National
Qualifications

X807/76/12

Biology
Paper 1 — Multiple choice

Duration — 40 minutes

Total marks — 25

Attempt ALL questions.

You may use a calculator.

Instructions for the completion of Paper 1 are given on *page 02* of your answer booklet X807/76/02.

Record your answers on the answer grid on *page 03* of your answer booklet.

Space for rough work is provided at the end of this booklet.

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

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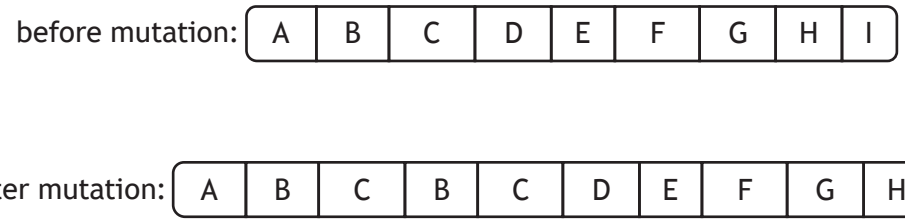
X8077612

Total marks — 25

Attempt ALL questions

1. The diagram shows the arrangement of genes on a chromosome before and after a mutation.



Which type of mutation has taken place?

A Inversion

B Insertion

C Duplication

D Translocation

2. Which row in the table matches each type of cell with how its DNA is organised?

	Type of cell	**Organisation of DNA**
A	animal	linear and circular chromosomes only
B	bacterial	linear chromosomes and plasmids only
C	yeast	circular chromosomes and plasmids only
D	plant	linear chromosomes only

3. Which of the statements about a primary mRNA transcript are correct?

1. It contains introns and exons.
2. Its exons are removed.
3. Its exons are spliced together to form the mature mRNA transcript.

A 3 only

B 1 and 2 only

C 2 and 3 only

D 1 and 3 only

4. The following list describes functions of DNA sequences.

1. Transcribed to mRNA
2. Transcribed to tRNA
3. Regulate transcription

Which of these are functions of non-coding regions of the genome?

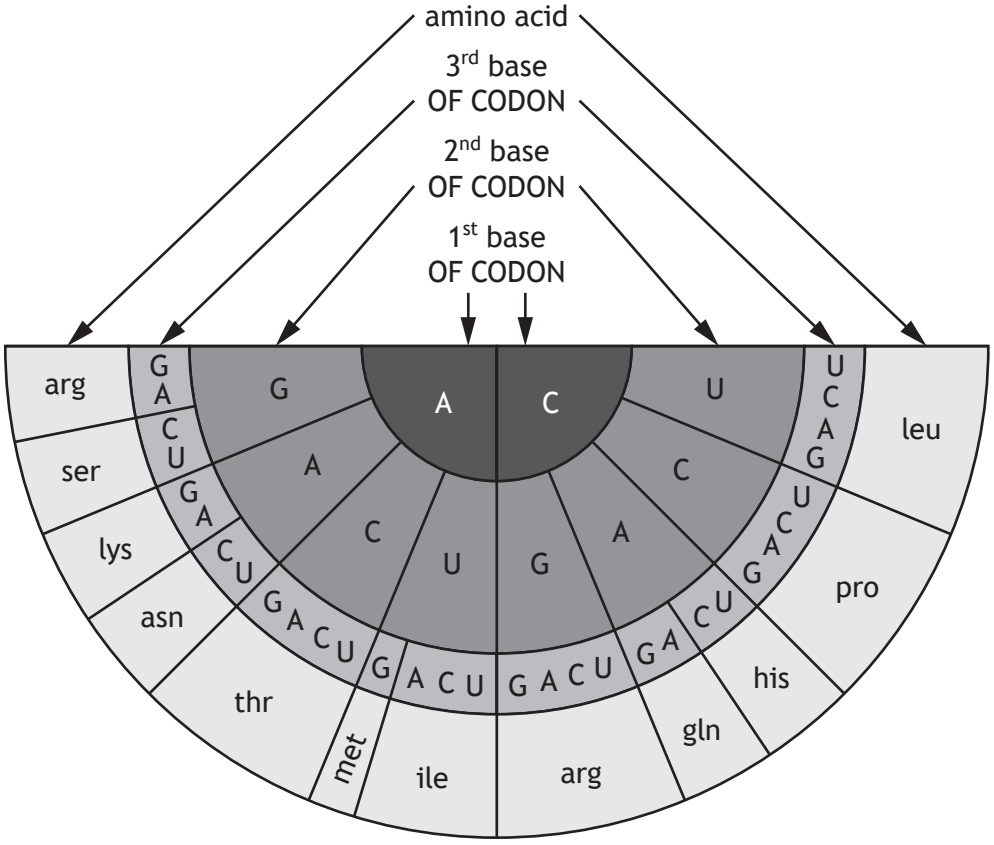
A 1 and 2 only

B 1 and 3 only

C 2 and 3 only

D 1, 2 and 3

5. The diagram shows the base sequence of some mRNA codons and the amino acids for which they code. For example, mRNA codons AGG and AGA both code for the amino acid **arg**.



A section of polypeptide contains the amino acid sequence **-ser-pro-lys-**.

Identify the DNA sequence that codes for this amino acid sequence.

A AGCCCAAAG

B ACTAGGCTT

C UCGGGGUUC

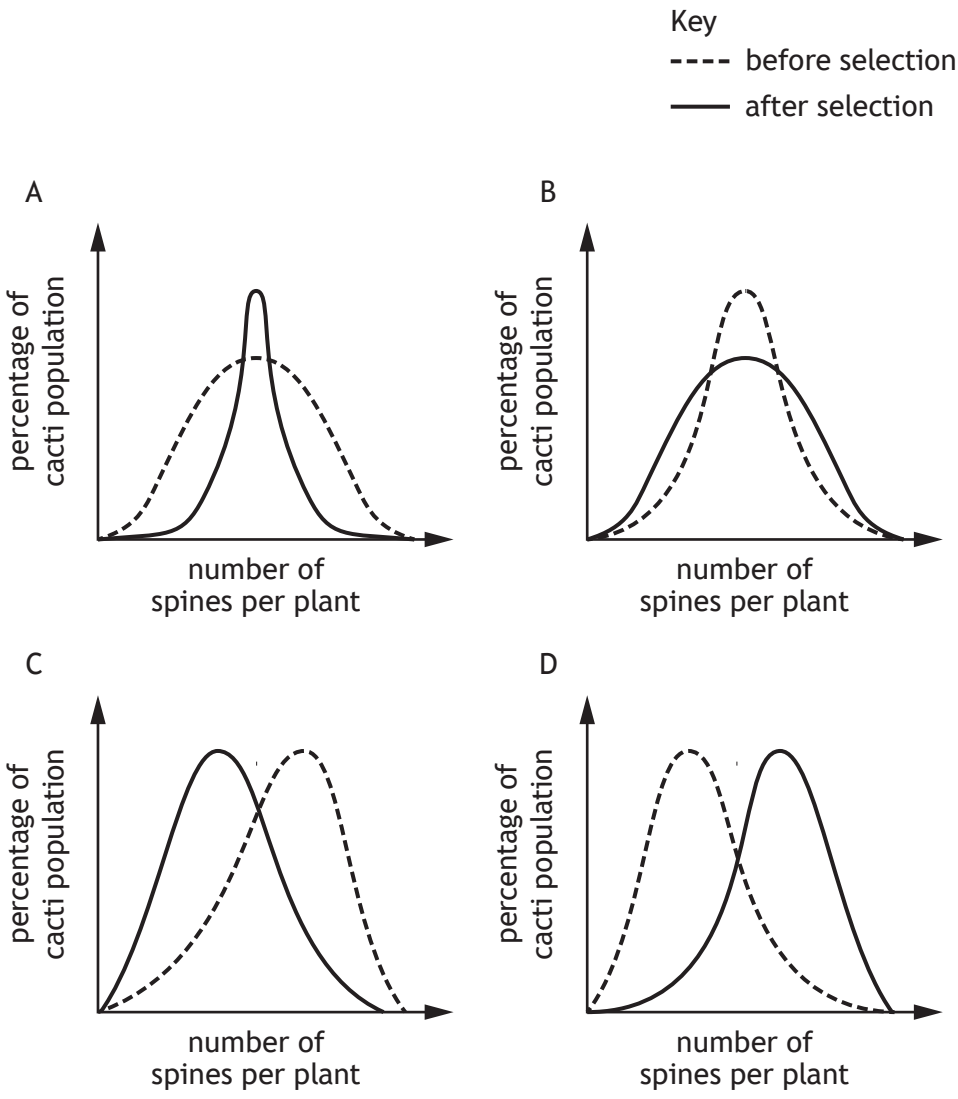
D TCGGGGTTC

[Turn over

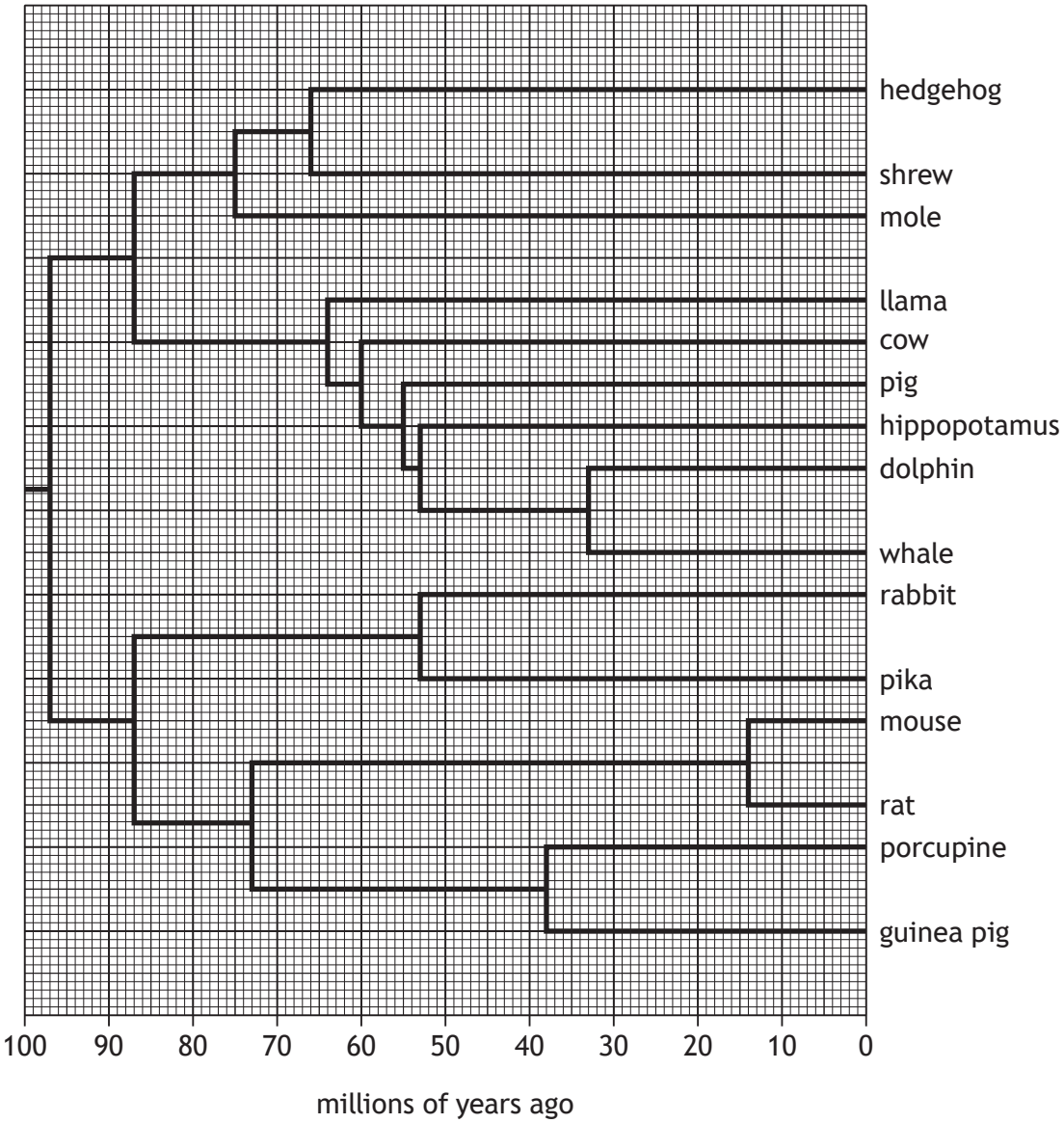
6. Cacti are plants that have spines to protect them from being eaten by herbivores. Cacti with more spines are less likely to be eaten.

However, the spines are sites where parasitic insects lay eggs and the larvae that hatch eat the plant. Cacti with a higher number of spines have a greater population of larvae.

Which graph represents these selection pressures?



7. The genomes of 15 related mammals were sequenced and the information was used in the construction of the phylogenetic tree shown.



Which two mammals are the most distantly related?

A Whale and rabbit

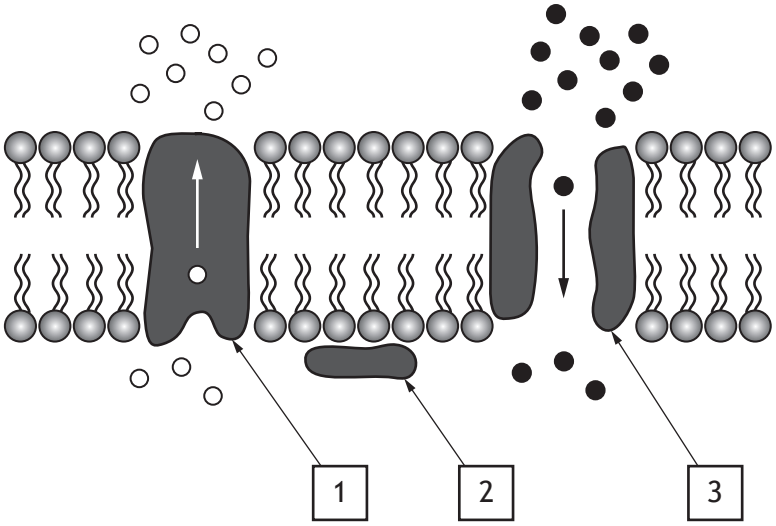
B Dolphin and shrew

C Whale and hedgehog

D Guinea pig and rabbit

[Turn over

8. The diagram shows part of a cell membrane and movement of substances through this membrane.

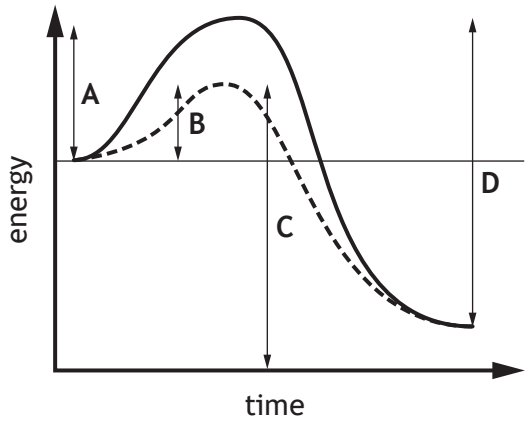


Which row in the table identifies proteins 1, 2 and 3?

	Pore	Pump	Enzyme
A	1	2	3
B	3	1	2
C	3	2	1
D	2	1	3

9. The graph shows the energy at different times of a reaction in the presence and absence of an enzyme.

Which letter represents the activation energy for this reaction in the presence of an enzyme?



10. Which of the following is true for conformers?

A They use negative feedback to control their internal environment

B They make behavioural responses to optimise metabolic rate

C They occupy a wide range of ecological niches

D They use energy from their metabolism to achieve homeostasis

11. Which row in the table identifies features of an amphibian heart?

	Number of atria	**Number of ventricles**	**Mixing of oxygenated and deoxygenated blood**
A	1	1	no
B	2	1	no
C	1	2	yes
D	2	1	yes

12. The following list relates to growth phases in a culture of the fungus *Penicillium chrysogenum*.

1. Growth is most rapid
2. Nutrients are completely depleted
3. Enzymes are induced
4. Antibiotics are produced

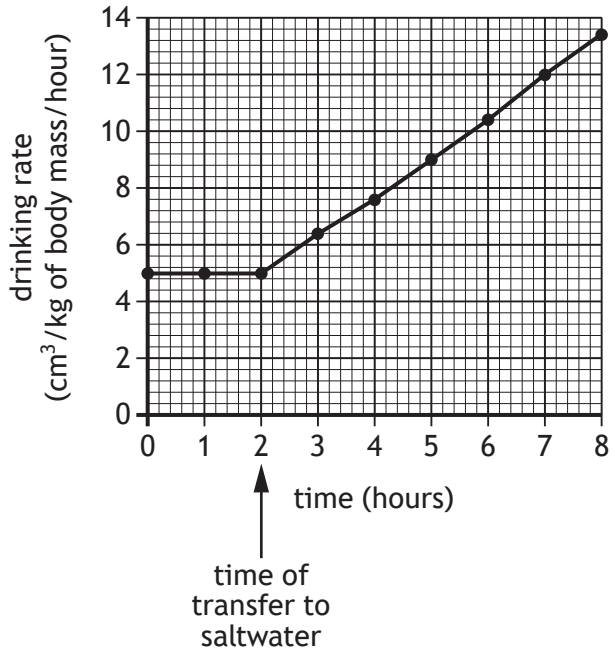
Which row in the table identifies the growth phases of this culture?

	Lag phase	**Log phase**	**Stationary phase**	**Death phase**
A	3	2	4	1
B	1	2	3	4
C	3	1	4	2
D	4	1	3	2

[Turn over

13. A sea trout (*Salmo trutta trutta*) was transferred from freshwater to saltwater.

The graph shows the change in the drinking rate of the sea trout.



The sea trout weighed 3 kg at 0 hours.

Calculate the volume of water the sea trout drank over the 2 hour period before it was transferred to saltwater.

A 5 cm^3

B 10 cm^3

C 15 cm^3

D 30 cm^3

14. An investigation was carried out to determine the respiration rate of maggots at different temperatures.

A probe was used to measure the CO_2 concentration in a sealed flask containing 20 maggots over a 10 minute period at three different temperatures.

The results are shown in the table.

Time (minutes)	CO_2 concentration (ppm)		
	3 °C	20 °C	30 °C
0	7100	7315	7105
2	7760	8010	8330
4	8160	8920	10 480
6	8500	9940	11 980
8	8840	11 840	13 470
10	9150	13 040	15 200

The conclusion relating to the aim of this investigation is, as the temperature increases the rate of

A CO_2 production increases

B CO_2 production decreases

C respiration increases

D respiration decreases.

15. An experiment was set up to investigate the effect of temperature on the heart rate of water fleas. The heart rates of 20 water fleas were measured at different temperatures of water at pH 6·5.

The results are shown in the table.

Temperature of water (°C)	Average heart rate (beats per minute)
5	23
10	80
20	92
30	173

The dependent variable in this experiment was the

A average heart rate of the water fleas

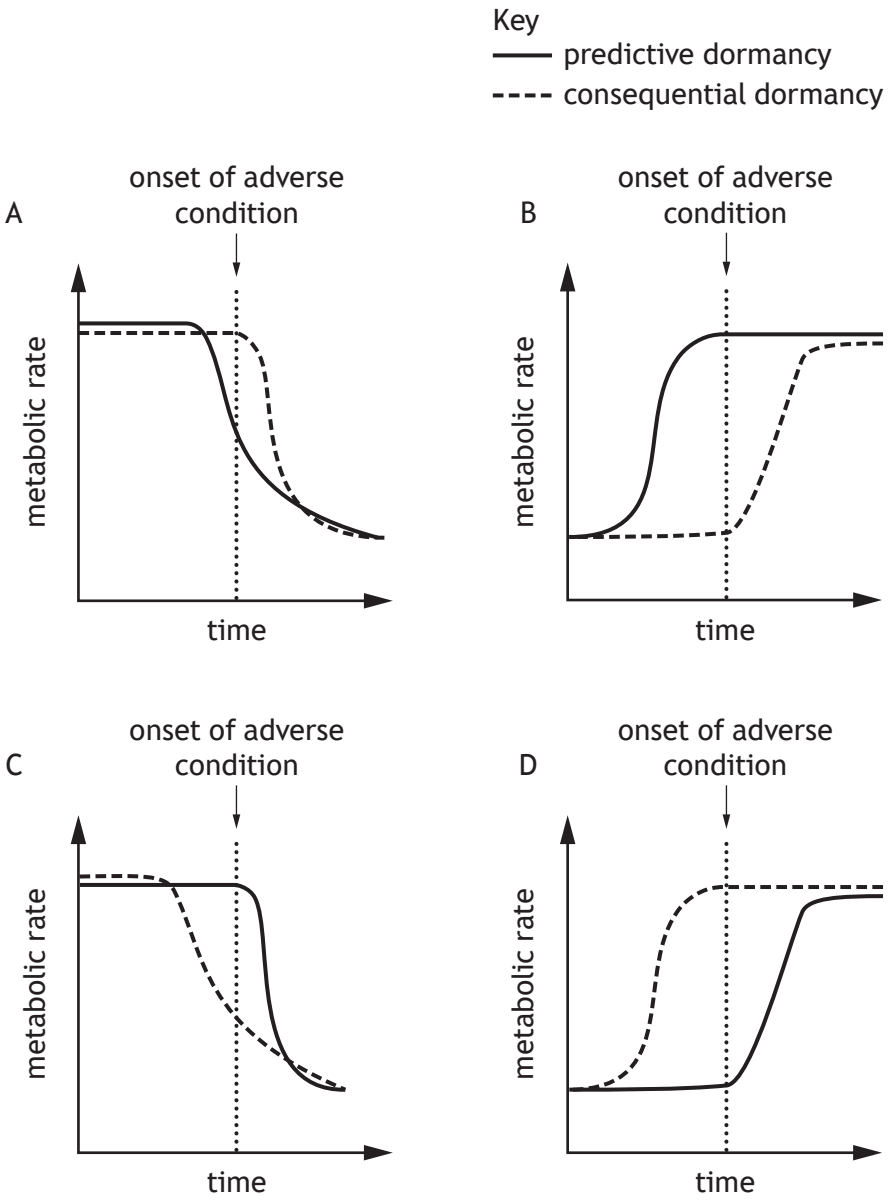
B temperature of the water

C number of water fleas

D pH of the water.

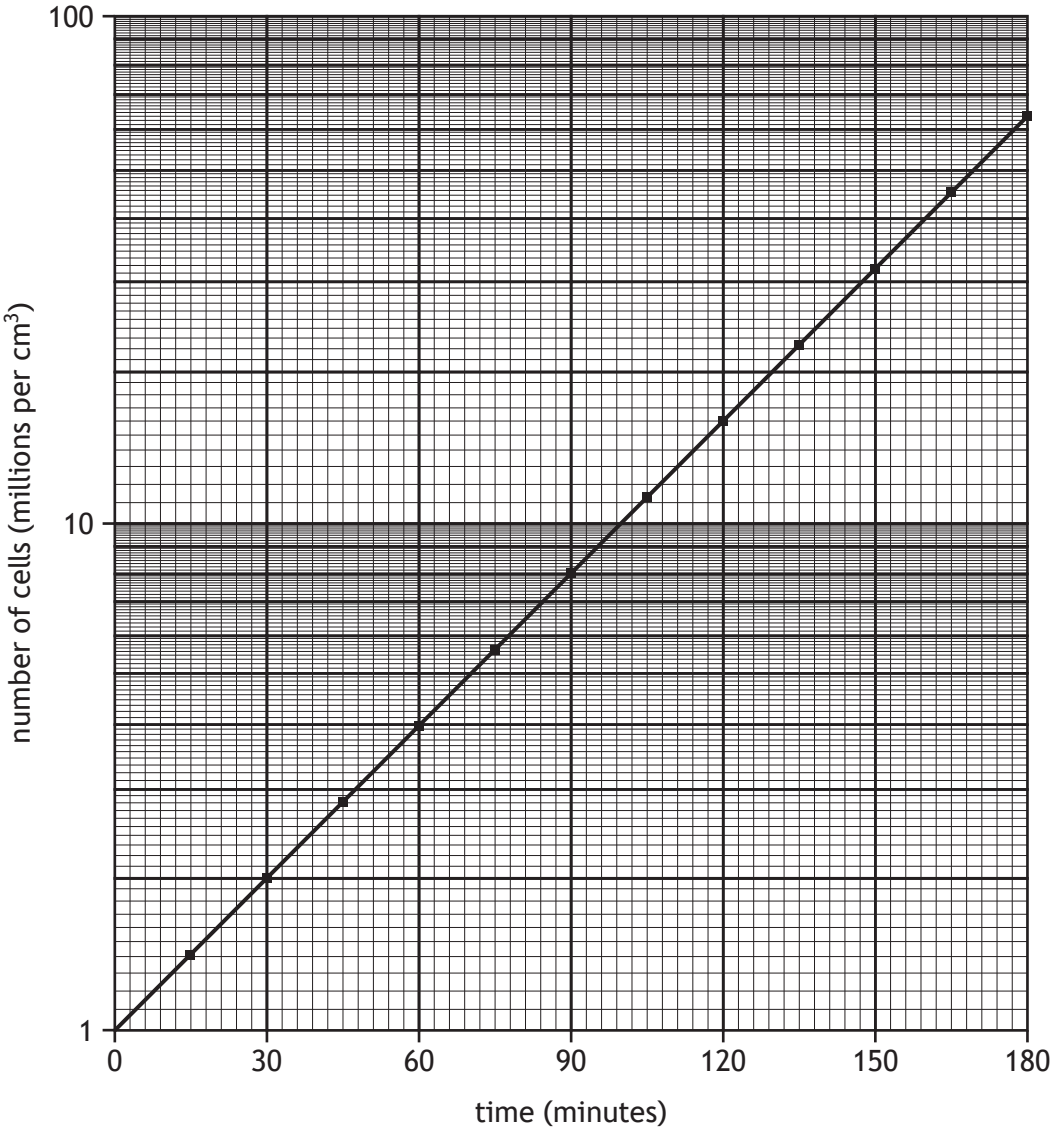
16. Dormancy in organisms can be predictive or consequential.

Which of the following graphs shows the changes in metabolic rate in organisms entering predictive and consequential dormancy?



17. Yeast cells were cultured in a growth medium and the number of cells were counted at regular intervals over a period of 180 minutes.

The semi-logarithmic graph shows the number of cells per cm^3 of culture medium during this period.



How many yeast cells were present in the culture after 2 hours?

A 1·6 million per cm^3

B 10·6 million per cm^3

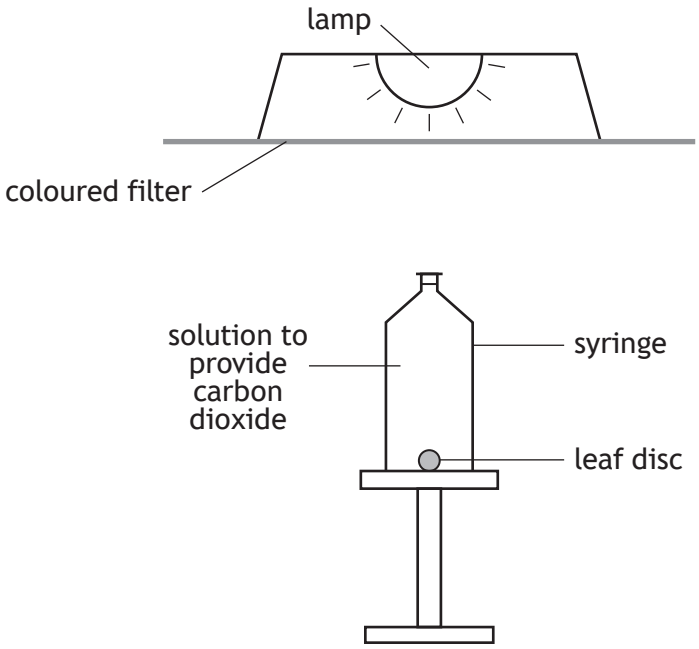
C 16·0 million per cm^3

D 70·0 million per cm^3

[Turn over

18. An experiment was carried out to investigate the effect of different colours of light on the rate of photosynthesis in oak leaf discs.

The apparatus was set up as shown, using different coloured filters to provide green, red or blue light.



Five syringes were set up for each filter colour and the times taken for the leaf discs to float to the top of the syringes were measured using a stopwatch.

The reliability of these results was improved by using

A the same size of leaf disc in each syringe

B five syringes for each filter colour

C a stopwatch to record the time

D three colours of light.

19. Which of the following events in photosynthesis requires hydrogen?

A Excitation of electrons

B Production of glyceraldehyde-3-phosphate (G3P)

C Photolysis of water

D Conversion of glyceraldehyde-3-phosphate (G3P) to RuBP

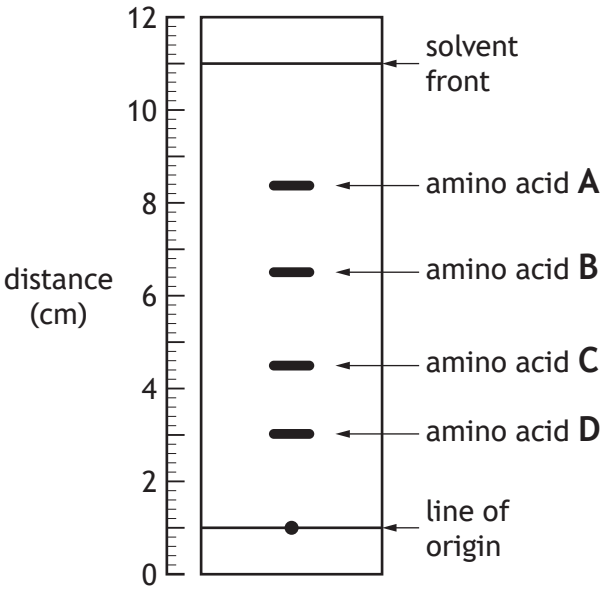
20. Chromatography can be used to separate amino acids in a mixture. To identify amino acids R_f values can be calculated as follows.

$$R_f = \frac{\text{distance travelled by the amino acid from line of origin}}{\text{distance travelled by the solvent from line of origin}}$$

The diagram shows a chromatogram in which four amino acids have been separated.

The table gives the R_f values of some amino acids.

Using information from the chromatogram and the table, identify which amino acid is threonine.



Amino acid	R_f value
glycine	0·26
glutamic acid	0·30
threonine	0·35
tyrosine	0·45
methionine	0·55
phenylalanine	0·68
leucine	0·75

21. Glyphosate is a non-selective herbicide used to control weeds. Recombinant DNA technology has been used to produce GR-maize crops that are resistant to glyphosate.

Which of the following would be an advantage to humans of planting GR-maize?

A Glyphosate could be used without reducing the yield of maize

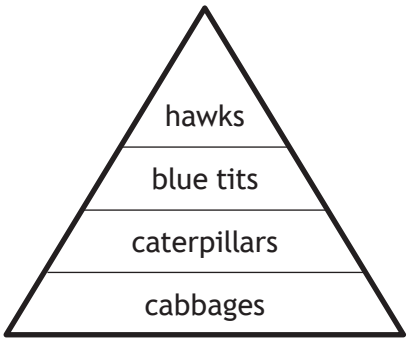
B The GR-maize crops are resistant to all herbicides

C Glyphosate would not be needed to control weeds

D Glyphosate resistance in weed species would occur

[Turn over

22. The diagram illustrates the energy content at different trophic levels of a food chain.



Pesticides are used to control caterpillar populations on cabbage crops.

Which of the following describes a possible bioaccumulation in this food chain after pesticide treatment of the cabbage crop?

A Decrease in energy content between caterpillars and blue tits

B Increase in concentration of pesticides between blue tits and hawks

C Increase in concentration of pesticides in caterpillars

D Increase in pesticide resistance in caterpillar populations

23. The Brangus breed of cattle is an F_1 hybrid produced by crossing the Brahman and Aberdeen Angus cattle breeds.

Which of the following statements could apply to Brangus cattle?

1. They could show inbreeding depression.
2. They could show improved characteristics.
3. Breeding them together could produce a genetically variable F_2

A 1 only

B 2 only

C 1 and 3 only

D 2 and 3 only

24. Painted wolves hunt in packs ranging in size from 3 to 20 individuals.
Compared to hunting alone this means that

A each individual gains less energy
B only subordinate wolves gain more energy
C only dominant wolves gain more energy
D less energy is used per individual.

25. Honeybees are social insects that live in colonies.
Which row in the table identifies activities carried out by drones and workers?

	Drones	**Workers**
A	fertilise eggs	produce eggs
B	fertilise eggs	defend hive
C	collect pollen	care for young
D	care for young	defend hive

[END OF QUESTION PAPER]

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National Qualifications

Mark

X807/76/01

Biology Paper 2

Duration — 2 hours 20 minutes

X8077601

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.

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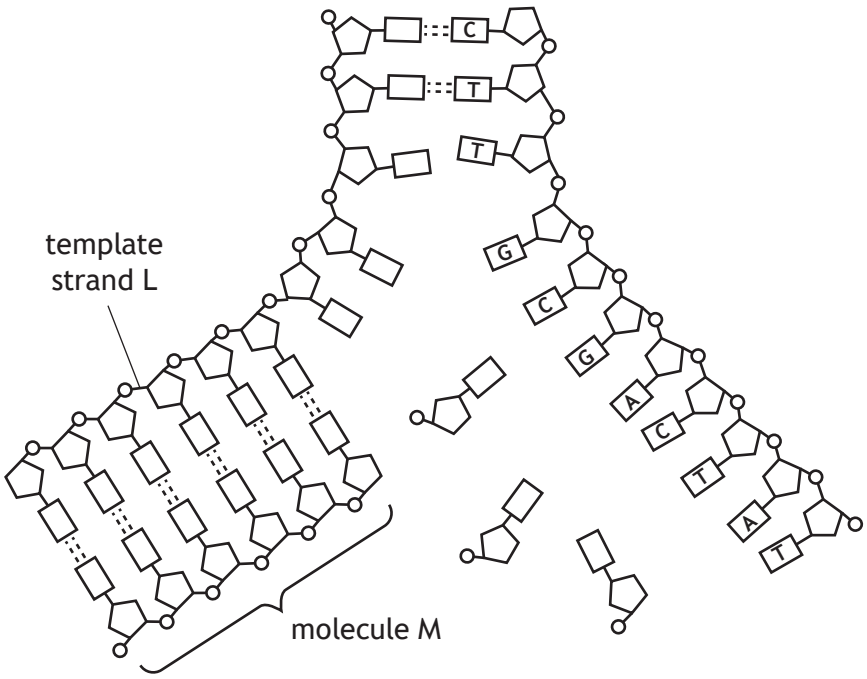
Total marks — 95

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**

_____

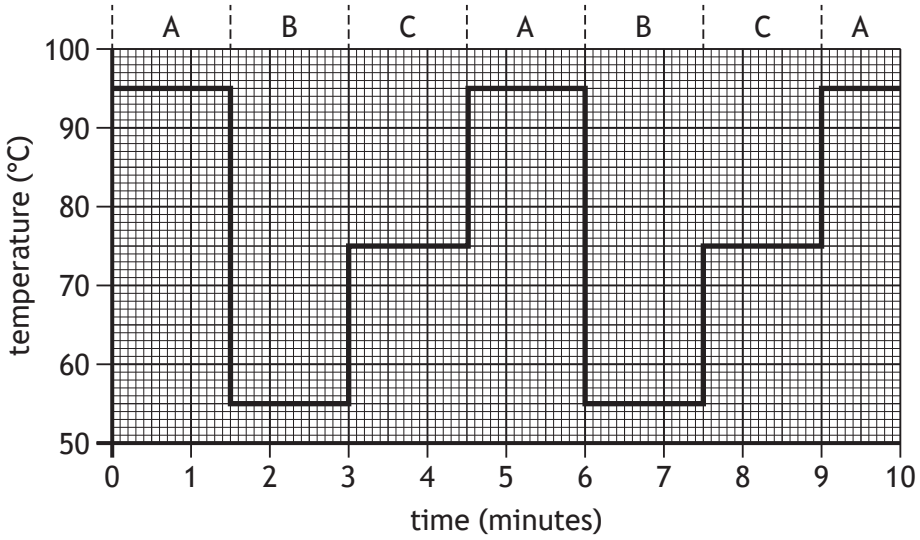
(iii) Name the enzyme that attaches free nucleotides to molecule M during DNA replication. **1**

_____

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**

_____

DO NOT WRITE IN THIS MARGIN

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

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**

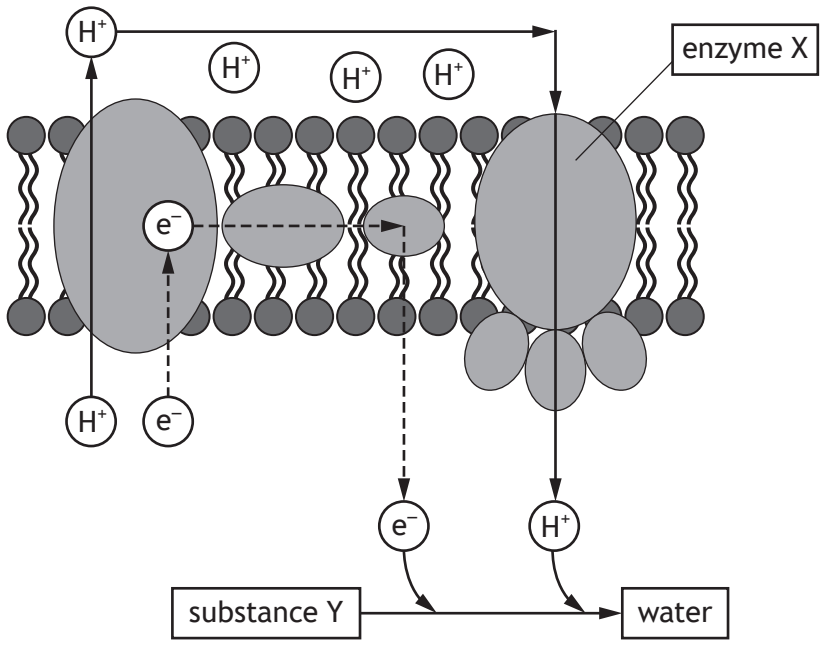
_____

_____

_____

[Turn over

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**

_____

_____

_____

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

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**

_____

_____

_____

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**

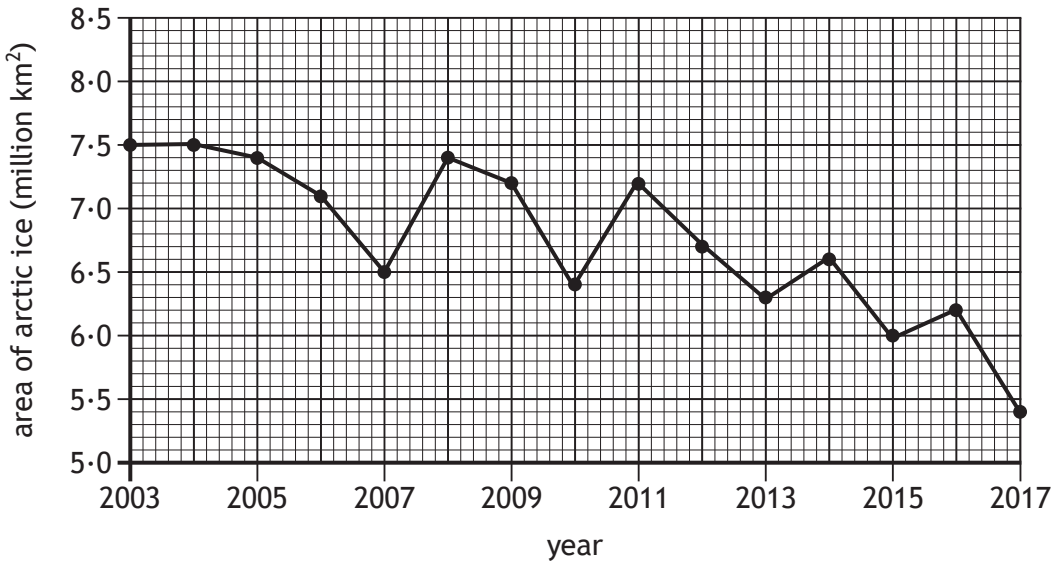
_____

[Turn over

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

_____%

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

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**

_____

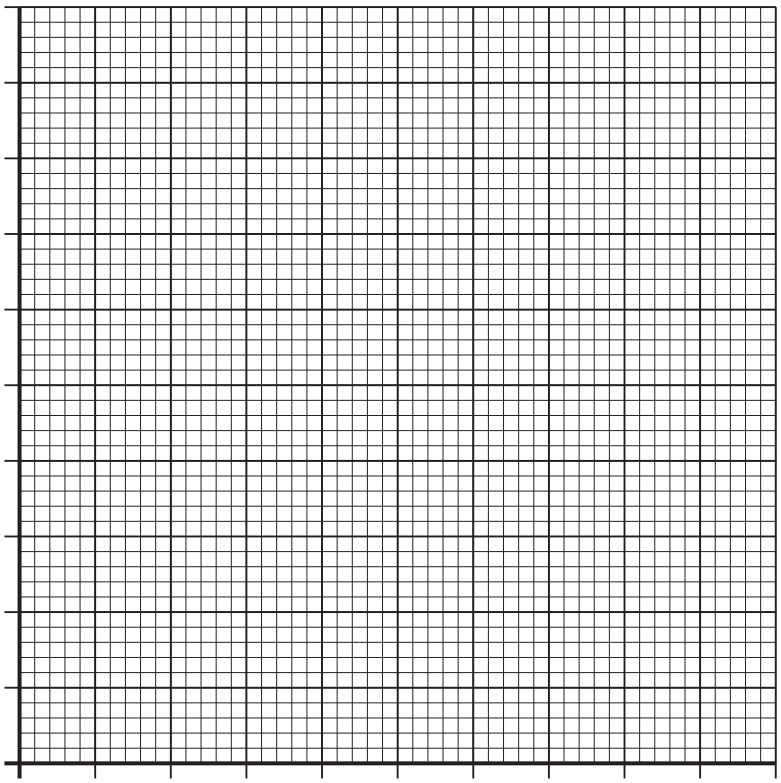
7. (continued)

(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*.)

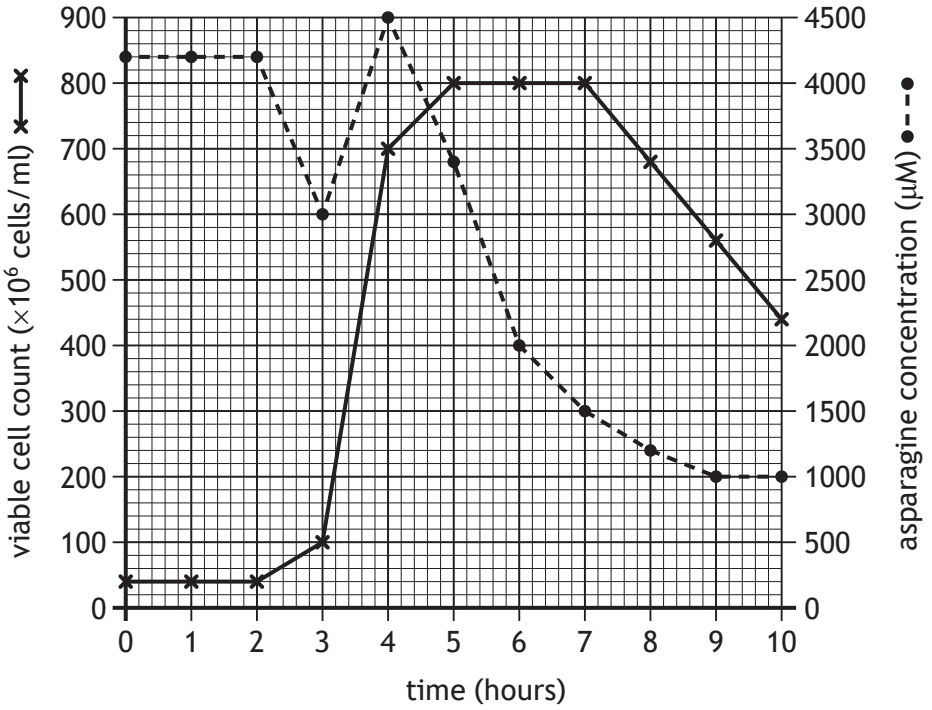


(d) It was concluded that Drug Z was more effective at inhibiting protein synthesis in human cells than Drug Y.

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

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

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

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 _____

_____

_____

9. (continued)

Metabolic pathways can be regulated by feedback inhibition.

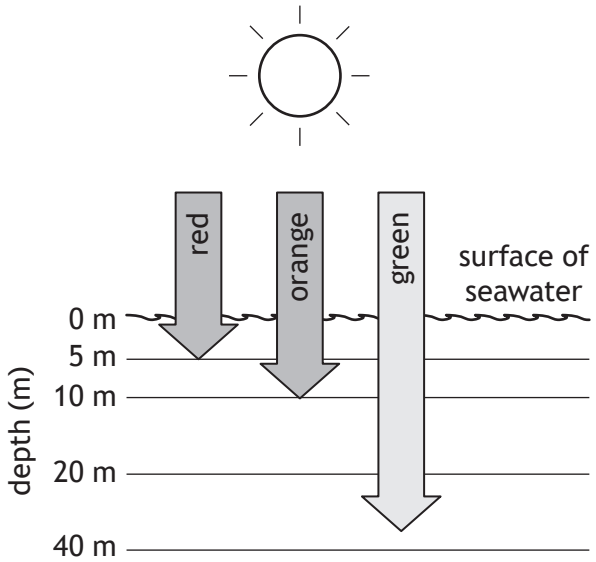
(b) (i) Describe feedback inhibition of a metabolic pathway. **2**

(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**

_____

_____

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**

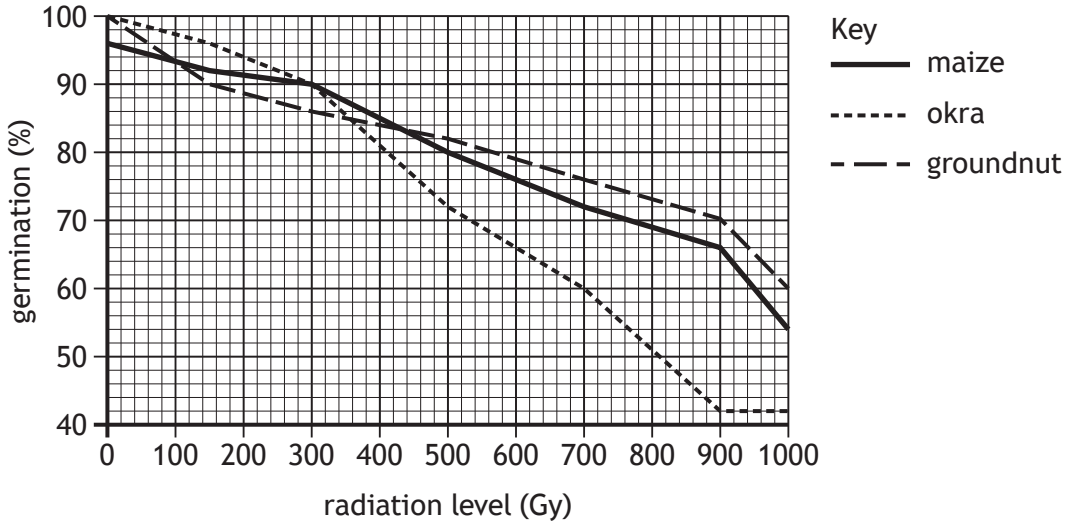
(c) Name a piece of apparatus that could be used to show which colours of light are absorbed by photosynthetic pigments. **1**

[Turn over

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**

_____%

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

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

Dandelion **Grass**

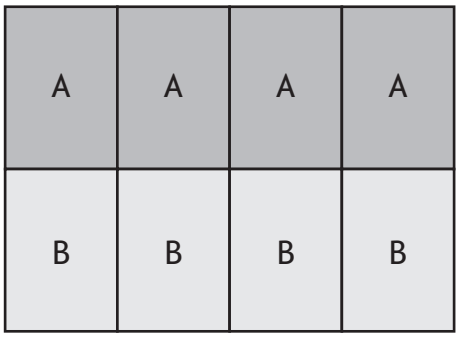
(a) Using information from the diagram

(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**

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.



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

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**

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

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**

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

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**

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