Structure and roles of ATP

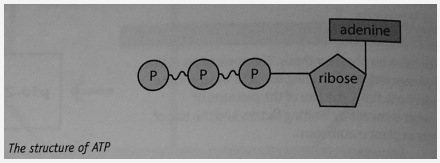
Adenine triphosphate belongs to a group of molecules called **nucleotides.**

It is made from **ribose** and **adenine** (ribulose) and **3 phosphates.**

It is the **universal energy carrier** (used in all reactions in all organisms), and **releases energy** in small quantities **(30.6kJ per mol)** via a one-step reaction when the **high energy bond** between the **second** and **third phosphate group** is **broken.**

This **hydrolysis** reaction is **hydrolysed** by the enzyme **ATPase.**

Structure of ATP



The structure of ATP

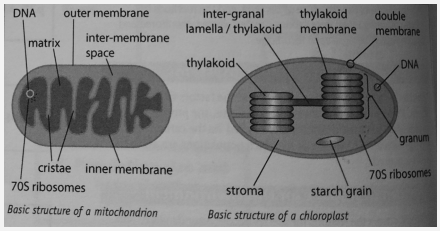
Structure of ATP

When **ATP** is **hydrolysed**, it provides **energy** for a **wide range** of processes including: **protein synthesis**, **active transport** and **mitosis.**

Comparison of ATP synthesis in mito and chloro

Features	Mitochondria	Chloroplasts
Mechanism	Uses **energy** carried by **electrons** to pump **protons** across the membrane, they then flow back through **stalked particles**	Uses electron energy to pump protons across the membrane, which then flow back through stalked particles
Enzyme involved	**ATP synthase**	**ATP synthase**
Proton gradient	From **inter-membrane space** to **matrix**	From **thylakoid space** to **stroma**
Site of electron transport chain		**Thylakoid membrane**
Co-enzyme involved	FAD, NAD	
Terminal electron acceptor		**NAPD** and **H+** (non-cyclic photophosphorylation) and **chlorophyll+** (cyclic photophosphorylation)

Structure of mitochondria and chloroplasts



The mitochondria and chloroplast membranes

During **photosynthesis** and **respiration**, **ATP** is made when **protons** are pumped **across membranes** using **energy** from **electrons** to create an **electrochemical** or **proton gradient.**

When the **protons flow** back through the **stalked particles** down the **concentration gradient**, by a process known as **chemiosmosis**, **ATP synthase** phosphorylates **ADP** into **ATP.**

In **chloroplasts** this occurs on the **thylakoid membranes**, whereas in **mitochondria** it occurs on the **inner membrane** or **cristae.**

The **electrons** pass from the **proton pumps** to a **terminal electron acceptor**: in **mitochondria** this is **oxygen**, in **chloroplasts** it is in the **coenzyme NADP** or **chlorophyll.**

Types of phosphorylation

Phosphorylation is the **addition** of a **phosphate group** or **ion** to a **molecule.**

In **respiration** and **photosynthesis ADP** is the molecule most often **phosphorylated**, but other molecules can be **phosphorylated**, e.g. **glucose in glycolysis** forming **glucose diphosphate.**

This makes the **glucose more reactive** and **easier to split** as it **lowers** the **activation energy** of the **reaction** involved.

1. **Oxidative phosphorylation.** This occurs when a **phosphate ion** is added to **ADP** using **energy** from **electron loss** i.e. **oxidation** reactions.

2. **Photophosphorylation.** The **energy** that powers the **proton pump** and **electron transport chain** in **chloroplasts** comes from **light**, hence **ATP** in **chloroplasts** is **synthesised** by **photophosphorylation.**

3. **Substrate level phosphorylation.** This occurs when **phosphate groups** are transferred from **donor molecules**, e.g. **phosphate** is transferred from **glycerate-3-phosphate** to **ADP** in **glycolysis** of **respiration.**

Key Terms	
Chemio-smosis	The **flow of protons** down an **electrochemical** gradient, through **ATP synthase**, coupled with the **synthesis of ATP** from **ADP** and a **phosphate ion.**
Activation energy	The **energy** needed to start a **chemical reaction.**

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