



GuideMyGrades

— YOUR GOALS. OUR EXPERTISE. —

EDEXCEL INTERNATIONAL GCSE BIOLOGY: QUESTIONS BY TOPIC

Use of Biological Resources (5)

International GCSE Biology Section 5

49 questions · 505 marks · Mark schemes included

Pearson Edexcel International GCSE (9–1) Biology 4BI1, Papers 1B, 1BR, 2B & 2BR, June 2019 - June 2025

 [guidemygrades.com](https://www.guidemygrades.com)

 @Guidemygrades

 @Guidemygrades

 @Guidemygrades

 info@guidemygrades.com

 Piccadilly Business Centre, Unit C, Aldow Enterprise Park
Blackett Street, Manchester, M12 6AE

HOW TO USE THIS BOOKLET

Questions are grouped by specification sub-topic; within each sub-topic they run from the lowest mark tariff to the highest.

Click any sub-topic heading or question row below to jump straight to it.

On every question page, click ANSWER in the top-right corner to jump to its mark scheme.

Diagrams, graphs, tables and data are printed exactly as they appeared in the original papers.

QUESTION	SOURCE	MARKS	PAGE
5(a) FOOD PRODUCTION		24 questions · 249 marks	4
1. Q6	Paper 2B January 2020	6	5
2. Q11	Paper 1B January 2021	6	7
3. Q10	Paper 1B November 2024	6	8
4. Q6	Paper 1BR June 2019	7	9
5. Q5 <i>also 4a</i>	Paper 1B June 2021	8	11
6. Q4	Paper 2B June 2021	8	13
7. Q10 <i>also 4d</i>	Paper 1BR November 2020	9	16
8. Q5 <i>also 5c</i>	Paper 1B November 2021	9	18
9. Q4 <i>also 5b, 4c</i>	Paper 2B January 2022	9	20
10. Q7 <i>also 2c, 2h</i>	Paper 1B November 2020	10	23
11. Q5	Paper 1B January 2021	10	25
12. Q5	Paper 1B January 2022	10	28
13. Q5	Paper 2BR January 2022	10	30
14. Q5 <i>also 2e</i>	Paper 1B January 2020	11	33
15. Q8 <i>also 4d</i>	Paper 1B January 2021	11	35
16. Q3 <i>also 1b, 2b</i>	Paper 1BR January 2022	11	37
17. Q7	Paper 2BR June 2019	12	40
18. Q10 <i>also 2h</i>	Paper 1B January 2022	12	42
19. Q9	Paper 1B November 2020	13	46
20. Q5	Paper 1BR January 2023	13	48
21. Q9	Paper 1B November 2024	13	51
22. Q4 <i>also 2h</i>	Paper 1B June 2025	13	55
23. Q7 <i>also 4b</i>	Paper 1BR January 2021	16	58
24. Q5 <i>also 5c</i>	Paper 1BR January 2022	16	62
5(b) SELECTIVE BREEDING		3 questions · 45 marks	67
25. Q6 <i>also 5d</i>	Paper 2B June 2023	11	68
26. Q9	Paper 1B November 2023	16	71
27. Q1 <i>also 5d, 3a</i>	Paper 2BR November 2020	18	74
5(c) GENETIC MODIFICATION (GENETIC ENGINEERING)		11 questions · 106 marks	78
28. Q9 <i>also 5b</i>	Paper 1B June 2025	6	79
29. Q2 <i>also 5a</i>	Paper 1BR November 2020	7	80
30. Q6	Paper 1BR January 2021	8	81
31. Q11 <i>also 2c</i>	Paper 1BR January 2023	8	83
32. Q4 <i>also 2e, 4d</i>	Paper 1BR June 2019	9	85



33.	Q5		Paper 1B November 2020	9	87
34.	Q2	<i>also 2j, 5a</i>	Paper 2BR January 2020	10	89
35.	Q9	<i>also 2j</i>	Paper 1B June 2023	10	91
36.	Q4	<i>also 2e, 5d</i>	Paper 2B January 2023	11	93
37.	Q9	<i>also 3b</i>	Paper 1BR June 2023	14	95
38.	Q8		Paper 1BR June 2025	14	98

5(d) CLONING

11 questions · 105 marks

102

39.	Q7		Paper 2B June 2019	4	103
40.	Q7		Paper 2BR January 2023	6	105
41.	Q4		Paper 2B November 2021	7	106
42.	Q5		Paper 2B November 2024	7	108
43.	Q3	<i>also 4d</i>	Paper 2BR January 2020	10	109
44.	Q5		Paper 2BR January 2021	10	111
45.	Q4		Paper 2B June 2025	10	113
46.	Q2	<i>also 2h, 5c</i>	Paper 2B November 2020	11	115
47.	Q3		Paper 2B January 2021	11	117
48.	Q5		Paper 2BR June 2025	12	120
49.	Q1		Paper 2BR June 2023	17	123



QUESTIONS

49 questions · 505 marks · grouped by sub-topic



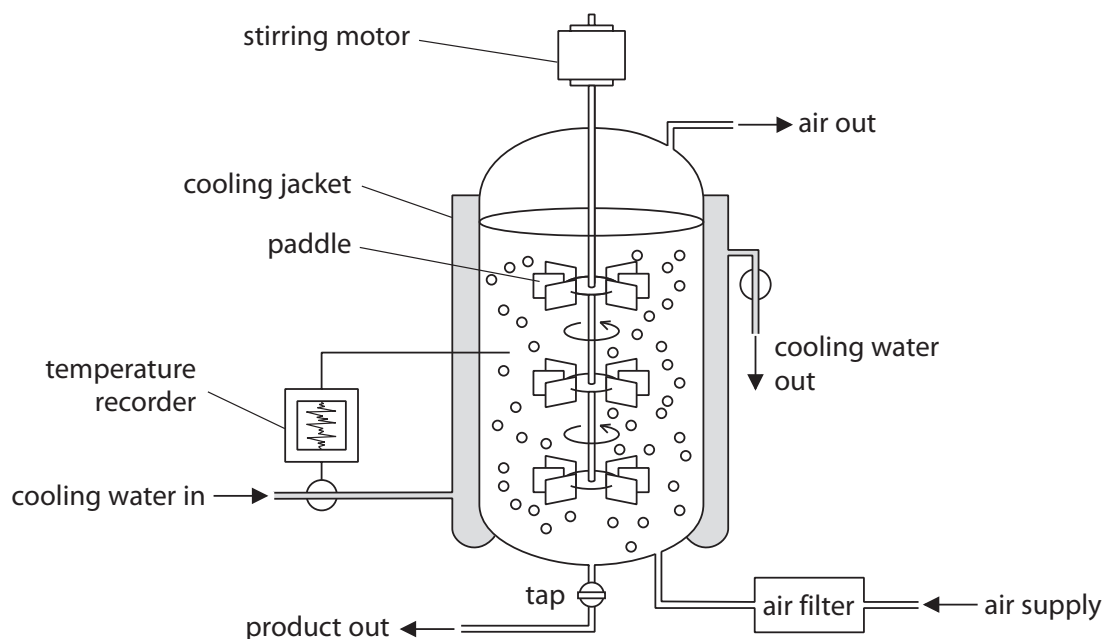
SUB-TOPIC 5(a)

FOOD PRODUCTION

24 questions in this sub-topic · 249 marks · lowest tariff first



6 The diagram shows a fermenter used to grow microorganisms.



(a) Describe the functions of the paddles in the fermenter.

(2)

(b) Explain why the fermenter has a filtered air supply.

(2)

- (c) Explain why the temperature recorder is connected to the liquid in the fermenter and the water input of the cooling jacket.

(2)

(Total for Question 6 = 6 marks)



10 Some scientists believe that increasing the temperature by 3°C in a glasshouse will significantly increase crop yield.

Design an investigation to determine whether a small change in temperature in a glasshouse will produce a significant increase in crop yield.

Include experimental details in your answer and write in full sentences.

(6)

(Total for Question 10 = 6 marks)



6 Yoghurt is made when bacteria are added to milk.

These bacteria produce an acid that gives yoghurt its taste.

(a) Name a bacterium used to make yoghurt.

(1)

(b) Name the acid produced when making yoghurt.

(1)

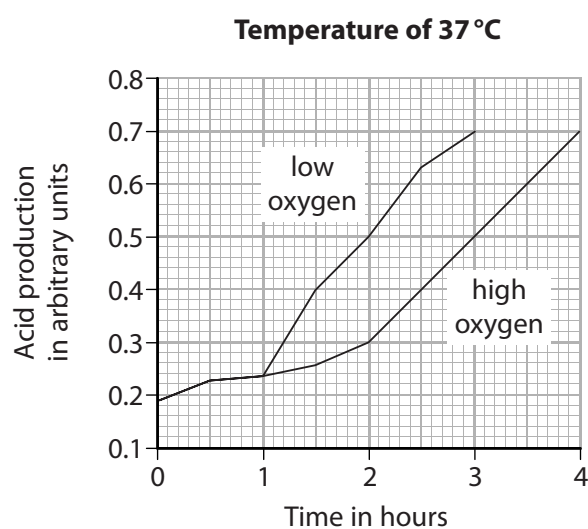
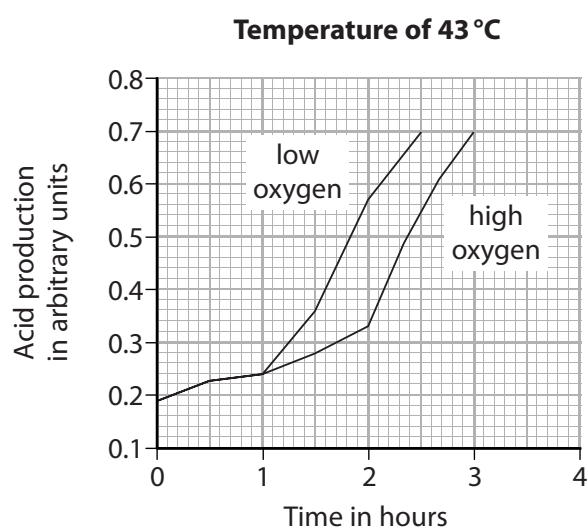
(c) A student investigates the production of acid when making yoghurt.

The student observes the effect of temperature and dissolved oxygen on acid production.

He uses milk kept in four different conditions.

- at 43 °C and low oxygen
- at 43 °C and high oxygen
- at 37 °C and low oxygen
- at 37 °C and high oxygen

The graphs show the results of his investigation.



- (i) Calculate the rate of acid production between 2 and 4 hours at 37°C and high oxygen.
(2)

rate = ... arbitrary units per hour

- (ii) Using information from the graphs, give three conclusions about the effects of temperature and the effects of dissolved oxygen on acid production in yoghurt.
(3)

1

.....

.....

2

.....

.....

3

.....

.....

(Total for Question 6 = 7 marks)



5 Weeds are plants that compete with crop plants.

A scientist investigates the use of two different ways of reducing the population of weeds.

This is her method.

- use chemical control in one field by spraying herbicides, a type of pesticide, that kill the weeds
- use biological control in another field by releasing insects that eat the weeds
- measure the mean (average) number of weeds in each field once a month from February to August

The table shows the scientist's results.

Month	Mean number of weeds per m ²	
	chemical control	biological control
February	2	12
March	16	8
April	3	4
May	20	3
June	3	4
July	18	3
August	2	3

(a) Describe a method to measure the mean number of weeds per m² in each field.

(3)

.....

.....

.....

.....

.....

.....



- (b) The scientist concludes that biological control is a better way of controlling weeds than chemical control.

Discuss this conclusion.

Use data from the table and your own knowledge to support your answer.

(5)

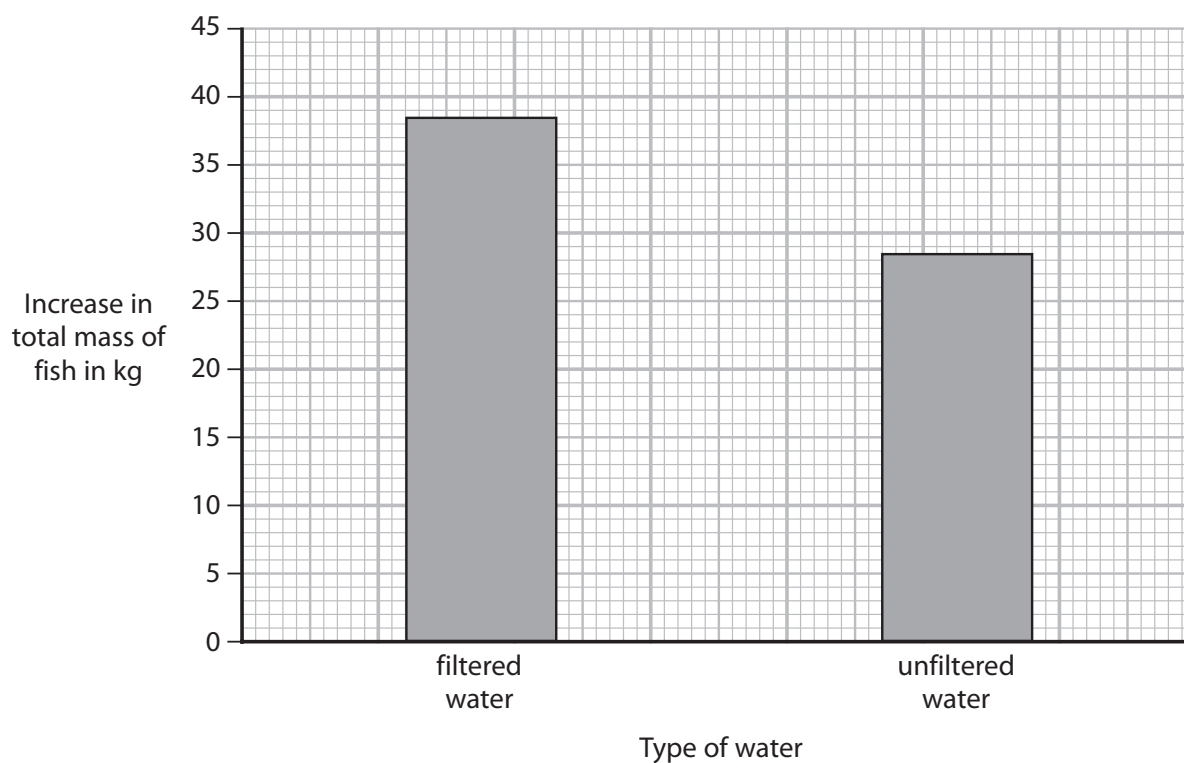
(Total for Question 5 = 8 marks)



4 A scientist uses this method to investigate the effect of water quality on the growth of fish.

- fill a pond with filtered water
- fill another pond with unfiltered water
- place the same mass of fish of the same species in each pond
- determine the increase in total mass of fish in each pond after 180 days

The graph shows the scientist's results.



- (a) The mean rate of increase in total mass of the fish in the filtered water is 0.214 kg per day.

Calculate the difference between the mean rate of increase in the total mass of the fish in filtered and unfiltered water.

(3)

difference in mean rate = ... kg per day

- (b) Unfiltered water contains more bacteria.

Explain why unfiltered water containing more bacteria affects the growth of fish.

(3)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(c) Give one biotic variable the scientist controlled in the investigation.

(1)

(d) Give a method the scientist could use to control interspecific predation in the ponds.

(1)

(Total for Question 4 = 8 marks)



10 Farmers may add chemical fertilisers to their soil.

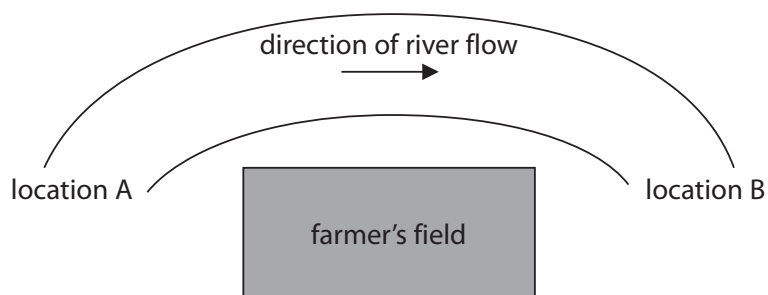
(a) Explain how chemical fertilisers can increase crop yield.

(4)



(b) These fertilisers may leak into rivers.

A scientist measures the oxygen content of water in two different locations of the same river during the month of April.



In location A he finds that the mean dissolved oxygen was 6 mg per litre and at location B he finds that the mean dissolved oxygen was 3 mg per litre.

He concludes that the use of fertiliser in the field has affected the oxygen content of the river.

Discuss his conclusion.

(4)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(c) Some farmers use alternative substances to chemical fertilisers.

Suggest one alternative substance that a farmer may use.

(1)

.....

(Total for Question 10 = 9 marks)



5 Genetic modification is a process used to improve crop yield.

(a) Describe the role of a named vector in the process of genetic modification.

(2)

(b) Weeds are plants that grow where they are not wanted.

Removing weeds reduces competition for mineral ions and improves crop yield.

(i) Name the mineral ion used to make chlorophyll.

(1)



(ii) Two different methods can be used to remove weeds to improve crop yield.

- Method A pull weeds out of the ground by hand
- Method B spray weeds with a chemical that kills them

Design an investigation to find out which method produces the highest crop yield.

Include experimental details in your answer and write in full sentences.

(6)

(Total for Question 5 = 9 marks)



4 Fish farming is often used to produce protein rich food.

- (a) Selective breeding is often used to produce fish that grow rapidly and do not waste much food.

Explain how selective breeding can be used to produce fish that grow rapidly.

(2)

- (b) Fish farming systems can often release ammonia into the water. The ammonia is converted into nitrates.

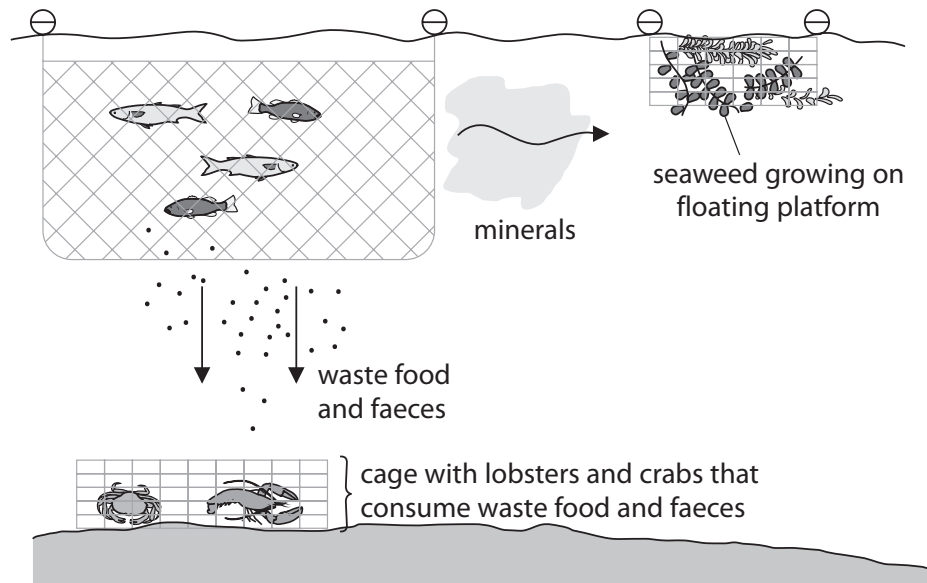
Describe how ammonia is converted into nitrates.

(2)



- (c) Multi-trophic level aquaculture is a method of fish farming that has been developed to reduce environmental pollution and increase profits.

The diagram shows a multi-trophic level aquaculture system.



Explain how the multi-trophic level aquaculture system reduces environmental pollution, and increases the profits of fish farming.

Use information from the diagram and your own knowledge to support your answer.

(5)

(Total for Question 4 = 9 marks)



- 7 The table gives the masses of protein and lipid (fat) in the same volume of milk from a cow and from a human.

	Protein in g	Lipid in g
cow	3.3	3.9
human	1.3	4.1

- (a) Describe how you would test a sample of cow's milk and a sample of human milk to show they contain different masses of protein.

(2)

.....

.....

.....

.....

.....

.....

- (b) Some of the proteins in milk are antibodies.

Explain why antibodies in milk are useful for babies.

(2)

.....

.....

.....

.....

.....

.....

(c) Give two ways that lipid in milk is used by babies.

(2)

1

.....

2

.....

(d) Milk is used to make yoghurt.

(i) Name the carbohydrate in milk used to make yoghurt.

(1)

.....

(ii) Name the bacteria added to milk to make yoghurt.

(1)

.....

(iii) Explain why milk needs to be heated to a high temperature at the start of the process for making yoghurt.

(2)

.....

.....

.....

.....

.....

.....

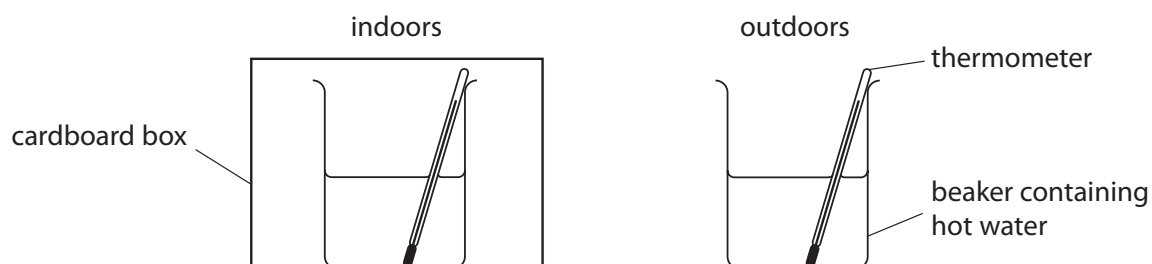
(Total for Question 7 = 10 marks)



5 Farmers can keep their animals indoors or outdoors.

A student uses this apparatus to compare the heat loss from animals kept indoors and outdoors.

He uses a covered beaker to represent animals indoors and an uncovered beaker to represent animals outdoors.



This is the student's method.

- pour 200 cm³ of hot water into each beaker
- measure the temperature of the water in each beaker
- cover one beaker with a cardboard box
- measure the temperature of the water in each beaker after 30 minutes

The student repeats the investigation six times and calculates the mean temperature of the water for each beaker.

The table shows the student's results.

Time in minutes	Mean temperature of water in °C	
	uncovered	covered
0	80	80
30	40	44

(a) Give the dependent variable in this investigation.

(1)

(b) Give one reason why the student uses the same volume of water in each beaker.

(1)

- (c) Calculate the difference between the percentage decrease in temperature for the uncovered beaker and the percentage decrease in temperature for the covered beaker. (2)

difference = ... %

- (d) The student concludes that it is better for farmers to keep their animals indoors. Discuss this conclusion. (4)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- (e) Describe how the student could modify his investigation to find out if an animal's body size affects heat loss.

(2)

(Total for Question 5 = 10 marks)



- 5 Scientists carry out an experiment to see if reducing the availability of oxygen affects the production of yoghurt.

They use increasing acidity as a measure of yoghurt production.

They record the acidity of two cultures, one with a reduced oxygen level and one with a normal oxygen level, over 210 minutes.

The table shows their results.

Time in minutes	Acidity (%)	
	reduced oxygen level	normal oxygen level
0	0.20	0.20
30	0.22	0.22
60	0.25	0.24
90	0.40	0.25
120	0.50	0.31
150	0.62	0.41
180	0.70	0.51
210	0.70	0.70

- (a) Explain why increasing acidity can be used as a measure of yoghurt production.

(2)

.....

.....

.....

.....

.....

.....

- (b) Give one abiotic variable that the scientists should control in their experiment.

(1)

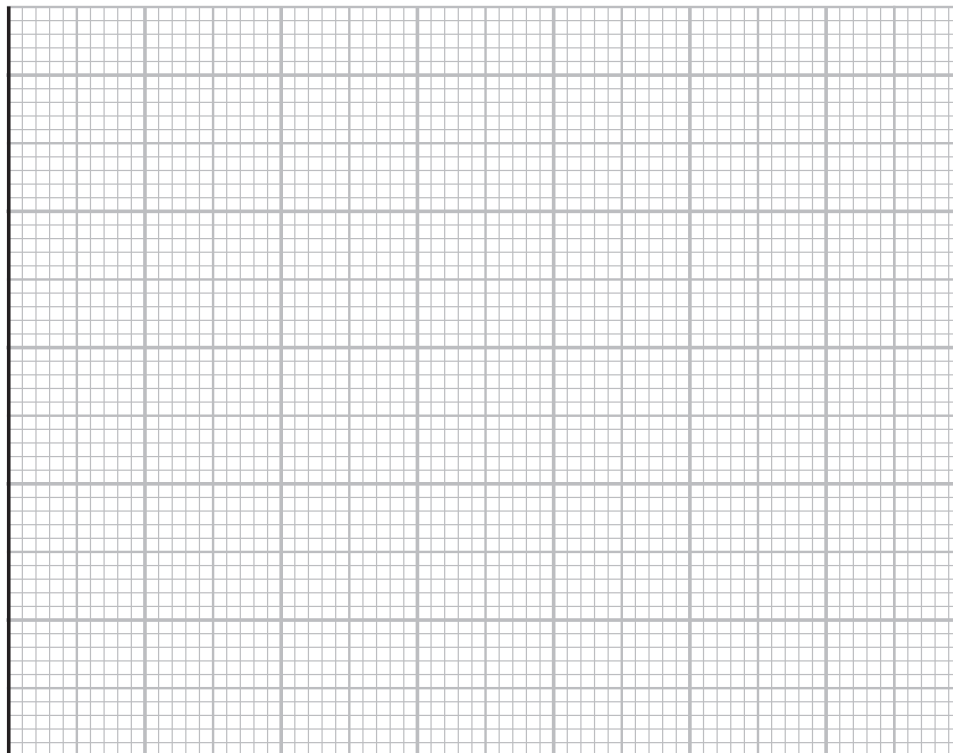
.....



- (c) (i) Plot a line graph to show how the percentage acidity changes over the period of 210 minutes for the reduced oxygen level and for the normal oxygen level.

Use a ruler to join the points with straight lines.

(5)



- (ii) Explain why the changes in percentage acidity are different in the reduced oxygen level and in the normal oxygen level cultures.

(2)

.....

.....

.....

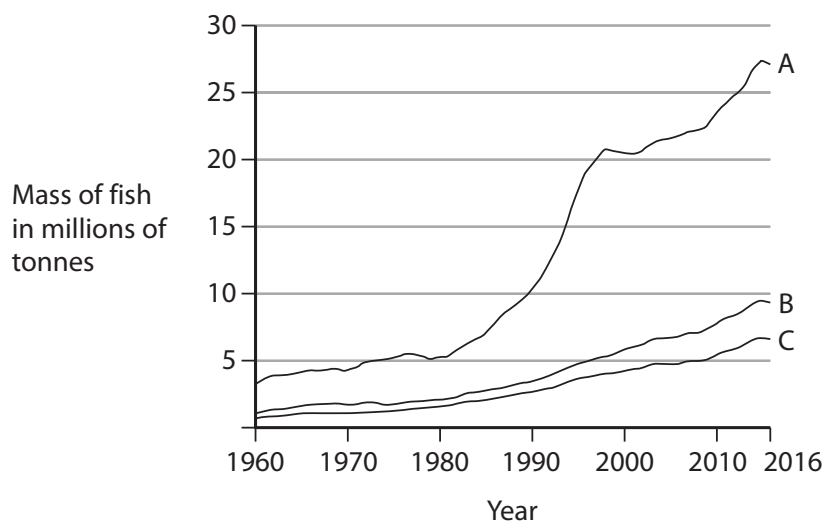
.....

.....

.....

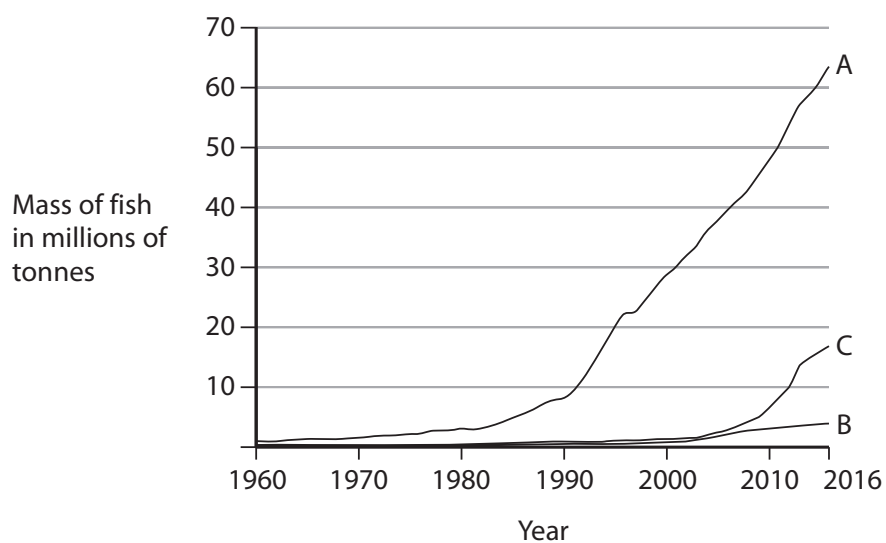
(Total for Question 5 = 10 marks)

- 5 Graph 1 shows the mass of fish caught by traditional fishing in tonnes from 1960 to 2016 in three countries.



Graph 1

Graph 2 shows the mass of fish produced by fish farming from 1960 to 2016 in the same three countries.



Graph 2

(a) Comment on the changes in the mass of fish caught by traditional fishing and the mass of fish produced by fish farming from 1960 to 2016.

Use information from the graphs to support your answer.

(5)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....



(b) Explain the methods a fish farmer can use to maximise production of fish.

(5)

(Total for Question 5 = 10 marks)



5 Farmers can increase their crop yield by growing crops in a temperature controlled glasshouse.

(a) (i) Explain how increasing the temperature can result in an increase in crop yield.

(2)

(ii) Farmers sometimes use a type of heater that burns gas or oil to raise the temperature of their glasshouse to improve crop yield.

Explain why they use this type of heater to improve crop yield.

(2)

(b) Some farmers also add chemical fertilisers to their crops in a glasshouse.

(i) Different minerals are added to chemical fertilisers. Explain one mineral that should be added to these fertilisers.

(2)



(ii) Discuss why some farmers limit the amount of chemical fertilisers they add to their crops.

(5)

(Total for Question 5 = 11 marks)



8 The table shows data on crops grown and pesticide used in Norway in 2011.

Crop type	Crop	Total area in km ²	Percentage of area sprayed with each type of pesticide (%)		
			herbicide	fungicide	insecticide
vegetable	potato	128	92	88	40
	onion	7	99	96	26
	carrot	13	93	42	73
fruit	strawberry	14	72	87	80
	apple	13	56	80	70
meadows	meadows for mowing and pastures	6207	6	–	–
cereals	barley	1450	91	64	10
	oats	694	94	24	4
	spring wheat	588	98	86	27
	winter wheat	139	96	85	7

(a) State what is meant by the term **pesticide**.

(1)

(b) Determine which crop had the largest area sprayed with herbicide.

Show your working.

(2)

largest area = ... km²

crop = ...



- (c) Suggest why spring and winter wheat have different percentages of insecticide applied to them.

(2)

- (d) Discuss the different combinations of pesticides applied to fruit and cereal crops.

(4)

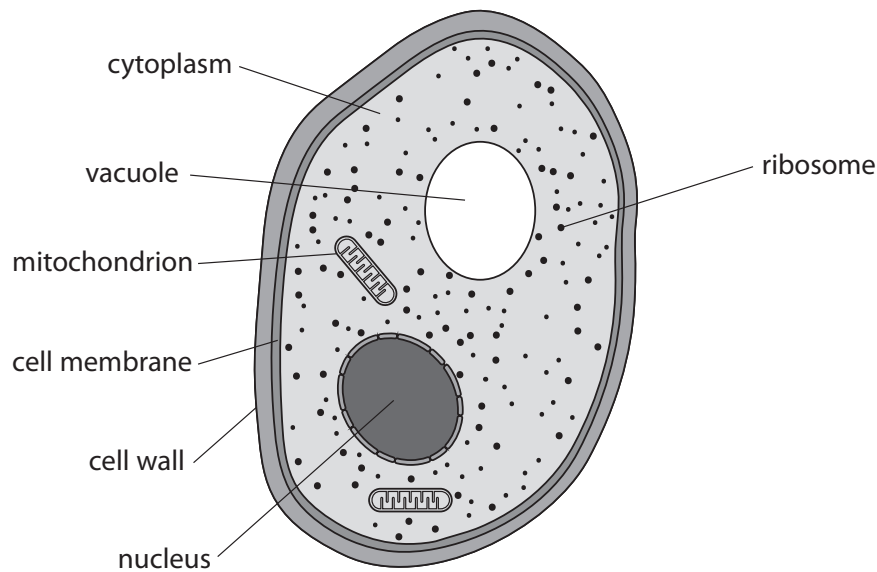
- (e) Explain an alternative to insecticide that a farmer could use.

(2)

(Total for Question 8 = 11 marks)



3 The diagram shows a yeast cell.



(Source: Pearson Education Ltd)

(a) (i) In which of the labelled structures in the yeast cell does aerobic respiration occur?

(1)

- ☒ A mitochondrion
- ☒ B nucleus
- ☒ C ribosome
- ☒ D vacuole

(ii) What substance is the yeast cell wall made of?

(1)

- ☒ A cellulose
- ☒ B chitin
- ☒ C glycogen
- ☒ D starch

(iii) Which of these structures found in the yeast cell would also be present in a prokaryotic cell?

(1)

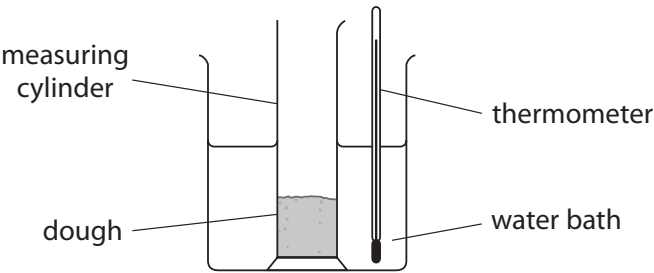
- ☒ A cell membrane
- ☒ B mitochondrion
- ☒ C nucleus
- ☒ D vacuole

(b) Yeast cells are often used when making bread.

A student uses this method to investigate the effect of temperature on the height that bread dough rises.

- place dough containing flour, sugar, water and yeast into a measuring cylinder
- measure the height of the dough
- place the measuring cylinder in a 25 °C water bath
- measure the height of the dough after two hours
- repeat the experiment at temperatures of 35 °C and 65 °C

The diagram shows the student’s apparatus.



The table shows the student’s results.

Temperature in °C	Height of dough in mm		Percentage (%) increase in height of dough
	at start	after two hours	
25	25	35	40
35	25	45	
65	25	27	8

- (i) Calculate the percentage increase in the height of the dough after two hours at a temperature of 35 °C.

(2)

percentage increase = ... %

(ii) Explain why yeast causes the bread dough to increase in height.

(2)

(iii) Explain why the dough rises to a different height at 25 °C compared with the height at 35 °C.

(2)

(iv) Explain why the dough rises to a different height at 35 °C compared with the height at 65 °C.

(2)

(Total for Question 3 = 11 marks)



7 The table shows information about world fish supply from 2009 to 2014.

Source	Fish supply in million tonnes					
	2009	2010	2011	2012	2013	2014
wild	90	89	94	91	93	93
farmed	56	59	62	66	70	74
total	146	148	156	157	163	167

- (a) (i) Calculate the difference between the percentage of total fish production that is farmed in 2009 and the percentage of total fish production that is farmed in 2014. (3)

difference = ...

- (ii) Describe the changes in fish supply from 2009 to 2014. (3)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....



(b) Farming large numbers of fish can cause problems for fish farmers.

Discuss how fish farmers solve these problems.

(6)

(Total for Question 7 = 12 marks)



10 Farmers sometimes use biological control to reduce the damage to their crops caused by pests such as insects.

(a) Which of these is an advantage of using biological control over chemical control?

(1)

- ☐ **A** it lasts a short time
- ☐ **B** it leads to bioaccumulation
- ☐ **C** it is specific
- ☐ **D** it is quicker

(b) Aphids are tiny insects that have very sharp mouthparts. They push these mouthparts into the phloem found in stems. They then feed on the phloem contents.



(Source: © Scenics & Science / Alamy Stock Photo)

(i) Name two substances the aphids obtain from the phloem.

(2)

1

2

(ii) Explain how aphids feeding from the phloem of crop plants can lead to a reduction in yield.

(4)

This image shows a full page of white paper with horizontal dashed lines, typical of primary school handwriting practice paper. The lines are evenly spaced and run across the entire width of the page. There are no margins, text, or other markings present.

(c) Silverflies and hoverflies are two species of insects whose larvae feed on aphids.

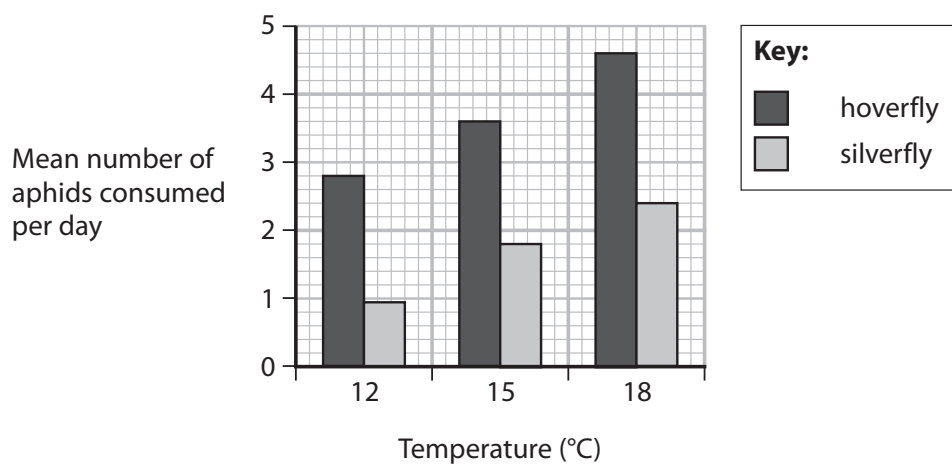
Scientists investigate the feeding behaviour of these species in a laboratory experiment.

This is the scientists' method.

- place a single silverfly in a container
- place a single hoverfly in a separate container
- keep the containers at 12 °C
- put 30 aphids in each container
- count the number of aphids consumed each day for several days
- determine the mean number of aphids consumed per day

The scientists repeat the method at two higher temperatures.

The graph shows the scientists' results.



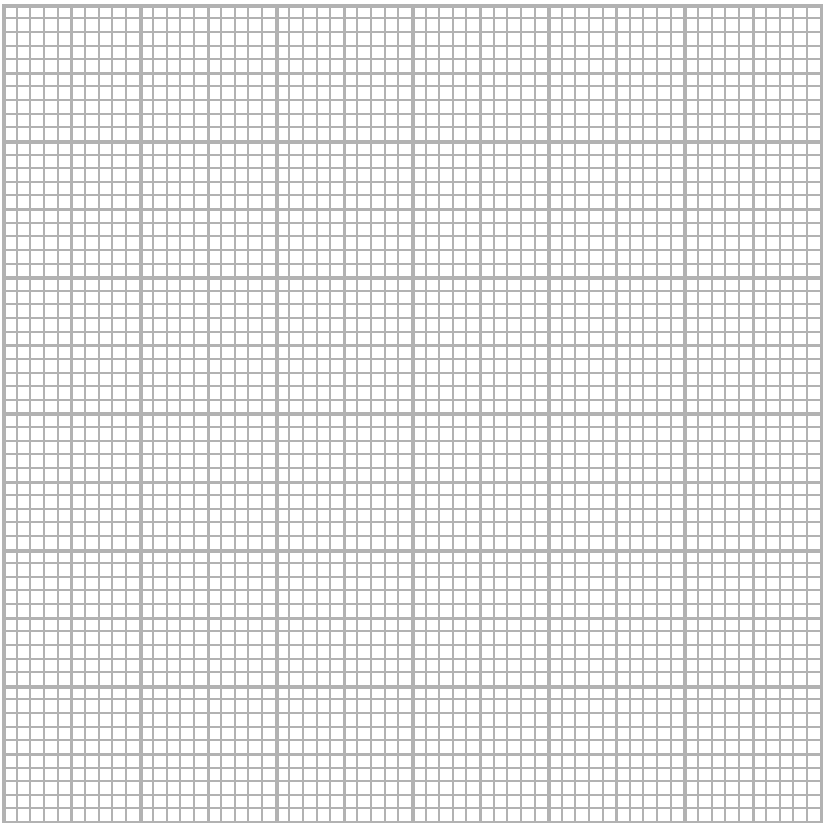
9 (a) The table shows the production of wheat and barley in the United Kingdom from 2011 to 2015.

Crop	Crop production in thousand tonnes per year				
	2011	2012	2013	2014	2015
wheat	15 300	13 200	11 900	16 600	16 100
barley	5 500	5 500	7 100	6 900	7 300

(i) Plot a line graph to show the changes in wheat and barley production from 2011 to 2015.

Use a ruler to join the points with straight lines.

(6)



(ii) Describe the changes in the production of each crop from 2011 to 2015.

(2)

.....

.....

.....

.....

.....

.....

(iii) Determine which of the crops had the greatest percentage change in production from 2011 to 2015.

Show your working.

(3)

.....

.....

(b) A wheat field, 100 m by 100 m, can produce a total yield of 25 000 kg of carbohydrate in a year.

Calculate the mean mass, in grams, of carbohydrate produced **each day** by a square metre of the wheat field.

(2)

mean mass = ... g

(Total for Question 9 = 13 marks)



5 The photograph shows a red fire ant.



(Source: © JAMES H. ROBINSON/SCIENCE PHOTO LIBRARY)

Fire ants are pests that damage crops.

Phorid flies can be used as a biological control of fire ants.

Scientists use this method to investigate the use of pesticides and biological control on populations of fire ants that live on plants in glasshouses.

- in one glasshouse, keep plants with no treatment
- in a second glasshouse, treat plants with pesticide
- in a third glasshouse, treat plants with pesticide and then immediately introduce phorid flies
- count the number of fire ants in each glasshouse at intervals for 24 months

The table shows the scientists' results.

Time after treatment in months	Number of fire ants		
	No treatment	Pesticide only	Pesticide and phorid flies
0	500	500	500
6	700	50	50
12	600	75	25
18	600	125	25
24	700	400	25

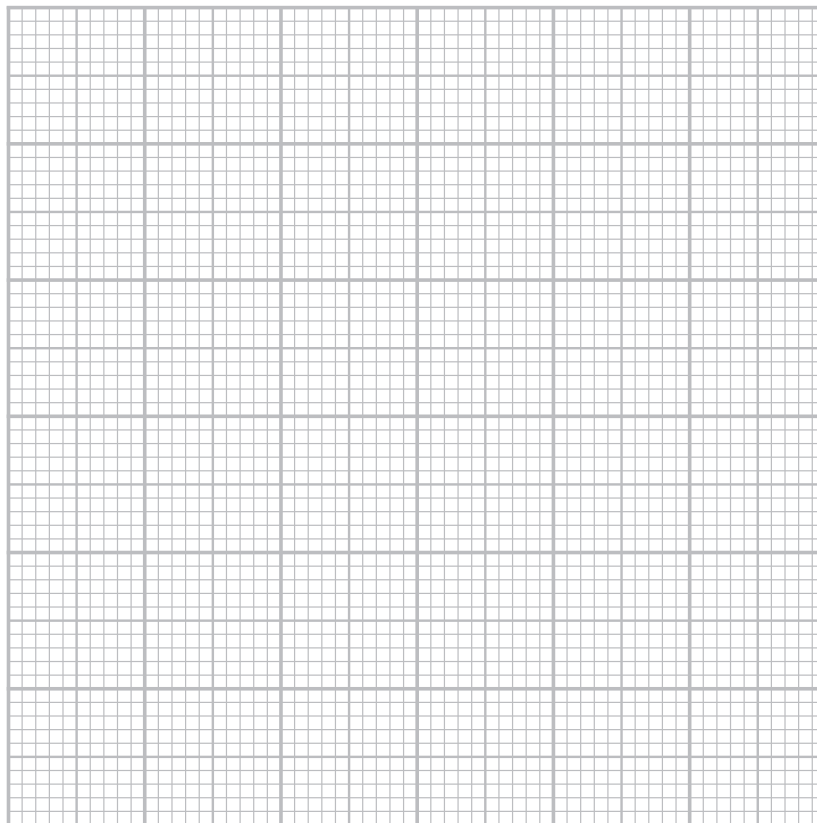
(a) Give a reason why the scientists include results from a glasshouse with no treatment in their investigation.

(1)

- (b) Draw a line graph to show the changes in the number of fire ants with pesticide only and with both pesticide and phorid flies for the 24 months.

Join your points with straight lines.

(5)



- (c) Describe the effect of using pesticide only on the number of fire ants for the 24 months.

(2)

.....

.....

.....

.....

(d) Discuss the effects of using pesticide only and of using both pesticide and phorid flies on the number of fire ants.

Use the data and your own biological knowledge in your answer.

(5)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Total for Question 5 = 13 marks)

9 Many insect species damage crop plants.

One such pest is the larvae of the Fall Armyworm moth.

The photograph shows a larva of this moth feeding on a leaf of a maize plant.



(Source: © Alchemist from India / Shutterstock)

(a) Explain how the larvae of the moth cause a reduction in the yield of the maize crop.

(2)

.....

.....

.....

.....

.....

.....

(b) Biological control involves using a predator species to control the numbers of a pest species.

Explain the advantages of using biological control rather than chemical pesticides to control a pest species.

(4)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

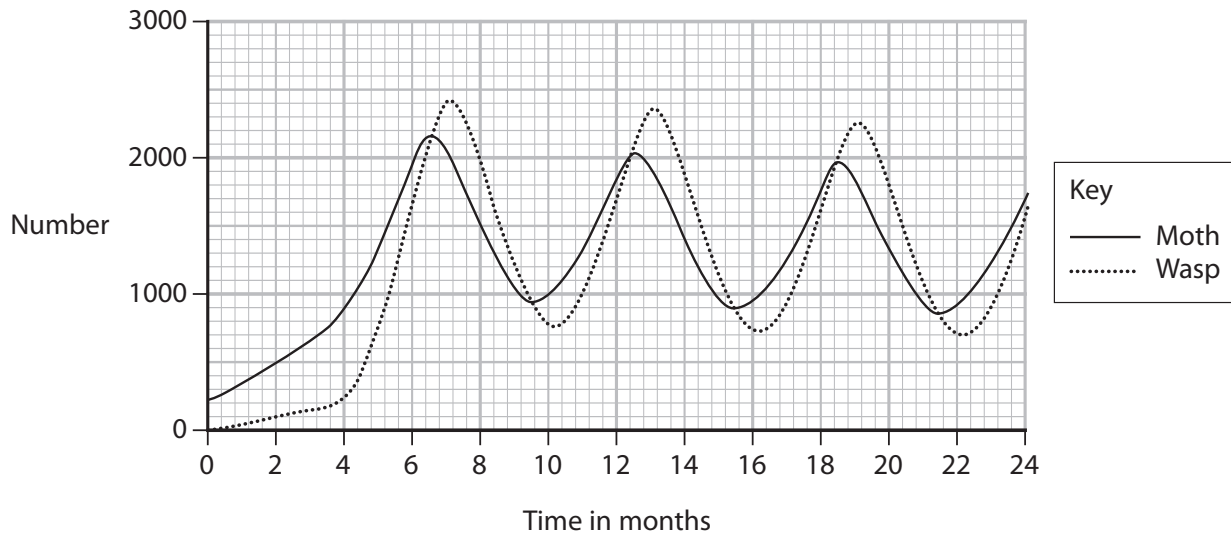
.....

.....

.....

- (c) A parasitic wasp is used as a biological control of the larvae of the Fall Armyworm moth. The wasp feeds off the moth larvae.

The graph shows the change in the numbers of the larvae of the Fall Armyworm moth. It also shows the change in the numbers of the parasitic wasp.



- (i) Explain the relationship between the number of moths and the number of wasps during the 24-month period.

(3)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(ii) The range in moth numbers is the difference between the highest number of moths and the lowest number of moths.

Use the graph to determine the maximum range in the number of moths in the period from 6 months to 24 months.

(2)

maximum range = ...

(iii) Suggest why some maize farmers choose not to use biological control to control the moth.

(2)

(Total for Question 9 = 13 marks)

4 Insect pests can eat and damage crop plants.

The cottony cushion scale insect is a pest that feeds on orange trees.

(a) This insect feeds from the phloem of the trees, reducing crop yield.

(i) Name two substances carried in the phloem.

(2)

1

2

(ii) Explain why insects feeding from the phloem can reduce crop yield from the orange trees.

(3)

.....

.....

.....

.....

.....

.....

.....

.....

.....

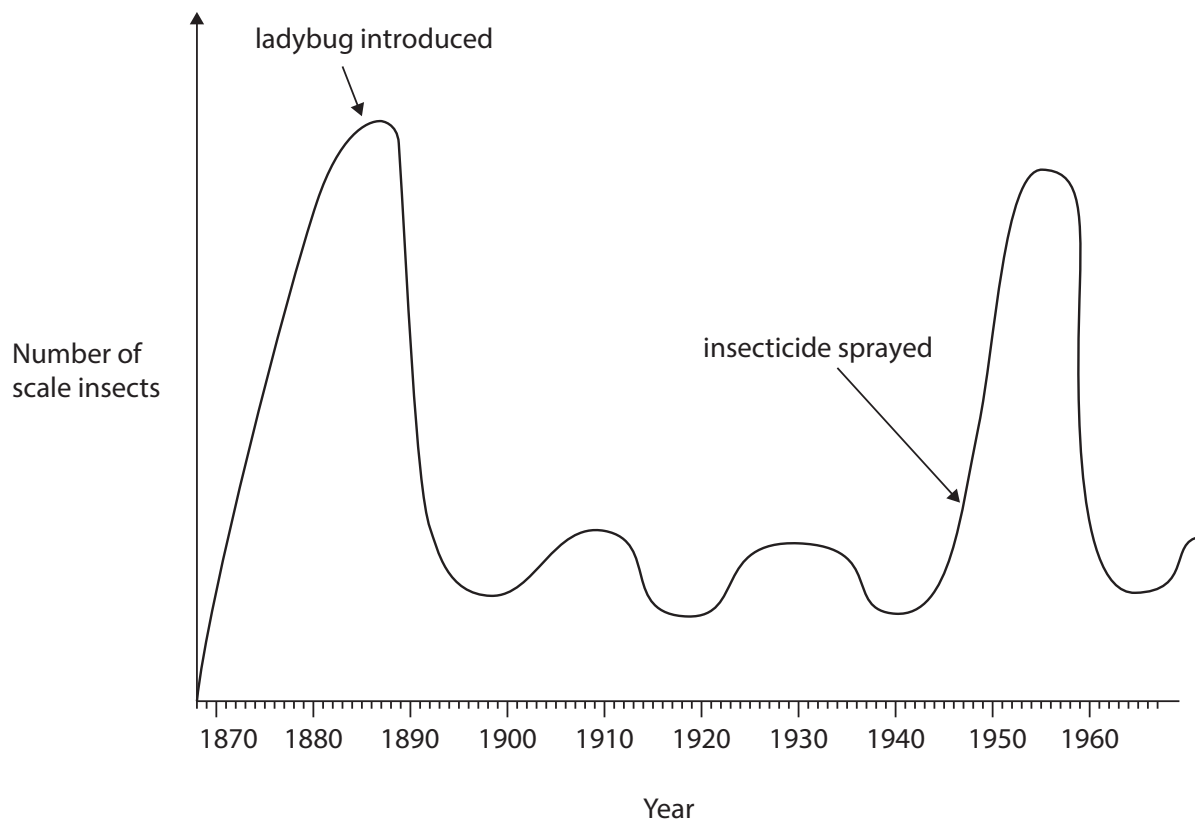


(b) Farmers can reduce insect pests by using chemical pesticide or biological control.

Insects called ladybugs can be used as a method of biological control as they feed on the scale insects.

The graph shows how the number of scale insects changes after the introduction of ladybugs.

The graph also shows how the number of scale insects changes after being sprayed with an insecticide, a pesticide that kills insects.



- (i) Discuss the effects that the introduction of ladybugs, and the use of insecticides, has on the numbers of scale insects.

Use information from the graph and your own knowledge to help with your answer.

(5)

[illegible]

- (ii) Give three advantages of using biological control instead of pesticides to control pests.

(3)

- 1
- 2
- 3

(Total for Question 4 = 13 marks)



- 7 In some countries, snails are farmed as a source of protein.

The photograph shows a snail.



(Source: © PAL/Shutterstock)

- (a) A scientist investigates the effect of temperature on the growth of snails.

The scientist measures the mean (average) shell height of groups of snails kept at three different temperatures for 24 weeks.

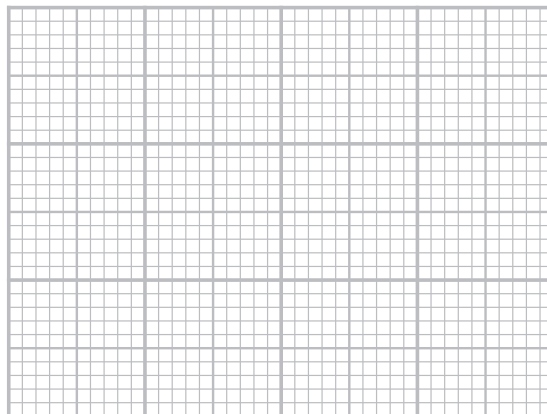
The table shows the scientist's results.

Time in weeks	Mean shell height in mm		
	at 8 °C	at 15 °C	at 23 °C
0	15.0	15.0	15.0
8	15.2	15.8	17.0
16	15.5	16.8	20.4
24	16.4	18.2	21.8

- (i) Plot a line graph to show how the mean shell height increases with time for each temperature.

Use a ruler to join the points with straight lines.

(5)



- (ii) Explain the effect of temperature on the growth of snails in this investigation.

(3)

.....

.....

.....

.....

.....

.....

.....

.....

(iii) State the dependent variable in the investigation.

(1)

(iv) State how the scientist made sure their results were reliable.

(1)

(b) Assimilation efficiency is the percentage of food that is eaten and not egested as faeces.

Assimilation efficiency is calculated using this formula.

$$\text{assimilation efficiency (\%)} = \frac{\text{mass of food eaten} - \text{mass of faeces egested}}{\text{mass of food eaten}} \times 100$$

(i) A snail eats 1.2 g of food and produces 0.30 g of faeces.

Calculate the assimilation efficiency of this snail.

(2)

assimilation efficiency = ... %

(ii) Explain why the assimilation efficiency of a primary consumer is less than the assimilation efficiency of a secondary consumer.

(2)



- (c) The production efficiency of an animal is the percentage of assimilated food that is made into new biomass.

The table shows the production efficiency of a mammal and a snail, both of which are primary consumers.

Animal	Production efficiency (%)
mammal	2
snail	35

Suggest why there is a difference in the production efficiency of the mammal and the snail.

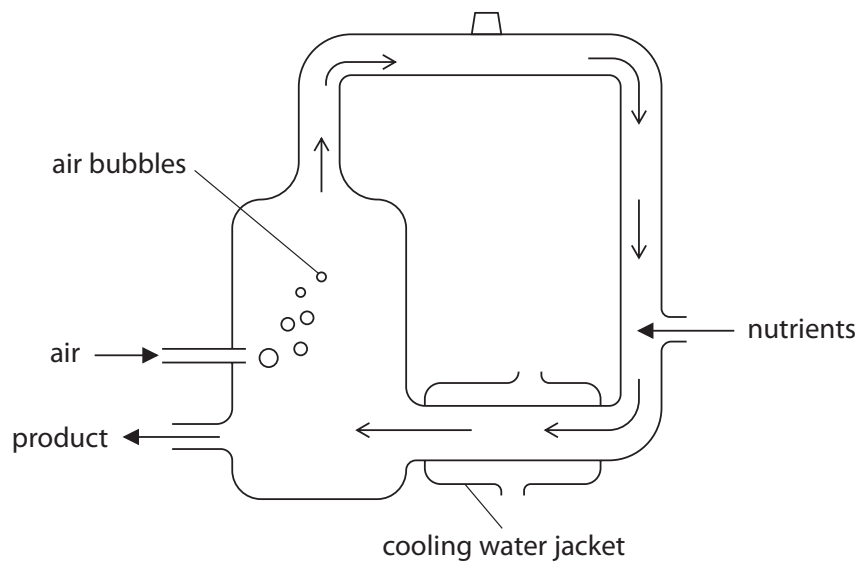
(2)

(Total for Question 7 = 16 marks)

5 Mycoprotein is protein produced by fungi that can be made into meat substitutes.

Large amounts of fungus are grown in fermenters to produce the mycoprotein.

The diagram shows a typical mycoprotein fermenter.



(a) (i) Explain why air is bubbled into the fermenter.

(2)

.....

.....

.....

.....

(ii) Explain why the fermenter is cleaned using steam before the fungus and nutrients are added.

(2)

.....

.....

.....

.....

- (b) A scientist investigates the production of mycoprotein by a genetically modified (GM) fungus and a non-genetically modified fungus (non-GM).

The scientist claims that the GM fungus will be better for large-scale production of mycoprotein.

The scientist measures the mass of mycoprotein produced by the fungi in fermenters for 30 days.

The table shows the scientist's results.

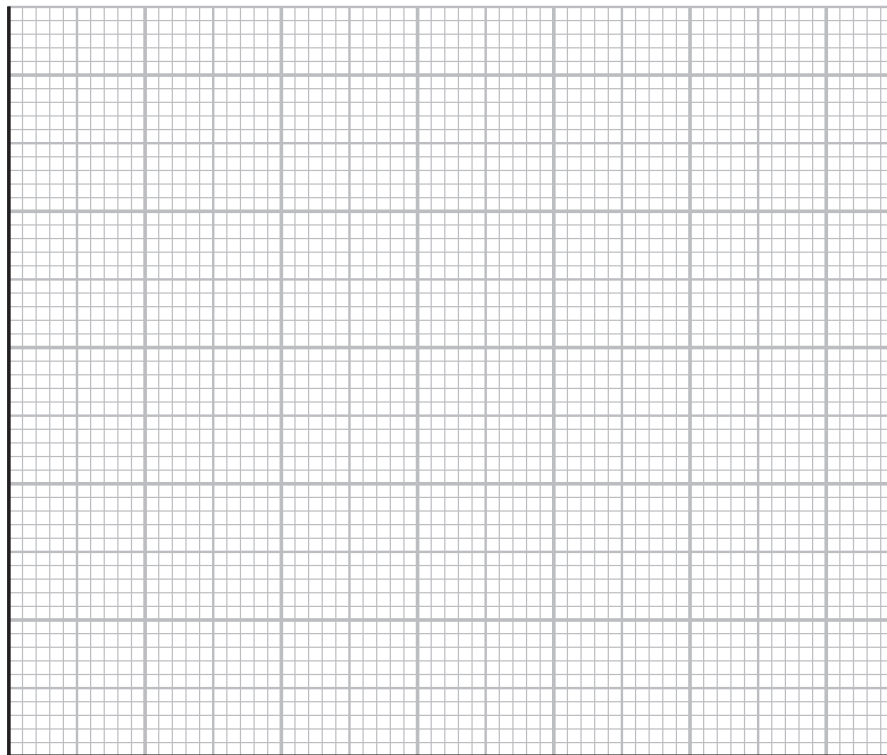
Time in days	Mass of mycoprotein produced in kg	
	GM fungus	Non-GM fungus
5	130	125
10	220	190
15	330	270
20	420	360
30	430	460



- (i) Plot a line graph to show how the mass of mycoprotein changes over the 30 days for each type of fungus.

Use a ruler to join the points with straight lines.

(5)



- (ii) The scientist claims that the GM fungus will be better for large-scale production of mycoprotein than the non-GM fungus.

Comment on the scientist's claim.

(2)

.....

.....

.....

.....

(iii) The table shows the nutritional composition of mycoprotein and the nutritional composition of lamb.

Nutritional component	Mass of nutritional component in 100 grams of food in grams	
	mycoprotein	lamb
protein	10.5	20.2
cholesterol	0.0	0.1
fat	3.0	25.5
fibre	6.0	0.7
iron	0.00039	0.0025
calcium	0.048	0.010



Discuss whether eating mycoprotein is more healthy than eating lamb for a growing human.

(5)

(Total for Question 5 = 16 marks)



SUB-TOPIC 5(b)

SELECTIVE BREEDING

3 questions in this sub-topic · 45 marks · lowest tariff first



6 The photograph shows a plant called a snapdragon.



(Source: © BRIAN GADSBY/SCIENCE PHOTO LIBRARY)

Selective breeding has been used to produce snapdragons with brightly coloured flowers.

- (a) (i) Describe how selective breeding can produce snapdragon plants with brightly coloured flowers.

(2)

- (ii) Micropropagation is often used to make copies of a snapdragon plant.

Describe the process of micropropagation.

(3)

- (b) Scientists investigate the effect of exposing snapdragon explants to increasing amounts of ionising radiation.

This is the scientists' method.

- take a snapdragon plant and use micropropagation to produce many explants
- expose groups of explants to different amounts of ionising radiation
- grow the explants into plants and record the number of differences in their phenotypes compared with the original plant
- take samples of each of the plants and measure the number of differences in DNA nucleotides of each plant compared with the original plant

- (i) Give the reason why micropropagation is used to produce the plants to be tested.

(1)

- (ii) What term is given to all the DNA in an organism?

(1)

- ☐ **A** gene
- ☐ **B** genome
- ☐ **C** genotype
- ☐ **D** nucleoid

9 Farmers and scientists have worked together for the last 50 years to develop crop plants and farm animals with desired characteristics.

- (a) Explain why selective breeding with crop plants is easier and quicker than selective breeding with farm animals.

(3)

- (b) Selective breeding in cattle has been used to improve features such as higher milk yield, longer life and increased muscle mass.

Describe how selective breeding can be used to improve milk yield in dairy cattle.

(4)

(c) Scientists and farmers are also selecting animals based on behaviour and temperament.

(i) Suggest why an animal with a calmer temperament may be more suitable for the farmer on a dairy farm.

(2)

.....

.....

.....

.....

.....

(ii) Cattle behaviour is also affected by the hormone adrenaline. When cattle are more stressed, they have higher levels of adrenaline.

The effect of adrenaline on the cattle nervous system is similar to the effect of adrenaline in humans.

Describe the production of adrenaline and its effects on the body.

(4)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- (iii) Stress in cattle can also affect their reproductive system, leading to damage to the placenta.

Describe the role of the placenta in reproduction.

(3)

(Total for Question 9 = 16 marks)

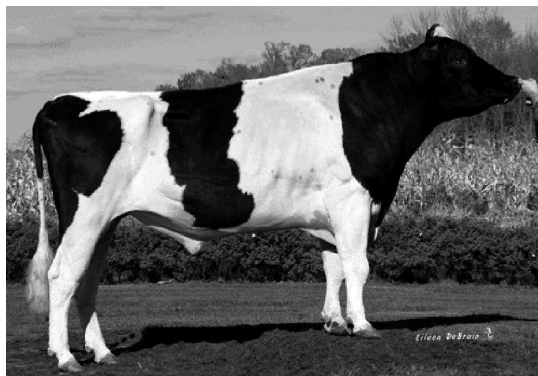


1 Read the passage below.

Use the information in the passage and your own knowledge to answer the questions that follow.

Toystory

Toystory is a bull who was born in 2001. The photograph shows Toystory.



5 In the world of dairy farming Toystory is a famous bull. He fathered 500 000 offspring but did not mate with any cows. He was able to father so many offspring because his semen was collected and then used to fertilise cows using artificial insemination.

Toystory's mother was a high milk producer and his father was a popular bull. He was sold for \$4 000 by his owner to a specialist breeding company called Genex.

10 Genex started to collect semen from Toystory when he was four years old. The semen is carefully collected, using a teaser animal and an artificial rubber vagina.

15 The semen is divided into many separate samples. These samples are put in small straws and frozen in liquid nitrogen. The straws can then be sold and sent to dairy farmers around the world to inseminate their cows. A total of 2.4 million samples of semen from Toystory was sold in more than 50 countries around the world.

20 Toystory's reputation grew as the offspring he fathered went on to be high milk producers. His semen straws sold for over \$60 each. Bull semen can now be sold as sexed or unsexed samples, with sexed samples being more expensive to purchase.

Toystory was highly valued because his offspring produced large quantities of milk of a desired composition. His semen was effective at getting cows pregnant, his daughters gave birth easily and were strong. He had a rare mix of fertility, genetics and appearance.

25 One of his daughters sold for \$300 000 in 2009. His record number of offspring is unlikely to be beaten. This is because bulls are often retired earlier as new genetic advances are discovered.

- (a) Suggest why Genex waited until Toystory was four years old before beginning to collect his semen (line 9).

(1)

- (b) Explain how the semen from the bull is used to fertilise cows using artificial insemination.

(2)

- (c) (i) Suggest why the semen is stored in liquid nitrogen (line 13).

(1)

- (ii) Sexed semen is guaranteed to produce offspring of one sex.

Suggest why dairy farmers would prefer to use sexed semen (line 19).

(1)

- (d) Determine the percentage success of Toystory's semen samples in producing offspring (line 2 and line 15).

(2)

percentage success = ... %



(e) Describe how scientists could investigate which of two bulls is the best to use as a father in dairy farming.

(3)

.....

.....

.....

.....

.....

.....

(f) Explain why the composition of milk is important to consumers (line 22).

(2)

.....

.....

.....

.....

(g) (i) Scientists are now using cloning to produce animals.
Describe the stages that are required to clone a bull.

(4)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(ii) Give two advantages of using cloning rather than selective breeding to produce offspring.

(2)

1

.....

2

.....

(Total for Question 1 = 18 marks)



SUB-TOPIC 5(c)

GENETIC MODIFICATION (GENETIC ENGINEERING)

11 questions in this sub-topic · 106 marks · lowest tariff first



9 Scientists can produce new varieties of plants by genetic modification.

(a) Describe how two named enzymes are used in genetic modification.

(4)

.....

.....

.....

.....

.....

.....

.....

.....

(b) Scientists can also produce new varieties of plants by selective breeding.

Give two differences between the use of genetic modification and selective breeding to produce new varieties of plants.

(2)

1

.....

.....

.....

2

.....

.....

.....

(Total for Question 9 = 6 marks)



2 Bacteria are genetically modified to make human proteins.

(a) Which part of a bacterium is used in genetic modification?

(1)

- ☐ **A** cell wall
- ☐ **B** nucleoid
- ☐ **C** plasmid
- ☐ **D** RNA

(b) The passage describes the use of an industrial fermenter to grow genetically modified bacteria.

Complete the passage by writing a suitable word in each blank space.

(6)

The hormone called is needed to control the blood glucose levels in humans.

Bacteria have been genetically modified to produce this hormone.

The fermenter is cleaned with before adding a nutrient broth that contains the genetically modified bacteria.

This cleaning provides aseptic conditions that prevent from other bacteria.

Paddles are used to the contents.

A gas called is bubbled into the fermenter.

The is controlled by using a cooling jacket.

(Total for Question 2 = 7 marks)

6 Scientists have developed genetically modified (GM) crops in order to increase food production by increasing crop yields.

(a) (i) Some GM crops are described as transgenic.

Explain what is meant by the term **transgenic**.

(2)

.....

.....

.....

.....

(ii) Give the role of **two** named enzymes in the production of GM organisms.

(2)

1

.....

2

.....



- (b) Some GM crops that are available to farmers are resistant to herbicides (weedkillers).
Other GM crops are resistant to diseases caused by viruses and to damage by insects.
Some people are for the use of GM crops because they may be beneficial to ecosystems.
Some people are against the use of GM crops because they could harm ecosystems.
Discuss these opinions for and against the use of GM crops.

(4)

(Total for Question 6 = 8 marks)



- 11** Biological washing powders contain protease enzymes to digest proteins in clothing stains.

Scientists have produced recombinant plasmids containing a gene for a protease enzyme that works at high temperatures. The plasmids have been inserted into bacteria so that the bacteria produce the protease enzyme.

- (a) Describe how named enzymes are used to produce a recombinant plasmid containing a gene for a protease.

(2)

- (b) Design an investigation to find the best temperature for removing protein stains by using washing powder that contains protease enzyme.

Include experimental details in your answer and write in full sentences.

(6)

(Total for Question 11 = 8 marks)



4 Fertilisers contain mineral ions to increase crop yield.

(a) Explain the role of the mineral ion nitrate in the growth of crops.

(2)

(b) These crops can be used to feed farm animals.

Mineral ions are absorbed by the animal's gut.

This is because mineral ions are

(1)

- ☒ **A** small and soluble
- ☒ **B** small and insoluble
- ☒ **C** large and soluble
- ☒ **D** large and insoluble

- (c) If the mineral ions are not absorbed, they are egested in the faeces.

The faeces of genetically modified (GM) farm animals contain less phosphate than the faeces of normal farm animals.

- (i) Some people catch fish from rivers near farm land.

Discuss why these people might support the genetic modification of farm animals.

(4)

[illegible]

- (ii) Describe the role of enzymes in genetic modification.

(2)

(Total for Question 4 = 9 marks)

5 Plants can be genetically modified (GM) to produce insect poison.

They are modified using a bacterium called *Agrobacterium*.

This bacterium has a plasmid that contains recombinant DNA.

(a) Describe how the plasmid is modified to contain recombinant DNA.

(3)

2 Insulin is a hormone produced in the human body.

(a) Which organ produces insulin?

(1)

- ☐ A brain
- ☐ B liver
- ☐ C ovary
- ☐ D pancreas

(b) Describe the role of insulin.

(2)

.....

.....

.....

.....

.....

(c) Some humans cannot produce insulin and need injections of insulin every day.

This insulin can be obtained from cows, but this insulin might cause an immune response in the human body.

Why does cow insulin cause an immune response in humans?

(1)

- ☐ A insulin acts as an antibody
- ☐ B insulin acts as an antigen
- ☐ C insulin is a large molecule
- ☐ D insulin is a pathogen

- (d) The insulin now used for injections is obtained from bacteria that have been genetically modified.

Describe how these bacteria are genetically modified to produce human insulin.

(3)

- (e) An industrial fermenter is used to grow the genetically modified bacteria.

Explain why the fermenter is cleaned using steam before the genetically modified bacteria are added.

(3)

(Total for Question 2 = 10 marks)



9 Genetically modified bacteria are used to produce the hormone insulin.

(a) Explain how these genetically modified bacteria are produced.

(4)

[illegible]

(b) Explain the role of insulin in the human body.

(2)



- (c) Some people are unable to produce insulin.

This condition is called diabetes mellitus.

People with diabetes mellitus control the condition by using insulin injections, controlling their diet, and monitoring how much they exercise.

- (i) Explain why the insulin is injected rather than taken by mouth.

(2)

- (ii) State why people with diabetes mellitus need to monitor how much they exercise.

(1)

- (iii) State how people with diabetes mellitus may need to modify their diet compared with people who do not have diabetes mellitus.

(1)

(Total for Question 9 = 10 marks)



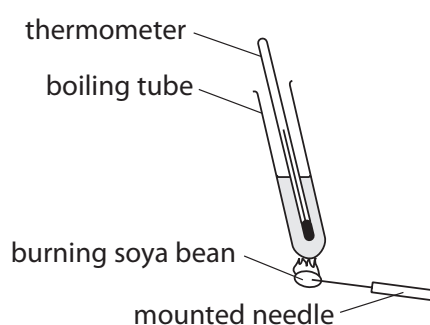
- 4 Scientists have genetically modified soya plants so that the soya beans they produce contain less saturated fat.

The scientists produced one transgenic soya plant. Micropropagation was then used to make multiple copies of this transgenic soya plant.

- (a) Explain why micropropagation was used to produce copies of the transgenic soya plant.

(2)

- (b) A student uses this equipment to compare the energy content of transgenic soya beans with the energy content of non-transgenic soya beans.



- (i) Describe how the student could use the equipment to make a valid comparison of the energy content of the two types of soya bean.

(4)

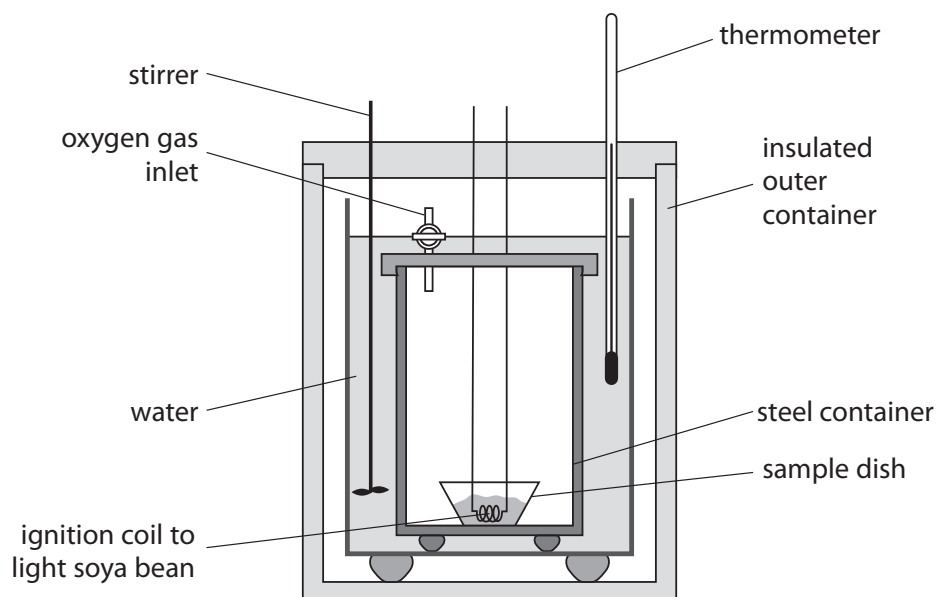
- (ii) Give one safety precaution that the student should take when using the apparatus.

(1)

.....

.....

- (iii) The diagram shows a different type of apparatus that can be used for the investigation.



Explain two reasons why this apparatus will give a more accurate energy value than the apparatus used by the student.

(4)

1

.....

.....

.....

2

.....

.....

.....

(Total for Question 4 = 11 marks)

- 9 Scientists have developed transgenic crop plants that are resistant to herbicides (weedkillers).

(a) (i) State what is meant by the term **transgenic**.

(1)

(ii) Suggest why growing herbicide-resistant crop plants is beneficial to farmers.

(2)

- (b) The photograph shows a weed called Palmer amaranth that is often found in fields growing soybeans.

Palmer amaranth



© Jim West/Alamy Stock Photo

Palmer amaranth is a weed that has become resistant to many different herbicides.

In some populations of Palmer amaranth plants, a recessive allele (r) makes the plants resistant to herbicide. A dominant allele (R) makes the plants not resistant to herbicide.

- (i) Give the possible genotypes of Palmer amaranth plants that are not resistant to herbicides.

(1)

-
- (ii) A Palmer amaranth plant that is resistant to herbicides is crossed with a Palmer amaranth plant that is heterozygous for herbicide resistance.

Draw a genetic diagram to show the genotypes of the parents, the gametes they produce, and the genotypes and the phenotypes of the offspring.

(3)

- (iii) Give the probability of the cross in (b)(ii) producing a plant that is resistant to herbicide.

(1)



8 Golden rice is an example of a genetically modified plant.

Golden rice has been given a gene to make a substance called carotene.

This gene was taken from daffodil plants.

- (a) (i) State the term for a genetically modified organism that has been given a gene from a different species.

(1)

.....

- (ii) Describe how named enzymes are used to transfer a gene from one species to another species.

(3)

.....

.....

.....

.....

.....

.....



(b) Carotene is converted into vitamin A after being consumed by humans.
Non-genetically modified rice does not usually contain carotene.

(i) Vitamin A deficiency is common in some countries.

Explain why growing golden rice may benefit people in these countries.

(2)

(ii) Suggest why some people may not agree with growing genetically modified crops such as golden rice.

(2)

(c) Chemical pesticides can be used in rice fields to kill insect pests.

Scientists investigate the effect that spraying pesticides in a rice field has on three types of organism.

The three types of organism investigated are:

- insect pests
- carnivorous beetles (predators of insect pests)
- lizards (higher trophic level predators)

The scientists count the number of each type of organism in the rice field.

The scientists then spray the field with pesticide.

The number of each type of organism in the field are then counted every three months for a year.

The table shows the scientists' results.

(ii) State two reasons why using biological control is better for the environment than using chemical pesticide.

(2)

1

.....

2

.....

(Total for Question 8 = 14 marks)



SUB-TOPIC 5(d)

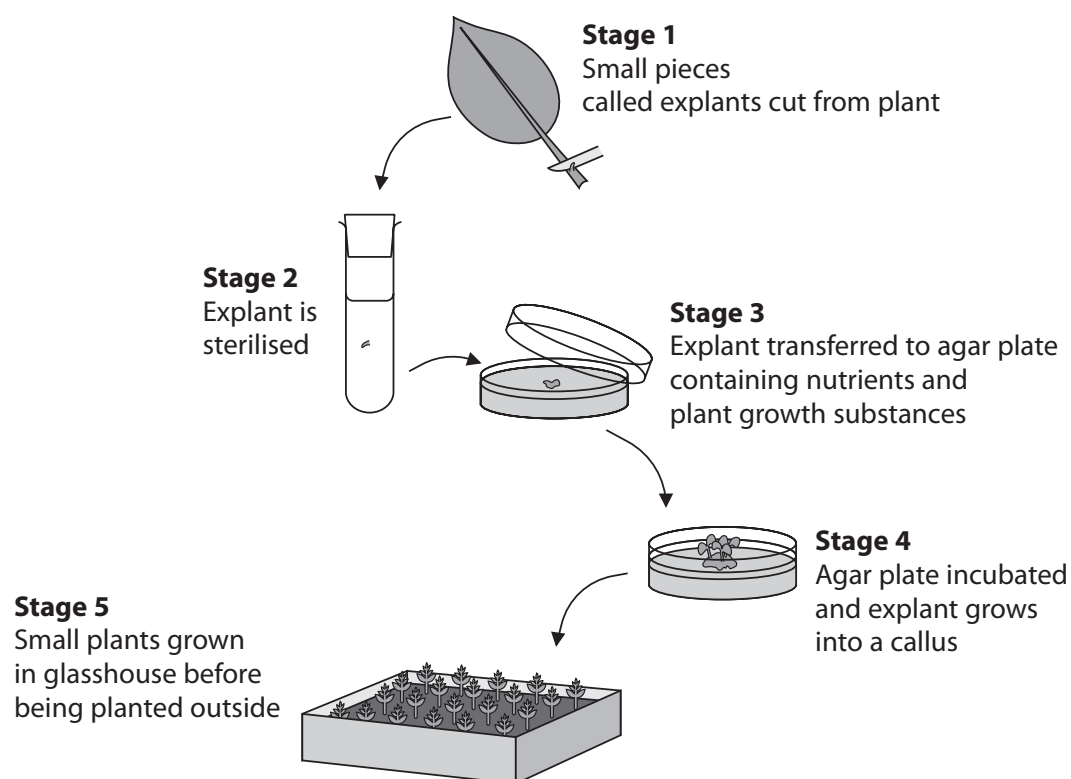
CLONING

11 questions in this sub-topic · 105 marks · lowest tariff first



- 7 Scientists produce large numbers of genetically identical plants using micropropagation.

The diagram shows some of the stages of micropropagation.



- (a) (i) Give a method that could be used to sterilise the explants in stage 2.

(1)

.....

.....

- (ii) Give the name of one of the nutrients that should be added to the agar plate in stage 3.

(1)

.....

.....

(b) In micropropagation, small pieces of plant tissue can grow into new individuals.

Explain why small pieces of animal tissue cannot grow into new individuals.

(2)

(Total for Question 7 = 4 marks)



- 7 The following passage contains information about using micropropagation to produce plants.

Complete the passage by writing a suitable word in each blank space.

(6)

Micropropagation uses small fragments of plants which are regrown into whole plants. These fragments of plants are known as

The surface of each fragment is sterilised to prevent growth of The fragments are placed in a growth medium. The growth medium contains agar and a source of energy such as

This method is able to produce large quantities of genetically identical plants called

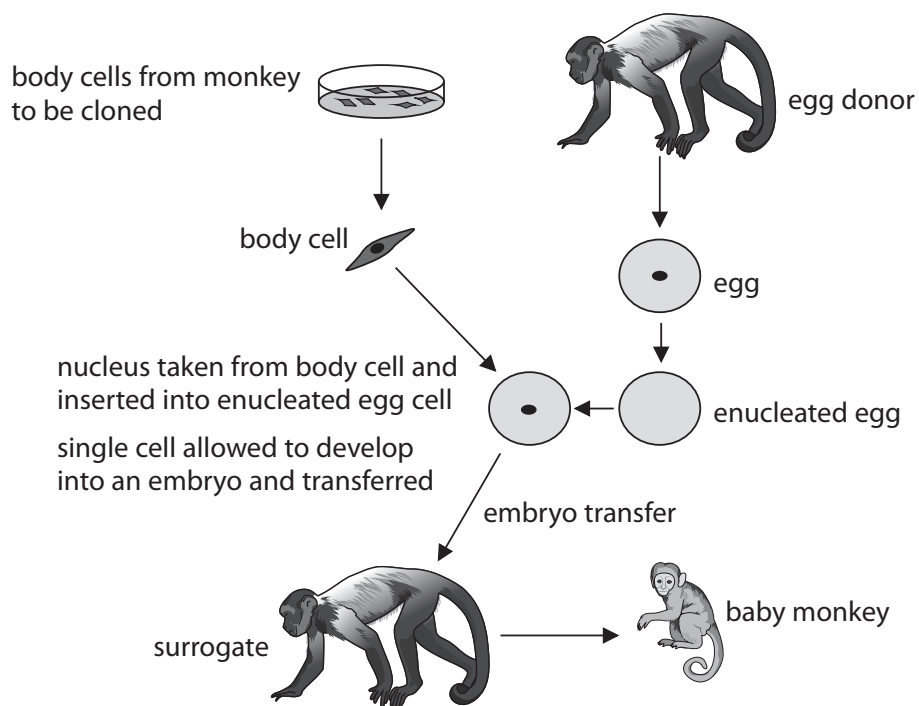
One advantage is that micropropagation is quicker than reproduction, which involves flower and seed production. Another advantage of micropropagation is that plants can be produced the year.

(Total for Question 7 = 6 marks)



4 Scientists have produced cloned monkeys.

The diagram shows the procedure used to produce cloned monkeys.



(a) (i) State the meaning of the term **enucleated**.

(1)

.....

.....

(ii) Describe how the single cell develops into an embryo.

(2)

.....

.....

.....

.....

5 The passage gives information about cloning.

Complete the passage by writing a suitable word in each blank space.

(7)

Animals such as sheep have been cloned.

Cloning involves taking the out of a diploid body cell from the sheep that is to be cloned. This structure is then placed into an cell that has had its removed.

Electricity is used to help the cell to by mitosis.

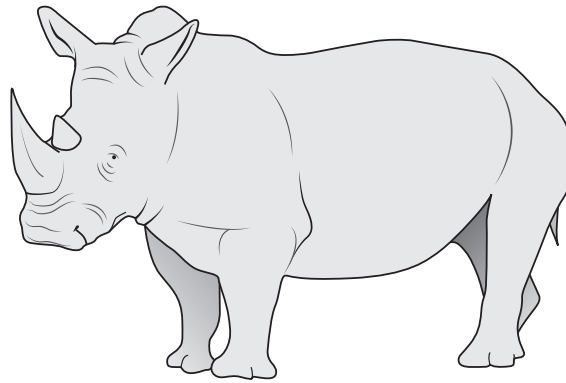
This then develops into an which is then placed into the of an unrelated female.

This female is known as the mother.

(Total for Question 5 = 7 marks)



- 3 The diagram shows a northern white rhino.



The northern white rhino is in danger of becoming extinct.

In 2018, there was only one left in the world.

This represents a 99.95% decrease in numbers from 1960 to 2018.

- (a) Calculate the population size of the northern white rhino in 1960.

(3)

population size = ...

(b) Cloning was considered as a method to increase the northern white rhino population.

In 2018, the only northern white rhino left was an old female. Old females produce too few eggs for cloning to be successful.

Suggest two reasons why many eggs are needed for cloning to be successful.

(2)

1

2

(c) Scientists are considering using semen from a southern white rhino to fertilise an egg from the northern white rhino.

Fertilisation would take place in a test tube and produce a zygote.

(i) Name the cell in semen that fertilises the egg.

(1)

.....

(ii) Explain what the scientists should do with the zygote so that it develops into a fetus.

(4)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Total for Question 3 = 10 marks)



5 Many mammals have been cloned since Dolly the sheep was produced by cloning in 1996.

(a) It took 277 attempts at cloning to produce one sheep.

Calculate how many attempts would have been needed to produce 50 cloned sheep in 1996.

Assume the same number of attempts are needed to produce each sheep as were needed to produce Dolly.

(1)

number of attempts = ...

(b) Describe the stages used to clone a male dog.

(5)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(4)

This image shows a full page of white paper with horizontal dashed lines, typical of primary-ruled notebook paper. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

(Total for Question 5 = 10 marks)

- 4 The photograph shows Prometea, the first cloned horse.



(Source: © MAURO FERMARIELLO / SCIENCE PHOTO LIBRARY)

Prometea was produced by cloning, using the nucleus of a skin cell from a horse called Stella Cometa.

- (a) Complete the passage about cloning by writing a suitable word or words in each blank space.

(5)

A nucleus was taken from a skin cell from Stella Cometa.

This nucleus was inserted into an enucleated that had been taken from a donor horse. An was used to start the type of cell division called, eventually producing an embryo. The embryo was then placed into the of the mother.

2 Blood clotting is an important process in humans.

The process is controlled by enzymes.

(a) (i) Give two reasons why blood clotting is important.

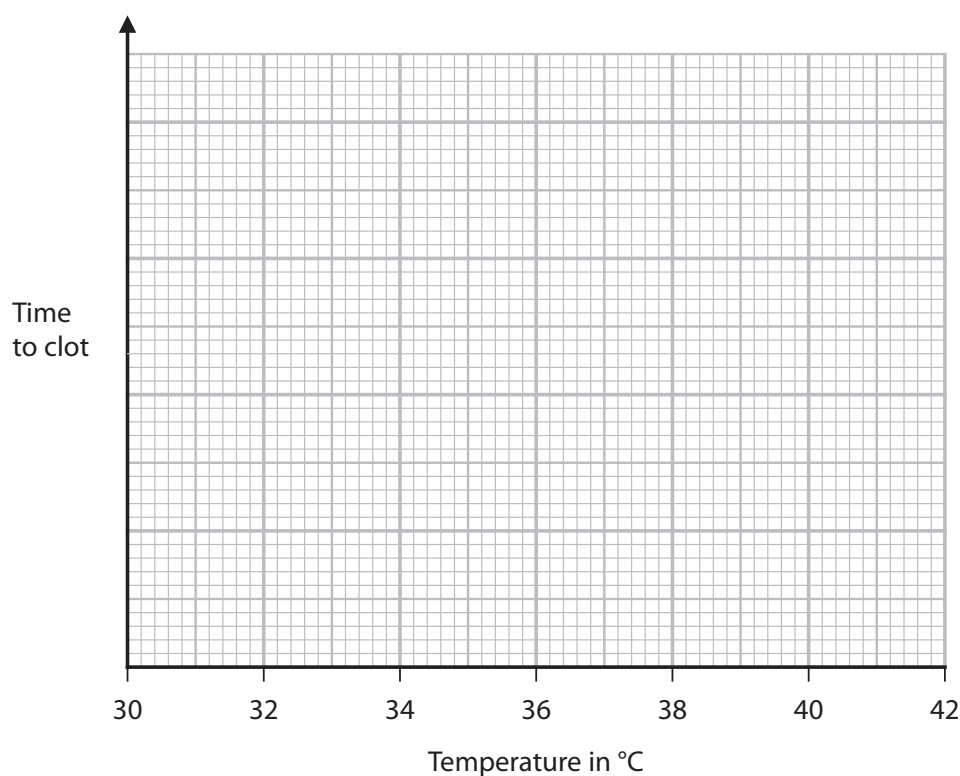
(2)

1

2

(ii) The optimum temperature for the enzymes involved in blood clotting is 37 °C.
Sketch a graph to show how temperature affects the time taken for blood to clot.

(1)



(b) Some people cannot make the proteins needed for blood clotting.

Cloning is used to produce large numbers of transgenic mammals.

These transgenic mammals can make the human blood-clotting proteins. The human blood-clotting proteins can then be removed from the mammals' milk and injected into people who cannot make the proteins.

(2)

(6)



3 Micropropagation is used to produce plant clones.

The process involves growing explants *in vitro*.

(a) State what is meant by the term ***in vitro***.

(1)

(b) The explants grow new roots and shoots.

A student investigates the effect of pH on the growth of new shoots.

The table shows the student's results.

pH	Mean number of shoots per explant
4.5	3.0
5.0	4.8
5.5	5.4
6.0	6.4
6.5	4.3

(i) Explain the relationship between pH and the mean number of shoots per explant.

(2)

(6)

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

(c) Give two benefits of using micropropagation to produce new plants rather than using seeds.

(2)

1

.....

2

.....

(Total for Question 3 = 11 marks)



- 5 Scientists collect data to measure how successful cloning is in cattle.

Table 1 shows the scientists' data.

	Number
embryos transferred	3374
live calves born	317
calves surviving 24 hours	279
calves surviving 150 days	225

Table 1

- (a) Calculate the percentage of embryos transferred that result in live calves being born.

(2)

percentage = ...%



(b) Describe the stages in the production of a cloned mammal from an adult mammal.

(4)

This image shows a full page of white paper with horizontal dashed lines, typical of primary school writing paper. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

(c) There is some evidence that cloned cattle may have weakened immune systems.

Explain why a weakened immune system can affect the health of cloned cattle.

(2)



- 1 Read the passage below. Use the information in the passage and your own knowledge to answer the questions that follow.

Tissue culture and plants

In micropropagation, plant tissues are grown *in vitro* on plant tissue culture media, under aseptic conditions in a controlled environment. This technique is possible because plant cells can differentiate and become specialised cells. This allows them to change their metabolism, growth and development to form a whole plant.



© suradach kulduang/Shutterstock

- 5 Plant tissue culture media contain substances to support the normal growth and development of plants. The media are mainly composed of minerals, vitamins, and plant hormones. The pH of the media is kept constant.

Plant hormones play an essential role in determining how cells and tissues develop in culture media. Plant cells can differentiate into different tissues and cell types.

- 10 The concentration of hormones can determine the tissue that develops. Auxins and cytokinins are the most widely used. A balance of both auxin and cytokinin leads to the development of a mass of undifferentiated cells known as a callus.

- 15 *In vitro* cell culture offers an alternative method for conserving endangered species and varieties. Tissue culture can be used when the plant species produce seeds that do not germinate or have seeds that cannot be stored for a long period of time. These can be successfully preserved using *in vitro* techniques for the maintenance of gene banks.

- 20 Embryo culture is a type of plant tissue culture that is used to grow embryos from seeds in nutrient media. In embryo culture, the plant develops directly from the embryo or indirectly through the formation of a callus and then subsequent formation of shoots and roots. The technique has been developed to break dormancy in seeds, and to reproduce rare species and haploid plants.

25 Scientists are also using cell suspension culture systems from which products can be extracted. A suspension culture is developed by transferring a portion of the callus into liquid media. The media are maintained under suitable conditions of agitation, light and temperature. This system can provide a continuous, reliable source of natural products independent of climate and soil conditions. The first commercial application of large-scale suspension cultivation of plant cells was carried out to produce shikonin. Shikonin is used in traditional Chinese medicine and is a potential anti-cancer treatment.

(a) State what is meant by the term *in vitro*. (line 1)

(1)

(b) Explain how plant cells differ from human cells in their ability to differentiate and specialise. (lines 2 and 3)

(2)

(c) Give the function of two named minerals included in the culture media. (line 6)

(4)

1

.....

.....

2

.....

.....

(d) Explain why the pH of the media needs to be kept constant. (line 7)

(2)

.....

.....

.....

.....

.....

.....



(e) Auxin also controls the response of plants to light.

Describe a simple experiment you could do to show the phototropic response of plant stems to light.

(3)

(f) Explain why scientists want to conserve endangered plant species and varieties.
(lines 13 and 14)

(2)

(g) Explain why plant cell suspension culture media are maintained under suitable conditions of agitation, light and temperature. (lines 24 and 25)

(3)

(Total for Question 1= 17 marks)



MARK SCHEMES

official Pearson Edexcel mark schemes



Question Number	Answer	Additional guidance	Mark
6 (a)	An explanation that makes reference to two of the following points: - to mix microorganisms / bacteria / fungi with the food substrates / prevent microorganisms / food settling / eq (1) - to mix / distribute / eq oxygen (1) - to keep temperature uniform / distribute heat (1)	Allow named nutrients e.g. glucose / amino acids	2

Question Number	Answer	Mark
6 (b)	An explanation that makes reference to the following points: - oxygen for <u>respiration</u> / for <u>aerobic respiration</u> (1) (filter) remove bacteria / fungi / microorganisms / prevent competition / contamination (1)	2

Question Number	Answer	Additional guidance	Mark
6 (c)	An explanation that makes reference to two of the following points: - monitor temperature (in fermenter) / control / maintain temperature / detect changes in temperature / keep temperature same (1) - turn on water supply to cooling jacket if temperature increases / turn off water supply to cooling jacket if temperature drops / release water if too hot / release water to cool down / adjust water supply depending on temperature (1) - prevent <u>enzymes</u> being denatured / maintains optimal temperature for <u>enzymes</u> (1)	Grad Ignore record and read temperature Ignore release hot water if too cold maintain optimal temperature for <u>enzymes</u> = two marks	2

Total = 6 marks

Question Number	Answer	additional guidance	Mark
11	An answer that makes reference to four of the following points • C change amount of starch (1) • O use same species / strain / genotype / mass / volume / measure of yeast (1) • R repeat each flour type more than once / eq (1) • M1 measure height / volume of dough / bread / use ruler (1) • M2 after stated time / same time (1) • S1 use same measure of flour / volume / mass of flour / volume/ mass of water / eq (1) • S2 same temperature / knead for stated / same time / eq (1)	ign amount ign amount allow cook at same temp	6

Question Number	Answer	Mark
10	C use at least two temperatures differing by 3°C / eq (1) O same species / same plant / age / size / condition / same crop / eq (1) R repeat / calculate mean / use more than one glasshouse (for each temperature) / eq (1) M1 measure mass / weight (of crop) / mass / weight of fruit / mass / weight of grain / number of fruits / number of grains / number of leaves / size of leaves / eq M2 stated time period (one day plus) / eq (1) S1 same light (intensity) / light duration / same sun(light) / same time of year / eq S2 same carbon dioxide concentration / mineral ions / water / soil / pH / humidity / eq (1)	6

total 6 marks



Question Number	Answer	Additional guidance	Mark
6(a)	<i>Lactobacillus</i> / <i>Lactobacillus bulgaricus</i> / <i>L. bulgaricus</i> / <i>Streptococcus</i> / <i>Streptococcus thermophilus</i> / <i>S. thermophilus</i> (1)	Allow phonetic spelling	1

Question Number	Answer	Mark
6(b)	lactic / lactate	1

Question Number	Answer	Additional guidance	Mark
6(c)(i)	- readings from graph line - divide by number of hours 0.2 (2)	Award full marks for correct numerical answer without working $0.7 - 0.3 = 0.4$ $0.4 \div 2 = 0.2$ Allow one mark if 0.7 and 0.3 in working	2

Question Number	Answer	Mark
6(c)(ii)	An answer that makes reference to the following points: - fast(er) production at higher temperature / at 43°C / more produced in stated time (1) - fast(er) production at low oxygen / more produced in stated time (1) - no effect in first hour / no difference up to one hour / both same in first hour / both similar in first hour / both reach 0.29 after one hour (1)	3 Allow converse for Mp1 and Mp2

Total 7 marks



Question Number	Answer	additional guidance	Mark
5(a)	An answer that makes reference to three of the following points: • <u>quadrat</u> (1) • repeat (<u>1</u>) • random / using coordinates / eq (1) • count / how many / amount / number /eq (1) • divide total /eq (count) by (area / number of) quadrats /eq (1)	use quadrats scores mp1 and mp 2	3

Question Number	Answer	additional guidance	Mark
5(b)	An answer that makes reference to five of the following points: • BC numbers decline slower / CC numbers lower at start / February / eq (1) • CC numbers lower in some / April/ June / August / stated months /eq (1) • BC numbers are (overall) lower / eq (1) • BC stays low / less variable / CC go up and down / eq (1) • BC no need to reapply / insects reproduce / eq (1) • BC less risk of pollution / eq (1) • BC less risk of resistance /eq (1) • BC is specific / not affect (other) food chains /eq (1) • BC no bioaccumulation / eq (1) • BC could become pest /eq(1)	allow converse allow biomagnification	5

Total = 8 marks



Question Number	Answer	Additional guidance	Mark
4(a)	- unfiltered increase of 28.5g - growth rate in unfiltered $28.5 \div 180 = 0.158$ $0.214 - 0.158 = 0.056$ (3) or $38.5 - 28.5 = 10$ kg $10 \div 180 = 0.056$ allow 0.05 recurring	Allow 1 mark for 28.5 or 10 kg Allow 1 mark for $\div 180$ Allow 0.0556 or 0.055 recurring for 3 marks Award full marks for correct numerical answer without working	3

Question Number	Answer	Mark
4(b)	An explanation that makes reference to three of the following points: (in unfiltered water there is) less growth / eq (1) - less oxygen (1) - less respiration (1) - more disease / damage gills / eq (1)	3

Question Number	Answer	Mark
4(c)	species / type / mass of fish (at start) / eq (1)	1

Question Number	Answer	Mark
4(d)	use a net / cage / shoot predators / make noise / eq (1)	1

Total = 8 marks



Question Number	Answer	Mark
10(a)	An explanation that makes reference to four of the following points: • nitrates (for growth) (1) • for amino acids (1) • for protein (1) • magnesium for chlorophyll / chloroplasts (1) • so more photosynthesis (1) • more glucose (1) • phosphates used for ATP / DNA / eq (1) • potassium for control of water movement / eq (1)	4 exp

Question Number	Answer	Mark
10(b)	An answer that makes reference to four of the following points: • fertiliser leaches into river / washed into river / eq (1) • fertiliser would cause algal / plant growth / algal bloom / eutrophication (1) • dead algae are decomposed / broken down by bacteria / decomposers (1) • (bacterial) respiration would reduce oxygen (1) • means were calculated / readings repeated so experiment is <u>reliable</u> / <u>valid</u> (1) • measurements taken at same time of year / in April (so are valid) (1) • direction of river is past farm (1) • reduced oxygen could be due to other factors / sources of fertiliser from other fields (1)	4 exp

Question Number	Answer	Mark
10(c)	• manure / faeces / dung / compost / seaweed / bone / blood / animal wastes / eq (1)	1 grad

Total 10 marks



Question Number	Answer	Additional guidance	Mark
5(a)	An explanation that makes reference to two of the following points: • plasmid / virus / bacteriophage / phage / gene gun / eq (1) • transfer (recombinant) / DNA / gene / into organism) eq (1)	allow carry DNA /gene introduce / insert DNA / gene	2

Question Number	Answer	additional guidance	Mark
5(b)(i)	Magnesium / Mg Iron / Fe Nitrate / NO₃	Mg²⁺ Fe²⁺ / Fe³⁺ NO₃⁻	1

Question Number	Answer	additional guidance	Mark
5(b)(ii)	An answer that makes reference to six of the following points: • C use pulling / method A and weedicide / method B /eq (1) • O uses same species of crop / same crop / plant (1) • R repeat investigation / uses more than one field (1) • M1 measure crop mass / weigh /eq (1) • M2 use quadrats / use sampling / per m² / per unit area / per tray / eq (1) • S1 after stated time period / one growing season / eq • S2 (control) temperature / light / carbon dioxide / soil / water / fertiliser / minerals /eq (1)	not amount not yield allow idea of in same region / climate for S2	6

Total 9 marks



Question Number	Answer	Additional guidance	Mark
4 (a)	An explanation that makes reference to two of the following: • (select and) mate fish that grow quickly / have desired characteristics / eq (1) • (select and) mate offspring that grow quickly / repeat breeding over several generations / eq (1) • (so that) genes / alleles for fast growth are passed on / eq (1)	Accept fish that do not waste food for grow quickly Ignore large fish Accept repeat with offspring	2

Question Number	Answer	Additional guidance	Mark
4 (b)	A description that makes reference to two of the following: • nitrifying bacteria / nitrification (1) • (ammonium) to nitrite / nitrite to nitrate (1)		2

Question Number	Answer	Additional guidance	Mark
4 (c)	An explanation that makes reference to five of the following: 1. waste food / faeces eaten / removed (by lobsters and crabs) / eq (1) 2. less decomposition / fewer decomposers / fewer bacteria (1) 3. less disease / infection (due to fewer bacteria) (1) 4. less (bacterial/ decomposers) respiration (1) 5. more oxygen in the water / less removal of oxygen / seaweed releases oxygen (1) 6. nitrate / minerals / nutrients / carbon dioxide removed by seaweed (1) 7. less algae growth / algal bloom / eutrophication / eq (1) 8. more products to sell (1) 9. no need to buy food for lobsters / crabs / no need to buy minerals for seaweed (1)	Accept converse for mps Accept (more) fish / animal respiration / eq Accept other correct named minerals Accept fish provide carbon dioxide for seaweed Accept can sell crabs / lobsters / seaweed	5

Total: 9 marks

Question Number	Answer	additional guidance	Mark
7(a)	A description that makes reference to two the following: • biuret (1) • deepest / darker / intensity purple contains most protein (1) • reference to same volume of milk / biuret (1)	allow other quantitative methods such as solidify the milk protein by denaturing (1) mass of the protein (1)	2 exp

Question Number	Answer	additional guidance	Mark
7(b)	An explanation that makes reference to two of the following points: • prevent infection / disease (1) • (by destroying / due to) virus / bacteria / pathogen (1) • provides immunity / eq (1)	ignore illness	2 exp

Question Number	Answer	additional guidance	Mark
7(c)	An answer that includes two of • use as a source of / for energy / respiration (1) • use as store of energy (1) • insulation / myelin sheath / protection fat around organs/ eq(1)	ignore for warmth	2 grad

Question Number	Answer	Mark
7(d)(i)	lactose	1 cler

Question Number	Answer	Mark
7(d)(ii)	<i>Lactobacillus</i> / <i>Streptococcus</i> Allow species names	1 cler

Question Number	Answer	Mark
7(d)(iii)	An explanation that makes reference to two of the following points • sterilise milk / pasteurise (1) • kill bacteria / pathogen / microorganisms (1) • prevent competition (for carbohydrate / sugar) (1)	2 exp

Total 10 marks

Question Number	Answer	Additional guidance	Mark
5(a)	Temperature (1)	allow heat loss / temperature loss	1

Question Number	Answer	Mark
5(b)	An answer that makes reference to one of the following points: • (to prevent) volume / surface area affecting heat loss / eq • valid comparison / fair test / eq	1

Question Number	Answer	Additional guidance	Mark
5(c)	• covered $40 \div 80 \times 100 = 50\%$ (1) • uncovered $36 \div 80 \times 100 = 45\%$ • difference = 5 (2)	allow 1 mark for 45 or 50 full marks for correct answer	2

Question Number	Answer	additional guidance	Mark
5(d)	An answer that makes reference to four of the following points: • less heat loss if indoors / eq (1) • depends upon outside temperature different in hot country (1) • but only small / 5% difference / eq (1) • animals move around less (1) • more energy for growth / making meat / eggs / milk / less energy used to keep warm /eq (1) • diseases easier to spread (1) • protected from predators (1) • ethical objection / cruel / quality of life idea / eq (1) • eat variety of food outdoors / taste/ eq (1)	allow converse ignore natural	4

Question Number	Answer	additional guidance	Mark
5(e)	An answer that makes reference to the following points: • use beakers / containers of different sizes / different volumes (1) • keep beakers out of box / keep beakers under box (1)	allow different volumes of water ignore animals	2

Total 10 marks

Question Number	Answer	Mark
5 (a)	An explanation that makes reference to two of the following: • anaerobic respiration (1) • (by) bacteria / named bacteria (1) • produces lactic acid / eq (1)	2

Question Number	Answer	Mark
5 (b)	• temperature / volume / mass of milk / lactose content of milk / type of milk / eq	1

Question Number	Answer	Additional guidance	Mark
5(c)(i)	A graph that makes includes: • scales linear and at least half page and axes the correct way around time on x axis (1) • (time in) minutes and acidity %(1) • straight lines joining points (1) • points correctly plotted (1) • key to identify normal and low oxygen (1)	Allow truncated y axis if starts at 0.2 or 0 and // within a small square	5

Question Number	Answer	additional guidance	Mark
5 (c)(ii)	An explanation that makes reference to the following: • reduced oxygen (more) anaerobic respiration (of milk) / less <u>aerobic</u> respiration / eq (1) • acidity increases <u>faster</u> / sooner / more rapidly / eq (1)	allow converse for more oxygen	2

total 10 marks

Question Number	Answer	additional guidance	Mark
5(a)	An answer that makes reference to 5 of the following points. fish caught / traditional fishing graph 1 • 1 increased (in all countries) (1) • 2 increased by almost same proportion in each country (1) fish farming graph 2 • 3 increase in farming (in all countries) (1) • 4 increased most in A (1) • 5 higher growth in C than B (1) comparison • 6 more tonnes from farming / graph 2 than catching in A / more tonnes from farming / graph 2 than catching in C / less in B (1) • 7 A has the highest for both (caught and farmed) / eq (1) other • 8 no information on fish species / type of fish (1) • 9 no information on sustainability / fish supply /eq (1) • 10 data not expressed as per capita /eq (1)		5

Question Number	Answer	Additional guidance	Mark
5(b)	An explanation that that makes reference to five of the following points: • separate different species to prevent predation / use nets to prevent predation / eq (1) • separate different sizes / ages to prevent predation / eq (1) • feed protein rich food / feed (frequently) in small quantities (to prevent accumulation of waste) / eq (1) • use antibiotics / fungicides to reduce disease eq (1) • (filter water to) remove faeces / waste / algae / remove dead fish / eq (1) • aerate water / use pumps to maintain oxygen levels / eq (1) • use selective breeding / GM (to maximise yield) /eq	not just control diet unqualified not just clean the water unqualified	5

total 10 marks

Question Number	Answer	Mark
5(a) (i)	An explanation that makes reference to two the following points: • as temperature increases so does (rate of) <u>photosynthesis</u> (1) • increased (kinetic) energy (of molecules) / molecules move faster / more collisions (1) • <u>optimum temperature for enzymes</u> (1) • more glucose / starch / sugar / carbohydrate / eq produced (1)	2

Question Number	Answer	Mark
5(a) (ii)	An explanation that makes reference to two the following points: • it releases CO₂ (1) • CO₂ a reactant / used in / needed in / for photosynthesis / eq (1) • as CO₂ is limiting factor (1)	2

Question Number	Answer	Additional guidance	Mark
5(b) (i)	An explanation that makes reference to the following points: • nitrate • for amino acids / proteins (1) • magnesium • for chlorophyll for chloroplasts (1)	Allow other minerals and their function ignore nitrogen eg phosphate for ATP / DNA can only gain function if mineral is correct	2

Question Number	Answer	Mark
5(b) (ii)	An answer that makes reference to five of the following points: • increased soil concentration reduces water potential of soil (1) • prevents water uptake / absorption by osmosis / causes water loss (1) • so plant wilts / eq (1) • damaging effect of leaching / escaping / washing into rivers lakes / eq (1) • causes eutrophication (1) • leads to algal bloom/ plant growth in river / lake / eq (1) • loss of <u>aquatic</u> life / fish / <u>water</u> plants die /eq; • (may prefer to) use natural fertiliser / manure (1) • can produce organic earn more money (1) • other factors limit growth / there is excess fertiliser / not all fertiliser is used (1)	5

Total = 11 marks



Question Number	Answer	Mark
8(a)	chemical / solution / eq that kills / destroys / eq pests / animals / plants / insects / eq (1)	1

Question Number	Answer	additional guidance	Mark
8(b)	1319.5 /1320 /1300 km ² (1) Barley (1)	Multiply total area by % sprayed 91 % of 1450	2

Question Number	Answer	additional guidance	Mark
8(c)	An answer that makes reference to two of - in winter cold / low temperature / less food eq (1) - fewer insects / pests (1) - less insecticide / pesticide needed (1)	allow converse for spring spring warmer / more food more insects more insecticide /pesticide	2

Question Number	Answer		Mark
8(d)	An answer that makes reference to four of - around 70% / even pattern of herbicide / fungicide and insecticide in fruit crops (1) - high(er)use of herbicide in cereals / low(er) use of herbicide in fruit(1) - as smaller plants / growing plants need to compete with weeds (1) - high(er) use of insecticide in fruit crops / low(er) use of insecticide in cereals (1) - more variation in fungicide use in cereals (1) - high use of fungicide on (rotting) fruit (1) - as fruit more prone to saprophytic decay/ high sugar content / eq	Allow converse mp 3 allow converse mp 7	4

8(e)	An answer that makes reference to • use biological control (1) • using a predator (species) (such as Encarsia) to target / eat / consume (specific) pest / insect / eq (eg whitefly) (1)	use nets (1) exclude insects from plants / eq (1) allow introduce consumer of insect / Allow example ladybird for aphids for mp 2	2
-------------	--	---	----------

Total 11 marks

Question Number	Answer	Mark
3(a)(i)	A mitochondrion <i>B is incorrect because the nucleus does not carry out photosynthesis</i> <i>C is incorrect because ribosomes carry out protein synthesis</i> <i>D is incorrect because the vacuole sores sap</i>	1

Question Number	Answer	Mark
3(a)(ii)	B chitin A is incorrect because fungal cell walls are not made of cellulose C is incorrect because fungal cell walls are not made of glycogen D is incorrect because fungal cell walls are not made of starch	1

Question Number	Answer	Mark
3 (a)(iii)	A cell membrane B is incorrect because prokaryotes do not contain mitochondria C is incorrect because prokaryotes do not contain nuclei D is incorrect because prokaryotes do not have vacuoles	1

Question Number	Answer	Additional guidance	Mark
3 (b)(i)	80 % (2)	one mark for 20 Award full marks for correct answer	2

Question Number	Answer	Additional guidance	Mark
3 (b)(ii)	An explanation that makes reference to two of the following: • (yeast) respire / fermentation / respiration (1) • producing / carbon dioxide (1) • (carbon dioxide) bubbles become trapped / stuck / inflate in dough (1)	Reject oxygen produced	2

Question Number	Answer	Additional guidance	Mark
3 (b)(iii)	An explanation that makes reference to two of the following: at 25 °C: • (kinetic) energy lower / molecules move slower / eq (1) • fewer collisions / fewer enzyme substrate complexes / further away from enzyme optimum / eq (1) • less carbon dioxide / gas released / eq (1)	Accept converse for 35 °C for all MPs	2

Question Number	Answer	Additional guidance	Mark
3 (b)(iv)	An explanation that makes reference to two of the following: at 35 °C • <u>enzymes</u> not denatured (1) • substrate fits into active site / active site shape not changed / eq (1) • so respiration continues / more carbon dioxide produced / yeast cells are alive / eq (1)	Accept converse for 65 °C for all MPs	2

Total for Question 3 = 11 marks



Question Number	Answer	Additional guidance	Mark
7(a)(i)	• $56 \div 146 \times 100$ • $74 \div 167 \times 100$ • $44 - 38 = 6\%$ 5.9 to 6.0 (3)	award full marks for correct numerical answer without working Allow one mark for 38 to 38.4 in working Allow one mark for 44 to 44.31 in working	3

Question Number	Answer	Additional guidance	Mark
7(a)(ii)	An answer that makes reference to three of the following points: • increase in (total) supply (1) • increase in farmed (1) • no / little change in wild fish / decrease and increase in wild fish / wild fish fluctuates / wild fish increases <u>slightly</u> / eq (1)	Ignore quoting values alone	3

Question Number	Answer	additional guidance	Mark
7(b)	An answer that makes reference to six of the following points: • selective breeding / GM (1) • separate sizes / ages / sex (1) • use nets / cages / cover / eq (1) • control amounts of food / frequency of feeding / protein rich (1) • remove uneaten food / waste / filter / change water / remove faeces / eq (1) • antibiotics / fungicide / vaccination / remove dead fish / biological control / wrasse / pesticide (1) • oxygen / aerate / use paddles / flowing water (1) • growth hormone / oestrogen(s) (1)	Mp 5 Ignore clean alone Mp6 Ignore medicine	6

Total 12 marks

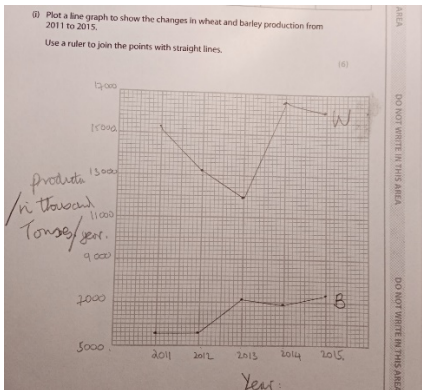
Question Number	Answer	Mark
10(a)	The only correct answer is C it is specific A it lasts a short time is not correct B it leads to bioaccumulation is not correct D it is quicker is not correct	1

Question Number	Answer	additional guidance	Mark
10(b)(i)	An answer that includes the following - sucrose / sugars (1) - amino acids / eq (1)	ignore water reject starch / glucose allow named amino acid	2
Question Number	Answer	additional guidance	Mark
10(b)(ii)	An explanation answer that makes reference to four of the following:		4

	- less respiration / eq (1) - less ATP / less energy (1) - less active transport/ less minerals <u>absorbed</u> / eq (1) - less / remove / eat carbohydrate / sucrose / sugars / less amino acids / eq (1) - less growth (of leaves / tubers /bulbs /grain/ fruit) (1) - less starch <u>stored</u> / less proteins (synthesis) (1) - less photosynthesis (1) - less <u>nectar</u> (1) - less (insects for) pollination (1) - spread disease / infection / eq (1)	not glucose stored or carried in phloem	
--	--	---	--

Question Number	Answer	Additional guidance	Mark
10(c)	An answer that that makes reference to five the following points: yes • hoverflies eat / consume more aphids / eq (1) • at each/ all temperature(s) / eq (1) • therefore fewer hoverflies need to be used (1) • greatest / most difference ($\times 3$) at 12 °C /eq / least at 18 °C ($\times 1.9$) (1) • (both) flies consume more at higher temperatures /eq (1) but not conclusive because • only one larvae used /should use more larvae / not repeated / eq (1) • (less valid) not natural habitat / not a field study / done in laboratory setting / eq (1) • only 2 species hoverfly and silverfly compared / eq (1)	allow % difference	5

total 12 marks

Question Number	Answer	additional guidance	Mark
9(a) (i)	An answer that includes • S scale linear and at least half axis (1) • L straight lines through points (1) • A axis labelled with crop production and year and correct way round (1)	bar chart lose L only No L for extrapolation  within one small square	6 exp

Question Number	Answer	Mark
9(a)(ii)	A description that makes reference to the following • wheat decreases to 2013/ eq and then increases (1) • barley constant and then increases to 2013 / eq (then fluctuates) (1)	2 grad

Question Number	Answer	Additional guidance	Mark
9(a)(iii)	percentage change in wheat $= 16\,100 - 15\,300 \div 15\,300$ $\times 100$ $= 5.23\%$ allow 5.2%/5%/eq (1) percentage change in barley $= 7\,300 - 5\,500 \div 5\,500$ $\times 100$ $= 32.73\%$ allow 32.7/ 33% barley greater (1)	allow one mark for greater change in barley allow 105% /eq allow 133% /eq allow one mark for each correct percentage	3 exp

Question Number	Answer	Additional guidance	Mark
9(b)	25 000 kg per 10 000 m² $25\,000 \div 10\,000$ $= 2.5$ kg per m² per year $2.5 \text{ kg} = 2500 \text{ g} \div 365$ $= 6.85 \text{ g}$	allow full credit for correct answer no working one mark for dividing by 365 or 365.25 allow 6.9 also allow for leap year $2500 / 365.25$ so 6.84 g allow 6.8g	2 exp

Total = 13 marks



Question Number	Answer	Additional guidance	Mark
5 (a)	it is a control (experiment) / to compare the results / check that change is due to the treatments / eq (1)	Allow see the difference / to see if any other factors affected the results / to see if there was a change without treatments / eq	1

Question Number	Answer	Additional guidance	Mark
5 (b)	- linear scales that use at least half grid (1) - both axes labelled (as months and number of ants) (1) - points plotted correctly (1) - points joined with straight lines (1) - key / lines labelled (1)	Ignore no treatment line Allow graph scales that use half grid with no treatment line +/- half square Bar chart loses line mark No line mark if extrapolated	5

Question Number	Answer	Additional guidance	Mark
5 (c)	A description that makes reference to two of the following: - decrease and an increase (1) - increases from 6 months (1)	Allow goes up from 12 months Allow decreases until 6 months	2

Question Number	Answer	Additional guidance	Mark
5 (d)	An answer that makes reference to five of the following: • with no treatment red fire ants increase (1) • both treatments / pesticide and pesticide + phorid flies reduce number of red fire ants (over first 6 months) / eq (1) • when using pesticides (alone) ants increase (later) / when using phorid flies ants do not increase / level off / eq (1) • when population is constant, reproduction rate equals death rate / predation / eq (1) • using (pesticides and) phorid flies / biological control lasts longer / is a long-term solution / only needs to be done once / eq (1) • phorid flies will breed / reproduce (for longer time) / eq (1) • pesticides wear off / wash off / stop working / eq (1) • fire ants mutate / eq (1) • (fire ants) become resistant (to the pesticides) / eq (1) • natural selection occurs / eq (1)	Allow refs to biological control for phorid flies and not biological control for pesticides Can piece together Allow pesticides reduce number in both treatments Allow survive and reproduce / pass allele on to next generation	5

(Total for Question 5 = 13 marks)

Question Number	Answer	additional guidance	Mark
9(a)	An explanation makes reference to two of the following points: • less (leaf) area / surface / fewer leaves / eq (1) • fewer chloroplasts / less chlorophyll /eq (1) • (less) photosynthesis / eq (1) • less carbohydrate / glucose / sugar / eq (1)	allow damages chloroplasts ignore no photosynthesis	2

Question Number	Answer	additional guidance	Mark
9(b)	An explanation makes reference to four of the following points: 1. lasts longer / does not need reapplication / eq (1) 2. specific / does not affect food chain / other organisms / eq (1) 3. no residue on crop / not eaten by humans / does not affect humans /eq (1) 4. no bioaccumulation / biomagnification / eq (1) 5. pest does not become resistant / eq (1)	allow converse ignore cheaper alone ignore immune	4

Question Number	Answer	Mark
9(c)(i)	An explanation that makes reference to three of the following points: 1. moth population rises (up to 6 months) / eq (1) 2. wasp population also rises as more moths / food is available / as eat moths / eq (1) 3. (from 6 months) moth population falls as eaten by wasp / eq (1) 4. wasp population falls as fewer moths to feed on / less food available / eq (1) 5. moth population recovers / repeats months / eq (1)	3

	Answer	additional guidance	Mark
9(c)(ii)	calculation method not marking points readings from graph 2150- 850 subtraction = 1300 (2)	full marks for correct answer no working allow 1 mark for one correct value 2150 or 850	2

Question Number	Answer	additional guidance	Mark
9(c)(iii)	An explanation that makes reference to two of the following points: • some moths remain / doesn't kill all moths / eq (1) • delay to act / kill moths / slower (than chemical) / eq (1) • numbers vary with time of year / seasons / eq (1) • wasps are expensive / eq (1) • wasps may become pest / may kill other organisms / may affect food chain / farmers may not want to leave wasps in their fields / may sting farmers / eq (1)	allow converse for chemical	2

total 13 marks

Question Number	Answer	additional guidance	Mark
4(a)(i)	- sucrose / sugars (1) - amino acids (1)	ignore glucose allow water / plant hormones / named plant hormone	2

Question Number	Answer	additional guidance	Mark
4(a)(ii)	An explanation that makes reference to three of the following - no /less respiration / no / less energy / eq (1) - no/ less protein / eq (1) - no / less growth / new cells / eq (1) - less fruit production / fewer oranges / smaller fruit / eq (1)	No credit for less sugar amino acid or glucose Ignore less crops / less yield	3

Question Number	Answer	additional guidance	Mark
4(b)(i)	An answer that makes reference to five of the following 1. reduce (quickly / steeply) after ladybug introduced / eq (1) 2. as the ladybugs feed on scale / pests /eq (1) 3. scale insects numbers go up and down / fluctuate / oscillate /eq (1) 4. some pests required for ladybugs to feed on / scale insects never completely wiped out / eq (1) 5. insecticide release causes (rapid) increase in scale insects / pests / eq (1) 6. as (more) ladybugs killed (than scales / pests) eq (1) 7. fewer scale insects are eaten / less predation / eq (1) 8. insecticide becomes less effective / disperses / ladybugs recover / ladybugs develop resistance / eq (1) 9. scale insects / pest numbers drop / eq (1) 10. ladybugs / biological control more effective than insecticide / kill more pests/ eq (1)		5

Question Number	Answer	Additional guidance	Mark
4(b) (ii)	An explanation makes reference to four of the following points: 1. lasts longer / does not need reapplication / eq (1) 2. specific / does not affect food chain / other organisms / eq (1) 3. no residue on crop / not eaten by humans / does not affect humans /eq (1) 4. no bioaccumulation / biomagnification / eq (1) 5. pest does not become resistant / eq (1)	allow converse ignore cheaper alone ignore pollution alone allow contaminate crops ignore immune	4

Question Number	Answer	Mark
7(a)(i)	S scale linear and uses at least half the grid (1) L line straight, neat and through points (1) A axes labelled 'mean height in mm' and 'time in weeks' (1) P points plotted correctly (1) K each line labelled with correct temperature (1)	5

Question Number	Answer	Mark
7(a)(ii)	An answer that makes reference to three of the following points: • higher temperatures produce more growth / faster growth / eq (1) • enzymes (1) • more kinetic energy (1) • more frequent collisions / enzyme substrate complexes form faster / eq (1) • faster respiration (1)	3

Question Number	Answer	Mark
7(a)(iii)	• (shell) height / growth of shell / (1)	1

Question Number	Answer	Mark
7(a)(iv)	• uses group / uses many / calculates mean / repeat / eq (1)	1

Question Number	Answer	Additional guidance	Mark
7(b)(i)	$1.2 - 0.3 = 0.9$ $0.9 \div 1.2 \times 100 = 75$ (2)	Award full marks for correct numerical answer without working Award one mark for 0.9 or 0.75 or $\div 1.2$	2

Question Number	Answer	Additional guidance	Mark
7(b)(ii)	An explanation that makes reference to the following points: - eat plants / producers (1) - cannot digest parts / (primary consumer) produces more faeces / more inedible parts / more waste egested (1)	Allow converse for secondary consumer for both MPs	2

Question Number	Answer	Additional guidance	Mark
7(c)	An explanation that makes reference to the following points: - more respiration / higher metabolic rate (1) - maintain body temperature / more movement / activity / eq (1) - heat loss / eq (1)	Allow converse for snail for all MPs	2

Total = 16 marks

Question Number	Answer	Mark
5 (a)(i)	An explanation that makes reference to two of the following: • <u>oxygen</u> is required (1) • for respiration (1)	2

Question Number	Answer	Additional guidance	Mark
5 (a)(ii)	An explanation that makes reference to two of the following: • to kill pathogens / other microorganisms / sterilises the fermenter / eq (1) • to prevent contamination (of the product) / competition (1) • steam condenses to water so does not affect product / taste/ flavour / eq (1)	Accept remove bacteria / eq Prevent bacterial contamination = 2 marks	2

Question Number	Answer	Additional guidance	Mark
5(b)(i)	A graph that includes: • S scales linear and at least half page and axes the correct way around (1) • A both axes labelled with units (1) • L straight lines joining points (1) • P points correctly plotted (1) • K key / labelled GM and non-GM (1)	Lose line mark for bar chart Units: time in days and mass in kg Ignore extrapolation to zero Plots +/- half square	5

Question Number	Answer	Additional guidance	Mark
5 (b)(ii)	An answer that makes reference to two of the following: • GM fungus grows faster up to 20 days / before day 30 / eq (1) • (but) over 30 days, the non-GM fungus produces a higher final yield / GM fungus starts to level off after 20 days / non-GM fungus produces more over longer time (1) • GM fungus is better if product is required in a shorter time / non-GM fungus is better if product is required after longer time period (1)	Accept converse for all MPs Accept GM produces more mass over first 20 days / produces more product in short time Accept at 30 days GM fungus produces less yield than non-GM / grows slower / non-GM has higher yield over last new days	2

Question Number	Answer	Additional guidance	Mark
5 (b)(iii)	An answer that makes reference to five of the following: <i>Yes because:</i> 1. there is less fat in mycoprotein (1) 2. there is less cholesterol in mycoprotein (1) 3. less risk of heart disease / obesity / eq (1) 4. there is more fibre in mycoprotein so less risk of constipation / moves through gut / gut / eq (1) 5. mycoprotein has more calcium for bones / teeth / eq (1) <i>No because:</i> 6. mycoprotein has less protein (1) 7. for growth / muscle growth / eq (1) 8. mycoprotein has less iron so may be a risk of anaemia / less haemoglobin / fewer red blood cells / eq (1)	Accept other protein functions	5

Total for Question 5 = 16 marks

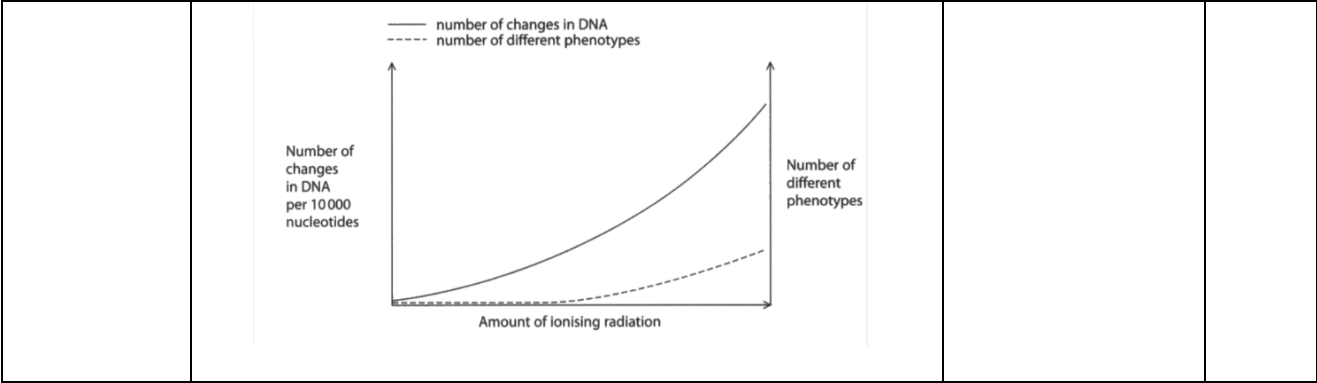
Question Number	Answer	Additional guidance	Mark
6(a)(i)	A description that makes reference to the following. - select plants with bright flowers <u>and</u> pollinate / breed / cross / eq (1) - select offspring (with bright flowers) and pollinate / breed / cross / repeat with offspring / eq (1)	Allow desired characteristics Allow breed two plants with bright flowers Allow repeat over several generations if mp1 has been awarded Ignore repeat if not about offspring / next generations	2

Question Number	Answer	Additional guidance	Mark
6(a)(ii)	A description that makes reference to three of the following. - take small samples / small tissue / few cells / scrape cells off / remove growth tips / eq (1) - sterilise / wash with ethanol / alcohol / disinfectant / antiseptic / eq (1) (place into) agar (1) - provide minerals / glucose / carbohydrates / amino acids / eq (1) - plant growth substances / auxin / rooting powder (1)	Allow any idea of small pieces of plant e.g. fragment Allow meristems Sterile agar = 2 marks Allow bleach Allow agarose Ignore nutrient Allow named minerals Allow sugar Allow hormones	3

Question Number	Answer	Additional guidance	Mark
6(b)(i)	An answer that makes reference to the following. all plants will be <u>genetically</u> identical / have same DNA / same <u>genetic</u> material / same genes / same alleles / eq (1)	Allow so they will be clones	1

Question Number	Answer	Mark
6(b)(ii)	The only correct answer is B (genome) <i>A is incorrect as all the DNA is not a gene</i> <i>C is incorrect as all the DNA is not a genotype</i> <i>D is incorrect as all the DNA is not a nucleoid</i>	1

Question Number	Answer	Additional guidance	Mark
6(b)(iii)	An answer that makes reference to four of the following. - more radiation increases the number of changes in DNA / genotypes and number of different phenotypes / eq (1) - mutations (have occurred in the DNA) (1) (mutations) change amino acid sequences / different protein / different enzyme / eq (1) - changes in DNA increases more / steeper (than number of different phenotypes) / changes in DNA occur with lower amount (of radiation) / eq (1) (some) DNA changes / mutations, have no effect / are silent / code for same amino acid / have similar amino acid / enzymes still work / proteins still work / eq (1) - DNA changes / mutations, may be recessive (so do not affect phenotype) / eq (1)	Allow increase number of mutations and number of phenotypes Allow positive correlation between DNA changes and phenotypes Ignore more rapid increase Allow converse Allow some mutations do not affect phenotype Allow mutations occur in non-coding DNA	4



(Total for Question 6 = 11 marks)

Question Number	Answer	additional guidance	Mark
9(a)	An explanation answer that makes reference to three of the following: - plants produce many more (seeds) / offspring / more yield / eq (1) - quicker to reach maturity / quicker to develop / shorter life cycle / eq (1) - plants can be self-pollinated / eq (1) - easier to control plants environment / eq (1)	allow converse allow grow fully not just reproduce quicker	3

Question Number	Answer	Additional guidance	Mark
9(b)	A description that makes reference to four of the following: - select / choose / mate breed bulls / fathers that produce daughters / have mothers/ sisters with highest milk yield / selecting for twins / eq (1) - select choose / mate breed cows / mothers that have highest milk yield / or from mothers / have sisters with highest milk yield / eq (1) - select choose / mate breed offspring (cows) that have highest milk yield of all (female) offspring / eq (1) - repeat for many generations /eq (1)	Ignore cattle allow male Inseminate allow female / cow	4

Question Number	Answer	Mark
9(c)(i)	An answer that makes reference to two of the following: • cows easier to manage / move around farm / milk / eq (1) • cows less likely to fight / harm farmer / harm other animals /eq (1) • cows less lightly to run around /eq(1) • more energy used in growth/ more milk production / more yield / eq (1)	2

Question Number	Answer	Mark
9(c)(ii)	A description that makes reference to four of the following: 1. produced by adrenal glands (1) 2. causes heart rate to increase /eq (1) 3. prepares body for fight / flight / fright / eq (1) 4. increases blood flow to muscles / blood diverted from intestines/eq (1) 5. increases breathing rate / depth / eq (1) 6. converts glycogen into glucose / increase blood glucose /increase blood sugar / eq (1) 7. pupils dilate / eq (1) 8. reactions are faster / eq (1)	4

Question Number	Answer	Additional guidance	Mark
9(c)(iii)	A description that makes reference to three of the following: - allows <u>diffusion</u> (1) - provides oxygen / glucose / amino acids / nutrients / vitamins / minerals /eq/(1) - provides antibodies (1) - removes of carbon dioxide / urea / eq (1) - secretes hormones / progesterone / eq (1)	Must indicate direction named vitamin / mineral ignore food alone Must indicate direction ignore waste allow oestrogen	3

Total 16 marks

Question Number	Answer	additional guidance	Mark
1(a)	so semen contained sperm / (bull is) (sexually) mature / sperm in semen / gone through puberty / fully developed / eq	accept converse ignore cannot produce semen	1 grad

Question Number	Answer	additional guidance	Mark
1(b)	An explanation that includes two of the following points - collect semen / sperm from penis of bull (1) - insert straw into / inject semen (into cow) (1) - put (it / semen / sperm) in vagina / uterus /womb /cervix(1)	semen injected into uterus scores m2 and mp3	2 exp

Question Number	Answer	additional guidance	Mark
1(c)(i)	preserve (sperm) / keep (sperm) alive / viable / prevent growth of microorganisms / slow down metabolism / eq	allow last longer ignore denatured	1 grad

Question Number	Answer	Mark
1(c)(ii)	provide females (produce milk) / will produce cows / eq	1 grad

Question Number	Answer	Additional guidance	Mark
1(d)	• $500\,000 \div 2.4 \text{ million} = 0.2083$ • $0.2083 \times 100 = \mathbf{20.83\% / 21.0\% / 20.8\%}$	award full marks for correct numerical answer without working allow 1 mark for $\div 2.4$ million	2 grad

Question Number	Answer	Mark
1(e)	A description that makes reference to three of the following points • use semen (from each bull) to fertilise (many / similar) cows (1) • collect / measure milk yields / eq (1) • from each daughter / offspring of these cows / mother of bull (1) • select bull with highest (average) milk yield (across all daughters) (1)	3 exp

Question Number	Answer	Mark
1(f)	An explanation that makes reference to two of the following points: • (milk that contains) (most) fat (1) • (most) protein (1) • (most) vitamins (1) • (milk that contains) (most) calcium (1)	2 exp

Question Number	Answer	additional guidance	Mark
1(g)(i)	A description that makes reference to four of the following points: - nucleus from (body) cell of bull (1) - insert this nucleus into enucleated egg cell (1) - electric shock (1) - mitosis / cell division (1) <u>embryo</u> into uterus / womb (1) - surrogate mother (1)	reject from udder reject egg cell from bull	4 exp

Question Number	Answer	Mark
1(g)(ii)	An explanation that makes reference to two of the following points genetically identical / no genetic variation / same (combination of) alleles (1) - quicker process (1)	2 exp

Total =18 marks

Question Number	Answer	Additional guidance	Mark
9(a)	A description that includes : 1. restriction enzyme (1) 2. cuts DNA from donor / cuts / cuts / opens plasmid / cuts gene / cuts genetic material / produces sticky ends / complementary bases / eq (1) 3. ligase (1) 4. join / insert / stick DNA together / eq (1)	If function does not match enzyme - can award one mark (for either enzyme or function)	4

Question Number	Answer	Additional guidance	Mark
9(b)	An answer that makes reference to two of the following: • GM uses foreign DNA / from other species / transgenic / eq (1) • GM quicker / fewer generations /eq (1) • GM involves asexual / clones / eq (1) • GM uses enzymes / plasmids / vectors / eq (1)	allow converse selection uses same species slower uses sexual reproduction / crossing / pollination/ fertilisation /eq	2

Question Number	Answer	Mark
2(a)	C plasmid <i>A is incorrect because it is not the cell wall</i> <i>B is incorrect because it is not the nucleoid</i> <i>D is incorrect because it is not RNA</i>	1 comp

Question Number	Answer	Additional guidance	Mark
2(b)	An answer that makes reference to three of the following points: • insulin / glucagon (1) • steam / hot water (1) • competition / contamination / eq (1) • mix / stir / agitate / distribute / eq (1) • oxygen / O₂ (1) • temperature (1)	Allow disinfectant / bleach / sterilising fluid / alcohol / ethanol Allow infection	6 grad

Total 7 marks

Question Number	Answer	Mark
6 (a)(i)	An explanation that makes reference to the following points • (transfer of a) gene / allele / DNA (1) • from a different species / eq (1)	2

Question Number	Answer	Mark
6 (a)(ii)	An answer that makes reference to the following points • restriction enzyme / endonuclease cuts DNA / gene / allele (1) • ligase joins DNA / gene / allele / plasmid (1)	2

Question Number	Answer	Mark
6 (b)	An answer that makes reference to four of the following points Points in favour of GM crops: • less insecticide / pesticide used (1) • less bioaccumulation of pesticides / less evolution of resistance to pesticides / no pesticide remaining in soil / eq (1) • pest resistant crops do not affect non-target species / pollinators (1) • weedkiller kills weeds but not (GM) crops / easier to remove weeds / eq (1) • less spread of viruses to other species / crops / eq (1) Points against GM: • gene transfer to other species / (cross) pollinate with other species / eq (1) • outcompete native species / affect food chains / eq (1) • reduction in insect populations (1) • requires herbicide use / more use of herbicides (1)	4

Total = 8 marks

Question Number	Answer	Additional guidance	Mark
11 (a)	A description that makes reference to the following points: - restriction enzymes cut out (protease) gene / cut plasmid / cut DNA (1) - ligase joins / combine / glue (protease) gene plasmid / DNA (1)		2

Question Number	Answer	Additional guidance	Mark
11 (b)	An answer that makes reference to the following points: - C: range of at least three temperatures / use a wide range of temperatures (1) - O: same concentration of enzyme / mass of washing powder / type of washing powder / type of enzyme / eq (1) - R: repeats (1) - M1: measure area / size of stain / mass of stain / colour of stain / mass of protein / eq (1) - M2: stated time period (1) - S1 same pH / water volume / washing movements / same type of material / clothing / size of material / eq (1) - S2 same mass of protein / area of protein / type of protein stain / same blood / same named protein / eq (1)	Allow amount of washing powder Ignore amount of stain Allow M1 and M2 for time taken to remove stain (2 marks) Allow times between 10 minutes and 24 hours Allow same concentration of stain	6

(Total for Question 11 = 8 marks)

Question Number	Answer	Additional guidance	Mark
4(a)	An explanation that makes reference to the following points: • amino acids (1) • protein / enzymes (1) • DNA / RNA / ATP / chlorophyll / (1)	Nitrate contains amino acids / protein = 0 Ignore chloroplasts	2

Question Number	Answer	Mark
4(b)	A small and soluble <i>B is incorrect because mineral ions are not insoluble</i> <i>C is incorrect because mineral ions are not large</i> <i>D is incorrect because mineral ions are not large and insoluble</i>	1

Question Number	Answer	Additional guidance	Mark
4(c)(i)	An answer that makes reference to the following points: • fewer plants / fewer algae / less eutrophication (1) • (more) light and (more) photosynthesis (1) • (less) <u>decomposition</u> / <u>decomposed</u> / <u>decomposers</u> (1) • (more) oxygen / not anoxic / less BOD (1) • respiration (ONCE) (1) • (catch) more fish / fewer fish killed / better catch / fish survive / fish do not suffocate / eq (1)	Allow converse for all Mps	4

Question Number	Answer	Additional guidance	Mark
4(c)(ii)	A description that makes reference to the following points: • restriction to (cut / eq) DNA / gene / allele / plasmid (1) • ligase to (join / eq) DNA / gene / allele / plasmid (1)	Allow restrictive	2

Total 9 marks



Question Number	Answer	Mark
5(a)	A description that makes reference to three of the following points: • (same) restriction enzyme to cut / remove / open /eq (1) • plasmid / vector <u>and</u> target gene / gene for making poison / eq (1) • ligase enzyme to join / stick / insert /eq (1) • complementary shapes / sticky ends /eq (1)	3 exp



Question Number	Answer	additional guidance	Mark
5(b)	An answer that makes reference to six of the following points: Good decision to use GM: • GM plants are specific / kill specific insects / pesticides kill other insects / plants / pesticide kills non-specific insects (1) • GM plants reduce need for pesticide (1) • pesticide needs reapplication / do not last long (1) • insects can become resistant to pesticide (1) • pesticides can enter food chains / bioaccumulation (1) • pesticides can lead to health problems / affect human health / eq (1) eg: organophosphates and nervous system Poor decision to use GM: • pesticides are quick to kill (1) • GM plants could result in cross pollination of other species (1) • GM pollen may kill insect pollinators (1) • insects may develop resistance to poison produced by GM crops (1) • customers may not buy GM crops (1) • patents mean farmers become dependent on companies for their seed (1)	ignore harmful unqualified pollution allow poisons humans	6 exp

Total 9 marks



Question Number	Answer	Mark
2(a)	D pancreas <i>A is not correct as the brain does not produce insulin</i> <i>B is not correct as the liver does not produce insulin</i> <i>C is not correct as the ovary does not produce insulin</i>	1

Question Number	Answer	Mark
2(b)	A description that makes reference to the following points: • lower blood glucose / converts blood glucose 1) • to glycogen (1) • (stored in) in muscles / liver (1)	2

Question Number	Answer	Mark
2(c)	B cow insulin acts as an antigen <i>A is not correct as it does not act as an antibody</i> <i>C is not correct as it is not due molecule size</i> <i>D is not correct as it is not a pathogen</i>	1

Question Number	Answer	additional guidance	Mark
2(d)	A description that makes reference to three of the following points: • human gene / allele / DNA (for insulin) gene from pancreas (1) • (cut with) restriction enzyme (1) • (join with) ligase (1) • vector / plasmid (1)	not just gene so gene for insulin or human gene or gene from pancreas ok	3

Question Number	Answer	Mark
2(e)	An explanation that makes reference to three of the following points: • aseptic conditions / sterilise /eq (1) • remove / kill other pathogens / bacteria /eq (1) • reduce <u>competition</u> (1) • reduce <u>contamination</u> (1) • cools to water / does not leave residue /eq (1)	3

Total 10 marks



Question Number	Answer	additional guidance	Mark
9(a)	An explanation that includes four of the following points • restriction enzyme used to cut gene / DNA / gene coding for (production of human) insulin / eq (1) • (same) restriction enzyme to cut bacterial plasmid (1) • (to produce) complementary pairings / sticky ends / eq (1) • ligase enzyme used to join / insert gene / DNA into plasmid (1) • plasmid / vector inserted into / taken up by bacterium (1)	insulin gene / insulin DNA	4

Question Number	Answer	additional guidance	Mark
9(b)	An explanation that makes reference to two of the following • causes liver / muscles to take up blood glucose or (convert) glucose to glycogen / eq (1) • when blood glucose _ concentration/ blood glucose / increases / is high / eq (1) • reduces blood glucose /eq (1)	not breaks down glucose to glycogen allow blood sugar allow blood sugar ignore controls glucose	2

Question Number	Answer	Additional guidance	Mark
9(c)(i)	An explanation that makes reference to the following - insulin is a protein / eq (1) - digested / broken down / eq (1) - by protease / pepsin / trypsin / in stomach / in small intestine / into amino acids / eq (1)	allow denatured in stomach for mp 2 and mp 3	2

Question Number	Answer	Mark
9(c)(ii)	(exercise) uses glucose / (exercise) increases glucose use / (exercise) increases sugar use / (exercise) reduces (blood) glucose / reduces (blood) sugar / (blood) glucose / sugar might get too low / become hypoglycaemic /eq (1)	1

Question Number	Answer	Additional guidance	Mark
9(c)(iii)	control / limit the carbohydrates / sugars / glucose in their diet / eq (1)	allow replace sugar with starch / eq	1

Total 10 marks

Question Number	Answer	Additional guidance	Mark
4 (a)	An explanation that makes reference to two of the following: - plants will be <u>genetically</u> identical / same <u>genes</u> / will all have the <u>gene</u> / same DNA / eq (1) <u>all</u> have same (saturated) fat / <u>all</u> have less (saturated) fat / eq (1) (only one plant was made) and there were no others to breed with / eq (1) - no need to repeat genetic modification / eq (1) - fast method (to produce many) / can be produced any time of year / eq (1)	Allow no genetic variation Allow they are clones	2

Question Number	Answer	Additional guidance	Mark
4(b)(i)	A description that makes reference to four of the following: - weigh beans / same mass of beans / (calculate) per gram of food / eq (1) - same volume of water / measure volume / same mass of water / stated volume of water / eq (1) - ignite bean / set fire, <u>and</u> hold under test tube / water / heat water / eq (1) - keep igniting until will no longer burn / burnt completely / eq (1) - measure temperature rise / start and end temp / start and highest temp / change in temp / eq (1) - repeats (1)	Ignore amount Ignore amount Allow hold bean at same distance from test tube If formula given, allow mp1, mp2 and mp5	4

Question Number	Answer	Additional guidance	Mark
4 (b)(ii)	An explanation that makes reference to one of the following: • wear eye protection / gloves / eq (1) • wear lab coat / tie back long hair / eq (1) • use a heat proof tile / place on safety flame when not using / use tongs / clamp test tube in stand / eq (1)		1

Question Number	Answer	Additional guidance	Mark
4 (b)(iii)	An explanation that makes reference to four of the following: - oxygen supply / oxygen gas inlet (1) - to ensure complete combustion / so burns fully / eq (1) OR - insulated coat / lid / insulation / eq (1) - to prevent heat loss / keep heat in / not affected by outside temp / eq (1) OR - stirrer / eq (1) - to provide even temperature / spreads heat around / eq (1) OR - large(r) volume of water / smaller surface area : volume ratio of water (1) - so less heat loss / eq (1) OR - burnt using ignition coil / ignition in the equipment / no need to move the burning bean / no need to relight / eq (1) - so less heat is lost / eq (1) OR - placed inside a steel container (1) - conducts / transfers heat to water / eq (1) OR - sample is surrounded by the water (1) - so more heat transferred to water / less heat lost / eq (1)	Mark in pairs Allow energy loss for heat loss throughout insulated coat and ignition coil in equipment reduces heat loss = 4 marks Allow lit inside the container	4

Total 11 marks

Question Number	Answer		Mark
9(a)(i)	An answer that makes reference to the following. (transfer of) genes / alleles / DNA between different <u>species</u> (1)	Allow (organism) with gene / allele / DNA from different <u>species</u> Ignore genetic modification alone Ignore organism	1

Question Number	Answer	Additional guidance	Mark
9 (a)(ii)	An answer that makes reference to two of the following. (herbicides) kills / removes, weeds but not crops / eq (1) - less competition / eq (1) - so increased yield / more (crop) growth / eq (1) - no need to remove weeds by hand / eq (1)	Allow (herbicide) <u>only</u> affects / kills, weeds / unwanted plants	2

Question Number	Answer	Additional guidance	Mark
9 (b) (i)	RR, Rr, (rR) (1)	Reject if rr included Allow other letters but not two different letters Allow 'homozygous dominant and heterozygous'	1

Question Number	Answer		Mark
9 (b)(ii)	An answer that makes reference to the following. - parents as Rr and rr (1) - gametes as R or r and r (or r) (1) - genotypes and stated phenotypes of Rr and rr AND non-resistant and resistant (1)	Allow other letters but not two different letters ECF for one mark only for gametes Allow all marks from Punnett square	3

Question Number	Answer	Additional guidance	Mark
9 (b)(iii)	0.5 / ½ / 50 % (1)	Allow 2/4	1

Question Number	Answer		Mark
9 (b)(iv)	An explanation that makes reference to four of the following. • mutation (produces resistance) / eq (1) • (produces) variation (1) • (weeds with gene) survive / eq (1) • reproduce / pollinate / eq (1) • pass on the allele / gene / mutation / eq (1)	Allow converse Allow correct ref to selection pressure / selective advantage Allow pass on allele to next generation for mp4 and mp5	4

Question Number	Answer	Additional guidance	Mark
9 (b)(v)	An explanation that makes reference to two of the following. - dominant alleles always expressed / expressed in heterozygotes OR recessive alleles only expressed when homozygous / not expressed in heterozygotes / eq (1) - if resistance is recessive, only homozygous (recessive) plants survive / no heterozygous plants survive / eq (1) - if resistance is dominant, heterozygous plants survive / eq (1) (when resistance is dominant) if two heterozygotes breed, non-resistant weeds produced / some homozygous recessive plants produced / eq (1)	Allow recessive alleles are not always shown (in phenotype) Allow no plants with dominant alleles survive Allow some plants carrying recessive alleles will survive / carriers survive Allow carriers for heterozygotes Allow both parents can pass on a recessive allele	2

(Total for Question 9 = 14 marks)

Question Number	Answer	Additional guidance	Mark
8(a)(i)	transgenic (1)		1

Question Number	Answer	Additional guidance	Mark
8(a)(ii)	A description that makes reference to three of the following: - plasmid (is used) (1) - restriction enzyme cuts gene / DNA / plasmid / eq (1) - ligase joins plasmid and gene / joins DNA / eq (1) - forming a <u>recombinant plasmid</u> / forming <u>recombinant DNA</u> / eq (1)	Accept viral vector Ignore restrictive / restricting enzyme Accept inserts / sticks for joins Accept lygase Reject lipase	3

Question Number	Answer	Additional guidance	Mark
8(b)(i)	An answer that makes reference to two of the following: - less night blindness / fewer eye problems / better vision / eq (1) - rice is a common food / part of many diets / common crop / cheap (for consumers) to buy / eq (1) - cheap to grow / easy to grow / easy to get large yields / eq (1) - less health care needed / less damage to economy / eq (1)	Reject scurvy / rickets / anaemia Accept rice is a staple food Accept (often) part of daily diet	2

Question Number	Answer	Additional guidance	Mark
8(b)(ii)	An answer that makes reference to two of the following: • (may grow in wild and) affect food chains / food webs / ecosystems / eq (1) • may <u>compete</u> with other species (in wild) / eq (1) • may interbreed with wild plants / genes may transfer into wild plants / eq (1) • people may think they are a risk to health / eq (1) • may be better to give people a more balanced diet / should use natural sources of carotene / eq (1)	Ignore ethical issues / playing God Accept <u>competition</u> with other species Accept may alter genes present in wild species Accept worried about side effects	2

Question Number	Answer	Additional guidance	Mark
8(c)(i)	An explanation that makes reference to four of the following: - all species decrease / eq (1) - insects increase after 3 months / from 6 months / eq (1) - beetles increase after 9 months / from 12 months / eq (1) - lizard numbers do not recover / stay low / do not increase / level off after 9 months / eq (1) - pesticide washes away / breaks down / eq (1) - pesticide passes along food chain to beetles / to lizards / eq (1) <u>insects</u> become <u>resistant</u> / eq (1) - insects increase as there are fewer beetles eating them / beetles decrease as few insects to eat / lizards decrease as few beetles to eat / eq (1) - insects have short life cycles / lizards have long life cycle / eq (1)	Accept pieced together Accept biomagnification occurs / bioaccumulation occurs Ignore immune Accept food for species being eaten Accept lizards drop / do not recover as less food / fewer beetles to eat Accept beetles increase when more insects to eat Accept beetles increase when few lizards to eat them Accept lizards reproduce slowly / lizards produce few offspring Accept insects reproduce quickly / produce many offspring	4

Question Number	Answer	Additional guidance	Mark
8(c)(ii)	An answer that makes reference to two of the following: • (biological is) more specific / does not kill other species / eq (1) • (biological is) not toxic to humans / no residue left on plants / crops / eq (1) • (biological is) no development of resistance / eq (1) • (biological) lasts longer / no need to keep reapplying / eq (1) • no bioaccumulation / no biomagnification / does not pass along food chains / eq (1)	Accept converse for pesticides for all mps Accept does not kill pollinators Accept not absorbed by plants Ignore immune Accept only need to apply once	2

(Total for Question 8 = 14 marks)

Question Number	Answer	Additional guidance	Mark
7(a)(i)	An answer that makes reference to one of the following: - bleach / hypochlorite / disinfectant / antiseptic / chlorine (1) - alcohol / ethanol (1) - radiation / uv / gamma rays / X-rays (1)	Reject boil / steam or any method that kills cells Reject acid / alkali / anti-bacterial wash / antibiotic / sterilising solution Boiling in ethanol = 0	1

Question Number	Answer	Additional guidance	Mark
7(a)(ii)	An answer that makes reference to one of the following: - nitrate / ammonium / magnesium / calcium / sulphate / potassium / phosphate / iron (1) - amino acids (1) - sucrose / glucose / fructose / sugar / starch (1)	Ignore water / phosphorus / nitrogen / mineral ions	1

Question Number	Answer	Additional guidance	Mark
7(b)	An explanation answer that makes reference to two of the following points: - cells are differentiated / specialised / can only form one cell type / cells unable to differentiate / specialise / form other cell types (1) - no / fewer stem cells (1) - stem cells found in embryo / bone marrow / umbilical cord (1)	Ignore references to plant tissue	2

Total 4 marks

Question Number	Answer	Mark
7	• explants • microorganisms / microbes / fungi / bacteria / pathogens / eq • sugar / named sugar / glucose / sucrose / starch / eq • clones • sexual • all / throughout/ during / through / anytime	6 ignore carbohydrate

Total = 6 marks



Question Number	Answer	Mark
4(a)(i)	nucleus removed / without nucleus	1

Question Number	Answer	Additional guidance	Mark
4(a)(ii)	A description that makes reference to two of the following points: - divides (many times) / produces ball of cells / cell division occurs (1) - by mitosis (1) - cells differentiate / specialise (1)	divides by mitosis = 2 marks	2

Question Number	Answer	Additional guidance	Mark
4(b)	An answer that makes reference to four of the following points: Against fetal: - same number of offspring produced with each body cell (1) - fewer pregnancies with fetal cells / lower proportion of pregnancies with fetal cells (1) - fewer surrogates used for fetal cells (1) 52% successful pregnancies / 29 % successful pregnancies (1) For fetal: - offspring from fetal cells are healthy / fetal cells produce more healthy offspring/ eq (1) Conclusion:	Allow both produce two offspring Allow converse for adult cells Allow converse for adult cells Allow other correct decimals Allow offspring from fetal cells survive longer / are not short lived / the two offspring from fetal cells survived	4

	fetal cells are more successful (for cloning) / fetal should be used (1)		
--	--	--	--

Total 7 marks



Question Number	Answer		Mark
5	An answer that makes includes the following: • nucleus (1) • egg / oocyte / ovum (1) • nucleus (1) • divide (1) • embryo (1) • uterus / womb (1) • surrogate (1)	Reject ovule Accept multiply	7

Question Number	Answer	Additional guidance	Mark
3(a)	$1 \text{ rhino} = 100 - 99.95 = 0.05\%$ $1.0\% = 1 \div 0.05 = 20$ $100\% = 1/0.05 \times 100$ 20×100 $= 2000 \text{ (3)}$	award full marks for correct numerical answer without working allow one mark for 0.05 and allow one mark for 20	3

Question Number	Answer	Additional guidance	Mark
3(b)	An answer that makes reference to three of the following points: - not all eggs survive / some die / some are not viable / do not accept nucleus / do not fuse / not all eggs divide / differentiate (1) - not all embryos implant / survive (1)	ignore reference to fertilisation	2

Question Number	Answer	Mark
3(c)(i)	sperm / sperm cell / spermatazoa / spermatazoon	1

Question Number	Answer	Mark
3(c)(ii)	An explanation that makes reference to four of the following points: (cell) division / mitosis (1) - place embryo in uterus (1) - surrogate mother (1) - Southern white rhino (1) - Northern white rhino too old (1)	4

Total 9 marks

Question Number	Answer	Mark
5(a)	277×50 13 850 (1)	1

Question Number	Answer	Mark
5(b)	An answer that makes reference to five of the following points - nucleus from (body) / adult / diploid cell of male dog (1) - insert (this) nucleus into enucleated / empty egg cell/eq (1) - electric shock (1) - mitosis / cell division (1) <u>embryo</u> into uterus / womb (1) - surrogate mother (1)	5

Question Number	Answer	Mark
5(c)	An answer that makes reference to four of the following points For cloning - can produce genetically identical pet / reduced genetic variation/ eq (1) - may have similar appearance / features to pet / eq (1) - can be cloned before death / may stop owner grieving / eq (1) Against - expensive / eq (1) - pet may behave different due to environment / training / eq (1) - many dogs used / die in attempt / dog farming / unethical / eq (1) - shorter life span (1) - idea of reduce variation within breed/ inbreeding idea bad for breed health / eq (1)	4

Total 10 marks

Question Number	Answer	Additional guidance	Mark
4(a)	An explanation that makes reference to the following points: • diploid (1) • egg (cell) / ovum (1) • (electric) shock / shock (1) • mitosis (1) • uterus / womb (1)	Accept 2n Reject mei... e.g. meiosis/ Accept mytosis Ignore endometrium	5

Question Number	Answer	Additional guidance	Mark
4(b)	An answer that makes reference to five of the following points: 1. most embryos made with cattle / fewest embryos made with goats / eq (1) 2. low success rate / few live births / few survive / pets usually live longer than two years / low life expectancy / eq (1) 3. cattle have highest survival rate (from live births) / goats have lowest survival rates (from live births) / eq (1) 4. goats have highest live birth rate / cattle have lowest live birth rate (1) 5. credit <u>manipulated</u> data (1) 6. cloning is expensive / not cost effective / more cost than buying a new pet / eq (1) 7. cloned pets are <u>genetically</u> identical / little <u>genetic</u> variation / could pass on harmful alleles / eq (1) 8. some variation is environmental / not all variation is genetic / some features of pets will not be same / eq (1) 9. no data for pets / pets may be different to farm animals / needs to be repeated for pets / eq (1) 10. raises ethical issues / may not be ethical / eq (1) 11. pet cloning could provide emotional benefits for people / eq (1)	Accept many attempts with cattle / few attempts with goats Accept most eggs / clones / embryos are wasted / very wasteful process Accept goats have highest (overall) survival rate (from embryos) / sheep have lowest (overall) survival rate (from embryos) Accept calculated percentages / fractions / ratios Accept not everyone can afford it Accept harmful genes would be the same in clones Accept behaviour / learning of pets may be different Accept may not be seen as moral	5

(Total for Question 4 = 10 marks)

Question Number	Answer	Mark
2(a)(i)	An answer that makes reference to the following points: • prevent loss of blood / stops bleeding (1) • prevent entry of pathogens / microbes / bacteria / viruses / fungi / eq / prevent infections (1)	2 grad

Question Number	Answer	Mark
2(a)(ii)	An answer that makes reference to the following point: • graph showing drop at 37 °C then increase	1 grad

Question Number	Answer	Mark
2(b)(i)	An explanation that makes reference to the following points: • (have been given) genetic material / gene / allele / DNA / genetically alter (1) • from human / different species (1)	2 grad

Question Number	Answer	Additional guidance	Mark
2(b)(ii)	An answer that makes reference to six of the following points: • use enucleated egg / empty egg / remove nucleus from egg / eq (1) • nucleus from body cell / diploid nucleus (placed into empty egg) / fuse adult cell with empty egg (1) • use of electricity / shock (1) • cell division / mitosis (1) • embryo (1) • uterus / womb (1) • surrogate mother (1)	Ignore DNA	6 exp

Total 11 marks

Question Number	Answer	Mark
3(a)	in glass / in test tube / in (Petri) dish (1)	1

Question Number	Answer	Mark
3(b)(i)	An explanation that makes reference to two of the following points: - increases up to pH 6 and decreases above pH 6 (1) - enzymes (1) <u>optimum pH</u> is 6 / (enzymes) denature at high / low pH / eq (1)	2

Question Number	Answer	Additional guidance	Mark
3(b)(ii)	A description that makes reference to five of the following points: - use forceps / scalpel / knife / eq to remove explants / pieces from plant (1) - wash in bleach / hypochlorite / ethanol / alcohol / sterile wipes / eq (1) (grow on) agar (1) - nutrients / minerals / carbohydrates / amino acids / named mineral / eq / growth factors / hormones (1) - add acid / alkali / buffer (1) - use several / multiple explants / repeat (1) - control temperature / carbon dioxide / light (1) - sterile agar / sterile tubes (1) - same age plant / same plant / same size of explants / eq (1) - count number of shoots after same / stated time (1)	Ignore sterilised alone Allow rooting powder Allow sterile cotton wool / Allow disinfected / ensure sterile conditions / sterilise equipment Allow roots	6

Question Number	Answer	Mark
3(c)	An answer that makes reference to two of the following points: - lots produced (1) - genetically identical / no variation / all same type / identical / same characteristics / guaranteed plant / they are clones (1) - can grow GM plants / eq (1) - faster / quicker (1) - any time of year (1) - can be used for plants that are hard to germinate / grow from seed (1)	2

Total 11 marks

Question Number	Answer	Additional guidance	Mark
5(a)	Calculation steps not mark points Full marks for correct answer $(317 \div 3374) \times 100$ $= 9.40(2)$	If answer incorrect allow one mark for $\div 3374$ Or 9.39 = 1 mark rounding error Allow 2 marks for 9.395 9.3954 etc	2

Question Number	Answer	Mark
5(b)	A description that makes reference to four of the following points: • use enucleated egg / empty egg / remove nucleus from egg / eq (1) • nucleus from body cell / diploid nucleus placed into empty egg / eq (1) • use of electricity / shock (1) • cell division / mitosis (1) • embryo into uterus / womb (1) • surrogate mother (1)	4

Question Number	Answer	Mark
5(c)	An explanation that makes reference to two of the following points: • fewer white blood cells / phagocytes / lymphocytes / memory cells / eq (1) • fewer antibodies produced / antibodies produced slower / less phagocytosis / less engulfing / eq (1) • less resistance / more susceptible to infection / disease / pathogen not killed / pathogen remains / eq (1)	2

Question Number	Answer	additional guidance	Mark
5(d)	An answer description that makes reference to four of the following 1. small study few cows involved /eq (1) 2. not repeated / not reliable / no information on strain / breed /type only females / only cows / eq (1) 3. higher birth mass in clones /eq (1) 4. older at puberty in clones / puberty later in clones / eq (1) 5. higher mass at puberty in clones /eq (1) 6. small difference / slight difference in growth rate / no significant difference in growth rate / slightly lower daily mass increase / eq (1) 7. no reference to diet / hormones / supplements / eq (1)	Allow converse for controls Not just higher mass Lower birth mass in controls younger / sooner lower mass at puberty slightly faster growth	4

Question Number	Answer	Mark
1(a)	in a test tube / culture dish / jar / glass / petri dish / container / in culture solution / in a lab / outside a living organism / eq (1)	1

Question Number	Answer	additional guidance	Mark
1(b)	An explanation that makes reference to the following points: - plant cells can differentiate / eq (1) - into all / different types / kinds of tissues or cells / specialised cells eq (1) - throughout the plants life / eq (1) - can form / regenerate (whole) new plant / eq(1)	allow converse for human cells only stem cells can only embryonic	2

Question Number	Answer	additional guidance	Mark
1(c)	An explanation that makes reference to the following points: • mineral 1 (1) • function (1) • mineral 2 (1) • function (1)	allow for eg named minerals to get function mineral must match no mineral no function not just for growth nitrate amino acids / proteins / DNA/ nucleic acids /eq Magnesium chlorophyll / chloroplasts / photosynthesis Phosphate ATP / DNA / RNA / nucleic acids / cell membranes/ eq Calcium cell wall / cell membranes / eq Potassium stomatal opening / eq allow other correct mineral ions ignore nitrogen / nitrites / phosphorous /	4

Question Number	Answer	additional guidance	Mark
1(d)	An explanation that makes reference to two of the following points: • <u>enzyme</u> affected by pH / by acid / by alkali / works best at optimum (1) • shape of active site changed / substrate can no longer bind / fit / eq (1) • <u>enzyme</u> / <u>active site</u> denatured (1)	to score mp 1 must mention enzymes somewhere in answer	2

Question Number	Answer	additional guidance	Mark
1(e)	A description that makes includes three of the following points: • (shoot) in light from one side / unidirectional light / eq (1) • (shoot) in darkness / light all around / light from other side / eq (1) • leave for both for stated time / use shoots of same type / same temperature / same water / other control variable / eq (1) • description of bending or growing towards light or measure angle / look at curve / bending / eq (1)	allow leave for a few days	3

Question Number	Answer	additional guidance	Mark
1(f)	An answer that makes reference to two of the following points: • maintain biodiversity / reduce damage to food chains / ecosystems / eq (1) • prevent extinction (1) • keep (species / varieties / genotypes) for future generations / future use / eq (1) • in case climate changes / eq (1) • for medicinal properties / eq	ignore increase biodiversity	2

Question Number	Answer	Mark
1(g)	An explanation that makes reference to three of the following points: • (agitation) to mix contents / mix media / mix oxygen / mix carbon dioxide (with plant cells) / substrates with plant cells / take up minerals / take up nutrients / eq (1) • (light) for photosynthesis / eq (1) • (suitable temperature) for enzyme action / eq (1)	3

Total = 17 marks