

### Structure and roles of ATP

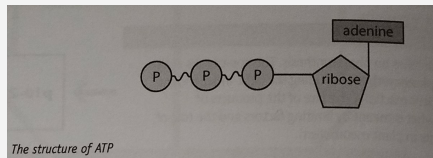
**Adenine triphosphate** belongs to a group of molecules called **nucleotides**.

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



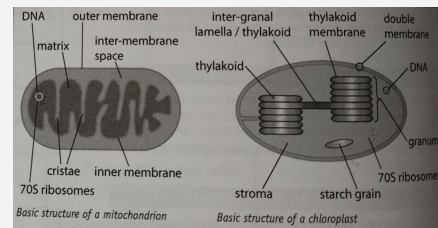
### Structure of ATP

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

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



By **lonnieRCH**  
[cheatography.com/lonnierch/](https://cheatography.com/lonnierch/)

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