4. α-Ketoglutarate dehydrogenase complex ($\Delta G'^{\circ}$ = -33.5 kJ/mol) – α-ketoglutarate → succinyl-CoA

  □ Releases CO_2, adds CoA, and generates NADH

  □ Just like pyruvate dehydrogenase, it uses cofactors FAD, lipoate, and TPP; it uses CoA and NAD+ as substrates
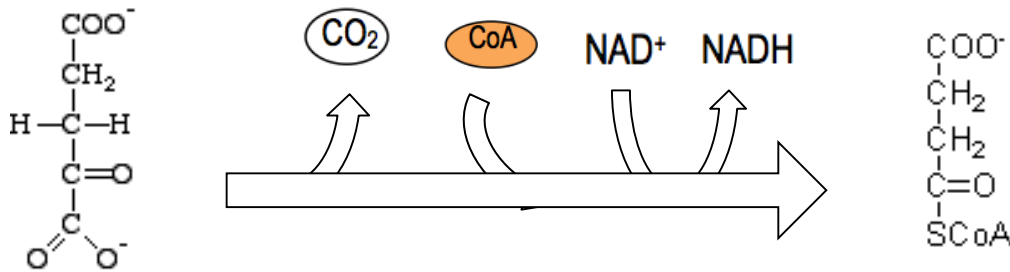
5. Succinyl-CoA synthetase ($\Delta G'^{\circ}$ = -3 kJ/mol) – succinyl-CoA → succinate

  □ Thioester bond is broken, and GTP is formed from GDP and P_i via substrate-level phosphorylation

    - Can form ATP from GTP via nucleoside diphosphate kinase reaction ($\Delta G'^{\circ}$ = 0 kJ/mol)

    - GTP is used for protein synthesis; mitochondria have their own DNA, therefore need some GTP
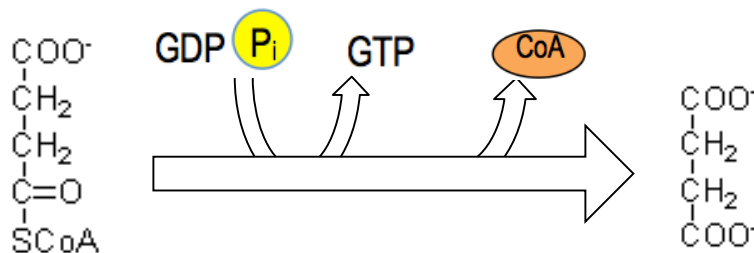
6. Succinate dehydrogenase ($\Delta G'^{\circ}$ = 0 kJ/mol) – succinate → fumarate

  □ Converts –ane to –ene (*trans* form) and produces $FADH_2$, actually part of complex II in electron transport chain

  □ Malonate is competitive inhibitor of this enzyme because it has similar chemical structure to succinate

  □ Succinate is symmetrical, so it's orientation in the active site will be random

    - Every turn of cycle, only 1/2 the labeled carbons come out due to randomization, next turn 1/4, then 1/8