ATP count

$$\text{Acetyl CoA} + 3\,NAD^+ + FAD + ADP + P_i + 2\,H_2O \longrightarrow 2\,CO_2 + 3\,NADH + FADH_2 + ATP + 2\,H^+ + CoA$$

1. **Two carbon atoms enter the cycle, while two carbon atoms leave the cycle in the form of CO_2.**
2. **Four pairs of hydrogen atoms leave the cycle in four oxidation reactions: 3 pairs in NADH, one pair in $FADH_2$.**
3. **One ATP produced from substrate-level phosphorylation.**
4. **Two water molecules are consumed.**
5. **Total ATP produced from aerobic oxidation of glucose in liver:**

   2×5 NADH + 2×1 $FADH_2$ + 6 ATP – 2 ATP =

   $10 \times 2.5 + 2 \times 1.5 + 4 = 32$ ATP

How to count

Stoichiometry of ATP synthesis

Each 360-degree rotation of *c* subunits and γ subunit: synthesis and release of 3 molecules of ATP

***c* subunits**: 10-14, average **12**

Each *c* subunit binds 1 H^+: 12 H^+ required for a 360-degree rotation, each ATP synthesis require 4 H^+ (12/3)

NADH + H^+: 10 H^+ pumped into inter-membrane space for ATP synthesis, so 2.5 (10/4) ATP synthesized

$FADH_2$: 6 H^+ pumped into inter-membrane space for ATP synthesis, so 1.5 (6/4) ATP synthesized

Total ATP produced from aerobic oxidation of glucose in liver:

2×5 NADH + 2×1 $FADH_2$ + 6 ATP – 2 ATP =

$10 \times 2.5 + 2 \times 1.5 + 4 = 32$ ATP

Each tca cycle produces:

Two molecules of carbon dioxide.

Three molecules of NADH.

Three hydrogen ions.

One molecule of $FADH_2$

One molecule of GTP.

Outline

The two carbon atoms that enter the cycle as the acetyl group.

the enzymes of the citric acid cycle are physically associated with one another.

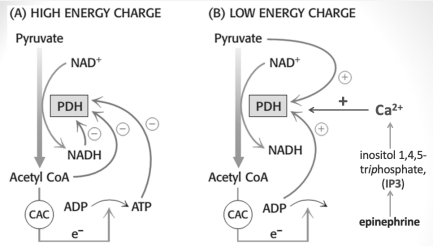
Substrate channeling; Metabolon

The cycle operates only under aerobic conditions, although oxygen does not participate directly in the cycle.

The pyruvate dehydrogenase complex is regulated allosterically and by reversible phosphorylation

ATP->ADP, H2O->Pi

energy charge



TCA cycle is controlled at several points

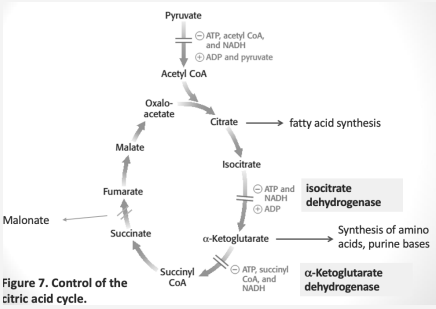
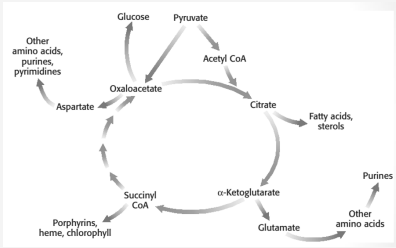


Figure 7. Control of the citric acid cycle.

TCA cycle-Source of Biosynthetic Precursors



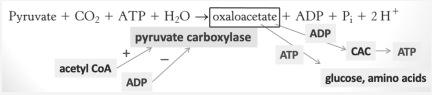
Outline

The citric acid cycle must be capable of being rapidly replenished if any are drawn off for biosynthesis, to allow the cycle to function

acetyl CoA can not convert into oxaloacetate or any other citric acid cycle intermediate

oxaloacetate can be formed by the carboxylation of pyruvate, a crucial role in gluconeogenesis, which is active only in the presence of acetyl CoA

Pyruvate to Oxaloacetate



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