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Engineering Chemistry-II (BS-104)

# Biochemistry

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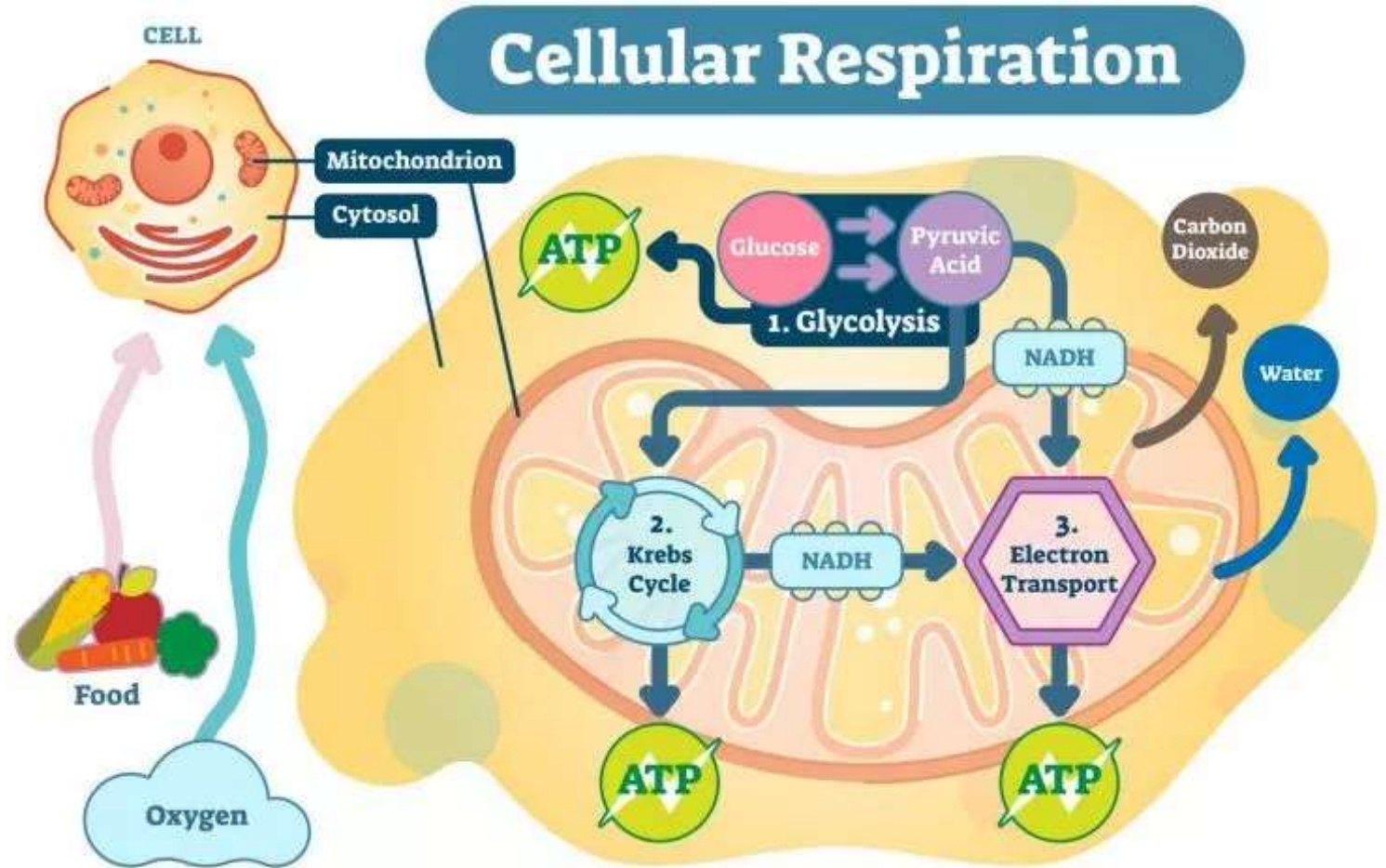
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USAR, GGSIPU



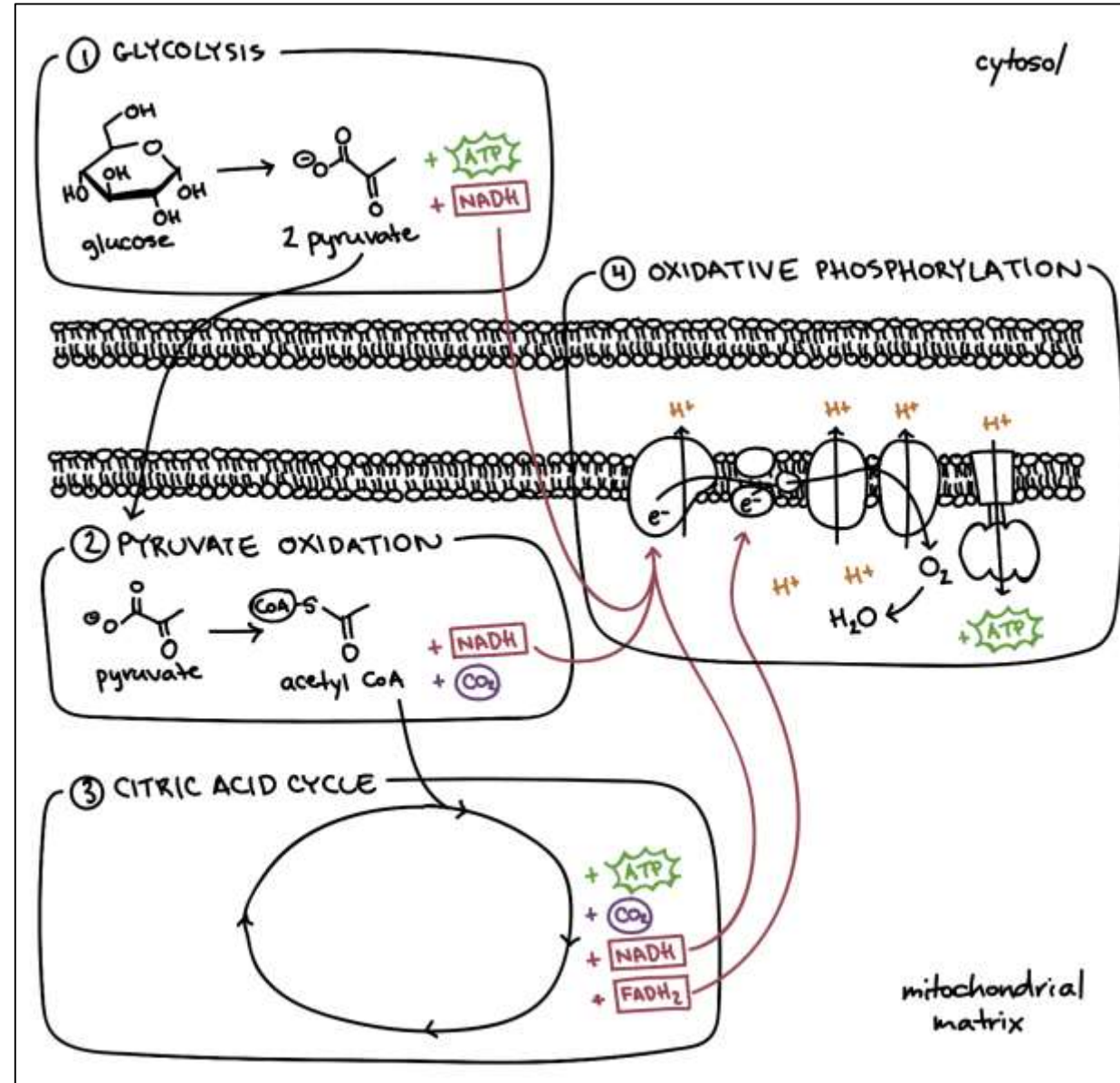
- **Cellular Respiration:**

- Cellular respiration is a metabolic pathway that breaks down glucose into  $\text{CO}_2$  and water and produces ATP.
- The stages of cellular respiration include:
  - i. Glycolysis,
  - ii. Pyruvate oxidation,
  - iii. The citric acid or Krebs cycle, and
  - iv. Oxidative phosphorylation.





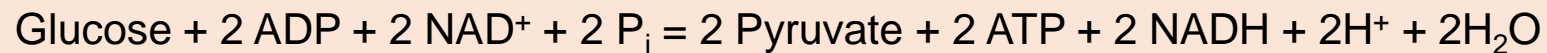
## Steps for cellular respiration



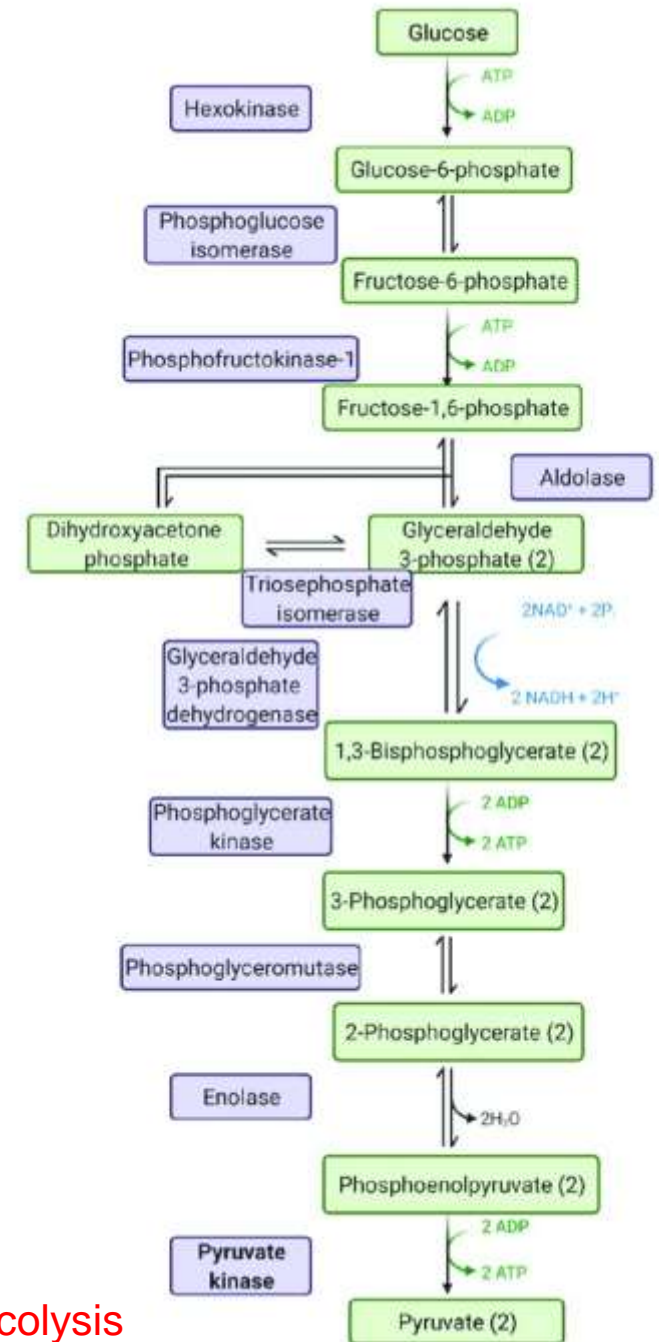


- **Step-1: GLYCOLYSIS:**

- **Glycolysis** is a series of reactions that extract energy from glucose by splitting it into two three-carbon molecules called pyruvates.
- It takes place in the **cytosol** of the cell's cytoplasm.
- It produces **two molecules of pyruvate**, **two molecules of ATP** (two are used during the process and four are produced), **two molecules of NADH**, and **two molecules of water**.
- There are 10 enzymes involved in breaking down sugar. The 10 steps of glycolysis are organized by the order in which specific enzymes act upon the system.
- The overall equation of glycolysis is:



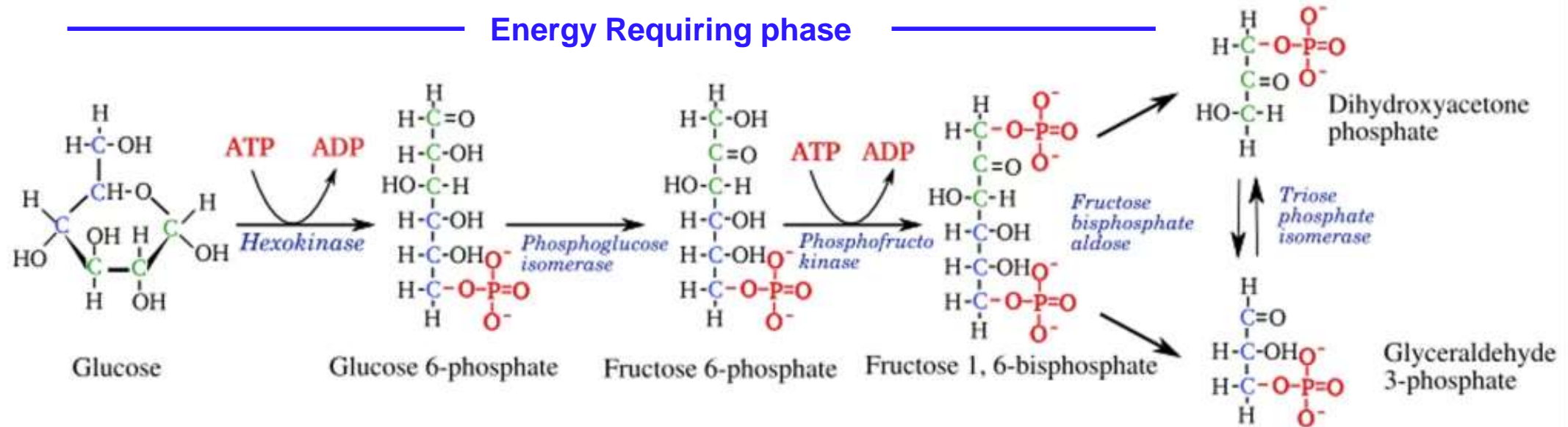
- NAD: Nicotinamide Adenine Dinucleotide: Oxidizing agent



Steps of glycolysis



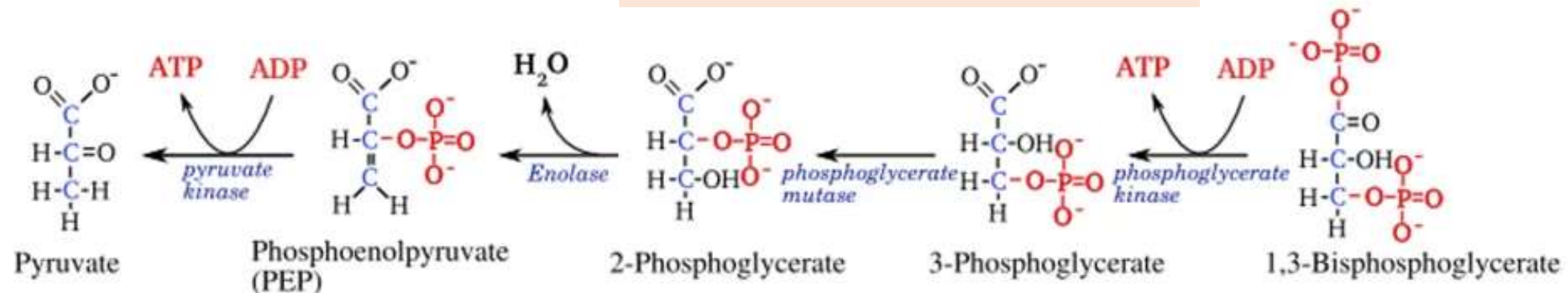
## Energy Requiring phase



# GLYCOLYSIS

Two half reactions occur simultaneously

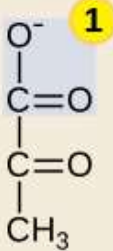
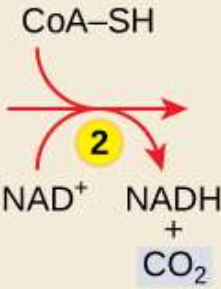
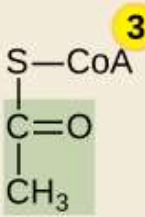
2X



## Energy Releasing phase

- **Step-2: PYRUVATE OXIDATION:**

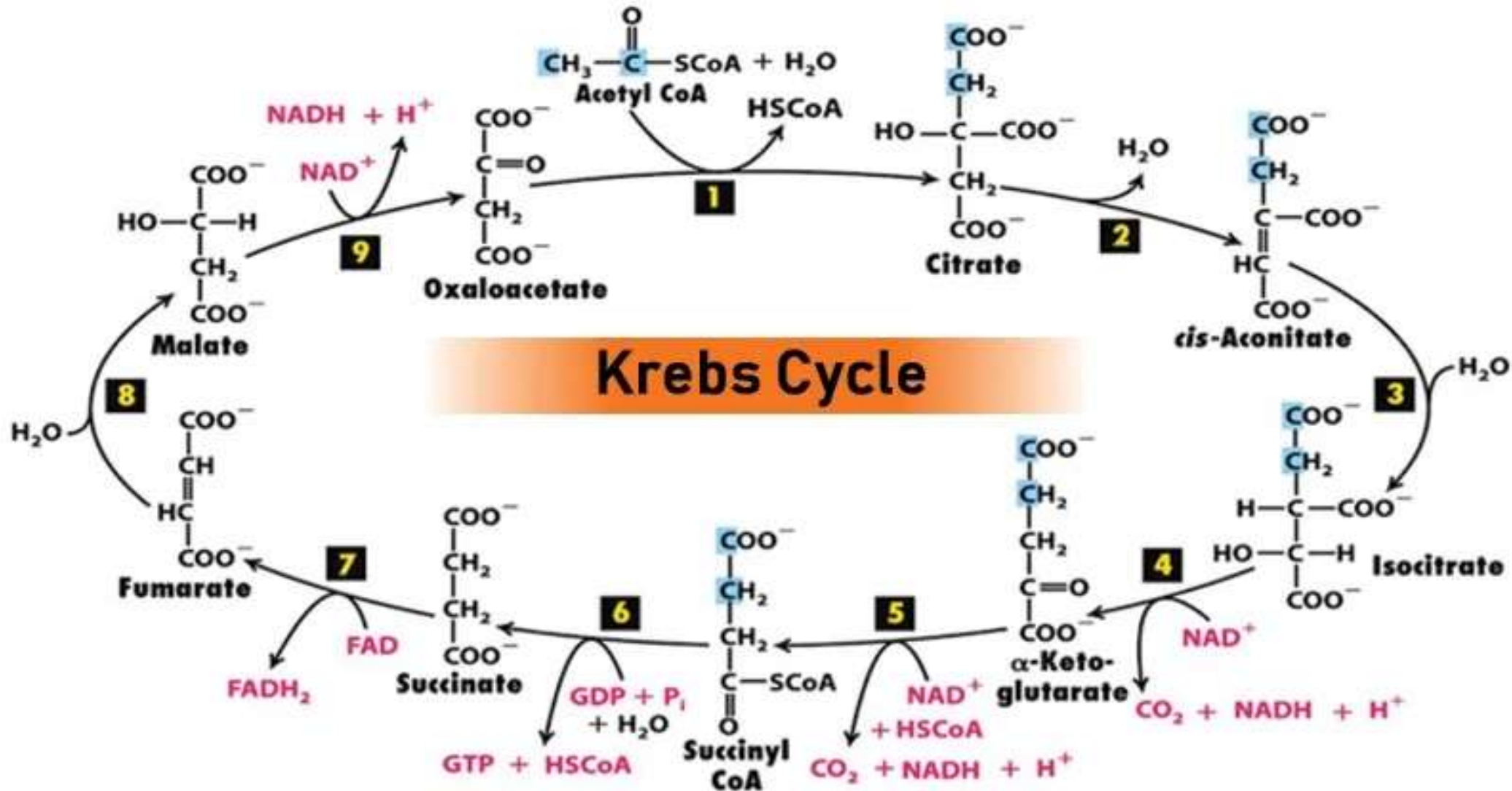
- Pyruvate oxidation is a key connector that links glycolysis to the rest of cellular respiration
- Each pyruvate from glycolysis goes into the **mitochondrial matrix**—the innermost compartment of mitochondria. There, it's converted into a 2-C molecule bound to Coenzyme A, known as acetyl CoA. Carbon dioxide is released and NADH is generated.

Oxidation of Pyruvate		
 <p>Pyruvate</p>	 <p>Oxidation reaction</p>	 <p>Acetyl CoA</p>
<p><b>1</b></p> <p>A carboxyl group is removed from pyruvate, releasing carbon dioxide.</p>	<p><b>2</b></p> <p>NAD<sup>+</sup> is reduced to NADH.</p>	<p><b>3</b></p> <p>An acetyl group is transferred to coenzyme A, resulting in acetyl CoA.</p>

- The steps above are carried out by a large enzyme complex called the **pyruvate dehydrogenase complex**.
- Summary:
  - Two molecules of pyruvate are converted into two molecules of acetyl CoA. (Acetyl CoA acts as fuel for the citric acid cycle in the next stage of cellular respiration.)
  - Two carbons are released as carbon dioxide—out of the six originally present in glucose.
  - 2 NADH are generated from NAD<sup>+</sup>



- **Step-3: Citric Acid/ TCA or Krebs' cycle:**
- The citric acid cycle takes place in the **matrix of the mitochondria**
- The citric acid cycle is a closed loop and includes eight major steps.
- In a single turn of the cycle,
  - two carbons enter from acetyl CoA, and two molecules of carbon dioxide are released
  - three molecules of NADH and one molecule of FADH<sub>2</sub> are generated;
  - one molecule of ATP or GTP is produced.

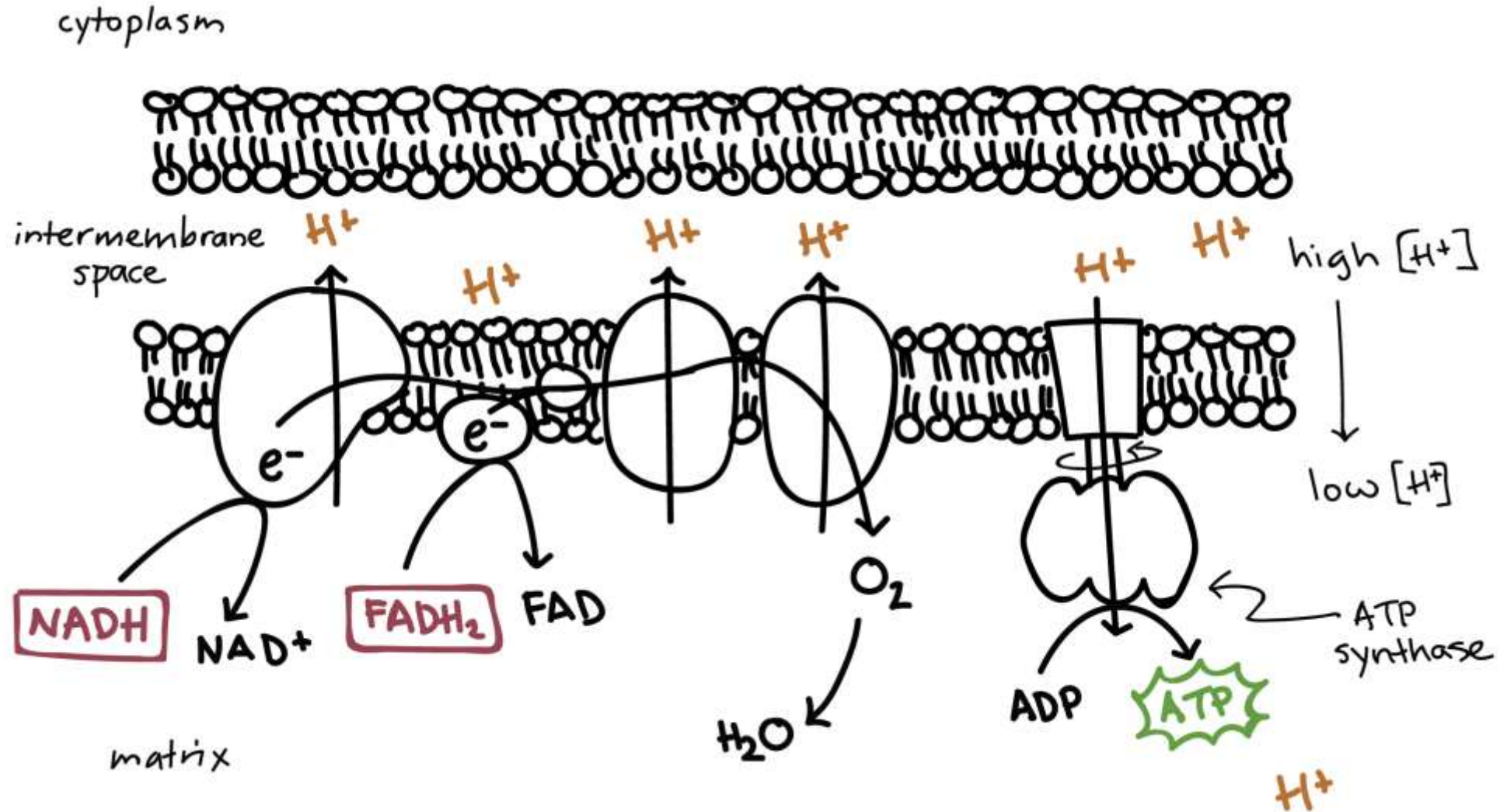






- **Step-4: Oxidative Phosphorylation:**

- Oxidative phosphorylation is the final step in cellular respiration.
- It occurs in the **mitochondria**.
- It is linked to a process known as **electron transport chain**. The electron transport system is located in the inner mitochondrial membrane. The electrons are transferred from one member of the transport chain to another through a series of redox reactions.
- ***Oxidative phosphorylation is the process of ATP formation, when electrons are transferred by electron carriers from NADH or FADH<sub>2</sub> to oxygen***



Oxidative phosphorylation



- Proteins:
- <https://thebiologynotes.com/amino-acids-proteins/>
- <https://www.khanacademy.org/science/biology/macromolecules/proteins-and-amino-acids/a/introduction-to-proteins-and-amino-acids>
- <https://www.biologyonline.com/dictionary/protein>