National
Qualifications
2025

X807/76/12

Biology
Paper 1 — Multiple choice

TUESDAY, 27 MAY
9:00 AM – 9:40 AM

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.

Total marks — 25 marks

Attempt ALL questions

1. Which row in the table shows the organisation of DNA in a nucleus, chloroplast and mitochondrion?

	Nucleus	Chloroplast	Mitochondrion
A	linear chromosome	plasmid	plasmid
B	circular chromosome	plasmid	linear chromosome
C	circular chromosome	linear chromosome	linear chromosome
D	linear chromosome	circular chromosome	circular chromosome

2. The DNA sequence shown is part of a gene that is transcribed and translated.

C A G A T C G T T A C T

State how many tRNA molecules, involved in translation of the mRNA transcribed from this sequence, would have anticodons containing **only one** uracil base.

A 0

B 2

C 3

D 4

3. An investigation was carried out to compare the mass of DNA in different types of fruit.

A 10 g sample from each of 5 different types of fruit was mixed with salt solution and detergent and incubated in a water bath at 60 °C.

Ethanol was added to precipitate the DNA and the mass of DNA was measured using a balance.

The entire investigation was repeated.

The validity of the investigation was improved by

A using 5 different types of fruit

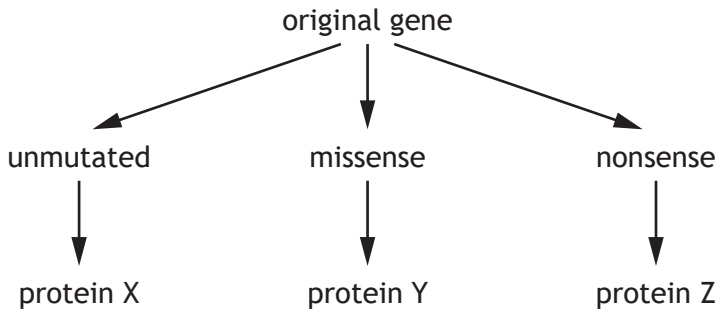
B using a balance to measure the mass of DNA

C using a water bath to incubate the mixture

D repeating the entire investigation.

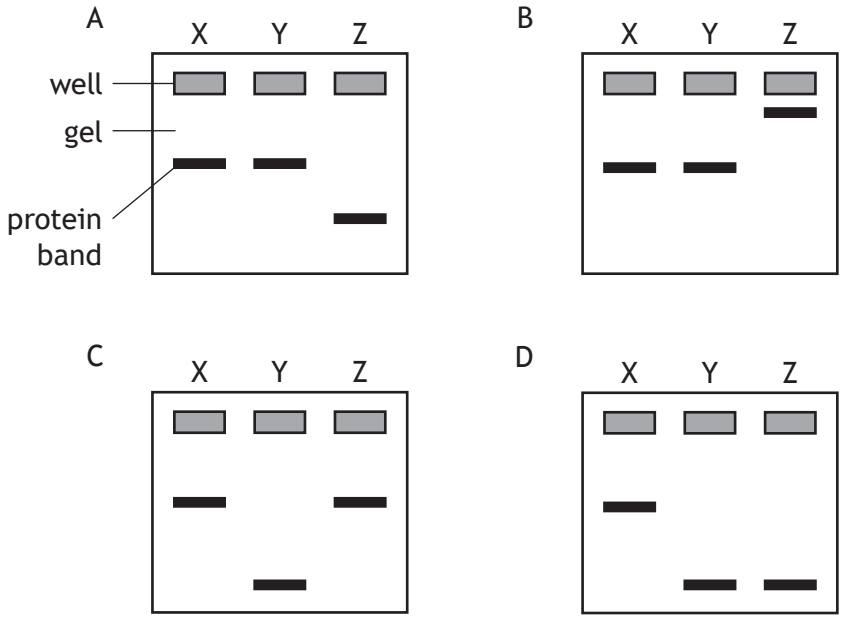
4. DNA sequences can undergo mutations, which can affect the protein produced.

The diagram shows the proteins produced from an unmutated sequence and from the sequences following two different mutations.



The sizes of the proteins can be compared using gel electrophoresis. Smaller proteins travel further in the gel.

Which of the following diagrams show the results of gel electrophoresis of proteins X, Y and Z?



5. The list describes methods of gene transfer in organisms.

1. Coat colour gene transferred by sexual reproduction in hamsters.
2. Ethanol tolerance gene transferred by asexual reproduction in yeast.
3. Antibiotic resistance gene transferred between bacteria of the same generation.

Which of these methods are examples of horizontal gene transfer?

A 1 only

B 3 only

C 1 and 2 only

D 2 and 3 only

6. Which of the following is a description of pharmacogenetics?

A Comparing sequence data using computers and statistical analysis.

B Studying the evolutionary relatedness among groups of organisms.

C Using an individual's genome sequence to select the most effective drugs.

D Studying the mutation rate in sequences over many generations.

7. Which of the following is a list of proteins embedded in membranes?

A Pore, histone and enzyme

B Enzyme, pump and histone

C Pore, ATP synthase and pump

D Histone, pump and ATP synthase

8. Which of the following molecules must be present in a living cell for glycolysis to occur?

A NAD and ATP

B Dehydrogenase and oxygen

C Glucose and NADH

D Pyruvate and ATP

9. An experiment was carried out into the effect of the concentration of an enzyme inhibitor on the rate of respiration in yeast.

Five flasks containing yeast, glucose and different concentrations of inhibitor were set up. The CO_2 concentration was measured using a probe.

The results are shown in the table.

Inhibitor concentration (%)	**CO_2 concentration (%)**
5	0.12
10	0.09
15	0.07
20	0.04

The reliability of these results could be improved by

A including a control flask with no inhibitor

B carrying out the experiment three times at each inhibitor concentration

C using a wider range of concentrations of inhibitor

D using the same volumes of glucose and yeast in each flask.

10. The ability of an organism to maintain its metabolic rate is affected by external abiotic factors such as

A temperature, salinity and pH

B disease, predation and food availability

C temperature, disease and predation

D pH, sterility and oxygen concentration.

11. The hypothalamus is the temperature monitoring centre in mammals that sends information to effectors to regulate body temperature.

Which row in the table identifies how the hypothalamus sends information to effectors and a corrective response to an **increase** in body temperature?

	How information is sent to effectors	**Corrective response**
A	bloodstream	vasoconstriction
B	bloodstream	vasodilation
C	nerves	vasoconstriction
D	nerves	vasodilation

[Turn over

12. An investigation was carried out to compare the lactose content of human milk and cow milk.

The enzyme lactase was used to break down the lactose to glucose. The glucose concentration was measured every 30 seconds for 3 minutes.

The results are shown in the table.

Time (minutes)	Glucose concentration (%)	
	Human milk	Cow milk
0.0	0.00	0.00
0.5	0.28	0.24
1.0	0.54	0.46
1.5	0.80	0.54
2.0	1.04	0.58
2.5	1.10	0.58
3.0	1.10	0.58

What statement comparing human milk and cow milk is supported by the data?

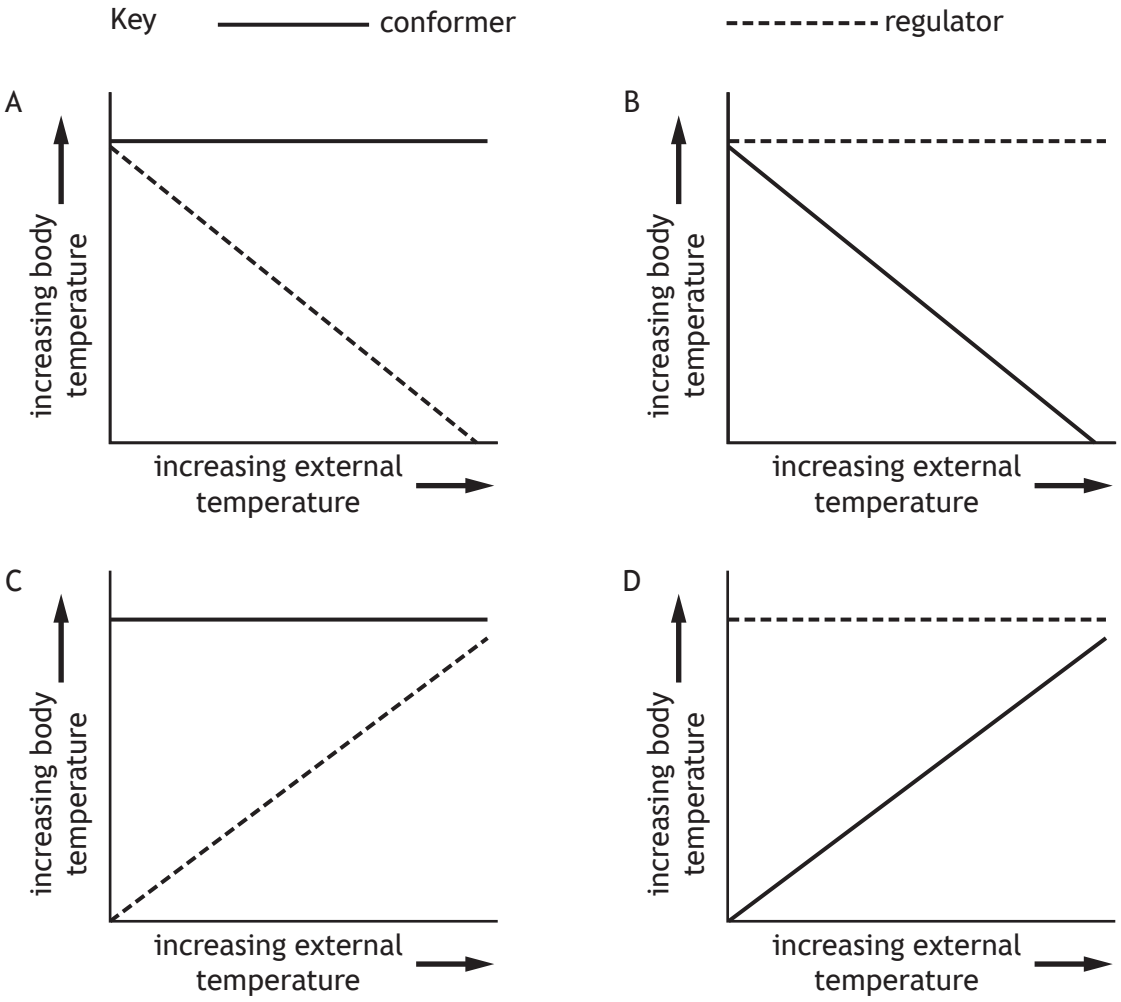
A Glucose production is faster in human milk.

B Glucose reached its maximum concentration sooner in human milk.

C No lactose remained in cow milk at 1.5 minutes.

D Glucose reached a maximum concentration in both milks at 2 minutes.

13. Which graph shows the effect of an increase in external temperature on the body temperature of conformers and regulators?



14. Which of the following descriptions relates to migration?

A It allows animals to avoid adverse conditions.

B It allows animals to survive adverse conditions.

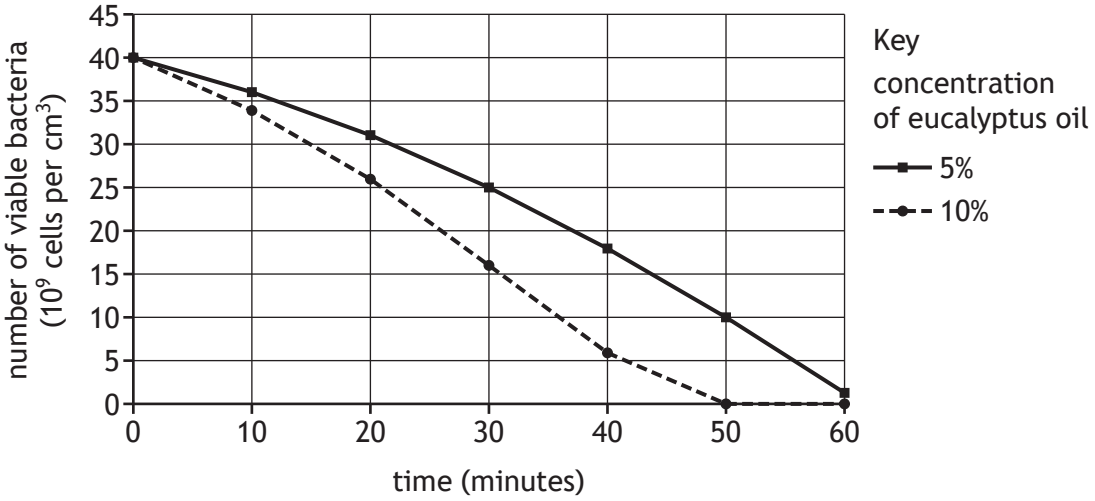
C It only involves learned behaviour.

D It only involves innate behaviour.

[Turn over

15. Eucalyptus oil inhibits growth of bacteria. A study was carried out to investigate the effect of the concentration of eucalyptus oil on bacterial growth. Bacteria were incubated for 1 hour with 5% and 10% eucalyptus oil.

The graph shows the number of viable cells in each culture at 10 minute intervals.



The percentage of bacteria killed by 5% eucalyptus oil after 50 minutes was

A 10%

B 25%

C 30%

D 75%.

16. Which statement about recombinant DNA technology is **not** correct?

A Plasmids are examples of vectors.

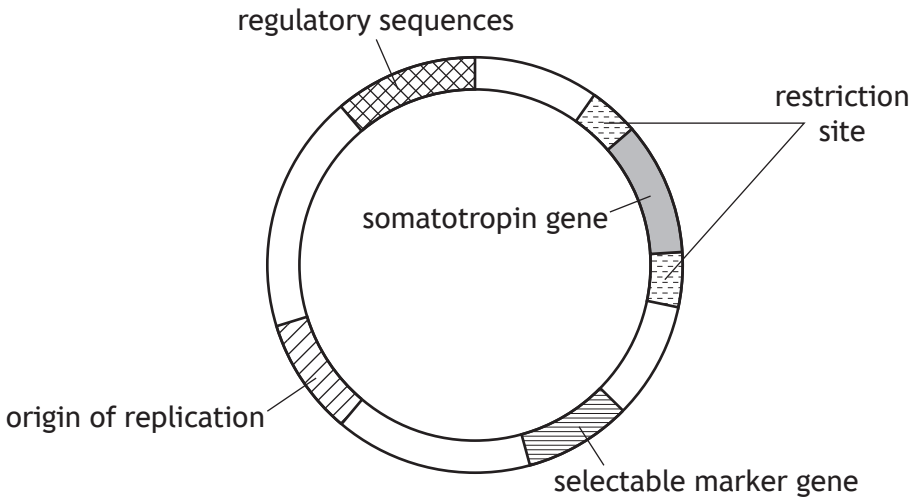
B Ligase cuts open plasmids and cuts specific genes out of chromosomes.

C Recombinant bacteria may result in proteins that are folded incorrectly.

D Artificial chromosomes are used when larger fragments of DNA are inserted.

17. A pharmaceutical company used recombinant DNA technology to produce genetically modified bacteria that synthesised the human growth hormone somatotropin.

The diagram shows the modified plasmid that was used to transform the bacteria.



The transformed bacteria were resistant to the antibiotic ampicillin.

Which feature of the modified plasmid is responsible for this resistance?

A Regulatory sequences

B Somatotropin gene

C Origin of replication

D Selectable marker gene

18. The following statements describe reactions in the carbon fixation stage of photosynthesis.

1. RuBP is converted to 3-phosphoglycerate (3PG).
2. 3PG is converted to glyceraldehyde-3-phosphate (G3P).
3. G3P is converted to glucose.

Which row in the table identifies a reaction catalysed by RuBisCO and a reaction that requires hydrogen ions?

	Catalysed by RuBisCO	**Requires hydrogen ions**
A	3	2
B	1	2
C	1	1
D	3	1

[Turn over

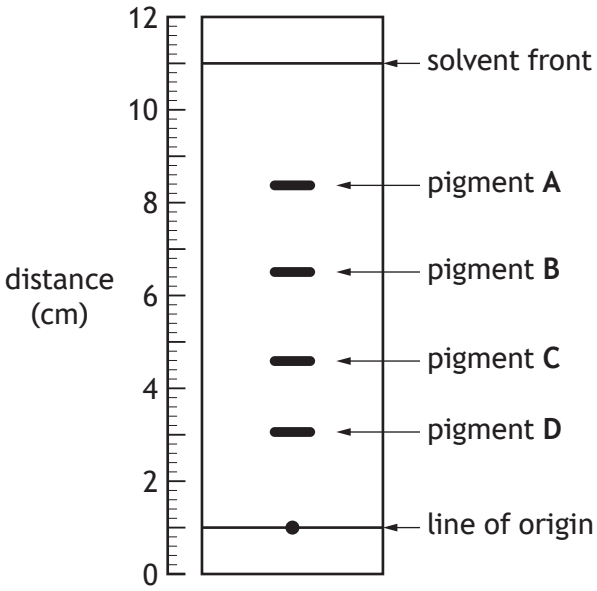
19. Pigments were extracted from plant leaves and separated using thin layer chromatography.

R_f values for each pigment can be calculated using the formula:

$$\frac{\text{distance travelled by pigment from the line of origin}}{\text{distance travelled by the solvent from the line of origin}}$$

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

The table gives the R_f values of some plant pigments.



Pigment	R_f value
Chlorophyll a	0.35
Chlorophyll b	0.20
Carotene	0.74
Xanthophyll	0.55
Anthocyanin	0.45
Phaeophytin	0.59

Using information from the chromatogram and the table, identify which pigment is xanthophyll.

20. The list describes features of a field trial designed to compare the yield of maize cultivars.

1. Treatments are allocated to plots randomly.
2. Trial includes plots of four different maize cultivars.
3. A sufficient number of replicates is used.

Which of the features would take into account the variability of yield in each cultivar?

A 2 only

B 3 only

C 1 and 2 only

D 1 and 3 only

21. Packs of grey wolves are found in many regions of Canada. The total area of territories in each region studied was measured and the number of packs of grey wolves found in each region was recorded.

The results are shown in the table.

Region of Canada	Total area of territories (km^2)	Number of packs
X	240	2
Y	351	14
Z	840	28

Calculate how many times larger the average area of territory per pack in region X is compared to region Z.

A 0.25

B 3.50

C 4.00

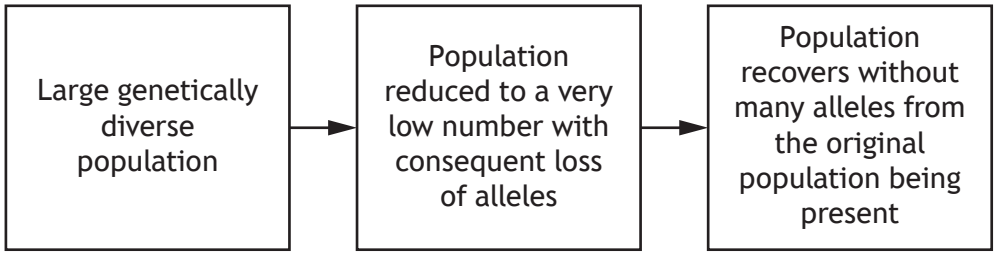
D 14.00

22. Which row in the table identifies kin selection?

	Donor	Recipient	Type of relationship
A	benefits	harmed	altruism
B	harmed	benefits	mutualism
C	harmed	benefits	altruism
D	benefits	harmed	mutualism

[Turn over

23. The sequence describes a population in a specific habitat over a long period of time.



This sequence describes

A natural selection
B prevention of gene flow
C recovery of genetic diversity
D the bottleneck effect.

24. The list describes components of biodiversity:

1. Number of different species in an ecosystem
2. Number and frequency of alleles in each species in an ecosystem
3. Proportion of each species in an ecosystem.

Which components would need to be considered when measuring species diversity?

A 1 and 2 only
B 1 and 3 only
C 2 and 3 only
D 1, 2 and 3

25. Grey squirrels were brought into the UK from North America over 100 years ago.
They are now described as an invasive species because they have spread rapidly and

A were introduced from outside the UK
B have become established within natural habitats
C have eliminated native red squirrels in many areas
D occupy the same habitat as native red squirrels.

[END OF QUESTION PAPER]

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SPACE FOR ROUGH WORK

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National Qualifications 2025

Mark

X807/76/01

Biology Paper 2

TUESDAY, 27 MAY
10:10 AM – 12:30 PM

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 5 and 15 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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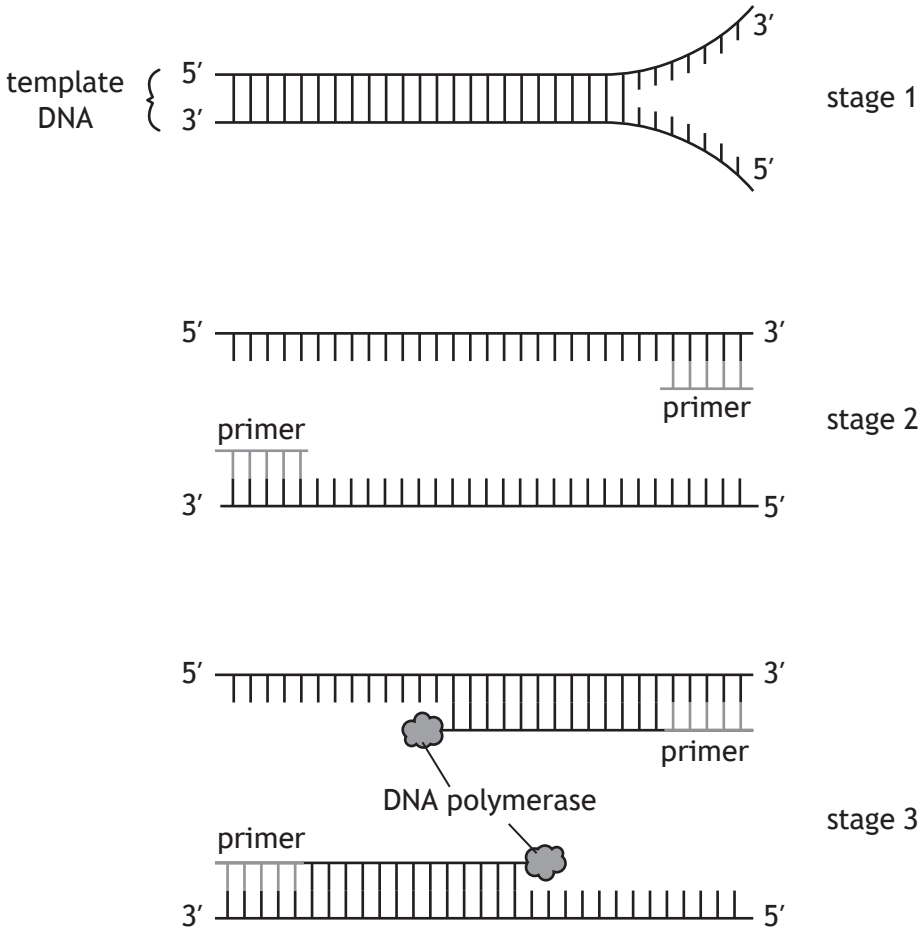
Total marks — 95

Attempt ALL questions

Questions 5 and 15 contain a choice

1. The diagram shows the stages that take place in a complete cycle of the polymerase chain reaction (PCR) being used to amplify human DNA.



(a) Name the part of a nucleotide found at the 3′ end of a DNA strand. **1**

_____

(b) (i) State a temperature required for stage 3 to occur. **1**

_____°C

(ii) Describe the role of DNA polymerase in stage 3. **1**

_____

1. (continued)

(c) (i) Explain why the enzyme ligase is **not** required in PCR. **1**

_____

_____

(ii) Explain why DNA polymerase extracted from human cells would **not** be suitable for PCR. **1**

_____

(d) The table shows the contents of a reaction tube used in PCR.

Content of reaction tube	Volume (µL)
Distilled water	15.8
Buffer	2.4
Nucleotides	1.7
Magnesium chloride	2.1
Primers	2.0
DNA polymerase	0.4
Template DNA	0.6

Calculate the percentage of the contents of the reaction tube that is DNA polymerase. **1**

Space for calculation

_____ %

(e) The original sample used contained 70 DNA molecules.

Calculate how many copies of DNA there would be after 8 cycles of PCR. **1**

Space for calculation

_____

2. The MSTN gene in cattle codes for the protein myostatin. Myostatin inhibits the growth of muscle tissue.

A mutation can occur in the MSTN gene.

Part of the base sequence of the MSTN gene in two breeds of cattle is shown.

Breed A ….C C C A C G G A G T G T G A G T A G….

Breed B ….C C C A C G G A G T T G A G T A G….

Breed A does not have the mutation and breed B does have the mutation in the MSTN gene.

(a) (i) Name the type of gene mutation that has occurred in breed B. **1**

_____

(ii) Explain why there would be a major effect on the structure of the protein produced. **1**

_____

_____

(b) Explain why breed B cattle will have an increase in muscle mass. **1**

_____

_____

2. (continued)

(c) The length of pregnancy and birth mass of beef and dairy cattle breeds were recorded.

The results are shown in the table.

Breed of cattle	Product	Average length of pregnancy (days)	Average birth mass (kg)
Aberdeen Angus	beef	285	34.6
Ayrshire	dairy	280	37.2
Hereford	beef	284	35.3
Holstein	dairy	277	38.2
Jersey	dairy	275	36.9

Compare the length of pregnancy and birth mass of beef and dairy cattle. **2**

[Turn over

3. In Lake Victoria there are two populations of male cichlid fish. One population is red and the other is blue.

The fish move freely between shallow and deep water. In shallow water, female cichlid fish are only attracted to and breed with blue males. In deeper water, females are only attracted to and breed with red males.

(a) (i) Name the type of isolation barrier that exists between these populations. **1**

_____

(ii) State the importance of isolation barriers in the evolution of new species. **1**

_____

(b) An investigation was carried out into the effect of the depth of water on the distribution of blue and red male cichlid fish. The fish were counted using underwater video cameras.

The results are shown in the table.

Depth of water (m)	Number of blue male cichlid fish	Number of red male cichlid fish
0–10	9924	57
10–20	7587	84
20–30	4457	119
30–40	301	6650
40–50	103	9210
50–60	74	11 570

(i) Predict the number of red male cichlid fish at a depth of 60–70 m. **1**

_____

(ii) Suggest a reason why the method used to count the cichlid fish could lead to inaccurate results. **1**

_____

_____

3. (b) (continued)

(iii) Compare the distribution of blue and red male fish as the depth of water increases. **1**

_____

_____

(c) It is predicted that these two populations will evolve into different species.

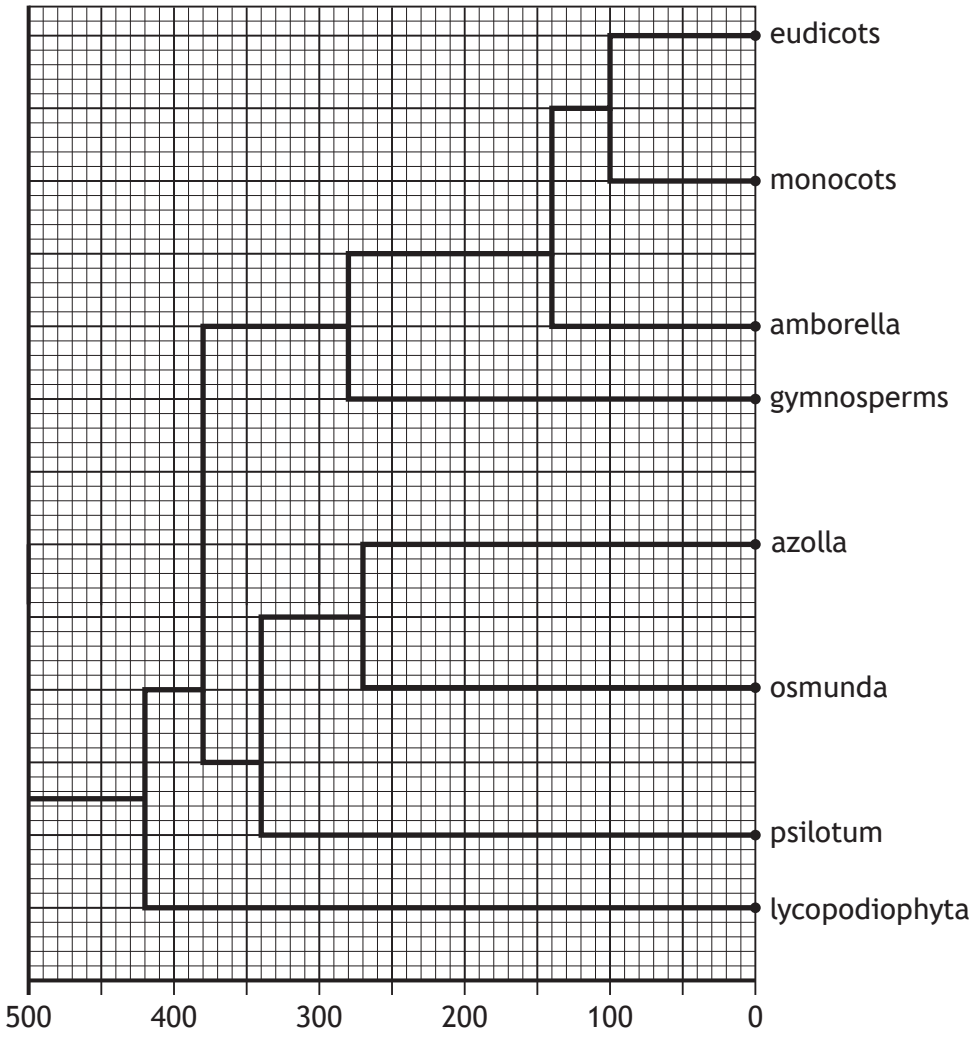
State how it could be proved that they are no longer the same species. **1**

_____

_____

[Turn over

4. The phylogenetic tree shown illustrates the evolutionary relatedness of eight groups of land plants.



(a) (i) Phylogenetics uses fossil evidence to study evolutionary relatedness.

Name another type of evidence required to construct a phylogenetic tree. **1**

_____

(ii) Using information from the diagram state when the last common ancestor of amborella and osmunda lived. **1**

_____ millions of years ago

(iii) State how many groups of land plants monocots shared a common ancestor with 200 million years ago. **1**

_____

4. (a) (continued)

(iv) Monocots are more closely related to gymnosperms than to lycopodiophyta.

Use information from the diagram to justify this statement. **1**

_____

_____

(b) The ACS gene is found in the eudicot plant group genome. Several different enzymes can be expressed from this gene.

(i) State the definition of a genome. **1**

_____

_____

(ii) In terms of gene expression, describe how different enzymes can be produced from a single ACS gene. **2**

_____

_____

_____

[Turn over

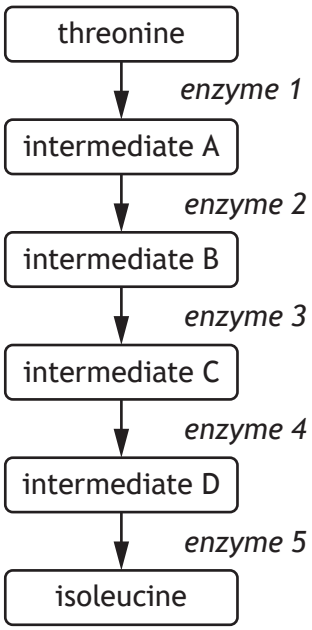
5. Attempt **either A or B**. Write your answer in the space below.

A Write notes on the transcription stage of gene expression. **4**

OR

B Write notes on chromosome mutations. **4**

6. The diagram shows a metabolic pathway, which converts the amino acid threonine to another amino acid isoleucine in cells.



Enzyme 1 catalyses the breakdown of threonine to intermediate A.

(a) (i) Name this type of metabolic reaction. **1**

_____

(ii) Describe what happens to the active site of enzyme 1 when threonine binds to it and explain how this increases the rate of reaction. **2**

Description _____

_____

Explanation _____

_____

[Turn over

6. (continued)

(b) When concentrations of isoleucine reach a high level, the metabolic pathway is blocked.

Describe how this happens and suggest how this is an advantage to the cell. **2**

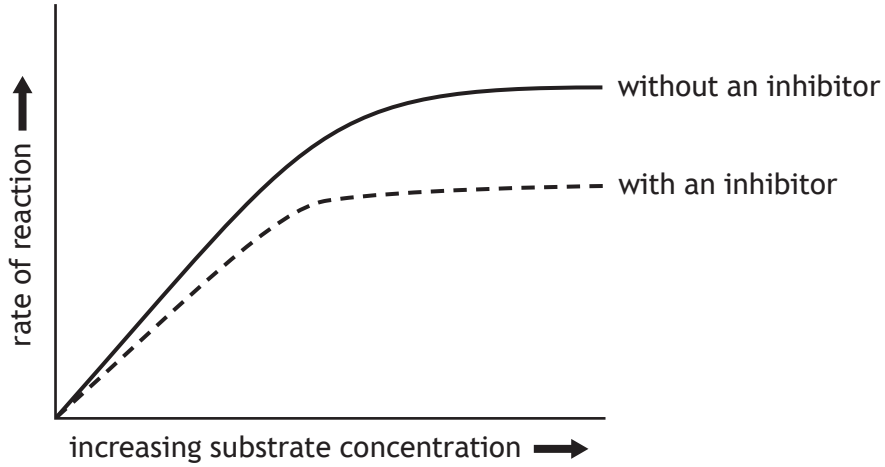
Description _____

_____

Advantage _____

_____

(c) The graph shows the rate of isoleucine synthesis with and without an inhibitor.



(i) Explain why the rate of reaction levels off at high substrate concentrations without an inhibitor. **1**

_____

_____

(ii) This is an example of non-competitive inhibition.

Use information from the graph to support this statement. **1**

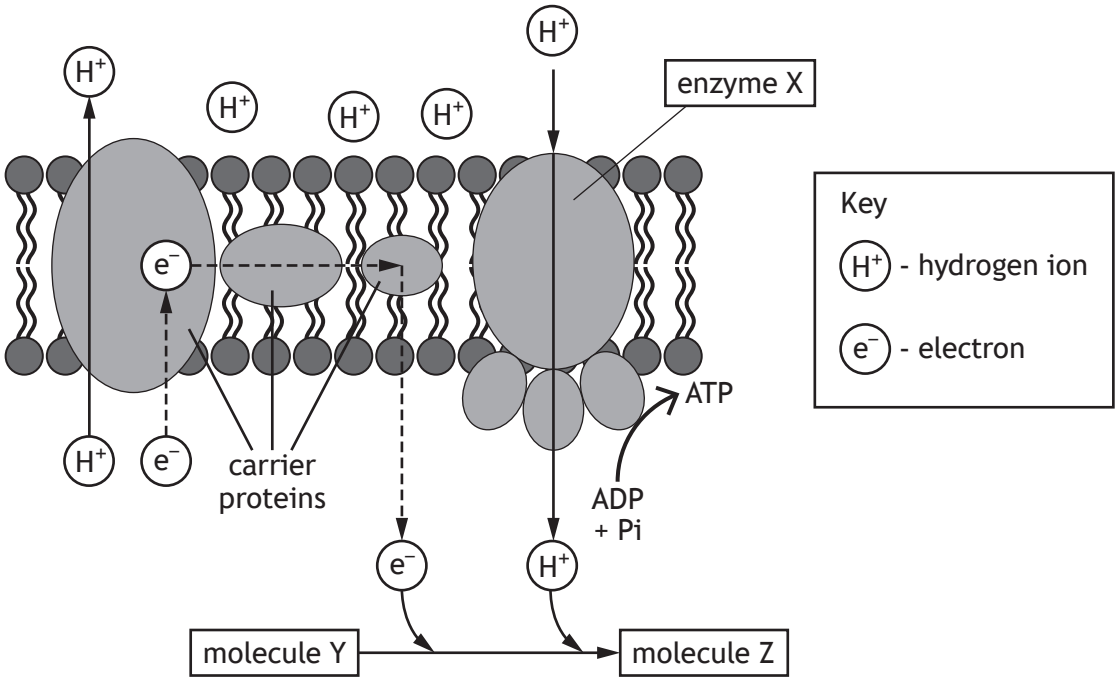
_____

_____

_____

7. The diagram illustrates how ATP is produced in the electron transport chain.

MARKS DO NOT WRITE IN THIS MARGIN



(a) (i) State the exact location of the electron transport chain in eukaryotic cells. **1**

_____

(ii) Name enzyme X. **1**

_____

(iii) Name molecules Y and Z. **2**

Y _____ Z _____

(b) Describe the role of the co-enzyme NAD. **2**

_____

_____

(c) Mitochondrial disease can be caused by a mutation that alters the structure of the carrier proteins shown in the diagram.

Suggest how the altered structure of these proteins can lead to reduced ATP production in individuals with this mutation. **2**

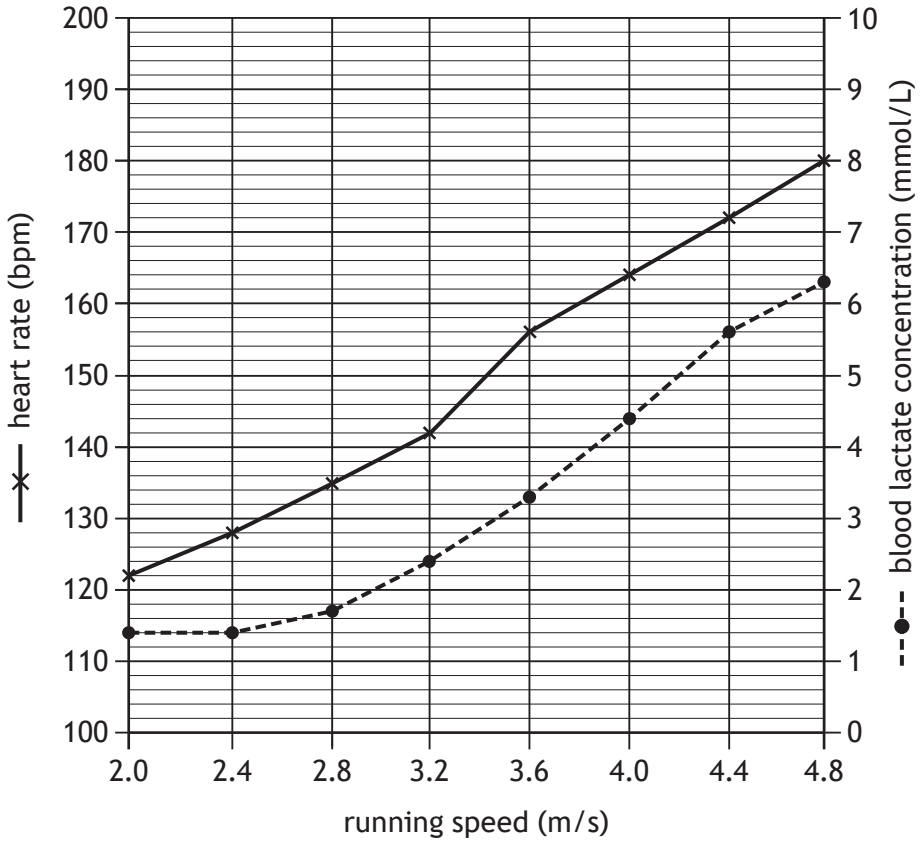
_____

_____

_____

8. In an investigation an athlete ran at different speeds on a treadmill. Their heart rate and blood lactate concentration were measured at each running speed.

The results are shown in the **graph**.



(a) (i) Use values from the graph to describe changes in blood lactate concentration as running speed increased from 2.0 to 4.8 m/s. **2**

_____

_____

_____

_____

(ii) State the blood lactate concentration when heart rate was 135 bpm. **1**

_____ mmol/L

(iii) Calculate the percentage increase in heart rate as running speed increased from 2.0 to 4.8 m/s. **1**

Space for calculation

_____ %

8. (continued)

(b) The power generated by the same athlete at different heart rates was calculated in another investigation on the same treadmill.

The results are shown in the **table**.

Heart rate (bpm)	Power (watts)
84	120
92	135
112	148
140	162
164	184

(i) Calculate the average increase in power generated as the heart rate increases from 84 to 164 bpm. **1**

Space for calculation

_____ watts per bpm

(ii) **Using information in the graph and table** state the athlete's blood lactate concentration when they generated 184 watts. **1**

_____ mmol/L

(c) Name the cell process that produces lactate. **1**

_____

(d) The athlete's blood lactate concentration was recorded 10 minutes after they finished running and it had decreased to 1.1 mmol/L.

Explain this observation. **1**

_____

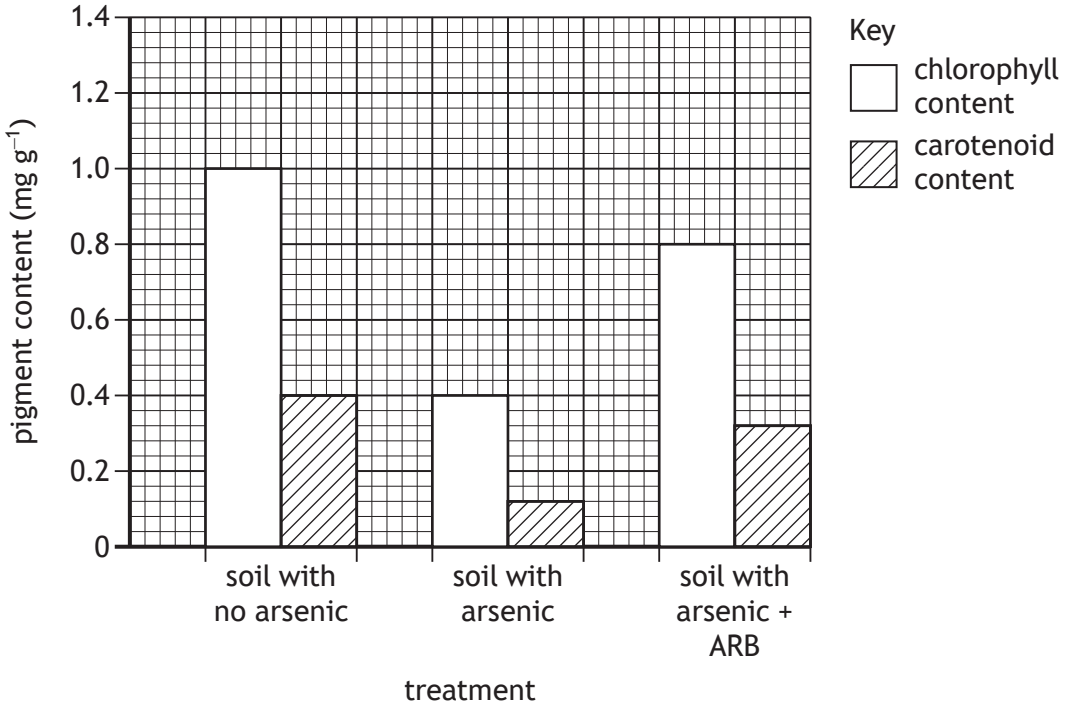
_____

9. Some areas of agricultural land are contaminated with arsenic. This can reduce the pigment content in crop plants.

A strain of bacteria, called ARB, breaks down arsenic in contaminated soils.

An investigation was carried out to determine the effect of adding ARB to soil on the chlorophyll and carotenoid content of plants.

The results are shown in the graph.



(a) (i) Express, as a simple whole number ratio, the carotenoid content of the plants grown in soil with no arsenic, soil with arsenic, and soil with arsenic + ARB. **1**

Space for calculation

_____ : _____ : _____

soil with no arsenic | soil with arsenic | soil with arsenic + ARB

(ii) Describe evidence from the graph that suggests that not all arsenic has been broken down by ARB. **1**

_____

_____

_____

9. (a) (continued)

(iii) Explain why the presence of carotenoids increases the rate of photosynthesis. **2**

(b) Describe how the absorbed light leads to the production of ATP, which is required for carbon fixation. **2**

[Turn over

10. Selective herbicides can be used to control weeds growing in wheat fields.

(a) (i) State why the presence of weeds reduces the productivity of wheat plants. **1**

_____

(ii) Explain why selective herbicides have a greater effect on some weeds compared to wheat plants. **1**

_____

_____

(b) The global human population and the number of species of herbicide-resistant weeds were recorded from 1980 until 2020.

The results are shown in the table.

Year	Global human population (billions)	Number of herbicide-resistant weed species
1980	4.4	8
1990	5.3	113
2000	6.1	264
2010	7.0	404
2020	7.8	480

(i) Calculate how many times greater the number of herbicide-resistant species was in 2020 compared to 1980. **1**

Space for calculation

_____ times

10. (b) (continued)

(ii) Use information from the table to suggest why there was a decrease in global food security between 1980 and 2020. **2**

(c) In terms of natural selection, explain how the use of herbicides results in an increase in the number of herbicide-resistant weed species. **2**

[Turn over

11. Problems with pesticides include toxicity to non-target species. Sumithion is an insecticide used to control tiger beetles, which are pests in fish farms.

An investigation was carried out into the effect of sumithion concentration on hatching success of fish eggs.

40 fertilised fish eggs were placed in containers with 250 cm^3 of water and different concentrations of sumithion. The hatching success was recorded after 20 days.

The results are shown in the table.

Sumithion concentration (mg/L)	Hatching success (%)
0.0	92
0.2	85
0.4	57
0.6	42
0.8	25
1.0	25

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

_____

(ii) Identify one variable, not already mentioned, that should have been controlled to allow a valid conclusion to be drawn. **1**

_____

(iii) Identify the sumithion concentration that acts as a control and describe the purpose of the control in **this** investigation. **2**

Sumithion concentration _____ mg/L

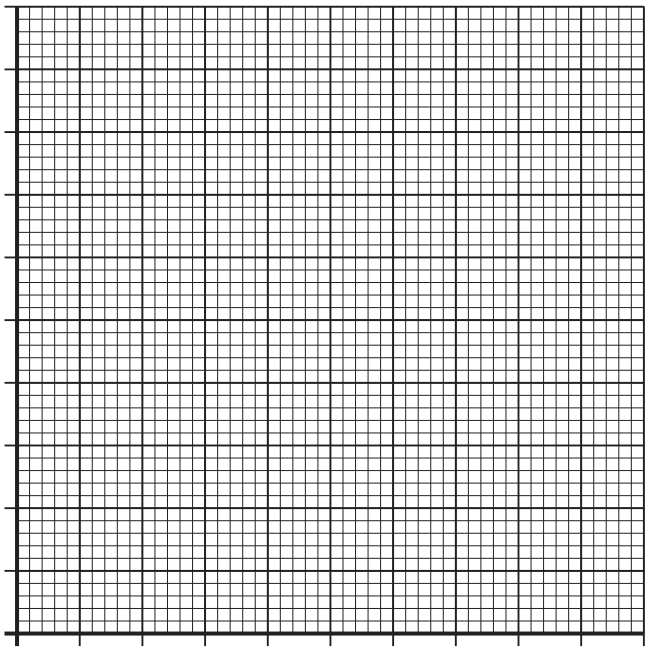
Purpose of the control _____

_____

_____

11. (continued)

(b) On the grid, draw a line graph using the results in the table. **2**
(Additional graph paper, if required, can be found on *page 30*.)



(c) State the conclusion from the results of the investigation. **1**

_____

_____

(d) State a problem with pesticide use, other than toxicity to non-target species. **1**

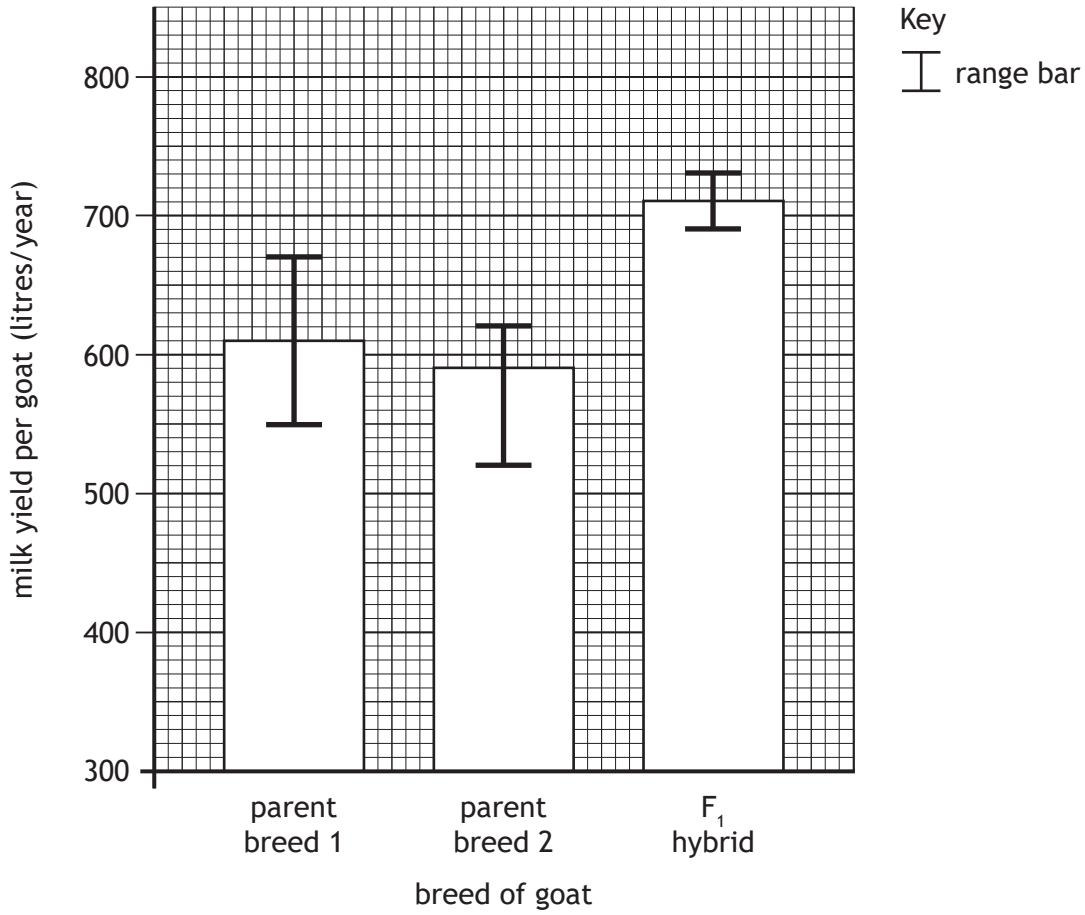
_____

[Turn over

12. Different breeds of goat can be crossbred to produce F_1 hybrids that have increased milk production.

In an investigation, the milk yields from the two parent breeds of goat and the F_1 hybrid were measured.

The results are shown in the graph. The bars show the average milk yield of 10 goats per group. The range bars show the range of milk yields in each group.



(a) (i) Calculate the difference in the lowest and highest milk yield from individual goats in this investigation. **1**

Space for calculation

_____ litres/year

(ii) State how the graph shows that milk yield was measured from more than one goat of each breed. **1**

_____

12. (continued)

(b) An F_2 population was produced by breeding F_1 hybrids together. Some individual goats within this population showed a decrease in milk yield compared with the F_1 hybrid.

Suggest why this decrease occurred. **1**

_____

(c) Some goats are intensively farmed. They are kept in buildings, which can lead to overcrowding and poor ventilation.

(i) State one advantage to the farmer of intensive farming. **1**

_____

(ii) Suggest a reason why parasites can spread rapidly in intensive farms. **1**

_____

_____

(iii) Animals that are intensively farmed often display signs of poor welfare, such as altered levels of activity.

State the term used to describe very high levels of activity. **1**

_____

[Turn over

13. Some species of bee live in large colonies. However, some species are solitary and live alone. Females of these solitary species lay eggs in holes in the ground. They collect pollen and put it in the holes as food for their larvae, which hatch from the eggs.

As the solitary bee does not guard her eggs, a species of fly can lay eggs in the same hole and the fly offspring eat the pollen intended for the bee larvae.

(a) The fly offspring are parasites.

Justify this statement. **2**

(b) These flies rarely lay eggs in the hives of social bees that live in colonies with many members.

Suggest why it would be difficult for the fly to lay eggs in a social beehive. **1**

(c) In social bees, most members of the colony are sterile and cooperate to raise the young.

Describe how this behaviour benefits the sterile bees. **1**

14. African wild dogs hunt in packs.

(a) (i) Pack members work together to chase down prey, increasing hunting success.

Name this type of behaviour. **1**

_____

(ii) State an advantage, not already mentioned, of hunting in packs. **1**

_____

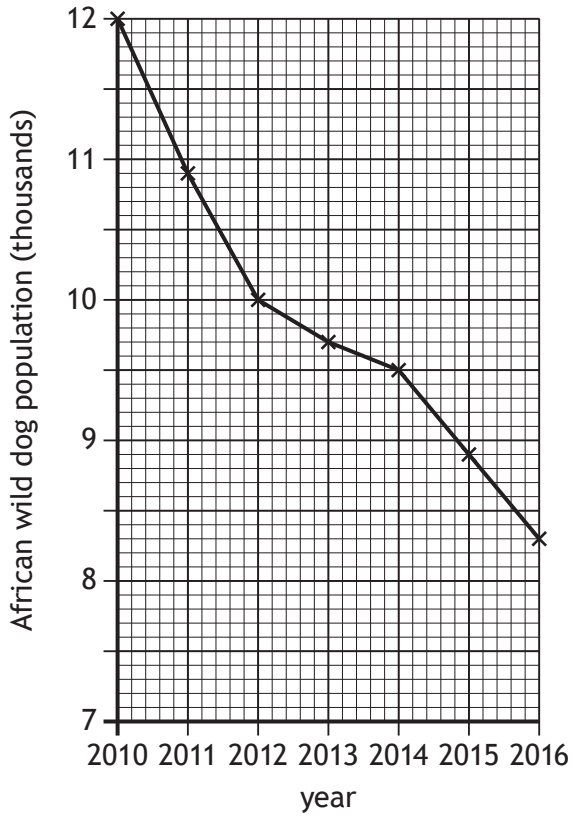
_____

[Turn over

14. (continued)

(b) A survey was carried out between 2010 and 2016 to estimate the population of African wild dogs.

The results are shown in the graph.



Using information from the graph, predict the estimated population of African wild dogs in 2018. **1**

_____ thousand

(c) It has been proposed that habitat fragmentation has caused the decrease in population size of African wild dogs.

Name a method used to reduce the effect of habitat fragmentation and explain how it could result in the recovery of African wild dog numbers. **2**

Method _____

Explanation _____

_____

MARKS | DO NOT WRITE IN THIS MARGIN

15. Attempt **either A or B**. Write your answer in the space below and on *pages 28* and *29*.

A Write notes on how animals survive adverse conditions. **7**

OR

B Write notes on the phases of growth of micro-organisms. **7**

[Turn over

MARKS | DO NOT WRITE IN THIS MARGIN

ADDITIONAL SPACE FOR ANSWER to question 15

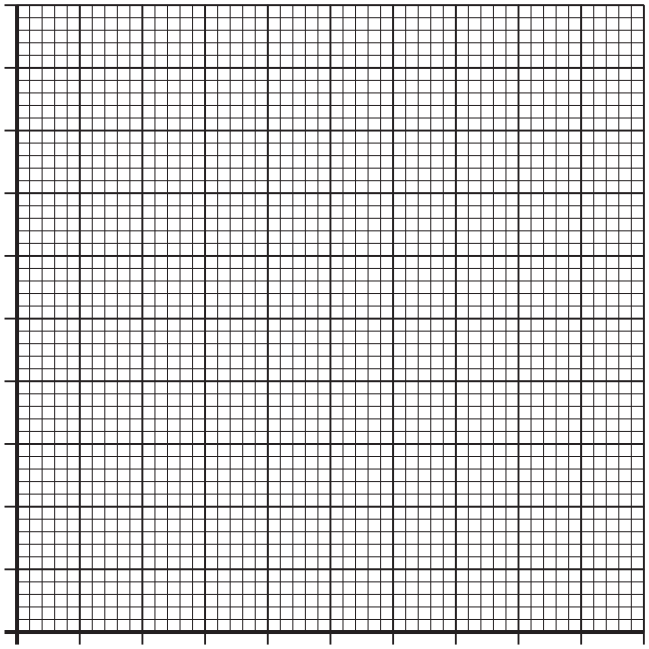
MARKS | DO NOT WRITE IN THIS MARGIN

ADDITIONAL SPACE FOR ANSWER to question 15

[END OF QUESTION PAPER]

ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

Additional graph paper for question 11 (b)



MARKS | DO NOT WRITE IN THIS MARGIN

ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

MARKS | DO NOT WRITE IN THIS MARGIN

ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

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