Question			Expected Answer	Mark	Additional Guidance
1	(a)	(i)	**X** adenine ; **Y** ribose ; **Z** (tri / 3) phosphate(s) ;	3	**Mark the first answer for each letter.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks** ***X*** **IGNORE** nitrogenous base / base / A **DO NOT CREDIT** adenosine ***Y*** **IGNORE** pentose / sugar **DO NOT CREDIT** ribulose / hexose ***Z*** **IGNORE** chemical formulae (as Q asks for name) **DO NOT CREDIT** phosphorus / phosphoryl (PO)

Question				Expected Answer	Mark	Additional Guidance
1	(a)	(ii)	1	transfers energy / energy 'currency' / releases energy / universal energy molecule / energy intermediate / (immediate) source of energy ;		*1* **IGNORE** contains energy **DO NOT CREDIT** produce energy
			2	phosphate(s) can be removed by hydrolysis ;		*2* $ATP \rightarrow ADP + P_{(i)}$ by hydrolysis **or** $ATP + H_2O \rightarrow ADP + P_{(i)}$ (must include water)
			3	to , release / provide , 30kJ (mol^{-1}) energy ;		*3* **ACCEPT** 28 – 32 kJ **DO NOT CREDIT** produce energy
			4	(energy released for) metabolism / appropriate named reaction / appropriate reaction described ;		*4* e.g. • muscle contraction • active transport • phosphorylation • glycolysis • during movement binding to proteins to change their shape **IGNORE** respiration / photosynthesis unqualified
			5	ADP can attach a phosphate (forming ATP) during , respiration / photosynthesis ;		*5* **CREDIT** during, oxidative phosphorylation / chemiosmosis / substrate level phosphorylation / photophosphorylation
			6	energy released in , small 'packets' (to prevent cell damage) / suitable quantity ;		**NOTE** 'it releases 30kJ of energy when a phosphate is removed by hydrolysis' = 3 marks (mps 3, 1 and 2)
					3 max	

Question			Expected Answer		Mark	Additional Guidance
1	(b)	(i)	crista ;		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** 'cristae' / **'**inner mitochondrial membrane' **IGNORE** 'stalked particles'
1	(b)	(ii)	chemiosmosis / oxidative phosphorylation ;		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** **IGNORE** description of chemiosmosis [e.g. • 'ATP synthesis' • 'electron flow along electron carriers'] **IGNORE** **'**aerobic respiration' **IGNORE** 'electron transport chain' alone (as this is not a process)
1	(c)	(i)	**1**	<u>substrate</u> respired changes over time ;	3 max	***1*** Needs to be a clear statement and not just names and not inferred from candidate's complete answer
			2	initially respires (mostly) **,** glucose / carbohydrate **;**		***2*** **IGNORE** respiring protein
			3	lower / decrease in / 0.75 **,** RQ indicates (more) **,** fat / lipid **,** as substrate ***or*** as time goes by (more) lipid is respired **;**		***3*** **IGNORE** respiring protein
			4	glucose / carbohydrate **,** used up / decreases (over time) **;**		
			5	protein not likely to be used as substrate / protein only used as a last resort **;**		***5*** 'Less protein respired' isn't quite enough for this mp

Question			Expected Answer	Mark	Additional Guidance
1	(c)	(ii)	***This is a QWC question***		**Only CREDIT** answers that refer to **preventing a decrease** in body temperature – no **ora** **IGNORE** negative feedback (Q only about preventing decrease)
			1 **peripheral** / skin , **thermoreceptors** / (heat) receptors , stimulated (by decrease in external temp) ; 2 (impulses sent to / blood temperature monitored in) **hypothalamus** / sensory **cortex** ; 3 **vasoconstriction** of , arterioles / small arteries , to reduce heat loss ; 4 (prevents heat loss by) **radiation** / **conduction** / **convection** ; 5 increased , **metabolic rate** / **metabolism** / respiration , to generate heat (energy) ; 6 (release of) **adrenaline** / **thyroxine** ; 7 shivering / (involuntary) muscle spasms , to generate heat (energy) ; 8 **erector** / hair , muscles raise , (skin) hair / fur , to trap , air / heat ; 9 AVP ;	**4 max**	***3*** **ACCEPT** '<u>pre</u>-capillary sphincter' instead of 'arterioles' **DO NOT CREDIT** other blood vessels **but allow QWC** ***5*** Emphasis needs to be on increase / higher rate / more ***7*** Needs the idea of generating heat not just 'to keep warm ' ***9*** e.g. • specific behavioural response (such as huddling / increased exercise / move to find sun) • involvement of sympathetic nervous system • reduce sweating / reduce panting / stop panting **DO NOT CREDIT** 'stop sweating'
			QWC - technical terms used appropriately and spelt correctly ;	**1**	Use of **three** terms from: **peripheral, thermoreceptor(s), hypothalamus, cortex, vasoconstriction, metabolic rate / metabolism, adrenaline, thyroxine, erector radiation / conduction / convection** **Please insert a QWC symbol next to the mark total bracket, followed by a tick (✓) if QWC has been awarded or a cross (×) if QWC has not been awarded** **You should use the green dot to identify the QWC terms that you are crediting.**
			Total	**[16]**	

Question			Expected Answers	Marks	Additional Guidance
2	(a)		glycolysis / glycolytic pathway ;	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** **CREDIT** phonetic spelling but must have 'glycol...'
2	(a)		cytoplasm ;	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** **CREDIT** cytosol **DO NOT CREDIT** cytoplasm, in / of, mitochondrion
2	(a)	(	**D** ATP ; **E** NAD ; **F** pyruvate ;	3	**Mark the first answer for each letter.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 mark** **E** **ALLOW** oxidised NAD **DO NOT CREDIT** NADP / reduced NAD **F** **ACCEPT** pyruvic acid

Question			Expected Answers		Marks	Additional Guidance
2	(b)					**Award marks from labelled / annotated diagrams – but ensure that mp 2 only awarded if H clearly shown to be accepted by pyruvate**
			1	(pyruvate / **F**) converted to lactate **;**		**1** **ACCEPT** lactic acid **DO NOT CREDIT** if pyruvate → ethanol in the animal is indicated/implied **DO NOT CREDIT** wrong reaction type (e.g. oxidation)
			2	**F** / pyruvate **,** accepts hydrogen (atoms) **;**		**2** **ACCEPT** pyruvic acid **DO NOT CREDIT** hydrogen **ions** (unless also e^-) / molecules
			3	hydrogen from **, reduced** NAD / **reduced E ;**		**3** **ACCEPT** NADH / $NADH_2$ / NADH + H^+
			4	(catalysed by) <u>lactate</u> dehydrogenase **;**		**4** for pyruvate → lactate **ACCEPT** LDH
			5	no, oxygen / O_2 **,** to act as (final), hydrogen / electron, acceptor **;**		
			6	(so) link reaction / Krebs cycle / ETC, cannot take place **;**		**6** Needs a clear statement of **not** taking place **CREDIT** no , electron transport chain / electron carrier chain / chemiosmosis / oxidative phosphorylation
			7	NAD / **E**, regenerated / recycled / able to be re-used **;**		**7** **IGNORE** reduced NAD **,** oxidised / reoxidised (as this does not give the idea of reusing it)
			8	allows glycolysis to continue / pyruvate continues to be made **;**		**8** Needs a clear statement
			9	limited / small amount of / some, ATP can be produced **;**		**9** **CREDIT** 1 ATP (per pyruvate) / 2 ATP (rather than 28-38 per glucose) / only substrate le phosphorylation **IGNORE** 'enough ATP for ...'
					5 max	

Question			Expected Answers		Marks	Additional Guidance
2	(c)		*physical (probably from diagrams)*		S & C	
		1	large nostrils (open) to take in air ;			1 **ACCEPT** oxygen
		2	(when submerged) nostrils close / nose closes , to , keep air in / stop air from escaping ;			2 **ACCEPT** oxygen **IGNORE** ref to keeping water out
		3	lungs / airways , have high (vital) capacity ;			3 **ACCEPT** deep / barrel / large , chest **IGNORE** big lungs **CREDIT** large lung volume / takes in large volume of oxygen / larger numbers of alveoli / larger (exchange) surface area / increased number of capillaries
			links to respiration			
		4	*idea that* seal , has low(er) metabolic rate / has low(er) respiratory rate / has low(er) energy requirements / uses (relatively) little ATP ;			4 e.g. • (streamlined, less resistance so) uses less energy • (insulated so retain heat so) uses less energy • (buoyant so) less energy required • (small flippers so less surface area of extremity so loses less heat so) uses less energy
		5	able to respire anaerobically for a long time / more glycolysis ;			5 'anaerobic' needs time ref
		6	large supplies of NAD (to accept H) ;			
		7	(this) prevents , build-up of lactate / lowering of pH ;			7 **ACCEPT** lactic acid
		8	*idea that* (seal) tolerates lactate / removes lactate quickly ;			8 **ACCEPT** lactic acid
		9	*idea that* (seal) tolerates high CO_2 concentration ;			
		10	*idea that* (seal) tolerates low pH / has **more** pH buffers ;			
			synoptic / inference			
		11	*idea that* blood diverted from certain regions / certain regions have reduced metabolic activity ;			11 **DO NOT CREDIT** zero respiration rate
		12	*idea that* has plenty of , haemoglobin / red blood cells / myoglobin (as oxygen source) ;			
		13	*idea that* haemoglobin has a higher affinity for oxygen / dissociates less readily / dissociation curve shifted to **left** ;		3 max	
				Total	13	

<table>
<tr><th colspan="3">Question</th><th>Expected Answer</th><th>Mark</th><th>Additional Guidance</th></tr>
<tr><td>3</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
3	(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
3	(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
3	(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
3	(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
3	(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			Expected Answer	Mark	Additional Guidance
4	(a)		**1** less ventilation / *Idea of* difficulty in exhaling due to less recoil / small surface area for gaseous exchange / less oxygen entering capillaries / less oxygen entering blood ; **2** less oxygen (reaching cells) for , (aerobic) respiration / oxidative phosphorylation ; **3** (so) less ATP produced ; **4** *idea of* increased acidity (as CO_2 / lactate builds up) interfering with / affects , enzymes / respiratory metabolism ;	**2 max**	**IGNORE** 'produces' energy in any mark point ***1*** **DO NOT CREDIT** **no** oxygen ***2*** **DO NOT CREDIT** **no** respiration ***3*** **DO NOT CREDIT** **no** ATP
	(b)		**1** not enough / less , glucose uptake into <u>cells</u> ; **2** not enough / less , glucose / substrate , for , respiration / ATP production ; **3** glucose not , stored as / converted to , glycogen ;	**2 max**	**ACCEPT** 'sugar' for glucose **IGNORE** (excess) glucose lost in urine (as does not answer the Q) **Only CREDIT ora** if candidate clearly states that the sequence of events does **not** happen in this case ***1*** **DO NOT CREDIT** **no** glucose uptake ***2*** **IGNORE** produces energy **DO NOT CREDIT** **no** respiration / **no** ATP / **no** glucose

Question			Expected Answer	Mark	Additional Guidance
4	(c)				**IGNORE** 'produces' energy in any mark point
			1 *idea of* slow rate of / sluggish , blood flow **or** low(er) blood pressure ;		***1*** **IGNORE** 'heart doesn't beat strongly enough' or 'heart beat is inefficient' **IGNORE** ref to volume of blood without time/rate
			2 less / irregular amount of , oxygen (reaching cells) for , (aerobic) respiration / oxidative phosphorylation ;		***2*** **DO NOT CREDIT** **no** oxygen / **no** respiration
			3 less glucose (reaching cells) for respiration ;		***3*** **IGNORE** sugar **DO NOT CREDIT** **no** glucose / **no** respiration
			4 (so) less ATP produced ;		***4*** **DO NOT CREDIT** **no** ATP
			5 *idea of* increased acidity (as CO_2 / lactate builds up) interfering with / affects , enzymes / respiratory metabolism ;	**2 max**	

Question			Expected Answer	Mark	Additional Guidance
4	(d)	(i)	1 less pyruvate for , link reaction / Krebs cycle **or** link reaction / Krebs cycle , cannot take place / reduced **or** only / mainly , glycolysis takes place ; 2 no / little , oxidative phosphorylation ; 3 less , energy / ATP , for muscle contraction / resulting in muscle weakness / for mental processes ; 4 <u>anaerobic</u> respiration takes place ; 5 lactate / decrease in pH , causing aching muscles ;	3 max	*2* **IGNORE** produces energy *3* **DO NOT CREDIT no** ATP **IGNORE** produces energy **IGNORE** muscle fatigue *5* **CREDIT** 'lactic acid' instead of 'lactate' **ACCEPT** muscle cramps
4	(d)	(ii)	1 *idea that* B lymphocytes do not respond to cytokines (that have been produced) ; 2 little , energy / ATP , for B cell , mitosis / clonal expansion ; 3 little , energy / ATP , for , production / release , of antibodies ;	1 max	
			Total	**10**	