

Unit 2 Metabolism & Survival

Key Area 2: Cellular Respiration

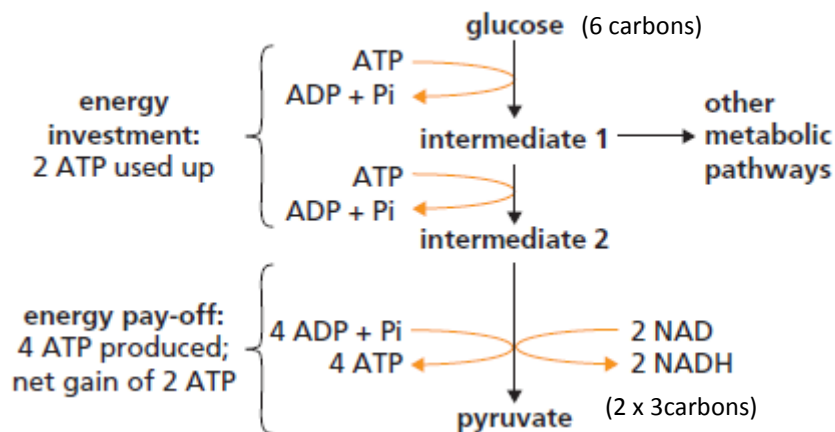
Cellular respiration is an enzyme-controlled series of reactions in which a respiration substrate such as Glucose is broken down to generate energy in the form of ATP.

Glycolysis

The 1st step is known as Glycolysis and involves the **breakdown of Glucose to Pyruvate**.

Glycolysis occurs in the **cytoplasm** of the cell.

ATP is required for the **phosphorylation of glucose and intermediates** during the **energy investment phase** of glycolysis. This leads to the **generation of more ATP** during the **energy pay-off stage** and results in a **net gain of ATP**.

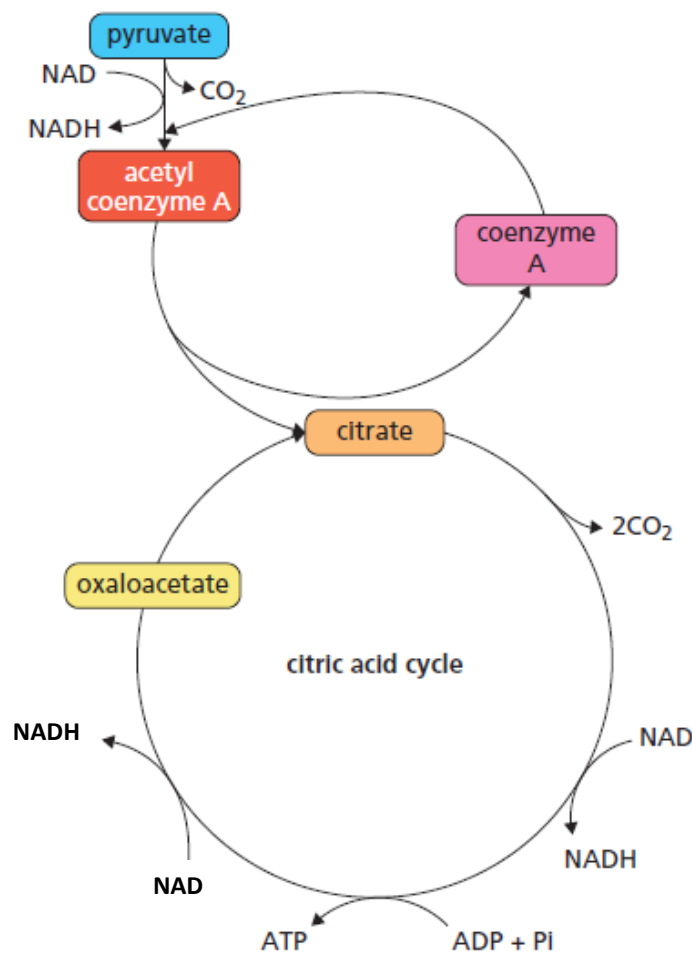


Citric Acid Cycle

The Aerobic phase of respiration takes place in the **Matrix of Mitochondria**.

In the presence of oxygen, **Pyruvate** is then **broken down** to an **Acetyl Group** that **combines with Coenzyme A** forming **Acetyl Coenzyme A**.

In the Citric Acid Cycle, the **Acetyl group** from Acetyl Coenzyme A **combines with Oxaloacetate** to form **Citrate**.



During a series of enzyme controlled steps, **Citrate** is gradually **converted back** into **Oxaloacetate** which results in the **generation of ATP** and **release of Carbon Dioxide**.

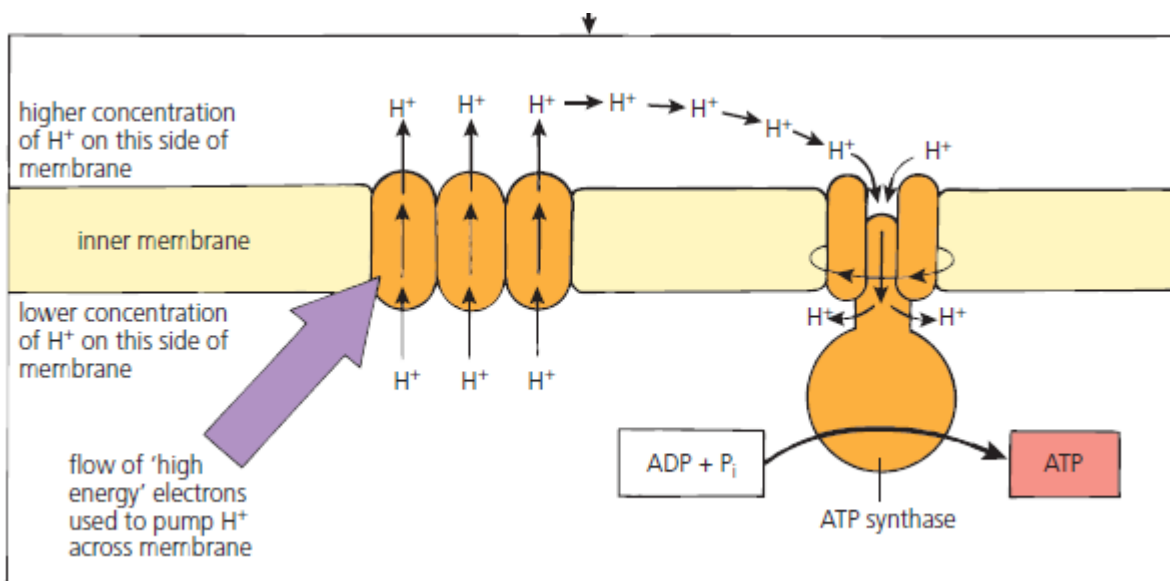
Dehydrogenase enzymes remove **hydrogen ions and electrons** and pass them to the Coenzyme **NAD**, forming **NADH**. This occurs in both Glycolysis and the Citric Acid Cycle. The **hydrogen ions and electrons from NADH** are passed to the **Electron Transport Chain** on the **inner mitochondrial membrane**.

ATP Synthesis

The **electron transport chain** is a series of carrier proteins attached to the inner mitochondrial membrane.

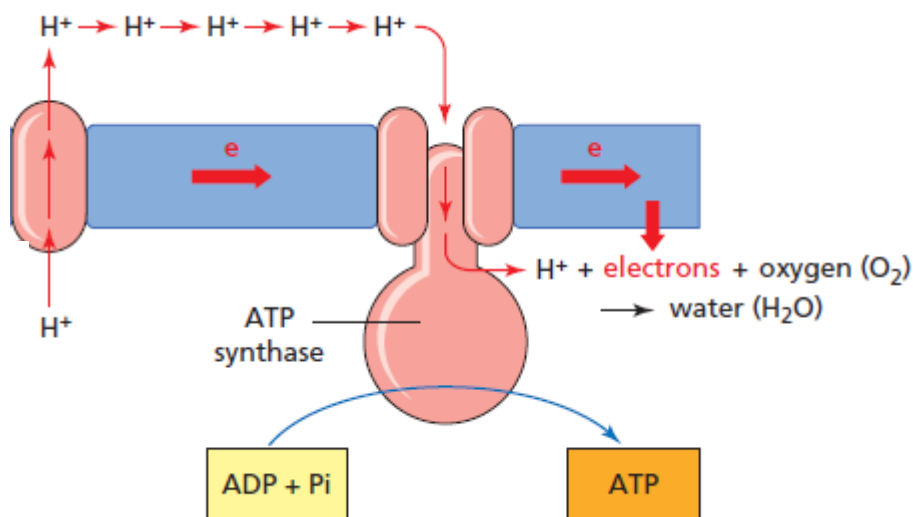
Electrons are passed along the **Electron Transport Chain releasing energy**. This energy allows **Hydrogen ions to be pumped across the inner mitochondrial membrane**.

The **flow of these ions** back through the membrane protein **ATP Synthase**, results in the **production of ATP**.



Finally, **hydrogen ions and electrons combine with oxygen to form water**.

Oxygen is required during the aerobic phase of respiration since it is the **final hydrogen acceptor**, combining with hydrogen ions & electrons to form water.



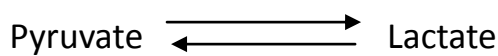
Fermentation

In the **absence of oxygen**, **fermentation** takes place in the **cytoplasm**.

Glycolysis takes place as normal, however the Pyruvate formed cannot enter the Citric Acid cycle. Instead, the Pyruvate is then fermented as follows:

Animal Cells

In animal cells, the **Pyruvate is converted to Lactate** in a reversible reaction.



Plant & Yeast Cells

In plant & yeast cells, the Pyruvate is converted to Ethanol and CO₂ in a reversible reaction.



Fermentation results in much less ATP being produced than in aerobic respiration.

Role of ATP

ATP is used to transfer energy to cellular processes which require energy.

E.g the ATP released during aerobic respiration provides the energy required for Protein Synthesis.

