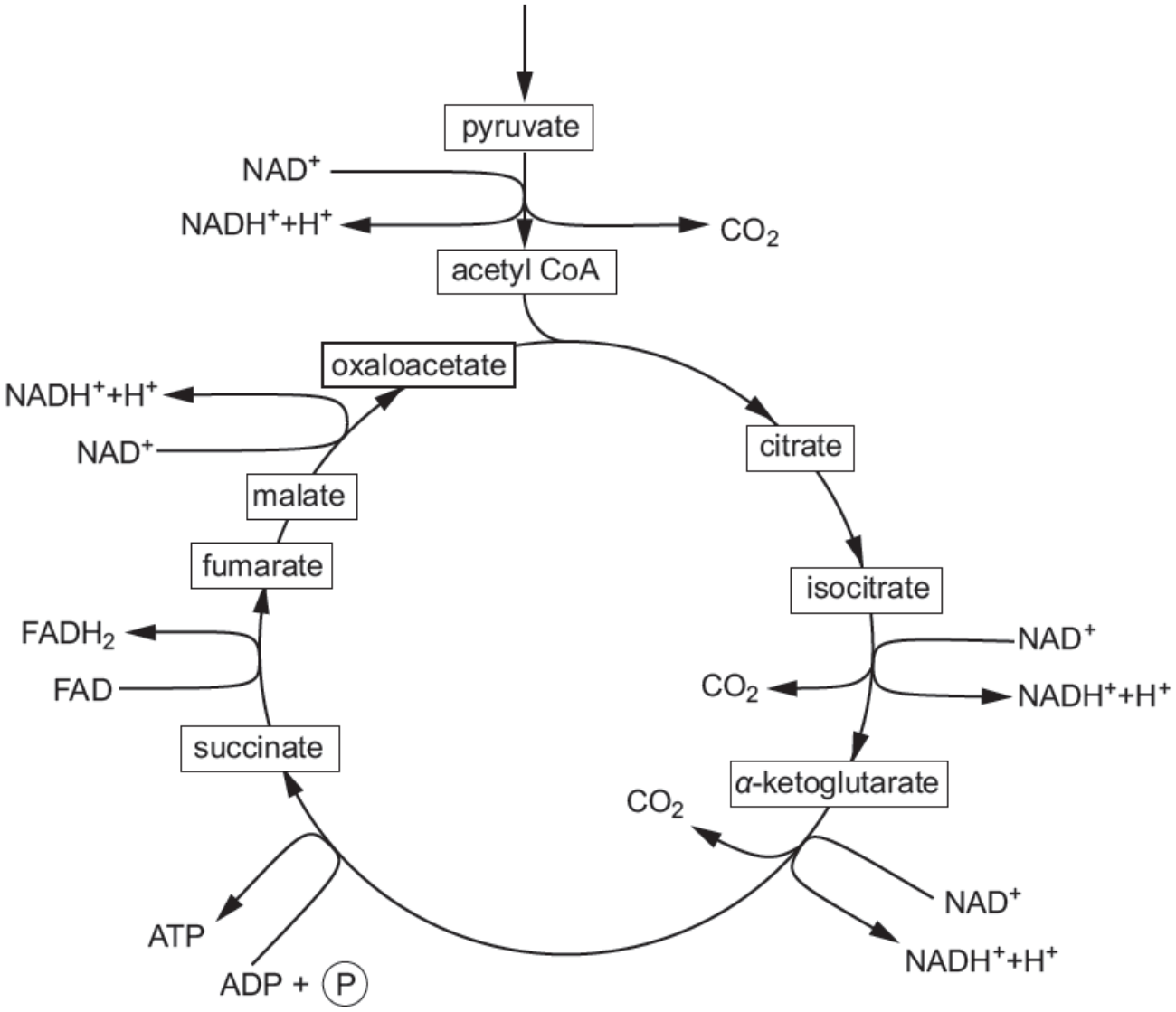
WJEC (Eduqas) Biology A-level
Topic 1.3 Respiration
Questions by Topic

1. The detailed diagram below shows the link reaction and Krebs cycle. Most of the intermediates involved are named.



(a) (i) Using the diagram above, and your own knowledge, determine how many carbons there are in the following Krebs cycle intermediates.

[1]

citrate . . . . . .

α-ketoglutarate . . . . . .

. . . . .

succinate . . . . . .

(ii) Explain precisely how you have arrived at these figures.

[2]

(b) Briefly describe how reduced FAD and reduced NAD are used to create an electrochemical gradient.

[4]

In patients with a suspected mitochondrial disorder a minimally invasive tissue biopsy provides the best opportunity to examine mitochondrial function, freezing the sample immediately after collection. In addition to activity measurements of individual enzymes, analysis of mitochondrial respiration and ATP production rates are performed. This includes the measurement of mitochondrial oxygen consumption in the presence of different substrates, such as pyruvate and α-ketoglutarate. Analysis may show increased levels of a Krebs cycle intermediate, such as malate and succinate.
Defects in mitochondrial ATP synthesis may lead to high lactate levels in blood.
J Inherit Metab Dis. 2011 April; 34(2): 283-292

(c) Name the **two** enzyme **types** involved in the conversion of pyruvate to acetyl CoA

[2]

Using the diagram opposite, the text above and your own knowledge, answer the following questions.

(d) Suggest a suitable tissue to examine mitochondrial function and explain why you have chosen this tissue with respect to patient safety.

[2]

(e) What could be deduced if the oxygen consumption was low with the pyruvate as a substrate but high with α-ketoglutarate as a substrate?

[2]

(f) What could be deduced if there was a build up of any one of the Krebs cycle intermediates?

[1]

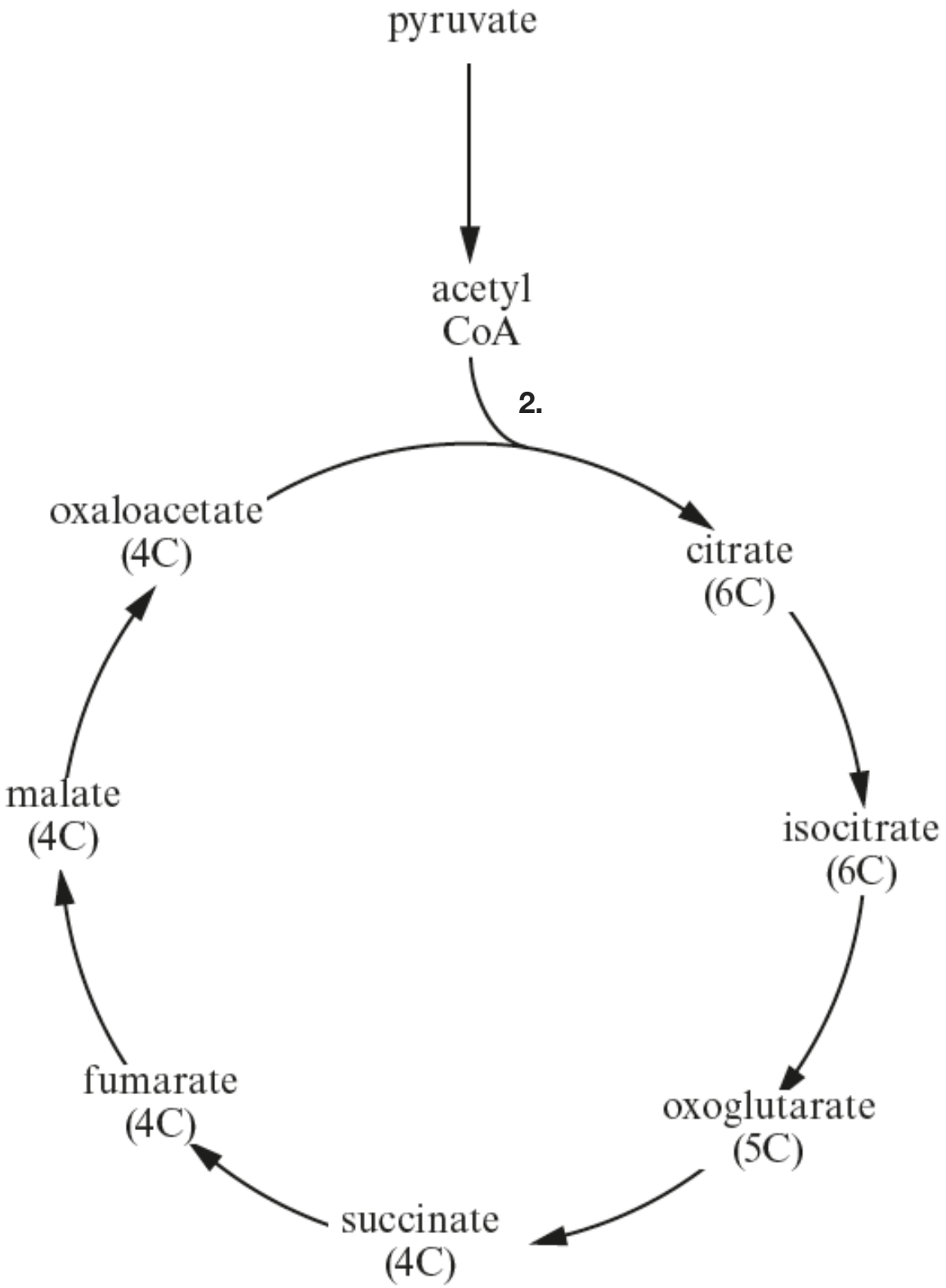
(g) Explain why there is a raised blood lactate level in many patients with mitochondrial disease.

[2]

The diagram below shows the link reaction and the Krebs Cycle.

The number of carbon atoms present in some of the molecules is shown.

2.



(a) State **precisely** where in the cell the reactions of the Krebs Cycle take place.

[2]

(b) (i) On the diagram opposite, use **arrows** marked **CO^2** to show the points where carbon dioxide is removed.

[2]

(ii) Name the process by which the carbon dioxide is removed.

[1]

(iii) Describe briefly what happens to a molecule of carbon dioxide removed in this way in a human.

[3]

(c) The role of the Krebs Cycle and glycolysis is to generate reduced NAD to be used in ATP manufacture.

Describe the way in which reduced NAD is produced in the Krebs Cycle.

[3]

(d) Reduced NAD is also produced during glycolysis.

Explain what happens to the reduced NAD under anaerobic conditions and why this is essential for glycolysis to continue.

[2]

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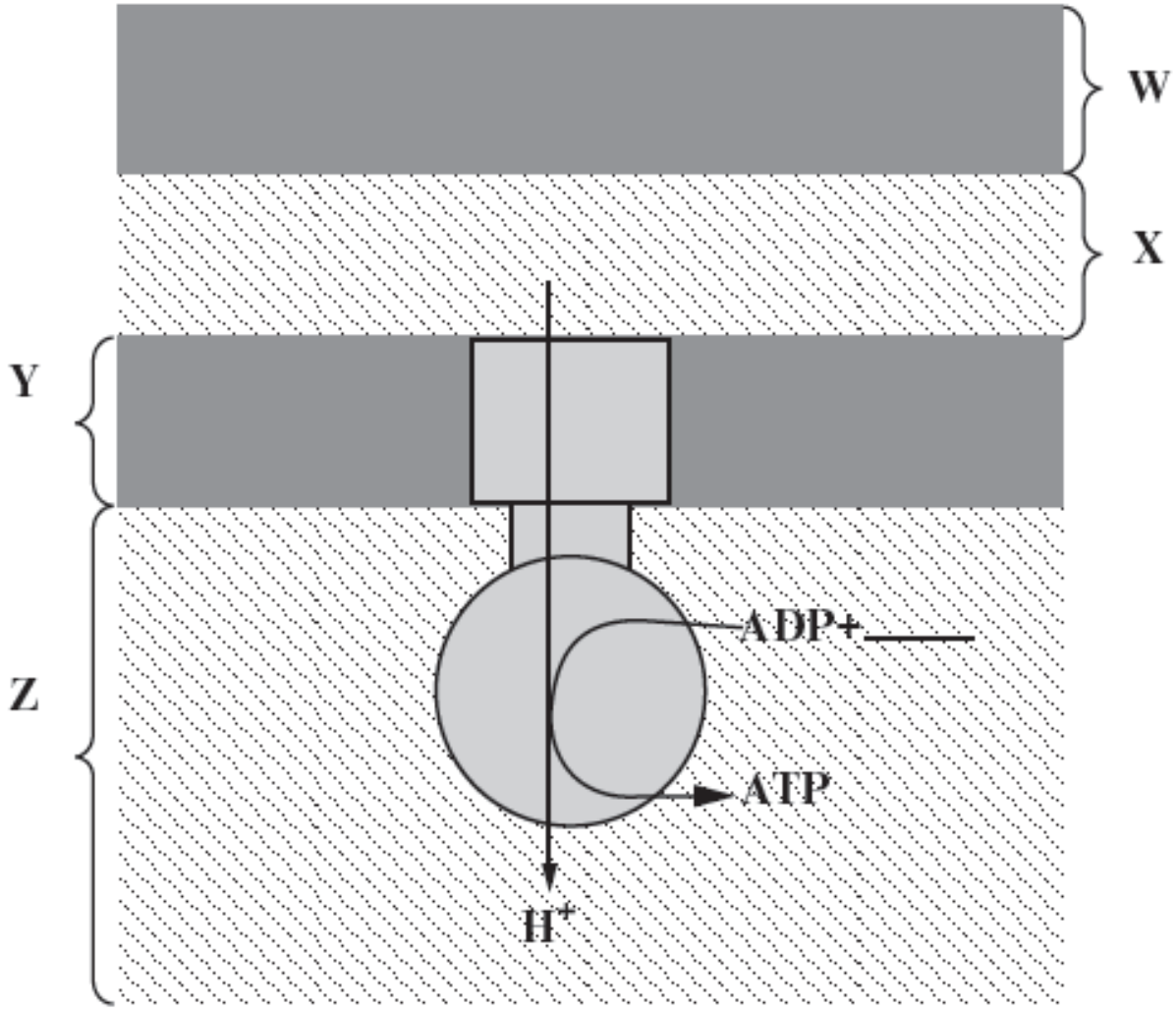
3. Respiration results in the production of ATP in cells. Production of ATP in the mitochondrion is catalysed by an enzyme and requires energy supplied by a proton gradient. The diagram below represents a model of the ATP synthetase complex.



(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]

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(b) The proton gradient can be maintained as long as reduced NAD is available in the mitochondrion.

Explain the reasons for reduced NAD being required to maintain a proton gradient.

[2]

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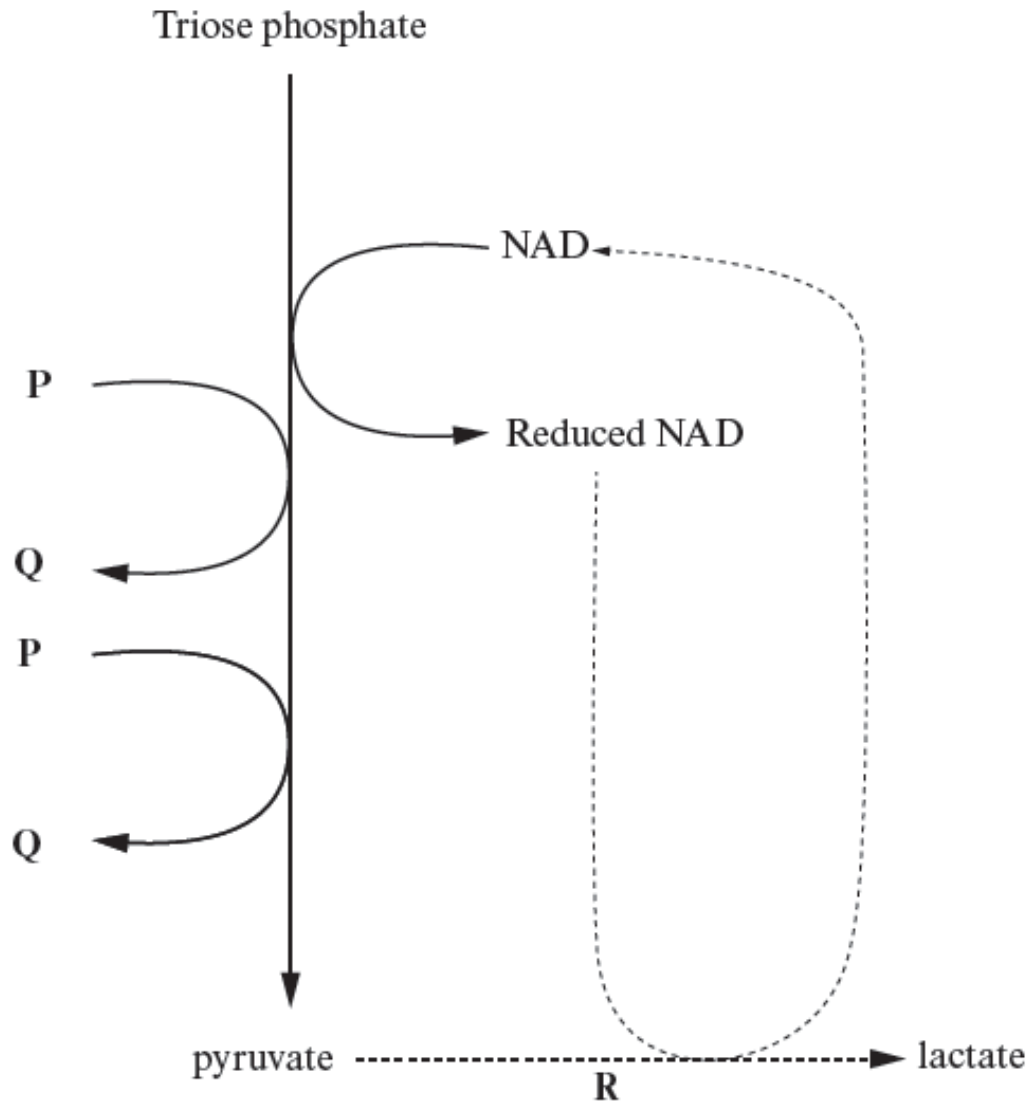
(c) The diagram below shows one stage of respiration in which reduced NAD is produced.



(i) Name chemicals **P** and **Q**.

[1]

P ..... **Q** .....

(ii) Where in the cell do the reactions shown in the diagram above occur?

[1]

.....

(iii) Outline the pathway for the production of triose phosphate in glycolysis.

[3]

(d) (i) The reaction labelled **R** on the diagram on the previous page occurs in humans when there are **anaerobic** conditions in a tissue.

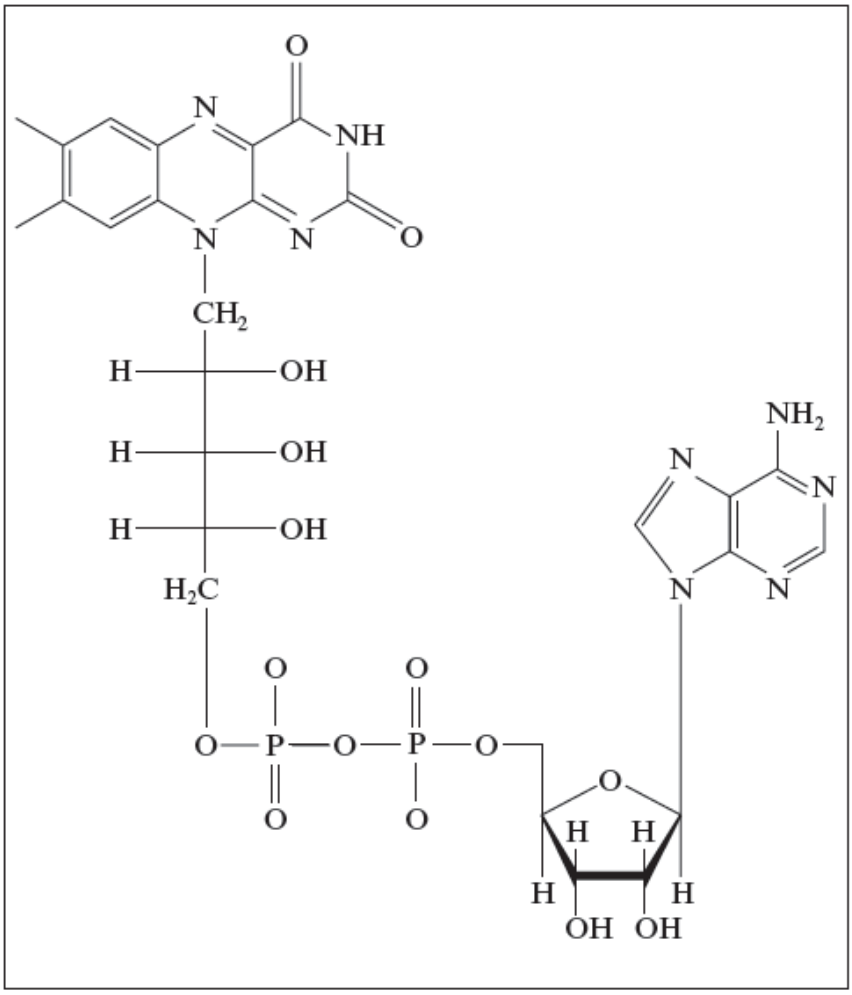
Explain the **biochemical** reasons for carrying out the reaction, despite the fact that lactate is toxic in high concentrations.

[3]

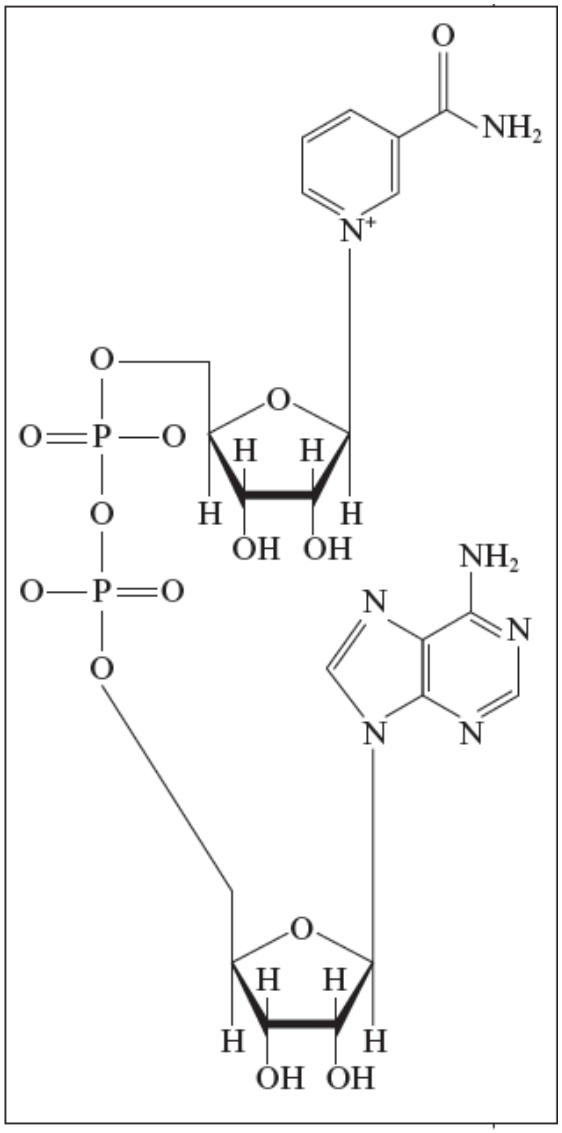
(ii) Reaction **R** sometimes occurs in muscle fibres when a short burst of very rapid ATP production is needed. Suggest a reason for this.

[1]

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) . . . . . .

. . . . . .

Difference

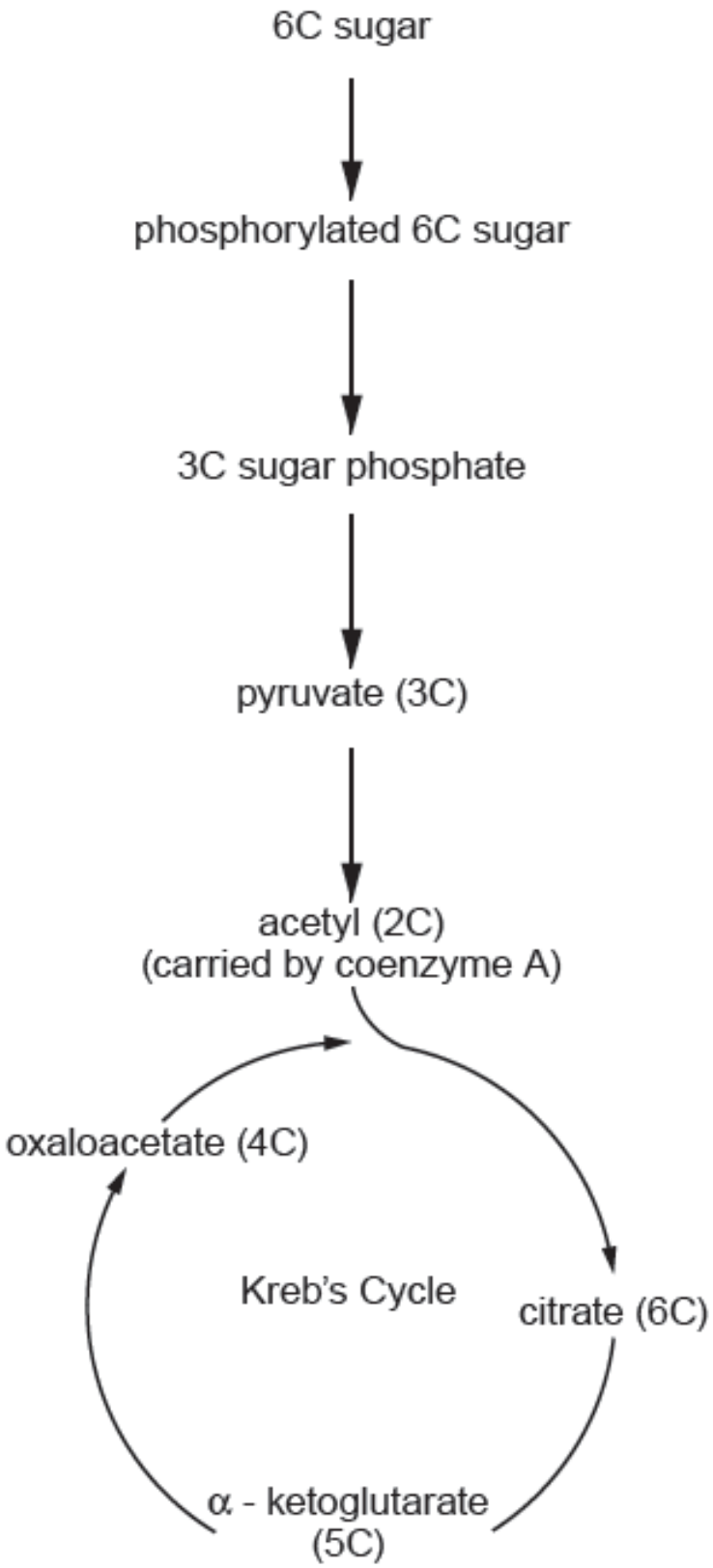
(b) Substrate level phosphorylation (SLP) is the simplest, oldest and least-evolved way to make ATP. In substrate level phosphorylation, ATP is made during the conversion of an organic molecule from one form to another. Energy released during the conversion is used to synthesise the high energy bond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



(iii) Draw **two** arrows labelled **A** and **B** on the diagram opposite to show the **two** steps where there is conversion of an organic molecule from one form to another and SLP occurs. [2]

(iv) Give the number of ATP molecules made by SLP at **each** of the conversions shown in part (iii) **per glucose molecule** in aerobic respiration. [2]

Arrow	Number of ATP molecules made per glucose molecule in aerobic respiration.
A	
B	

(c) (i) Where does the link reaction occur in cells?

[1]

(ii) Name the **two** types of enzyme involved in the link reaction.

[1]

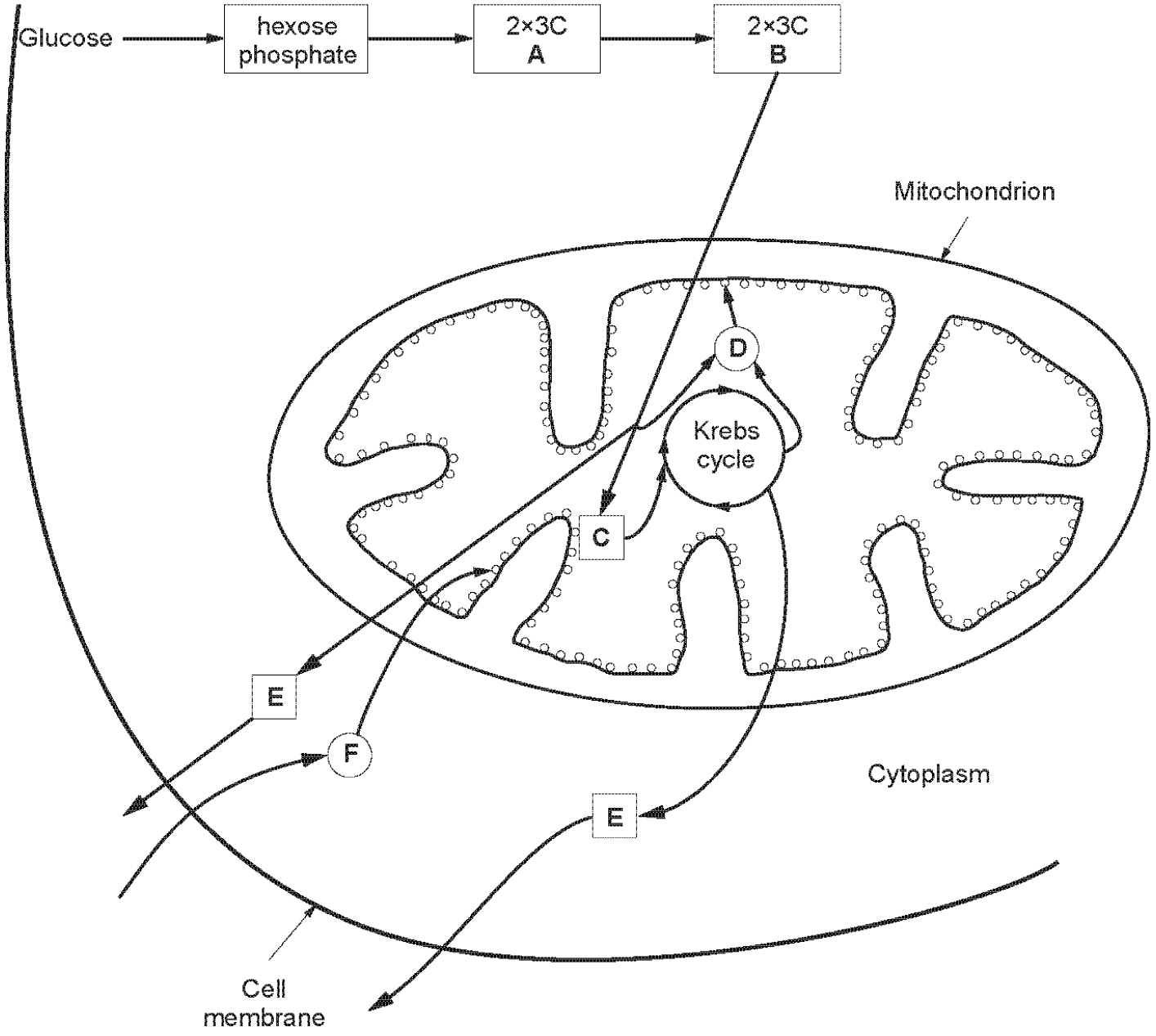
5. For **each** stage of the respiratory cycle shown in the table below use ticks (√) to indicate which statements are correct.

	Stage of Respiratory Cycle			
Statement	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				

6. More than a billion years ago, aerobic bacteria colonised primordial eukaryotic cells that lacked the ability to use oxygen metabolically. A symbiotic relationship developed and became permanent. The bacteria evolved into mitochondria, thus enabling the host cells to carry out aerobic metabolism, a much more efficient way to release energy than anaerobic glycolysis.

Describe the role of mitochondria in eukaryotic cells using your knowledge of respiratory pathways.
Explain how the original aerobic bacteria and primordial eukaryotic cells benefitted from this relationship.
Detailed diagrams are not required. [9 QER]

7. The diagram represents an overview of the main stages in the breakdown of a glucose molecule in a liver cell when oxygen is freely available.



(a) Identify the molecules which are represented by the boxes **A – F**. [6]

A .....

B .....

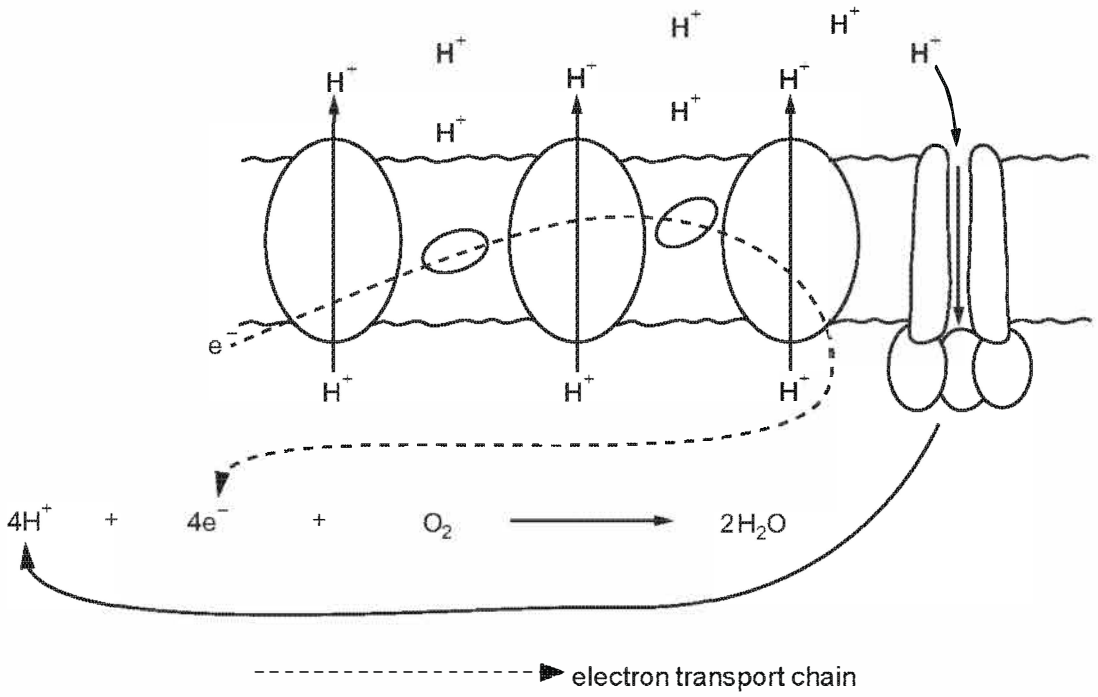
C .....

D .....

E .....

F .....

(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]

.....

8. *(a)* Describe the reactions that link glycolysis to the Krebs cycle. [3]

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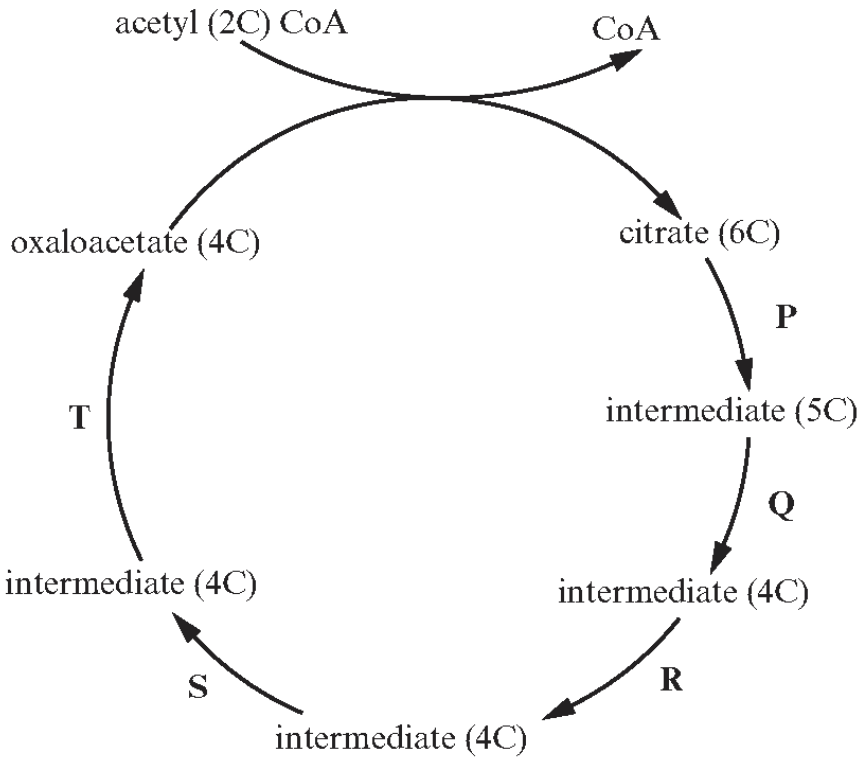
(b) Where precisely in the cell does each of the following occur? [2]

(i) Glycolysis .....

(ii) Krebs cycle .....

(c) The diagram shows an outline of the Krebs cycle.



A two carbon acetyl group enters the cycle by combining with a molecule of oxaloacetate (4C) with the formation of a molecule of citrate (6C). This is then decarboxylated and dehydrogenated to regenerate the oxaloacetate.

(i) Explain the following terms. [2]

I Decarboxylation

.....

II Dehydrogenation

.....

(ii) State the **letters** showing the individual steps in the cycle where decarboxylation is taking place. [1]

.....

(d) ATP is made directly by substrate level phosphorylation in the Krebs cycle.

(i) State the number of ATP molecules that are made directly **per 'turn'** of the cycle. [1]

.....

(ii) Complete the table to show the number of ATP molecules that are made in the electron transport chain **per 'turn'** of the cycle. [2]

	In the link reaction using NADH	*In the Krebs Cycle using NADH*	*In the Krebs Cycle using FADH*
Number of molecules of ATP formed			

(iii) Explain why the two hydrogen acceptors NAD and FAD lead to the production of different numbers of ATP molecules. [1]

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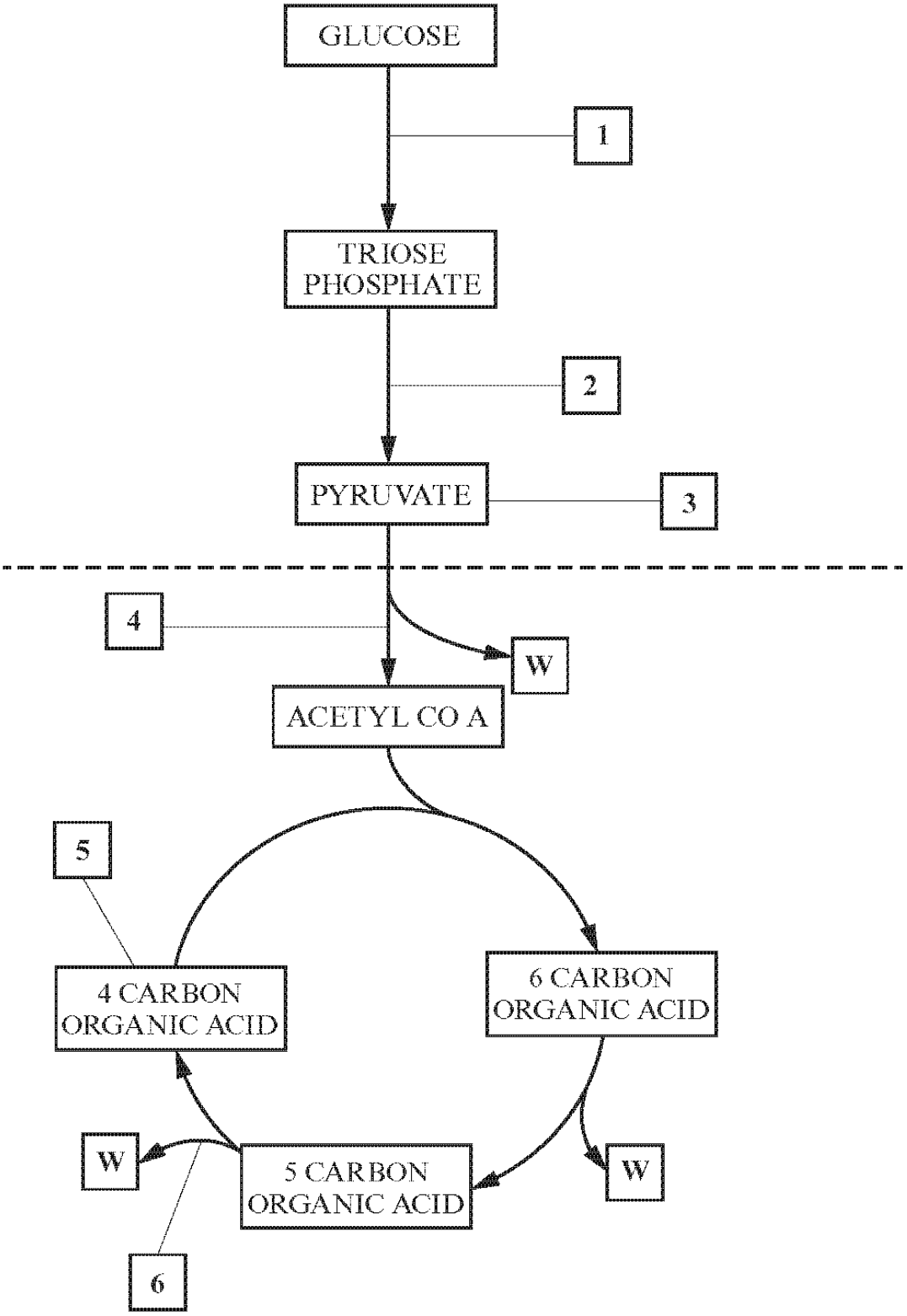
(Total 12 marks)

9.

The diagram shows an outline of three stages of aerobic respiration.



(a) (i) Name the three stages of respiration shown in the diagram opposite and state where in the cell they occur. **[3]**

Name of stage of respiration	*Where it occurs in the cell*

(ii) Which of these stages will operate in the absence of oxygen? **[1]**

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(b) (i) Identify substance **W** shown on the diagram opposite. **[1]**

.....

(ii) Name the enzyme responsible for its production. **[1]**

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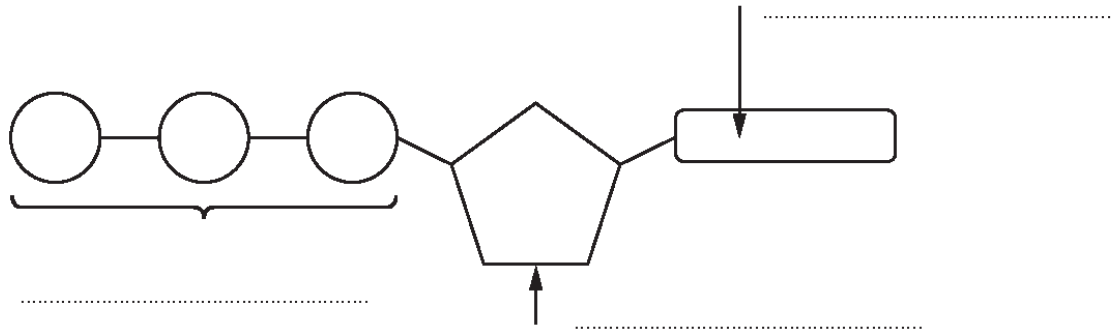
(c) Use the numbers **1** to **6** from the diagram opposite to identify where the following events take place during respiration. The numbers can be used once, more than once, or not at all. **[4]**

Event	Point(s) on Diagram
Substrate-level phosphorylation occurs	
Glycerol can be converted to a 3C sugar which enters respiration at this point	
ATP is used in phosphorylation	

10. The diagram below shows a molecule of ATP.



(a) (i) Label the component parts of the molecule. [2]

(ii) Give the full name of the molecule. [1]

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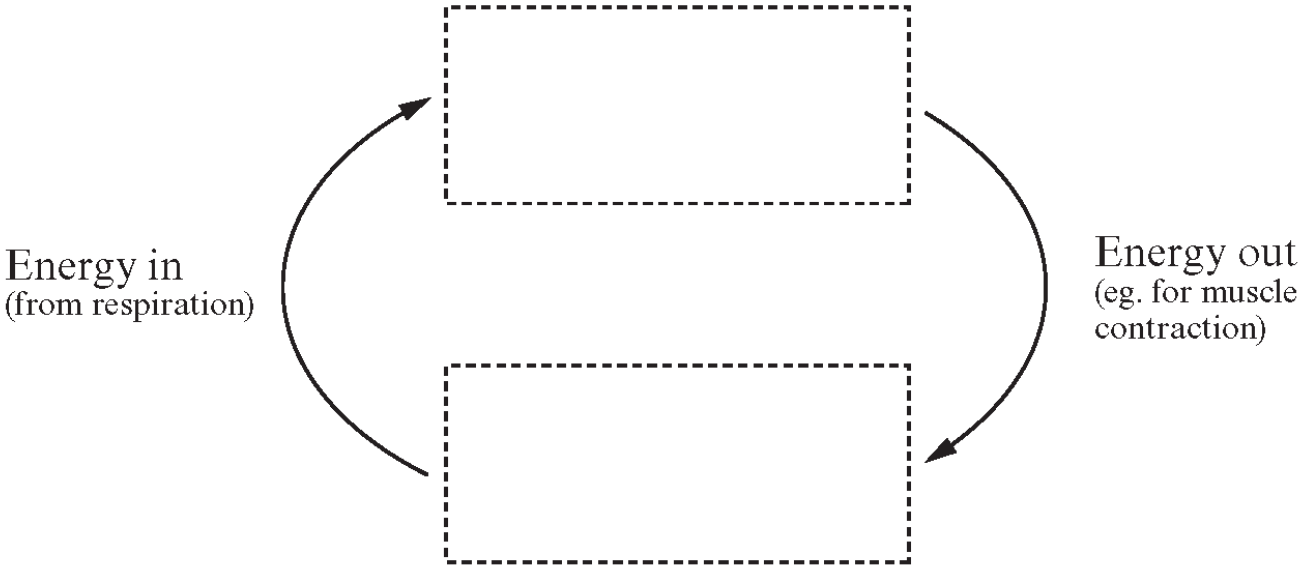
(b) (i) In the spaces indicated below, use drawings similar to the one above to show the changes that this molecule undergoes in cells. [1]



(ii) Apart from muscle contraction, name **one** *other* process in cells which requires energy. [1]

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(c) There are four main stages in the production of ATP by **aerobic** respiration.

(i) Complete the table below to show where the listed stages take place and how many molecules of ATP and reduced cofactor are produced from one molecule of glucose. **[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				
Krebs cycle				

(ii) Name the fourth stage and give its precise location in the cell. [1]

Name of stage .....

Precise location in the cell .....

(iii) State the number of ATP molecules this stage produces for one molecule of each type of reduced cofactor. [1]

$NADH_2$ .....

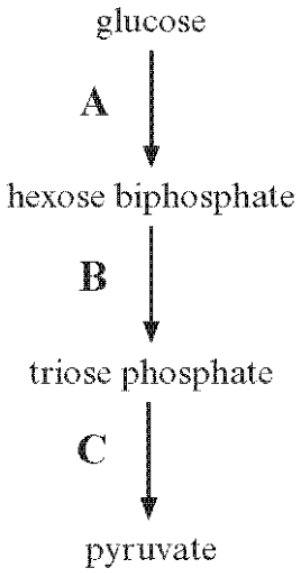
$FADH_2$ .....

(d) Complete the word equation below to show the products of **anaerobic** respiration in yeast cells.

(Total 10 marks)

11.

(a) The diagram below is an outline of glycolysis.



(i) State where glycolysis takes place in a cell. [1]

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(ii) Use the letters **A**, **B** or **C** from the diagram above, to indicate when the following processes take place. [4]

dehydrogenation .....

substrate level phosphorylation .....

phosphorylation using ATP .....

splitting of hexose .....

(iii) State the net gain of ATP when one molecule of glucose is broken down to pyruvate in glycolysis. [1]

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(iv) Describe what would happen to the pyruvate molecules formed under **anaerobic** conditions in human muscle. [3]

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(b) The chemical formula for the fat tripalmitin is $C_{51}H_{98}O_6$ and for the sugar glucose $C_6H_{12}O_6$.

(i) Use your own knowledge and the information above to explain what happens to tripalmitin under aerobic conditions and why it has a higher energy value per molecule than glucose.

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.....

..... [3]

.....

(ii) In what form is the carbon from the tripalmitin and glucose excreted from the body?

[1]

(iii) Although fats such as tripalmitin have a higher energy value than glucose, they are not the main source of energy in muscles. Suggest why this is the case.

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..... [2]

.....

12. Respiration is a process that takes place in all cells.

(a) (i) Describe the stage of the biochemical pathway in the cytoplasm which produces reduced NAD. [2]

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The energy budget for the complete oxidation of a single glucose molecule is frequently quoted as 38 ATP.

The majority of ATP produced in respiration is from the re-oxidation of the reduced NAD and reduced FAD, by the electron transport chain.

Some of the reduced coenzymes must be transferred from the cytoplasm into the mitochondrial matrix. This is done via two mechanisms in insect flight muscles.

A If levels of reduced NAD in the cytoplasm are high, the reduced NAD is transferred into the matrix through the outer and inner mitochondrial membranes.

B If cytoplasmic levels of reduced NAD are low, then an alternative pathway is used whereby the reduced NAD passes its electrons to FAD in the inner mitochondrial membrane.

(ii) Explain why the ATP yield per glucose molecule will be decreased if mechanism **B** is used. [2]

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(iii) Explain why mechanism **A** would be used in the muscle of flying insects. [2]

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(b) If a human eats a diet low in nutrients, amino acids from muscle tissue can be used as an alternative respiratory substrate. The amino acids, when processed, produce nitrogenous waste.
Describe the production of nitrogenous waste and state where this takes place. [3]