• succinyl CoA is also produced from propionyl CoA derived from metabolism of fatty acids (odd number) and several amino acids

6) CLEAVAGE OF SUCCINYL CoA
• Succinyl CoA \( \rightarrow \) succinate thiokinase (succinyl CoA synthetase) \( \rightarrow \) succinate
• GDP \( \rightarrow \) GTP (substrate-level phosphorylation)

GTP and ATP are energetically interconvertible by the nucleoside diphosphate kinase reaction:
\[
GTP + ADP \leftrightarrow GDP + ATP
\]

7) OXIDATION OF SUCCINATE
• Succinate \( \rightarrow \) succinate dehydrogenase \( \rightarrow \) fumarate
• FAD \( \rightarrow \) FADH\(_2\) (because reducing power of succinate is not sufficient enough to reduce NAD\(^+\))
• succinate dehydrogenase is the only enzyme of TCA cycle that is embedded in the inner mitochondrial membrane
• fumarate is also produced by the urea cycle, in purine synthesis and during catabolism of the amino acids phenylalanine and tyrosine

8) HYDRATION OF FUMARATE
• Fumarate \( \rightarrow \) fumarase (fumarate hydratase) \( \rightarrow \) malate
• Reversible reaction

9) OXIDATION OF MALATE
• Malate \( \rightarrow \) malate dehydrogenase \( \rightarrow \) oxaloacetate
• Yielding of one NADH
• Oxaloacetate is also produced by transamination of aspartic acid (an amino acid)

ENERGY PRODUCED BY THE CYCLE
During one turn of the cycle;
• 2 carbon atoms enter the cycle as acetyl CoA and leave it as CO\(_2\)
• No net consumption or production of OAA or of any other intermediate
• 3 NAD\(^+\) \( \rightarrow \) 3 NADH (one NADH gives three ATP in electron transport chain)
• 1 FAD \( \rightarrow \) 1 FADH\(_2\) (one FADH\(_2\) gives two ATP in electron transport chain)
• GDP + Pi \( \rightarrow \) GTP \( \leftrightarrow \) ATP
• So, total yield of ATP from the oxidation of 1 acetyl CoA = 9 + 2 + 1 = 12 ATP

REGULATION OF THE CYCLE
• Most important regulated enzymes: citrate synthase, isocitrate dehydrogenase, and \( \alpha \)-ketoglutarate dehydrogenase complex