Question number	Answer	Additional guidance	Mark
1 (a)(i)	An answer that links the following • tall is dominant (1) • they are heterozygous / have one tall allele (1)	accept short is recessive accept one of each allele ignore genes accept they have inherited one tall dominant allele for 2 marks	(2)

Question number	Answer	Additional Guidance	Mark
1(a)(ii)	An answer including: • provide {optimal/identical /best/ideal/controlled} growth conditions (1) • reduce chances of disease/pests/pathogens (1)	accept all grown under the same conditions accept examples of optimal conditions. accept prevent unwanted pollination	(2)

Question number	Answer	Additional guidance	Mark
1 (b)(i)	One mark for gametes One mark for the offspring 25 (%) (1)	accept aA accept ecf from the Punnett square	(3)

	A	a
A	AA	Aa
a	Aa	aa

Question number	Answer	Additional guidance	Mark
1(b)(ii)	An answer linking the following: • genetic variation increases / (offspring) show variation (1) • more likely to survive {a disease / environmental change / selection pressure} / allows evolution/survival of the fittest (1)	accept different combination of alleles accept allows dispersal of offspring through seeds accept other examples of a survival reason e.g. natural disaster	(2)

Question number	Answer	additional guidance	Mark
1 (c)	An answer linking: • mix the food in ethanol and pour into water (1) • white emulsion forms (1)	accept add water and ethanol and mix accept white precipitate / goes cloudy /emulsion test accept rub pea / food on filter paper (1) and look for a translucent mark (1)	(2)

Question Number	Answer	Acceptable answers	Mark
2(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) • from bacteria (1) • insertion of gene / DNA into crops / plants (1)	Any named enzyme must be in correct context. Ignore plasmids Reject replace	**(3)**

Question Number	Answer	Acceptable answers	Mark
2(b)	• in the phloem (1)	Accept phonetic spelling e.g. phloem /flowem	**(1)**

Question Number	Answer	Acceptable answers	Mark
2(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)**

Question Number	Answer	Acceptable answers	Mark
2(c)(ii)	B - 30 arbitrary units		**(1)**

Question Number	Answer	Acceptable answers	Mark
2(d)(i)	• number of **species** increase / go up (1)	Ignore number of weeds	**(1)**

Question Number	Answers	Acceptable answers	Mark
2(d)(ii)	Suggestions including two of the following linked points • increased use of herbicide-resistant 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)**

Question Number	Answer	Acceptable answers	Mark
3(a)	A – chromosomal DNA		**(1)**

Question Number	Answer	Acceptable answers	Mark
3(b)(i)	Any **two** from the following • cell wall (1) • capsule / slime coat (1) • small ribosome (1) • pilli (1) • mesosome (1)	not membrane ignore flagellum / vacuole / DNA	**(2)**

Question Number	Answer	Acceptable answers	Mark
3(b)(ii)	A description including any **three** from the following • removal of (human) gene (1) • plasmid is cut / removed from bacteria (1) • using enzymes (1) • gene / DNA (from human cell) added to plasmid (1) • plasmid inserted into bacterium (1)	ignore ref to DNA being removed from plasmid	**(3)**

Question Number	Answer	Acceptable answers	Mark
3(b)(iii)	Any **two** from the following • to produce medicines/vaccines / hormones /insulin / clotting factors (1) • an appropriate advantage (1)	 ignore details of modification e.g. cure diseases, for diabetes, less likely to be rejected, avoids use of animals, produces large quantities, can be used by vegans Allow an appropriate advantage of golden rice	 **(2)**

Question Number	Answer	Acceptable answers	Mark
4a	**B** Two cells that are genetically identical		**(1)**

Question Number	Answer	Acceptable answers	Mark
4bi	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	***4(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	

Question Number	Answer	Acceptable answers	Mark
4(c)	Any three of the following points: the clones will all be genetically identical (1) so test results will be similar / not affect by genes (1) the clones could be GE to have specific human diseases /(dogs have) similar diseases / disorders to humans (1) dogs and humans are mammals / have similar anatomy / physiology / DNA (1)	 accept a disease will affect dogs in a similar way to humans accept dogs could be cloned who have (specific human) diseases / disorders accept dogs are similar to humans	**(3)**

Total for question 3 = 12 marks

Question Number	Answer	Acceptable answers	Mark
5(a) (i)	flavonoids / bioflavonoids	anthocyanins antioxidants	**(1)**

Question Number	Answer	Acceptable answers	Mark
5(a) (ii)	**A** ☒ a gene from another species		**(1)**

Question Number		Indicative Content	Mark
QWC	**5(b)**	A description including some of the following points **genetic modification** • transferring a gene from one organism to another • 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 to it • example of a suitable gene eg drought resistance / insect 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 culture • explants • grown into crops	**(6)**
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	

Question Number	Answer	Acceptable answers	Mark
5(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)**