PEARSON EDEXCEL GCSE BIOLOGY (HIGHER) · 1BI0

BIOLOGY



MARK SCHEME

TOPIC 4: NATURAL SELECTION AND GENETIC MODIFICATION (PACK 3)

SCORE	PERCENTAGE
/58	%

STEMUP

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Mark Scheme

Q1.

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

Q2.

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 not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. **AO1 (6 marks)** • bacteria reproduce rapidly generating a large population • there is variation among a bacterial population • some bacteria develop a resistance to antibiotics through mutation • antibiotic treatment exerts a selection pressure • bacteria resistant to antibiotics survive • antibiotic resistance inherited • non-resistant bacteria do not survive • levels of antibiotic resistance in a population of bacteria increase	**(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 developed. (AO1) • Presents an 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 the scientific ideas is detailed and fully developed. (AO1) • Presents an explanation that has a well-developed structure that is clear, coherent and logical. (AO1)

Q3.

Question number	Answer	Additional guidance	Mark
	An explanation linking four of the following: • the population of great tits shows variation (1) • bird feeders provide a selection pressure (1) • birds with longer beaks {can feed from bird feeders/get more food} (1) • these birds are more likely to {survive/ reproduce} / survival of the fittest (1) • pass the {allele/gene /characteristic} for long beaks to their offspring (1) • over many generations the beak length of the bird population increases (1)	accept there is a mutation that leads to some birds having longer beaks accept there is competition for food / birds with longer beaks outcompete accept birds with shorter beaks can't get food accept birds with shorter beaks die out accept offspring have long beaks accept the process continues/repeats itself	**(4)** **AO2 1**

Q4.

Question number	Answer	Additional guidance	Mark
	An explanation linking four of the following: • the population of great tits shows variation (1) • bird feeders provide a selection pressure (1) • birds with longer beaks {can feed from bird feeders/get more food} (1) • these birds are more likely to {survive/ reproduce} / survival of the fittest (1) • pass the {allele/gene /characteristic} for long beaks to their offspring (1) • over many generations the beak length of the bird population increases (1)	accept there is a mutation that leads to some birds having longer beaks accept there is competition for food / birds with longer beaks outcompete accept birds with shorter beaks can't get food accept birds with shorter beaks die out accept offspring have long beaks accept the process continues/repeats itself	**(4)** **AO2 1**

Q5.

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)

Q6.

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)

Q7.

Question number	Answer	Additional guidance	Mark
	An explanation linking four of the following: • people do not finish their course (of Colistin) (1) • natural selection /evolution (occurs) (1) • some bacteria have a mutation/ (genetic) variation (1) • (these) resistant bacteria survive /resistant bacteria reproduce (1)	accept overuse / repeated exposure (to the antibiotic) accept they have evolved accept some bacteria have a {**gene/allele**} for resistance accept the non-resistant bacteria die	**(4)** AO2 1

		/ the fittest bacteria survive ignore immune bacteria	

Q8.

Question number	Answer	Additional guidance	Mark
	An explanation linking four of the following: • people do not finish their course (of Colistin) (1) • natural selection /evolution (occurs) (1) • some bacteria have a mutation/ (genetic) variation (1) • (these) resistant bacteria survive /resistant bacteria reproduce (1)	accept overuse / repeated exposure (to the antibiotic) accept they have evolved accept some bacteria have a {**gene/allele**} for resistance accept the non-resistant bacteria die / the fittest bacteria survive ignore immune bacteria	**(4)** AO2 1

Q9.

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**

Q10.

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**

Q11.

Question number	Answer	Additional guidance	Mark
(i)	An explanation including the following: • (fewer bright feathers) would be less noticeable / they are camouflaged / they blend in (1) And **one** from: • therefore they are less likely to be eaten / by predators (1) • therefore more likely to get food / from prey (1)	**ignore more likely to survive** accept ideas of less likely to be hunted / killed	**(2)** **A02 1**

Question number	Answer	Additional guidance	Mark
(ii)	An answer including the following: • female birds are those who {produce offspring / lay eggs} (1) • one male bird can reproduce with many female birds (1)	accept males do not produce the {offspring / eggs} reject males don't reproduce accept {named species/in **rare** cases} females can reproduce asexually	**(2)** **AO2 1**

Q12.

Question number	Answer	Mark
	An explanation that combines identification - knowledge (1 mark) and reasoning/justification - understanding (1mark): • cut DNA at recognition sites (1) • to create areas called sticky ends (1)	**(2)**

Q13.

	Answer	Acceptable answers	Mark
	A suggestion including 3 of the following: • Predation / disease (1) • change in environmental conditions (1) • loss of food source / reduced food source (1) • increased competition (1) • limited adaptations / survival of the fittest (1) • unable to reproduce / reproduce less (1)	Accept named environmental change / climate change Accept food source eaten by other animals / humans Accept unable to fly so cannot escape	**(3)**

Q14.

	Answer	Acceptable answers	Mark

	A suggestion including 3 of the following: • Predation / disease (1) • change in environmental conditions (1) • loss of food source / reduced food source (1) • increased competition (1) • limited adaptations / survival of the fittest (1) • unable to reproduce / reproduce less (1)	Accept named environmental change / climate change Accept food source eaten by other animals / humans Accept unable to fly so cannot escape	**(3)**

Q15.

Question Number	Answer	Acceptable answers	Mark
	A description to include three of the following selection of individuals with {favourable characteristics/largest cobs}/collect seeds from plants with large cobs (1) cross breeding (of selected individuals)/plant seeds together (from maize with large cobs) (1) selection of offspring (1) repeat process over time (1)	accept selective breeding	**(3)**

Q16.

Question Number	Answer	Acceptable answers	Mark
	A description to include three of the following selection of individuals with {favourable characteristics/largest cobs}/collect seeds from plants with large cobs (1) cross breeding (of selected individuals)/plant seeds together (from maize with large cobs) (1) selection of offspring (1) repeat process over time (1)	accept selective breeding	**(3)**

Q17.

Question Number	Answer	Acceptable answers	Mark
	An explanation including two of the following reduce number of pests (1) reduced damage to crop/maize (1) increased yield (1) OR kills weeds (1) reduces competition for {light/space/named resource}(1) increased yield (1)	accept kill pests/insects/named pest/deters animals **reject** predators	**(2)**

Q18.

Question Number	Answer	Acceptable answers	Mark
	An explanation linking the following: soft body tissue decays / decompose (1) some parts / bones may have been eaten / moved away from rest of skeleton / (by animals before fossilisation) (1) (some parts) not found / eroded / corroded / damaged / crushed / changed by pressure / heat (when in ground / excavated)(1)		**(3)**

Q19.

	Answer	**Acceptable answers**	**Mark**
	An explanation including **two** of the following points: • soft tissue of organisms does not form fossils (1) • some fossils are yet to be found (1) • fossils may be damaged (1) • conditions not correct for fossil formation (1) • fossils may only be fragments / not whole organisms (1)	accept: references to plant or animal tissue accept: reasons why they may not be found accept: reasons for damage e.g. earthquakes accept: named conditions e.g. pH	**(2)**

Q20.

	Answer	Acceptable answers	Mark
	A suggestion including any three linked points • ref to use of enzymes (1) • isolate / remove /cut out gene / DNA (for resistance)(1) • (coding for) enzyme (1) • from bacteria (1) • insertion of gene / DNA into crops / plants (1)	Any named enzyme must be in correct context. Ignore plasmids Reject replace	**(3)**

Q21.

Question Number	Answer	Acceptable answers	Mark
(a)	**B** Two cells that are genetically identical		**(1)**

Question Number	Answer	Acceptable answers	Mark
(b)(i)	A description to include 2 of the following points: select a species that glows (when UV light is shone on it) (1) identify the gene location (1) cut the gene out (1) . using a (restriction) enzyme (1)		**(2)**

Question Number		Indicative Content	Mark
QWC	***(b)(ii)**	a description to include some of the following: • diploid nucleus is removed from the genetically engineered cell • making a lone nucleus • a donor egg is enucleated/its nucleus is removed • the diploid nucleus from the GE cell is inserted into the enucleated egg cell • division of the nucleus is stimulated • by electric shock/chemicals • cell divides by mitosis • cells put into surrogate mother • cells divide further and differentiates to form an embryo • Tegon born and is a glow in the dark beagle The above points could be made diagrammatically, but a written description is also required.	**(6)**

Level	**0**	No rewardable content
1	**1 - 2**	• a limited description including at least one stage of cloning in an appropriate context • the answer communicates ideas using simple language and uses limited scientific terminology • spelling, punctuation and grammar are used with limited accuracy
2	**3 - 4**	• a simple description of at least two stages of cloning linked sequentially in an appropriate context • the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately • spelling, punctuation and grammar are used with some accuracy
3	**5 - 6**	• a detailed explanation of most of the stages of cloning • answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors

Q22.

Question Number	Answer	Acceptable answers	Mark
(a)	**B** Two cells that are genetically identical		**(1)**

Question Number	Answer	Acceptable answers	Mark
(b)(i)	A description to include 2 of the following points: select a species that glows (when UV light is shone on it) (1) identify the gene location (1) cut the gene out (1) using a (restriction) enzyme (1)		**(2)**

Question Number		Indicative Content	Mark
QWC	***(b)(ii)**	a description to include some of the following: • diploid nucleus is removed from the genetically engineered cell • making a lone nucleus • a donor egg is enucleated/its nucleus is removed • the diploid nucleus from the GE cell is inserted into the enucleated egg cell • division of the nucleus is stimulated • by electric shock/chemicals • cell divides by mitosis • cells put into surrogate mother • cells divide further and differentiates to form an embryo • Tegon born and is a glow in the dark beagle The above points could be made diagrammatically, but a written description is also required.	**(6)**

Level	0	No rewardable content
1	**1 - 2**	• a limited description including at least one stage of cloning in an appropriate context • the answer communicates ideas using simple language and uses limited scientific terminology • spelling, punctuation and grammar are used with limited accuracy
2	**3 - 4**	• a simple description of at least two stages of cloning linked sequentially in an appropriate context • the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately • spelling, punctuation and grammar are used with some accuracy
3	**5 - 6**	• a detailed explanation of most of the stages of cloning • answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors

Q23.

	Answer	Acceptable answers	Mark
(a) (i)	flavonoids / bioflavonoids	anthocyanins antioxidants	**(1)**
(a) (ii)	**A** ☒ a gene from another species		**(1)**

			Indicative Content	
QWC		***(b)**	A description including some of the following points **genetic modification** • transferring a gene from one organism to anot • restriction enzymes to cut the gene out • plasmids used to carry gene • sticky ends to join complementary bases • ligase to join the DNA **use of *Agrobacterium*** • *Agrobacterium* is a vector (for the gene) • the *Agrobacterium* has a suitable gene added t • example of a suitable gene eg drought resista resistance / larger yield / for flavonoids • *Agrobacterium* naturally invades plant cells • its DNA is incorporated into the plant's DNA **production of plants** • plant sprayed with *Agrobacterium* • crown gall (formed) • crown gall is cut into small pieces • leaf discs are incubated with *Agrobacterium* • (crown gall tissue / leaf discs) grown in tissue • explants • grown into crops	
Level	**0**	No rewardable content		
1	**1 - 2**	• a limited description of at least **one** of the areas involved in creating transgenic plants. Steps may be missing or out of sequence. • the answer communicates ideas using simple language and uses limited scientific terminology • spelling, punctuation and grammar are used with limited accuracy		
2	**3 - 4**	• a simple description of at least **two** of the areas involved in creating transgenic plants or a detailed description of **one** area involved in creating transgenic plants • the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately		

		• spelling, punctuation and grammar are used with some accuracy	
3	**5 - 6**	• a detailed description of the genetic modification, use and production of transgenic plants. Steps should be in sequence. • the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors	

	Answer	**Acceptable answers**	**Mark**
(c)	An explanation of one advantage for **two** marks • crop produces a toxin that kills insects (that eat plant)(1) • so less damage by insect / increased crop yield (1) • less man-made chemicals used / specific to pests / less pollution (1) An explanation of one disadvantage for **two** marks • cross pollination / fertilisation with other plants (species) (1) • producing weeds that contain the toxin(1) • non target organisms may be affected (1) OR • idea of large areas of monocultures (1) • reduction in insect numbers / biodiversity (1) • negative impact on food chains (1) OR • GM crops cost more (1) • Farmers cannot afford them / become reliant on them (1)	accept references to ICP accept does not kill other insects	**(4)**

Q24.

Question number	Answer	Additional guidance	Mark
	• to produce more food (1) • to improve quality of food (1)	bigger plants , produce more kernels, more sweet/juicy, pest resistant,	**(2)**

Q25.

Question Number	Answer	Additional Guidance	Mark
(i)	location in the rock layer / age of fossils surrounding it	accept radiometric dating / stratigraphy / comparison to other *Hipparion* fossils ignore carbon dating	**(1)** **AO2 1**

Question Number	Answer	Additional Guidance	Mark
(ii)	similar (pentadactyl) limb structure / similarities in the {skeleton / bone} structure	ignore similar body shape	**(1)** **AO3**

Q26.

	Answer	Acceptable answers	Mark
(a)	A suggestion including any three linked points • ref to use of enzymes (1) • isolate / remove /cut out gene / DNA (for resistance)(1) • (coding for) enzyme (1)	Any named enzyme must be in correct context. Ignore plasmids	**(3)**

	• from bacteria (1) • insertion of gene / DNA into crops / plants (1)	Reject replace	
(b)	• in the phloem (1)	Accept phonetic spelling e.g. phloem /flowem	**(1)**
(c)(i)	A description including two of the following points • 0 to 10/11 no effect / change / difference (1) • 10/11 to 28 / 29/30 decrease in mass / yield (1) • Over 28 / 29/30 no change (1)	Accept decreases for 1 mark (if no other marks awarded) ecf throughout	**(2)**
(c)(ii)	B - 30 arbitrary units		**(1)**
(d)(i)	• number of **species**increase / go up (1)	Ignore number of weeds	**(1)**
(d)(ii)	Suggestions including two of the following linked points • increased use of herbicideresistant crops (1) • increased use (concentration / time) of herbicide (1) • ref to transfer of genes into weeds from other plants / cross pollination (1) • mutation(1)	Ignore ref to evolution / natural selection Ignore immune (to herbicide) Accept a description eg continued use of herbicide Accept cross breeding / reproduction / contamination	**(2)**

Q27.

	Answer	**Acceptable answers**	**Mark**
(a)	A suggestion including any three linked points • ref to use of enzymes (1)	Any named enzyme must be in correct context.	**(3)**

	• isolate / remove /cut out gene / DNA (for resistance)(1) • (coding for) enzyme (1) • from bacteria (1) • insertion of gene / DNA into crops / plants (1)	Ignore plasmids Reject replace	
(b)	• in the phloem (1)	Accept phonetic spelling e.g. phloem /flowem	**(1)**
(c)(i)	A description including two of the following points • 0 to 10/11 no effect / change / difference (1) • 10/11 to 28 / 29/30 decrease in mass / yield (1) • Over 28 / 29/30 no change (1)	Accept decreases for 1 mark (if no other marks awarded) ecf throughout	**(2)**
(c)(ii)	B - 30 arbitrary units		**(1)**
(d)(i)	• number of **species**increase / go up (1)	Ignore number of weeds	**(1)**
(d)(ii)	Suggestions including two of the following linked points • increased use of herbicideresistant crops (1) • increased use (concentration / time) of herbicide (1) • ref to transfer of genes into weeds from other plants / cross pollination (1) • mutation(1)	Ignore ref to evolution / natural selection Ignore immune (to herbicide) Accept a description eg continued use of herbicide Accept cross breeding / reproduction / contamination	**(2)**

Q28.

Question number	Answer	Additional guidance	Mark
	An explanation that combines application of knowledge (2 marks) and reasoning/justification – application of understanding (2 marks) • The phosphorescent gene needs to be isolated from the DNA of the phosphorescent organism using enzymes to expose sticky ends(1) • The plasmid is removed from the bacterial cell and cut open using the same enzymes to expose complementary sticky ends (1) • The phosphorescent gene is inserted into the bacterial cell matching the sticky ends using the enzyme ligase (1) • The plasmid is inserted back into the bacterial cell and is grown on a petri dish each bacterial cell will express the phosphorescent gene and glow in the dark (1)		**(4)**

Q29.

Question number	Answer	Mark
	An answer that provides a description by making reference to: • an extra/new gene (1) • present in the DNA/chromosome (1)	**(2)**

Q30.

Question number	Answer	Additional guidance	Mark
	An answer that combines the following points of application of knowledge and understanding to provide a logical description: • best characteristics/named characteristic chosen (1) • parents bred together (1) • offspring produced showing some of the best characteristics are selected(1) • selection and breeding process repeated (1)	accept reference to pollination / fertilisation	(3)