

# Biotechnology and Genetic Engineering

## Mark Scheme 1

Level	IGCSE
Subject	Biology
Exam Board	CIE
Topic	Biotechnology and Genetic Engineering
Paper Type	(Extended) Theory Paper
Booklet	Mark Scheme 1

Time Allowed: 68 minutes

Score: /56

Percentage: /100

1 (a)	taking a, gene/DNA/ allele, from one species ; inserting it into another organism ;  OR  changing the, genetic material/ chromosome of, an organism/ cell ; by removing/ changing/ inserting, <u>genes</u> / <u>DNA</u> / <u>alleles</u> ;	max [2]																						
(b)	<table><tr><th>Letter from fig</th><th>Name</th><th>Descrip</th></tr><tr><td>M</td><td>chromosomes</td><td>threads of DNA found in the nucleus</td></tr><tr><td>N</td><td>gene/ allele ;</td><td>section of DNA removed from human cell</td></tr><tr><td>Q</td><td>plasmid</td><td>vector / loop/ circle, of DNA (that can carry a foreign section of DNA) / separate piece of DNA (from chromosome) ;</td></tr><tr><td>R</td><td>bacterial (cell) ; A yeast</td><td>type of cell that is genetically engineered</td></tr><tr><td>O</td><td>insulin/ protein ;</td><td>specific chain of amino acids coded by the section of DNA removed from the human cell</td></tr><tr><td>P</td><td>fermenter</td><td>(container in which) bacteria / microorganisms / cells, reproduce / grow/ produce insulin ;</td></tr></table>	Letter from fig	Name	Descrip	M	chromosomes	threads of DNA found in the nucleus	N	gene/ allele ;	section of DNA removed from human cell	Q	plasmid	vector / loop/ circle, of DNA (that can carry a foreign section of DNA) / separate piece of DNA (from chromosome) ;	R	bacterial (cell) ; A yeast	type of cell that is genetically engineered	O	insulin/ protein ;	specific chain of amino acids coded by the section of DNA removed from the human cell	P	fermenter	(container in which) bacteria / microorganisms / cells, reproduce / grow/ produce insulin ;	[5]	
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2 (a) (i)	all bacteria are, susceptible / sensitive to this antibiotic / not resistant ; (antibiotics) killed the bacteria / stopped bacteria growing / AW ;	[max 1]	R immune (as equivalent to resistance)
(ii)	(all) bacteria are, resistant / not affected (by the antibiotic) / ORA ;	[1]	R immune (as equivalent to resistance) ecf from 2(a)(i)
(iii) 1 2 3	only a few bacteria from the sample are resistant / ORA ; caused, by mutations / genes ; resistant bacteria, grew / reproduced ;	[max 2]	R immune (as equivalent to resistance) ecf from 2 (a)(i) and 2 (a)(ii) A susceptible bacteria did not grow
(b) 1 2 3 4	person may be infected with bacteria, that are resistant to, some / an, antibiotic(s) ; (test) to find the most effective antibiotic ; that kills all bacteria (in the person) ; prevents antibiotic resistance ;	[max 2]	R immune (as equivalent to resistance) No ecf from 2 (a)
(c) 1 2 3 4 5 6 7	prescribe / use antibiotics less often ; not for viral / fungal infections ; make sure people complete the course of antibiotics / AW ; develop new antibiotics ; do not use the same antibiotics for too long / rotate antibiotics / AW ; use combinations of antibiotics ; AVP ; e.g. isolation of patients with antibiotic-resistant infections / good hygiene to prevent spread of infection	[max 4]	

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2 (d) (i)	<table><tr><td>S</td><td></td><td>V</td><td>R</td><td>T</td><td>Q</td></tr></table>	S		V	R	T	Q	[1]	
S		V	R	T	Q				
(ii) 1 2 3 4 5 6 7	easier/quicker, to supply the demand ; more cost effective ; no/less, rejection/allergies/side effects ; human insulin more effective (than animal insulin) ; because can be individually modified ; no risk of transmission of disease from animals ; ethical/religious/animal welfare consideration ;	[max 3]							
		[Total:14]							

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Question			E Answers	Marks	Additional Guidance
3	(a)	(i)	amino acids ;	[1]	A (di/oligo/poly)peptide
		(ii)	(permanent) increase in, size/length/AW ; increase in <u>dry</u> mass ; increase in <u>cell</u> number ;	[max 2]	<b>Note:</b> increase in dry mass = 2 marks <b>A</b> ref to cell division/mitosis/reproduction of cells <b>R</b> reproduction unqualified <b>ignore</b> development
	(b)	1 2 3 4 5 6 7 8	identify/locate, the (position of) gene (in bovine genome) ; cutting, chromosome/DNA/plasmid ; insert gene into a, plasmid/vector ; plasmid/vector, enters the bacterium ; reproduction/growth, of (GM) bacteria (in fermenters) ; bacteria, synthesise/produce, the protein/BST ; protein/BST, harvested/purified ; correct reference to (named) enzyme ;	[max 3]	<i>answers referring to insulin can be credited with marking points 2,3,4,5,8</i>  e.g. restriction enzyme/ligase/endonuclea

3	(c)	(i)	<p><i>mean milk yield to max 4</i></p> <p>1 immediate increase (from treatment/week 10) ;</p> <p>2 peaks/increases and decreases ;</p> <p>3 (general) decrease after 20 weeks/43.3 – 43.7 kg per day ;</p> <p>4 (mean) BST/<b>A</b>, yield always higher than, <b>B</b>/no BST (from 10 week/treatment) ;</p> <p>5 any suitable data quote giving mean milk yield with units and week ;</p> <p><i>mean food energy intake to max 4</i></p> <p>6 peaks/increase and decreases ;</p> <p>7 (then) levels off ;</p> <p>8 (mean) BST/<b>A</b>, energy always higher than, <b>B</b>/no BST (from 10 week/treatment) ;</p> <p>9 any suitable data quote giving mean food energy intake with units and week ;</p>	<p><b>Note:</b> All units (kg per day) must be stated for mean milk yield but <b>ignored</b> for food energy intake</p> <p><b>A</b> optimum/maximum for peak</p> <p><b>MP 5</b>  39 kg per day at, 10 weeks/start of treatment  43.3–43.7 kg per day at <i>either</i> 19/20 weeks <i>or</i> 9/10 weeks, after treatment  29 kg per day at <i>either</i> 36–37 weeks <i>or</i> 26 - 27 weeks, after treatment  approx 10 kg per day difference between <b>A</b> and <b>B</b></p> <p><b>MP 9</b>  158 MJ per day at, 10 weeks/start of treatment  164 MJ per day from <i>either</i> week 29 – 34 <i>or</i> after 19–24 weeks of treatment  165 MJ per day at <i>either</i> week 36–37 <i>or</i> 26–27 weeks, after treatment  172 MJ per day at 19.5–20 weeks</p>	[max 6]
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Question			Answers	Marks	Additional Guidance
3 (c)	(ii)	<p>1 milk yield does not increase much (from initial yield) ;</p> <p>2 increase only for, 10 weeks/short period ;</p> <p>3 increase in food (energy) intake ;</p> <p>4 cattle feed adds extra costs ;</p> <p>5 <i>idea of</i> milk yield decreases but food (energy) intake remains high (from 20 week) ;</p> <p>6 use of comparative data in support ;</p> <p>7 cost of, using/producing, BST ;</p>		[max 3]	<p><b>MP 6</b></p> <p>after, 30 weeks/20 weeks treatment, differences in milk yield <math>10 \pm 2</math> kg (per day), differences in food energy 26–52 MJ (per day)</p> <p>milk yield shows a <math>20 \pm 2\%</math> increase, food intake shows a 15 – 32 % increase after, 30 weeks/20 weeks treatment</p>
	(d)	<p>1 labelling, provides information/allows consumer choice ;</p> <p>2 concerns about hormones 'in the milk' ;</p> <p>3 possible effects on human health ; e.g. allergies/side effect</p> <p>4 ref to, animal welfare/health of cattle expected to produce more milk ;</p> <p>5 there is no reason to label the milk/described example ;</p>		[max 3]	<p><b>ignore</b> unethical unqualified</p> <p><i>examples for MP5</i></p> <p>confusion in consumer minds about GM food</p> <p>loss in sales</p> <p>there is no difference in the milk</p> <p>this is not a GM food, but GM technology is used in the production of BST</p> <p><b>ignore</b> 'milk is safe'</p>
			<b>[Total: 18]</b>		



Question		Answers	Marks	Additional Guidance
4	(a)	ref. to limiting factor(s) ; nutrients used up ; no space ; oxygen used up ; build up of waste ; waste is toxic ; pH could change to be unsuitable ;	[max 3]	<b>A</b> (fungus) reached carrying capacity <b>A</b> food  <b>R</b> any references to temperature
	(b)	<i>general</i> mixes nutrients with fungus ; increases contact between fungus and nutrients ; <i>air</i> (provides oxygen) for <u>aerobic</u> respiration ; releases energy for, growth / reproduction ; <i>ammonia</i> provide <u>nitrogen</u> for making, amino acids / proteins ; provide alkaline conditions / helps maintain pH ;	[max 3]	     <b>R</b> 'produce' energy  <b>A</b> mycoprotein / nucleic acids
	(c)	<u>optimum</u> ; reactions occur at a constant rate ; if higher, enzymes <u>denature</u> ; therefore, no growth / fungus dies / reaction stops; if lower, rate of reactions is (too) slow / enzyme activity slows ; ref. to collisions ; therefore slow growth ; heat is generated during respiration ;	[max 4]	<b>ignore</b> reference to economic consequences / productivity
	(d)	glucose / air / ammonia, continually supplied ; fungus continually removed ; remove, waste product(s) / carbon dioxide ; optimum / AW, temperature, ref. to heat exchanger / cold water ;	[2]	<b>A</b> nutrients / raw materials <b>R</b> food here <b>A</b> unlimited supply <b>R</b> mycoprotein removed

4	(e)	improve / give, taste / flavour; preservation / lengthen shelf life / AW ; give colour ; give texture / shape ; AVP ; e.g. improve appearance	[max 2]	<b>R</b> add nutrients / named nutrients <b>R</b> keep fresh
			<b>[Total: 14]</b>	

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