WJEC (Wales) Biology A-level Topic 3.3: Respiration Questions by Topic - Mark Scheme

Question		Marking details	Marks Available	Question
1.				
(a)	(i)	**All three correct for one mark** Citrate 6 α-ketoglutarate 5 Succinate 4	1	*(e)*
	(ii)	4C oxaloacetate plus 2 C acetyl; 1C lost/ CO_2 lost {before α-ketoglutarate/ from isocitrate}/ isocitrate is decarboxylated **and** 1C lost/ CO_2 lost {from α-ketoglutarate/ before succinate} / α-ketoglutarate decarboxylated;	2	
(b)		Reduced NAD and reduced FAD pass electrons to the Electron Transport Chain; The high energy electrons/ electrons provide energy; (Used to power) proton pumps; On the inner mitochondrial membrane/cristae; Which pump H^+ into the inter-membrane space; Reduced NAD powers all 3 pumps/ Reduced FAD passes to 2nd pump/ OWTTE; ATP synthesis = neutral	Max 4	(f) (g)
(c)		Dehydrogenase; decarboxylase;	2	
(d)		(Skeletal) muscle; High numbers of mitochondria and easy to access/ OWTTE;	2	
(e)		*Low with pyruvate* {The pathway leading to Acetyl Co A/link reaction} is not working/ {Enzymes/dehydrogenase/decarboxylase} are not active/ There is no reduced NAD for the Electron Transport Chain (so no O_2 needed); *High with α-ketoglutarate* The pathway between α-ketoglutarate and the rest of the cycle is working correctly/ There is enough reduced {NAD/FAD} to drive the ETC (which needs O_2);	2	
(f)		Enzymes catalysing the conversion of the molecule to the next in the cycle are not functional/ The {molecule/named example} cannot be converted to the {next intermediate/ named example} / build up of reduced NAD and FAD;	1	
(g)		The {Krebs cycle/ link reaction/ Electron Transport Chain} is not working (as well); Pyruvate levels {build up/ increase/ higher}; (Excess) {pyruvate/$NADH_2$} is converted to Lactate;	Max 2	
		Question 6 Total	**[16]**	

2.

Question			Marking details	Marks Available
2	*(a)*		mitochondrion; matrix;	2
	(b)	(i)	pyruvate to acetyl Co-A; iso citrate to oxaloglutarate and oxaloglutarate to succinate;	2
		(ii)	decarboxylation;	1
		(iii)	diffuses out of mitochondria; into blood/ tissue fluid/ plasma; carried as hydrogen carbonate ions; breathed out;	3 max
	(c)		dehydrogenation/ dehydrogenase activity/ oxidation of intermediates/compounds; removal of hydrogen ions; stepwise/series of reactions; five pairs of hydrogens; NAD to $NADH_2$/ reduced NAD/ $NADH^+ + H^+$;	3 max
	(d)		Pyruvate is used to form lactic acid; Regenerate NAD;	2
			Question 2 total	**[13]**

3.

Question			Marking details	Marks Available
	(a)	(i)	phosphate / Pi / inorganic phosphate/ iP/ PO_4^{3-};	1
		(ii)	W is outer (mitochondrial) membrane; Z is the (mitochondrial) matrix;	2
		(iii)	most concentrated in part X;	1
	(b)		(reduced NAD) supplies protons; and brings (high energy) electrons; electrons {supply energy for proton pumping/ fuels proton pumps};	2
	(c)	(i)	P = ADP/ ADP + Pi Q = ATP	1
		(ii)	cytoplasm/ cytosol;	1
		(iii)	glucose is phosphorylated by ATP; two phosphorylations / production of hexose/fructose (bi)phosphate; hexose (bi)phosphate is split (from 6C to two 3C);	3
	(d)	(i)	allows reduced NAD to be converted back to NAD/ regenerate reduced NAD/ without oxygen reduced NAD not converted to NAD by {electron transport chain/ krebs/ link reaction}; allowing ATP production/ without oxygen no ATP production by oxidative phosphorylation; allows {glycolysis/ substrate level phosphorylation} to continue/ ORA; No O_2 to act as the final {hydrogen/ electron} acceptor/ NADH {must find an alternative hydrogen acceptor/ must use pyruvate};	3
		(ii)	Only glycolysis required/ shorter metabolic pathways; oxygen supply too slow/ no need for oxygen {supply/diffusion}; no need to carry out Krebs cycle/ electron transport / oxidative phosphorylation; no need to build up a proton gradient; no need to transport pyruvate into the mitochondrion;	Max 1
			Question 5 Total	**[15]**

4.

Question			Marking details	Marks Available
4	*(a)*		Similarities (Both contain) a 5 carbon sugar; Both have two phosphate groups; Both contain (two) nitrogenous bases/ adenine/ organic base; Dinucleotide; Accept adenosine for 1 mark if MP1 and 3 not awarded	max 2
			Differences FAD only contains one (ring form) sugar **and** NAD contains 2/ One 5C sugar is in its linear form in FAD and both 5C sugars are in ring form in NAD/ NAD contains nicotinamide and FAD contains flavin/ FAD has a three ring base and NAD has one ring base;	1
	(b)	(i)	The bond between the {terminal/last two} phosphate groups on ATP;	1
		(ii)	Does not involve the ETC/complex series of carriers and pumps; Does not need stalked particles/ATP synthetase; Does not need an electrochemical gradient/eq; Does not require oxygen; Accept 'Does not require mitochondria' as alternative to MPs 1, 2,3	Max 2
		(iii)	Arrows showing In the conversion of triose phosphate to pyruvate; After the 5C compound in the Kreb's cycle;	2
		(iv)	4; 2;	2
	(c)	(i)	In the mitochondrial matrix;	1
		(ii)	Dehydrogenase AND decarboxylase;	1
			Question 4 Total	**[12]**

5.

Question	Marking details	Marks Available

5

	Glycolysis	Link reaction	Krebs cycle	Oxidative phosphorylation
Substrate level phosphorylation takes place	✓		✓	
NAD is reduced	✓	✓	✓	
FAD is reduced			✓	
Dehydrogenation takes place	✓	✓	✓	
Decarboxylation takes place		✓	✓	
Oxygen is used				✓
ATP is produced	✓		✓	✓
Takes place in the cytoplasm	✓			
Takes place in the mitochondrial matrix		✓	✓	
Takes place in the inner mitochondrial membrane				✓
Coenzyme A is used as an acceptor		✓		

One mark per row

Question 5 Total **[11]**

6.

Marking details	Marks available					
	AO1	AO2	AO3	Total	Maths	Prac
Link reaction and Krebs cycle • Pyruvate transported in from cytoplasm • Correct description of link reaction • Decarboxylation and dehydrogenation to produce 2C Acetyl coenzyme A • Correct description of Krebs cycle • Correct description of 4C + Acetyl coenzyme A giving 6C molecule. • Progressive removal of C as CO_2 to reform 4C molecule • Removal of H/use of dehydrogenase/ use of decarboxylase • Formation of Reduced NAD and Reduced FAD *Electron transport chain* • Correct description of ETC • use of oxygen as final electron acceptor • Use of Reduced NAD and Reduced FAD as source of high energy electrons for ETC • Formation of an EC gradients/ chemiosmosis • subsequent synthesis of ATP by the use of ATP synthase in stalked particles *Benefits* • *Bacteria* have a source of pyruvate/oxygen • Constant environment e.g. pH/ water potential • Protection from predation • *Eukaryote* – increased ATP availability – increased metabolic rate/increased cell division/increased active transport/able to metabolise other respiratory substrates/e.g. fatty acids • Compartmentalisation • Increase in size/ complexity	7	2				
7-9 marks Detailed content from Link reaction and Krebs + Electron Transport chain + Benefits *The candidate constructs an articulate, integrated account, correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses scientific conventions and vocabulary appropriately and accurately.* **4-6 marks** Content from any two parts out of Link reaction and Krebs Electron Transport chain Benefits *The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate usually uses scientific conventions and vocabulary appropriately and accurately.* **1-3 marks** Content from one part out of Link reaction and Krebs Or Electron Transport chain Or Benefits *The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate has limited use of scientific conventions and vocabulary.* **0 marks** *The candidate does not make any attempt or give a relevant answer worthy of credit.*						
Question 6 total	**7**	**2**	**0**	**9**	**0**	**0**

7.

Question			Marking details	Marks Available
7	*(a)*		A = Triose phosphate / TP; B = Pyruvate / pyruvic acid; C = Acetyl coenzyme A / acetate / Coenzyme A; D = NAD / $NADH_2$; E = CO_2 ; F = O_2;	6
	(b)	(i)	inner mitochondrial membrane / cristae;	1
		(ii)	Hydrogen;	1
			Question 7 Total	**[8]**

8. (a) pyruvic acid / pyruvate is converted to two carbon acetate;

two molecules of reduced NAD formed;

loss of two molecules of carbon dioxide;

actate combines with coenzyme A (to form acetyl coenzyme A) [3]

(b) (i) cytoplasm;

(ii) matrix of mitochondrion [2]

(c) (i) (Decarboxylation) is the removal of carbon dioxide / carboxyl group;

(Dehydrogenation) is the removal of hydrogen [2]

(ii) P and Q [1]

(d) (i) one [1]

(ii)

	In the link reaction using NADH	In the Krebs Cycle using NADH	In the Krebs Cycle using FADH
Number of Molecules of ATP Formed	3	6	2

[2]

(iii) NAD has three pumps FAD has two pumps. [1]

[Total 12 marks]

9.	*(a)*	(i)	Glycolysis	cytoplasm;	3
			Link reaction	matrix (of mitochondria);	
			Krebs Cycle	matrix (of mitochondria);	
			[1 mark each row]		
		(ii)	Glycolysis;		1
	(b)	(i)	Carbon dioxide/ CO_2;		1
		(ii)	Decarboxylase;		1
	(c)		Substrate- level phosphorylation	2; and 6;	4
			Glycerol can be converted to a 3C sugar which enters respiration at this point	3;	
			ATP is used in phosphorylation	1;	

10. (a) (i)	phosphate; pentose/ribose; adenine (all correct for 2; 1 error = 1) (not: adenosine/nitrogenous base)	**2**
(ii)	adenosine triphosphate (not: triose phosphate/ATP)	**1**
(b) (i)	ATP drawn as in part a in upper box; ADP two Ps attached + 1P not attached in lower box.	**1**
(ii)	protein synthesis/biosynthesis/active transport/nerve conduction/cell division/avp (not: metabolism/growth/movement)	**1**

(c) (i) **2**

Stage	Precise location in cell	Number of molecules of ATP	Number of molecules of $NADH_2$	Number of molecules of $FADH_2$
Glycolysis	**cytoplasm**	**2 (net)**	**2**	**0**
Link reaction	**matrix of mitochondrion**	**0**	**2**	**0**
Krebs cycle	**matrix of mitochondrion**	**2**	**6**	**2**

(1 mark for each correct row) (if only 'matrix' penalise once only)

(ii)	name of stage - electron transfer/transport chain/oxidative phosphorylation + location-inner membrane/cristae of mitochondrion (not: ETC)	**1**
(iii)	$NADH_2$ -3 $FADH_2$ -2	**1**
(d)	NAD, ethanol + carbon dioxide in correct places (not: alcohol)	**1**
		Total 10 marks

11.

Question		Marking details	Marks Available
(a)	(i)	Cytoplasm;	1
	(ii)	C; C; A; B;	4
	(iii)	2;	1
	(iv)	Accept hydrogen / reduced by; $NADH_2$ / reduced NAD / NADH H+; Lactate/ lactic acid;	3
(b)	(i)	Fats to fatty acids and glycerol; Glycerol into glycolysis; Fatty acids to 2C fragments; Acetyl group into Krebs; oxidative phosphorylation; More hydrogen in a substrate more for oxidative phosphorylation; Ref.Chemiosmosis;	3
	(ii)	CO_2/ urea;	1
	(iii)	More O_2 ; More CO_2; For blood to supply and remove; Anaerobic;	2
		Question 2 total	**[15]**

12.

Question			Marking details	Marks Available					
				AO1	AO2	AO3	Total	Maths	Prac
(a)	(i)		Any 2 from: From glycolysis (1) NOT link reaction/ Krebs Oxidation/ dehydrogenation reaction/ action of dehydrogenase (1) conversion of triose phosphate to pyruvate (1)	2			2		
	(ii)		Reduced FAD {passes its electrons to the second proton pump / only uses two proton pumps}(1) Only 2 ATP are produced (per reduced FAD) (1)		2		2		
	(iii)		{More respiration/ more ATP} required for muscle contraction(1) the cells use the mechanism which yields {more ATP/ 3 ATP per reduced NAD} (1)		2		2		
(b)			Removal of {amino/ amine/ NH_2} group/ deamination/ formation of {keto acids/ammonia} (1) Combining of amino group with carbon dioxide/formation of urea (amino/ amine/ NH_2 group)(1) In the liver (1)	3			3		
			Question 8 total	**5**	**4**	**0**	**9**	**0**	**0**