WJEC EDUQAS A-LEVEL BIOLOGY · COMPONENT 1

BIOLOGY



EXAM QUESTION PACK

1.1 IMPORTANCE OF ATP

SCORE	PERCENTAGE
/39	%

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1. ATP is regarded as a universal energy currency as it is used in all organisms for cellular processes.

(a) Draw a simple, fully labelled diagram of ATP. [2]

(b) The energy released when glucose is broken down in the presence of oxygen is coupled with an endergonic reaction in order to produce ATP. However, only a fraction of the released energy goes into the high-energy bonds of ATP; energy is lost as heat.

Using the following equation, the efficiency of ATP production can be determined by comparing the energy in ATP synthesised with the total energy released in the respiration of one glucose molecule:

$$\text{efficiency} = \frac{N \times E_{ATP}}{E_{react}} \times 100$$

N	number of ATP molecules synthesised
E_{ATP}	energy in terminal ATP bond
E_{react}	total energy released in the respiration of one glucose molecule

Under standard conditions

$E_{ATP} = -7.3$ kcal mol^{-1}

$E_{react} = -686$ kcal mol^{-1}

Assume that 38 molecules of ATP are synthesised.

(i) Calculate the efficiency of ATP production from glucose for the figures above. Give your answer to one decimal place. [2]

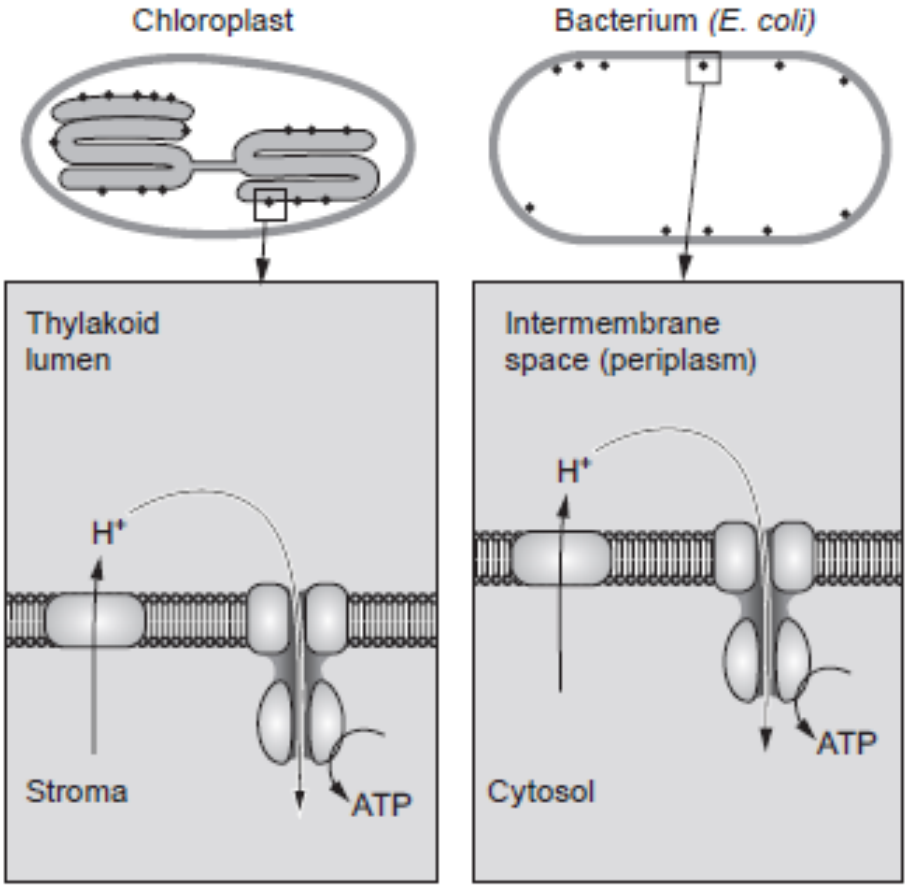
Efficiency = ... %

(ii) The efficiency of an electric motor or petrol engine is between 10% and 20%. Use the result from your calculation to make a quantitative conclusion about the efficiency of ATP synthesis from glucose compared with that of an electric or petrol engine. [1]

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(c) A simple diagram showing ATP synthesis in a chloroplast and a Gram negative bacterium is shown below.



State **four** similarities between the process of ATP synthesis in chloroplasts and the bacterium. [4]

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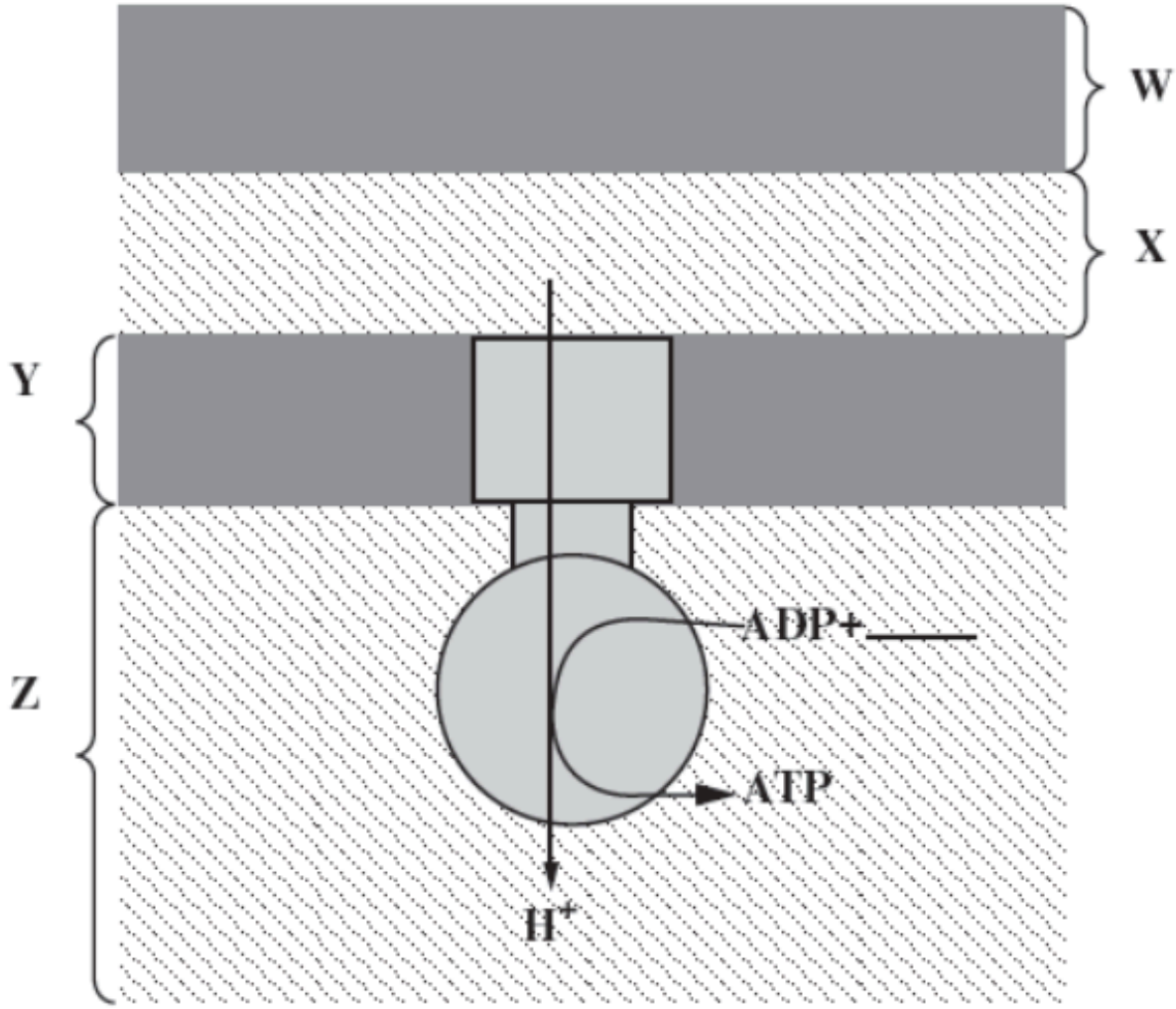
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2. Respiration results in the production of ATP in cells. Production of ATP in the mitochondrion is catalysed by an enzyme and requires energy supplied by a proton gradient. The diagram below represents a model of the ATP synthetase complex.



(a) (i) On the diagram above, complete the equation for the production of ATP.

[1]

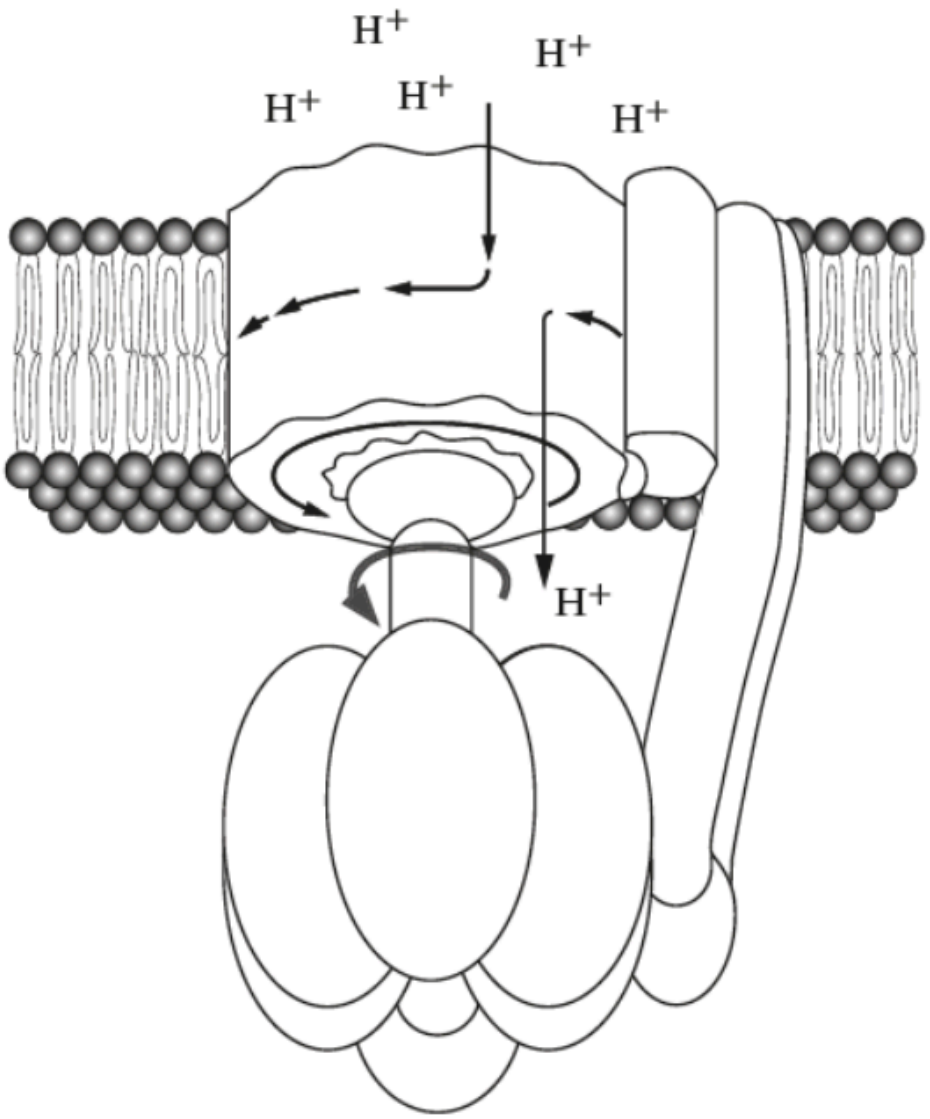
(ii) Name parts **W** and **Z** shown on the diagram above.

[2]

W ..... **Z** .....

(iii) State whether the H^+ concentration is highest in part **W**, **X**, **Y** or **Z**. [1]

3. The diagram below shows the most recent model of the ATP synthetase complex. This complex results in the synthesis of ATP from ADP and inorganic phosphate.



(a) State the position of this complex within a mitochondrion.

[1]

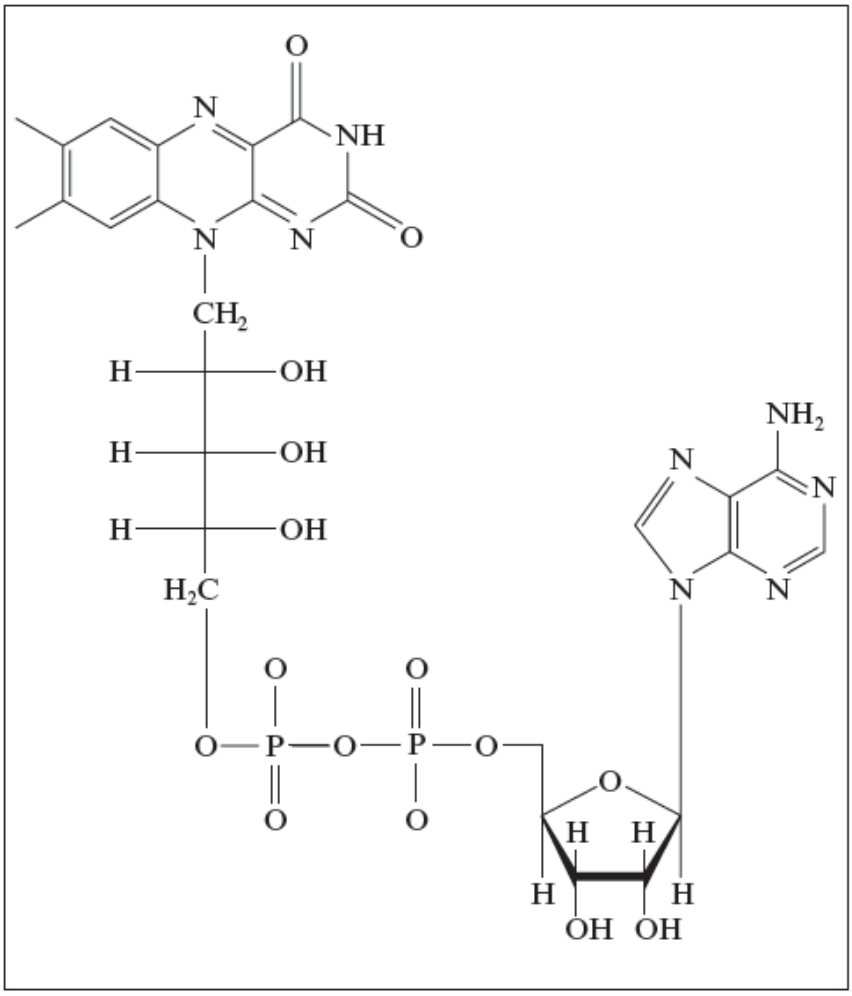
(b) Describe how the proton gradient that causes ATP synthesis is produced.

[3]

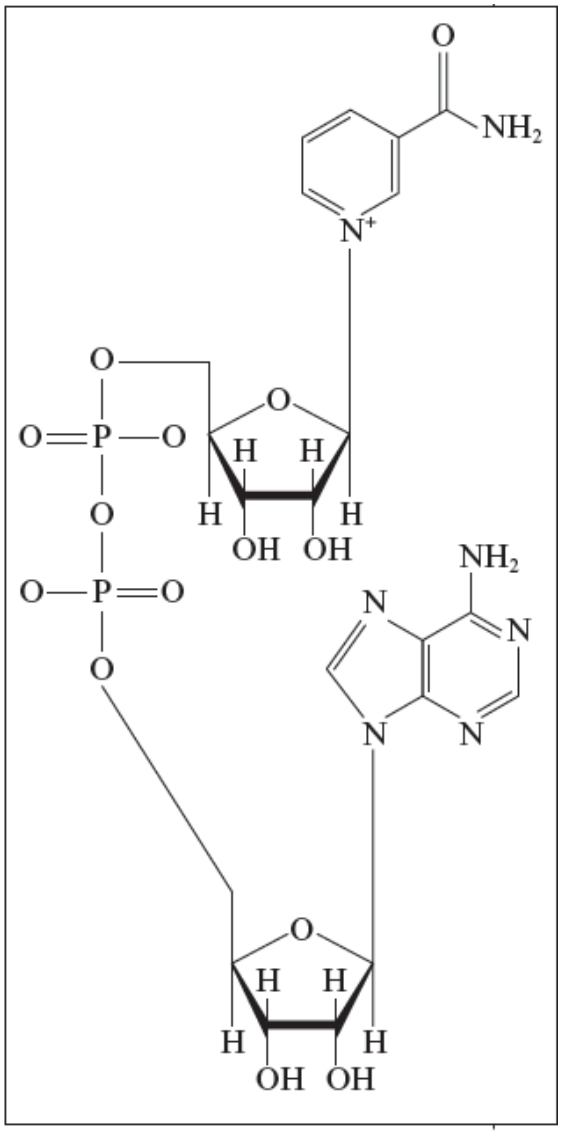
(c) Describe the role of oxygen in the electron transport chain.

[2]

4. The two diagrams below show nicotinamide adenine dinucleotide (NAD) and flavin adenine dinucleotide (FAD), two nucleotides used in respiration.



FAD



NAD

(a) State **two** chemical features which these two molecules have in common and **one** difference between the two molecules.

[3]

Features in common.

(i) . . . . . .

. . . . . .

(ii) . . . . . .

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Difference

(b) Substrate level phosphorylation (SLP) is the simplest, oldest and least-evolved way to make ATP. In substrate level phosphorylation, ATP is made during the conversion of an organic molecule from one form to another. Energy released during the conversion is used to synthesise the high energy bond of ATP.

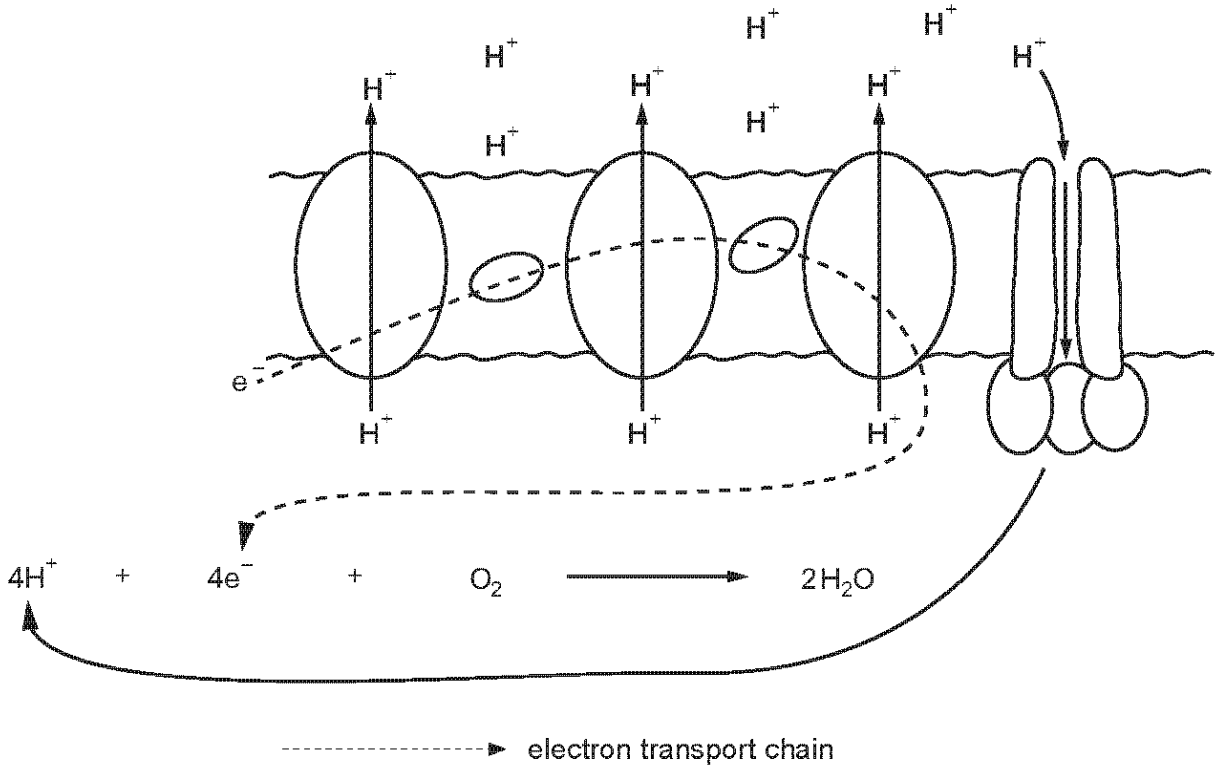
(i) Describe the position of the 'high energy bond of ATP' referred to in the paragraph above.

[1]

(ii) Suggest why SLP is referred to as the 'simplest and oldest way to make ATP'.

[2]

5. *(b)* The diagram below represents the electron transport chain in a liver cell.



(i) State precisely where this process takes place in the liver cell. [1]

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(ii) What is the **origin** of the electron passed along the chain? [1]

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(iii) As electrons are passed along the electron transport chain, energy is made available for the production of ATP. Using information from the diagram, explain how this energy is used to produce ATP. [5]

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6. DNP is an insecticide which inhibits ATP production in mitochondria. DNP acts as an agent that can transport protons across biological membranes. It greatly decreases the proton gradient across mitochondrial membranes. Instead of producing ATP, the energy of the proton gradient is lost as heat.

(a) Following the establishment of an electrochemical gradient, describe the normal route that the protons would take in order to synthesise ATP. [2]

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(b) Explain how DNP can act as an insecticide. [2]

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In the 1930s DNP in high doses was used as a dieting aid. People lost weight rapidly, they felt fatigued, sweated excessively and had an elevated body temperature. After a number of years, DNP was identified as causing severe side-effects, including deaths. In 1938, DNP was designated as "extremely dangerous and not fit for human consumption" and its use ceased.

More recently DNP has again caused deaths in people taking it to lose weight.

(c) Explain in detail how DNP brings about the symptoms described. [4]

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(d) How might DNP cause the rapid death of a person who is taking it to lose weight? [1]

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1.

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
1	(a)			 Only one phosphate need be labelled. Pentagon shape with adenine and 3 phosphates coming off at correct points (1) Ignore shape of adenine Correct labels = ribose + adenine + phosphate (1) Accept adenosine if structures bracketed Reject pentose Reject base	2			2		
	(b)	(i)		40.4 = 2 marks $\frac{38 \times 7.3}{686} \times 100\ \%$ = 40 = 1 mark incorrect dp Correct substitution into equation = 1 mark		2		2	2	
		(ii)		Approx {twice/ four times} as efficient / {20/30}% more ECF from (i)			1	1		
	(c)			Any four (x1) from: 1. Both involve proton pumps/ protons are pumped(1) 2. {Driven/ powered} by {electron (energy)/ redox reactions of ETC}(1) 3. Creation of {electro chemical/ proton/ chemiosmotic} gradient (1) 4. {Diffusion/ flow} of {hydrogen ions/ protons}/ protons {travel down/ pass through} {stalked particle/ carrier protein}/ chemiosmosis(1) 5. {through/ use} ATP synthase (synthesising ATP) (1) Accept synthetase		4		4		
				Question 1 total	**2**	**6**	**1**	**9**	**2**	**0**

2.

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
			Question 5 Total	[4]

3.

Question			Marking details	Marks Available
	(a)		inner membrane/crista;	1
	(b)		ref to NADH/FADH; membrane impermeable to protons; pumped across membrane; to intermembrane space;	3 max
	(c)		accepts electrons and protons; final acceptor of ETC; forms water; to maintain flow of electrons;	2 max
			Question 7 Total	**[6]**

4.

Question			Marking details	Marks Available
	(a)		<u>Similarities</u> (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
			<u>Differences</u> FAD only contains one (ring form) sugar **<u>and</u>** NAD contains 2/ One 5C sugar is in its linear form in FAD <u>and</u> 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

Question 6 Total **[6]**

5.

Question			Marking details	Marks Available
5	*(a)*	(i)	inner mitochondrial membrane / cristae;	1
		(ii)	Hydrogen;	1
		(iii)	Any **5** from: As electrons pass along the ETC energy released; used to pump protons; into inter membrane mitochondrial space; creates proton concentration gradient / electrochemical gradient / proton motive force; protons flow through / move down surface of stalked particles; provides energy for ATP synthetase / ATP synthase ; ADP + Pi to ATP; chemiosmosis;	5
			Question 5 Total	**[7]**

6.

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths *	Prac **
6	(a)			From the intermembrane space into the matrix (1) Via (a stalked particle containing) ATP synthase (1)	2			2		
	(b)			Cannot produce enough/lower yield of ATP/ no ATP produced (1) For {flight/muscle contraction/active transport / transmission of nerve impulses/ no protein synthesis/ cell division} (1) NOT overheating/ denaturation of proteins		2		2		
	(c)			**Any 4 (x1) from:** A. Use of fat stores as an energy source causes weight loss (1) reference to muscle/ protein is neutral B. Increased metabolic rate to compensate for ATP underproduction (1) C. Lack of ATP causes tiredness/fatigue (1) D. Heat produced as a by-product so increases body temperature (1) E. More sweat production to lower body temperature (1)		1 1	1 1	4		
	(d)			Overheating/hyperthermia/organ failure			1	1		
				Question 6 total	**2**	**4**	**3**	**9**	**0**	**0**