# Cellular Respiration

## Keywords for Cellular Respiration

- Aerobic (Consuming of $O_2$)
- A reaction that happens in the Mitochondrian
- Exergonic Reaction; The energy released is from the breaking of these chemical organic molecules. From this we can conclude it's a Catabolic reaction.

The Chemical Reaction to break down the organic molecules is a Redox (Reduction, oxidation) reaction. In its transfer of ē comes the the required energy for synthesising ATP.

Glycolysis is a common factor between cellular respiration and fermentation ⟶ It (Glycolysis) happens in the cytosol without $O_2$

The Krebs cycle's startin molecule is Acetyl CoA

Harvesting ē happens firstly via a main enzyme called Dehydrogenase. It strips 2 hydrogenes (from the main nutrient) at delievers it to one of the main ē acceptors.

* In harvesting the energy of $\bar{e}$ in the synthesis of ATP, we use 2 major $\bar{e}$ acceptors (The place where the $\bar{e}$ energy is stored):

1) $NAD^+$ (Harvests 2 high energy $\bar{e}$ in NADH)
2) FAD (Harvests 2 high energy $\bar{e}$ in $FADH_2$)

* The $2^{nd}$ $H^+$ doesn't get used in neutralizing $NAD^+$

Dehydrogenase (Main enzyme)
→ $NAD^+$ (coenzyme)
→ FAD (coenzyme)

* Phosphorilation is a process that ATP is used to add a phosphate group to a molecule via the enzyme Kinase.

Types of phosphorylation:

1) Substrate-level (The substrate) phosphorylation: The direct synthesis of ATP from ADP when coupled with a product that has a phosphate group.

2) Oxidative phosphorylation: ATP is generated here from the energy of oxidizing NADH and $FADH_2$

* From here we can understand the full reason it's called a redox reaction ⟶ $NAD^+$ and FAD get reduced to NADH and $FADH_2$ in Glycolysis and Krebs cycle, then they get oxitated in the oxidative phosphorylation stage

Glycolysis → Energy investment phase
Glycolysis → Energy payoff phase

**Decarboxylation:** Removal of $CO_2$ from carboxylic acid

**Isomerization:** The change of an organic molecule to one of its Isomers (like Glucose → fructose)

* The beginning of the energy investment phase.

1) ATP —Hexo Kinase→ Glucose by its $6^{th}$ carbon

* Glucose 6-phosphate

2) Isomerization

Glucose 6-phosphate → Fructose 6-phosphate

3) Fructose 6-phosphate —Phospho-Fructo Kinase→ fructose 1,6 biphosphate

Unstable → highly unstable

* One of the reasons we need energy for the addition of a phosphate group is to counteract the repullsion of the phosphate group already in the ADP

* we can conclude that the purpose of the $3^{rd}$ stage is to make the Fructose 6-phosphate MORE unstable so we can break it easily in the next stage (The more unstable, the easier it breaks)

4) Fructose 1,6 biphosphate —Aldolase→
1) Glyceraldehyde 3-phosphate
2) Dihydroxyacetone phosphate (acetone: Ketone)

5) Dihydroxyacetone phosphate —Isomerase→ Glyceraldehyde 3-phosphate

* Dihydroxyacetone has a higher concentration than Glyceraldehyde 3-phosphate, so it gets ismorised to Glyceraldehyde 3-phosphate

* This step never reaches equalibrium because Glyceraldehyde 3-Phosphate gets used immeditley (So it's a 1 way reaction/step)

* The end of the energy investment phase.

The beginning of the energy payoff phase.

6) Triose phosphate dehydrogenase comes to Glyceraldehyde 3-phosphate and takes 2 hydrogen from it (It get oxidized) and takes them to $NAD^+$ to make it NADH (To reduce it)

From the energy of the redox reaction, a phosphate group is added to form 1,3-Biphosphate.

2NADH are formed, 1 each

7) 1,3-Bisphosphoglycerate —Phosphoglycero Kinase→ 3-Phosphoglycerate.

2ADP —2P→ 2ATP

Substrate-level phosphorylation

8) 3-Phosphoglycerate —Phosphoglyceromutase→ 2-Phosphoglycerate

A simple change in the phosphate group's location.

9) 2-Phosphoglycerate —Enolase→ Phosphoenolpyruvate

Enolase removes $H_2O$

10) Phosphoenolpyruvate —Pyruvate Kinase→ Pyruvate

2ADP —2P→ 2ATP

Substrate-level phosphorylation

The end of the energy payoff phase.