

FOR OFFICIAL USE

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X007/301

Total for
Sections
B and C

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NATIONAL
QUALIFICATIONS
2002

FRIDAY, 31 MAY
1.00 PM – 3.30 PM

**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.

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.
(c) Question 9 is on pages 22, 23 and 24. Question 10 is on pages 25, 26 and 27. Pages 24 and 25 are fold-out pages. The additional graph paper is on page 36.
- 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.



SECTION A

Read carefully

- 1 Check that the answer sheet provided is for Biology Higher (Section A).
- 2 Fill in the details required on the answer sheet.
- 3 In this section a question is answered by indicating the choice A, B, C or D by a stroke made in **ink** in the appropriate place in the answer sheet—see the sample question below.
- 4 For each question there is only **one** correct answer.
- 5 Rough working, if required, should be done only on this question paper—or on the rough working sheet provided—**not** on the answer sheet.
- 6 At the end of the examination the answer sheet for Section A **must** be placed inside the front cover of this answer book.

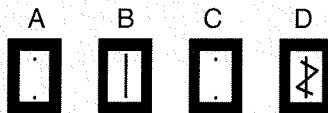
Sample Question

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

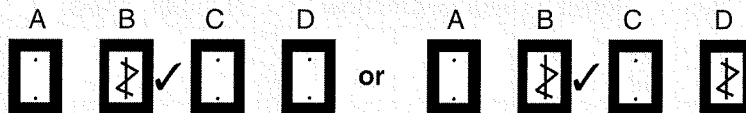
- A respirometer
- B calorimeter
- C klinostat
- D gas burette.

The correct answer is **B**—calorimeter. A **heavy** vertical line should be drawn joining the two dots in the appropriate box in the column headed **B** as shown in the example on the answer sheet.

If, after you have recorded your answer, you decide that you have made an error and wish to make a change, you should cancel the original answer and put a vertical stroke in the box you now consider to be correct. Thus, if you want to change an answer D to an answer B, your answer sheet would look like this:



If you want to change back to an answer which has already been scored out, you should enter a tick (✓) to the **right** of the box of your choice, thus:



SECTION A

All questions in this section should be attempted.

Answers should be given on the separate answer sheet provided.

- When an animal cell is immersed in a hypotonic solution it will
 - burst
 - become turgid
 - shrink
 - become flaccid.
- In photosynthesis, the function of the pigment carotene is to
 - receive light energy from chlorophyll for photolysis of water
 - allow the plant to absorb a wider range of wavelengths of light
 - allow photosynthesis to take place in light of low intensity
 - increase the capacity of chlorophyll to absorb light.
- On Earth, the energy input from sunlight is around 2.0×10^{12} kilojoules per hectare per annum. The energy captured by photosynthesising plants is around 2.0×10^{10} kilojoules per hectare per annum. (A hectare is a measurement of area.)

What is the percentage efficiency of photosynthesis of these plants?

 - 1%
 - 2%
 - 17%
 - 200%
- Three different strains of yeast each lacked a different respiratory enzyme involved in the complete breakdown of glucose.

Strain X – cannot produce carbon dioxide from pyruvic acid.

Strain Y – cannot form pyruvic acid.

Strain Z – cannot reduce oxygen to form water.

Which of the strains could produce ethanol?

 - Strains X and Y
 - Strains X and Z
 - Strain Y only
 - Strain Z only
- Which of the following proteins has a fibrous structure?
 - Pepsin
 - Amylase
 - Insulin
 - Collagen
- Insulin synthesised in a pancreatic cell is secreted from the cell. Its route from synthesis to secretion includes
 - Golgi apparatus → endoplasmic reticulum → ribosome
 - ribosome → Golgi apparatus → endoplasmic reticulum
 - endoplasmic reticulum → ribosome → Golgi apparatus
 - ribosome → endoplasmic reticulum → Golgi apparatus.
- If a living tissue is transplanted from one person to another, there is a risk of rejection because the recipient reacts against the foreign
 - antibodies
 - antigens
 - DNA
 - RNA.

[Turn over

8. Which of the following cells are responsible for producing antibodies?
- A Monocytes
 - B Lymphocytes
 - C Phagocytes
 - D Red blood cells

9. Viruses consist of a
- A lipid coat enclosing DNA or RNA
 - B protein coat enclosing DNA only
 - C protein coat enclosing DNA or RNA
 - D lipid coat enclosing DNA only.

10. What is the significance of chiasma formation?
- A It results in the halving of the chromosome number.
 - B It results in the pairing of homologous chromosomes.
 - C It permits gene exchange between homologous chromosomes.
 - D It results in the independent assortment of chromosomes.

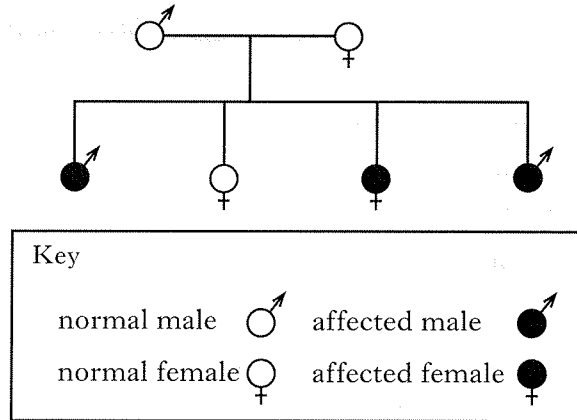
11. The table below shows some genotypes and phenotypes associated with forms of sickle-cell anaemia.

Genotype	Phenotype
Hb ^A Hb ^A	normal
Hb ^A Hb ^S	sickle-cell trait
Hb ^S Hb ^S	acute sickle-cell anaemia

A normal man marries a woman with the sickle-cell trait. What are the chances that any child born to them will have acute sickle-cell anaemia?

- A None
- B 1 in 1
- C 1 in 2
- D 1 in 4

12. The diagram shows the transmission of the gene for albinism.



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.

13. In *Drosophila*, the long-winged condition (L) is dominant to the vestigial-winged condition (l) and broad abdomen (B) is dominant to narrow abdomen (b).

When parent flies, heterozygous for both wing shape and abdomen width, were crossed with flies having vestigial wings and narrow abdomens, the results were as shown in the table below.

	Number of male offspring	Number of female offspring
Long wings, broad abdomen	230	227
Long wings, narrow abdomen	4	3
Vestigial wings, broad abdomen	3	3
Vestigial wings, narrow abdomen	238	240

These results indicate

- A crossing over
- B independent assortment
- C a mutation
- D sex-linkage.

14. Colour blindness is a recessive, sex-linked characteristic controlled by the allele b .

Two parents with normal vision have a colour-blind boy.

The genotypes of the parents are

- A $X^B Y$ and $X^B X^b$
 B $X^b Y$ and $X^B X^B$
 C $X^b Y$ and $X^B X^b$
 D $X^B Y$ and $X^b X^b$
15. Which of the following mutations would cause a change in chromosome number?
- A Translocation
 B Non-disjunction
 C Inversion
 D Insertion
16. Genes a to j occur on part of a chromosome.

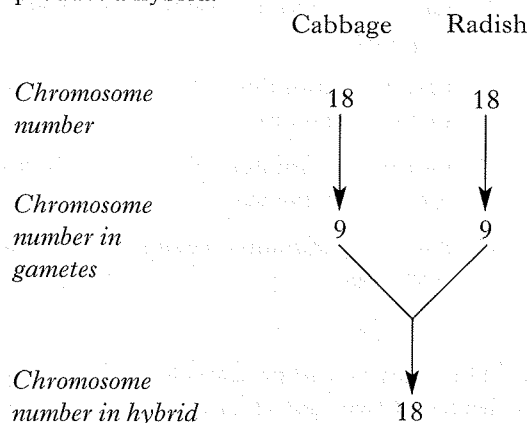
a b c d e f g h i j

After cell division, this part of the chromosome had the following sequence of genes:

a b c d e f g d e f g h i j

This change is called a

17. Cabbage and radish each have a diploid number of 18. These plants can be crossed to produce a hybrid.



Which of the following statements is true?

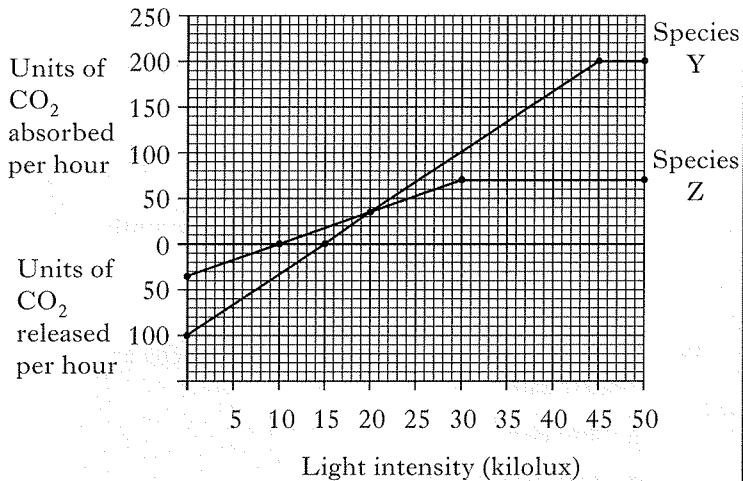
- A The hybrid contains 9 pairs of homologous chromosomes.
 B The chromosomes in the hybrid cannot pair during meiosis.
 C The hybrid can produce gametes with a haploid number of 9.
 D The hybrid can interbreed successfully with either parent.
18. In the formation of protoplasts, plant cells are treated with
- A amylase
 B lipase
 C restriction enzymes
 D cellulase.
19. Which of the following is an example of intraspecific competition?
- A Plants of the same species competing for the same growth requirements.
 B Plants of the same species competing for different growth requirements.
 C Plants of a different species competing for the same growth requirements.
 D Plants of a different species competing for different growth requirements.

[Turn over

20. 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 always produces an identical response
 - D harmless stimulus ceases to produce a response.

21. The rates of carbon dioxide exchange by the leaves of two species of plants were measured at different light intensities.

The results are shown in the graph below.



What are the light intensities at which species Z and Y reach their compensation points?

	Light Intensity (kilolux)	
	Z	Y
A	10	15
B	20	20
C	20	30
D	30	45

22. Which of the following statements explains the structural differences between cells in different tissues of an organism?

- A Cells in some tissues have more genes than cells in other tissues.
- B As different tissues develop, different genes are lost from their cells.
- C Different cell types have the same genes but different genes are active.
- D Some tissues have genes from one parent while some have genes from the other.

23. The thyroid gland is involved in the control of metabolic rate.

Which of the following shows the correct sequence for metabolic control.

- A Pituitary → thyroxine → thyroid → TSH
- B Pituitary → TSH → thyroid → thyroxine
- C TSH → thyroxine → pituitary → thyroid
- D Thyroid → TSH → thyroxine → pituitary

24. Which of the following is the correct sequence of events that occurs in control of the concentration of blood sugar?

	<i>Concentration of blood sugar</i>	<i>Glucagon secretion</i>	<i>Insulin secretion</i>	<i>Glycogen stored in liver</i>
A	increases	decreases	increases	increases
B	increases	decreases	increases	decreases
C	decreases	increases	decreases	increases
D	decreases	decreases	increases	decreases

25. Which of the following is **not** the result of a magnesium deficiency in flowering plants?

- A Curling of the leaves
- B Yellowing of the leaves
- C Reduction in shoot growth
- D Reduction in root growth

26. A 30 g serving of breakfast cereal with 125 cm³ of semi-skimmed milk contains 1.5 mg of iron. Only 25% of this iron is absorbed into the bloodstream.

If a woman in late pregnancy requires a daily intake of 6 mg of iron, how much cereal and milk would have to be eaten to meet this requirement?

	<i>Cereal (g)</i>	<i>Milk (cm³)</i>
A	60	250
B	120	500
C	240	1000
D	480	2000

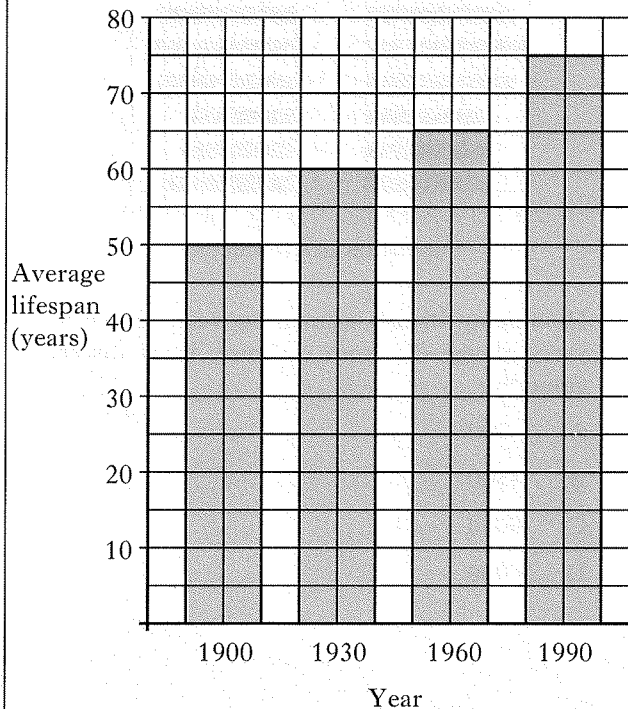
27. In humans, vitamin D plays an essential role in the absorption of

- A glucose
- B calcium
- C iron
- D lipids.

28. Which one of the following factors affecting a population of rabbits is density independent?

- A Viral disease
- B The population of foxes
- C The biomass of the grass
- D Rainfall

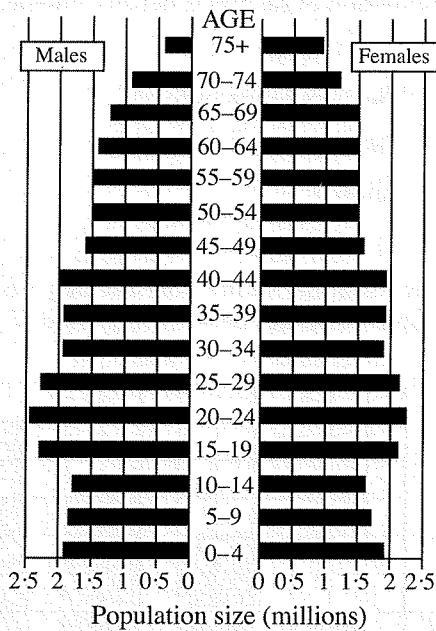
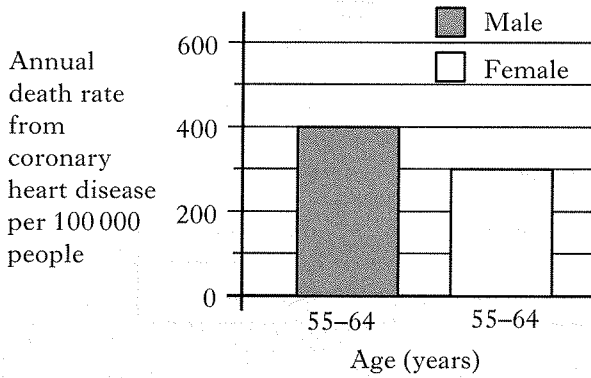
29. The diagram shows the average lifespan of people in Britain between 1900 and 1990.



What is the percentage increase in lifespan during this period?

- A 25%
- B 45%
- C 50%
- D 75%

30. The graphs below contain information about the population of Britain.



How many British women between 55 and 64 years of age die from coronary heart disease annually?

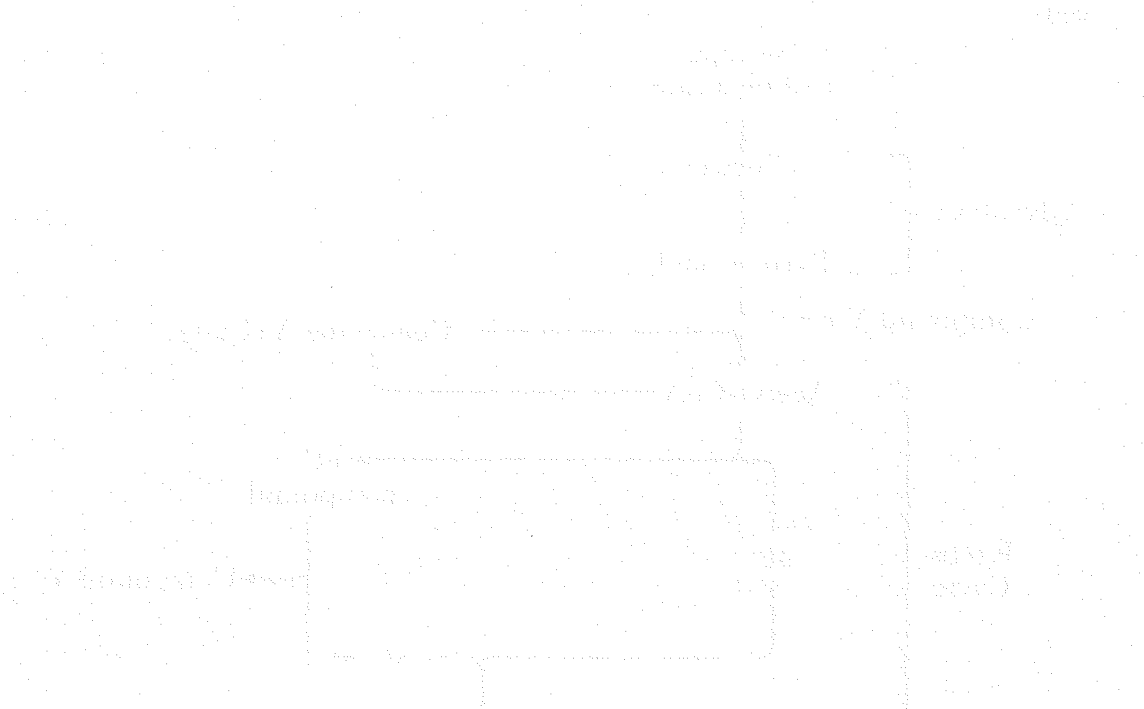
- A 300
- B 4500
- C 9000
- D 21000

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

SECTION A

Answer all the questions in this section.

1. The diagram shows a rectangle ABCD. The length of the rectangle is 12 cm and the width is 8 cm.



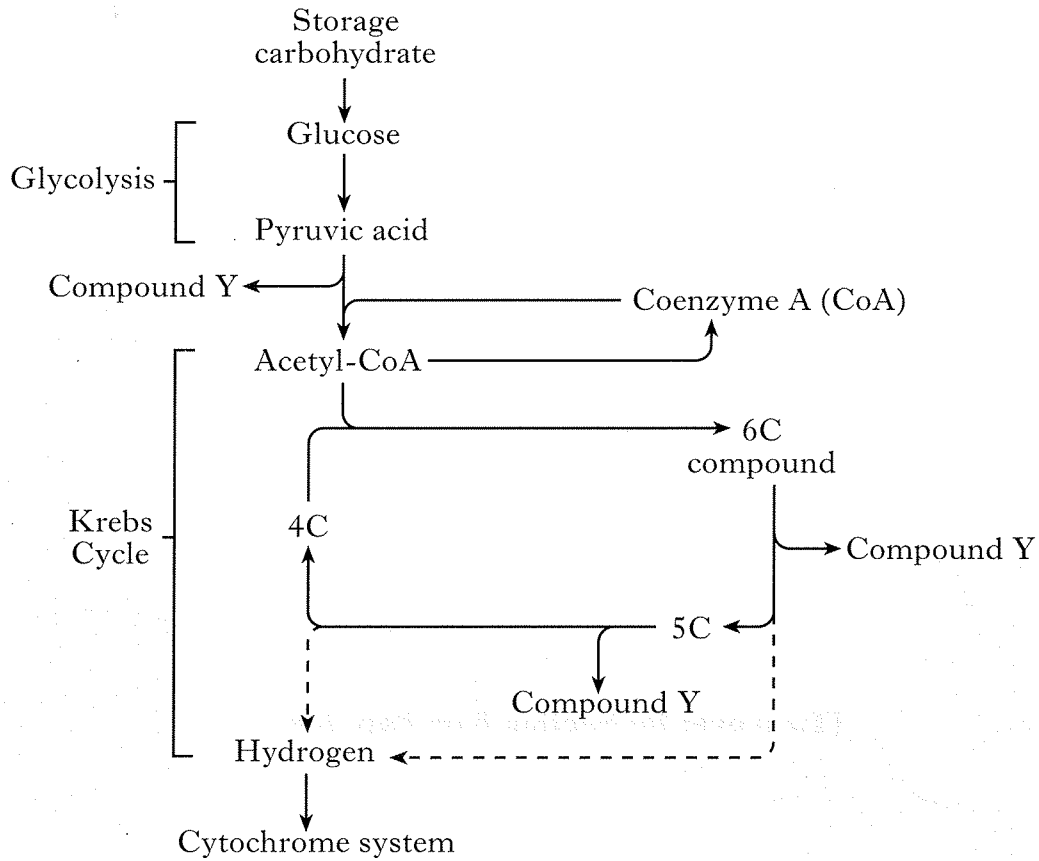
[Turn over for Section B on Page ten

SECTION B

Marks

All questions in this section should be attempted.

1. The diagram below represents stages in aerobic respiration in mammalian liver cells.



- (a) Name the storage carbohydrate in liver cells.

1

- (b) Other than carbohydrate, name an alternative respiratory substrate.

1

- (c) State the exact location within a liver cell of:

1 Glycolysis _____

2 Krebs cycle _____

2

- (d) State the net gain of ATP molecules from the breakdown of a glucose molecule to pyruvic acid.

1

Marks

1. (continued)

(e) Name the 6 carbon compound and compound Y shown in the Krebs cycle.

6C compound _____

Compound Y _____

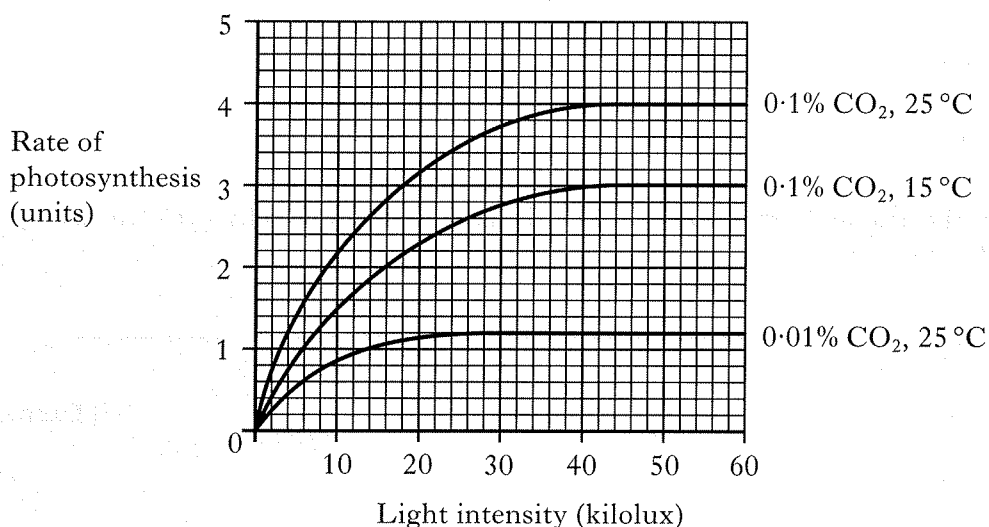
2

(f) Name the chemical that transports hydrogen from the Krebs cycle to the cytochrome system.

1

[Turn over

2. (a) The graph below shows the effects of varying light intensity, carbon dioxide concentration and temperature on the rate of photosynthesis in a plant. Marks



- (i) At a light intensity of 60 kilolux, identify which factor, as shown in the graph, has the greater effect in increasing the rate of photosynthesis. Justify your answer.

Factor _____

Justification _____

1

- (ii) The experiment was repeated at a carbon dioxide concentration of 0.01% and a temperature of 15 °C. **Onto the graph above**, draw a curve to show the predicted results of this experiment.

1

- (iii) The rate of photosynthesis can be calculated by measuring a change in dry mass with time. State **one** other method that can be used to calculate the rate of photosynthesis.

1

- (b) Other than being absorbed for use in photosynthesis, give **two** possible fates of the light energy that shines onto the leaves of plants.

1 _____

2 _____

1

- (c) Within which region of a chloroplast does the absorption of light take place?

1

2. (continued)

Marks

- (d) Name the **two** chemical compounds produced in the light dependent stage that are essential for the conversion of GP to glucose.

Compound 1 _____

Compound 2 _____

1

- (e) Complete the table below by inserting the number of carbon atoms present in each of the chemical compounds.

<i>Compound</i>	<i>Number of carbon atoms</i>
GP	
RuBP	
Glucose	

1

- (f) What would be the effect on the RuBP concentration if conditions were changed from light with carbon dioxide present to light with carbon dioxide absent.

Explain your answer.

Effect _____

Explanation _____

2

- (g) The list below shows terms which refer to the role of light in the growth and development of plants and animals.

<i>List of terms</i>
Phototropism
Compensation point
Etiolation
Photoperiodism

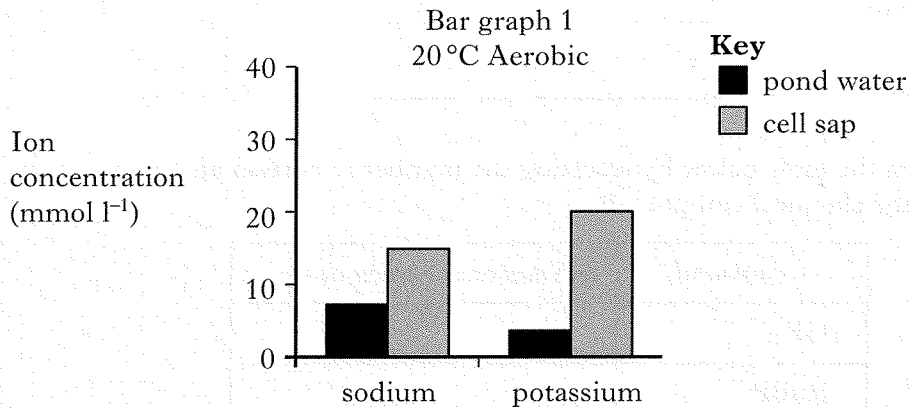
In the table below insert the term that is described by each statement.

<i>Statement</i>	<i>Term</i>
The rate of respiration equals the rate of photosynthesis at a certain light intensity.	
If germinated in darkness, a seedling has long internodes and small yellow leaves.	
Plants respond to directional light by a growth curvature.	
A change in the number of hours of light in the day can affect growth and development in many plants and animals.	

2

Marks

3. (a) Bar graph 1 shows the concentrations of sodium and potassium in the cell sap of a water plant and in the surrounding pond water. The data were collected at 20°C under aerobic conditions.



- (i) What evidence from the bar graph suggests that:

1 ion uptake is by active transport? _____

_____ 1

2 ion uptake is selective? _____

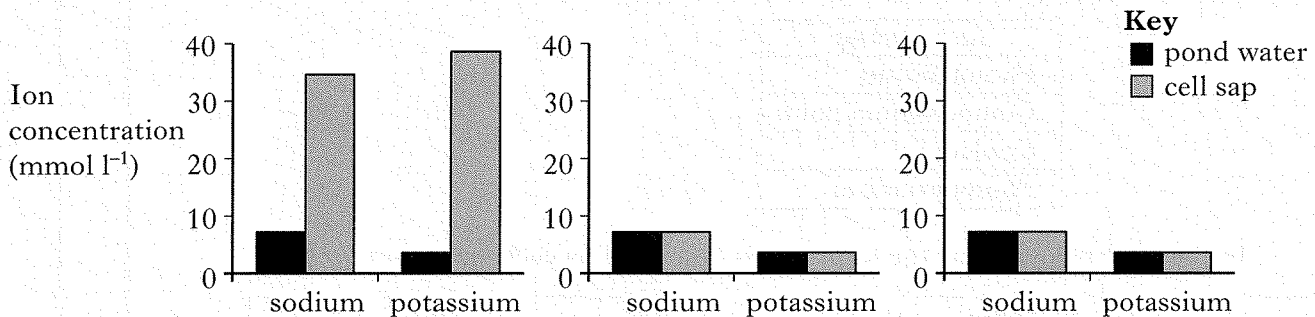
_____ 1

The experiment was repeated at different temperatures and oxygen availability. The results obtained are shown below.

Bar graph 2
30°C Aerobic

Bar graph 3
50°C Aerobic

Bar graph 4
20°C Anaerobic



Marks

3. (a) (continued)

(ii) Complete the table below to identify **two** bar graphs which could be compared to support each statement.

<i>Statement</i>	<i>Comparison</i>	
	Bar graph number	Bar graph number
Enzyme activity increases with increasing temperature		
Membrane proteins may be denatured		

2

(iii) Account for the differences in ion uptake shown in bar graphs 1 and 4.

2

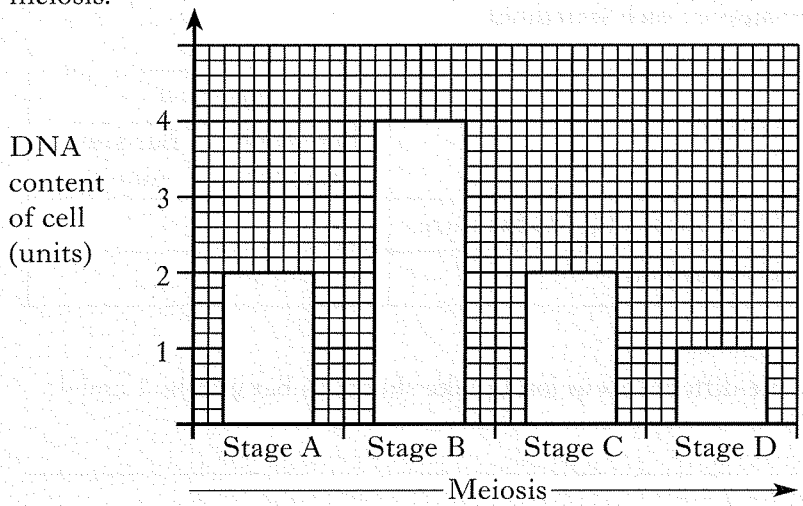
(b) State the importance of potassium in the normal functioning of plant cells.

1

[Turn over

Marks

4. (a) A gamete mother cell undergoes meiosis to form gametes.
The bar graph below shows the DNA content per cell at different stages in meiosis.



Describe what happens during meiosis to account for the change in the DNA content per cell between the following stages.

- 1 Stages A and B _____
_____ 1
- 2 Stages B and C _____
_____ 1
- 3 Stages C and D _____
_____ 1

(b) The table below shows the percentage recombination frequencies for four genes present on the same chromosome.

Gene pairs	% recombination frequency
P and Q	16
P and R	8
R and S	12
Q and S	4

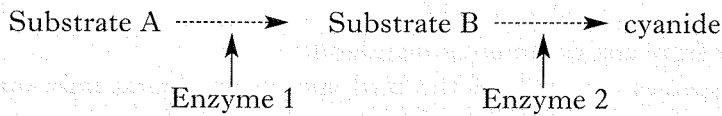
(i) What term is used to describe genes present on the same chromosome?
_____ 1

(ii) Use the information to identify the order in which these genes lie on the chromosome.
Space for calculation

Order _____ 1

Marks

5. (a) Cyanogenic clover plants produce cyanide when their tissues are damaged. Cyanide is toxic and its production defends plants against herbivores. The diagram below shows the metabolic pathway which produces cyanide.



The genes which code for Enzymes 1 and 2 have alleles with properties shown in the table below.

Gene coding for Enzyme 1		Gene coding for Enzyme 2	
Allele R	Synthesises Enzyme 1	Allele T	Synthesises Enzyme 2
Allele r	Cannot synthesise Enzyme 1	Allele t	Cannot synthesise Enzyme 2

- (i) Complete the cross below by:

- inserting the genotype of the gametes of the individual with the genotype RrTt;
- showing the possible genotypes of the offspring.

Parental phenotypes Cyanogenic X Non-cyanogenic
Parental genotypes RrTt X rrtt

<i>Gamete(s)</i> →					
↓					
(rt)					

1

1

- (ii) Express the expected number of cyanogenic to non-cyanogenic plants as the simplest whole number ratio.

Ratio cyanogenic _____ : non-cyanogenic _____

1

- (b) Give **two** examples of adaptations which allow plants to tolerate grazing.

Example 1 _____

Example 2 _____

1

[Turn over

Marks

6. (a) The following statements refer to the Hawaiian islands and species which inhabit them.

Statements

1. The Hawaiian islands are of volcanic origin.
2. The islands are far from any continental mainland.
3. 91% of the plant species and 81% of the bird species are found only on these islands.
4. Hawaiian honeycreepers are species of birds which are descended from a seed-eating ancestral species.
5. Honeycreeper species show a wide range of beak shapes for eating the seeds, fruits, nectar and insects available.
6. Estimates of the present number of honeycreeper species range from 29 to 33 with many extinctions having occurred after the arrival of man on the islands.

- (i) Name the isolation mechanism illustrated in Statement 2.

1

- (ii) State the importance of isolating mechanisms in the evolution of new species.

1

- (iii) Identify the **two** statements which suggest that the evolution of the honeycreeper species is an example of adaptive radiation.

Statement numbers _____ and _____

1

- (iv) Name **two** methods used to conserve species and prevent their extinction. (Statement 6)

2

Marks

6. (continued)

- (b) Populations may be monitored to provide data for a wide variety of purposes. The table below shows the sulphur dioxide concentrations within various areas and the number of lichen species present.

<i>Sulphur dioxide concentration in area (ppm)</i>	<i>Number of lichen species present</i>
32	0
17	4
8	11
0	17

From the table explain how lichen can be used as indicator species.

1

- (c) Explain the need to monitor populations of fish such as cod.

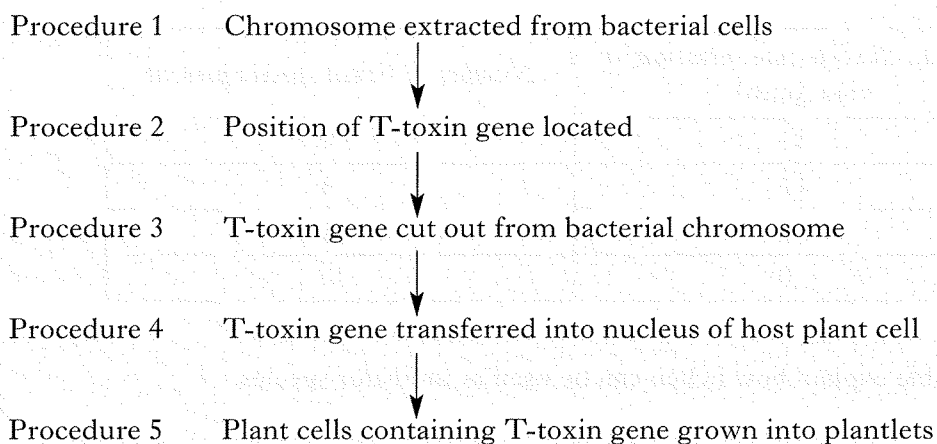
1

[Turn over

Marks

7. The bacterium *Bacillus thuringiensis* produces a substance called T-toxin that is harmful to leaf-eating insects.

The information below shows some of the procedures used by genetic engineers to insert the gene for the production of T-toxin into crop plants.



- (a) Name a technique that could be used in Procedure 2 to locate the position of the T-toxin gene.

_____ 1

- (b) Name the enzyme used in procedure 3.

_____ 1

- (c) Explain why such genetically engineered crop plants would grow better than unmodified crop plants.

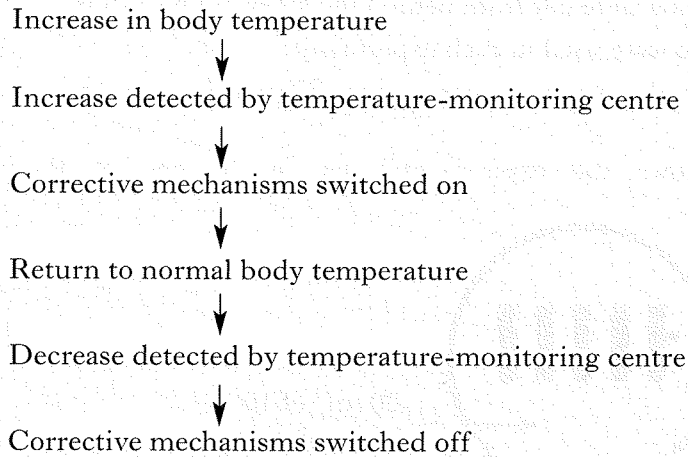
_____ 2

- (d) These crops were commercially successful for several years. However, they have since become susceptible to attack by some members of a particular insect species.
Suggest a reason that would account for this observation.

_____ 1

Marks

8. The flowchart represents the control system involved in returning body temperature to normal after an increase.



- (a) State the exact location of the temperature-monitoring centre

1

- (b) In the following sentence **underline** one of the alternatives in each pair to describe a corrective mechanism that is switched on when body temperature increases.

In this corrective mechanism { vasoconstriction } results in { increased } blood

flow to the skin and therefore, { increased } heat loss from the skin by

radiation.

1

- (c) Describe another corrective mechanism that would reduce body temperature.

1

- (d) How is the message carried from the temperature-monitoring centre to effectors?

1

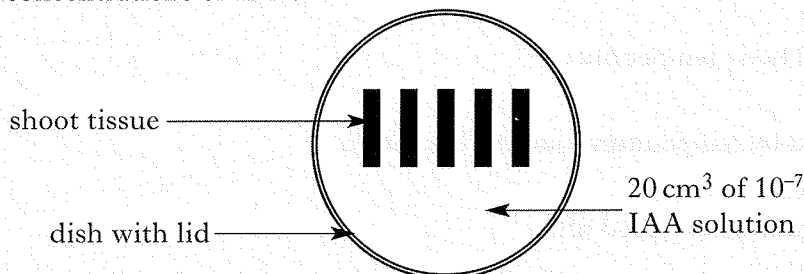
- (e) What is the importance of body temperature in humans to metabolic processes?

1

9. An investigation was carried out into the effect of different concentrations of indole-acetic acid (IAA) on growth of shoot tips.

The method used in the investigation is outlined below.

- 10 mm lengths of shoot tissue were cut from behind the shoot tip meristem.
- Five lengths of shoot tissue were used in each experiment.
- Shoot tissues were immersed in solutions containing different concentrations of IAA.
- The diagram below shows the experimental set up at one of the concentrations of IAA.



- A control experiment was set up with five 10 mm lengths of intact shoot tip tissue immersed in distilled water.
- The experiments were left in the dark for 48 hours.
- The length of each shoot tip tissue was measured.
- For each IAA concentration, the average length of shoot tip tissue was compared with the control experiment.

Key

- + Growth greater than control
– Growth less than control

The results are shown in the table below.

<i>Concentration of IAA solution (molar)</i>	<i>Difference between the average length of shoot tissue and the control (mm)</i>
10^{-7}	+4
10^{-6}	+8
10^{-5}	+5
10^{-4}	+3
10^{-3}	0
10^{-2}	-2
10^{-1}	-4

[Question 9 continues on Page twenty-three and fold-out Page twenty-four