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National
Qualifications
2021 ASSESSMENT RESOURCE

Mark

X807/76/01

Biology
Paper 2

Duration — 2 hours 20 minutes

X807760 1

Fill in these boxes and read what is printed below.

Full name of centre

Town

Forename(s)

Surname

Number of seat

Date of birth

Day | Month | Year

Scottish candidate number

Total marks — 95

Attempt ALL questions.

You may use a calculator.

Questions 4 and 16 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.

Before leaving the examination room you must give this booklet to the Invigilator; if you do not, you may lose all the marks for this paper.

SQA ©

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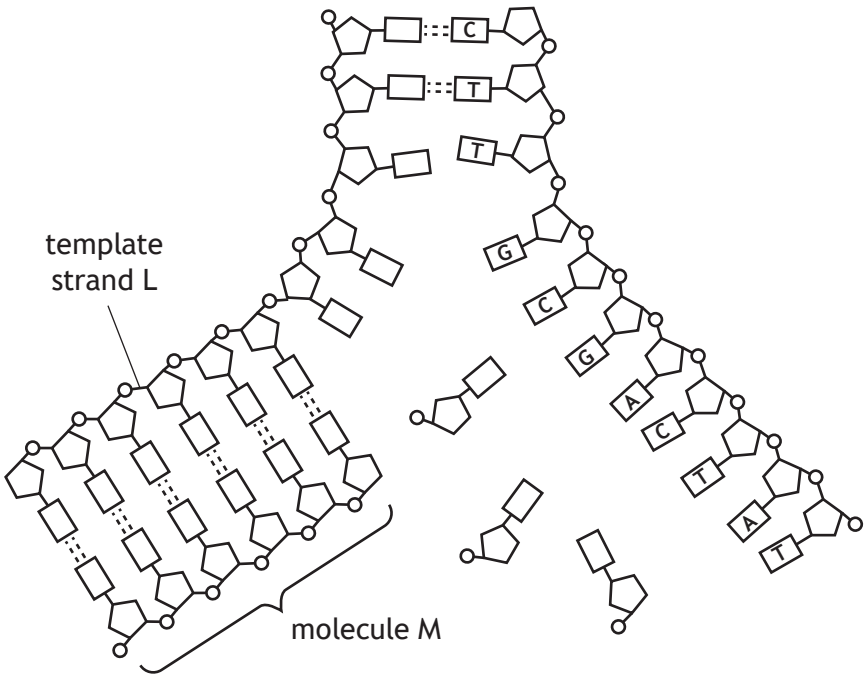
MARKS | DO NOT WRITE IN THIS MARGIN

Total marks — 95

Attempt ALL questions

Questions 4 and 16 contain a choice

1. The diagram illustrates part of a DNA molecule during replication in a eukaryotic cell.



(a) Name the base at the 5′ end of template strand L. **1**

_____

(b) (i) Name molecule M that is required to start DNA replication. **1**

_____

(ii) Give the sequence of bases for molecule M. **1**

_____

(iii) Name the enzyme that attaches free nucleotides to molecule M during DNA replication. **1**

_____

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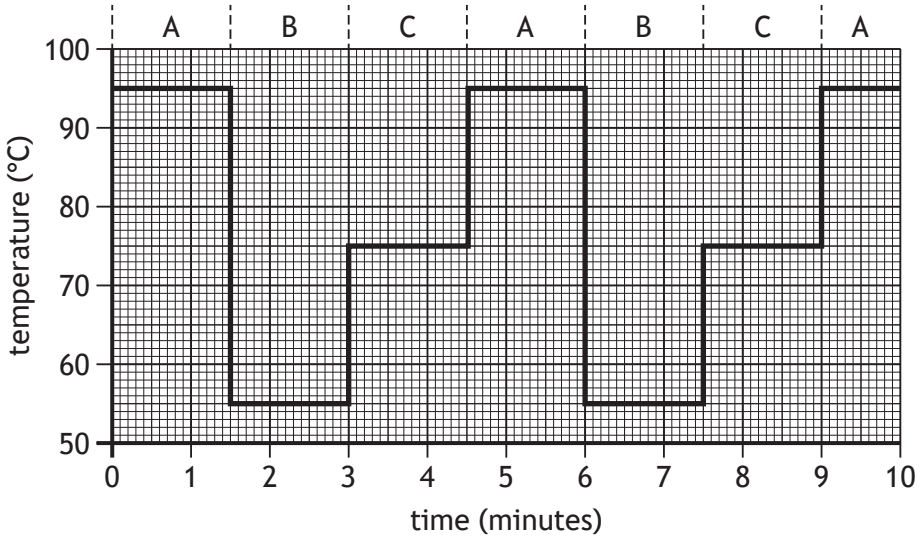
MARKS | DO NOT WRITE IN THIS MARGIN

1. (continued)

(c) The polymerase chain reaction (PCR) amplifies specific sequences of DNA.

The graph shows the changes in temperature during this process.



(i) Describe the events that occur during stage A and stage B. **2**

Stage A _____

_____

Stage B _____

_____

(ii) An original sample of DNA contained 100 copies of the target sequence.

Calculate how long it would take to produce at least 25 000 copies of this sequence. **1**

Space for calculation

_____ minutes

(d) State **one** practical application of PCR. **1**

_____

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2. Anole lizards are found on islands in the Atlantic ocean. The leg length and surface area of the feet of these lizards affect their ability to cling to branches during windy conditions.

A study was carried out to investigate the effect of a hurricane on characteristics of one species of anole lizard on two islands.

Scientists measured the foot surface area and leg length of lizards on both islands before and after a hurricane.

The results are shown in the table.

Characteristic	**Lizard population on Island 1**		**Lizard population on Island 2**	
	Before hurricane	**After hurricane**	**Before hurricane**	**After hurricane**
Average foot surface area (mm^2)	16·0	16·9	14·6	16·1
Average leg length (mm)	22·0	20·3	25·6	22·4

MARKS | DO NOT WRITE IN THIS MARGIN

2. (continued)

(a) Calculate the percentage decrease in the average leg length of the lizard population on Island 2 after the hurricane. **1**

Space for calculation

_____ %

(b) Using the information given, explain how natural selection due to hurricanes could result in an increase in foot surface area of future generations of this species. **2**

_____

_____

_____

(c) The populations of lizard isolated on two islands could become different species as a result of natural selection.

(i) Name the type of speciation that would occur. **1**

_____

(ii) What evidence would confirm that speciation had occurred? **1**

_____

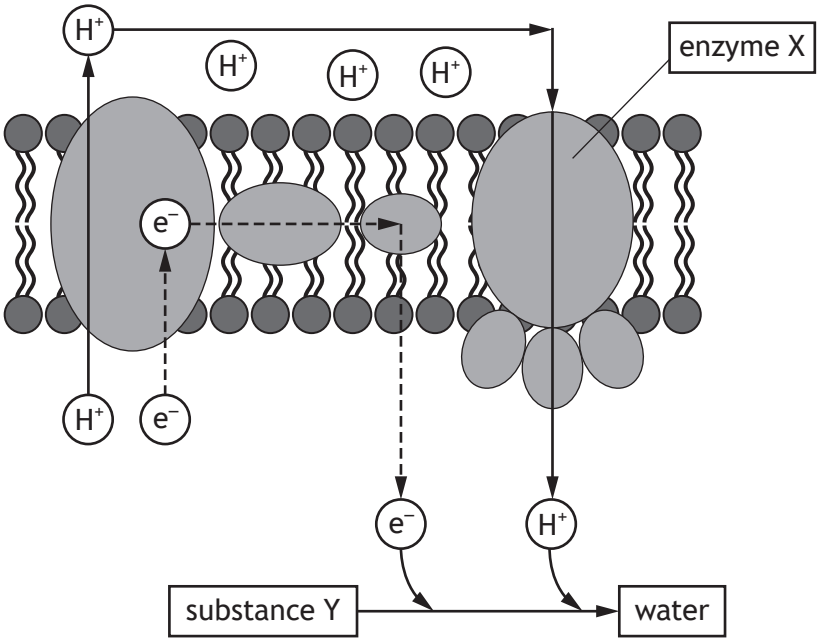
_____

_____

[Turn over

MARKS | DO NOT WRITE IN THIS MARGIN

3. The diagram shows a stage in aerobic respiration occurring in eukaryotic cells.



(a) Name this stage and state its exact location in eukaryotic cells. **2**

Stage _____

Exact location _____

(b) Name enzyme X and substance Y. **2**

X _____

Y _____

(c) Describe the role of electrons in this stage and how this leads to the production of ATP. **2**

_____

_____

_____

MARKS | DO NOT WRITE IN THIS MARGIN

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

A Write notes on the process of glycolysis in respiration. **4**

OR

B Write notes on plasmids as vectors in recombinant DNA technology. **4**

You may use labelled diagrams where appropriate.

[Turn over

MARKS | DO NOT WRITE IN THIS MARGIN

5. An investigation was carried out into the effect of exposure to low temperature on human body temperature.

Two volunteers, A and B, were immersed in ice baths over an 8 minute period. Body temperatures were measured every 2 minutes.

The results are shown in the table.

	Body temperature (°C)	
Time of exposure (minutes)	**Volunteer A**	**Volunteer B**
0	37·2	37·1
2	36·9	36·9
4	36·4	36·8
6	35·8	36·8
8	35·2	36·7

(a) (i) Calculate the average decrease in body temperature per minute for Volunteer A during the investigation. **1**

Space for calculation

_____ °C/min

(ii) Using evidence from the results, suggest why the reliability of the results would be improved if more volunteers were included in the investigation. **1**

_____

_____

_____

MARKS | DO NOT WRITE IN THIS MARGIN

5. (continued)

(b) (i) Give an example of a corrective response to a decrease in body temperature and explain how it helps to regulate body temperature. **2**

Response _____

Explanation _____

_____

_____

_____

(ii) Human body temperature is usually maintained at 37 °C.

Apart from optimal enzyme activity, give one reason for the importance of thermoregulation to maintain metabolism. **1**

_____

[Turn over

MARKS | DO NOT WRITE IN THIS MARGIN

6. Polar bears (*Ursus maritimus*) live in arctic regions and feed on seals resting on the ice. Some polar bears hibernate to survive the winter.

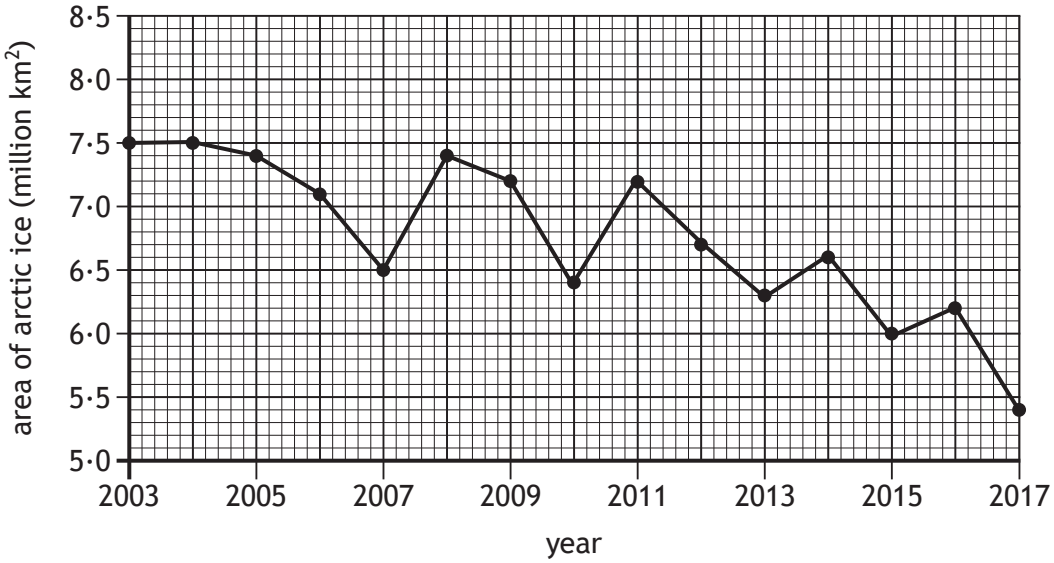
(a) Explain how hibernation helps polar bears survive the winter. **1**

_____

_____

_____

(b) The graph shows how the area of arctic ice has changed between 2003 and 2017.



(i) Calculate the area of arctic ice in 2017 as a percentage of the area in 2003. **1**

Space for calculation

_____ %

MARKS | DO NOT WRITE IN THIS MARGIN

6. (b) (continued)

(ii) The population of polar bears is likely to decrease if the overall trend in the graph continues.

Suggest a reason for this. **1**

_____

_____

(c) Other than hibernation, name one way that animals survive adverse conditions. **1**

_____

[Turn over

MARKS | DO NOT WRITE IN THIS MARGIN

7. Cancer is a disease in which cell division is uncontrolled. Some anticancer drugs inhibit protein synthesis.

An experiment was carried out to compare the effect of two drugs, Y and Z, on protein synthesis in human cells.

Two different human cell cultures, HeLa and HL-60, were incubated with drugs Y and Z in liquid growth media at 35 °C.

HeLa cells + drug Y | HL-60 cells + drug Z

A range of concentrations of each drug were used and protein synthesis was measured.

The results are shown in the table.

Drug concentration (nM)	Protein synthesis (% of control)	
	Drug Y	Drug Z
0 (Control)	100	100
10	100	85
50	56	35
75	32	14
100	7	0

(a) (i) Name a piece of apparatus that could be used to maintain the temperature at 35 °C. **1**

_____

(ii) Give **one** variable, not already mentioned, that should be kept constant so that a valid conclusion can be drawn on the effect of drug Y on protein synthesis on HeLa cells. **1**

_____

MARKS | DO NOT WRITE IN THIS MARGIN

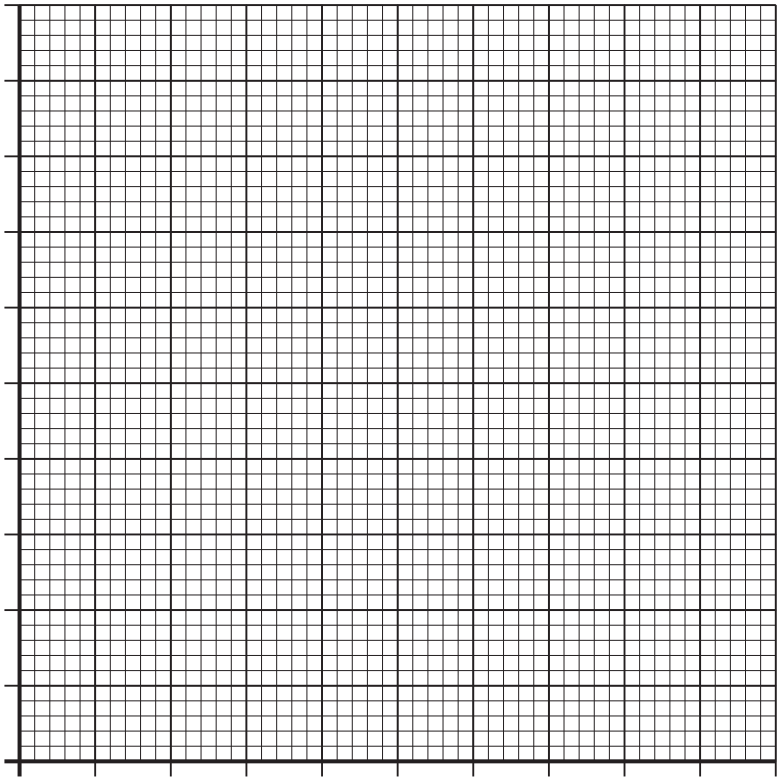
7. (continued)

(b) Drugs Y and Z were dissolved in a solvent before being added to the growth media.

Explain why this solvent would also have to be added to the control cultures. **1**

(c) On the grid, draw a line graph to show the results for **both drugs**. **3**

(Additional graph paper, if required, can be found on *page 32*.)



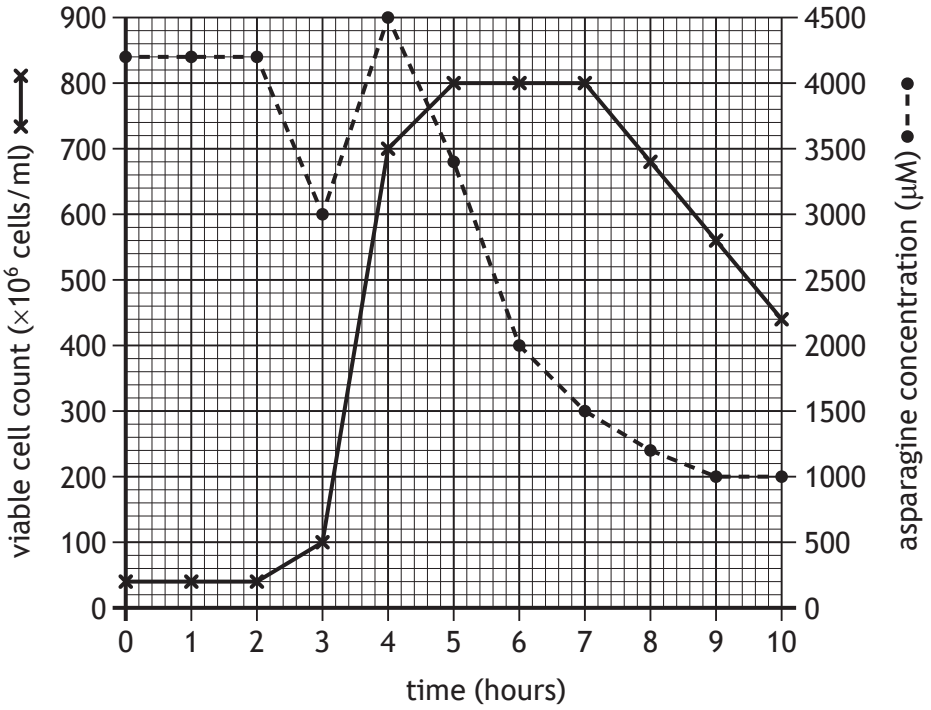
(d) It was concluded that Drug Z was more effective at inhibiting protein synthesis in human cells than Drug Y.

Using the information given, suggest why this conclusion is **not** valid. **1**

MARKS | DO NOT WRITE IN THIS MARGIN

8. Growth media used to culture the bacteria *E. coli* often contain the amino acid asparagine even though *E. coli* can produce this amino acid.

The graph shows the viable cell count of *E. coli* and the asparagine concentration in a culture grown over a period of 10 hours.



(a) (i) State the asparagine concentration when the viable cell count was 100×10^6 cells/ml. **1**

_____ μM

(ii) Calculate the simplest whole number ratio of the asparagine concentration at 4 hours to that at 10 hours. **1**

Space for calculation

_____ : _____
4 hours 10 hours

(iii) Predict the viable cell count that would be expected at 11 hours. **1**

Space for calculation

_____ $\times 10^6$ cells/ml

MARKS | DO NOT WRITE IN THIS MARGIN

8. (continued)

(b) (i) Using the information given, suggest why there is a rapid increase in asparagine concentration between 3 and 4 hours. **2**

(ii) Explain the changes in the viable cell count between 7 and 10 hours. **1**

(c) (i) State why *E. coli* requires the amino acid asparagine for growth. **1**

(ii) Bacteria require other complex molecules apart from amino acids for biosynthesis.

Name another complex molecule that could be added to the growth medium. **1**

[Turn over

MARKS | DO NOT WRITE IN THIS MARGIN

9. Some plants have nodules in their roots that contain bacteria, which use the enzyme nitrogenase to produce compounds required for the synthesis of amino acids.

In an investigation, nitrogenase activity was measured at different concentrations of its substrate, nitrous oxide, in the presence and absence of two inhibitors P and Q.

The results are shown in the table.

	Nitrogenase activity (units)		
Concentration of nitrous oxide (mol l^{-1})	**No inhibitor**	**Inhibitor P**	**Inhibitor Q**
0	0	0	0
5	13	4	3
10	25	17	11
15	36	26	14
20	36	35	14
25	36	36	14

(a) (i) In the presence of inhibitor P, calculate how many times greater the nitrogenase activity is at a nitrous oxide concentration of 15 mol l^{-1} compared to 5 mol l^{-1}. **1**

Space for calculation

_____ times greater

(ii) Name the type of inhibition shown by Q and use evidence from the table to justify your answer. **2**

Type of inhibition _____

Justification _____

_____

_____

MARKS | DO NOT WRITE IN THIS MARGIN

9. (continued)

Metabolic pathways can be regulated by feedback inhibition.

(b) (i) Describe feedback inhibition of a metabolic pathway. **2**

_____

_____

_____

(ii) Suggest **one** advantage to a cell of using feedback inhibition. **1**

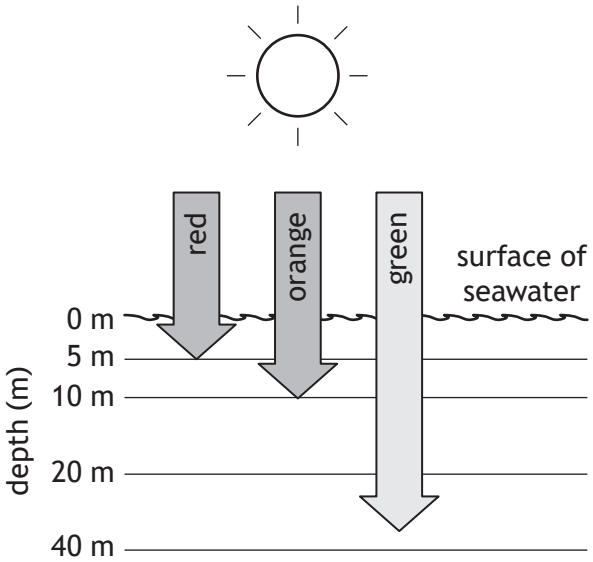
_____

_____

[Turn over

10. In coastal ecosystems different species of seaweed are found at different depths of seawater.

The diagram shows the depth to which some different colours of light penetrate seawater.



The table shows the seaweed species present at different depths of seawater.

Depth (m)	Seaweed species present
0 – 5	*A. mirabilis*
15 – 20	*D. anceps*
20 – 25	*H. grandifolius* and *D. menziesii*

(a) Name a pigment that absorbs mainly red and blue light. **1**

_____

(b) *H. grandifolius* has higher levels of carotenoids in its cells than *A. mirabilis*.

(i) Describe the role of carotenoids. **1**

_____

_____

MARKS | DO NOT WRITE IN THIS MARGIN

10. (b) (continued)

(ii) **Using information from the table and the diagram**, explain why *H. grandifolius* requires higher levels of carotenoids than *A. mirabilis*. **2**

_____

_____

_____

_____

(c) Name a piece of apparatus that could be used to show which colours of light are absorbed by photosynthetic pigments. **1**

_____

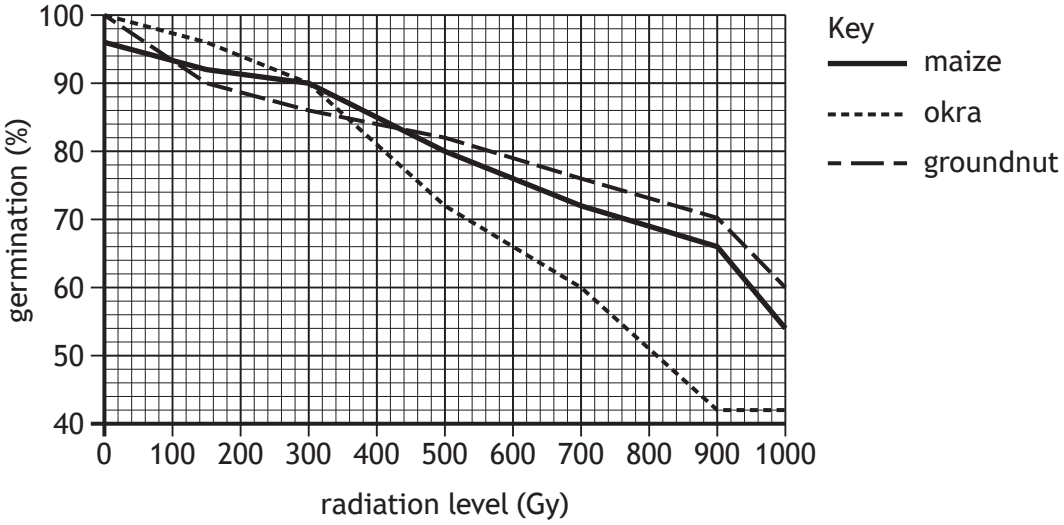
[Turn over

MARKS | DO NOT WRITE IN THIS MARGIN

11. An investigation was carried out to determine the effect of radiation on germination of seeds of the crop plants maize, okra and groundnut.

Five hundred seeds of each crop plant were exposed to different levels of radiation. They were then placed in dishes containing wet filter paper and left for five days to germinate. Control dishes were set up for each type of seed.

The percentage germination for each was calculated and the results are shown in the graph.



(a) (i) Using values from the graph, describe the changes in the percentage germination of okra as the radiation level increased. **2**

_____

_____

_____

(ii) State the percentage germination of maize in the control dish. **1**

_____ %

MARKS | DO NOT WRITE IN THIS MARGIN

11. (continued)

(b) The germinated seedlings were grown for eight weeks. The total dry mass of each crop was measured. The average dry mass per plant was calculated for each crop.

The results are shown in the table.

Radiation level (Gy)	Average dry mass per plant (g)		
	maize	okra	groundnut
0	40	32	24
150	36	30	23
300	35	27	22
500	27	23	21
700	22	18	17
900	17	10	14
1000	10	9	13

(i) Using information from the table, suggest which crop is least affected by the radiation and justify your answer. **2**

Crop _____

Justification _____

_____

_____

(ii) **Using information in the graph and table**, calculate the total dry mass of maize eight weeks after the 500 seeds were exposed to 500 units of radiation. **1**

Space for calculation

_____ g

[Turn over

MARKS | DO NOT WRITE IN THIS MARGIN

12. Selective herbicides are often used in sprays to control perennial weeds such as dandelions growing in areas of grass.

Dandelion **Grass**

(a) Using information from the diagram

(i) explain why dandelions could be incorrectly identified as annual weeds. **1**

_____

_____

(ii) suggest why a selective herbicide would have a greater effect on dandelions than on grass. **1**

_____

_____

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MARKS | DO NOT WRITE IN THIS MARGIN

12. (continued)

(b) A field trial was carried out to investigate the effectiveness of a selective herbicide to control dandelions in eight grass plots as shown.

A	A	A	A
B	B	B	B

Key A – untreated
B – treated with herbicide spray

Suggest an improvement to the design of this field trial and justify your answer. **2**

Improvement _____

_____

Justification _____

_____

[Turn over

MARKS | DO NOT WRITE IN THIS MARGIN

13. Related meerkats (*Suricata suricatta*) live in large social groups. Some act as lookouts and make alarm calls when a predator is detected.

(a) Explain why the behaviour of the lookouts could be described as altruistic. **1**

(b) State why behaviour, which appears to be altruistic, is more common in related animals. **1**

(c) The table shows information on the number of meerkats acting as lookouts and the predation success of hawks on a population of meerkats.

Number of meerkat lookouts	Predation success of hawks (%)
1	56
3	45
5	23
8	10
10	8
12	8

Using values from the table, describe the changes in predation success of hawks as the number of meerkat lookouts increases. **2**

MARKS | DO NOT WRITE IN THIS MARGIN

13. (continued)

(d) (i) Meerkats live in social hierarchies.

Name a type of behaviour that is often shown by dominant members of a social group. **1**

_____

(ii) Give an advantage of being in a social hierarchy. **1**

_____

_____

[Turn over

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MARKS | DO NOT WRITE IN THIS MARGIN

14. A study was carried out to compare the populations of some species of invertebrates on two different chicken farms, A and B. On Farm A chickens were free range, while on Farm B chickens were farmed intensively.

The results of the study are shown in the table.

	Average population of invertebrates (per m^2)	
Invertebrate species	**Farm A**	**Farm B**
D. gallinae	3	127
H. affinis	8	5
H. rufipes	5	0
L. pilicornis	6	3
C. impunctatus	59	56

(a) State which farm has the greater invertebrate species richness and justify your answer. **1**

_____

_____

(b) Mites (*D. gallinae*) and chickens have a symbiotic relationship in which the mites feed on the chicken's blood.

(i) Name this type of symbiotic relationship. **1**

_____

(ii) State the term used to describe the chicken in this relationship. **1**

_____

(iii) Mites are spread by direct contact.

Use the information given to support this statement. **2**

_____

_____

_____

_____

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MARKS | DO NOT WRITE IN THIS MARGIN

14. (continued)

(c) Intensively farmed chickens show abnormally low levels of activity.
State the term used to describe this behaviour. **1**

_____

(d) State an advantage to humans of intensive farming. **1**

_____

_____

[Turn over

MARKS | DO NOT WRITE IN THIS MARGIN

15. Due to a growing population, areas of rainforest in Brazil have been cleared for food production. This has led to habitat fragmentation.

Biodiversity in isolated fragments is decreasing as the edges of the fragments degrade.

(a) Explain why biodiversity in isolated fragments decreases as the size of the fragment gets smaller. **2**

(b) Jaguars (*Panthera onca*) are native to rainforest in Brazil. Their population has decreased as a result of habitat fragmentation. It has been proposed that linking isolated fragments of rainforest by planting trees will increase the jaguar population size.

(i) Give a reason why reproductive rates of jaguars in isolated fragments are low. **1**

(ii) State the term used to describe areas of land that connect isolated fragments. **1**

(iii) Explain why linking habitat fragments may result in an increase in the jaguar population. **1**

(c) Areas of cleared rainforest can be used for cattle farming or crop production.

Suggest why less habitat would have to be cleared if it was only used for crop production. **1**

MARKS | DO NOT WRITE IN THIS MARGIN

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

A Write notes on

(i) stem cells **4**

(ii) uses of stem cells. **4**

OR

B Write notes on

(i) single gene mutations **5**

(ii) effects of single gene mutations on proteins synthesised. **3**

You may use labelled diagrams where appropriate.

[Turn over

MARKS | DO NOT WRITE IN THIS MARGIN

SPACE FOR ANSWERS

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MARKS | DO NOT WRITE IN THIS MARGIN

SPACE FOR ANSWERS

[END OF QUESTION PAPER]

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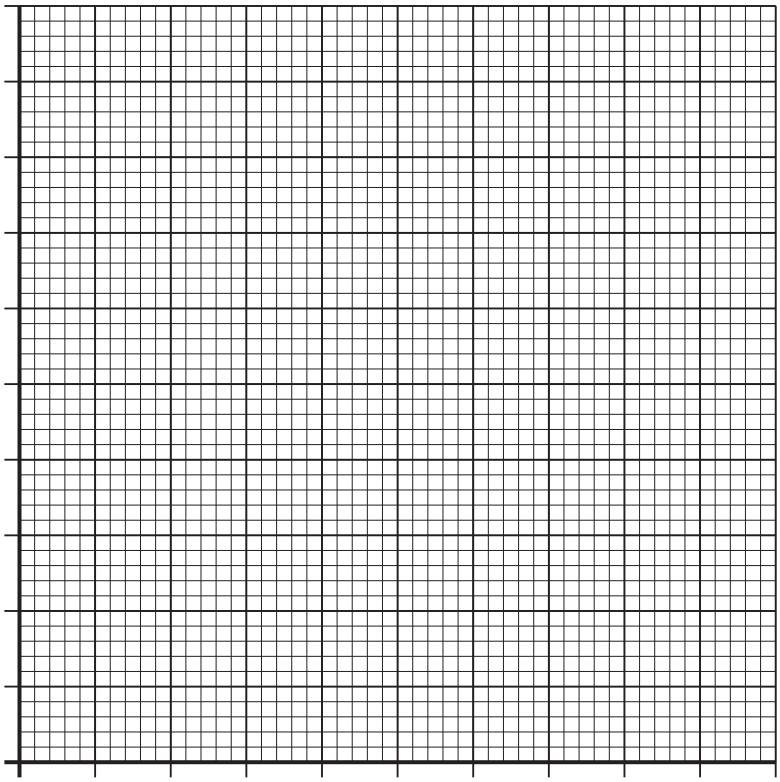
MARKS | DO NOT WRITE IN THIS MARGIN

ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

Additional graph paper for question 7 (c)



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MARKS | DO NOT WRITE IN THIS MARGIN

ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

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MARKS | DO NOT WRITE IN THIS MARGIN

ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

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