Question Number	Answer	Mark
1(a)	1. reference to {restriction enzyme / endonuclease} ; 2. to cut gene out of animal DNA ; 3. idea of amplification using DNA polymerase (in PCR) ; 4. (enzymes) open plasmid ; 5. (same endonuclease) to produce 'sticky ends' /description / at selected base sequence ; 6. H bonds formed between bases at 'sticky ends' ; 7. ligase ; 8. to join gene to plasmid / eq ; 9. reference to {phosphodiester / eq} bond ;	**(5)**

Question Number	Answer	Mark
1(b)	1. (small) {circle /eq} of DNA ; 2. containing bacterial (survival) genes and {protein / animal} gene ; 3. marker gene / description given ;	**(2)**

Question Number	Answer	Mark
1(c)	1. idea of easier to manage growth e.g. do not need sterile conditions ; 2. idea that it is safer (than bacteria) ; 3. idea of more protein can be made /eq ; 4. bacteria may not have correct amino acids to make protein / eq ; 5. idea that it could produce edible drugs ; 6. idea that plants have introns/bacteria do not so gene does not need modifying ; 7. idea that it is cheaper ;	**(2)**

Question Number	Answer	Mark
1(d)	1. idea of gene transfer to other {species / eq} ; 2. idea of consequence of transfer e.g. resistance to pesticide / antibiotics, superweeds ; 3. idea of possible harmful effects from genes e.g. biochemical changes to substances that could act as allergens, long term effects of consuming ; 4. idea that benefit focused on developed countries / converse ; 5. idea of risk related to use of viral vectors ; 6. idea of effect on organic farmers ;	**(2)**

Question Number	Answer	Mark
2(a)	1. tumour has {decreased in size / grown less / eq} ; 2. decrease in size quantified ; 3. rats survive longer / eq ; 4. idea that {more rats survive / higher survival rate / lower death rate} ; 5. 80% ;	**max (3)**

Question Number	Answer	Mark
2(b)(i)	1. reference to (virus acting as a) vector ; 2. idea that virus is used to get the {gene / DNA} into the cells ;	**(2)**

Question Number	Answer	Mark
2(b)(ii)	reference to {neurones in spinal cord / endorphins being made in spinal cord / spinal cord connects to brain / eq} ;	**(1)**

Question Number	Answer	Mark
2(b)(iii)	idea that endorphins have pain-reducing properties / more {endorphins / endorphins secreting cells} produced ;	**(1)**

Question Number	Answer	Mark
2(b)(iv)	1. {little change / eq} in control but treated rats {rise and fall / eq} ; 2. in first {2 weeks / ½ month} level of tolerance is {(almost) the same in both groups slightly higher in control group} / eq ; 3. after the first 2 weeks the level of tolerance is higher in the rats given gene therapy / eq ; 4. between 2 weeks and 2 months there is an increase in tolerance in rats given gene therapy but control group {remains the same / drops (slightly)} / eq ; 5. ref to decrease in tolerance in group given gene therapy {in last month / after two months} and (slight) increase in control group ; 6. credit correct comparative manipulation of figures ;	**max (3)**

Question Number	Answer	Additional Guidance	Mark
3(a)(i)	1. as it is a greenhouse gas / eq ; 2. idea of CO_2 leading to global warming ;	**2 ACCEPT** description of effect of global warming	**(2)**

Question Number	Answer	Additional Guidance	Mark
*3(a) (ii	***QWC – Spelling of technical terms must be correct and the answer must be organised in a logical sequence** 1. idea of using gene involved / eq ; 2. reference to {restriction enzyme / endonuclease} / eq ; 3. idea of same (restriction) enzyme used to cut open plasmid / eq ; 4. reference to sticky ends ; 5. detail of sticky ends e.g. complementary bases exposed ; 6. (DNA) ligase used to bind useful gene to plasmid / eq ; 7. by forming phosphodiester bonds / eq ; 8. idea of uptake of plasmid by bacterium ;	**QWC Emphasis is on logical sequence** **1 ACCEPT** allele **6 ACCEPT** join for bind **7 ACCEPT** description of a phosphodiester bond	**(6)**

Question Number	Answer	Additional Guidance	Mark
3(b)	Correct answer gains both marks 1. (one gene contains) 580 000÷525 / 1104.76 base pairs ; 2. this is { 2210 / 2209.5 } bases ; **OR** 3. (genome is 580 000 x 2) = 1160 000 bases ; 4. (one gene is 1160 000 ÷ 525) = { 2210 / 2209.5} bases ;	**Allow 1 mark:** 1105 bases	**(2)**

Question Number	Answer	Additional Guidance	Mark
3(c)(i)	1. deoxyribose in DNA AND ribose in RNA ; 2. thymine in DNA AND uracil in RNA ; 3. idea of enzymes being used are different e.g. DNA polymerase v. RNA polymerase ; 4. 2 strands in DNA and 1 strand for RNA ;	**2 ACCEPT** T and U **3 ACCEPT** DNA formed by DNA replication and RNA by transcription **4 ACCEPT** double helix for 2 strands in DNA	**(3)**

Question Number	Answer	Additional Guidance	Mark
3(c)(ii)	so it can be inserted into a bacterium / idea of less likely to degrade ;	**ACCEPT:** less likely to {mutate / break down }	**(1)**
		IGNORE: for storage unqualified	

Question Number	Answer	Additional Guidance	Mark
3(d)	1. idea that product of a gene acts as an inhibitor ; 2. idea of inhibits next gene ; 3. (if) 1st gene active, it inhibits 2nd gene so 3rd gene is active ; 4. Idea of gene is transcribed for a limited time ;	**1 ACCEPT** protein/polypeptide for product, and repressor for inhibitor **3 ACCEPT** other logical sequence e.g. 2, 3 and then 1	**(3)**

Question Number	Answer	Additional Guidance	Mark
3(e)	1. each step requires its own enzyme / eq ;		
	2. to catalyse / control the step ; 3. idea of the product of one step being the {substrate / eq} for the next step ; 4. all steps must function for nitrogen to be converted to ammonia / eq ; 5. idea of involvement of { cofactors / coenzymes / eq } ;	**1 ACCEPT** appropriate ref to specificity e.g. enzyme 1 only acts on substrate 1 **3 ACCEPT** intermediates involved / reactant for substrate **4 ACCEPT** nitrogen gas {reduced to /H^+ added to form} ammonia **5 ACCEPT** ATP / FAD / NAD	**(4)**

Question Number	Answer	Additional Guidance	Mark
3(f)	1. idea of being non-pathogenic ; 2. virus will {identify / bind to / eq} cancer cells / eq ; 3. virus destroys cancer cells / eq ;	**1 ACCEPT** attenuated, harmless **3 ACCEPT** replicates in cancer cells	**(2)**

Question Number	Answer	Additional Guidance	Mark
3(g)	1. (small number of) healthy people / eq ;		
	2. in case the treatment is dangerous / eq ; 3. idea of establishing dosage ;	**2 ACCEPT** ref to side effects, to make sure it is safe	**(3)**

Question Number	Answer	Additional Guidance	Mark
3(h)	<table><tr><th></th><th>Stem</th><th>Ins</th><th></th></tr><tr><td>1.</td><td>{ any / eq } genes can be activated</td><td>most genes deactivated / eq</td><td>;</td></tr><tr><td>2.</td><td>{ un / less } differentiated</td><td>Differentiated</td><td>;</td></tr><tr><td>3.</td><td>cell can continue to divide / no Hayflick limit</td><td>{ limited / no } cell division / Hayflick limited</td><td>;</td></tr><tr><td>4.</td><td>can give rise to various different cell types</td><td>cannot give rise to other types of cell</td><td>;</td></tr><tr><td>5.</td><td>No insulin made / insulin gene not active</td><td>Insulin made / insulin gene active</td><td>;</td></tr><tr><td>6.</td><td>Found in various locations / named location (other than pancreas)</td><td>Found in pancreas</td><td>;</td></tr></table>	**1 ACCEPT** switched off **2 ACCEPT** specialised for differentiated	**(3)**

Question Number	Answer	Additional Guidance	Mark
3(i)	radiation could lead to { cancer / mutation / eq } ;	**ACCEPT:** named example e.g. deletion	**(1)**