PEARSON EDEXCEL A-LEVEL BIOLOGY B · 9BI0

BIOLOGY



MARK SCHEME

TOPIC 5: ENERGY FOR BIOLOGICAL PROCESSES

LINK REACTION AND KREBS CYCLE

SCORE	PERCENTAGE
/241	%

STEMUP

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Mark Scheme

Q1.

Question Number	Answer	Mark
(a)	molecule R - ATP / adenosine triphosphate ; molecule S - ADP / adenosine diphosphate ;	**(2)**

Question Number	Answer	Mark
(b)(i)	1. carbon dioxide / CO_2 ; 2. idea that the C has been removed from C_6 or C_5 ;	**(2)**

Question Number	Answer	Mark
(b) (ii)	1. cycle would stop / eq ; 2. 4 carbon compound would accumulate / eq ; 3. 6 carbon compound would {run short / not be synthesised} / 5 carbon compound would run short / eq ; 4. idea that {molecule T / H} reduce ;	**(3)**

Question Number	Answer	Mark
(c)	1. idea of electrons being {passed along / eq} the electron transport chain ; 2. idea of {losing / eq} energy ; 3. (used to) add a phosphate to ADP to make ATP / eq ; 4. reference to ATPase ; 5. idea of chemiosmosis ; 6. idea of oxygen as the final acceptor ;	**(3)**

Q2.

Question Number	Acceptable Answer	Additional Guidance	Mark
	An answer that makes reference to the following: **Similarities** • both use an electron transport chain on membranes (1) • both use ATPase driven by { H^+ gradient / chemiosmosis / eq } (1) • in both, electrons passed from one carrier to another lose energy which drives ATP production (1)	At least one similarity and one difference must be given to gain full marks. Max 2 marks if only 3 similarities provided Max 1 marks if only 2 similarities provided	**(5)**

	Differences • energy is provided by light in chloroplasts but by { glucose / pyruvate / eq } in mitochondria (1) • ATP is made by photophosphorylation in chloroplasts but by { substrate level / oxidative phosphorylation } in mitochondria (1) • in chloroplasts, electrons are provided by chlorophyll but in mitochondria, electrons are brought by reduced { NAD / FAD } (1) • in chloroplasts, (some) electrons return to chlorophyll whereas in mitochondria, electrons are accepted by oxygen (1)	Max 3 marks if only 4 differences provided Max 2 marks if only 3 differences provided Max 1 marks if only 2 differences provided	

Q3.

Question Number	Answer	Additional Guidance	Mark
	A description that makes reference to the following: • acts as an {electron / e^- / H^+ / proton} acceptor / becomes reduced (1) • forms water (1)	**DO NOT ACCEPT** hydrogen **ACCEPT** for 2 marks $2H^+ + O^{2-} \rightarrow H_2O$	(2)

Q4.

Question Number	Answer	Additional guidance	Mark
(i)	An explanation that makes reference to five of the following: • (cyanide) changes tertiary structure / changes active site / substrate no longer fits {active site / enzyme} (1) • therefore transport of {electrons / hydrogen ions} stops (1) • carrier(s) cannot be reduced (1) • (so that) ATP manufacture stops / less ATP made (1) • muscles {cannot contract / go into spasm} / breathing stops / heart stops (1) • any other named biological process that requires ATP stops eg active transport (1)		(5)

Question Number	Answer	Additional guidance	Mark
(ii)	• mass of cyanide that kills = 10 mg (1) • mass of cyanide inhaled per minute • time taken to inhale lethal dose (1) OR • mass of cyanide that kills = 10 mg (1) • volume that provides lethal dose (1) • time taken to inhale lethal dose (1)	1 x 10 = 10 mg 0.24 mg dm^{-3} x 15 = 3.6 (mg per minute) 10 ÷ 3.6 = **2.78** minutes (3sf) 1 × 10 = 10 mg 10 ÷ 0.24 = 41.67 (dm^3) 41.67 ÷ 15 = **2.78** minutes (3sf)	**(3)**

Q5.

Question Number	Answer	Additional Guidance	Mark
(i)	• {fewer / smaller} cristae / less folding of the inner membrane / reduced surface area of inner membrane		(1)
(ii)	An explanation that makes reference to two of the following: • (fewer cristae / lower surface area) therefore reduced electrontransport chain (1) • because ribosomes prevented from synthesising {enzymes / ATPase / electron transport molecules} (1) • credit reason linked to protein not made (1)	e.g. no enzymes to catalyse steps in Krebs cycle, noATPase channels for {protons to pass through / phosphorylation of ADP}, no ETC so no redox reactions **ACCEPT** less intermembrane space foraccumulation of protons = 1 mark	(2)
(iii)	An explanation that makes reference to the following: • no ATP will be produced (if both inhibited / glycolysis inhibited) (1) • therefore no {energy / ATP} for metabolic process / named metabolic processes / cell division} (1)		(2)

Q6.

Question Number	Indicative content
*	Answers will be credited according to candidates' deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. Indicative content: • membranes both made of phospholipid bilayer with embedded proteins • lipid content is the phospholipid bilayer • phospholipids needed for {fluidity / compartmentalisation} • higher protein : lipid ratio in the inner membrane / more protein compared to lipid in the inner membrane • protein content equals lipid content in outer membrane • role of inner membrane is oxidative phosphorylation / chemiosmosis / synthesise ATP • inner membrane contains proteins involved in electron transport • inner membrane contains ATPase channels • movement of protons through ATPase channels results in ATP formation • proteins in outer membrane to allow pyruvate to pass through

Level 0	Marks	No awardable content
Level 1	1-2	An explanation may be attempted but with limited interpretation or analysis of the scientific information with a focus on mainly just one piece of scientific information. The explanation will contain description of membrane structure 1 mark = 2 points 2 marks = 3 points
Level 2	3-4	An explanation will be given with occasional evidence of analysis, interpretation and/or evaluation of both pieces of scientific information. The explanation shows some linkages between the two membranes and their lipid and protein content 3 marks = explanation of ATPase or electron transport proteins or outer membrane 4 marks = explanation of two from ATPase, electron transport proteins, outer membrane
Level 3	5-6	An explanation is made which is supported throughout by sustained application of relevant evidence of analysis, interpretation and/or evaluation of both pieces of scientific information. The explanation shows a well-developed and sustained line of scientific reasoning which relates named protein molecules to the high protein content of the inner membrane 5 marks = explanation of ATPase, electron transport proteins and outer membrane 6 marks = clear, accurate account of oxidative phosphorylation

Q7.

Question Number	Acceptable Answer	Additional guidance	Mark
(a)	C		**(1)**

Question Number	Acceptable Answer	Additional guidance	Mark
(b)	B		**(1)**

Question Number	Acceptable Answer	Additional guidance	Mark
(c)	C		**(1)**

Question Number	Acceptable Answer	Additional guidance	Mark
(d)	A description that makes reference to the following: • it is transported into the (matrix) mitochondria (1) • link reaction oxidises pyruvate to form NADH + H^+ (1) • carbon dioxide is removed (1) • molecule combines with acetyl CoA to form coenzyme A (1)		**(4)**

Q8.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to four of the following: • aerobic respiration inhibited / anaerobic respiration occurs (1) • therefore {electron transport chain / oxidative phosphorylation} inhibited / therefore {glycolysis occurs / ethanol produced} (1) • less {ATP synthesis / reduced NAD} (1) • (less) active transport (of mineral ions) (1) • less {GP / GALP / IAA pumping / spindle fibre contraction / protein synthesis} (1)	**ACCEPT** valid substances / energy requiring processes **DO NOT ACCEPT** starch	**(4)**

Q9.

Question Number	Answer	Additional Guidance	Mark
	inner membrane / cristae		**(1)**

Q10.

Question Number	Answer	Mark
(i)	**The only correct answer is C** ***A*** *is not correct because an insertion adds an additional base* ***B*** *is not correct because monosomy is a chromosome mutation* ***D*** *is not correct because translocation is a chromosome mutation*	**(1)**

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to three of the following: • it will change the {amino acid sequence / primary structure } of ATP synthase **(1)** • therefore the ATP synthase active site could be a different {structure / shape } so ADP cannot {bind / bind as well} **(1)** • therefore the {channel / ATP synthase} the wrong {structure / shape} so {hydrogen ions / protons} cannot {pass through / pass through as well} **(1)** . therefore { no / less} {ATP made / oxidative phosphorylation} **(1)**	**Accept** a stop codon could result changing the {length / shape / structure} of the protein	**(3)**

Q11.

Question Number	Answer	Additional Comments	Mark
(a)	1. only (alpha) 1-4 glycosidic bonds in amylose / (alpha) 1-6 only found in amylopectin ; 2. only amylopectin has side branches / only amylose is {coiled / eq} ; 3. Amylopectin is a {larger / eq} molecule than amylose ;	**1. ACCEPT** 1-6 and 1-4 in amylopectin	**(2)**

Question Number	Answer	Additional Comments	Mark
(b)	1. Different individuals in the {colony / eq} take on specific {roles / jobs / eq} ; 2. Example given e.g. queen produces offspring ;	**1. Accept** division of labour **2. Accept** dominance by queen, {few of the males / kings} involved in breeding	**(2)**

Question Number	Answer	Additional Comments	Mark
(c) (i)	Idea that body temperature of animal mimics the ambient temperature ;	**Accept** body temp follows environmental temperature	**(1)**

Question Number	Answer	Additional Comments	Mark
(c) (ii)	1. Lack of insulating layer: Idea that does not impede transfer of heat energy / allows exchange of heat energy more easily ; 2. A marked reduction in sweat glands: Idea that they do not need to cool down OR less water lost ;	**1. Accept** enables heat transfer between environment and NMR	**(2)**

Question Number	Answer	Additional Comments	Mark
(d)	1. (Cancer causing) gene identified / eq ; 2. Gene {cut / isolated / eq} from DNA / eq ; 3. Using a {restriction / eq} enzyme / eq ; 4. Gene in {vector / named vector} ; 5. Mechanism for getting {gene/vector} into host cells (of mice) / eq ;	**1. Accept** screen for the gene **2. Accept** extracted **3. Accept** correctly named restriction enzyme e.g. EcoR1 **4. Accept** Named egs – retrovirus, virus, liposome, plasmid, bacteria **5. Accept** reference to (micro)injection, microprojectiles, electroporation, gene gun, inhaler, transduction	**(3)**

Question Number	Answer	Additional Comments	Mark
* (e)	QWC – Spelling of technical terms (*shown in italics*) must be correct and the answer must be organised in a logical sequence 1. {*neurone* (cell) surface membrane exposed / no *myelination* / eq} at nodes of *Ranvier* ; 2. Nodes are the site of clusters of {*sodium-gated channel proteins / potassium channels*} ; 3. Which {open / close} when *impulse* arrives / eq ; 4. Allowing *depolarisation* at nodes / eq ; 5. idea that *myelin*/eq acts as an (electrical) *insulator* (on *neurone* surface between nodes) ; 6. reference to *Schwann* cell ; 7. idea that *impulse/depolarisation* 'jumps' to next node ; 8. Reference to this being *saltatory conduction* ; 9. idea that this happens between the *myelin* layers of the *Schwann* cell ;	**QWC emphasis on spelling** **3. Accept** influx of sodium ions	**(5)**

Question Number	Answer	Additional Comments	Mark
(f)	1. idea of heart working less efficiently ; 2. idea of less oxygen absorbed at lungs / eq ; 3. less blood pumped to brain ; 4. concentration gradient (for oxygen) at brain reduced / eq ; 5. less oxygen in blood (in brain) diffuses into brain tissue / eq ; 6. idea of less oxygen in brain tissue due to continual (aerobic) respiration ;		**(3)**

Question Number	Answer	Additional Comments	Mark
(g)	gonadotrophin-releasing (hormone) stimulates gonadotrophin release / gonadotrophin stimulates ovulation / testosterone stimulates {sperm production / (male) secondary sexual characteristics / other named example} ;		**(1)**

Question Number	Answer	Additional Comments	Mark
(h)	1. Idea of effect on mitochondria ; 2. (therefore) reduced {energy / ATP / eq} for flagellum movement ;	**1. Accept** less efficient / fewer / none **2. Accept** tail for flagellum	**(2)**

Question Number	Answer	Additional Comments	Mark
(i)	1. idea that fat is an energy store ; 2. reduces dependence on external food source / eq ; 3. enables disperser to travel / eq ; 4. (metabolic) water is released (on oxidation) / eq ; 5. acts as a thermal insulator / eq ;	**Accept** energy-rich	(3)

Question Number	Answer	Additional Comments	Mark
(j)	1. idea that unfamiliar males are likely to be genetically different ; 2. idea that this is outbreeding ; 3. idea that this increases genetic diversity ;	**3. Accept** producing offspring that are genetically different	(2)

Question Number	Answer	Additional Comments	Mark
(k)	the order of the {bases / genes and non-coding sequences / eq} in the DNA (of the naked mole rats) is found / eq ;	**Accept** exons and introns **Ignore** genes unqualified	(1)

Question Number	Answer	Additional Comments	Mark
(l)	Paired responses: 1. reduced sensitivity to chemical pain / disconnection of 'pain nerves' ; 2. Idea of pain relief e.g. dealing with post traumatic pain, post surgical pain, joint pain after a knee operation ; 3. haemoglobin has higher affinity for oxygen ; 4. Idea of dealing with reduced oxygen situations such as due to a heart attack or stroke ; 5. Naked mole rat {incisors / eq } grow through skin (of lip) without damage ; 6. Idea of better prosthesis e.g. new {coatings / permanent seal} at {skin / bone / metal} interface, soft tissue not damaged, avoid infection ; 7. High protein stability / does not (easily) lose 3D shape ; 8. (so) reduced effect of oxidative {damage / stress} / reduced effect of oxygen-containing free radicals / live healthily into old age ; 9. Cell overcrowding early warning gene / ref. to two tiered contact inhibition / presence of gene p16 ; 10.Idea of cancer prevention e.g. cancer resistance, future cancer therapy ; 11.Naked mole rat neurones display immature {characteristics / physiological properties} / brain cells that cope with {low oxygen / hypoxia} ; 12.To treat people with temporary loss of oxygen to brain e.g. heart attack, stroke, drowning / to prevent permanent brain damage ; 13.High levels of oxytocin receptors in {brain / nucleus accumbens}; 14.Idea of links to autism ; 15.Naked mole rats do not experience menopause ; 16.Ref to osteoporosis {treatment / prevention} (without side effects) ; 17.circadian rhythms / sleep patterns of naked mole rats ; 18.Idea that may help with sleep disorders ;	**9. Accept** anticancer mechanism	

Q12.

Question Number	Correct Answer	Additional guidance	Mark
(a)	An explanation that makes reference to the following: • wash immerse in water / water without nitrate ions (1) • at a suitable temperature / stated temperature (less than 25 °C) (1) • reference to sterile water (1)		**(3)**

Question Number	Correct Answer	Additional guidance	Mark
(b)	An answer that makes reference to the following: • reading from graph 5 mins = 4 μmol dm^{-3} 30 mins = 8 μmol dm^{-3} (1) • mean rate = increase ÷ time (4 ÷5) (1) • correct answer with units = 0.8 μmol dm^{-3} min^{-1} (1)	Candidate must state units for full marks	**(3)**

Question Number	Correct Answer	Additional guidance	Mark
(c)	An explanation that makes reference to the following: • rate the same for both solutions between 0–10 minutes because initial uptake in both by (passive) diffusion (1) • rate with DNP zero between 20–30 minutes because uptake requires {energy / ATP} for active transport (1) • DNP prevents formation of ATP by chemiosmosis (1)		**(3)**

Question Number	Correct Answer	Additional guidance	Mark
(d)	An explanation that makes reference to the following: • DNP transports protons across the inner mitochondrial membrane (1) • therefore preventing the establishment of a gradient across the membrane (1) • which prevents the formation of ATP (1)	cristae Accept inhibits interaction between protons and ATP synthase	**(3)**

Q13.

Question Number	Acceptable Answer	Additional guidance	Mark
	An explanation that makes reference to the following: • electron carrier components are on chloroplast membranes (1) • detergents disrupt the phospholipid bilayer in the membranes (1) • therefore electrons can no longer move along the chain (1)		**(3)**

Q14.

Question Number	Correct Answer	Additional guidance	Mark
(a)	An explanation that makes reference to the following: • reference to electron transport chain (1) • oxygen as final proton and electron acceptor (1)		**(2)**

Question Number	Correct Answer	Additional guidance	Mark
(b)(i)	• 25% of 8 g = 2 g and 10% of 8 g = 0.8 g (1) • 2 g – 0.8 g = 1.2 g (1)		**(2)**

Question Number	Correct Answer	Additional guidance	Mark
(b)(ii)	An answer that makes reference to the following: • *T. indica* because eats fewer plant roots (1) • plant roots contain more water than insects (1)		**(2)**

Question Number	Correct Answer	Additional guidance	Mark
(c)	B		**(1)**

Question Number	Correct Answer	Additional guidance	Mark
(d)	C		**(1)**

Question Number	Correct Answer	Additional guidance	Mark
(e)	An explanation that makes reference to the following: • desert mammals have long loops of Henle (1) • which allows for a greater counter current multiplier effect (1) • therefore a higher concentration of solute / sodium chloride at base of the medulla (1) • which causes greater amounts of water to be reabsorbed from collecting ducts (1)		**(4)**

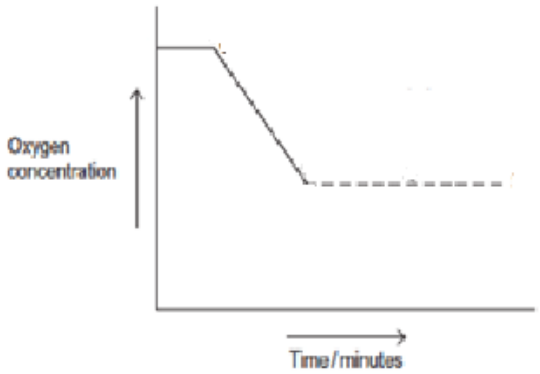
Q15.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to three of the following: • mutation may prevent {electrons being passed down the electron transport chain / ATPase from working properly} **(1)** • therefore {NADH / reduced NAD} cannot be oxidised **(1)** • therefore pyruvate and {NADH / reduced NAD} will produce lactate **(1)** • lactate produced at a faster rate than it can be removed **(1)**	**Accept** reformed / converted back	**(3)**

Q16.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to two of the following: • because a lipid molecule contains a higher proportion of hydrogen (than a carbohydrate molecule) (1) • therefore more reduced {NAD / FAD / coenzyme} (1) • therefore more hydrogen (ions) {to accumulate in the inter-membrane space / to produce a proton gradient / to pass through ATP synthase channels / for chemiosmosis / for oxidative phosphorylation} (1)	**ACCEPT** converse throughout **ACCEPT** NADH / $FADH_2$	(2)

Q17.

Question Number	Answer	Additional Guidance	Mark
	An answer that makes reference to the following: • line decreasing from 5 to 15 minutes (1) • line level from 15 to 25 minutes (1)		(2)

Mark Scheme

Q1.

Question Number	Answer	Mark
(a)	molecule R - ATP / adenosine triphosphate ; molecule S - ADP / adenosine diphosphate ;	**(2)**

Question Number	Answer	Mark
(b)(i)	1. carbon dioxide / CO_2 ; 2. idea that the C has been removed from C_6 or C_5 ;	**(2)**

Question Number	Answer	Mark
(b) (ii)	1. cycle would stop / eq ; 2. 4 carbon compound would accumulate / eq ; 3. 6 carbon compound would {run short / not be synthesised} / 5 carbon compound would run short / eq ; 4. idea that {molecule T / H} reduce ;	**(3)**

Question Number	Answer	Mark
(c)	1. idea of electrons being {passed along / eq} the electron transport chain ; 2. idea of {losing / eq} energy ; 3. (used to) add a phosphate to ADP to make ATP / eq ; 4. reference to ATPase ; 5. idea of chemiosmosis ; 6. idea of oxygen as the final acceptor ;	**(3)**

Q2.

Question Number	Answer	Mark
(a)	1. idea that less {food /eq} required to deliver energy requirement ; 2. (so) more likely to have extra food not respired / {extra/surplus} energy ; 3. which could be laid down in body as fat / eq ;	**(2)**

Question Number	Answer	Mark
(b)	Any two from: 1. ADP 2. Pi / inorganic phosphate 3. pyruvate / pyruvic acid / lactate 4. fatty acids 5. NAD / eq 6. acetyl CoA / eq 7. water ; ;	**(2)**

Question Number	Answer	Mark
(c)	1. many {alpha / eq} glucose monomers ; 2. joined by glycosidic bonds ; 3. detail of glycosidic bonds e.g. 1-4 ; 4. reference to side branches present / 1-6 glycosidic bonds ;	**(3)**

Question Number	Answer	Mark
(d)	1. more gonadotropins ; 2. {use / muscle uptake} of (excess) fatty acids ; 3. respired to release (much) energy / increased fat metabolism ; 4. idea of reduced requirement to replenish glycogen stores ;	**(3)**

Question Number	Answer	Mark
(e)	1. (slow twitch muscles) carry out aerobic respiration / full oxidation / eq ; 2. which produces more ATP (than anaerobic) / eq ; 3. 'energy' not locked up in lactate / eq ; 4. idea that it takes longer for lactate levels to build up ;	**(2)**

Question Number	Answer	Mark
***(f)**	QWC – Spelling of technical terms (*shown in italics*) must be correct and the answer must be organised in a logical sequence) 1. Ca^{2+} leaks out of {cell / *cytoplasm* / *sarcoplasmic reticulum*} ; 2. idea of change in Ca^{2+} binding to *troponin* ; 3. causes displacement of *tropomyosin* / eq ; 4. idea of change in number of *myosin* binding sites exposed ; 5. comment on *myosin* binding to *actin* ; 6. (loss of Ca^{2+} from cell / cytoplasm) therefore force exerted by muscle is lower than expected OR (more Ca^{2+} in cytoplasm) results in less ATP so less muscle contraction ;	**(4)**

Question Number	Answer	Mark
(g)	**Process** / **Two nucleic acids involved in the process** Transcription of the ACE gene / DNA & mRNA ; Production of ACE at a ribosome / Any **two** from: mRNA, tRNA, rRNA ;	**(2)**

Question Number	Answer	Mark
(h)	1. obtain a sample of cells / extract DNA (from cells) ; 2. reference to named enzyme ; 3. idea of how to increase amount of DNA ; 4. reference to electrophoresis ; 5. details of electrophoresis ; 6. use a {DNA / gene} probe ; 7. with a base sequence complementary to that on the {variant / eq} ; 8. idea of matching with known variant profile ;	**(4)**

Question Number	Answer	Mark
(i)	B ;	**(1)**

Question Number	Answer	Mark
(j)	1. (higher metabolic rate) means more chemical reactions / eq ; 2. more {energy released / ATP used} / eq ; 3. (which) releases heat / eq ; 4. keeps divers warmer / warm for longer / able to swim without a wetsuit / eq ;	**(3)**

Question Number	Answer	Mark
(k)	1. carbon dioxide due to {deforestation / land cleaning / burning fossil fuels / correct ref to respiration / eq} ; 2. methane from {rice fields / anaerobic bacterial action / ruminant fermentation / named ruminant} ;	**(2)**

Question Number	Answer	Mark
(l)	1. 1.4 ÷ 37 = ; 2. 3.8 (%) ; Correct answer gains both 2 marks	**(2)**

Q3.

	Answer	Mark
(i)	<table><tr><th>Investigation</th><th>Type of respiration</th><th>Potassium hydroxide solution absent or present</th><th>Coloured liquid moved to the left</th><th>Coloured liquid moved to the right</th><th>Coloured liquid did not move</th></tr><tr><td>1</td><td>Anaerobic</td><td>Absent</td><td>☒</td><td>☒</td><td>☒</td></tr><tr><td>2</td><td>Aerobic</td><td>Absent</td><td>☒</td><td>☒</td><td>☒ ;</td></tr><tr><td>3</td><td>Aerobic</td><td>Present</td><td>☒ ;</td><td>☒</td><td>☒</td></tr></table>	(2)

Question Number	Answer	Additional Guidance	Mark
(ii)	1. (as anaerobic) no O_2 absorbed / eq ; 2. no CO_2 produced / eq ; 3. so no change in {volume/pressure} (so liquid does not move) ; 4. since for each 6C glucose respired, 2x3C lactate formed / eq ;	1. **ACCEPT** No oxygen used	(3)

Question Number	Answer	Additional Guidance	Mark
(iii)	1. (reduced NAD from glycolysis) enters mitochondria/ moves through outer mitochondrial membrane / eq ; 2. moves to inner membrane of mitochondrion / eq ; 3. becomes {oxidised /NAD / NAD^+} ; 4. as {electrons / eq} transferred to {electron transport chain / eq} / eq ; 5. fate of hydrogen ions described e.g. pumped into membrane space ; 6. (NAD) returns to {Krebs cycle/ matrix / eq} ;	**2. ACCEPT** crista for inner mitochondrial membrane **6. ACCEPT** cytoplasm, glycolysis	**(4)**

Q4.

Question Number	Indicative content
*	Answers will be credited according to candidates' deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. Indicative content: • membranes both made of phospholipid bilayer with embedded proteins • lipid content is the phospholipid bilayer • phospholipids needed for {fluidity / compartmentalisation} • higher protein : lipid ratio in the inner membrane / more protein compared to lipid in the inner membrane • protein content equals lipid content in outer membrane • role of inner membrane is oxidative phosphorylation / chemiosmosis / synthesise ATP • inner membrane contains proteins involved in electron transport • inner membrane contains ATPase channels • movement of protons through ATPase channels results in ATP formation • proteins in outer membrane to allow pyruvate to pass through

Level 0	Marks	No awardable content
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Level 2	3-4	An explanation will be given with occasional evidence of analysis, interpretation and/or evaluation of both pieces of scientific information. The explanation shows some linkages between the two membranes and their lipid and protein content 3 marks = explanation of ATPase or electron transport proteins or outer membrane 4 marks = explanation of two from ATPase, electron transport proteins, outer membrane
Level 3	5-6	An explanation is made which is supported throughout by sustained application of relevant evidence of analysis, interpretation and/or evaluation of both pieces of scientific information. The explanation shows a well-developed and sustained line of scientific reasoning which relates named protein molecules to the high protein content of the inner membrane 5 marks = explanation of ATPase, electron transport proteins and outer membrane 6 marks = clear, accurate account of oxidative phosphorylation

Q5.

Question Number	Acceptable Answer	Additional guidance	Mark
(a)	C		**(1)**

Question Number	Acceptable Answer	Additional guidance	Mark
(b)	B		**(1)**

Question Number	Acceptable Answer	Additional guidance	Mark
(c)	C		**(1)**

Question Number	Acceptable Answer	Additional guidance	Mark
(d)	A description that makes reference to the following: • it is transported into the (matrix) mitochondria (1) • link reaction oxidises pyruvate to form NADH + H^+ (1) • carbon dioxide is removed (1) • molecule combines with acetyl CoA to form coenzyme A (1)		**(4)**

Q6.

Question Number	Acceptable Answer	Additional guidance	Mark
(i)	B (Krebs cycle)		**(1)**

Question Number	Acceptable Answer	Additional guidance	Mark
(ii)	B (5%)		**(1)**

Question Number	Acceptable Answer	Additional guidance	Mark
(iii)	A description that makes reference to the following: • glucose is phosphorylated using ATP (1) • this product is converted into glycerate 3-phosphate (GP) (1) • GP converted to pyruvate producing reduced NAD (NADH) and ATP (1)		**(3)**

Q7.

Question Number	Answer	Mark
(i)	**The only correct answer is B** ***A*** *is not correct because no bonds are being broken* ***C*** *is not correct because no phosphate group is being added* ***D*** *is not correct because if FAD is reduced to* $FADH_2$ *the succinate is being oxidised*	**(1)**

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to four of the following: • completely oxidises {pyruvate / acetyl Co A} (1) • to release as much energy as possible (1) • to generate ATP (directly) (1) • to produce {reduced coenzyme / NADH} (1) • so that ATP can be produced {in the ETC / by oxidative phosphorylation} (1)	**ACCEPT** glucose **DO NOT ACCEPT** makes **ACCEPT** $FADH_2$ / FADH / reduced {NAD / NADH} / reduced {FAD / FADH / $FADH_2$}	**(4)**

Q8.

Question Number	Answer	Additional Comments	Mark
(a)	1. only (alpha) 1-4 glycosidic bonds in amylose / (alpha) 1-6 only found in amylopectin ; 2. only amylopectin has side branches / only amylose is {coiled / eq} ; 3. Amylopectin is a {larger / eq} molecule than amylose ;	**1. ACCEPT** 1-6 and 1-4 in amylopectin	**(2)**

Question Number	Answer	Additional Comments	Mark
(b)	1. Different individuals in the {colony / eq} take on specific {roles / jobs / eq} ; 2. Example given e.g. queen produces offspring ;	**1. Accept** division of labour **2. Accept** dominance by queen, {few of the males / kings} involved in breeding	**(2)**

Question Number	Answer	Additional Comments	Mark
(c) (i)	Idea that body temperature of animal mimics the ambient temperature ;	**Accept** body temp follows environmental temperature	**(1)**

Question Number	Answer	Additional Comments	Mark
(c) (ii)	1. Lack of insulating layer: Idea that does not impede transfer of heat energy / allows exchange of heat energy more easily ; 2. A marked reduction in sweat glands: Idea that they do not need to cool down OR less water lost ;	**1. Accept** enables heat transfer between environment and NMR	**(2)**

Question Number	Answer	Additional Comments	Mark
(d)	1. (Cancer causing) gene identified / eq ; 2. Gene {cut / isolated / eq} from DNA / eq ; 3. Using a {restriction / eq} enzyme / eq ; 4. Gene in {vector / named vector} ; 5. Mechanism for getting {gene/vector} into host cells (of mice) / eq ;	**1. Accept** screen for the gene **2. Accept** extracted **3. Accept** correctly named restriction enzyme e.g. EcoR1 **4. Accept** Named egs – retrovirus, virus, liposome, plasmid, bacteria **5. Accept** reference to (micro)injection, microprojectiles, electroporation, gene gun, inhaler, transduction	**(3)**

Question Number	Answer	Additional Comments	Mark
* (e)	QWC – Spelling of technical terms (*shown in italics*) must be correct and the answer must be organised in a logical sequence 1. {*neurone* (cell) surface membrane exposed / no *myelination* / eq} at nodes of *Ranvier* ; 2. Nodes are the site of clusters of {*sodium-gated channel proteins / potassium channels*} ; 3. Which {open / close} when *impulse* arrives / eq ; 4. Allowing *depolarisation* at nodes / eq ; 5. idea that *myelin*/eq acts as an (electrical) *insulator* (on *neurone* surface between nodes) ; 6. reference to *Schwann* cell ; 7. idea that *impulse*/*depolarisation* 'jumps' to next node ; 8. Reference to this being *saltatory conduction* ; 9. idea that this happens between the *myelin* layers of the *Schwann* cell ;	**QWC emphasis on spelling** **3. Accept** influx of sodium ions	**(5)**

Question Number	Answer	Additional Comments	Mark
(f)	1. idea of heart working less efficiently ; 2. idea of less oxygen absorbed at lungs / eq ; 3. less blood pumped to brain ; 4. concentration gradient (for oxygen) at brain reduced / eq ; 5. less oxygen in blood (in brain) diffuses into brain tissue / eq ; 6. idea of less oxygen in brain tissue due to continual (aerobic) respiration ;		(3)

Question Number	Answer	Additional Comments	Mark
(g)	gonadotrophin-releasing (hormone) stimulates gonadotrophin release / gonadotrophin stimulates ovulation / testosterone stimulates {sperm production / (male) secondary sexual characteristics / other named example} ;		(1)

Question Number	Answer	Additional Comments	Mark
(h)	1. Idea of effect on mitochondria ; 2. (therefore) reduced {energy / ATP / eq} for flagellum movement ;	**1. Accept** less efficient / fewer / none **2. Accept** tail for flagellum	(2)

Question Number	Answer	Additional Comments	Mark
(i)	1. idea that fat is an energy store ; 2. reduces dependence on external food source / eq ; 3. enables disperser to travel / eq ; 4. (metabolic) water is released (on oxidation) / eq ; 5. acts as a thermal insulator / eq ;	**Accept** energy-rich	(3)

Question Number	Answer	Additional Comments	Mark
(j)	1. idea that unfamiliar males are likely to be genetically different ; 2. idea that this is outbreeding ; 3. idea that this increases genetic diversity ;	**3. Accept** producing offspring that are genetically different	(2)

Question Number	Answer	Additional Comments	Mark
(k)	the order of the {bases / genes and non-coding sequences / eq} in the DNA (of the naked mole rats) is found / eq ;	**Accept** exons and introns **Ignore** genes unqualified	(1)

Question Number	Answer	Additional Comments	Mark
(I)	Paired responses: 1. reduced sensitivity to chemical pain / disconnection of 'pain nerves' ; 2. Idea of pain relief e.g. dealing with post traumatic pain, post surgical pain, joint pain after a knee operation ; 3. haemoglobin has higher affinity for oxygen ; 4. Idea of dealing with reduced oxygen situations such as due to a heart attack or stroke ; 5. Naked mole rat {incisors / eq } grow through skin (of lip) without damage ; 6. Idea of better prosthesis e.g. new {coatings / permanent seal} at {skin / bone / metal} interface, soft tissue not damaged, avoid infection ; 7. High protein stability / does not (easily) lose 3D shape ; 8. (so) reduced effect of oxidative {damage / stress} / reduced effect of oxygen-containing free radicals / live healthily into old age ; 9. Cell overcrowding early warning gene / ref. to two tiered contact inhibition / presence of gene p16 ; 10.Idea of cancer prevention e.g. cancer resistance, future cancer therapy ; 11.Naked mole rat neurones display immature {characteristics / physiological properties} / brain cells that cope with {low oxygen / hypoxia} ; 12.To treat people with temporary loss of oxygen to brain e.g. heart attack, stroke, drowning / to prevent permanent brain damage ; 13.High levels of oxytocin receptors in {brain / nucleus accumbens}; 14.Idea of links to autism ; 15.Naked mole rats do not experience menopause ; 16.Ref to osteoporosis {treatment / prevention} (without side effects) ; 17.circadian rhythms / sleep patterns of naked mole rats ; 18.Idea that may help with sleep disorders ;	**9. Accept** anticancer mechanism	

Q9.

Question Number	Answer	Additional Guidance	Mark
(i)	concentration of protein read from graph	0.58 / 0.57 (mg cm^{-3})	**(1)**

Question Number	Answer	Additional Guidance	Mark
(ii)	• initial rate of reaction calculated (1) • ratio calculated (1)	0.00267 / 0.0027 (mg sec^{-1}) / 0.16 (mg min^{-1}) 0.58 : 0.0027 = 214.81 : 1 or 3.63 : 1 21481 : 100 or 363 : 100 0.57 : 0.0027 = 211.11 : 1 or 3.56 : 1 21111 : 100 or 356 :100 **CE applies from both (i) and the value for initial rate of reaction**	(2)

Q10.

Question Number	Answer	Additional guidance	Mark
(a)	1. Idea an enzyme converts a named substrate into named product e.g. enzyme 1 converts P to Q ; 2. idea that this product becomes the substrate of next step ; 3. idea of specificity ; 4. {controls / eq} the conversion / eq ; 5. speeds up the conversion / eq ; 6. by reducing activation energy / eq ; 7. credit reference to control of whole process ;	ACCEPT answers in context of respiration ACCEPT 1 - ref to an enzyme converting one named intermediate to the next e.g.{enzyme/ named enzyme} used to convert hexose to phosphorylated hexose ACCEPT 3 - description of specificity e.g. active site of enzyme 1 only accepts substance P or in context of named respiratory intermediate ACCEPT 4 – regulates ACCEPT 5 - catalysis / enzyme acts as a catalyst ACCEPT 7 - end product inhibition or description	**(4)**

Question Number	Answer	Additional guidance	Mark
(b)(i)	1. W = {NAD / NAD^+ / NAD_{ox} / eq} ; Any two of the following: 2. (due to) reduced NAD {releasing/eq} {electrons / eq} ; 3. Idea of electrons go to {carrier A / ETC / eq} ; 4. idea of H^+ moved into inter-membranal space ;	ACCEPT 2 – being oxidized Releasing hydrogen (atoms), H^+/protons ACCEPT 3 – 1st electron carrier/correctly named carrier	**(3)**

Question Number	Answer	Additional guidance	Mark
(b)(ii)	1. substance **X** is ATP ; Any two of the following : 2. due to H^+ pass through {stalked particle / ATP synthase} ; 3. (H^+ passes) down an electrochemical gradient ; 4. (sufficient) energy is {released / eq} ; 5. to join ADP and {Pi / eq} ; 6. reference to chemiosmosis ;	ACCEPT 2 –ATPase ACCEPT 3 - description of electrochemical gradient ACCEPT 5 – phosphorylation of ADP	**(3)**

Question Number	Answer	Additional guidance	Mark
(c)	<table><tr><th rowspan="2">Situation</th><th colspan="3">Movement of coloured liquid</th></tr><tr><th>towards A</th><th>towards B</th><th>does not move</th></tr><tr><td>Screw clip is open</td><td></td><td></td><td>☒</td></tr><tr><td>Screw clip is closed</td><td>☒</td><td></td><td></td></tr><tr><td>Potassium hydroxide is replaced with water and screw clip is closed</td><td></td><td></td><td>☒</td></tr></table>		(3)

Q11.

Question Number	Answer	Mark
(i)	The only correct answer is **B** matrix **A** is incorrect because only glycolysis takes place in the cytoplasm **C** is incorrect because stroma is in chloroplasts not mitochondria **D** is incorrect because tonoplasts are in plant cells only	(1)

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to three of the following: • in anaerobic conditions, the pyruvate is used to reoxidise NADH so no Krebs cycle (1) • no oxygen available to act as a (terminal) electron acceptor (1) • so reduced { NAD / FAD / coenzyme} cannot be reoxidised (1) • so no (oxidised) coenzyme to bind {hydrogen ions / protons / H^+/electrons} (1)	**ACCEPT** oxygen binds to electrons **ACCEPT** NADH / $FADH_2$	(3)

Q12.

Question Number	Answer	Additional Guidance	Mark
(i)	• when one molecule of carbohydrate is respired the number of carbon dioxide molecules produced is the same as the number of molecules of oxygen used	**ACCEPT** carbon dioxide produced = oxygen used	(1)

Question Number	Answer	Additional Guidance	Mark
(ii)	• volume of both gases calculated (1) • RQ value calculated to {1 / 2} decimal places (1)	<u>Example of calculation:</u> oxygen volume = 4.5 × 21 + 3.75 = 98.25 carbon dioxide volume = 3 × 21 + 6 = 69 69 ÷ 98.25 = 0.70 / 0.7 / 0.702 **ACCEPT** ecf	(2)