IB · DP · Biology

2 hours 15 questions

Structured Questions: Paper 2

8.2 Cell Respiration

8.2.1 Oxidation, Reduction & Phosphorylation / 8.2.2 Overview of the Stages of Respiration / 8.2.3 Glycolysis / 8.2.4 The Link Reaction & The Krebs Cycle / 8.2.5 Oxidative Phosphorylation / 8.2.6 Mitochondria / 8.2.7 Skills: Cell Respiration

Easy (5 questions)	/43
Medium (5 questions)	/49
Hard (5 questions)	/48
Total Marks	**/140**

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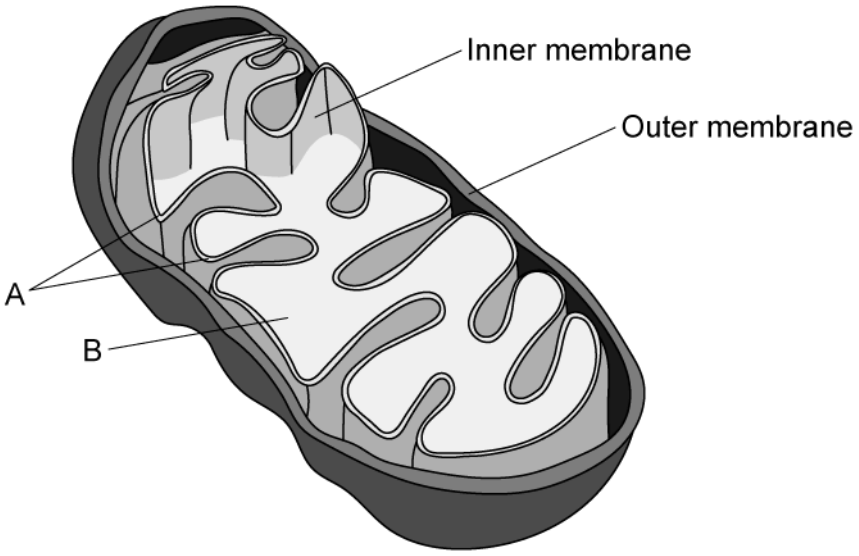
Easy Questions

1 (a) The diagram shows a mitochondrion.



Identify the parts labelled **A** and **B**.

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(2 marks)

(b) The stages of respiration take part in different locations in a cell as shown in the table below.

Complete the missing parts of the table.

Stage of respiration	**Location in cell**
	Cytoplasm
Link Reaction	
Krebs cycle	Matrix of mitochondria
Oxidative phosphorylation	

.....

(3 marks)

(c) Mitochondria are highly adapted to carry out respiration. One adaptation is a highly folded inner membrane, the cristae.

Describe how the folding of a membrane is an adaptation of an organelle such as the mitochondria.

(1 mark)

(d) Anaerobic respiration also occurs in cells, but not in the mitochondria.

State the names of the two types of anaerobic respiration. One type occurs in animal cells and the other type occurs in yeast cells.

(1 mark)

2 (a) Respiration can be represented by a chemical equation.

State the balanced chemical equation for aerobic respiration.

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(2 marks)

(b) Respiration involves the oxidation and reduction of chemical compounds.

Define oxidation in terms of electrons lost or gained.

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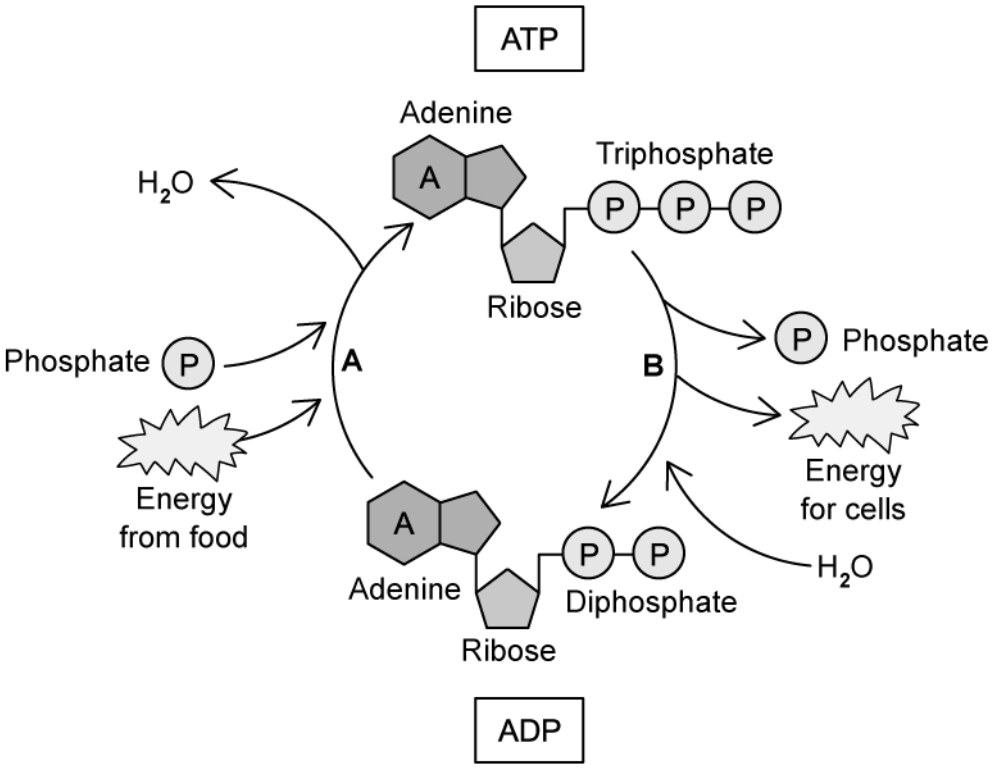
(1 mark)

(c) The diagram below shows the cyclic formation of ATP from ADP.

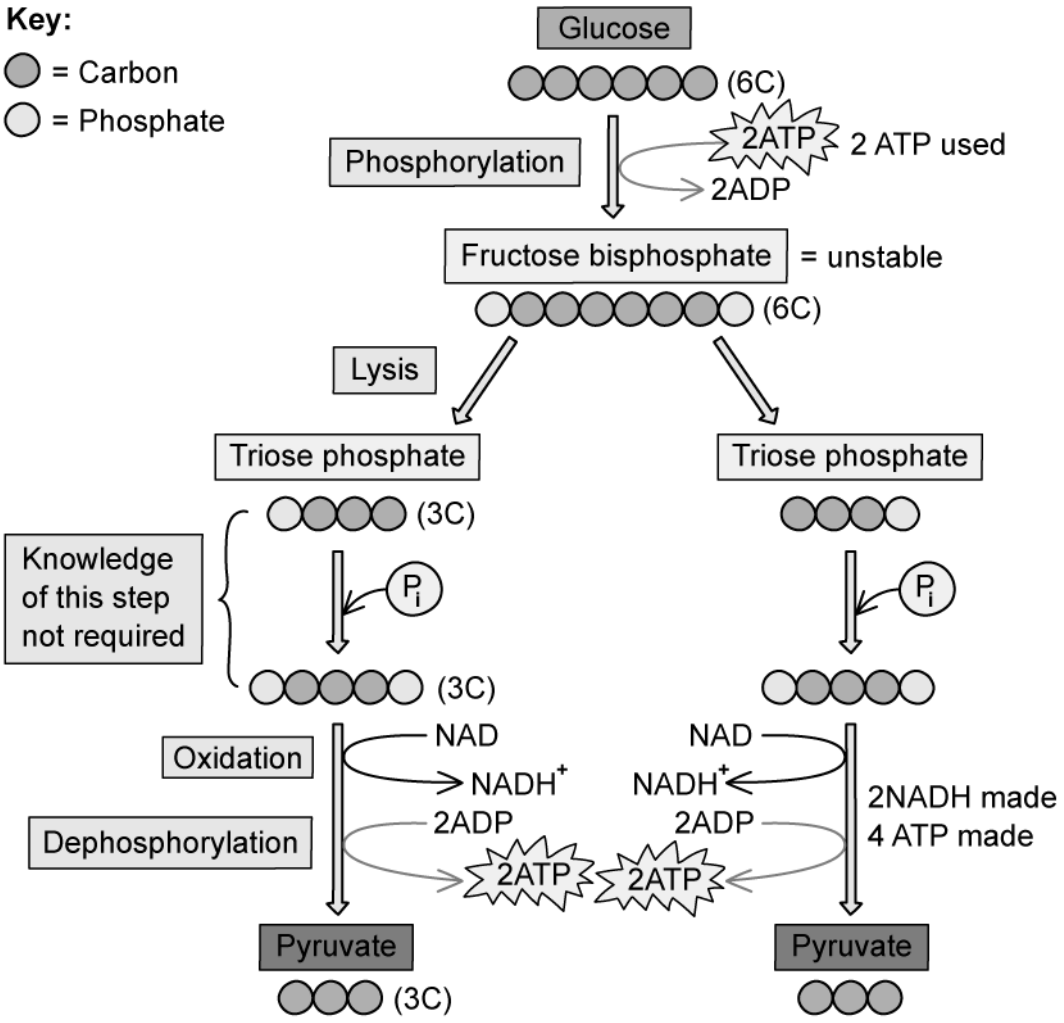
Use the diagram to identify which of processes **A** and **B** is the process of phosphorylation.



(1 mark)

(d) Phosphorylation occurs during the process of glycolysis.

Use the diagram below to describe phosphorylation during glycolysis.



(2 marks)

3 (a) The Link Reaction is described as an oxidative decarboxylation reaction.

State which molecule is decarboxylated during the Link Reaction.

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(1 mark)

(b) Coenzyme A is a molecule used in the Link Reaction,

State the role of coenzyme A in the Link Reaction.

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(2 marks)

(c) During the Krebs cycle, two molecules of carbon dioxide are released.

State how many molecules of carbon dioxide are released in the Krebs cycle per glucose molecule.

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(1 mark)

(d) The coenzyme NAD is reduced six times during the Krebs cycle stage of respiration.

Describe the events that occur to the molecule of NAD in order to reduce it.

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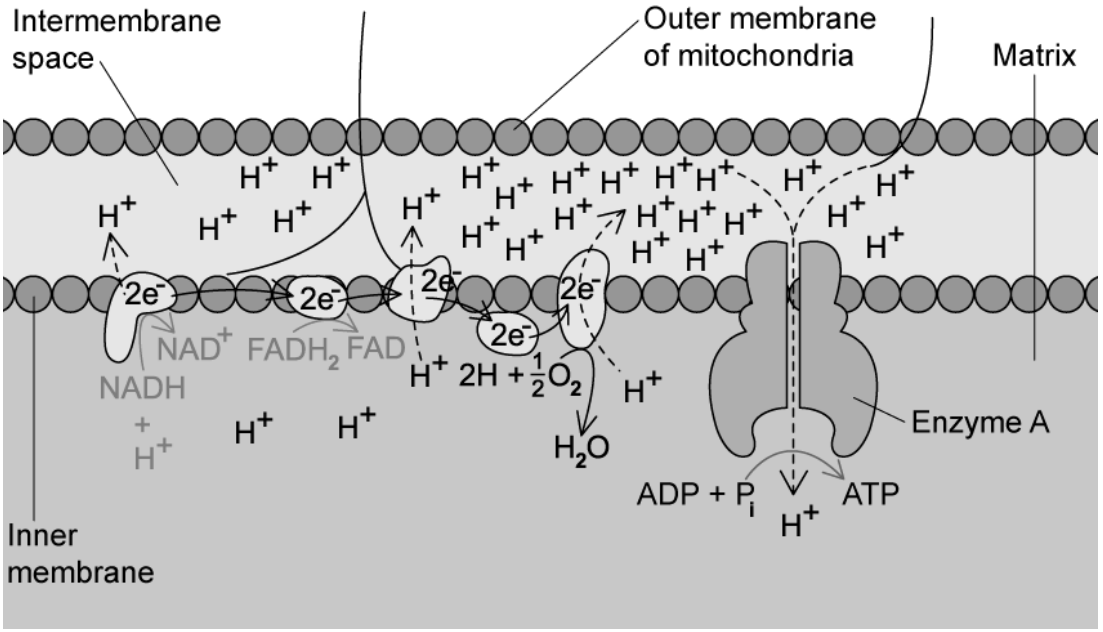
(2 marks)

4 (a) The diagram below shows the process of oxidative phosphorylation.



Identify enzyme A from the diagram.

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(1 mark)

(b) Describe the role of enzyme A from the diagram in part (a).

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(3 marks)

(c) An important process in respiration is the electron transport chain. This uses a series of redox reactions where electrons, donated from specific molecules, are transported through a chain of electron carriers.

State the two molecules which act as electron donors in the electron transport chain.

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(2 marks)

(d) Oxygen is described as the final electron acceptor in the electron transport chain.

Explain the importance of oxygen as the final electron acceptor.

(3 marks)

5 (a) *One mark is available for clarity of communication throughout this question.*

Describe the steps involved in the link reaction.

(3 marks)

(b) Describe the role of the inner membrane of the mitochondria.

(4 marks)

(c) The four main stages of aerobic respiration are glycolysis, the link reaction, Krebs cycle and oxidative phosphorylation.

Describe each stage, including the location of each.

(8 marks)

Medium Questions

1 (a) Mitochondrial diseases in humans cause their mitochondria to malfunction. Individuals that suffer from mitochondrial disease are only able to endure intense exercise for a short period of time.

Explain why this is.

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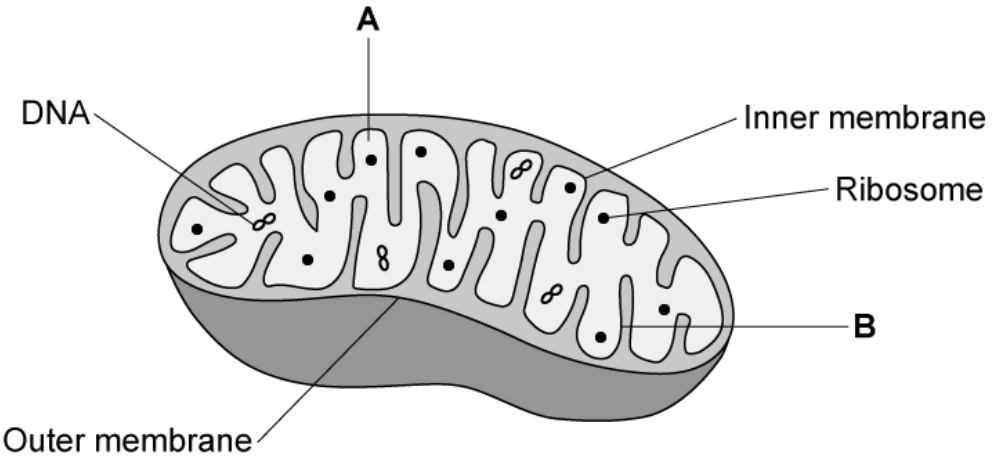
(2 marks)

(b) The diagram below shows a mitochondrion.



Identify the structures labelled **A** and **B** in the diagram

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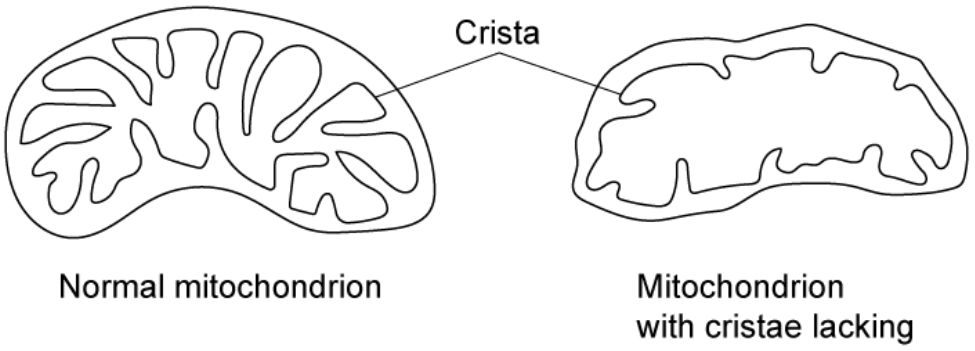
(1 mark)

(c) Some forms of mitochondrial dysfunction result in mitochondria that lack fully formed cristae as shown in the diagram below.



Suggest, with a reason, the effect of this on the production of ATP.

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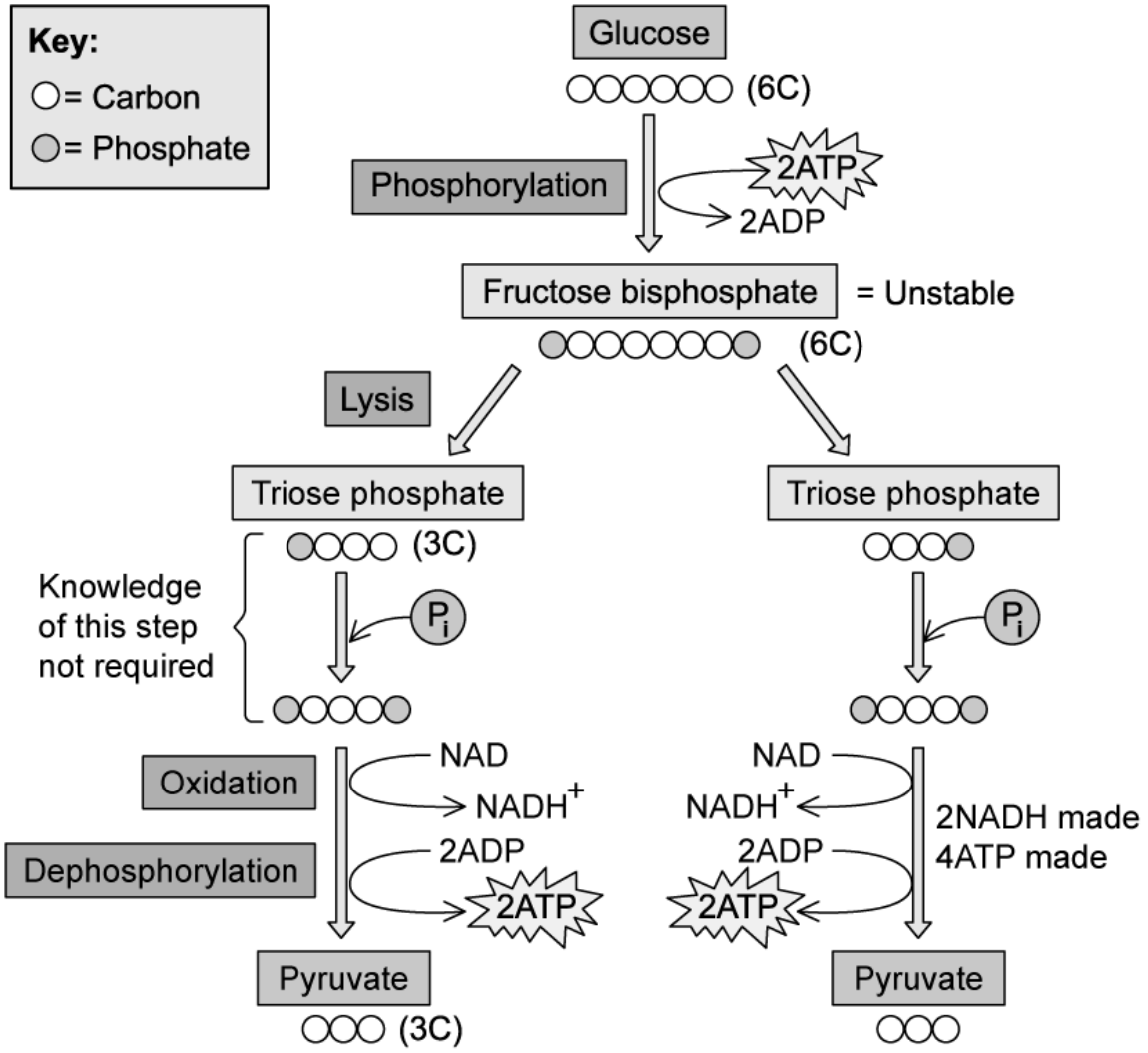
(3 marks)

(d) The diagram below shows glycolysis.



State the net production of ATP and reduced NAD during glycolysis.

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(1 mark)

2 (a) The Krebs cycle, which takes place in the mitochondrial matrix, releases hydrogen ions.

These hydrogen ions provide a source of energy for the synthesis of ATP, using coenzyme.

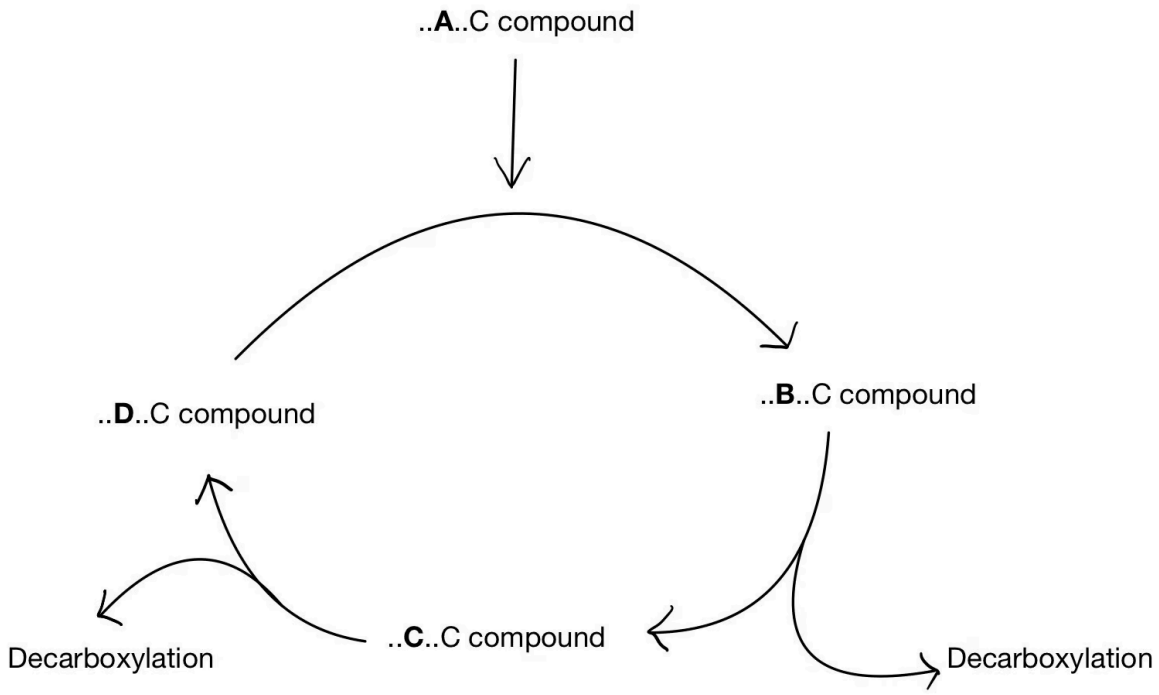
Describe the role of the coenzymes in the synthesis of ATP.

(3 marks)

(b) Explain why the link reaction is described as an oxidative decarboxylation reaction.

(2 marks)

(c) The diagram below shows the Krebs cycle.



Identify the number of carbon atoms (e.g. 1C) at each stage of the Krebs cycle.

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(2 marks)

(d) NAD and FAD are important electron carriers produced throughout the stages of respiration.

Complete the table below to show how many molecules of NAD and FAD are produced at each stage per molecule of glucose.

Stage of respiration	Number of NAD molecules	Number of FAD molecules
Glycolysis		
Link reaction		
Krebs cycle		
Electron transport chain		
Chemiosmosis		

.....

.....

(2 marks)

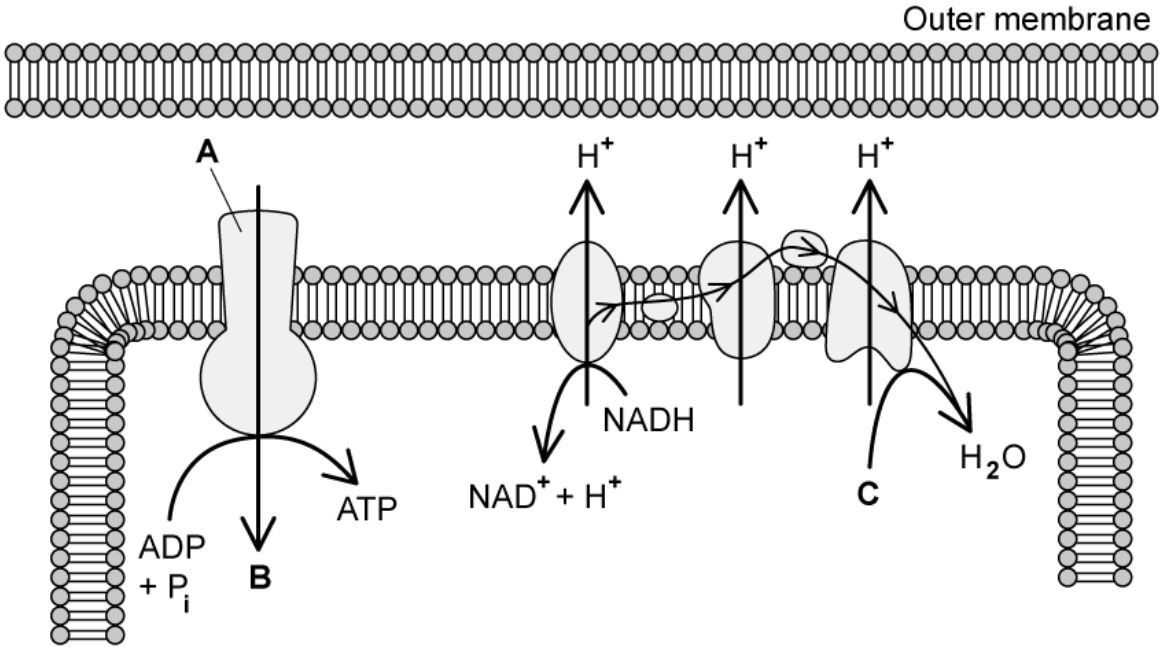
3 (a) Describe the role of oxygen in respiration.

(3 marks)

(b) Outline the events of the electron transport chain.

(3 marks)

(c) The diagram below shows part of a mitochondrion.



Suggest, with a reason, which part of the mitochondrion is shown in the diagram.

(2 marks)

(d) Label parts **A**, **B** and **C** in the diagram in part c).

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(1 mark)

4 (a) Draw an annotated diagram of a mitochondrion as seen through an electron microscope.

Your drawing should be a longitudinal cross-section; it should show the mitochondrion as if it has been cut open end-to-end.

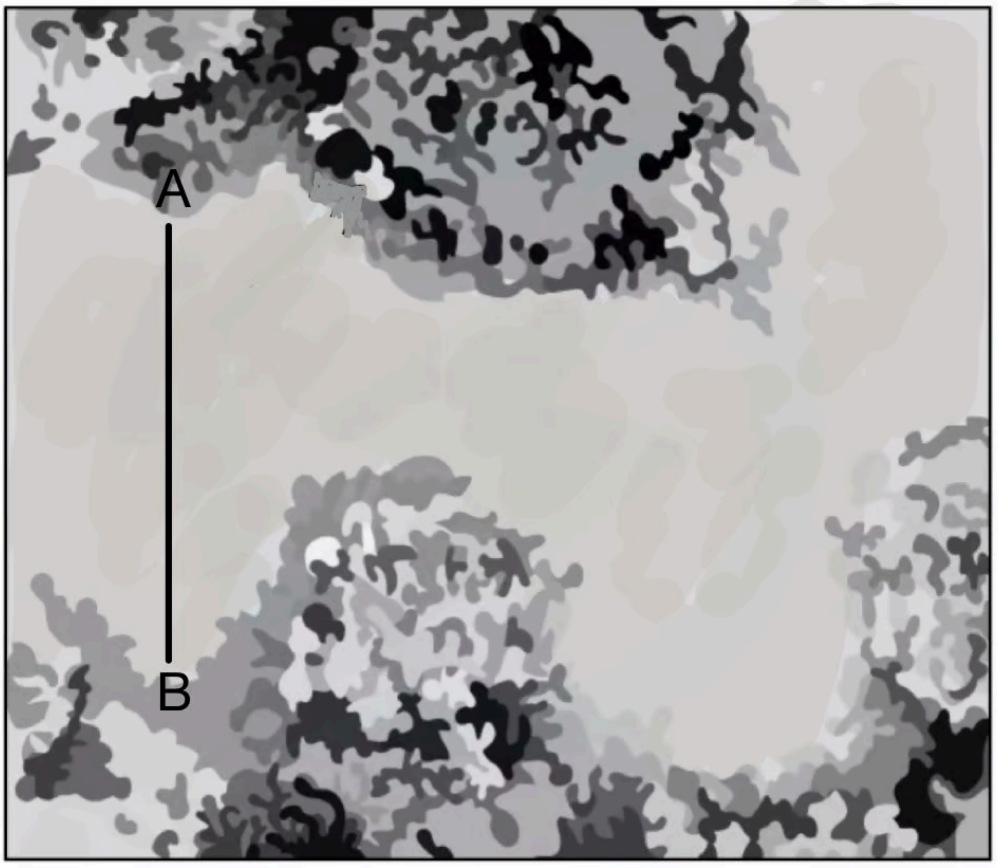
(3 marks)

(b) Electron tomography has been used to make new discoveries about mitochondria.

Describe features of the mitochondria that have been identified by the use of electron tomography.

(2 marks)

(c) The diagram below shows the cristae of a mitochondrion viewed with a magnification of x7000.



Use the information from the diagram and above to calculate the actual size space between **A** and **B**. You may assume that the line AB, when printed on paper, has a length of 3.5 cm.

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(1 mark)

(d) Phosphorylation occurs on the cristae membrane.

i. Describe the process of phosphorylation of ATP.
ii. State the stage(s) of respiration in which substrate level phosphorylation occurs.

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(3 marks)

5 (a) *One mark is available for clarity of communication throughout this question.*

Describe the mechanism by which ATP is formed in the mitochondria.

(8 marks)

(b) In the 1960s Peter Mitchell developed the theory of chemiosmosis which was a novel idea from the current theories.

Outline the key principles of his hypothesis that made it a paradigm shift.

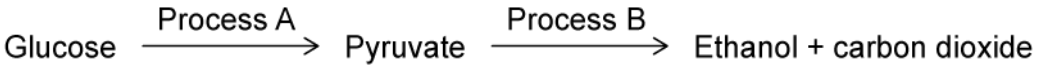
(4 marks)

(c) Explain the relationship between the structure of the mitochondria and how it is related to its function.

(3 marks)

Hard Questions

1 (a) Most plants can respire aerobically and anaerobically. The diagram below shows a summary of anaerobic respiration.



State precisely in the cell where Process A occurs.

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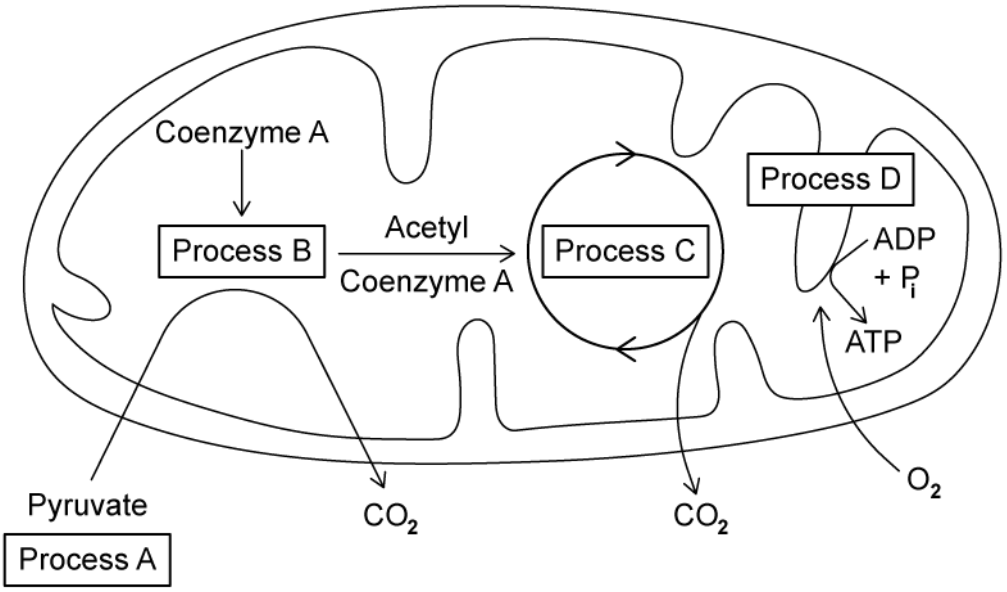
(1 mark)

(b) The diagram below shows a summary of the processes involved in aerobic respiration.



Explain how Process D enables Process A to continue

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(2 marks)

(c) Aerobic respiration produces more ATP per molecule of glucose than anaerobic respiration.

Explain why.

(3 marks)

(d) Different stages of respiration can be inhibited by a range of substances. DNP is a steroid drug used in the weight loss industry. It inhibits respiration by preventing a proton gradient being maintained across membranes. When added to isolated mitochondria it caused the following effects:

- Less ATP produced
- Increase in heat production
- No change in the uptake of oxygen

Explain how DNP caused these changes.

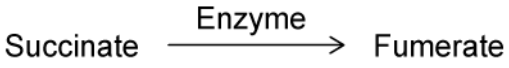
(3 marks)

2 (a) The Krebs cycle takes place in the mitochondrial matrix. The process releases hydrogen ions which provide a source of energy for the synthesis of ATP, using co-enzymes and carrier proteins.

Describe the role of co-enzymes and carrier proteins in the production of ATP.

(3 marks)

(b) The following reaction takes place in the Krebs cycle.



A student investigated the effect of the enzyme inhibitor malonate on this reaction. The structure of malonate is similar to the structure of succinate.

In the investigation, the student added malonate and the respiratory substrate, pyruvate, to a suspension of isolated mitochondria. She also bubbled oxygen through the suspension.

Explain why the student used pyruvate and not glucose as a respiratory substrate.

(2 marks)

(c) Explain how malonate inhibits the formation of fumarate from succinate.

(2 marks)

(d) The student measured the uptake of oxygen by the mitochondria during the investigation. The uptake of oxygen decreased when malonate was added.

Explain why.

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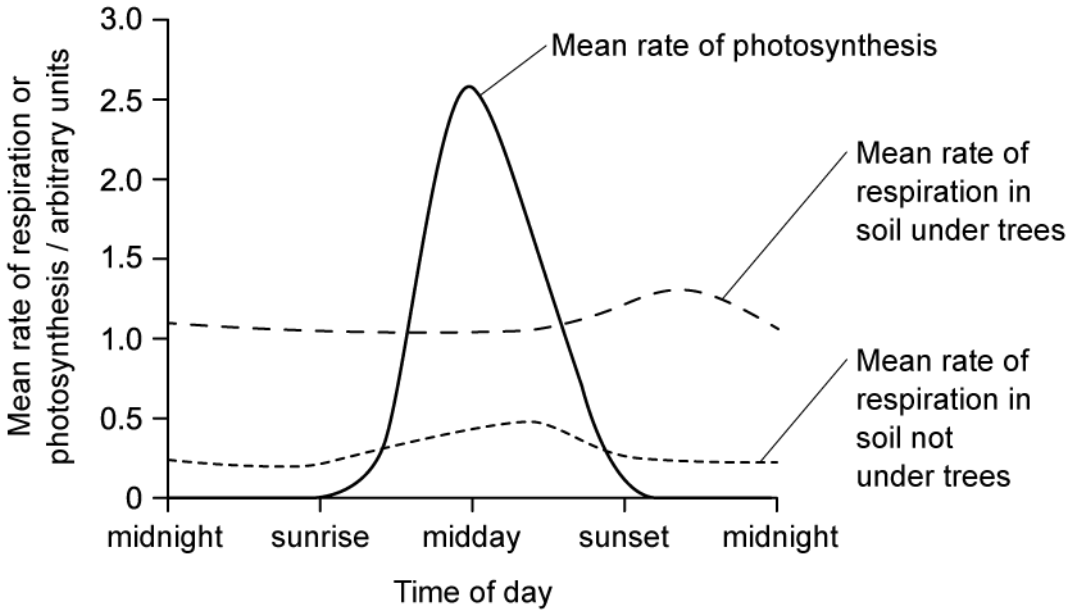
(2 marks)

3 (a) A group of scientists measured the mean rate of respiration in soil found under trees and soil that was not from under trees within the same woodland. The mean rate of photosynthesis in leaves was also measured. The measurements were taken throughout a 24 hour period during the summer.

The diagram below shows the scientists' results.



Suggest an explanation for the mean rate of respiration in soil not under the trees between midday and sunset.

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(2 marks)

(b) The mean rate of respiration is higher in soil under the trees throughout the 24hours. The scientists suggested the mean rate of photosynthesis was the cause of this.

Suggest how the rise in the mean rate of photosynthesis could lead to the rise in the mean rate of respiration in soil under trees.

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(2 marks)

(c) Suggest why there is a delay between the rise in the mean rate of photosynthesis and the rise in the mean rate of respiration.

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(1 mark)

(d) State the measurements needed for the scientists to calculate the rate of carbon dioxide production.

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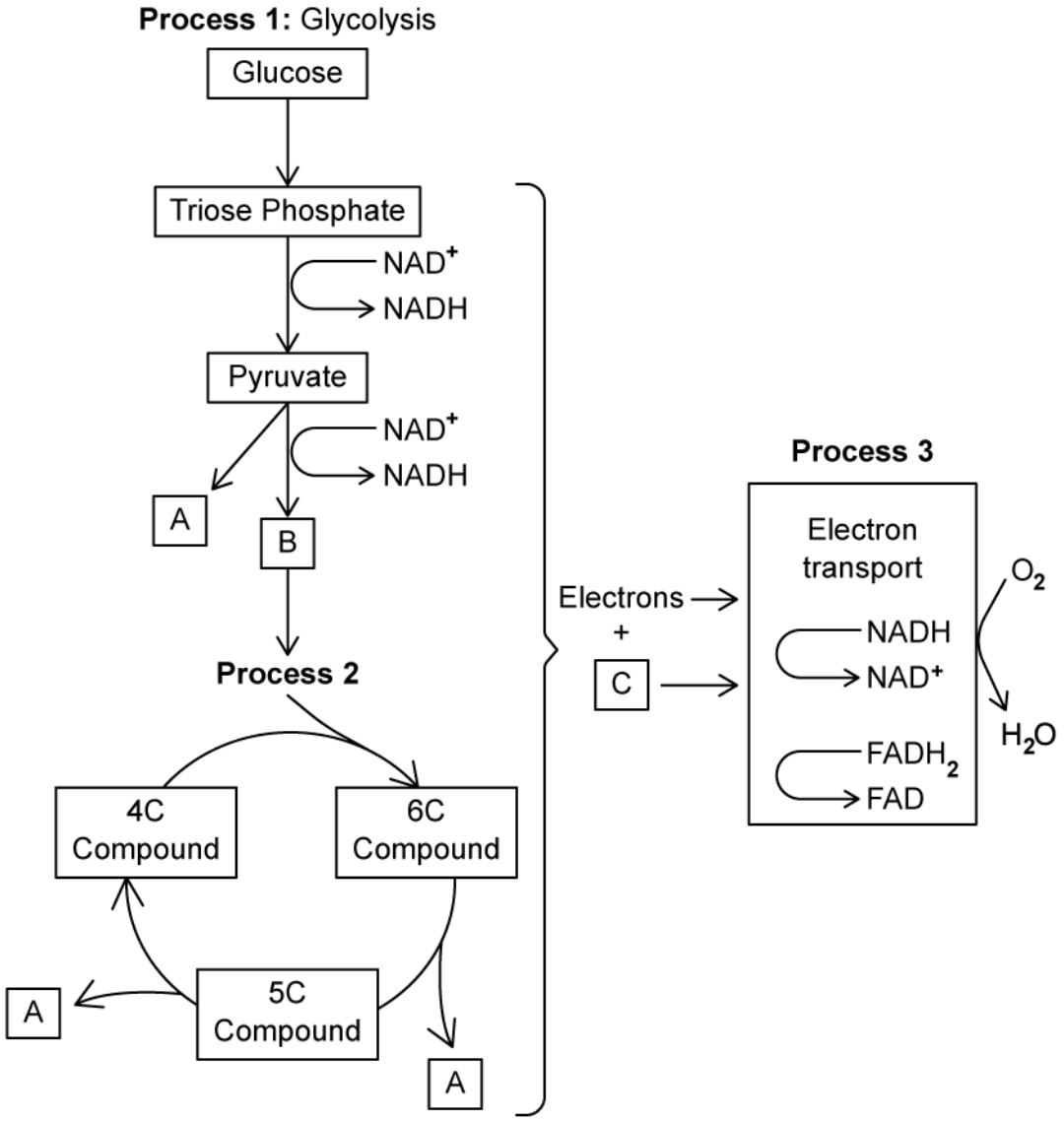
(2 marks)

4 (a) The diagram below shows the main stages of aerobic respiration.



Name substances A, B and C

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(3 marks)

(b) Annotate on the diagram,

(i) with an X, where oxidation occurs

[1]

(ii) with a Y, where decarboxylation occurs

[1]

.....

.....

(2 marks)

(c) State precisely where in the cell Process 2 is occurring.

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(1 mark)

(d) Compare the roles of NAD+ and NADH in Process 1 and Process 3.

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(2 marks)

5 (a) *One mark is available for clarity of communication throughout this question.*

A large number of disorders are being linked to mitochondrial disease, MD. MD can affect the skeletal muscles, causing fatigue and weakness. Some mitochondrial diseases are caused by mutations of mitochondrial genes inside the mitochondria. Most mitochondrial diseases are caused by mutations of genes in the cell nucleus that are involved in the functioning of mitochondria.

One form of MD is caused by a mutation of a mitochondrial gene that codes for a tRNA. which changes the anticodon on the tRNA. This results in the formation of a non-functional protein in the mitochondrion.

Suggest how a change in anticodon on the tRNA can lead to muscle weakness and fatigue.

(5 marks)

(b) A person with MD often has a decreased uptake of oxygen in their respiring cells. This has been attributed to an inhibitory compound of the Krebs cycle.

Explain why an inhibitor of the Krebs cycle would decrease the rate of oxygen uptake by cells.

(3 marks)

(c) Explain the role of chemiosmosis in the process of oxidative phosphorylation

(7 marks)