

Citric Acid Cycle

Kreb's Cycle, Tricarboxylic Acid Cycle (TCA)



Citric Acid Cycle Preparation

in cytosol
Glycolysis

Product:
Pyruvate

Pyruvate
(x2)

in mitochondrial matrix
Pyruvate Dehydrogenase Complex :

2 CoA-SH + 2 NAD⁺ + TPP, lipolate, FAD, Mg²⁺ → 2 NADH + 2 Acetyl-CoA (x2)
pyruvate dehydrogenase (PDH)

- Goal: convert pyruvate to **Acetyl-CoA**
- Stimulated** by Insulin, AMP/ADP, CoA, NAD⁺, Ca²⁺
- Inhibited** by Acetyl-CoA, ATP, NADH, and fatty acids

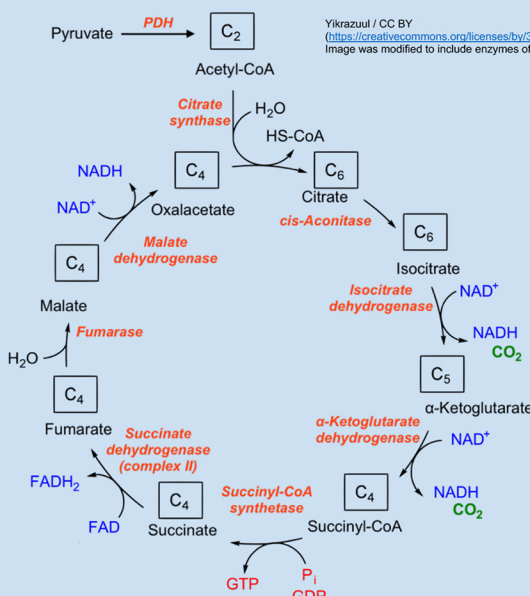
Citric Acid Cycle

Overall Reaction: 2 acetyl groups + 6 NAD⁺ + 2 FAD + 2 ADP + 2 Pi → 4 CO₂ + 6 NADH + 6 H⁺ + 2 FADH₂ + 2 ATP

- in mitochondrial matrix [cytosol of prokaryotes]
- Objective: oxidize **acetyl-CoA** to CO₂, while producing **energy** carriers **NADH**, **FADH₂**, and **GTP**.
- Aerobic respiration (CO₂ present)

Steps:

- Citrate Formation
- Citrate Isomerized to Isocitrate
- α-Ketoglutarate and CO₂ Formation*
- Succinyl-CoA and CO₂ Formation
- Succinate Formation
- Fumarate Formation
 - Takes places on **inner membrane**
 - GTP formed directly
- Malate Formation
- Oxaloacetate Regenerated



NET ATP

(1 NADH = 2.5 ATP,
1 FADH₂ = 1.5 ATP)

GLYCOLYSIS

2 NADH → 5 ATP
2 ATP → 2 ATP

PDC

2 NADH → 5 ATP

CAC

6 NADH → 15 ATP
2 FADH₂ → 3 ATP
2 GTP → 2 ATP

TOTAL = 30 – 32 ATP
[from 1 molecule of glucose]

MNEMONIC

CAC Substrates: **Please, Can I Keep Selling Seashells For Money, Officer?**

Pyruvate
Citrate
Isocitrate
α-Ketoglutarate
Succinyl-CoA
Succinate
Fumarate
Malate
Oxaloacetate

Key Control Points:

- ⇒ Citrate synthase (**step 1**)
 - Irreversible
 - Stimulated** by ADP, NAD⁺
 - Inhibited** by NADH, succinyl CoA, citrate, ATP
- ⇒ Isocitrate Dehydrogenase (**step 3**)
 - Rate limiting step, irreversible
 - Stimulated** by ADP, Ca²⁺
 - Inhibited** by ATP
- ⇒ α-Ketoglutarate dehydrogenase complex (**step 4**)
 - Irreversible
 - Stimulated** by Ca²⁺, NAD⁺
 - Inhibited** by succinyl-CoA, NADH

For CAC in general:

- Stimulators:** NAD⁺, ADP
- Inhibitors:** NADH, ATP

Reminder:

The MCAT will not test on individual enzymes – only the major inputs, outputs, and regulatory enzymes.