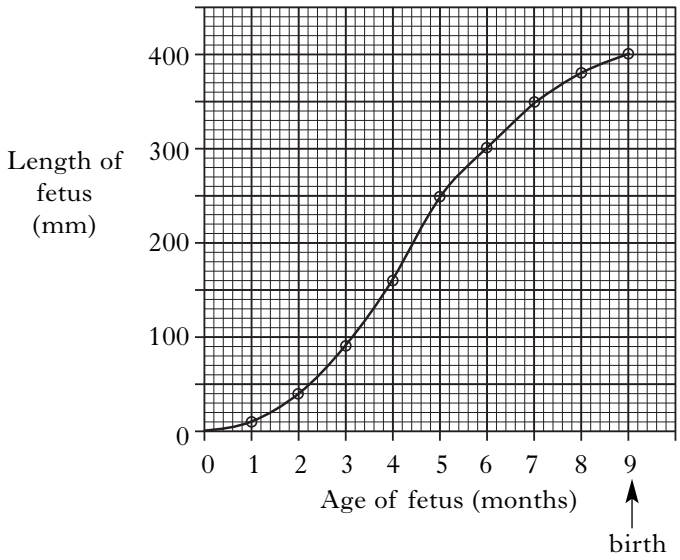
A week 2

B week 4

C week 6

D week 8

30. The graph below shows the length of a human fetus before birth.



What is the percentage increase in length of the fetus during the 4 months before birth?

A 33·3%

B 37·5%

C 60·0%

D 150%

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

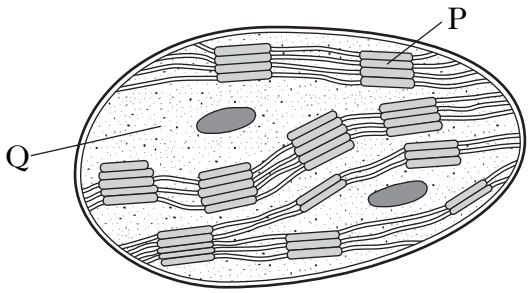
Marks

SECTION B

All questions in this section should be attempted.

All answers must be written clearly and legibly in ink.

1. The diagram shows a chloroplast from a palisade mesophyll cell.



(*a*) Name regions P and Q.

P _____

Q _____ **1**

(*b*) (i) Mark an X on the diagram to show the location of chlorophyll molecules. **1**

(ii) As well as chlorophyll, plants have other photosynthetic pigments.

State the benefit to plants of having these other pigments.

_____

_____ **1**

(*c*) (i) Name **one** product of the light dependent stage of photosynthesis which is required for the carbon fixation stage (Calvin cycle).

_____ **1**

(ii) The table shows some substances involved in the carbon fixation stage of photosynthesis.

Complete the table by inserting the number of carbon atoms present in one molecule of each substance.

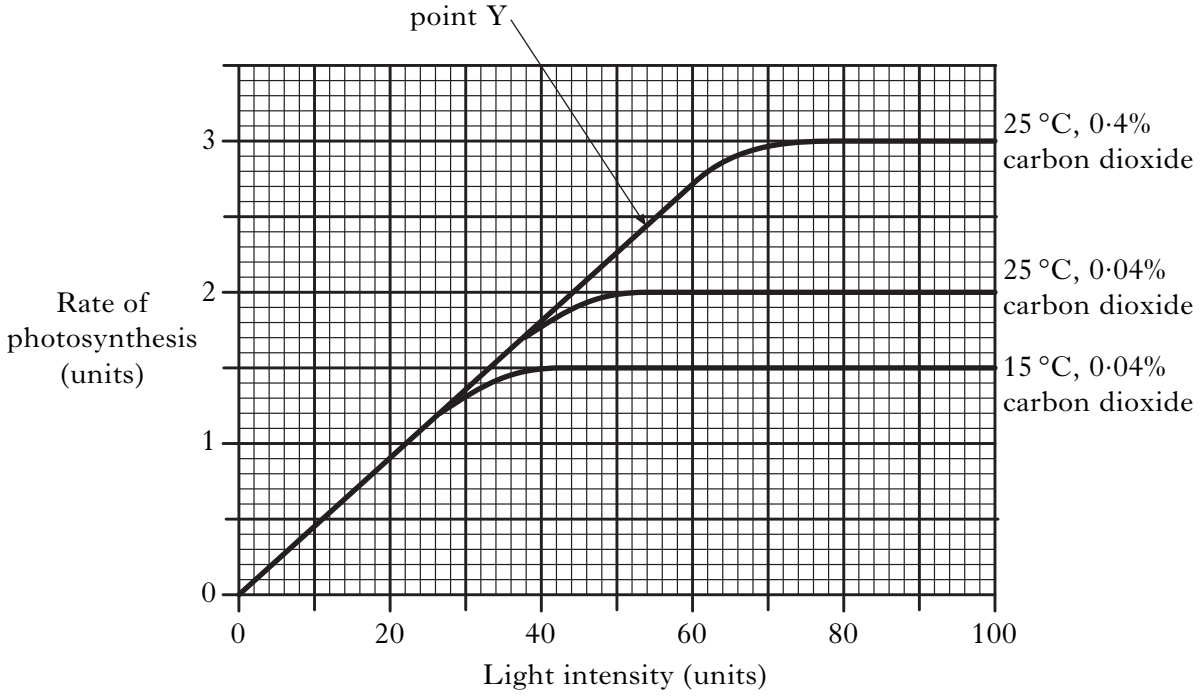
Substance	*Number of carbon atoms in one molecule*
Glucose	
Carbon dioxide	
Glycerate phosphate (GP)	
Ribulose bisphosphate (RuBP)	

2

Marks

1. (continued)

(*d*) The graph below shows the effect of increasing light intensity on the rate of photosynthesis at different carbon dioxide concentrations and temperatures.



(i) Identify the factor limiting the rate of photosynthesis at point Y on the graph.

_____ **1**

(ii) From the graph, identify the factor that has the greatest effect in increasing the rate of photosynthesis at a light intensity of 80 units.

Justify your answer.

Factor _____

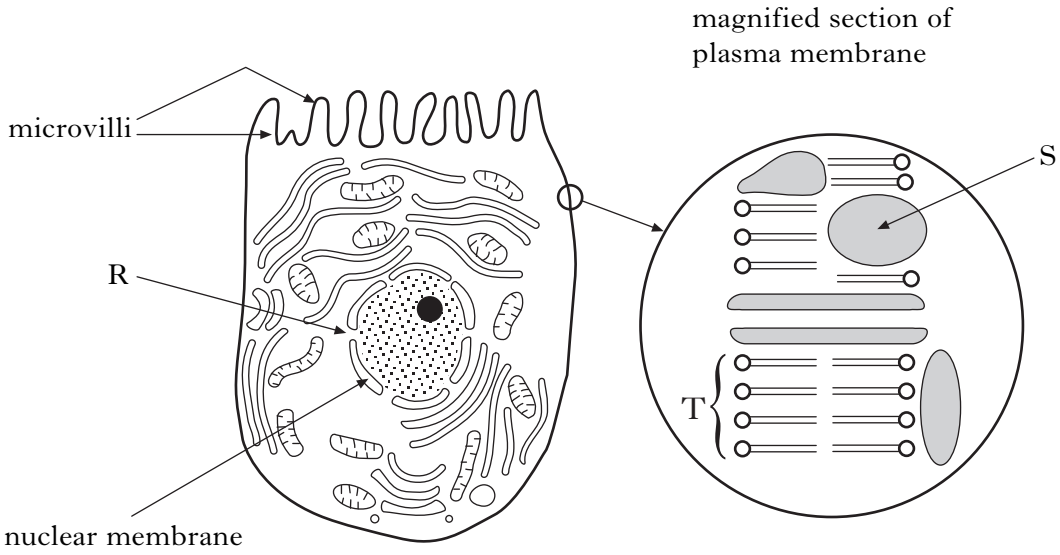
Justification _____

_____

_____ **1**

[Turn over

2. The diagram shows a human liver cell and a magnified section of its plasma membrane. *Marks*



(*a*) (i) Identify molecules S and T.

S _____ **1**

T _____ **1**

(ii) A pore in the nuclear membrane is shown by label R.

Describe the importance of these pores in protein synthesis.

_____

_____ **1**

(iii) What evidence in the diagram suggests that this cell produces large quantities of ATP?

_____ **1**

2. (continued) *Marks*

(*b*) Some liver cells take up glucose from the blood by the process of diffusion.

(i) Describe this process.

_____

_____ **1**

(ii) Suggest a reason for the presence of microvilli in liver cells as shown in the diagram.

_____

_____

_____ **2**

(iii) Glucose taken up by liver cells can be converted into a storage carbohydrate.

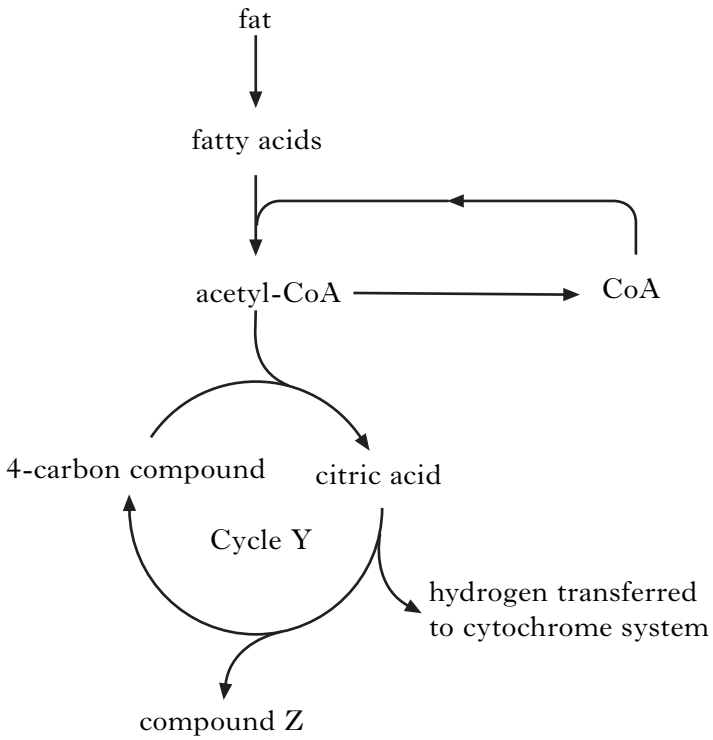
Name this carbohydrate.

_____ **1**

[Turn over

Marks

3. Fat can be used as an alternative respiratory substrate. The diagram shows the breakdown of fat in an athlete's muscle cells during the final stages of a marathon race.



(*a*) Name a respiratory substrate, other than fat, which can be used by muscle cells.

_____ **1**

(*b*) (i) Name cycle Y and compound Z.

Cycle Y _____

Compound Z _____ **1**

(ii) Name the carrier that accepts and transfers hydrogen to the cytochrome system.

_____ **1**

(*c*) Describe the role of oxygen in aerobic respiration.

_____

_____ **1**

3. (continued)

Marks

(*d*) During an 800 metre race, an athlete's muscle cells may respire anaerobically to produce ATP.

(i) State **one** other metabolic product of anaerobic respiration in muscle cells.

_____ **1**

(ii) Where in a cell does anaerobic respiration occur?

_____ **1**

(iii) Describe the importance of ATP to cells.

_____

_____ **1**

[Turn over

Marks

4. (*a*) Decide if each of the following statements about DNA replication is **True** or **False** and tick (✓) the appropriate box.

If the statement is False, write the correct word in the correction box to replace the word underlined in the statement.

Statement	*True*	*False*	*Correction*
During DNA replication hydrogen bonds between bases break.			
During the formation of a new DNA molecule, base pairing is followed by bonding between deoxyribose and bases.			
As a result of DNA replication, the DNA content of a cell is halved.			

2

(*b*) Free DNA nucleotides are needed for DNA replication.

Name **one** other substance that is needed for DNA replication.

_____ **1**

(*c*) A single strand of a DNA molecule has 6000 nucleotides of which 24% are adenine and 18% are cytosine.

(i) Calculate the combined percentage of thymine and guanine bases on the same DNA strand.

Space for calculation

_____ % **1**

(ii) How many guanine bases would be present on the complementary strand of this DNA molecule?

Space for calculation

_____ bases **1**

Marks

5. Ponderosa pine trees produce resin following damage to their bark.

In an investigation, three individual pine trees were chosen from areas with different population densities. Each tree was damaged by having a hole bored through its bark.

Measurements of resin production from each hole following this damage are shown in the table.

Population density (Number of trees per hectare)	*Volume of resin produced in the first day* (cm^3)	*Duration of resin flow* (days)	*Total volume of resin produced* (cm^3)
2	8·3	7·0	29·3
10	0·8	4·8	2·9
50	0·6	4·6	2·8

(*a*) (i) Describe how population density affects the total volume of resin produced.

_____

_____

_____ **2**

(ii) Calculate the average resin flow per day at a population density of 2 trees per hectare **after the first day**.

Space for calculation

_____ cm^3 per day **1**

(*b*) Explain how resin production protects trees.

_____

_____ **1**

[Turn over

Marks

6. An investigation was carried out to compare the rates of water loss from tree species during winter when soil water availability is low.

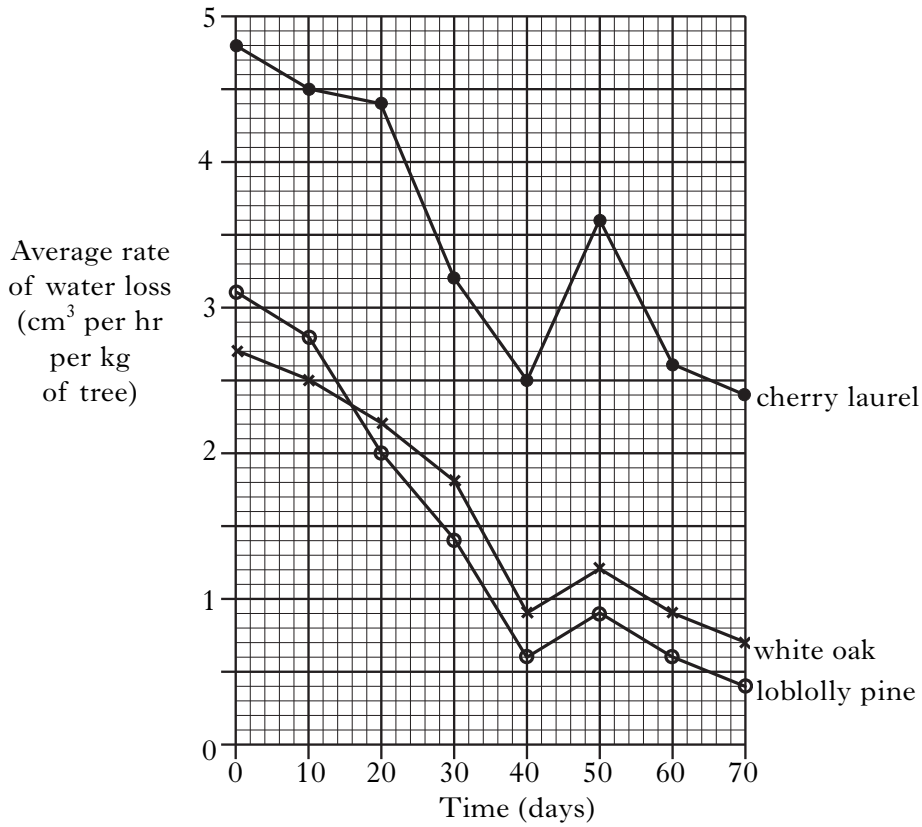
The table shows information about the tree species involved.

Tree species	*Leaf type*	*Leaves lost in winter*
cherry laurel	broad	no
white oak	broad	yes
loblolly pine	needle-like	no

One year old trees of each species were grown outside in identical environmental conditions during winter. The average rate of water loss from each species was measured every tenth day over a 70 day period.

The results are shown in **Graph 1**.

Graph 1



(*a*) (i) **Use values from Graph 1** to describe the changes in rate of water loss from loblolly pine over the 70 day period.

_____

_____

_____ **2**

(ii) Calculate the percentage decrease in rate of water loss from cherry laurel between day 0 and day 50.

Space for calculation

_____ % **1**

6. (*a*) (continued)

Marks

(iii) **From Graph 1** express, as the simplest whole number ratio, the rates of water loss from white oak and cherry laurel on day 20.

_____ white oak : _____ cherry laurel **1**

(iv) Using the information from the table **and** from Graph 1, suggest the advantage to the white oak of losing its leaves in winter.

Justify your answer.

Advantage _____

Justification _____

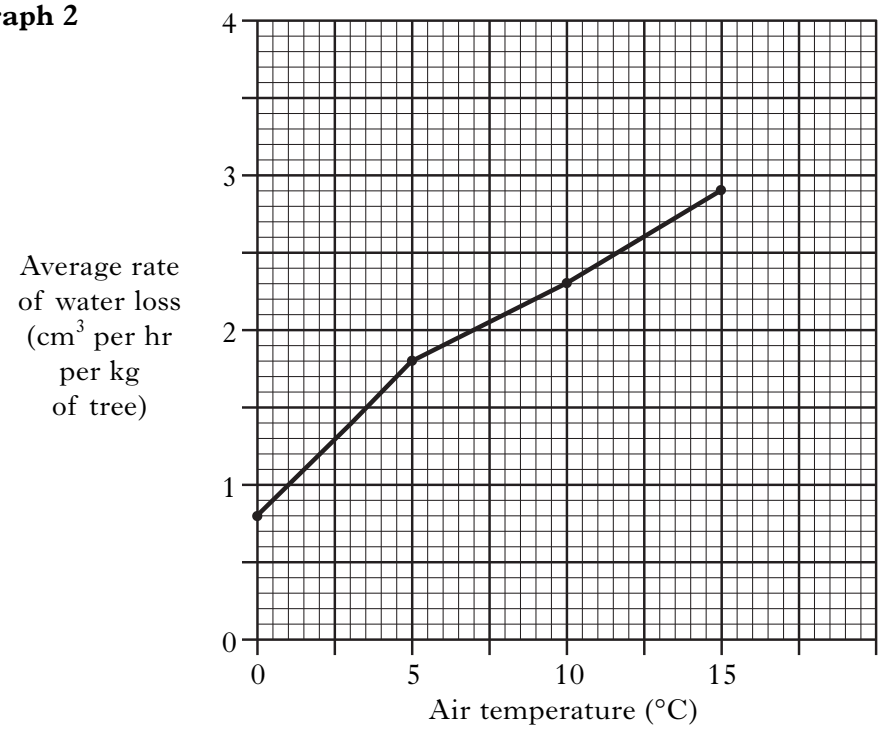
_____

_____ **2**

(*b*) In a further investigation, the effect of air temperature on the average rate of water loss from loblolly pine was measured.

The results are shown in **Graph 2**.

Graph 2



(i) Use the information from **Graphs 1 and 2** to suggest the air temperature on day 30 of the investigation.

_____ °C **1**

(ii) Predict the rate of water loss from loblolly pine at an air temperature of 18 °C.

_____ cm^3 per hour per kg of tree. **1**

(iii) Apart from air temperature and soil water availability, state **one** factor which can affect water loss from trees.

_____ **1**

Marks

7. In horses, coat colour is determined by two genes. The allele for black coat (**B**) is dominant to the allele for chestnut coat (**b**). The allele for grey coat (**G**) is dominant to the allele for non-grey coat (**g**).

Horses with the allele **G** are **always** grey.

A male with the genotype **GgBb** was crossed with a female with the genotype **ggBb**.

(*a*) (i) State the phenotype of each parent.

Male _____

Female _____ **1**

(ii) Complete the grid by adding the genotypes of:

1 the male and female gametes; **1**

2 the possible offspring. **1**

		Male gametes			
Female gametes					

(iii) Give the expected phenotype ratio of the offspring from this cross.

_____ Grey : _____ Black : _____ Chestnut **1**

(*b*) A further gene determines the presence of large white markings in the coat. The allele for the presence of white markings (**T**) is dominant to the allele for their absence (**t**).

A breeder found that a male horse with white markings always produced offspring with white markings when crossed with a female of any phenotype.

Explain this observation in terms of the genotype of this male horse.

_____

_____ **1**

Marks

8. Grey wolves hunt in packs. Their prey includes a variety of large herbivores.

(*a*) (i) Name the hunting method used by wolves and state **one** advantage of this method.

Name _____ **1**

Advantage _____

_____ **1**

(ii) Following the capture of prey, higher ranking wolves feed first.

State the term which describes this type of social organisation.

_____ **1**

(iii) Wolf packs occupy territories ranging from 80 to 1500 km^2.

1 Describe **one** advantage to the wolf pack of occupying a territory.

_____

_____ **1**

2 Suggest **one** factor that could influence the size of a territory occupied by a wolf pack.

_____ **1**

(*b*) The grey wolf was once common in North America but is now an endangered species in many areas.

Following steps to conserve the species, wolf numbers in one wildlife reserve increased from 31 to 683 individuals during an eight year period.

(i) Calculate the average yearly increase in wolf numbers during this period.

Space for calculation

_____ per year **1**

(ii) Other than wildlife reserves, describe **one** method used to conserve endangered species.

_____ **1**

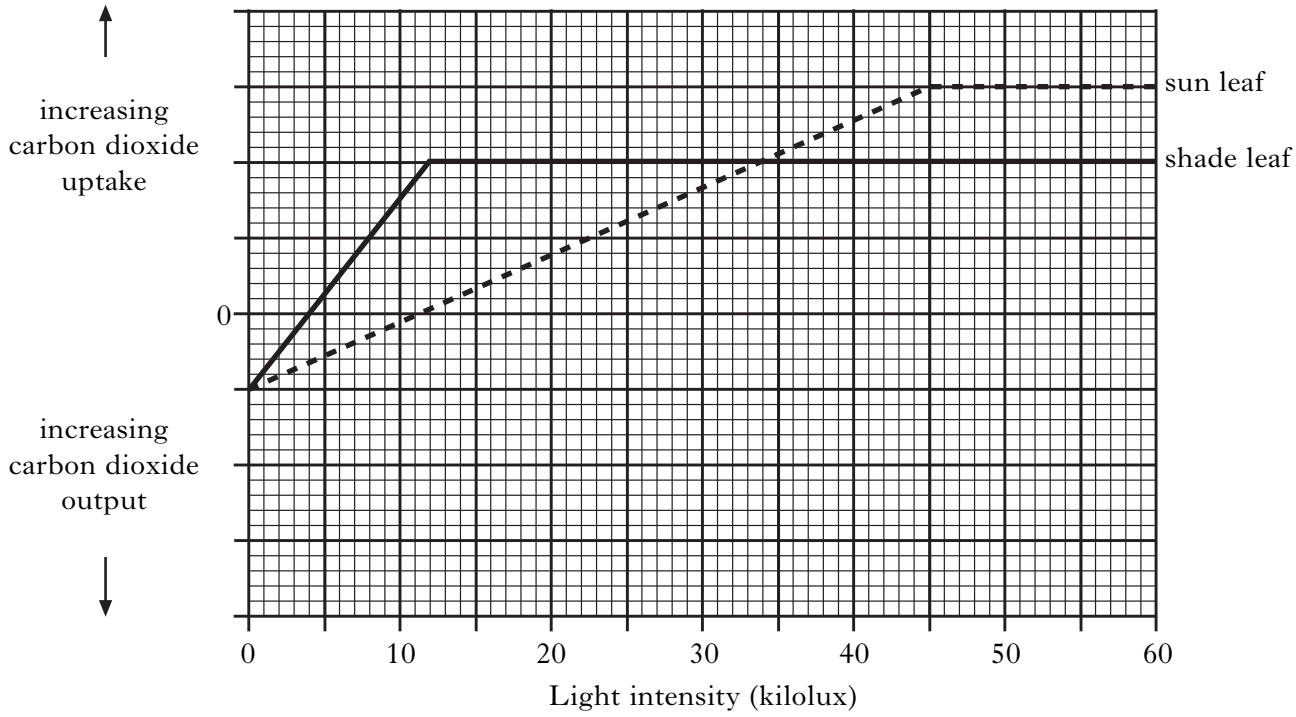
[Turn over

Marks

9. Beech trees have two types of leaf. Sun leaves are exposed to high light intensities for most of the day and shade leaves are usually overshadowed by sun leaves.

The rates of carbon dioxide exchange at different light intensities were measured for sun leaves and shade leaves from one beech tree.

The results are shown on the graph.



(*a*) State the light intensity at which the shade leaves reach their compensation point.

_____ kilolux **1**

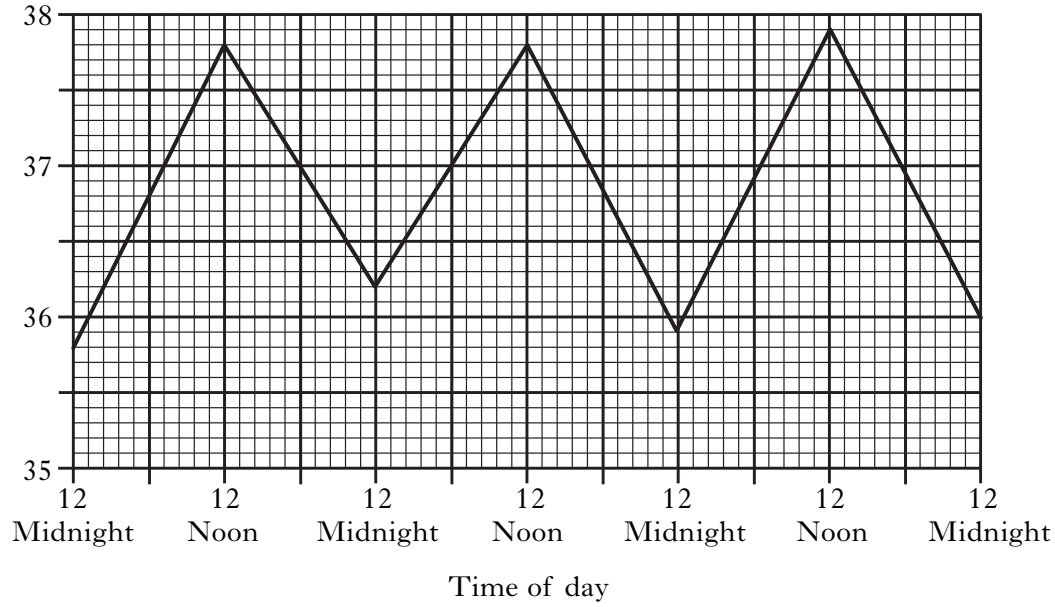
(*b*) Explain why having shade leaves is an advantage to a beech tree.

_____

_____ **1**

Marks

10. Camels live in deserts where temperatures rise to 50 °C during the day and fall to minus 10 °C at night. The graph shows how the body temperature of a camel varied over a three day period.



(*a*) From the information given, what evidence is there that camels obtain heat from their own metabolism?

_____

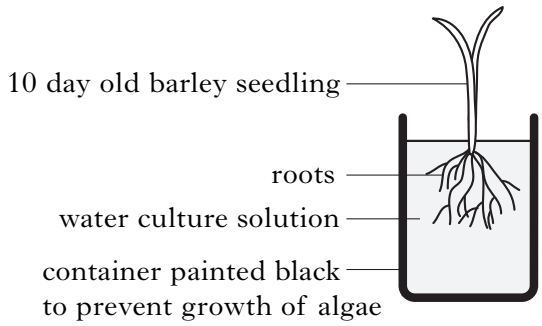
_____ **1**

(*b*) What term is used for animals that obtain most of their body heat from their own metabolism?

_____ **1**

[Turn over

11. In an investigation into the effect of potassium on barley root growth, twelve containers were set up as shown. *Marks*



The water culture solution provided all the elements needed for normal growth.

In six of the containers, the potassium concentration was 2 micromoles per litre. In the other six containers, the potassium concentration was 5 millimoles per litre.

The containers were kept at 20 °C and in constant light intensity.

Every three days, the roots from one container at each potassium concentration were harvested and their dry mass measured.

(*a*) How many times greater was the potassium concentration in the 5 millimoles per litre solution than in the 2 micromoles per litre solution?

1 millimole per litre = 1000 micromoles per litre

Space for calculation

_____ times **1**

(*b*) (i) Identify **one** variable, not already described, that should be kept constant.

_____ **1**

(ii) Suggest **one** advantage of growing the seedlings in water culture solutions rather than soil.

_____ **1**

(iii) Complete the table to give the reasons for each experimental procedure.

Experimental procedure	*Reason*
paint containers black to prevent growth of algae	
measure dry mass rather than fresh mass of roots	

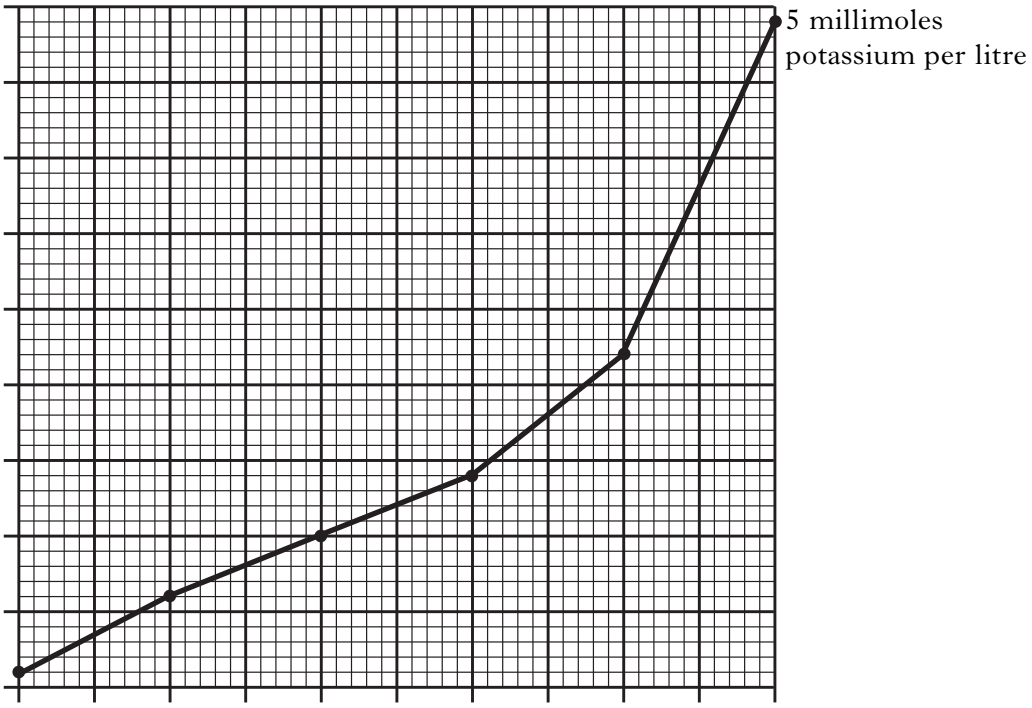
2

(*c*) The results of the investigation are shown in the table.

Marks

Time (days)	*Dry mass of roots* (mg)	
	Potassium concentration 2 micromoles per litre	*Potassium concentration 5 millimoles per litre*
3	1	1
6	5	6
9	8	10
12	11	14
15	16	22
18	22	44

The results for the seedlings grown in 5 millimoles potassium per litre solution are shown on the graph.



Complete the graph by:

(i) adding the scale and label to each axis; **1**

(ii) presenting the results for the 2 micromoles potassium per litre solution **and** labelling the line. **1**

(Additional graph paper, if required, will be found on page 36.)

(*d*) In a further experiment, bubbling oxygen through the water culture solutions was observed to increase the uptake of potassium by the barley roots.

Explain this observation.

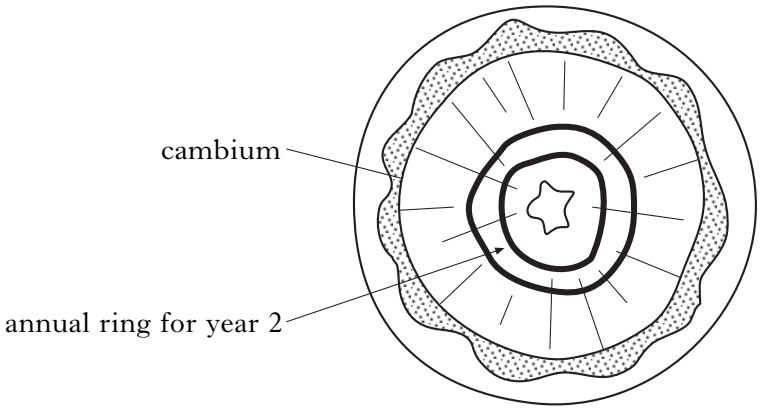
_____

_____

_____ **2**

Marks

12. The diagram shows a section through a three year old hawthorn twig with annual rings.



(*a*) (i) State the function of cambium.

_____ **1**

(ii) Name the tissue of which annual rings are composed.

_____ **1**

(*b*) The tree suffered an infestation of leaf-eating caterpillars during year 2.

Explain how an infestation of leaf-eating caterpillars could account for the narrow appearance of this annual ring.

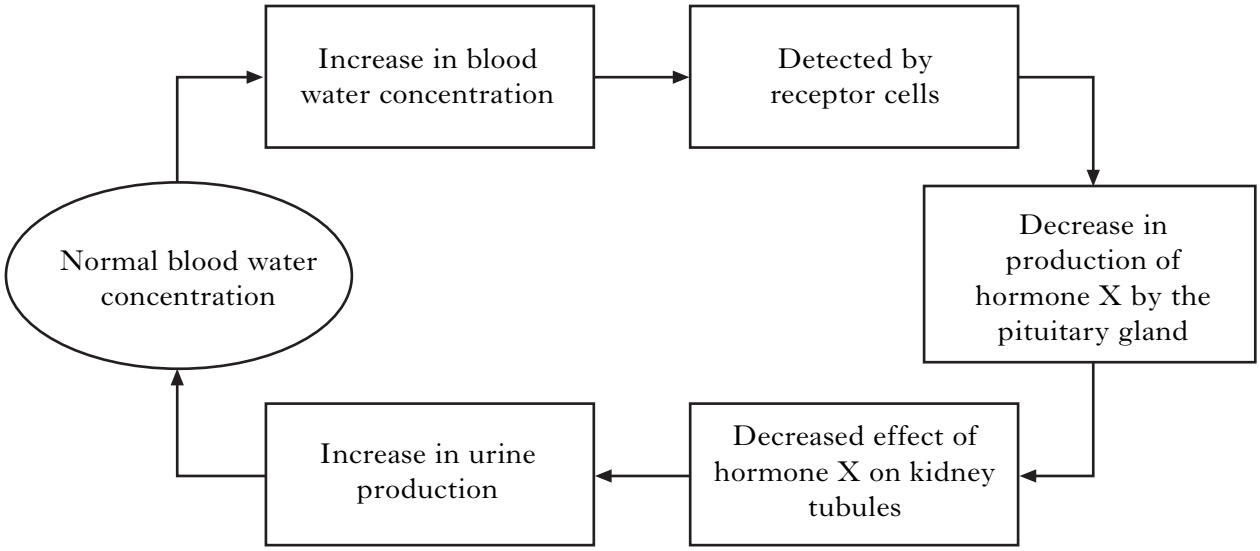
_____

_____

_____ **2**

Marks

13. The flow chart shows part of the homeostatic control of water concentration in human blood.



(*a*) (i) Suggest a reason for the increase in blood water concentration.

_____ **1**

(ii) State the location of the receptor cells.

_____ **1**

(iii) Name hormone X and state its effect on the kidney tubules.

Name _____ **1**

Effect _____

_____ **1**

(*b*) Control of water concentration in human blood involves negative feedback.

Explain what is meant by negative feedback.

_____

_____

_____ **2**

[Turn over

Marks

14. Frequency of mating in a population of wild goats was observed from June to November.

The results are shown in the table.

Month	*Average number of hours of light per day*	*Frequency of mating* *0 = no mating* *+ = occasional mating* *++ = frequent mating*
June	19	0
July	17	0
August	15	0
September	13	+
October	11	++
November	9	++

(*a*) Using the information given, identify the trigger stimulus which results in mating of goats.

_____ **1**

(*b*) Young goats are born 5 months after mating.

Explain how the pattern of mating frequency shown increases the survival rate of the offspring.

_____

_____

_____ **2**

(*c*) What general term is used to describe the effect of light on the timing of breeding in mammals such as goats?

_____ **1**

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.

All answers must be written clearly and legibly in ink.

Labelled diagrams may be used where appropriate.

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

A. Write notes on:

(i) the control of lactose metabolism in *E. coli*; **6**

(ii) phenylketonuria in humans. **4**

(10)

OR

B. Write notes on population change under the following headings:

(i) the influence of density dependent factors; **5**

(ii) succession in plant communities. **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. Give an account of gene mutations and mutagenic agents. **(10)**

OR

B. Give an account of somatic fusion in plants and genetic engineering in bacteria. **(10)**

[*END OF QUESTION PAPER*]

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ADDITIONAL GRAPH PAPER FOR QUESTION 11(*c*)