Questions

Q1.

Penicillin, isolated from a fungus, was the first antibiotic used to treat bacterial infections and is still widely used today

Scientists have genetically engineered bacteria to produce large amounts of penicillin.

Describe how scientists would produce a genetically modified bacterium that produces penicillin.

(4)

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(Total for question = 4 marks)

Q2.

Figure 2 shows some information about two types of cattle.

type of cattle	survival in high temperatures	meat quality
Brahman	good	poor
Shorthorn	poor	good

Figure 2

Describe how these types of cattle could be selectively bred to produce cattle that can survive high temperatures and have good meat quality.

(2)

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(Total for question = 2 marks)

Q3.

The population of humans on Earth has increased significantly, leading to food shortages.

The growth of drought-resistant crop plants could lead to an increase in food supply.

Describe how drought-resistant crop plants can be produced.

(3)

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(Total for question = 3 marks)

Q4.

Describe how racehorses alive today have been selectively bred to run faster.

(3)

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(Total for question = 3 marks)

Q5.

A scientist was trying to produce plants that are tolerant to acidic soil.
The scientist has 100 plant seeds.

(i) Describe the method the scientist could use to grow plants from these seeds that are tolerant to low levels of acid in the soil.

(2)

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(ii) The scientist wants to use these plants in a selective breeding programme to produce plants that could grow in higher levels of acid.

Describe how the scientist could use these plants in a selective breeding programme.

(2)

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(iii) Explain one benefit of producing food crops that can be grown in acidic soil.

(2)

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(Total for question = 6 marks)

Q6.

Human growth hormone (hGH) can be used as a medical treatment.

Before 1980, hGH was extracted from the pituitary glands of humans after they had died.

Since 1980, hGH can be produced by bacteria that have been genetically modified.

(i) Describe the advantages of producing hGH using genetically modified bacteria.

(2)

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Answer the question with a cross in the box you think is correct ☒ . If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒ .

(ii) Figure 4 shows a percentile growth chart for the height of girls aged 2 – 20.

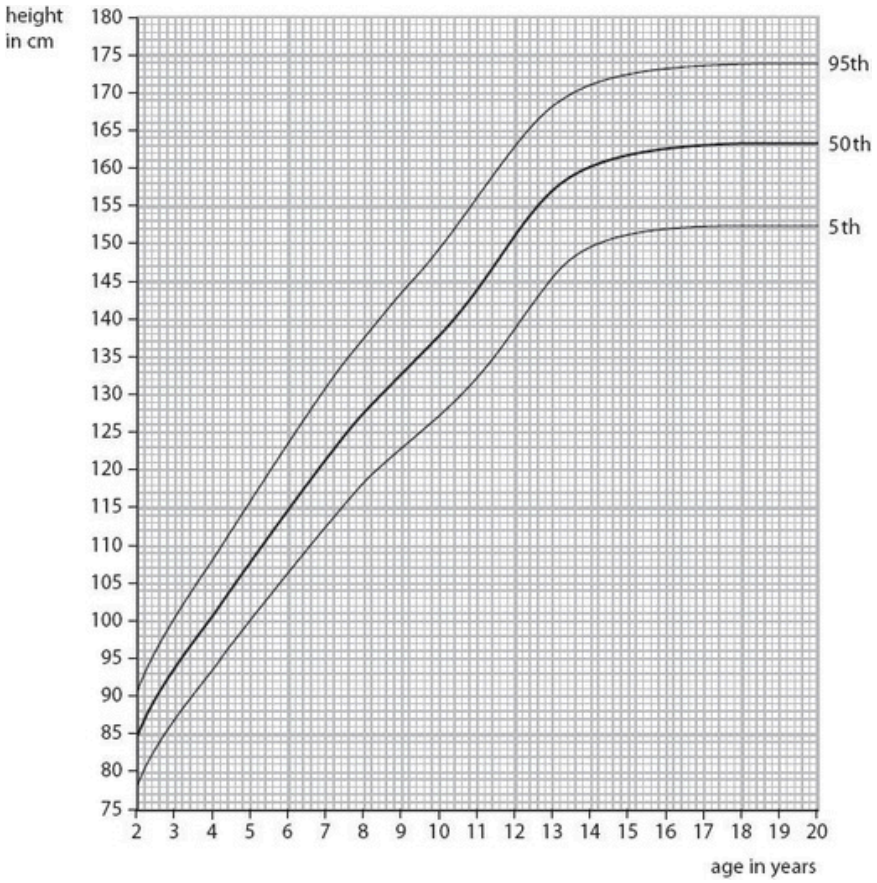

Figure 4

Which girl is most likely to need to be treated with human growth hormone?

(1)

- ☒ A a 7 year old who is 125 cm tall
- ☒ B a 9 year old who is 135 cm tall
- ☒ C a 10 year old who is 145 cm tall
- ☒ D a 12 year old who is 128 cm tall

(Total for question = 3 marks)

Q7.

* Bacteria have been genetically engineered to produce human insulin since 1978.

Explain how bacteria can be genetically engineered to produce human insulin.

(6)

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(Total for question = 6 marks)

Q8.

Bacterial cells can be genetically modified using enzymes to produce the hormone insulin.

Explain how enzymes are used to produce a genetically modified plasmid in a bacterial cell.

(3)

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(Total for question = 3 marks)

Q9.

Yeast cells can be genetically modified to produce a painkiller.

This painkiller is usually obtained from opium poppies.

One method for genetically modifying a yeast cell uses a plasmid containing the desired gene.

(i) Explain how a gene can be inserted into a plasmid.

(2)

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(ii) Discuss the possible benefits and risks of producing painkillers from genetically modified yeast cells rather than extracting the painkillers from poppies.

(3)

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(Total for question = 5 marks)

Q10.

* Figure 14 shows two varieties of potato plant.

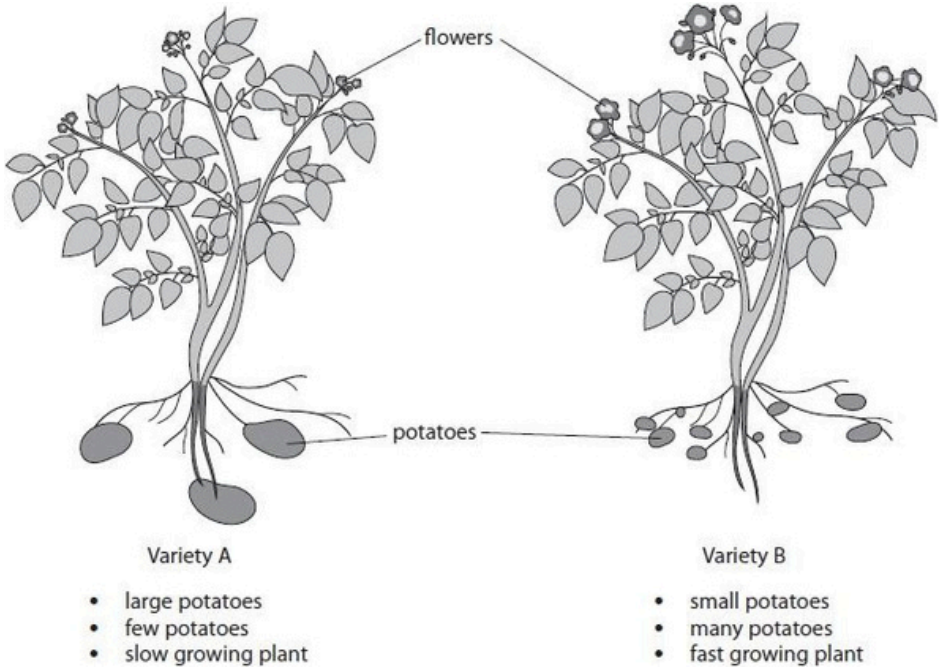

Figure 14

New varieties of potato plant can be produced by selective breeding.

Explain how selective breeding of the two varieties of potato plants can produce new potato plants that are all faster growing and produce many, large potatoes.

(6)

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(Total for question = 6 marks)

Q11.

Figure 8 shows a plasmid containing the human insulin gene.

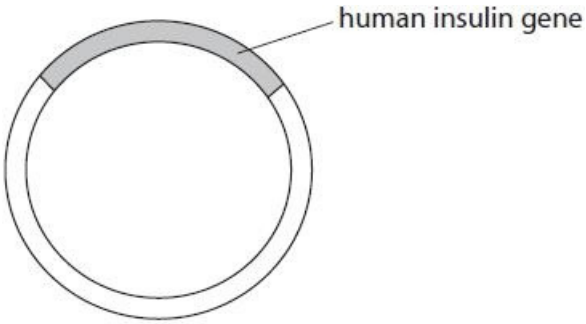

Figure 8

Explain how the human insulin gene can be inserted into a plasmid.

(3)

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(Total for question = 3 marks)

Q12.

Chymosin can be produced by genetically modified bacteria.

Figure 12 shows a bacterial cell.

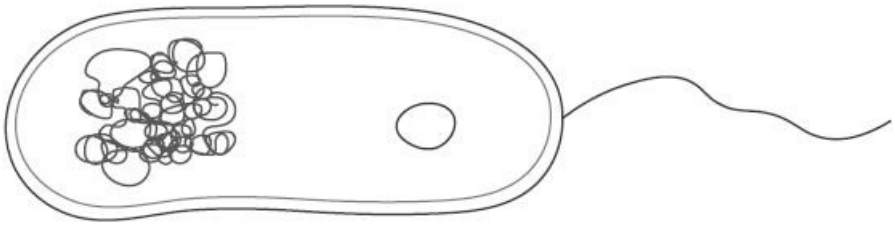

Figure 12

Explain how to genetically modify a bacterial cell to produce chymosin.

(3)

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(Total for question = 3 marks)

Q13.

Some crop plants have been genetically engineered to produce toxic chemicals in their leaves.

Explain one advantage of producing these genetically modified crop plants.

(2)

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(Total for question = 2 marks)

Q14.

* Some crop plants have been genetically modified to be resistant to insect pests.

Explain the advantages and disadvantages of producing genetically modified crop plants.

(6)

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(Total for question = 6 marks)

Q15.

Farmers selectively breed chickens to produce larger chickens.
Figure 9 shows how the size of chickens has changed over time.

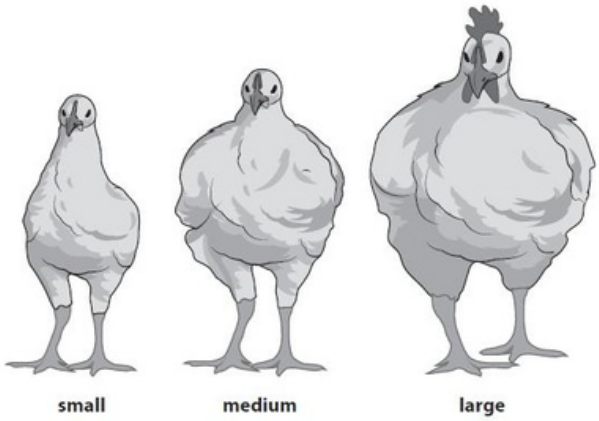

Figure 9

(i) Explain how farmers have used selective breeding to produce larger chickens.

(3)

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(ii) Describe one benefit and one risk of selectively breeding chickens.

(2)

benefit .....

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risk .....

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(Total for question = 5 marks)

Q16.

Figure 9 shows a plant with plantlets growing from it.

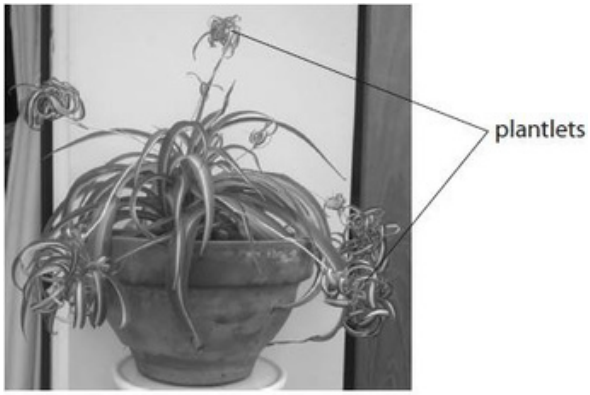

Figure 9

If a plantlet touches soil, it will grow roots and become a new plant.

This is an example of asexual reproduction.

Figure 11 shows the characteristics of three different varieties of this plant.

characteristic	plant K	plant L	plant M
size of leaves	small	large	small
striped leaves	none	none	green and white
flowers	small white	large white	large pink

Figure 11

A gardener wants to use selective breeding to produce a plant with large green and white striped leaves and large white flowers.
Explain which plants the gardener should use.

(3)

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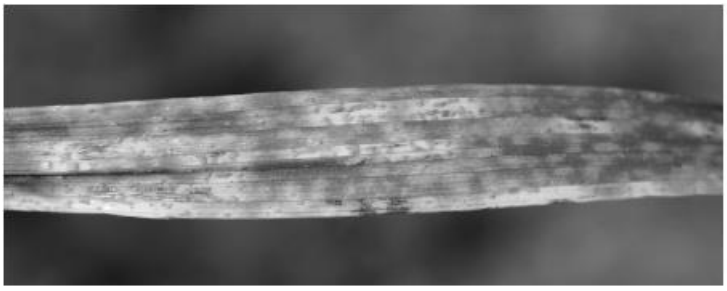
(Total for question = 3 marks)

Q17.

Figure 5 shows the leaf of a wheat plant with a fungal disease.



(Source: © Kazakov Maksim/Shutterstock)

Figure 5

Give two benefits of breeding wheat plants that are resistant to fungal disease.

1 .....

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2 .....

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(Total for question = 2 marks)

Q18.

GM crops often produce a larger yield than non-GM crops.

Give one reason why this could reduce the destruction of forests.

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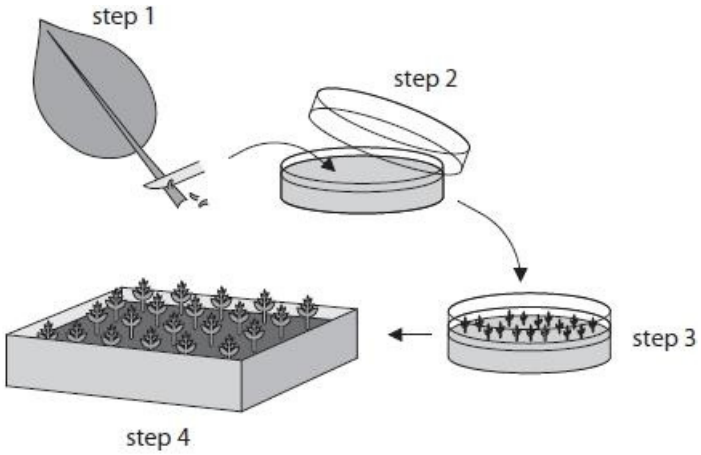
(Total for question = 1 mark)

Q19.

Figure 15 shows a method of producing plants.



Step 1. Cells taken from parent plant.

Step 2. Cells placed on agar growth medium.

Step 3. Cells develop into tiny plantlets.

Step 4. Plantlets grown in compost.

Figure 15

(i) Some cells in each plantlet develop into root cells.

Name the process occurring as these cells develop into root cells.

(1)

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(ii) Describe the advantages of producing plants by the method shown in Figure 15.

(2)

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(iii) An autoclave is used to prepare the agar growth medium used in Step 2.
Explain why the agar growth medium is autoclaved.

(2)

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(iv) One of the plantlets had different coloured leaves.
Give one reason why this plantlet had different coloured leaves.

(1)

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(Total for question = 6 marks)

Q20.

Figure 9 shows the number of organ transplants needed and the number of donors available in the USA from 1991 to 2018.

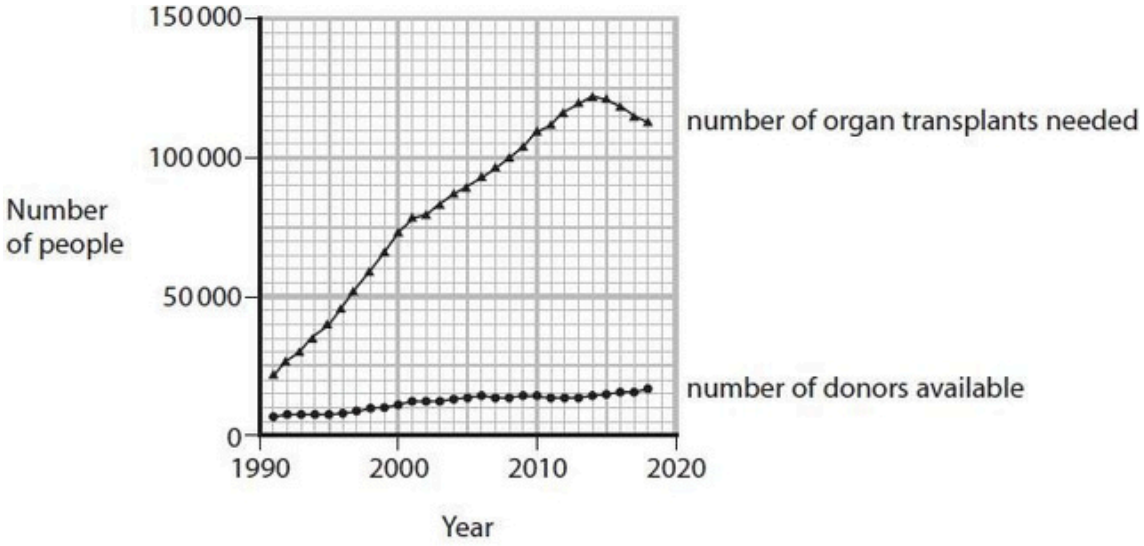

Figure 9

(i) Compare the number of donors available with the number of organ transplants needed from 1991 to 2018.

Use information from the graph to support your answer.

(3)

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(ii) State why scientists are genetically engineering animals for organ transplants.

(1)

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(Total for question = 4 marks)

Q21.

Some crop plants are genetically modified to make them resistant to attack by insect pests.

State one disadvantage of genetically modified crop plants.

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(Total for question = 1 mark)

Mark Scheme

Q1.

Question number	Answer	Mark
	An answer that combines knowledge (2 marks) and understanding (2 marks) to provide a logical description: • use restriction enzymes to remove the gene and cut the plasmid (1) • use of ligase to join DNA molecules together (1) • cut the gene from the genome of the fungus and extract a plasmid from the bacteria (1) • insert the recombinant plasmid back into the bacteria (1)	**(4)**

Q2.

Question Number	Answer	Mark
	A description including **two** from: • {cross / breed} Brahman cattle with Shorthorn cattle (1) • select the offspring with the desired characteristics and {cross / breed} them (1) • repeat over many generations (1)	**(2)** **AO2 1**

Q3.

Question number	Answer	Mark
	An answer that combines the following points of application of knowledge and understanding to provide a logical description: • genetic variation means that some plants will be tolerant of drought conditions and these can be selected (1) • cross-pollinate these plants and grow the seeds under drought conditions (1) • select offspring and repeat over several generations (1)	**(3)**

Q4.

Question Number	Answer	Additional Guidance	Mark
	An answer including: • breed two animals that can run fast (1) • selection of offspring that can run fast (1) • repeat the process over many generations (1)	accept beneficial characteristic for running fast	**(3)** **AO2 1**

Q5.

Question number	Answer	Additional guidance	Mark
(i)	An answer that combines the following points to provide a logical description of the plan/method/experiment: • prepare soil with a low level of acid /select a weakly acidic soil (1) • put the seeds in the soil to grow/plant the seeds (1)	accept grow seeds in (weakly) acidic soil select the best plants (1)	**(2)**

Question number	Answer	Additional guidance	Mark
(ii)	An answer that combines the following points of application of knowledge and understanding to provide a logical description: • cross the selected plants and grow seeds in higher acid soil (1) • select the best offspring and repeat over several generations (1) OR • put the plants in a higher level of acidic soil (1) • grow the seeds from the surviving plants and repeat over several generations (1)	ignore just breed the plants accept breed two plants tolerant to acidic soil together	(2)

Question number	Answer	Additional guidance	Mark
(iii)	An explanation that combines identification - application of knowledge (1 mark) and reasoning/justification - application of understanding (1 mark): • crops can be grown in areas which previously couldn't be used (1) • increase in food production/ higher yield / more crops grown (1)	accept grow in more places accept tolerate acid rain ignore grow anywhere ignore grow faster, bigger	(2)

Q6.

Question number	Answer	Additional guidance	Mark
(i)	An answer that combines two of the following points of application of knowledge and understanding to provide a logical description: • more hGH can be produced / hGH can be obtained quickly /hGH is easier to produce (1) • hGH sample is pure/less likely to be contaminated/ less chance of {transfer of pathogens/infections} (1) • hGH more effective/ hGH less likely to be rejected (1)	accept more people can be treated accept hGH doesn't carry a disease ignore safer/cleaner ignore idea of waiting until someone dies ignore references to costs or religious beliefs	(2)

Question number	Answer	Mark
(ii)	D a 12 year old who is 128 cm tall	(1)

Q7.

Question number	Indicative content	Mark
	AO1 • the gene that codes for human insulin is identified • in the human DNA • this is removed using a restriction enzyme • the plasmid of a bacterial cell is removed • using lysosomes/lysozyme • the plasmid is cut open • using (the same) restriction enzyme • leaving complementary sticky ends • the human gene is inserted into the bacterial plasmid • using the enzyme ligase • the plasmid is returned to the bacterial cell • the bacterial cell multiplies	(6)

Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1–2	• Demonstrates elements of biological understanding, some of which is inaccurate. Understanding of scientific ideas lacks detail. (AO1) • Presents an explanation with some structure and coherence. (AO1)
Level 2	3–4	• Demonstrates biological understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas is not fully detailed and/or underdeveloped. (AO1) • Presents and explanation that has a structure which is mostly clear, coherent and logical. (AO1)
Level 3	5–6	• Demonstrates accurate and relevant biological understanding throughout. Understanding of scientific ideas is detailed and fully developed. (AO1) • Presents and explanation that has a well developed structure which is clear, coherent and logical. (AO1)

Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1–2	• A brief understanding of the removal of the human gene or how the bacterial cell is altered • The process described links to the next or a key aspect of the process
Level 2	3–4	• A brief understanding of both the removal of the human gene and the use of a plasmid / bacterial DNA / vector • Linked to the use of at least one correct enzyme
Level 3	5–6	• A clear understanding of the removal of the human gene, the use of the bacterial plasmid including one correct enzyme, and insertion of the (recombinant) plasmid into a bacterium • Linked to the correct enzymes for removal of the gene and the insertion into the plasmid AND the role of sticky ends

Level	Mark	Examples of answers
	0	No rewardable material.
Level 1	1–2	• The human insulin gene is inserted into the bacterial DNA - 1 • Cut the human insulin gene from a cell and insert it into the bacteria -2 • Cut the human insulin gene leaving sticky ends - 2
Level 2	3–4	• Cut the human insulin gene and cut a plasmid. Insert the gene into the plasmid DNA - 3 • Cut the human insulin gene and cut a plasmid with restriction enzymes. Insert the gene into the plasmid DNA - 4 • Remove the insulin gene using restriction enzymes and cut the plasmid with the same restriction enzyme, Use ligase to insert the gene into the plasmid - 4
Level 3	5–6	• Cut the insulin gene using a restriction enzyme that leaves sticky ends. Cut the plasmid DNA with the same restriction enzyme and insert the gene into the plasmid. Insert the recombinant plasmid back into the bacteria - 5 (no ligase) • Cut the insulin gene using a restriction enzyme. Cut the plasmid DNA with the same restriction enzyme and insert the gene into the plasmid. Insert the recombinant plasmid back into the bacteria – 5 (no sticky ends) • Cut the insulin gene using a restriction enzyme that leaves sticky ends. Cut the plasmid DNA with the same restriction enzyme to leave complementary sticky ends. Join the gene and the plasmid using ligase. Insert the recombinant plasmid back into the bacteria – 6

Q8.

Question number	Answer	Mark
	An explanation that combines identification - knowledge (3) • a {plasmid/bacterial DNA} is cut using the restriction enzymes and the (insulin) gene is cut using restriction enzymes (1) • these enzymes produce **complementary** {sticky ends / base pairs} (1) • the gene (for insulin) is inserted into the plasmid using ligase (to join the gene to the plasmid) (1)	**(3)**

Q9.

Question Number	Answer	Additional guidance	Mark
(i)	An explanation linking two of the following: • cut the {plasmid/gene/DNA} with a **restriction enzyme** (1) • insert the gene into the plasmid using **ligase** (1) • gene and plasmid have the same sticky ends / complementary sticky ends (1)	accept vector for plasmid	**(2)** AO 1 1

Question Number	Answer	Additional guidance	Mark
(ii)	An evaluation that combines three of the following points: At least one from benefits • (yeast grows rapidly) increasing yield (1) • it can be produced in a shorter time period (1) • production is cheaper/easier to extract (1) • takes up less space than growing plants (1) • yeast growth is not weather dependent (1) At least one from risks • concerns over the genetically modified yeast being manufactured illegally (1) • the painkillers may not be identical/as effective (1) • concerns over GM organisms entering environment (1)	Max of 2 marks for benefits. Max of 2 marks for risks. accept possible health risks of painkillers from GM yeast	**(3)** AO 2 1

Q10.

Question number	Indicative content	Mark
*	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are therefore not required to include all the material that is indicated as relevant. Additional content included in the response must be scientific and relevant. • Select variety A because it has large potatoes ; • Select variety B because is faster growing and produces many potatoes ; • Crossbreed variety A with variety B; • Transfer pollen from flower of variety A to flower of variety B / ORA; • Grow the new plants • Select the offspring with the desired characteristics • Repeat the process over many generations; • until all offspring show desired characteristics;	**(6)** AO 2 1

Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1–2	• The explanation attempts to link and apply knowledge and understanding of scientific ideas, flawed or simplistic connections made between elements in the context of the question. • Lines of reasoning are unsupported or unclear. (AO2)
Level 2	3–4	• The explanation is mostly supported through linkage and application of knowledge and understanding of scientific enquiry, techniques and procedures, some logical connections made between elements in the context of the question. • Lines of reasoning mostly supported through the application of relevant evidence. (AO2)
Level 3	5–6	• The explanation is supported throughout by linkage and application of knowledge and understanding of scientific ideas, logical connections made between elements in the context of the question. • Lines of reasoning are supported by sustained application of relevant evidence. (AO2)

Q11.

Question number	Answer	Additional guidance	Mark
	An explanation linking the following: • cut the gene (from the genome) using **restriction** enzymes (1) • cut the plasmid with a **restriction** enzyme (1) • to leave {complementary / matching} sticky ends (1) • join the DNA using **ligase** (1)	accept endonucleases accept endonucleases accept the same sticky ends reject lipase	**(3)** AO1(1)

Q12.

Question Number	Answer	Additional Guidance	Mark
	An explanation linking **three** from: • **plasmid** is cut with **restriction** enzymes/ chymosin gene is cut with a **restriction** enzyme (1) • sticky ends are complementary (1) • ligase is used to connect the chymosin gene and the plasmid (1) • recombinant plasmid is inserted back into the bacterial cell (1)	accept insert a plasmid with chymosin gene into the bacteria	**(3)** **AO2 1**

Q13.

Question number	Answer	Additional guidance	Mark
	An answer that links the following: • kills insects /pests / pathogens (which feed on the crops) (1) • less damage to the crops / increased crop yield (1) • no need to use insecticides / pesticides (1)	accept fungicides	**(2)** AO1(1)

Q14.

Question Number	**Indicative content**	Mark
*	**Advantages** • less crop damage / spoilage • so higher yield • so more food for people • crop plants are less likely to have diseases that are spread by insects • so less pesticides / insecticides used • more profit • so more income for developing countries	**(6)** **AO2 1**

	Disadvantages • concerns about the long-term effects (of genetically modified organisms) • ethical concerns / wrong to move genes between species • GM crops could contribute to the development of medical conditions in humans • GM crops could trigger allergic reactions • genes could be transferred to other species / weeds • so weeds could grow out of control / compete with crop plants • genetically modified seeds could be more expensive to buy • reliance of farmers on GM seed companies • reduced gene pool • insects will evolve so crops are no longer resistant to insect pests	

Level	Mark	• Descriptor •
	0	• No rewardable material.
Level 1	1-2	• The explanation attempts to link and apply knowledge and understanding of scientific ideas, flawed or simplistic connections made between elements in the context of the question • Lines of reasoning are unsupported or unclear.
Level 2	3-4	• The explanation is mostly supported through linkage and application of knowledge and understanding of scientific ideas, some logical connections made between elements in the context of the question. • Lines of reasoning mostly supported through the application of relevant evidence.
Level 3	5-6	• The explanation is supported throughout by linkage and application of knowledge and understanding of scientific ideas, logical connections made between elements in the context of the question. • Lines of reasoning are supported by sustained application of relevant evidence.

Level 1	1-2	• an advantage OR a disadvantage is identified • makes an attempt to explain the advantage / disadvantage
Level 2	3-4	• an advantage AND a disadvantage is identified **OR** • more than one advantage OR more than one disadvantage is identified • clearly explains one of the advantages OR clearly explains one of the disadvantages
Level 3	5-6	• more than one advantage AND more than one disadvantage is identified • clearly explains one of the advantages AND clearly explains one of the disadvantages

Q15.

Question number	Answer	Mark
(i)	An answer including: • select large chickens /chicks from larger chickens (1) • breed together (1) • repeat over (many) generations / long period of time (1)	(3) AO2 1

Question number	Answer	Mark
(ii)	Benefit • produces more food / fewer chickens needed for the same amount of meat (1) Risk • less variation /losing useful genes (from the gene pool) / losing traits which may be desirable in the future / health issues related to larger bodies (1)	(2) AO2 1

Q16.

Question number	Answer	Additional guidance	Mark
	An explanation including **three** from: • select plants L **and** M (1) • because these have the desired alleles / the offspring will inherit the desired alleles (1) • L because of large white flowers **and** large leaves (1) • M because of striped leaves (1)		(3) **AO3** **2a 2b**

Q17.

Question Number	Answer	Additional guidance	Mark
	Any **two** from: • (wheat) plants not damaged (1) • the spread of the fungus would be reduced (1) • greater yield / profit (1) • reduced use of fungicides / pesticides (1)	accept the (wheat) plants would live longer accept their offspring would also be resistant to fungal disease (1)	**(2)** **AO2 1**

Q18.

Question number	**Answer**	**Mark**
	(Larger yield means) less land is needed to grow GM crops	**(1)** AO2 1

Q19.

Question Number	**Answer**	**additional guidance**	**Mark**
(i)	differentiation (1)	accept specialisation	**(1)** AO 2 1

Question Number	Answer	additional guidance	Mark
(ii)	A logical description including two of the following: • many plants produced (1) • quicker than sexual reproduction (1) • genetically identical/ clones produced (1) • with the desired characteristics (1) • plants from endangered/rare plants (1)	accept gives more of that plant/higher yield of that plant ignore plants grow faster obtain plants difficult to grow from seed (1)	(2) AO 1 1

Question Number	Answer	Additional guidance	Mark
(iii)	Any two from: • sterilises agar growth medium (1) • destroys unwanted {bacteria /pathogens/fungi/microorganisms/viruses} /there is no contamination (1) • so microorganisms don't {affect growth of plantlets / don't compete with plantlets/ don't use nutrients needed by plantlets} (1)	ignore prevents microorganisms getting in accept only the plantlets grow	(2) AO 2 2

Question Number	Answer	Additional guidance	Mark
(iv)	• mutation / disease	accept different alleles/ genotypes/genetic variation	(1) AO 2 1

Q20.

Question number	Answer	Additional guidance	Mark
(i)	A comparison including **three** of the following: • the number of transplants needed increased rapidly but the number of donors {only increased slightly /remained low} (1) • from {2014 / 2015} the numbers of transplants required decreased (1) • the number of donors available was always lower than the number of transplants needed (1) • comparison of figures from the graph of the number of people needing an organ and donating an organ (1)	accept peaked in {2014 / 2015} accept there are not enough donors for the transplants needed accept a comparative mathematical manipulation of the data	**(3)** **AO3 2ab**

Question number	Answer	Mark
(ii)	not enough donors are available / to increase the number of organs for donation / to meet the demand for organ transplants	**(1)** **AO3 2b**

Q21.

Question number	Answer	Additional guidance	Mark
	risk of GM plants cross-pollinating with other plants / reduced biodiversity	accept creates 'super weeds' / consumers do not want GMOs	**(1)** AO2 1