<table>
<tr><th colspan="3">Question</th><th>Expected Answer</th><th>Mark</th><th>Additional Guidance</th></tr>
<tr><td>1</td><td>(a)</td><td>(i)</td><td>
1 lag phase / slow increase
(in , population / number / percentage) ,
at start / initially / day 0 - 1 / during day 1 ;

2 log phase / exponential increase / rapid increase ,
day 1 - 3 ;

3 <u>rate</u> <u>of</u> <u>increase</u> , slows / less steep ,
days 3 - 4 / during day 3 ;

4 stationary phase / population levels off /
population stays at 100% ,
at end / finally / remaining days / days 4 - 6 ;

5 comparative figures quoted with 2 x-y readings ;
</td><td>4 max</td><td>
IGNORE explanations
ACCEPT ‘the population grows’ or ‘it grows’ (rather than increase)
DO NOT CREDIT ‘yeast grow(s)’

1 ACCEPT days 0 - 0.9
ACCEPT lasts 1 day

2 ACCEPT days 0.9 - 3.5

3 ACCEPT days 3.3 - 3.6

4 ACCEPT after day 3.5 - 4

5 Each unit must be quoted at least once

<table>
<tr><th>Time (days)</th><th>Yeast (% final population)</th></tr>
<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>
</table>

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.
</td></tr>
</table>

Question			Expected Answer	Mark	Additional Guidance
1	(a)	(ii)	**1** sugar converted to ethanol **;** **2** in anaerobic respiration **;** **3** sugar **,** undergoes glycolysis / converted to pyruvate **;** **4** pyruvate **,** loses carbon dioxide / decarboxylated / forms ethanal **;** **5** reduced NAD giving hydrogen to ethanal **;** **6** *idea of* NAD being **,** regenerated / recycled , (so) glycolysis continues ; **7** correct ref to **,** pyruvate decarboxylase / ethanol dehydrogenase **;**	**3 max**	**CREDIT** glucose / maltose / maltotriose for 'sugar' **2** **IGNORE** fermentation **5** **CREDIT** $NADH_2$ / NADH ($+H^+$) / red NAD
1	(a)	(iii)	*ethanol is* produced in **, all** yeast growth phases / **all** of the time **or** production of ethanol increases as yeast population increases **or** *idea that* ethanol is a normal (metabolic waste) product (of yeast) **;**	**1**	**IGNORE** ref to ethanol not being a secondary product **CREDIT** 'produced during normal growth' **CREDIT** follows growth curve for yeast **IGNORE** waste unqualified

Question			Expected Answer	Mark	Additional Guidance
1	(a)	(iv)	**1** sugar concentration falls **too** low **;** **2** pH falls **too** low / conditions become **too** acidic / decrease in pH causes enzymes to denature **;** **3** high ethanol concentration **,** damages / poisons / inhibits **,** yeast **;**	**2 max**	**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 concentration kills yeast
1	(b)		**1** glucose can **,** be used / enters glycolysis **,** directly / without being broken down (first) **;** **2** maltose**,** must **,** be hydrolysed / have glycosidic bonds broken ; **3** enzyme / maltase **,** only made when **,** needed / maltose present / glucose running out **;** **4** enzyme induced **/** gene(s) switched on **;** **5** transcription and translation / protein synthesis **,** takes time **;** **6** maltotriose requires, more (2) hydrolysis (reactions) / breaking of more (2) glycosidic bonds **or** enzyme to break down maltotriose made last **;**	**3 max**	**ACCEPT** 'monosaccharide' for glucose and 'disaccharide' for maltose and 'trisaccharide' for maltotriose throughout **1** **IGNORE** ref to glucose being used first / at start / immediately (as stated in Q)

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

Question			Answer		Marks	Guidance
2	(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)	*any two from* 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** **ad**sorption (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 **;**	4	
			2	product**,** pure(r) / uncontaminated **;**		**2 ACCEPT** product not mixed with enzyme
			3	reduced downstream processing costs **;**		**3 ACCEPT** save money on purifying product
			4	(immobilised enzyme) works at high(er) temperature **;**		**4 CREDIT** enzymes not denaturing at increased temperature **CREDIT** immobilised enzymes thermostable
			5	(immobilised enzyme) works in changed pH **;**		**5 CREDIT** enzymes not denaturing in changed pHs
			6	reaction, can be faster / have higher yield , because can be done at higher temperature **;**		**6** This explanation scores mp 4 and mp 6 (unless mp 4 already awarded).
				Total	**8**	

Question			Answer	Marks	Guidance
3	(a)		**P** lag **;** **Q** log(arithmic) / 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
	(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
	(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
	(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
	(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)

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>3</td><td>(d)</td><td>(i)</td><td>
<table>
<tr><th>factor (F)</th><th>change needed (C)</th></tr>
<tr><td>oxygen ;</td><td>increase it / more / high
or
stir / sparging ;</td></tr>
<tr><td>(named)
nutrient ;</td><td>increase it / more / high
or
stir ;</td></tr>
<tr><td>temperature ;</td><td>maintain at / control at /
change to , optimum
or
cool
or
ref. to using water jacket ;</td></tr>
<tr><td>pH ;</td><td>maintain at / control at /
change to, optimum
or
add, buffer / acid / alkali ;</td></tr>
<tr><td>(waste)
product / gas /
CO_2 ;</td><td>harvest / remove /
waste gas vent ;</td></tr>
<tr><td>other /
unwanted /
harmful /
competing ,
microbes ;</td><td>prevent entry / asepsis ;</td></tr>
</table>
</td><td>4</td><td>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
C CREDI idea of paddles distributing the available oxygen more evenly
C ACCEPT continuous, adding / supply, of oxygen
IGNORE aeration as named F but ACCEPT for C
C CREDIT idea of paddles distributing the available nutrients more evenly
C ACCEPT continuous, adding / supply, of nutrients
IGNORE food as named F but ACCEPT for C

C ACCEPT ‘suitable’ for ‘optimum’ temperature
ACCEPT prevent overheating / enzymes denaturing

C ACCEPT ‘suitable’ for ‘optimum’ pH
ACCEPT prevent enzymes denaturing

C CREDIT reduce pressure (for waste gases)

F CREDIT named microbes e.g. bacteria / fungi / pathogens
C CREDIT idea of use of filters or aseptic techniques</td></tr>
</table>

Question			Answer	Marks	Guidance
3	(d)	(ii)	**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	**ACCEPT** reverse reasoning throughout e.g. **1** in gene therapy **,** the person's cells are altered / a functional allele is introduced. **1** **DO NOT ACCEPT** gene replacement **ACCEPT** genotype **2** **CREDIT** named vector **3** **CREDIT** (the) protein / polypeptide
			Total	**15**	

Question			Answer	Marks	Guidance
4	(a)		**C ;** **D ;** **B ;** **A ;**	4	**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**
4	(b)		goal **D ;** **A ;** **B ;** **C ;** **E ;**	5	**Mark the first answer in each box.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks**
			Total	**9**	

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Mark</th><th>Guid</th></tr>
<tr><td>5</td><td>(a)</td><td></td><td>DNA (combined) from (two) , sources / organisms ;</td><td>1</td><td>ACCEPT DNA, contains / has inserted in it, DNA or gene from, other / another, organism / species
ACCEPT foreign for idea of other source</td></tr>
<tr><td></td><td>(b)</td><td></td><td>
<table>
<tr><th>application of genetic modification</th><th>vector</th></tr>
<tr><td>goats making spider silk protein</td><td>BAC /
YAC /
virus /
liposome</td></tr>
<tr><td>somatic gene therapy for a recessive human genetic disorder</td><td>virus /
liposome</td></tr>
<tr><td>plants that express a bacterial toxin that kills insects feeding on them</td><td>Agrobacterium tumefaciens/
(Ti) plasmid /
liposome</td></tr>
<tr><td>bacteria that produce a human protein for therapeutic use</td><td>BAC /
(bacterio)phage /
plasmid</td></tr>
</table>
;
;
;
;
</td><td>4</td><td>FA in each box

DO NOT CREDIT microinjection / electroporation / gene gun (as they are not vectors)

IGNORE tumour forming bacterium</td></tr>
</table>

Question			Answer	Mark	Guid
5	(c)		**1** somatic / adult, cell / nucleus **;** **2** fused with / injected into **;** **3** empty / enucleate **,** egg cell **;** **4** from another goat **;** **5** *idea of* electric shock / electrostimulation **;** **6** this cell or embryo, grown on **,** in vitro / in tied oviduct **;** **7** (early) embryo / blastocyst **,** split **;** **8** *idea that* embryos replaced in **,** surrogate mothers / other females **;** **9** AVP **;**	max 5	**1 ACCEPT** differentiated or body cell or example, e.g. skin cell, udder cell **2 ACCEPT** inserted / placed. If term use is "electrofused" gets mp 2 and mp 5 **4 ACCEPT** named (A, B) or numbered goats **5** "electrofused" gets mp 2 and mp 5 **6 ACCEPT** in petri dish / test tube culture **7 ACCEPT** description of an embryo being split, even if produced by wrong method (IVF) **8 IGNORE** host mothers **9** e.g. further detail of any stage of process correct ref. to haploid / diploid **,** nuclei

Question			Answer	Mark	Guid
5	(d)		*advantages* **A1** all offspring will inherit the, (silk) gene / foreign DNA **;** **A2** all offspring female **;** **A3** certain / all make **,** silk / milk / product **;** **A4** faster / many obtained in a short time **;** **A5** avoid mating risks **;** **max 3 advantages** *disadvantages* **D1** no genetic variability (in population) / AW **;** **D2** (so makes goats) more susceptible to**,** environmental factors / (infectious) disease **;** **D3** cloned animals may, have shorter life spans / be less healthy **;** **D4** *idea that* cloning success rate is very poor **;** **D5** (more) expensive / needs (more) technology / (more) labour intensive **;** **max 3 disadvantages**	5 max	**IGNORE** disadvantages of breeding given in the first (advantages of cloning) section, i.e. **DO NOT CREDIT** reverse arguments **A5 ACCEPT** idea of physical damage or disease transfer **IGNORE** advantages of breeding given in the second (disadvantages of cloning) section, i.e. **DO NOT CREDIT** reverse arguments **D1 ACCEPT** they are all genetically identical **D2 IGNORE** disease if stated to be genetic
			Total	**15**	