Citric Acid Cycle (Krebs Cycle)

The citric acid cycle, also called the Krebs cycle, is an important biochemical reaction used by aerobic organisms to generate energy through the oxidation of acetyl co-enzyme A. Each cycle takes in an acetyl-CoA, which comes from the breakdown of carbohydrates, fats, and proteins, and goes through a series of oxidation, decarboxylation and phosphorylation reactions to generate energy stored in the forms of NADH, GTP (which is later converted to ATP) and FADH2. Acetyl-CoA is a two-carbon molecule that combines with oxaloacetate, which is a four- carbon molecule to produce citric acid or citrate. Citric acid then becomes isocitric acid and goes through an oxidation and decarboxylation reactions to produce alpha-ketoglutarate, making NADH along the way. Alpha-ketoglutarate goes through another oxidation to produce NADH, and becomes succinyl-CoA. Succinyl-CoA gets phosphorylated, producing GTP and succinate. Succinate then undergoes oxidation to generate FADH2 and fumarate. Fumarate gets hydrated to become malate, and malate goes through the last step of oxidation to generate NADH and return oxaloacetate to the cycle. NADH is equivalent of 2.5 GTP and FADH2 is equivalent of 1.5 GTP. These GTP molecules are quickly converted to ATP at a ratio of 1:1, as ATP is the primary source of energy in these organisms.



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Characteristics

Acetyl-CoA + Oxaloacetate
A-seagull and Ox
This is the first step in the citric acid cycle. Acetyl CoA is a two-carbon molecule that combines with oxaloacetate, which is a four-carbon molecule. This is an irreversible reaction.

Citric Acid
Citric-lemon
Acetyl-CoA and oxaloacetate combine to form citric acid, also called citrate. This is an irreversible aldol condensation reaction forming this six-carbon molecule.

Isocitric Acid
Iced-citric-lemon
Citric acid becomes isocitric acid also called isocitrate. This is actually a reversible dehydration and then hydration reaction.

Produces NADH
lemon-NADE
Isocitric acid undergoes an oxidation reaction to produce NADH, which is a form of energy storage. One NADH is equivalent to 2.5 GTP (which is quickly converted to ATP at a ratio of 1:1, yielding 2.5 ATP). Remember that oxidation reactions in the citric acid cycle yields NADH or FADH2.

Alpha-Ketoglutaric Acid
Key-to Lemon House
As a result of two back to back reactions, isocitric acid becomes alpha-ketoglutarate. Alpha-ketoglutarate is actually a product of an oxidation reaction, quickly followed by a decarboxylation reaction, which means that it loses one of its carbons to become a five-carbon molecule.

Produces NADH
lemon-NADE
Alpha-ketoglutarate undergoes an oxidation reaction to produce NADH, which is a form of energy storage. One NADH is equivalent to 2.5 GTP (which is quickly converted to ATP at a ratio of 1:1, yielding 2.5 ATP). Remember that oxidation reactions in the citric acid cycle yields NADH or FADH2.

Succinyl CoA
Suckers
Alpha-ketoglutarate then goes through another decarboxylation reaction to become succinyl-CoA.

Produces GTP
Gold-TP wrapped Battery
Succinyl CoA undergoes a substrate level phosphorylation to produce one GTP on its way to becoming succinate. This GTP is quickly converted to ATP at a 1:1 ratio, which serves as the main source of energy for organisms.

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Succinate
Sucker-snake
Succinyl CoA goes through a substrate level phosphorylation through a succinyl-CoA synthetase to become succinate.

Produces FADH2
FADH2-flames
Succinate undergoes an oxidation reaction to produce FADH2, which is a form of energy storage. One FADH2 is equivalent to 1.5 GTP (which is quickly converted to ATP at a ratio of 1:1, yielding 1.5 ATP). Remember that oxidation reactions in the citric acid cycle yields NADH or FADH2.

Fumarate
Fuming
Succinate becomes fumarate after an oxidation reaction, which yields one FADH2. This is through the enzyme succinate dehydrogenase.

Uses Water
Water
Hydration is a reaction that combines the water with the substrate. In this case, fumarate combines with water to produce malate.

Malate
Mallet
Malate is the last substrate in the citric acid cycle, in which it undergoes one last oxidation reaction to yield an NADH and return oxaloacetate to the beginning of the cycle.

Produces NADH
lemon-NADE
Malate undergoes an oxidation reaction to produce NADH, which is a form of energy storage. One NADH is equivalent of 2.5 GTP (which is quickly converted to ATP at a ratio of 1:1, yielding 2.5 ATP). Remember that oxidation reactions in the citric acid cycle yields NADH or FADH2.

Oxaloacetate
Ox
Oxaloacetate is the first substrate of the cycle. It is formed from malate and combines with acetyl-CoA to start the cycle all over again.

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