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National
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X807/76/01

**Biology
Paper 2**

TUESDAY, 28 APRIL
10:10 AM – 12:30 PM



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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Number of seat

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Date of birth

Day

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Month

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Year

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Scottish candidate number

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Total marks — 95

Attempt ALL questions.

You may use a calculator.

Questions 9 and 14 contain a choice.

Write your answers clearly in the spaces provided in this booklet. Additional space for answers and rough work is provided at the end of this booklet. If you use this space you must clearly identify the question number you are attempting. Any rough work must be written in this booklet. Score through your rough work when you have written your final copy.

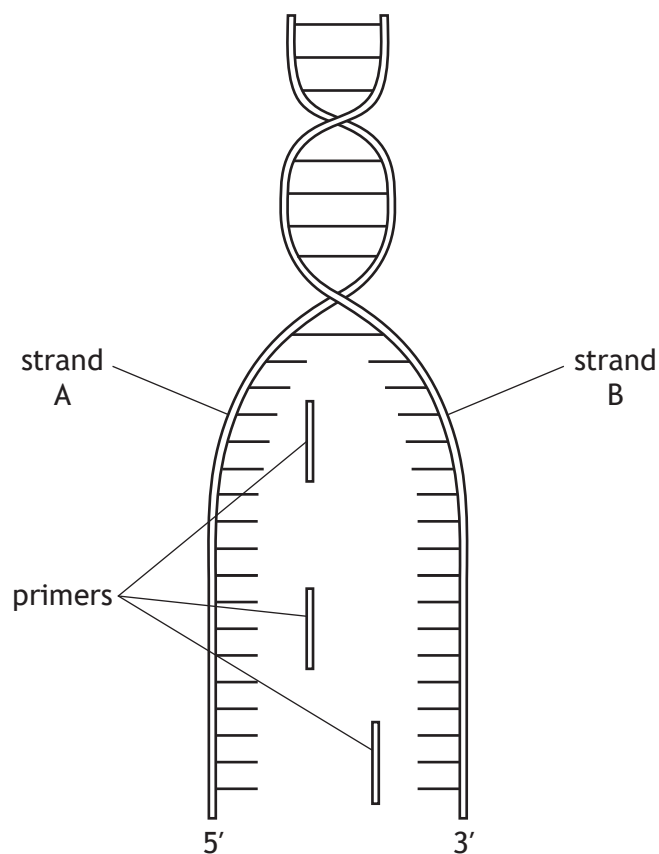
Use **blue** or **black** ink.

Do not remove any exam materials. You must leave this booklet on your desk; if you do not, you could lose all the marks for this paper.



Total marks — 95
Attempt ALL questions
Questions 9 and 14 contain a choice

1. The diagram represents a stage in DNA replication.



- (a) (i) State the term used to describe the shape of a DNA molecule. 1

- (ii) Name the part of a nucleotide found at the 5' end of a DNA strand. 1



1. (continued)

(b) Primers are necessary for DNA replication.

(i) State why replication of strand B requires only one primer.

1

(ii) Primers are short strands of **RNA nucleotides**.

The base sequence of DNA on strand B that the primer binds to is shown.

C G A A T C G T

Give the base sequence of this primer.

1

(c) Name one enzyme involved in DNA replication and state its function.

2

Enzyme _____

Function _____

(d) In prokaryotic cells, DNA replicates at a rate of 1000 nucleotides per second. In comparison, eukaryotic DNA can replicate at a rate of 50 nucleotides per second.

Calculate how many times greater the rate of replication is in prokaryotic cells compared to eukaryotic cells.

1

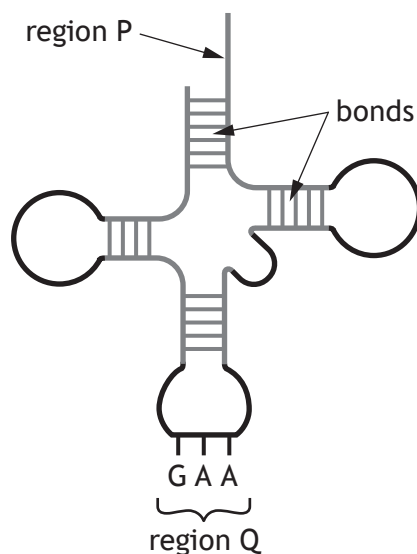
Space for calculation

_____ times greater

[Turn over



2. tRNA is a single strand of RNA, which has an important role in translation. It is folded into a specific shape as shown in the diagram.



- (a) (i) Name regions P and Q.

2

Region P _____

Region Q _____

- (ii) Name the type of bonds shown in the diagram that hold the tRNA molecule in shape.

1

- (b) Describe the role of tRNA in translation.

2

- (c) Describe the effects of frame-shift and nonsense mutations on the resulting sequence of amino acids in a polypeptide.

2

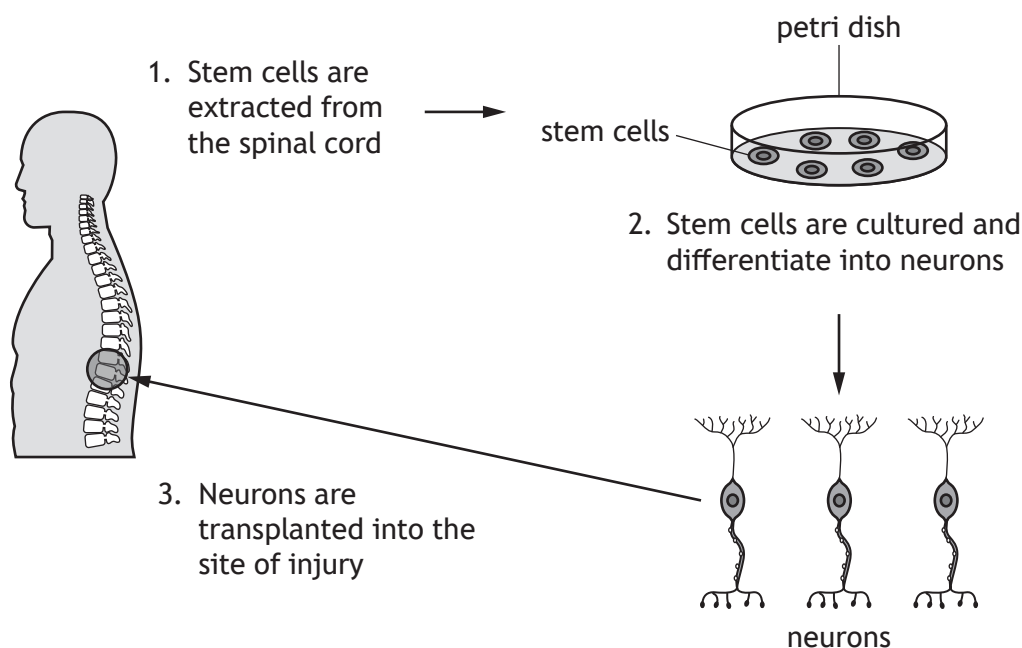
Frame-shift _____

Nonsense _____



3. Damage to the spinal cord can result in changes to body functions below the site of injury.

The diagram shows a therapeutic use of stem cells following a spinal cord injury.



- (a) (i) Describe the process of cell differentiation.

1

- (ii) Using information from the diagram, state why the stem cells from the spinal cord are known as tissue stem cells.

1

- (iii) State why this method is an example of a therapeutic use of stem cells.

1

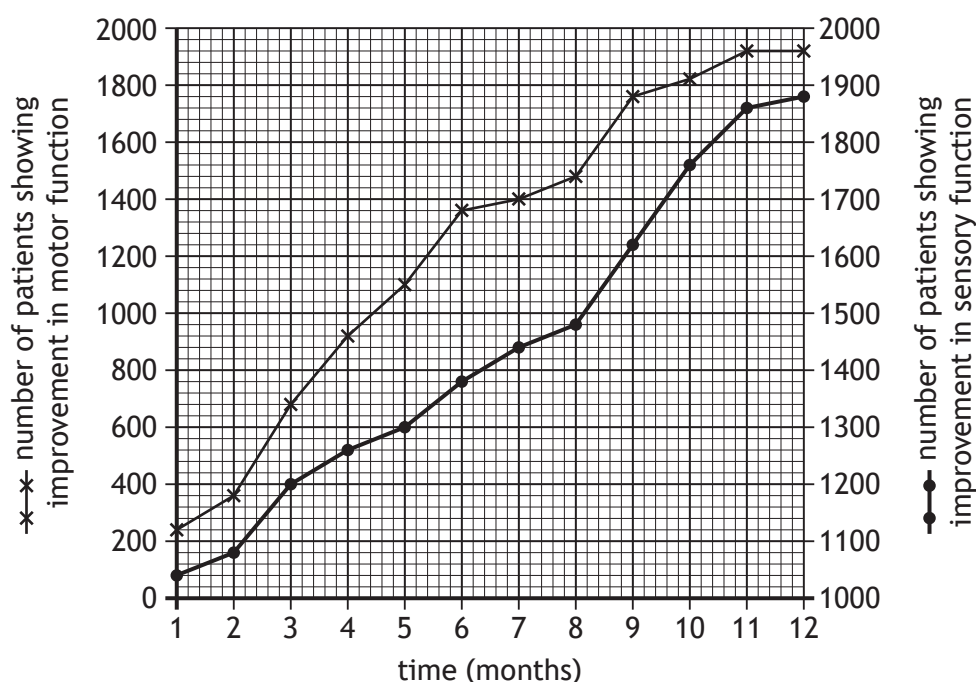
- (iv) State an ethical reason for using tissue stem cells rather than embryonic stem cells to treat spinal cord injuries.

1

3. (continued)

- (b) A clinical study involving 2500 spinal injury patients was carried out to investigate the effectiveness of stem cell therapy.

The graph shows the number of patients showing an improvement in motor function and sensory function over 1 year of treatment.



- (i) State the number of patients showing improvement in motor function at 11 months.

1

- (ii) Calculate the percentage of patients who showed an improvement in motor function at 3 months.

1

Space for calculation

_____ %



3. (b) (continued)

- (iii) State the number of patients showing an improvement in sensory function when the number of patients showing an improvement in motor function is 1400.

1

- (iv) Some patients showed improvement in both motor and sensory function. Use evidence from the graph at 9 months to support this statement.

1

[Turn over



4. Saddleback and domed tortoises are two different sub-species of giant tortoise that live on the Galapagos Islands. Saddleback tortoises have a high shell behind the neck and long front legs, allowing them to eat tall cactus plants. Domed tortoises have a low shell behind the neck, short front legs and feed mainly on grass.



saddleback tortoise



domed tortoise

A population of saddleback tortoises lives on a dry, hot island, and a population of domed tortoises lives on an island with humid forests.

Speciation is thought to be occurring.

- (a) (i) These two populations have been isolated by a geographical barrier.

Explain the importance of this barrier in speciation.

1

- (ii) Name the type of speciation that may occur.

1

- (iii) Describe how it could be proved that the two populations of tortoise were still the same species.

1

- (b) The shells of saddleback tortoises rise upward behind their necks allowing them to feed on tall plants.

Explain how natural selection has led to the increase in frequency of high shells of the saddleback tortoises living on the dry, hot island.

2



4. (continued)

- (c) Giant tortoise numbers on the Galapagos Islands have been estimated and the data are shown in the table.

Year	Estimated population
1600	200 000
1970	2500
2020	17 000

The rapid decline in numbers between 1600 and 1970 was due to human impact. The increase in numbers after 1970 is due to a captive breeding and release programme.

- (i) Calculate the percentage decrease in the population of giant tortoises between 1600 and 1970.

1

Space for calculation

_____ %

- (ii) Assuming numbers increase at the same rate as they have between 1970 and 2020, predict the estimated tortoise number in 2030.

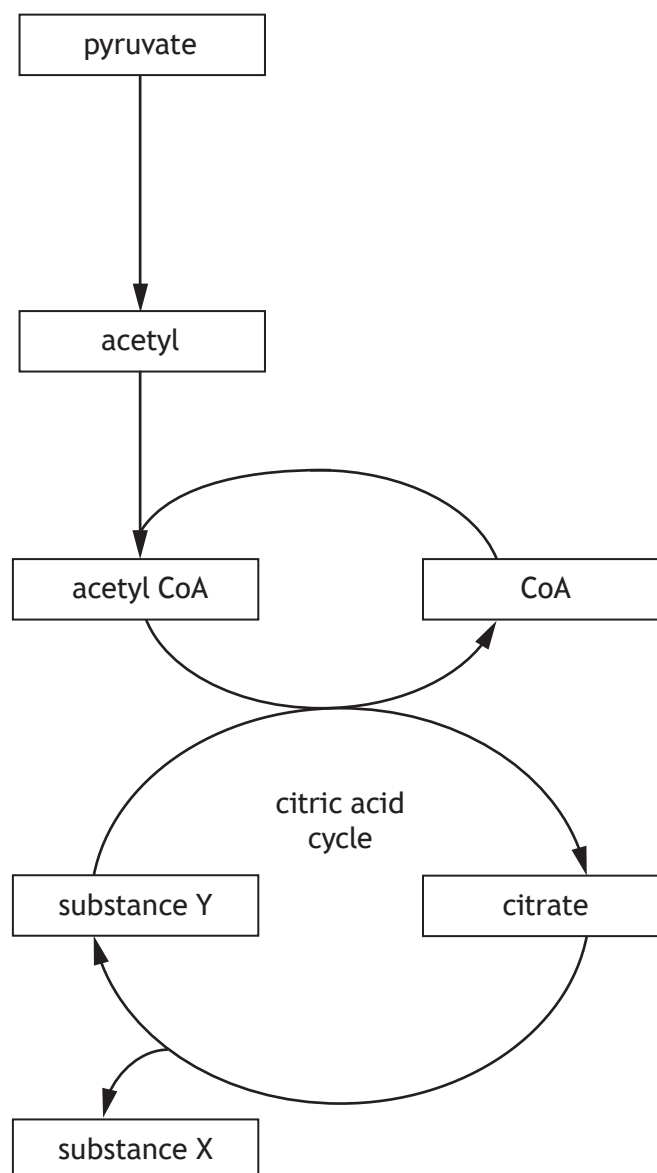
1

Space for calculation

[Turn over



5. The diagram shows stages of aerobic respiration.



(a) Name substances X and Y.

2

X _____

Y _____

(b) State the exact location of the citric acid cycle in yeast cells.

1



5. (continued)

- (c) Describe the role of dehydrogenase and NAD in the citric acid cycle.

2

Dehydrogenase _____

NAD _____

- (d) Fermentation can take place in yeast cells.

- (i) State the conditions required for fermentation to take place.

1

- (ii) Name the products of fermentation in yeast cells.

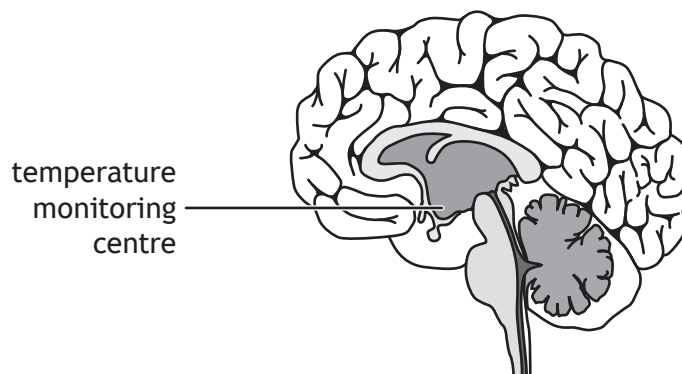
1

[Turn over



6. In humans, body temperature changes are detected and corrective responses by effectors return the body temperature to normal.

The diagram shows the region of the brain responsible for monitoring body temperature.



- (a) (i) Name the temperature monitoring centre in the brain.

1

- (ii) Describe how information is communicated from the temperature monitoring centre to the effectors.

1



6. (continued)

- (b) Describe one corrective response that would take place in the human body when exposed to low temperatures and explain how this response helps to return body temperature to normal.

2

Corrective response _____

Explanation _____

- (c) Explain the importance of thermoregulation in humans.

2

- (d) Name the mechanism used by humans to achieve homeostasis.

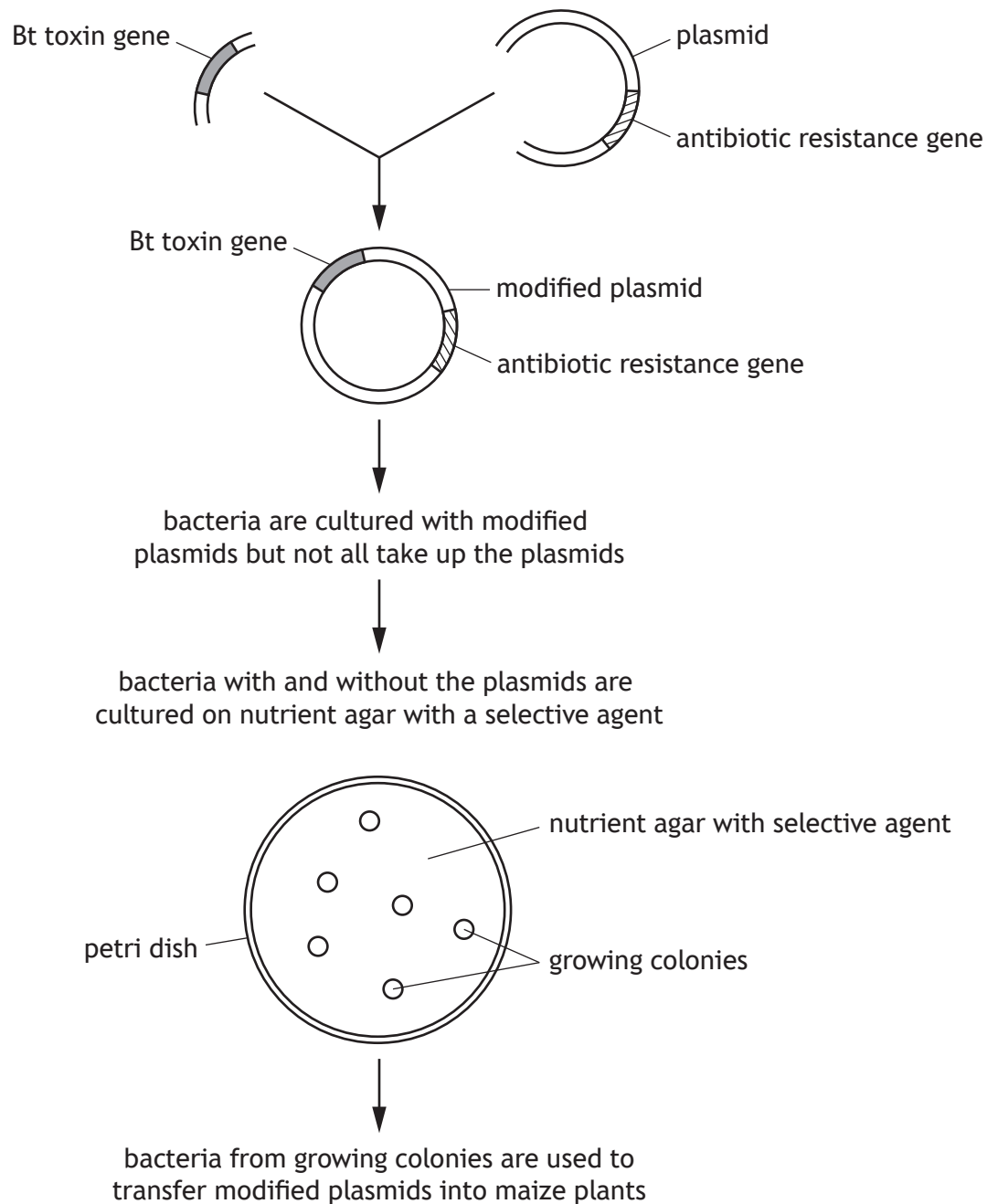
1

[Turn over



7. The food crop maize has been genetically modified to produce a protein called Bt toxin, which kills invertebrate pests that feed on the leaves.

The diagram shows some stages in the production of these plants.



7. (continued)

- (a) Explain why the same restriction endonuclease must be used to remove the Bt toxin gene and to open the plasmid.

1

- (b) Name the enzyme used to seal the Bt toxin gene into the plasmid.

1

- (c) The bacteria were grown on nutrient agar plates containing a selective agent. Name the selective agent and explain the importance of including it in the nutrient agar.

2

Selective agent

Explanation

- (d) Explain why growing maize plants containing the Bt toxin gene results in an increase in yield.

2

[Turn over

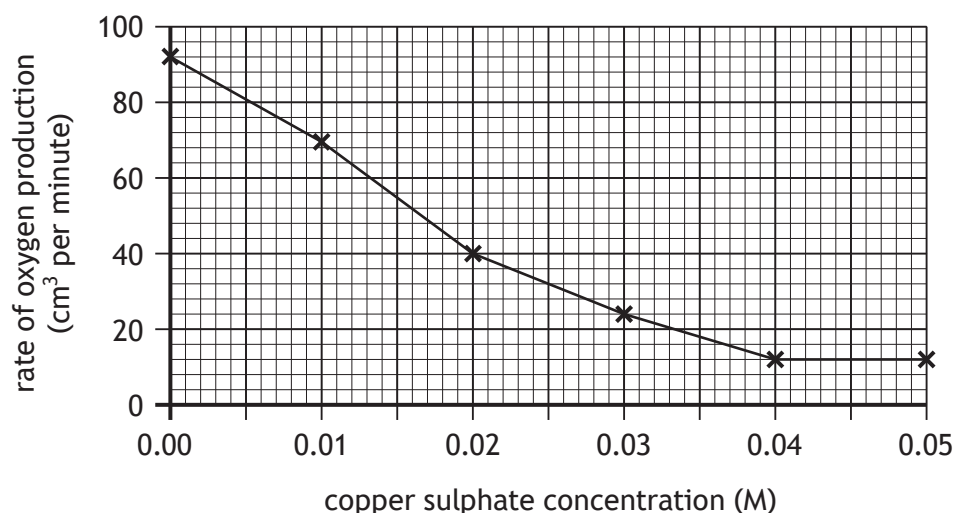


8. Catalase is an enzyme that breaks hydrogen peroxide down into oxygen and water. Enzyme activity can be measured by recording the rate of oxygen production during this reaction.

An investigation was carried out into the effect of concentration of the inhibitor copper sulphate on catalase activity.

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

Graph 1



- (a) Using values from **Graph 1**, describe changes in the rate of oxygen production as copper sulphate concentration increases.

2

- (b) One of the copper sulphate concentrations acted as a control. State the copper sulphate concentration of the control.

1

_____ M



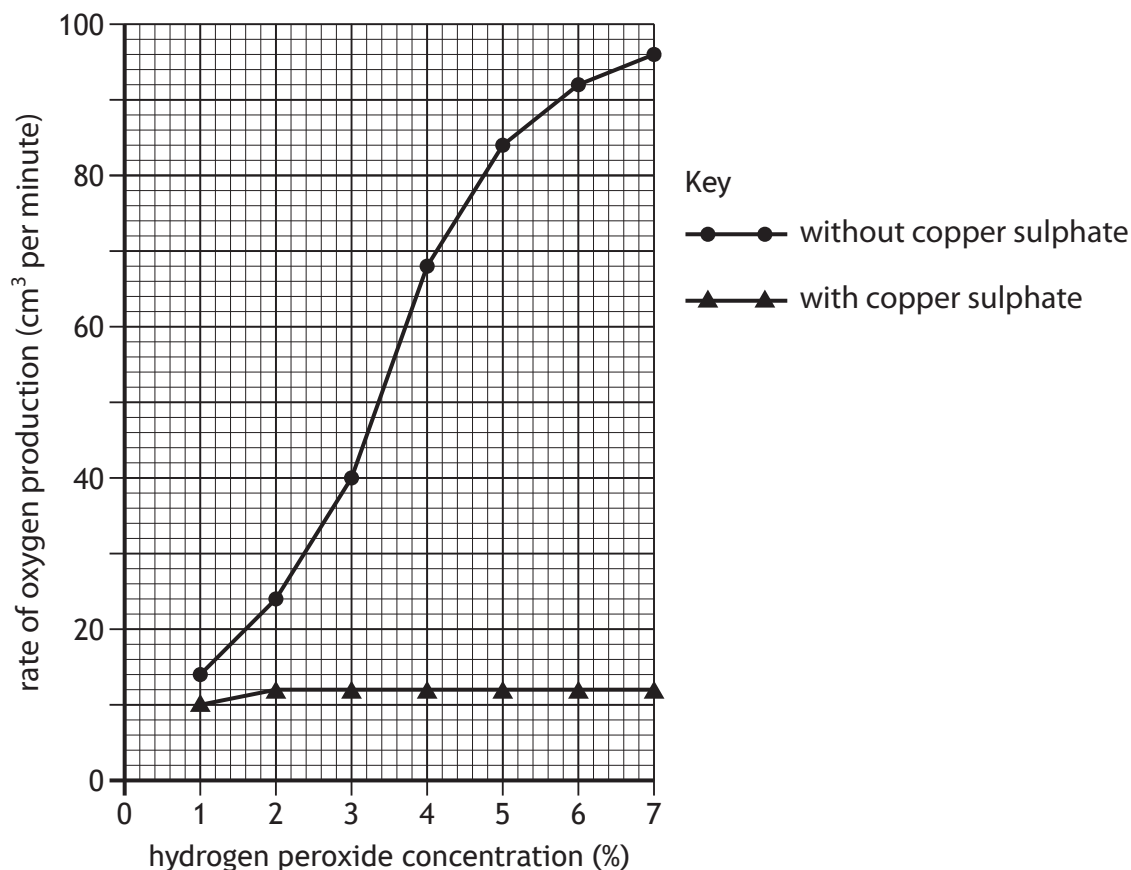
8. (continued)

MARKS DO NOT WRITE IN THIS MARGIN

- (c) The effect of increasing the hydrogen peroxide concentration on the rate of oxygen production was investigated in the presence and absence of copper sulphate.

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

Graph 2



Name the type of inhibition taking place in this reaction and justify your answer.

2

Type of inhibition _____

Justification _____

- (d) Using information from Graph 1 and Graph 2:

- (i) identify the concentration of hydrogen peroxide used to produce the data shown in **Graph 1**

1

_____ %

- (ii) suggest the concentration of copper sulphate used to produce the data shown in **Graph 2**.

1

_____ M



* X 8 0 7 7 6 0 1 1 7 *

9. Attempt **either A or B**. Write your answer in the space below.

A Write notes on the electron transport chain in aerobic respiration.

4

OR

B Write notes on growth media and culture conditions for growing micro-organisms.

4

You may use labelled diagrams where appropriate.



[Turn over for next question

DO NOT WRITE ON THIS PAGE



10. The concentrations of chlorophyll a, chlorophyll b, and the carotenoids xanthophyll and carotene in the cells of two different species of algae were measured.

The results are shown in the table.

Pigment	Concentration (mg/L)	
	Species A	Species B
Chlorophyll a	87	86
Chlorophyll b	35	36
Xanthophyll	31	61
Carotene	24	71

- (a) (i) Calculate the difference in carotenoid concentration in species B relative to species A.

1

Space for calculation

_____ mg/L

- (ii) Algal species A and B grow below the surface of the water.

Suggest why species B would grow better than species A in a pond containing many surface plants.

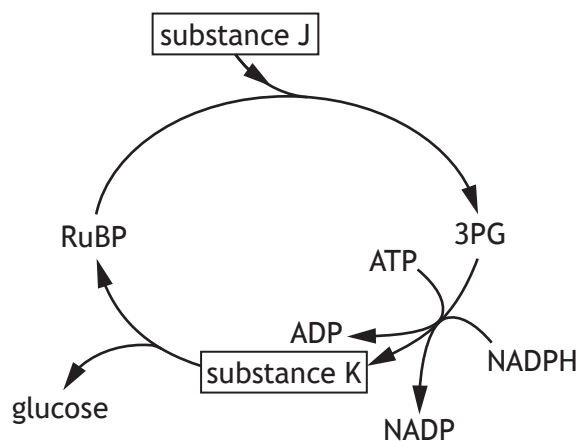
2



10. (continued)

MARKS DO NOT WRITE IN THIS MARGIN

- (b) The diagram represents the carbon fixation (Calvin cycle) stage of photosynthesis.



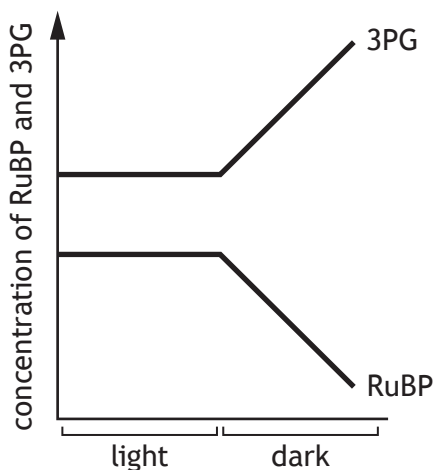
Name substances J and K.

2

J _____

K _____

- (c) In an investigation into the effect of light on photosynthesis, algal cells were exposed to a period of light then dark. The concentrations of RuBP and 3PG were recorded throughout the investigation and are shown in the diagram.



- (i) Explain why the concentration of RuBP remained constant in the light.

1

- (ii) Explain why the concentration of 3PG increased in the dark.

1



11. Rice plants develop structures called spikelets from which rice grains can be harvested. The greater the number of spikelets per plant the greater the rice yield.

A field trial was carried out to test the effect of mass of nitrate fertiliser on the number of spikelets produced. The rice plants were grown in same sized plots with four replicates per mass of nitrate fertiliser. After 16 weeks growth, the number of spikelets per plant was counted.

The results are shown in the table.

Mass of nitrate fertiliser (g per plot)	Average number of spikelets per plant				
	Replicate 1	Replicate 2	Replicate 3	Replicate 4	Overall average
10	23	22	25	26	24
25	52	20	77	55	51
50	69	65	70	68	68
100	77	73	72	74	74
150	79	83	72	82	79
200	81	75	78	82	79

- (a) (i) Name the independent variable. 1

- (ii) Identify one variable in this field trial, not already mentioned, which would have to be kept constant so that a valid conclusion can be made. 1

- (iii) Identify the mass of nitrate fertiliser a farmer should apply to generate the highest profit and justify your answer. 2

Mass of nitrate fertiliser _____ g per plot

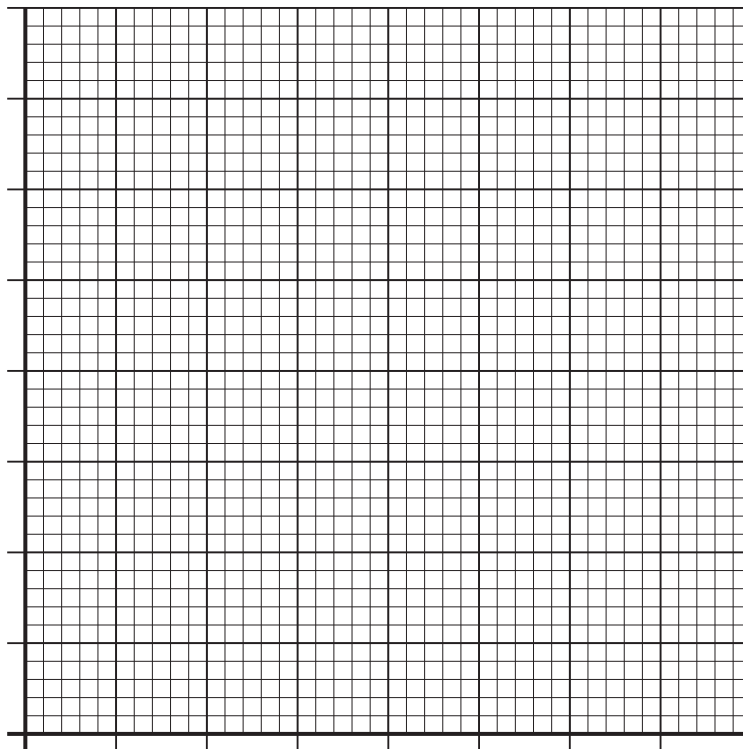
Justification _____



11. (continued)

- (b) On the grid, draw a line graph using the overall average results in the table.
(Additional graph paper, if required, can be found on *page 32*.)

2



- (c) State the conclusion from the results of this field trial.

1

[Turn over



12. The pug is a modern breed of dog, bred for desirable characteristics such as flattened face, curly tail and big eyes. Pugs have been produced by breeding closely related animals for many generations.

(a) Name this type of breeding used to produce pugs.

1

- (b) Pugs often suffer from health problems including breathing difficulties and abnormal hip joints.

State the term used to describe the cause of these health problems and explain how it occurs.

2

Term _____

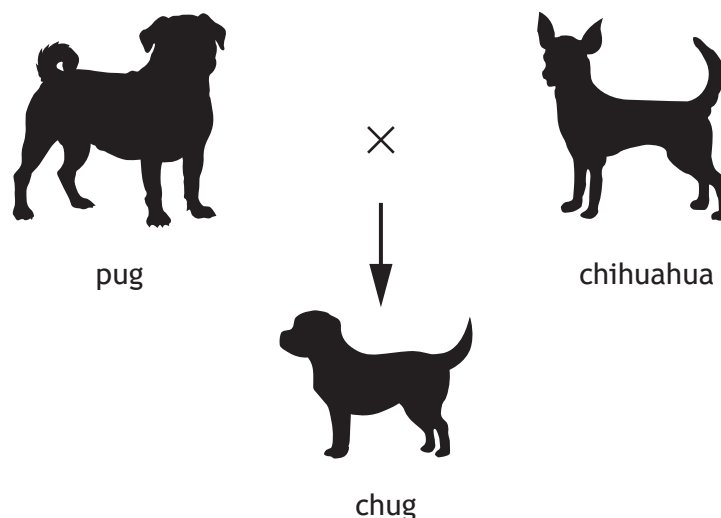
Explanation _____



* X 8 0 7 7 6 0 1 2 4 *

12. (continued)

- (c) Dog breeders have crossed pugs with chihuahuas to produce a F_1 hybrid called a chug.



- (i) Some chugs have improved characteristics compared to their parents. State the term used to describe improved characteristics in chugs. 1
- _____
- (ii) Explain why dog breeders produce chugs by crossbreeding pugs and chihuahuas rather than breeding two chugs together. 1
- _____
- _____
- (d) The allele for long nose is dominant and the allele for flattened nose is recessive. A chihuahua homozygous for a long nose was bred with a pug with a flattened nose. All the F_1 chugs produced had long noses. If one of the F_1 chugs was bred with a pug with a flattened nose, calculate the percentage of their offspring likely to have flattened noses. 1
- Space for calculation*

_____ %



13. Stoats are predators native to the UK. They were introduced to New Zealand in the 1880s by humans to control the rabbit population.

Since their introduction, stoats have spread rapidly, and their population has increased. As a result, the population size of some native species has decreased.



- (a) Name the type of control used to manage the population of rabbits. 1

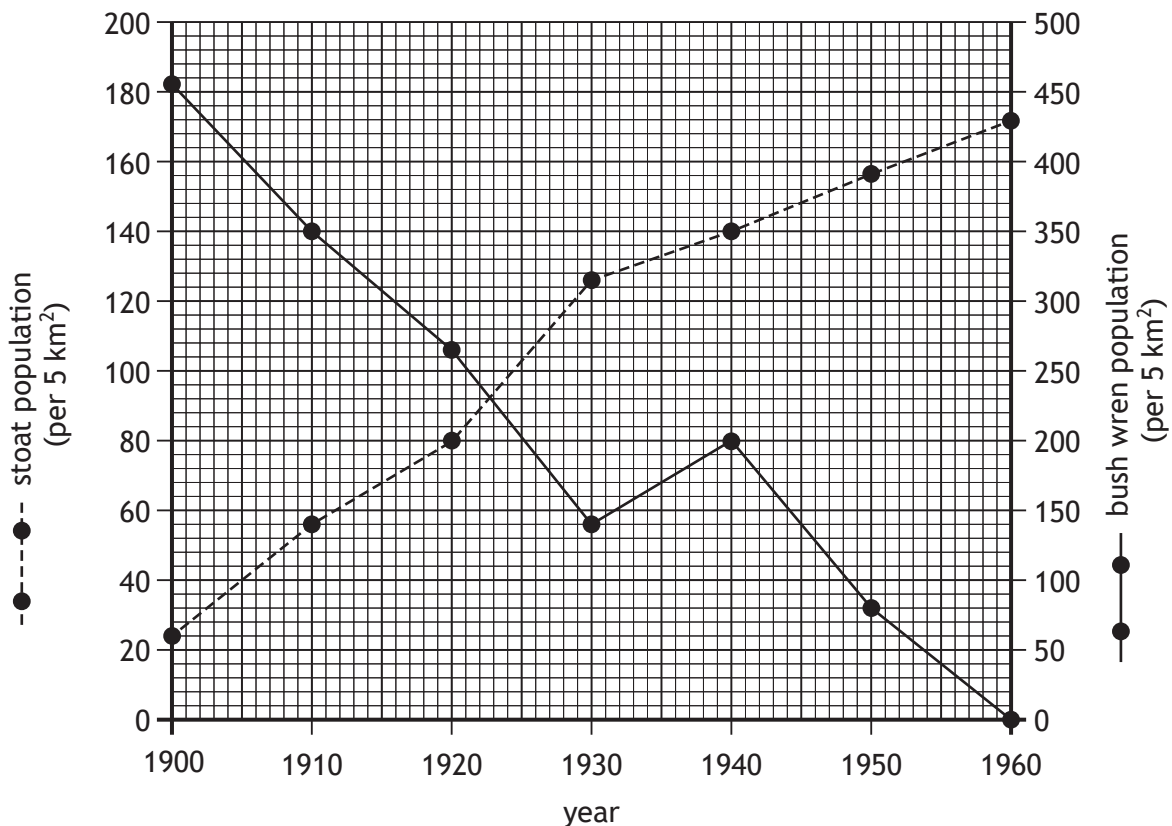
- (b) (i) Suggest why the population size of some native species has decreased. 1

- (ii) State a reason why the population of stoats has increased faster in New Zealand than in their native habitat. 1

13. (continued)

MARKS DO NOT WRITE IN THIS MARGIN

- (c) Bush wren was a bird species native to New Zealand. The populations of stoats and bush wrens were measured over a 60-year period between 1900 and 1960. The results are shown in the graph.



- (i) Express, as the simplest whole number ratio, the bush wren population to the stoat population in 1940.

1

Space for calculation

_____ : _____
bush wren stoat

- (ii) Using information from the graph, predict what the population of stoats was in 1980.

1

_____ per 5 km²

- (iii) Give evidence from the graph that shows that the stoat population was not the only factor affecting the bush wren population.

1



13. (c) (continued)

(iv) Stoats are an invasive species in New Zealand.

Use evidence from the graph to justify this statement.

1



14. Attempt **either A or B**. Write your answer in the space below and on *pages 30 and 31*.

A Write notes on crop productivity under the following headings:

(i) problems with weeds and invertebrate pests

5

(ii) chemical control.

3

OR

B Write notes on interdependence under the following headings:

(i) parasitism

5

(ii) social insects.

3

You may use labelled diagrams where appropriate.

[Turn over



ADDITIONAL SPACE FOR ANSWER to question 14

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ADDITIONAL SPACE FOR ANSWER to question 14

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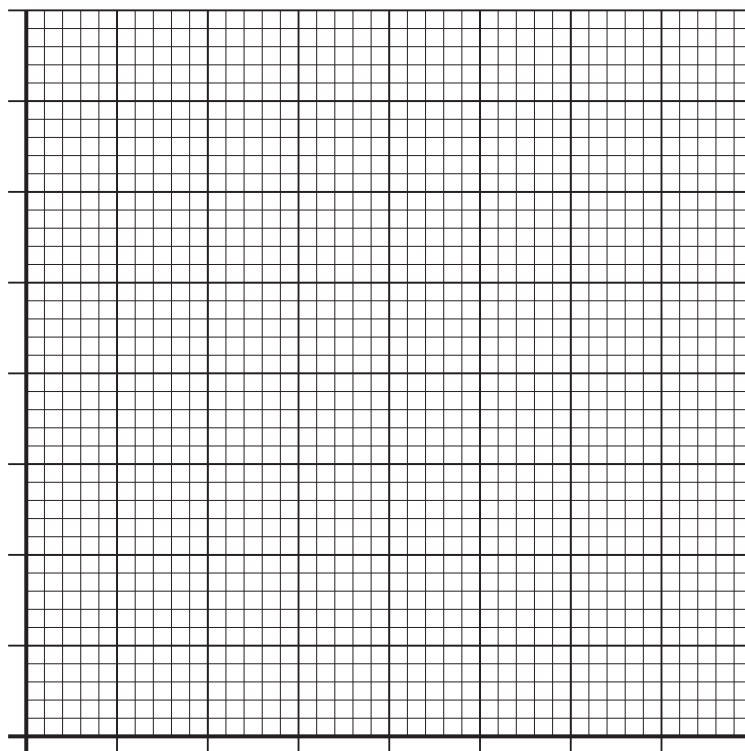
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* X 8 0 7 7 6 0 1 3 1 *

ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

Additional graph paper for question 11 (b)





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ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK



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