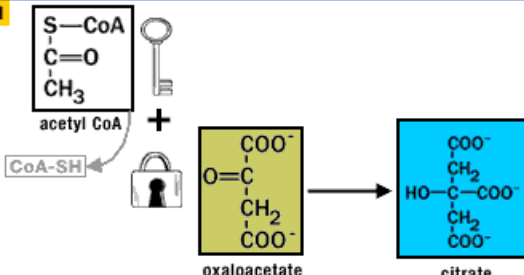
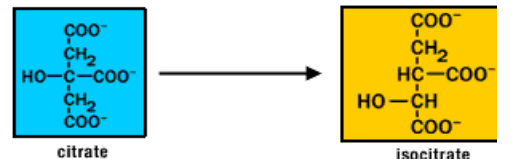
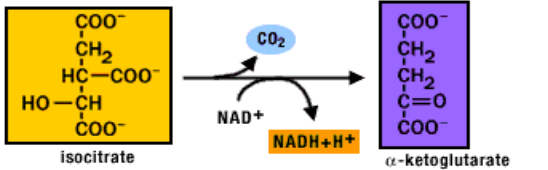


Biology Lecture Notes

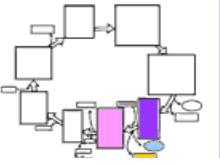
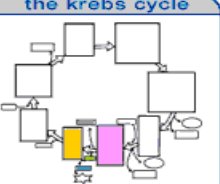
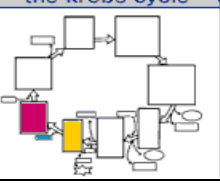
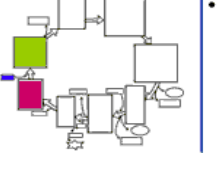
Aerobic Respiration: The Krebs Cycle

>> Key Concepts:

- ↪ **Review:** During **glycolysis**, one molecule of glucose is split to form two **pyruvate** molecules, with a net profit of two ATP. The two pyruvate molecules then enter the mitochondria, where they are converted to **acetyl CoA**.
- ↪ Once pyruvate is converted to acetyl CoA, it enters the Krebs cycle (also known as the citric acid cycle).
- ↪ The **Krebs cycle** is an eight-step cycle in which acetyl CoA is added to oxaloacetate, which is further broken down producing CO₂, reduced coenzymes (NADH + H⁺ and FADH₂), and ATP.

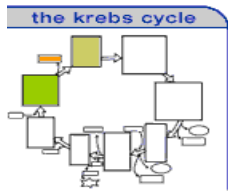
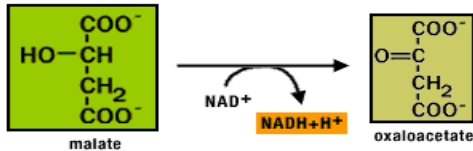
<p>Step 1</p>  <p>acetyl CoA + oxaloacetate → citrate + CoA-SH</p>	<p>The Krebs Cycle</p> <p>Step 1: In the first step of the Krebs cycle, acetyl CoA is added to oxaloacetate to form citrate.</p> <p>Note that coenzyme A (CoA-SH) is removed in the process.</p>
<p>Step 2</p>  <p>citrate → isocitrate</p> <p>the krebs cycle</p> <ul style="list-style-type: none"> • Citrate is isomerized to form isocitrate • Isocitrate is less stable than citrate and therefore has a higher energy. 	<p>Step 2: Citrate is isomerized forming isocitrate, which is less stable than citrate.</p> <p>During this step, one water molecule is removed and another water molecule is added.</p>
<p>Step 3</p>  <p>isocitrate → α-ketoglutarate + CO₂ + NADH + H⁺</p> <p>Remember...</p> <p>One glucose gave rise to two acetyl CoAs. So, multiply the reactions in the Krebs cycle by two.</p> <ul style="list-style-type: none"> • Isocitrate is decarboxylated, releasing CO₂. • NAD⁺ is reduced forming NADH+H⁺. • Isocitrate has now become α-ketoglutarate (5 carbons). 	<p>Step 3: Isocitrate is converted into alpha-ketoglutarate. In this process, isocitrate is decarboxylated (carbon dioxide is removed), and NAD⁺ is reduced, forming NADH + H⁺.</p>

Biology Lecture Notes

<p>Step 4</p> <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;"> $\begin{array}{c} \text{COO}^- \\ \\ \text{CH}_2 \\ \\ \text{C}=\text{O} \\ \\ \text{COO}^- \end{array}$ <p>α-ketoglutarate</p> </div> <div style="text-align: center;"> $\xrightarrow[\text{NAD}^+ \rightarrow \text{NADH}+\text{H}^+]{\text{CoA-SH} \rightarrow \text{CO}_2}$ </div> <div style="text-align: center;"> $\begin{array}{c} \text{COO}^- \\ \\ \text{CH}_2 \\ \\ \text{C}=\text{O} \\ \\ \text{S-CoA} \end{array}$ <p>succinyl CoA</p> </div> </div> <p>the krebs cycle</p>  <ul style="list-style-type: none"> • α-ketoglutarate is decarboxylated releasing CO_2. • NAD^+ is reduced forming $\text{NADH}+\text{H}^+$. • Coenzyme A is added forming succinyl CoA (4 carbons) which is less stable than α-ketoglutarate. 	<p>Step 4: Alpha-ketoglutarate is converted to succinyl CoA. During this step coenzyme A is added, carbon dioxide is lost, and NAD^+ is reduced, forming $\text{NADH} + \text{H}^+$.</p>
<p>Step 5</p> <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;"> $\begin{array}{c} \text{COO}^- \\ \\ \text{CH}_2 \\ \\ \text{CH}_2 \\ \\ \text{C}=\text{O} \\ \\ \text{S-CoA} \end{array}$ <p>succinyl CoA</p> </div> <div style="text-align: center;"> $\xrightarrow[\text{ADP} \rightarrow \text{GTP}+\text{P}]{\text{CoA-SH}}$ </div> <div style="text-align: center;"> $\begin{array}{c} \text{COO}^- \\ \\ \text{CH}_2 \\ \\ \text{CH}_2 \\ \\ \text{COO}^- \end{array}$ <p>succinate</p> </div> </div> <p>the krebs cycle</p>  <ul style="list-style-type: none"> • Coenzyme A is removed from succinyl CoA, forming succinate and releasing energy. 	<p>Step 5: Succinyl CoA is converted to succinate. During this step, coenzyme A is released and GTP is made. GTP is then hydrolyzed to form ATP.</p>
<p>Step 6</p> <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;"> $\begin{array}{c} \text{COO}^- \\ \\ \text{CH}_2 \\ \\ \text{CH}_2 \\ \\ \text{COO}^- \end{array}$ <p>succinate</p> </div> <div style="text-align: center;"> $\xrightarrow[\text{FAD} \rightarrow \text{FADH}_2]$ </div> <div style="text-align: center;"> $\begin{array}{c} \text{COO}^- \\ \\ \text{CH} \\ \\ \text{HC} \\ \\ \text{COO}^- \end{array}$ <p>fumarate</p> </div> </div> <p>the krebs cycle</p>  <ul style="list-style-type: none"> • FAD is reduced forming FADH_2. • Succinate has been transformed into fumarate. 	<p>Step 6: Succinate is converted to fumarate. During this step FAD is reduced forming FADH_2.</p>
<p>Step 7</p> <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;"> $\begin{array}{c} \text{COO}^- \\ \\ \text{CH} \\ \\ \text{HC} \\ \\ \text{COO}^- \end{array}$ <p>fumarate</p> </div> <div style="text-align: center;"> $\xrightarrow{\text{H}_2\text{O}}$ </div> <div style="text-align: center;"> $\begin{array}{c} \text{COO}^- \\ \\ \text{HO-CH} \\ \\ \text{CH}_2 \\ \\ \text{COO}^- \end{array}$ <p>malate</p> </div> </div> <p>the krebs cycle</p>  <ul style="list-style-type: none"> • H_2O is added to fumarate forming malate. 	<p>Step 7: Fumarate is converted to malate with the addition of water.</p>

Biology Lecture Notes

Step 8



- NAD^+ is reduced forming $\text{NADH}+\text{H}^+$.
- Malate is transformed into oxaloacetate.
- The oxaloacetate is now ready to take part in step 1 with a new acetyl CoA.

Step 8: In the last step of the Krebs cycle, malate is converted to oxaloacetate. In the process, NAD^+ is reduced to form $\text{NADH} + \text{H}^+$.

Oxaloacetate can then accept another acetyl CoA and begin the Krebs cycle again.