

Ch. 9 Cellular Respiration and Fermentation

Cellular respiration and **fermentation** are **catabolic pathways** involved in the breaking down of complex molecules to produce energy. The term **cellular respiration** is considered an “umbrella” term that encompasses both **aerobic** and **anaerobic respiration**.

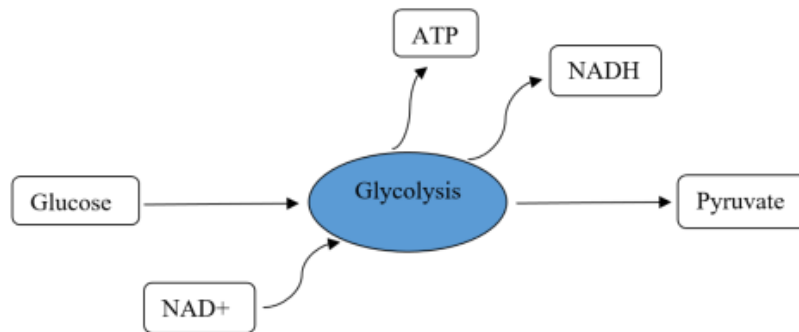
Cellular (aerobic) respiration:

Aerobic respiration occurs in the presence of oxygen. Oxygen is the final electron acceptor for step 4.

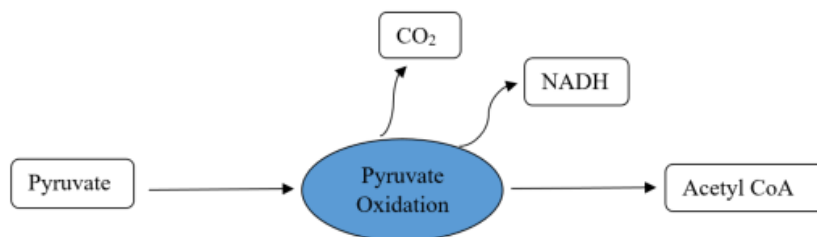
Steps:

1. Glycolysis	Glucose is broken down into pyruvate ATP is produced NAD ⁺ is converted into NADH
2. Pyruvate Oxidation	Pyruvate is oxidized into acetyl CoA CO ₂ is released NADH is produced
3. Citric Acid (or Krebs) Cycle	Acetyl CoA is oxidized ATP, NADH, and FADH ₂ are produced CO ₂ is released
4. Oxidative Phosphorylation	Electron transport chain accepts electrons from NADH and FADH ₂ NADH becomes NAD ⁺ FADH ₂ becomes FAD ATP and H ₂ O are produced

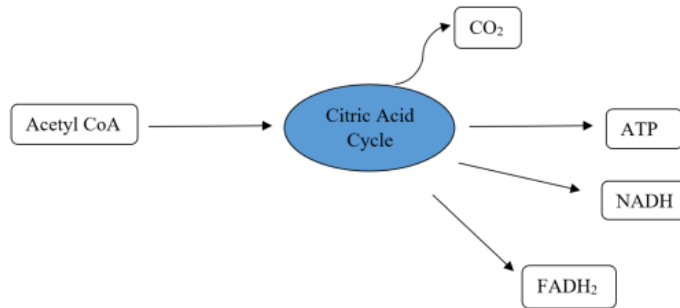
Step 1:



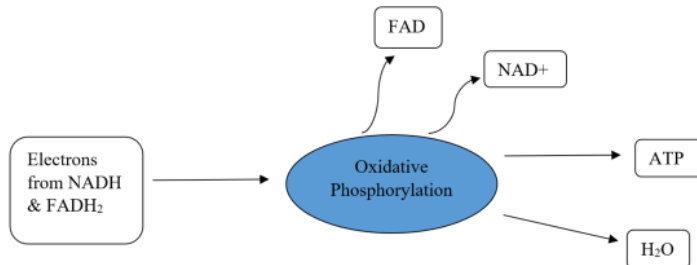
Step 2:



Step 3:



Step 4:

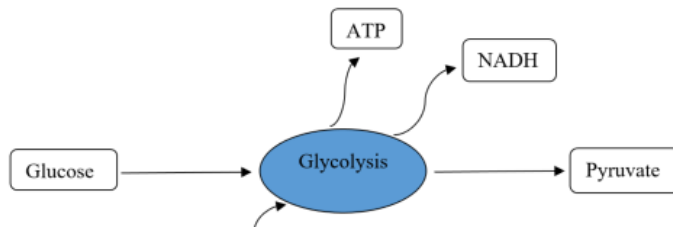


Cellular (anaerobic) respiration:

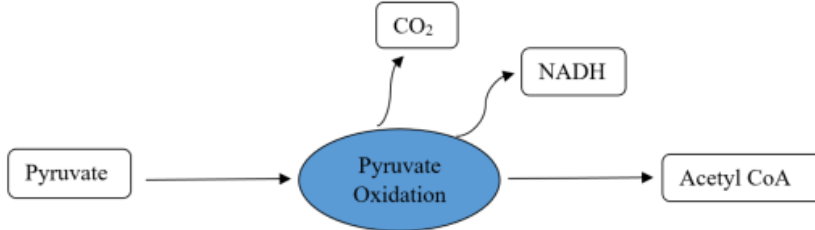
Anaerobic respiration does not require oxygen. Oxygen is not the final electron acceptor in step 4, depending on the microorganism it will be a different compound (e.g. nitrate ions, sulfate ions, etc.).

1. Glycolysis	Glucose is broken down into pyruvate ATP is produced NAD ⁺ is converted into NADH
2. Pyruvate Oxidation	Pyruvate is oxidized into acetyl CoA CO ₂ is released NADH is produced
3. Citric Acid (or Krebs) Cycle	Acetyl CoA is oxidized ATP, NADH, and FADH ₂ are produced CO ₂ is released
4. Non-Oxidative Phosphorylation	Electron transport chain accepts electrons from NADH and FADH ₂ NADH becomes NAD ⁺ FADH ₂ becomes FAD ATP and H ₂ O are produced

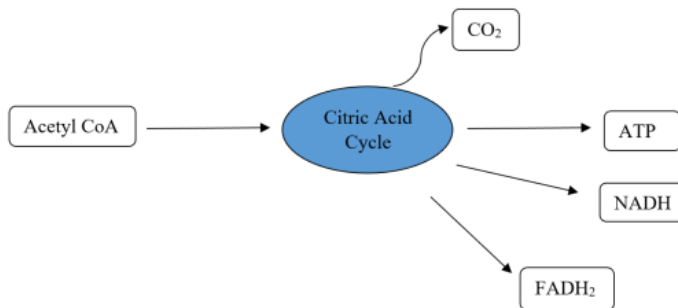
Step 1:



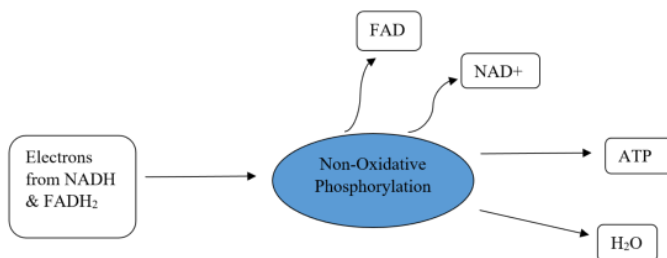
Step 2:



Step 3:



Step 4:



Fermentation:

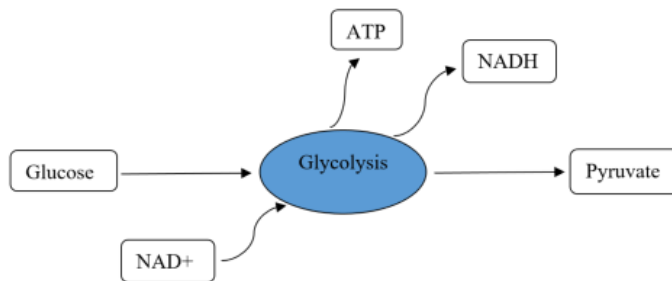
There are **two different types** of fermentation: **alcohol fermentation and lactic acid fermentation**

Fermentation occurs in the absence of oxygen.

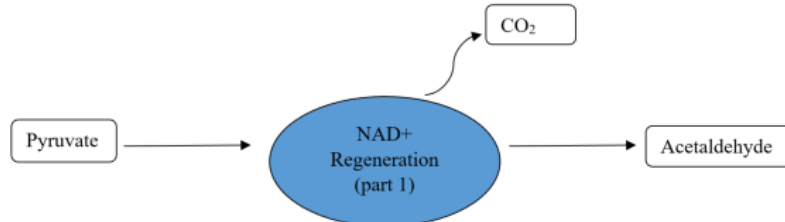
Steps for alcohol fermentation:

1. Glycolysis	Glucose is broken down into pyruvate ATP is produced NAD ⁺ is converted into NADH
2. NAD ⁺ Regeneration (Part 1)	Pyruvate is converted into acetaldehyde CO ₂ is released
3. NAD ⁺ Regeneration (Part 2)	Acetaldehyde is reduced to ethanol (by NADH) NADH becomes NAD ⁺ (= NAD ⁺ regeneration)

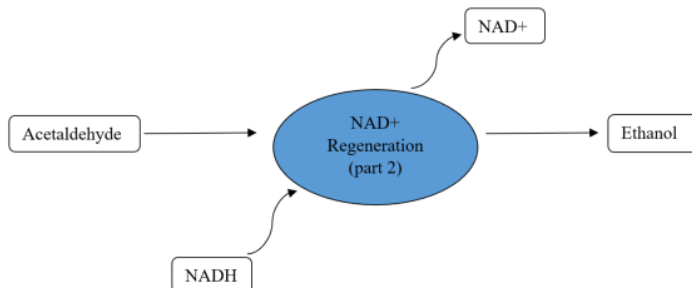
Step 1:



Step 2:



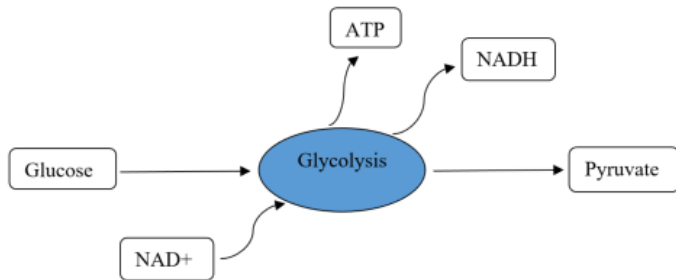
Step 3:



Steps for lactic acid fermentation:

1. Glycolysis	Glucose is broken down into pyruvate ATP is produced NAD ⁺ is converted into NADH
2. NAD ⁺ regeneration	Pyruvate is converted into lactate (by NADH)

Step 1:



Step 2:

