

BIOENERGETICS

ΔG Gibbs Free Energy - maximum amount of useful work at constant T and P

ΔG°° - biochemical standard state Gibbs Free Energy; all concs = 1 M, partial P = 1 atm, but pH=7

EXERGONIC REACTIONS - ΔG is negative, reaction can be used to do work

ENDERGONIC REACTIONS - ΔG is positive, energy must be supplied for reaction to go

REVERSIBLE REACTIONS - ΔG is small, ratio of [products]/[reactants] determine direction

IRREVERSIBLE REACTIONS - ΔG is large, only direction is with negative ΔG

REACTION COUPLING - an exergonic reaction drives an endergonic reaction, both reactions have a common intermediate

HIGH ENERGY BONDS -coupled with catabolic reactions to save energy (condensation)
-coupled with anabolic reactions to supply energy (hydrolysis)

ATP + H ₂ O → ADP + P _i	ΔG°° = -7.3 kcal/mole
ATP + H ₂ O → AMP + PP _i	ΔG°° = -7.7 kcal/mole
PP _i + H ₂ O → 2 P _i	ΔG°° = -8.0 kcal/mole
thioester + H ₂ O → sulfhydryl + carboxylic acid	ΔG°° = -7.5 kcal/mole
acyl phosphate + H ₂ O → phosphate + carboxylic acid	ΔG°° = -11.8 kcal/mole

OXIDATION OF CARBOHYDRATES OR FATS IS HIGHLY EXERGONIC

Combustion of glucose ΔG°° = -686 kcal/mole
Combustion of palmitic acid ΔG°° = -2340 kcal/mole

OXIDATION OF REDUCED COENZYMES BY OXYGEN IS EXERGONIC

1/2 O ₂ + 2H ⁺ + 2e ⁻ → H ₂ O	ΔG°° = -38 kcal/mole
NADH/H ⁺ → NAD ⁺ + 2H ⁺ + 2e ⁻	ΔG°° = -15 kcal/mole
FADH ₂ → FAD + 2H ⁺ + 2e ⁻	ΔG°° = -10 kcal/mole

BIOSYNTHESIS OF LINKAGES BY CONDENSATION IS ENDERGONIC

Linkage	ΔG°° (kcal/mole)
Acetal	4.0
Acetal phosphate	5.0
Amide	4.8
Ester	4.7
Phosphoester	3.3