



National
Qualifications
2016

X707/76/02

Biology
Section 1 — Questions

MONDAY, 9 MAY

9:00 AM – 11:30 AM

Instructions for the completion of Section 1 are given on *Page 02* of your question and answer booklet X707/76/01.

Record your answers on the answer grid on *Page 03* of your question and answer booklet.

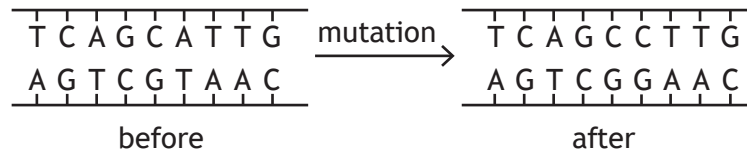
Before leaving the examination room you must give your question and answer booklet to the Invigilator; if you do not, you may lose all the marks for this paper.



SECTION 1 — 20 marks

Attempt ALL questions

1. The diagram below shows part of a DNA molecule before and after a mutation.



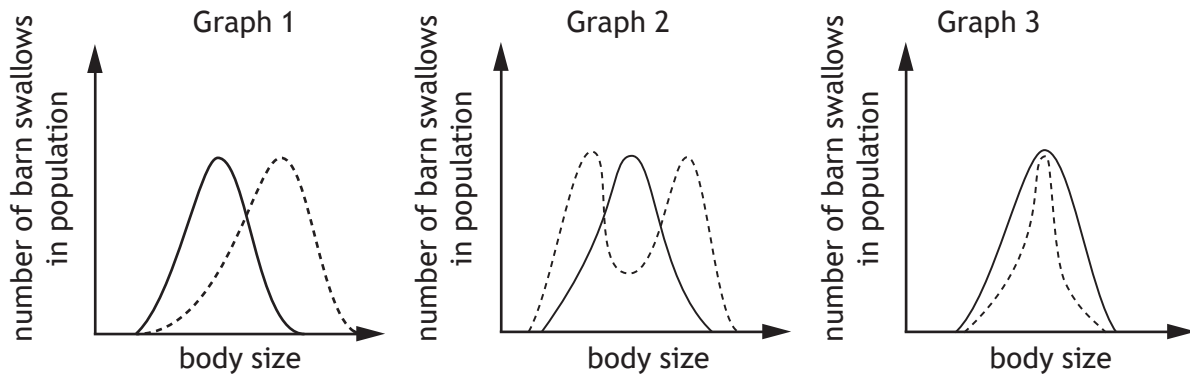
The type of mutation shown is

- A deletion
 - B substitution
 - C insertion
 - D inversion.
2. Which of the following are required in a polymerase chain reaction (PCR)?
- A DNA polymerase, template strand and primers
 - B RNA polymerase, template strand and primers
 - C DNA polymerase, template strand and ligase
 - D RNA polymerase, ligase and primers
3. Each cycle of a polymerase chain reaction (PCR) takes 5 minutes.
- If there are 1000 DNA fragments at the start of the reaction, how long will it take for the number of fragments produced by the reaction to be greater than 1 million?
- A 15 minutes
 - B 35 minutes
 - C 50 minutes
 - D 55 minutes

4. The graphs below show possible changes in the body size of a population of barn swallows, *Hirundo rusticana*, in response to a selection pressure.

———— original population

..... population after selection

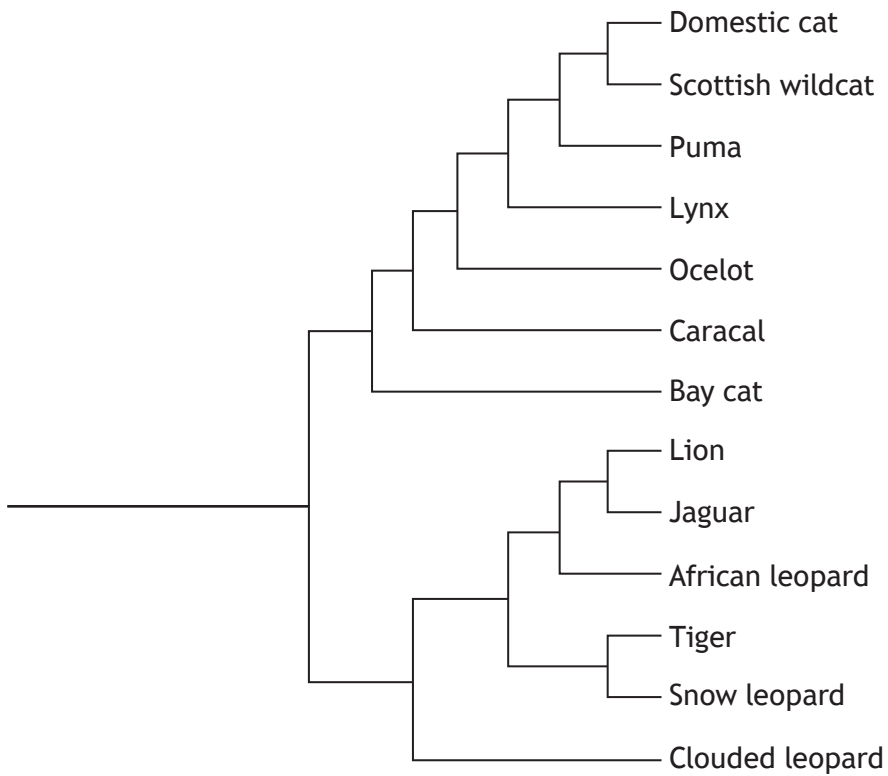


Which row in the table below matches each graph with the type of selection taking place?

	Graph		
	1	2	3
A	disruptive	directional	stabilising
B	directional	disruptive	stabilising
C	stabilising	disruptive	directional
D	directional	stabilising	disruptive

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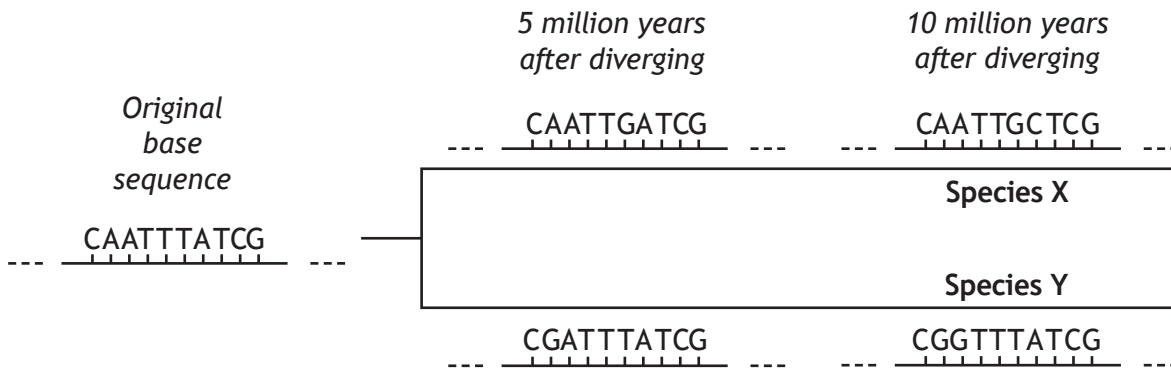
5. The diagram below represents a phylogenetic tree showing the evolutionary relatedness of several species of cat.



With how many species does the African leopard share a common ancestor in this phylogenetic tree?

- A 2 only
- B 5 only
- C 12 only
- D 13

6. Over millions of years of evolution, mutations occur at a broadly constant rate within a gene. This allows genes to be used as molecular clocks. The diagram below shows how the base sequence in part of a gene changed as two evolutionary lineages diverged from an original base sequence. The base sequence in the gene has changed at a rate of 1 base per 5 million years as shown.



Assuming this rate of mutation continued, by how many bases would this part of the gene differ in Species X compared with Species Y 20 million years after diverging from the original base sequence?

- A 4
B 8
C 16
D 20
7. In metabolic pathways, the rates of reaction can be affected by the presence of enzyme inhibitors.

Which row in the table below is correct?

	Type of inhibition	Inhibitor binds to active site	Effect of increasing substrate concentration on inhibition
A	competitive	yes	reversed
B	non competitive	yes	unaffected
C	competitive	no	unaffected
D	non competitive	no	reversed

8. Which row in the table below identifies the number of heart chambers and the type of circulatory system in amphibians?

	Number of heart chambers	Type of circulatory system
A	3	incomplete double
B	4	incomplete double
C	3	complete double
D	4	complete double

9. During unexpected periods of drought the South American lungfish, *Lepidosiren paradoxa*, survives by burying into mud.

This type of behaviour is known as

- A predictive dormancy
- B daily torpor
- C aestivation
- D hibernation.

10. An experiment was set up to investigate the effect of different respiratory substrates on the rate of respiration in yeast. Methylene blue can be used to measure the rate of respiration as it changes from dark blue to colourless when it accepts hydrogen ions. Four test tubes were set up, each containing yeast, methylene blue and one of the respiratory substrates.

The table below shows the results of this investigation.

Test tube number	Respiratory substrate	Appearance of the methylene blue after 20 minutes
1	starch	dark blue
2	sucrose	light blue
3	lactose	dark blue
4	glucose	colourless

Which of the following conclusions is correct?

The rate of respiration is

- A higher with starch than with glucose
- B lower with sucrose than with lactose
- C higher with glucose than with lactose
- D lower with glucose than with sucrose.

11. Stages of aerobic respiration are shown below.

- 1 Glycolysis
- 2 Citric acid cycle
- 3 Electron transfer chain

Which stage(s) involve(s) **both** phosphorylation of intermediates and generation of ATP?

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

12. Which row in the table below identifies a stage of aerobic respiration, its site and an event which occurs during that stage?

	<i>Stage</i>	<i>Site</i>	<i>Event</i>
A	electron transfer chain	inner mitochondrial membrane	carbon dioxide is released
B	electron transfer chain	matrix of mitochondrion	hydrogen ions combine with oxygen
C	citric acid cycle	inner mitochondrial membrane	hydrogen ions combine with oxygen
D	citric acid cycle	matrix of mitochondrion	carbon dioxide is released

13. A field trial was set up to investigate the effect of phosphate fertiliser on the yield of the potato cultivar Maris Piper. Potatoes were planted in 5 plots, each of which received a different level of phosphate fertiliser. When they were harvested the yield from each plot was recorded.

A list of suggested improvements to this field trial is shown below.

- 1 Apply equal volumes of water to each plot.
- 2 Grow the same number of potato plants in each plot.
- 3 Use 10 plots at each phosphate fertiliser level.
- 4 Plant different potato cultivars in each plot.

Which of the suggestions would improve the validity of the results?

- A 1 and 2
B 1 and 3
C 2 and 4
D 3 and 4

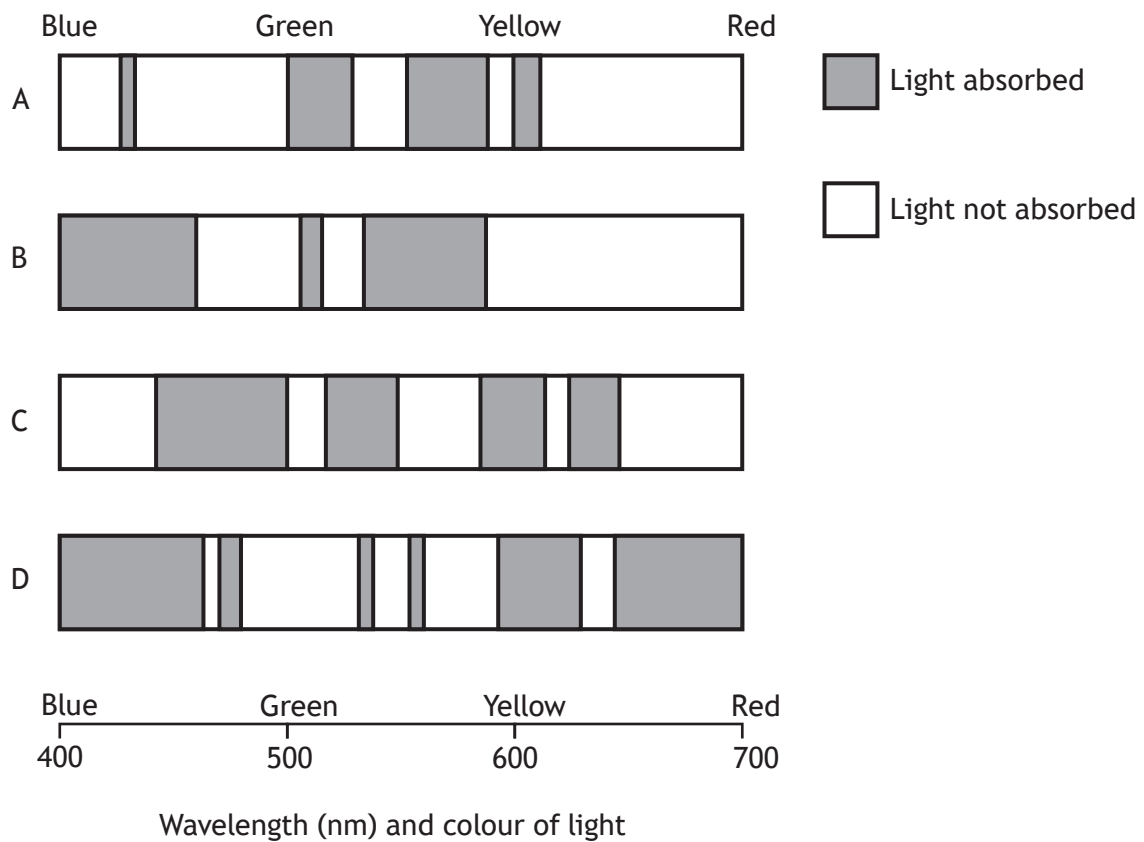
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14. Which compound combines with hydrogen during carbon fixation (Calvin cycle)?

- A Ribulose biphosphate
- B NADP
- C Oxygen
- D 3-phosphoglycerate

15. The following absorption spectra were obtained by testing four different plant extracts.

Which extract contains chlorophyll?

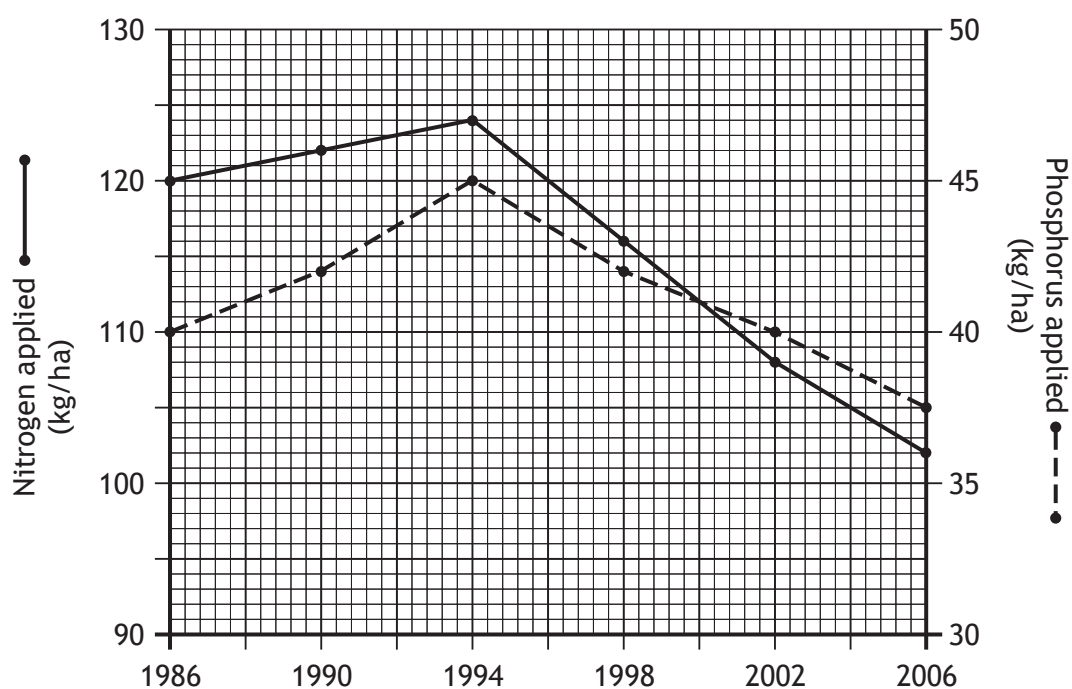


16. The table below shows the biological and economic yields of four different crops.

<i>Crop</i>	<i>Biological yield</i> (tonnes of dry mass/hectare)	<i>Economic yield</i> (tonnes of dry mass/hectare)
pea	10	2
rice	15	10
wheat	30	8
potato	30	10

The crop with the highest harvest index is

- A pea
 - B rice
 - C wheat
 - D potato.
17. The graph below shows the levels of nitrogen and phosphorus applied to crops in an area of Scotland between 1986 and 2006.



In which year was there the smallest difference between the levels of nitrogen and phosphorus applied?

- A 1998
- B 2000
- C 2002
- D 2006

18. Which of the following are features of naturally inbreeding crop plants?
- 1 Susceptible to inbreeding depression
 - 2 Deleterious alleles eliminated by natural selection
 - 3 Self-pollinating
- A 1 and 2 only
B 1 and 3 only
C 2 and 3 only
D 1, 2 and 3
19. On returning to their roost after feeding, vampire bats may regurgitate blood to feed an unrelated individual in the same social group.
- This is an example of
- A mutualism
B altruism
C social hierarchy
D kin selection.
20. The statements below refer to behaviour sometimes displayed by lions kept in captivity.
- 1 Repetitive chewing on cage bars
 - 2 Excessive licking of body
 - 3 Continually pacing backwards and forward
- Which are examples of stereotypy?
- A 1 only
B 1 and 2 only
C 2 and 3 only
D 1, 2 and 3

[END OF SECTION 1. NOW ATTEMPT THE QUESTIONS IN SECTION 2
OF YOUR QUESTION AND ANSWER BOOKLET]

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X707/76/01**Biology**
Section 1 — Answer Grid
and Section 2

MONDAY, 9 MAY

9:00 AM – 11:30 AM



* X 7 0 7 7 6 0 1 *

Fill in these boxes and read what is printed below.

Full name of centre

Town

--

Forename(s)

Surname

Number of seat

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Date of birth

Day

Month

Year

Scottish candidate number

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Total marks — 100

SECTION 1 — 20 marks

Attempt ALL questions.

Instructions for the completion of Section 1 are given on *Page 02*.**SECTION 2 — 80 marks**

Attempt ALL questions.

Questions 7 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. You should 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.



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

The questions for Section 1 are contained in the question paper X707/76/02.

Read these and record your answers on the answer grid on *Page 03* opposite.

Use **blue** or **black** ink. Do NOT use gel pens or pencil.

1. The answer to each question is **either** A, B, C or D. Decide what your answer is, then fill in the appropriate bubble (see sample question below).
2. There is **only one correct** answer to each question.
3. Any rough working should be done on the additional space for answers and rough work at the end of this booklet.

Sample Question

The thigh bone is called the

- A humerus
- B femur
- C tibia
- D fibula.

The correct answer is **B** — femur. The answer **B** bubble has been clearly filled in (see below).

A	B	C	D
<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>

Changing an answer

If you decide to change your answer, cancel your first answer by putting a cross through it (see below) and fill in the answer you want. The answer below has been changed to **D**.

A	B	C	D
<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>

If you then decide to change back to an answer you have already scored out, put a tick (✓) to the **right** of the answer you want, as shown below:

A	B	C	D
<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>

or

A	B	C	D
<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>



* X 7 0 7 7 6 0 1 0 2 *

SECTION 1 — Answer Grid



	A	B	C	D
1	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
7	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
8	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
9	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
10	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
11	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
12	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
13	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
14	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
15	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
16	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
17	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
18	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
19	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
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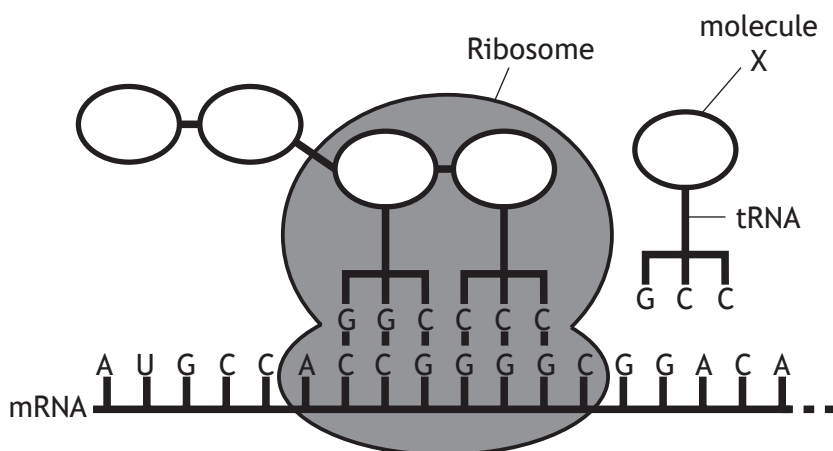
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1. The diagram below shows a process involved in the production of a polypeptide in a cell.



- (a) Name molecule X.

1

- (b) State **one** substance, other than ribosomal RNA (rRNA), that makes up the ribosome.

1

- (c) Many polypeptides are modified in order to produce functional proteins. Describe **one** way in which a polypeptide could be modified.

1

- (d) In some eukaryotic cells, different mRNA molecules, and therefore different proteins, can be expressed from a single gene.

Name and describe the process which results in different mRNA molecules being expressed.

2

Name _____

Description _____



2. DNA holds the genetic information in both prokaryotic and eukaryotic cells.

- (a) (i) Describe **one** organisational difference between prokaryotic and eukaryotic chromosomal DNA.

1

- (ii) Name the substance with which DNA is packaged in eukaryotes.

1

- (b) State **one** location, other than the nucleus, where DNA is found in eukaryotic cells.

1

- (c) During DNA replication two new daughter strands are synthesised using the original strands as templates.

- (i) State why the antiparallel nature of the DNA molecule results in one of the strands being synthesised in short fragments.

1

- (ii) Template DNA, enzymes and ATP are necessary for DNA replication. State **one** other substance required.

1

- (d) Explain why cells need to carry out DNA replication.

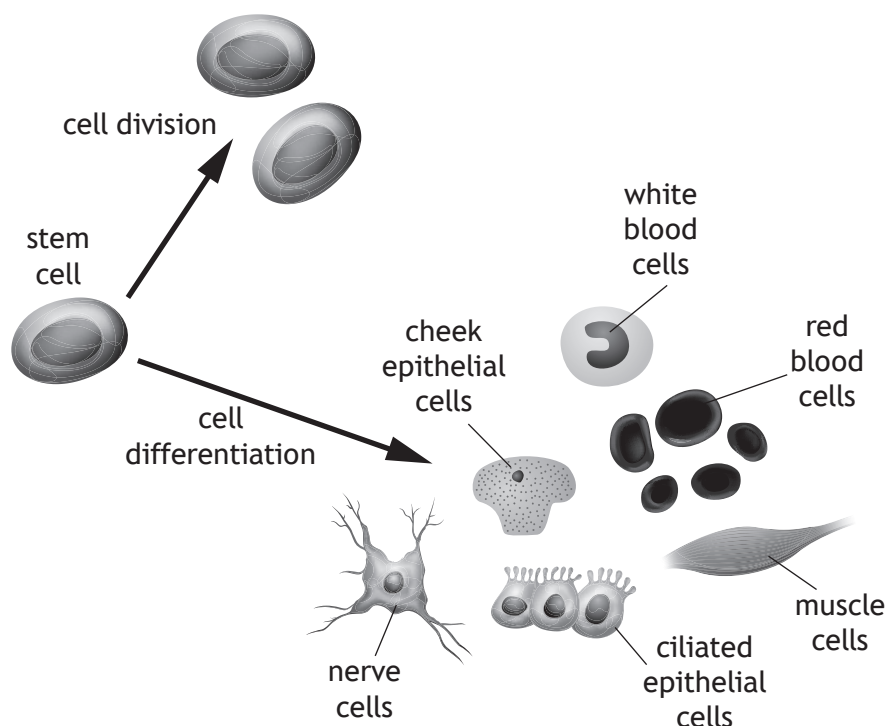
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3. Stem cells are unspecialised cells which can be found in embryonic and adult tissue.



- (a) Explain how the diagram above indicates that the stem cell shown is an embryonic and not a tissue (adult) stem cell.

1

- (b) After a stem cell differentiates, only certain genes are expressed. Explain how this results in different cell types.

1

- (c) Give **one** therapeutic use of stem cells.

1

- (d) State **one** ethical issue relating to the use of embryonic stem cells.

1



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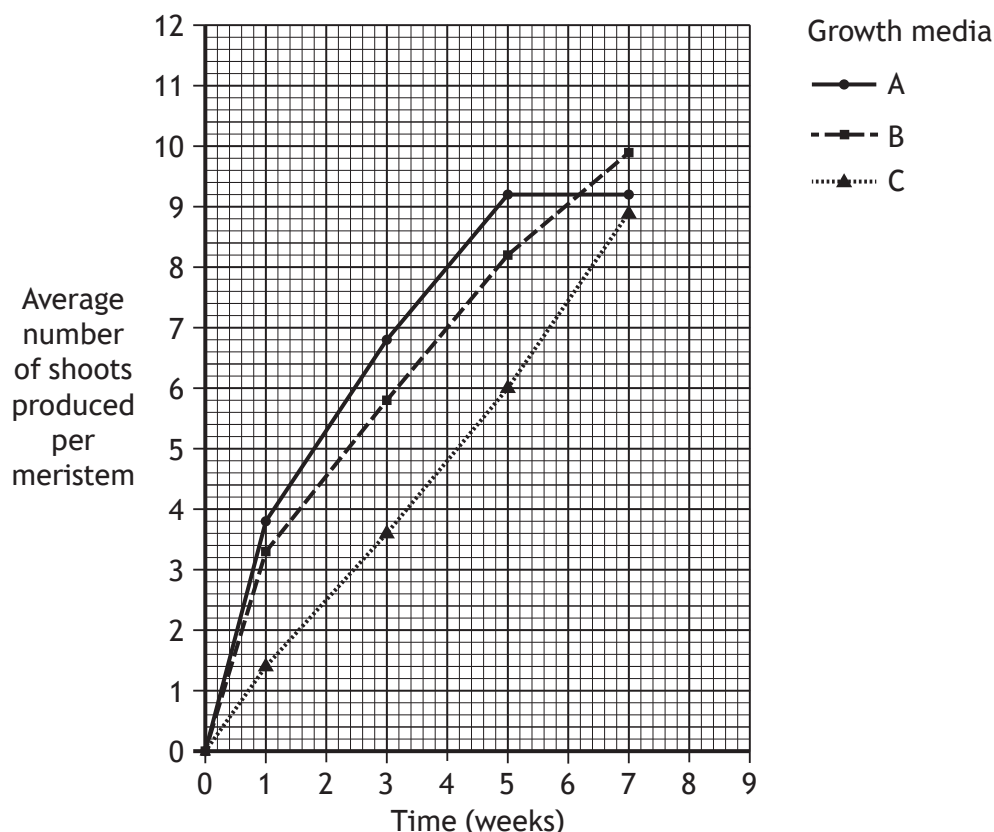
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4. Meristems can be cultured in growth medium to produce new plants.

An experiment was carried out to investigate the effects of three different growth media (A, B and C) on the production of shoots by meristems of African violet plants.

Five meristems were removed and cultured in each medium for a period of seven weeks. The average number of shoots produced per meristem was recorded at specific times during the investigation.

The results are shown in the graph below.



- (a) (i) Use values from the graph to describe the average number of shoots produced per meristem over the seven week period in medium A.

2

- (ii) Calculate the percentage increase in the average number of shoots produced per meristem between week 1 and week 7 in medium B.

1

Space for calculation

_____ %



4. (a) (continued)

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- (iii) Table 1 below shows the number of shoots produced per meristem at three weeks in one of the media.

Table 1

Meristem	Number of shoots produced per meristem
1	4
2	5
3	7
4	7
5	6

Using information from **Table 1** and the graph, state the medium in which these meristems were cultured.

1

Space for calculation

Medium _____

- (b) Predict which medium would produce plants with the greatest number of shoots after nine weeks growth. Give a reason for your answer.

2

Medium _____

Reason _____

- (c) In a further experiment, the average number of roots and average root length at 7 weeks were recorded in each of the media.

The results are shown in Table 2 below.

Table 2

Medium	Average number of roots produced per meristem	Average root length (mm)
A	12	12
B	11	19
C	12	17

After analysing the results, medium B was used for the commercial production of plants.

Use the information in **Table 2** to explain why plants cultured in medium B would grow best.

2



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

5. In the North Pacific Ocean there are two different populations of killer whales *Orcinus orca*. One population feeds mainly on fish while the other feeds mainly on sea mammals.

This behavioural barrier has led to considerable genetic variation between these populations.

- (a) (i) Name the type of speciation which could occur as a result of this barrier. 1

- (ii) State the importance of isolation barriers in speciation. 1

- (iii) Scientists believe that these two populations are still the same species.

Suggest how they could confirm this. 1

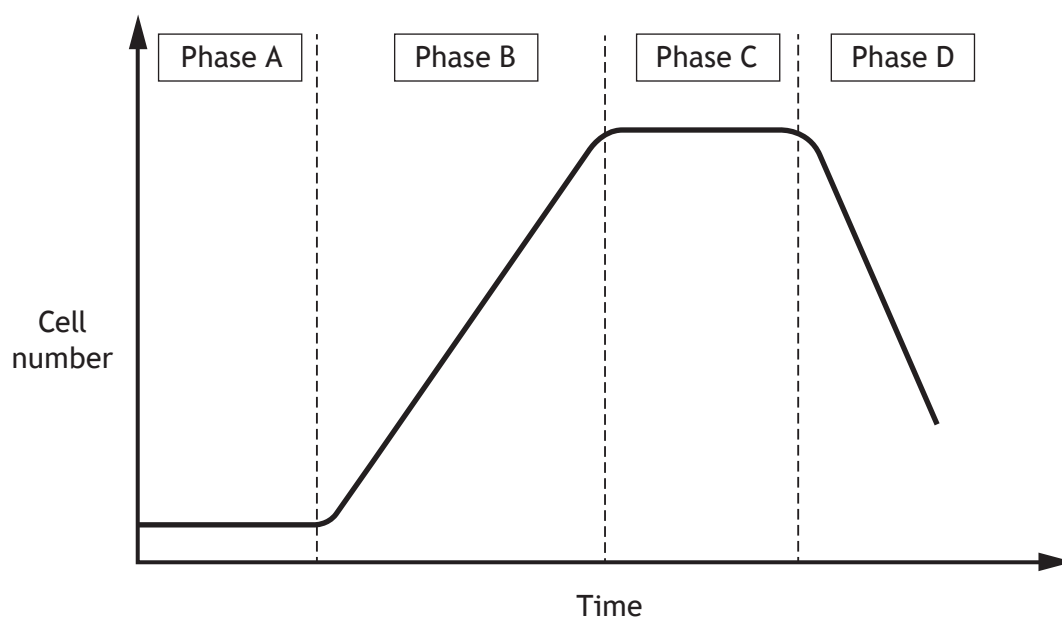
- (b) Polyploidy can lead to speciation.

- (i) State what is meant by the term polyploidy. 1

- (ii) Describe **one** example of the importance of polyploidy in evolution. 1



6. The antibiotic bacitracin is produced by the bacterial species *B. subtilis*.
The graph below shows the growth curve of a population of *B. subtilis* cultured to produce the antibiotic.



- (a) Name Phase A and explain why cells do not divide during this phase. 2

Name _____

Explanation _____

- (b) (i) Name the phase in which the bacteria produce the secondary metabolite bacitracin. 1

- (ii) Explain why this secondary metabolite gives an ecological advantage to *B. subtilis*. 1

- (c) This growth curve shows viable cell numbers of *B. subtilis*.
Give evidence from the graph to justify this statement. 1



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7. Answer **either A or B** in the space below.

A Describe and compare anabolic and catabolic reactions.

4

OR

B Describe and compare metabolism in conformers and regulators.

4



* X 7 0 7 7 6 0 1 1 4 *

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* X 7 0 7 7 6 0 1 1 5 *

8. An investigation was set up to monitor growth of bacteria in compost. The compost was added to a fermenter and the temperature of the compost was recorded over a 20 day period. Samples of the compost were cultured and the numbers of three bacterial species present were recorded.

The compost temperatures and the populations of the three species of bacteria are shown in the table below.

Time (days)	Compost Temperature (°C)	Population (millions per gram of compost)		
		Species A	Species B	Species C
0	21	396.0	0.4	123.0
2	40	4.2	10.2	14.6
4	72	0.1	195.0	0.1
6	53	0	8.5	0
20	32	0	0	0

- (a) Calculate how many times greater the population of Species A was compared to Species B at the start of the investigation.

1

Space for calculation

- (b) Describe the relationship between temperature of the compost and population of Species C over the first four days.

1



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

8. (continued)

- (c) (i) Using information in the table, state which species of bacteria is thermophilic and justify your answer.

2

Species _____

Justification _____

- (ii) Describe how thermophilic bacteria are adapted to survive in their environment.

1

- (iii) Give an example, other than in compost, of an environment where thermophilic bacteria are adapted to grow successfully.

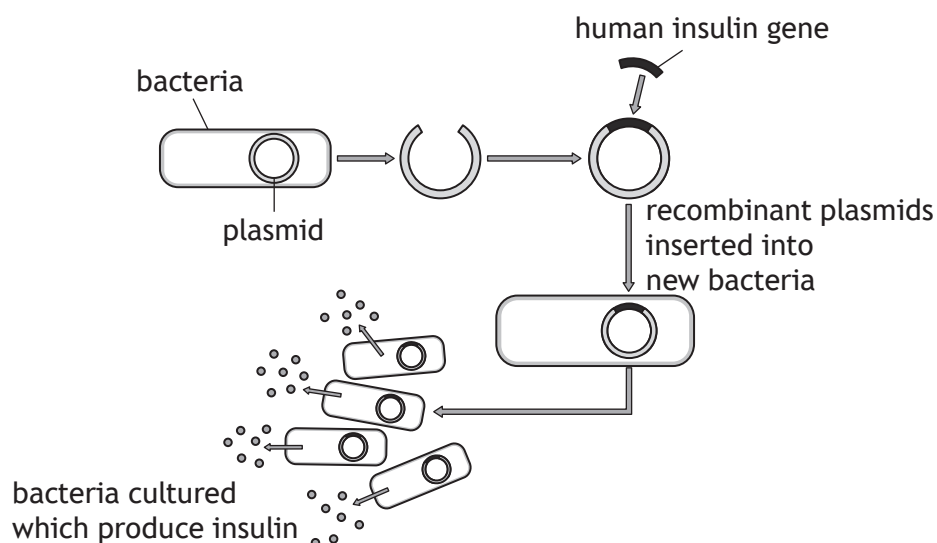
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* X 7 0 7 7 6 0 1 1 7 *

9. The diagram below shows how a human gene can be inserted into bacteria to produce human insulin using recombinant DNA technology.



- (a) Name **one** enzyme used in this process and state its function. 2

Name _____

Function _____

- (b) (i) The recombinant plasmid also contains a gene for resistance to the antibiotic, ampicillin.

Describe a procedure which would allow only cells containing the recombinant plasmid to be selected. 2

- (ii) Plasmids with these antibiotic resistance genes have been passed to other bacterial species by horizontal transfer.

Describe the process of horizontal transfer. 1

- (c) When culturing the bacteria which produce insulin, sterile conditions are maintained.

Explain why this is important. 1



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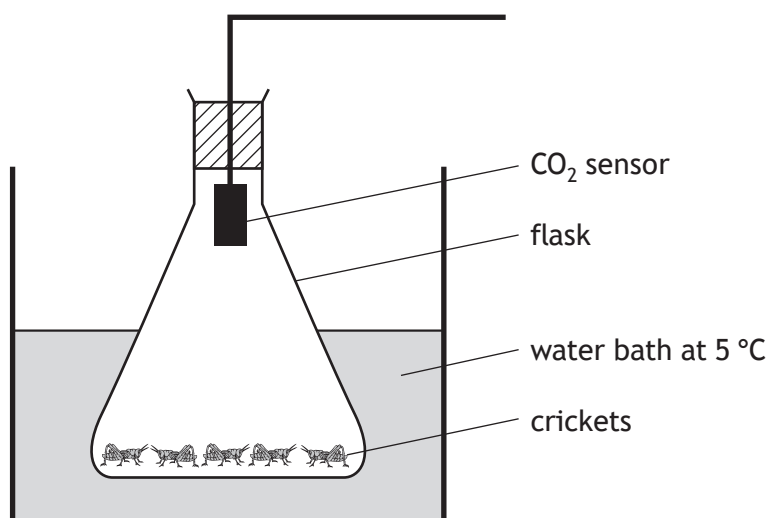
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* X 7 0 7 7 6 0 1 1 9 *

10. An investigation was carried out to compare the rate of metabolism in a species of cricket, *Gryllus assimilis*, at different temperatures.

Five crickets were placed in a sealed flask which was fitted with a carbon dioxide (CO₂) sensor as shown in the diagram below.



The flask was placed in a water bath at 5 °C and left for 10 minutes.

The CO₂ produced per minute was then measured. This procedure was repeated at 10, 15, 20 and 30 °C.

The results are shown in the table below.

Temperature (°C)	Rate of CO ₂ production (units per minute)
5	300
10	500
15	800
20	1200
30	1600

- (a) (i) Give a reason why the flask was left for 10 minutes at each temperature **before** each reading was taken.

1

10. (a) (continued)

(ii) A control flask should be included in this investigation.

Describe the control and explain its purpose in the investigation.

2

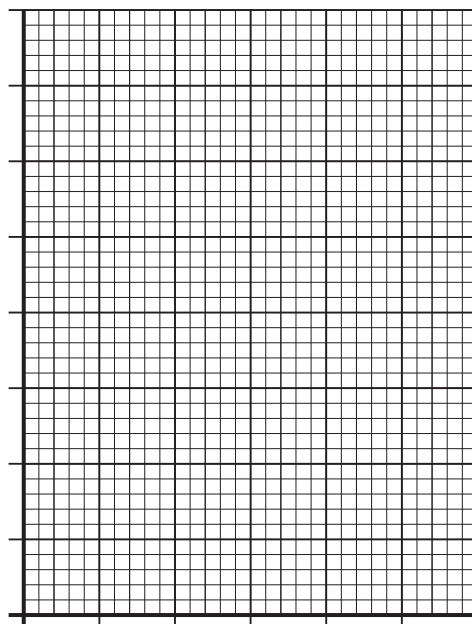
Description _____

Explanation _____

(b) Plot a line graph to show the results of the investigation.

2

(Additional graph paper, if required can be found on *Page 31*).



(c) Draw a conclusion from these results.

1

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11. Colchicine is a chemical used in plant breeding programmes to induce mutations and produce cultivars with improved characteristics.

Sesame is an important crop plant grown for its edible seeds and leaves.

An investigation was carried out to determine the effects of colchicine concentration on sesame. Sesame seeds were soaked in different concentrations of colchicine solution for 24 hours. Seeds from each concentration were germinated and 50 plants were grown from each concentration. Ninety days later the total leaf area, number of seeds and mass of seeds per plant were recorded.

The average results are shown in the table below.

Colchicine concentration (m mol l^{-1})	Average total leaf area per plant (cm^2)	Average number of seeds per plant	Average total mass of seeds per plant (g)
0	1500	548	2.8
0.1	2315	532	3.5
0.5	2786	550	4.4
1.0	3500	512	4.7

- (a) (i) Identify the independent variable in this investigation. 1

- (ii) State an aspect of the investigation which helped to ensure that reliable results were obtained. 1

- (b) (i) An important characteristic of food crops is the *1000 seed mass* which is the total mass of a sample of 1000 seeds.

Calculate the *1000 seed mass* for the plants grown from seeds soaked in a colchicine concentration of 0.5 m mol l^{-1} . 1

Space for calculation

_____ g



11. (b) (continued)

- (ii) Express, as the simplest whole number ratio, the average total leaf area per plant from seeds soaked in a colchicine concentration of 0 to that at 1.0 mmol l^{-1} .

1

Space for calculation

_____ : _____
0 1.0
 mmol l^{-1} mmol l^{-1}

- (c) Explain the relationship between the total leaf area and total mass of seeds.

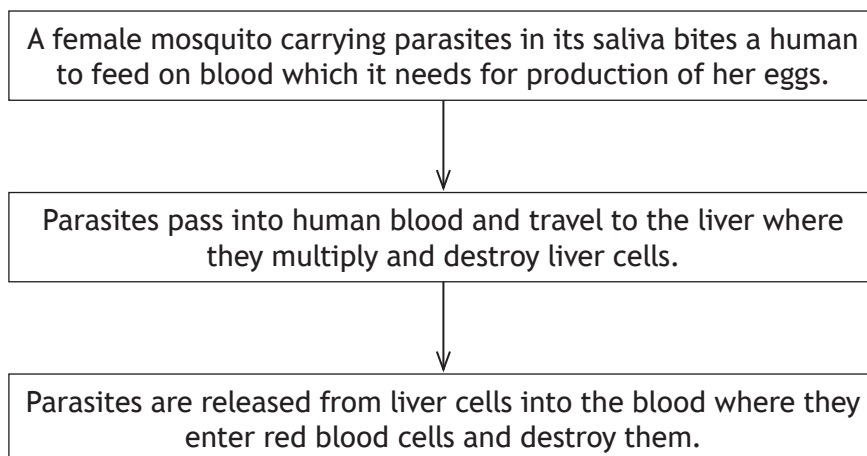
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* X 7 0 7 7 6 0 1 2 3 *

12. Malaria is a disease in humans caused by a parasite which is transmitted from human to human by mosquitoes. The stages of infection in humans are shown in the flow diagram below.



- (a) (i) Identify the vector in this parasitic relationship. 1

- (ii) Give a reason why only female mosquitoes transmit the malaria parasite. 1

- (b) Explain the effect of a parasitic relationship on the host. 1

- (c) Two methods used to control the spread of malaria are described below.

Method 1 – mosquito repellent applied to the skin.

Method 2 – anti-malarial drugs that kill the parasite.

Choose **one** of these methods and explain how it can reduce the number of cases of malaria. 1

Method _____

Explanation _____



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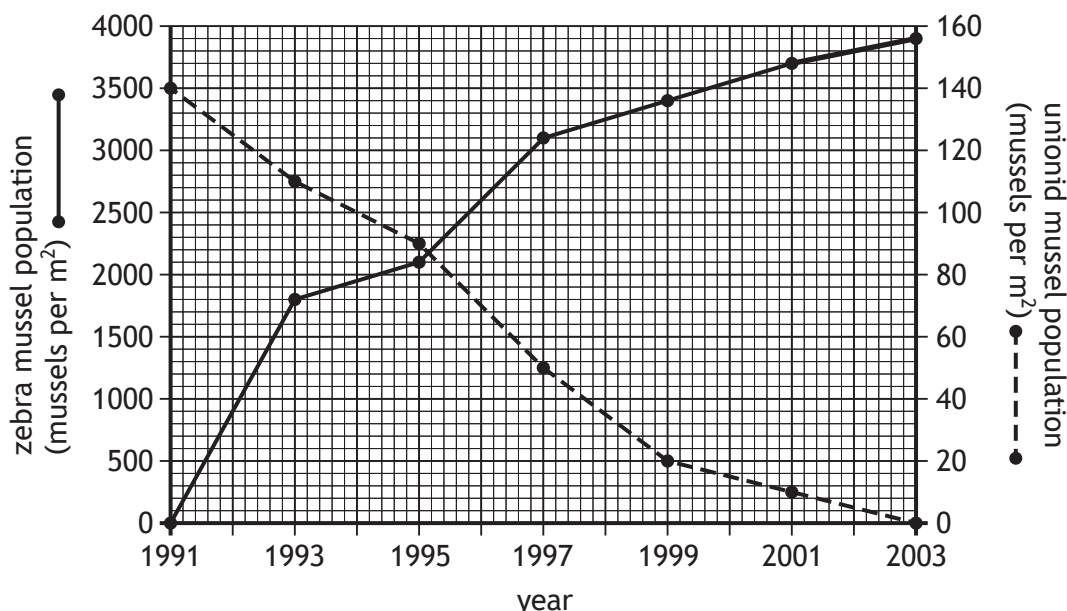
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13. Freshwater mussels are small animals which live on the beds of lakes and rivers. Zebra mussels are a species of freshwater mussel native to lakes in Russia. They were accidentally introduced by humans into a river in North America in 1991. The populations of zebra mussels and the native unionid mussels were measured over a 12 year period.

The results are shown in the graph below.



- (a) (i) State the unionid mussel population in 1993. 1
- _____ mussels per m²
- (ii) State the zebra mussel population when the unionid mussel population was 50 mussels per m². 1
- _____ mussels per m²
- (iii) Calculate the average increase per year in the zebra mussel population between 1991 and 2003. 1
- _____ mussels per m² per year
- Space for calculation
- (b) Explain how the graph confirms that zebra mussels are more successful competitors than unionid mussels. 1

13. (continued)

- (c) Using evidence from the graph, explain why zebra mussels are an invasive species.

1

- (d) Suggest a reason why the population of zebra mussels may have increased faster in the North American river than in its native habitat.

1

- (e) Invasive species have a negative impact on genetic diversity of an ecosystem.

State what is meant by genetic diversity.

1

[Turn over for next question]



* X 7 0 7 7 6 0 1 2 7 *

14. Answer **either A or B** in the space below and on *Pages 29* and *30*.

A Write notes on crop protection under the following headings:

(i) weeds, pests and diseases;

4

(ii) methods of control.

4

OR

B Write notes on social behaviour in animals under the following headings:

(i) social hierarchy and cooperative hunting;

4

(ii) social insects.

4



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

SPACE FOR ANSWERS



* X 7 0 7 7 6 0 1 2 9 *

SPACE FOR ANSWERS

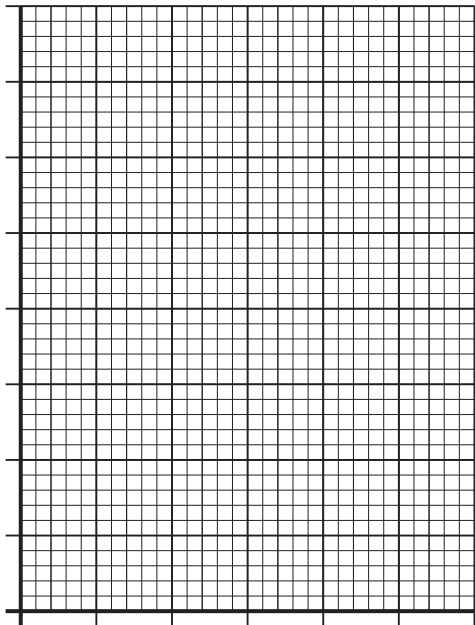
[END OF QUESTION PAPER]



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

ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

ADDITIONAL GRAPH PAPER FOR QUESTION 10 (b)



MARKS

DO NOT
WRITE IN
THIS
MARGIN

ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK



* X 7 0 7 7 6 0 1 3 2 *

ACKNOWLEDGEMENT

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