

Question	Expected Answer	Mark	Additional Guidance
1 (a) (i)	microbes / (living) organisms / cells / enzymes ; (make) product / for human benefit / (carry out) conversion / reaction / industrial process ;		<p>CREDIT microorganisms / bacteria / prokaryotes / fungi CREDIT living things CREDIT cell components / parts of cells</p> <p>CREDIT example such as (named) food or medicine BUT IGNORE cheese (as stated in question) IGNORE process unqualified</p>
1 (a) (ii)	microbes / AW , killed / removed / not present ; enzymes <u>denatured</u> ; (so no) competitors / unwanted reactions / (human) health risk ;	2	<p>Mark the first two suggestions IGNORE contamination / sterile IGNORE idea of preserving milk</p> <p>AW for microbes as in (a)(i) plus ACCEPT organisms</p> <p>DO NOT CREDIT microbes denatured</p> <p>CREDIT (no) competition CREDIT (no) food spoilage / change of flavour / loss of quality CREDIT (no) pathogens / harmful microbes / TB</p> <p>“Kills harmful microbes” or “Kills pathogens” scores 2 marks (mps 1 & 3)</p>
		2 max	

Question	Expected Answer	Mark	Additional Guidance
1 (b) (i)	1 enzyme ; plus any 2 of the following (enzyme) not, changed / used up ; ora 3 idea of ESC (forms) / substrate and enzyme (bind) ; 4 products (and enzyme) released at end ;	1	Award mp 1 plus 2 max from the other mark points 1 ACCEPT globular / tertiary / catalyst / catalytic (protein) 2 ora = can be used again / re-used IGNORE enzyme recycled 3 ESC = enzyme-substrate complex ACCEPT substrate entering active site
1 (b) (ii)	1 (enzyme can be removed to be) used again ; 2 (enzyme can) to leave pure(r) product ; ora 3 (enzyme) more stable / more efficient / works better ;	max 2	Mark the FIRST suggestion on each numbered line IGNORE 'cheaper' without qualification 2 ACCEPT cheaper / easier, downstream processing 3 CREDIT less susceptible to, pH / temperature, change / extremes "enzymes work at high temperatures" = 0 "enzymes work at higher temperatures" = 1 (because comparative statement made)
		2	

Question	Expected Answer	Mark	Additional Guidance
1 (c)	<p>This is a QWC question Section I - Obtaining the gene use restriction, enzyme / endonuclease ; to, cut out / get / isolate, (rennin) gene / DNA coding for rennin <u>or</u> to, fragment / digest, DNA ;</p> <p>3 gene probe ; OR 4 obtain rennin mRNA ; 5 (use) reverse transcriptase ; 6 to make cDNA ; OR 7 sequence, rennin (protein) ; 8 work out base code ; 9 make this DNA sequence ;</p> <p>10 sticky ends ;</p> <p>Section II - Vector cut (open), plasmid / phage ;</p> <p>12 using same <u>restriction</u> enzyme ;</p> <p>13 annealing / base pairing of sticky ends ; 14 join sugar-phosphate backbones ; 15 (using DNA) ligase ; 16 <u>recombinant</u>, vector / plasmid / phage / DNA ;</p> <p>Section III - Introduction into host cell mix with bacteria ; detail of conditions ; <u>transformation</u> (plasmid) / <u>transduction</u> (phage) ;</p>		<p>1 CREDIT named example e.g. <i>Eco</i> R1, <i>Bam</i> H1, <i>Hin</i> dIII 2 DO NOT CREDIT 'cut gene' IGNORE 'break up DNA'</p> <p>NOTE 1-9 CREDIT whichever of the three alternative "obtaining the gene" protocols yields most marks, either award marking points 1-3 or 4-6 or 7-9</p> <p>10 can be awarded, once only, in Sections I or II</p> <p>11 DO NOT CREDIT 'cut out plasmid' DO NOT CREDIT 'ring of DNA' unless it is clear that plasmid is being referred to</p> <p>12 CREDIT same named enzyme (re. mp1)</p> <p>13 CREDIT idea of sticky end bases hydrogen bonding 14 CREDIT formation of phosphodiester bonds</p> <p>18 e.g. Ca²⁺ ions added / heatshock (freeze then inc to 40°C) 19 CREDIT transform / transformed / transduce / transduced IGNORE transgenic</p>
		max 7	
	<p>QWC – sequencing of steps – at least 1 mark point scored from each of the three sections, in the correct order ;</p>	1	<p>I. obtaining gene (mp 1 – 9) followed by II. vector (mp 13 – 16) followed by III. introduction to host cell (mp 17 – 19)</p>
	TOTAL	17	

Question	Expected Answer	Mark	Additional Guidance										
5 (a) (i)	<p>1 lag phase / slow increase (in , population / number / percentage), at start / initially / day 0 - 1 / during day 1 ;</p> <p>2 log phase / exponential increase / rapid increase, day 1 - 3 ;</p> <p>3 <u>rate of increase</u>, slows / less steep, days 3 - 4 / during day 3 ;</p> <p>4 stationary phase / population levels off / population stays at 100% , at end / finally / remaining days / days 4 - 6 ;</p> <p>5 comparative figures quoted with 2 x-y readings ;</p>	4 max	<p>IGNORE explanations ACCEPT 'the population grows' or 'it grows' (rather than increase) DO NOT CREDIT 'yeast grow(s)'</p> <p>1 ACCEPT days 0 - 0.9 ACCEPT lasts 1 day</p> <p>2 ACCEPT days 0.9 - 3.5</p> <p>3 ACCEPT days 3.3 - 3.6</p> <p>4 ACCEPT after day 3.5 - 4</p> <p>5 Each unit must be quoted at least once</p> <table border="1" data-bbox="933 324 1141 851"> <thead> <tr> <th>Time (days)</th> <th>Yeast (% final population)</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>24</td> </tr> <tr> <td>1</td> <td>32</td> </tr> <tr> <td>3</td> <td>90</td> </tr> <tr> <td>3.5 - 6</td> <td>100</td> </tr> </tbody> </table> <p>Take care to distinguish between an increase in percentage (by either quoting the figures for the days or by calculating the difference) and a percentage increase.</p>	Time (days)	Yeast (% final population)	0	24	1	32	3	90	3.5 - 6	100
Time (days)	Yeast (% final population)												
0	24												
1	32												
3	90												
3.5 - 6	100												

Question	Expected Answer	Mark	Additional Guidance
5 (a) (ii)	<p>1 sugar converted to ethanol ;</p> <p>2 in <u>anaerobic respiration</u> ;</p> <p>3 sugar , undergoes glycolysis / converted to pyruvate ;</p> <p>4 pyruvate , loses carbon dioxide / decarboxylated / forms ethanal ;</p> <p>5 reduced NAD giving hydrogen to <u>ethanal</u> ;</p> <p>6 <i>idea of</i> NAD being , regenerated / recycled , (so) glycolysis continues ;</p> <p>7 correct ref to , pyruvate decarboxylase / ethanol dehydrogenase ;</p>	3 max	<p>CREDIT glucose / maltose / maltotriose for 'sugar'</p> <p>2 IGNORE fermentation</p> <p>5 CREDIT NADH₂ / NADH (+H⁺) / red NAD</p>
5 (a) (iii)	<p><i>ethanol is</i> produced in , all yeast growth phases / all of the time</p> <p>or</p> <p>production of ethanol increases as yeast population increases</p> <p>or</p> <p><i>idea that</i> ethanol is a normal (metabolic waste) product (of yeast) ;</p>	1	<p>IGNORE ref to ethanol not being a secondary product</p> <p>CREDIT 'produced during normal growth'</p> <p>CREDIT follows growth curve for yeast</p> <p>IGNORE waste unqualified</p>

Question	Expected Answer	Mark	Additional Guidance
5 (a) (iv)	<ol style="list-style-type: none"> 1 sugar <u>concentration</u> falls too low ; 2 pH falls too low / conditions become too acidic / decrease in pH causes enzymes to denature ; 3 high ethanol <u>concentration</u> , damages / poisons / inhibits , yeast ; 		<ol style="list-style-type: none"> 1 ACCEPT very low sugar concentration / sugar concentration decreases as used up 2 ACCEPT very low pH / very acidic DO NOT CREDIT 'falls and rises' 3 ACCEPT high ethanol <u>concentration</u> kills yeast
5 (b)	<ol style="list-style-type: none"> 1 glucose can , be used / enters glycolysis , directly / without being broken down (first) ; 2 maltose, must , be <u>hydrolysed</u> / have <u>glycosidic</u> bonds broken ; 3 enzyme / maltase , only made when , needed / maltose present / glucose running out ; 4 enzyme induced / gene(s) switched on ; 5 transcription <u>and</u> translation / protein synthesis , takes time ; 6 maltotriose requires, more (2) <u>hydrolysis</u> (reactions) / breaking of more (2) <u>glycosidic</u> bonds or enzyme to break down maltotriose made last ; 	2 max	<p>ACCEPT 'monosaccharide' for glucose and 'disaccharide' for maltose and 'trisaccharide' for maltotriose throughout</p> <ol style="list-style-type: none"> 1 IGNORE ref to glucose being used first / at start / immediately (as stated in Q)
		3 max	

Question	Expected Answer	Mark	Additional Guidance
5 (c)	<p><i>advantages of using yeast</i></p> <p>A1 less energy required ;</p> <p>A2 does not need , high temperature / 300°C / high pressure ;</p> <p>A3 can use waste material (as a substrate) ;</p> <p>A4 substrate is , sustainable / grown each year ;</p> <p>A5 process does not use up , oil reserves / fossil fuels ;</p> <p>A6 product is carbon neutral / no carbon footprint ;</p> <p>A7 AVP ;</p> <p><i>disadvantages of using yeast</i></p> <p>D1 time consuming / takes several days ;</p> <p>D2 needs , downstream processing / purification of product ;</p> <p>D3 is killed by product ;</p> <p>D4 can (only) use batch method ;</p> <p>D5 aseptic / sterile , conditions required ;</p> <p>D6 AVP ;</p> <p>QWC ;</p>	5 max 1	<p>CREDIT statements relating to yeast method only IGNORE statements relating to chemical method IGNORE ref to cost</p> <p>A2 ACCEPT works well at low , temperatures / pressures</p> <p>A3 CREDIT example e.g. sugar cane waste</p> <p>A6 IGNORE ref to global warming / greenhouse gases</p> <p>A7 e.g. yeast is readily available / easily accessible / yeast is in plentiful supply / yeast has simple growth requirements / process is less hazardous</p> <p>D1 ACCEPT slower rate of reaction D2 ACCEPT need to separate ethanol from yeast D3 ACCEPT is inhibited by product</p> <p>D5 ACCEPT more likely to become contaminated D6 e.g. concentration of ethanol produced is limited</p> <p>Award if 2 A marks <u>and</u> 2 D marks have been awarded</p> <p>Place a tick or a cross alongside the pencil icon to indicate whether or not the QWC mark has been awarded.</p>
	Total	19	

Question	Answer	Marks	Guidance
1 (a)	reduce / slow, flow rate ; repeat process / run milk through again ; test for (named) sugars in milk ;	2	ACCEPT close tap for a time period CREDIT glucose, galactose, lactose, Benedict's test
(b) (i)	<i>any two from</i> hydrophobic / ionic bond, to (named), solid / support ; covalent bond / cross-link to, (named) substance; membrane separation ; (en)trap / encapsulate / suspend, in (named), matrix ;	2	Mark as prose. IGNORE ref to cross-linking agents ACCEPT 'insoluble material for solid. Suitable solids = clay, carbon, resin, glass, gold, ceramic beads. CREDIT adsorption (but not absorption) CREDIT carrier bound. CREDIT cross-link them together. Suitable substances = other enzymes, collagen, cellulose. ACCEPT microcapsules Suitable matrix materials = collagen, cellulose, silica gel, hydrogel, but DO NOT CREDIT entangled / alginate
(ii)	1 (enzyme) can be re-used so reduces cost ; 2 product, pure(r) / uncontaminated ; 3 reduced downstream processing costs ; 4 (immobilised enzyme) works at high(er) temperature ; 5 (immobilised enzyme) works in changed pH ; 6 reaction, can be faster / have higher yield , because can be done at higher temperature ;	4	2 ACCEPT product not mixed with enzyme 3 ACCEPT save money on purifying product 4 CREDIT enzymes not denaturing at increased temperature CREDIT immobilised enzymes thermostable 5 CREDIT enzymes not denaturing in changed pHs 6 This explanation scores mp 4 and mp 6 (unless mp 4 already awarded).
	Total	8	

Question	Answer	Marks	Guidance
4 (a)	<p>1 mutation ;</p> <p>2 <u>meiosis</u> ;</p> <p>3 cross(ing)-over ;</p> <p>4 between non-sister chromatids ;</p> <p>5 (in) <u>prophase I</u> ;</p> <p>6 independent / random , assortment / segregation ;</p> <p>7 (in) <u>metaphase</u> ;</p> <p>8 <i>idea of</i> random , fertilisation / fusion of gametes ;</p> <p>9 AVP ;</p>	5	<p>1 CREDIT in context of gene or chromosome mutation ACCEPT a suitable description e.g. change in DNA base sequence / non-disjunction</p> <p>2 DO NOT CREDIT incorrect spelling of meiosis</p> <p>3 ACCEPT formation of chiasmata</p> <p>4 DO NOT CREDIT sister here (CON) but IGNORE sister for mp 3 and mp 5 needs to be in context of 3 or 4</p> <p>6 ACCEPT description e.g. random alignment of bivalents</p> <p>7 needs to be in context of 6 metaphase I (chromosomes) or I I (chromatids) IGNORE anaphase</p> <p>8 CREDIT description relating to plant (as Q states rhu barb) e.g. any pollen grain could land on any stigma / any pollen grain could reach any ovule</p> <p>9 ref. epigenetics</p>

Question		Answer	Marks	Guidance
4	(b) (i)	reproductive ; cloning ;	2	ACCEPT 'whole organism'
4	(b) (ii)	(callus / plant) tissue culture / micropropagation ;	1	Mark the first answer. If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = 0 marks ACCEPT tissue culturing / micropropagating IGNORE cloning
4	(b) (iii)	<i>they have different (qualitatively or quantitatively)</i> 1 genes / DNA / alleles / genotypes ; 2 repressor proteins ; 3 enzymes ; 4 protein folding / tertiary structure / thermostability ; 5 (plant) growth regulators / hormones ;	2	Mark the first 2 suggestions. Must have 'different' idea at least ONCE e.g. higher / only one of them has x
4	(c)	1 (test) different varieties ; 2 several plants or leaves (of each) / repeat readings ; 3 same age ; 4 same soil , type / mineral content / pH ; 5 same light , exposure / conditions ; 6 same , watering regime / temperature / <u>CO₂ concentration</u> ;	5	3 CREDIT different enzymes or different amounts 4 CREDIT enzyme activity at different temperatures 5 ACCEPT PGRs / named hormones eg gibberellins 1 ACCEPT 'Timperley Early' and 'Victoria' IGNORE species 2 ACCEPT three or more CREDIT 'control / controlled' for 'same' in mps 3,4,5,6 & 7 4 IGNORE soil nutrient level or content 5 CREDIT light intensity / wavelength / duration IGNORE amount of light <i>If none of mps 4-6 awarded</i>

Question	Answer	Marks	Guidance
	<p>7 same, preparation or testing procedure detail ; (e.g. leaf mass / volume of solvent / soaking time / temperature)</p> <p>8 test / measure, (oxalic) acid concentration / acidity / pH / H⁺ ion concentration ;</p> <p>9 detail of measuring method ;</p>		<p>ACCEPT 'grown under same conditions' for 1 mark and dot for QWC if stated as controlled</p> <p>7 IGNORE amount (of solvent / water / ethanol / alcohol) or size (of leaf). Procedure can be liquidising/pestle and mortar, stated same for each.</p> <p>8 IGNORE amount / content / how much (of acid or H⁺ ions) except for QWC</p> <p>9 e.g. pH probe universal indicator (not litmus) titration IGNORE colorimetry</p>
QWC ;		1	<p>Award if variables correctly identified as independent (1 only) and controlled (any of 3/4/5/6/7) and dependent (8 only).</p>

Question		Answer	Marks	Guidance
4	(c)	<p>1 bacteria / fungi ;</p> <p>2 <i>idea of external digestion ;</i></p> <p>3 by , enzymes / named enzymes ;</p> <p>4 absorption of breakdown products ;</p> <p>5 release of carbon dioxide and water ;</p> <p>6 (breakdown of protein) makes , ammonium , ions / compounds or NH_4^+ ;</p>	3	<p>1 DO NOT CREDIT wrong bacteria eg nitrogen fixing, nitrifying, denitrifying, <i>Rhizobium</i>, <i>Nitrosomonas</i>, <i>Nitrobacter</i></p> <p>2 CREDIT saprotrophic / saprophytic / saprobiotic ACCEPT 'breaking down' for digestion e.g. cellulase / lignase</p> <p>3</p> <p>6 CREDIT ammonification IGNORE ammonia / nitrates</p>
4	(d)	<p>auxin / IAA ;</p> <p>not destroyed by light / more present in dark ;</p> <p>moves down from shoot tip / uniformly distributed ;</p> <p>(causes) <u>cell</u> elongation ;</p>	2	<p>IGNORE gibberellins and references to phototropism and more light on one side</p>
Total			21	

Question	Answer	Marks	Guidance
6 (a)	P lag ; Q log(arithmetic) / exponential ; R stationary ;	3	Mark the first answer on each prompt line. If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = 0 marks IGNORE plateau
6 (b)	(molecule made in or needed for cell's normal) survival / function / growth / development / reproduction ; named example ;	2	IGNORE metabolism (as stated in Q) / phase e.g. glucose / sucrose / (named) amino acid / CO ₂ / ethanol / (named) nucleotide / named named respiratory intermediate / (named) protein / (named) enzyme DO NOT CREDIT antibiotics
6 (c) (i)	Q ;	1	Mark the first answer. If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = 0 marks ACCEPT log / exponential
6 (c) (ii)	R ;	1	Mark the first answer. If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = 0 marks ACCEPT stationary
6 (c) (iii)	R / S ;	1	Mark the first answer. If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = 0 marks ACCEPT stationary / decline / death (phase)

Question	Answer	Marks	Guidance														
6	(d)	4															
(i)	<table border="1" data-bbox="268 376 1279 1796"> <thead> <tr> <th data-bbox="268 376 322 452">factor (F)</th> <th data-bbox="268 452 322 1796">change needed (C)</th> </tr> </thead> <tbody> <tr> <td data-bbox="322 376 450 452">oxygen ;</td> <td data-bbox="322 452 450 1796">increase it / more / high or stir / sparging ;</td> </tr> <tr> <td data-bbox="450 376 577 452">(named) nutrient ;</td> <td data-bbox="450 452 577 1796">increase it / more / high or stir ;</td> </tr> <tr> <td data-bbox="577 376 785 452">temperature ;</td> <td data-bbox="577 452 785 1796">maintain at / control at / change to , optimum or cool or ref. to using water jacket ;</td> </tr> <tr> <td data-bbox="785 376 944 452">pH ;</td> <td data-bbox="785 452 944 1796">maintain at / control at / change to, optimum or add, buffer / acid / alkali ;</td> </tr> <tr> <td data-bbox="944 376 1040 452">(waste) product / gas / CO₂ ;</td> <td data-bbox="944 452 1040 1796">harvest / remove / waste gas vent ;</td> </tr> <tr> <td data-bbox="1040 376 1279 452">other / unwanted / harmful / competing , microbes ;</td> <td data-bbox="1040 452 1279 1796">prevent entry / asepsis ;</td> </tr> </tbody> </table>	factor (F)	change needed (C)	oxygen ;	increase it / more / high or stir / sparging ;	(named) nutrient ;	increase it / more / high or stir ;	temperature ;	maintain at / control at / change to , optimum or cool or ref. to using water jacket ;	pH ;	maintain at / control at / change to, optimum or add, buffer / acid / alkali ;	(waste) product / gas / CO ₂ ;	harvest / remove / waste gas vent ;	other / unwanted / harmful / competing , microbes ;	prevent entry / asepsis ;	4	<p>Mark the first suggestion on each prompt line. If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = 0 marks</p> <p>C CREDIT idea of paddles distributing the available oxygen more evenly</p> <p>C ACCEPT continuous, adding / supply, of oxygen</p> <p>IGNORE aeration as named F but ACCEPT for C</p> <p>C CREDIT idea of paddles distributing the available nutrients more evenly</p> <p>C ACCEPT continuous, adding / supply, of nutrients</p> <p>IGNORE food as named F but ACCEPT for C</p> <p>C ACCEPT 'suitable' for 'optimum' temperature</p> <p>ACCEPT prevent overheating / enzymes denaturing</p> <p>C ACCEPT 'suitable' for 'optimum' pH</p> <p>ACCEPT prevent enzymes denaturing</p> <p>C CREDIT reduce pressure (for waste gases)</p> <p>F CREDIT named microbes e.g. bacteria / fungi / pathogens</p> <p>C CREDIT idea of use of filters or aseptic techniques</p>
factor (F)	change needed (C)																
oxygen ;	increase it / more / high or stir / sparging ;																
(named) nutrient ;	increase it / more / high or stir ;																
temperature ;	maintain at / control at / change to , optimum or cool or ref. to using water jacket ;																
pH ;	maintain at / control at / change to, optimum or add, buffer / acid / alkali ;																
(waste) product / gas / CO ₂ ;	harvest / remove / waste gas vent ;																
other / unwanted / harmful / competing , microbes ;	prevent entry / asepsis ;																

Question	Answer	Marks	Guidance
6 (d) (ii)	<ol style="list-style-type: none"> 1 (child's) cells / DNA / genes / alleles, not changed ; 2 vector not used (in child) ; 3 child / cells , not producing , HGH / hormone ; 4 HGH / drug / injection , has to be given repeatedly / is a short term solution / not a cure ; 	3	<p>ACCEPT reverse reasoning throughout e.g. 1 in gene therapy , the person's cells are altered / a functional allele is introduced.</p> <ol style="list-style-type: none"> 1 DO NOT ACCEPT gene replacement ACCEPT genotype 2 CREDIT named vector 3 CREDIT (the) protein / polypeptide
	Total	15	

Question	Answer	Mark	Guidance
4 (a)	<p><i>fungal</i> long cells / hyphae OR multinucleate OR <u>chitin</u> cell wall ;</p> <p><i>bacterial</i> free DNA / DNA not in a nucleus OR circular DNA (molecule) OR naked DNA / no histones OR peptidoglycan / murein, cell wall OR smaller / 70S / 18nm, ribosomes ;</p>	1	<p>FA for each microorganism IGNORE prokaryotic / eukaryotic (as given in question)</p> <p>ACCEPT no nucleus / nuclear envelope</p> <p>IGNORE loop, plasmids, nucleoid</p>
(b)	<u>disease-causing</u> (organism) ;	1	IGNORE harmful, infection

Question	Answer	Mark	Guidance
4	<p>(c)</p> <p>1 What is <i>biotechnology</i>? large-scale / industrial / commercial use (of living organisms / enzymes) ;</p> <p>2 to produce, food / named example ;</p> <p>3 detail of, microbe / enzyme , involved ;</p> <p>4 to produce, drugs / named example ;</p> <p>5 detail of, microbe / enzyme , involved ;</p> <p>6 to make, (useful) enzymes / biogas / calcium citrate / for bioremediation / for water treatment / for microbial mining ;</p> <p>7 Advantages of <i>microorganisms</i> fast, growth / reproduction / products ;</p> <p>8 microbes can be genetically engineered ;</p> <p>9 processes occur at low , temperatures / pressures ;</p> <p>10 low , temp / pressure , cheaper / safer , to maintain ;</p> <p>11 products , pure / easy to separate ;</p> <p>12 grow on unwanted, food / nutrients ;</p> <p>13 AVP ;</p> <p>QWC – balanced account ;</p>	7 max	<p>2 e.g. cheese / yogurt / beer / wine / cider / vinegar / soya sauce / mycoprotein / etc. 3 e.g. <i>Lactobacillus</i> / yeast / <i>Fusarium</i> / etc. IGNORE wrong kingdom</p> <p>4 e.g. antibiotic / penicillin / augmentin / insulin</p> <p>5 e.g. <i>Penicillium</i> IGNORE wrong kingdom</p> <p>6 e.g. detergent enzymes, pectinase, sewage treatment, blue technology</p> <p>8 ACCEPT in context of example mps 1 - 6</p> <p>10 CREDIT less energy used for low, temp /pressure</p> <p>11 ACCEPT little downstream processing</p> <p>12 ACCEPT named e.g. whey, starch waste.</p> <p>13 e.g. no animal welfare issues Award QWC if 2 marks awarded from mps 1 – 6 and 2 marks awarded from mps 7 – 13</p>
	Total	11	

Question	Answer	Marks	Guidance
5	<p>BIOTECHNOLOGY</p> <p>ASEPTIC</p> <p>FUNGI</p> <p>CONTINUOUS</p> <p>IMMOBILISATION</p>	5	CREDIT asepsis for aseptic (3 down)
Total		5	

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4 (a) (i)	<p>1 <i>description</i> lactose decreases <u>and</u> qualified ;</p> <p>2 ammonia decreases <u>and</u> qualified ;</p> <p>3 ammonia , plateaus / constant , at c. 2 (a.u.) (between 55 -140 h) ; max 2</p> <p>4 <i>explanation</i> idea that lactose / ammonia , used , for growth / to make biomass ;</p> <p>5 lactose / ammonia , used to make penicillin ;</p> <p>6 lactose broken down to glucose (and galactose) ;</p> <p>7 lactose / glucose , used for , respiration / energy ;</p> <p>8 ammonia used to make named N-containing molecule ; max 2</p>	<p>1</p> <p>2</p> <p>3</p> <p>4</p> <p>5</p> <p>6</p> <p>7</p> <p>8</p> <p>4 max</p>	<p>max 2 for description and max 2 for explanation</p> <p>If bacteria mentioned, penalise once and then apply ecf.</p> <p>If incorrect units used, penalise the mark point and then apply ecf for subsequent mark points.</p> <p>eg • single figure quote either at start (96 / 97 (a.u.)) or levelling-off point (45 - 60 h) or end (65 -70 h)</p> <p>eg • single figure quote either at start (34 (a.u.)) or levelling-off point (40 - 55 h)</p> <p>IGNORE ammonia eg • amino acids / protein / nucleotides / nucleic acids / chitin / glycoprotein</p>

Question	Expected Answer	Mark	Additional Guidance
4 (a)	(ii)		If bacteria mentioned, penalise once and then apply ecf. IGNORE incorrect ref to stationary phase
4 (a)	lactose and ammonia levels , stay high / oscillate ; biomass , continues to rise / does not level off ;	2	DO NOT CREDIT 'remains constant' without the idea of more being added ACCEPT 'biomass , rises and falls / levels off' only if reference made to harvesting / removal
4 (b)	(i)	2 max	If bacteria mentioned, penalise once and then apply ecf.
4 (b)	(i)	3 max	If bacteria mentioned, penalise once and then apply ecf.
			<p>1 : IGNORE pathogens</p> <p>2</p> <p>3</p> <p>4</p> <p>5 : DO NOT CREDIT contamination unqualified</p> <p>6</p>

Question	Expected Answer	Mark	Additional Guidance
4 (b) (ii)	temperature - as it affects enzymes ; pH - as it affects enzymes ; oxygen content -- ref. respiration ; AVP ;	3 max	If bacteria mentioned, penalise once and then apply ecf. DO NOT CREDIT air eg <ul style="list-style-type: none"> • salt concentration – affects osmosis / water potential / enzymes • removal of waste gases (CO₂) – reduce pressure / prevents explosion of fermenter • speed of stirrer – ensure even , mixing / temperature
Total		14	