Biochemistry I: Formulas and Constants

Enzyme Kinetics:

For $[E]+[S] \leftrightarrow [ES] \rightarrow [E]+[P]$

$V_{max} = k_{CAT}[E_T]$ $\quad K_M = (k_{OFF}+k_{CAT})/k_{ON}$

$$v = \frac{V_{MAX}[S]}{K_M+[S]}$$

Double reciprocal plot: $\dfrac{1}{v} = \dfrac{K_M}{V_{MAX}}\dfrac{1}{[S]} + \dfrac{1}{V_{MAX}}$

$$v = \frac{\dfrac{V_{MAX}}{\alpha'}[S]}{\dfrac{\alpha}{\alpha'}K_M+[S]}, \qquad \alpha = 1+\left(\frac{[I]}{K_I}\right)$$

$\alpha' = 1$ for competitive inhibition
$\alpha' > 1$ for mixed-type inhibition
$\quad \alpha$: ratio of slopes $\qquad \alpha'$: ratio of y-intercept

Thermodynamics:

$\Delta G = \Delta G^o + RT\ln[\text{Products}]/[\text{Reactants}]$

$\Delta G^o = -RT\ln K_{eq}$

$\Delta G^o = \Delta H^o - T\Delta S^o$

$\mu = \mu^O + RT\ln[X]$

$S = R\ln W$

For $A \leftrightarrow B$: $\quad f_A = 1/(1+K_{EQ}) \quad f_b = K_{EQ}/(1+K_{EQ})$

$$\Delta G = RT\ln\frac{[X]_{IN}}{[X]_{OUT}} + ZF\Delta\psi$$

$F = 96{,}000$ Coul/mol, $\Delta\psi$ is in volts, 1Volt=1J/coul

$T_M = 81.5 + 0.41\times(\%GC) - 625/N$

Acid-Base Chemistry:

$pH = pK_a + \log([A^-]/[HA])$

$pH = -\log[H^+]$

$[HA] = [A_T]/(1+R)$

$[A^-] = [A_T]R/(1+R)$

$R = [A^-]/[HA]$

Ligand Binding (L is the Ligand)

$Y = K_{EQ}[L]/(1+K_{EQ}[L]) = [L]/([L]+K_D)$

$Y = [ML]/([M]+[ML])$

$K_D = k_{OFF}/k_{ON}$

Hill Plot: $\log(Y/(1-Y))$ versus $\log[L]$

Miscellaneous Formula & Constants:

$A = \varepsilon C l$

$R = 8.3$ J/mol-deg $\quad RT = 2.5$ kJ/mol @ 300K

$\log2 = 0.3 \quad \ln2 = 0.69 \qquad \ln X = 2.3\log_{10}X$

$\log50{,}000 = 4.69, \log150{,}000 = 5.17, \log200{,}000 = 5.3$
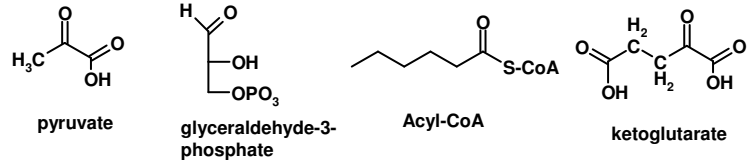
To convert from ^{o}C to K, add 273.

Amino Acid Names:

Alanine: Ala	Arginine: Arg	Asparagine: Asn
Aspartic Acid: Asp	Cystine: Cys	Glycine: Gly
Histidine: His	Isoleucine: Ile	Lysine: Lys
Leucine: Leu	Methionine; Met	Phenylalanine:Phe
Proline: Pro	Serine: Ser	Threonine: Thr
Tryptophan: Trp	Tyrosine: Tyr	Valine: Val
Glutamine: Gln	Glutamic Acid: Glu	

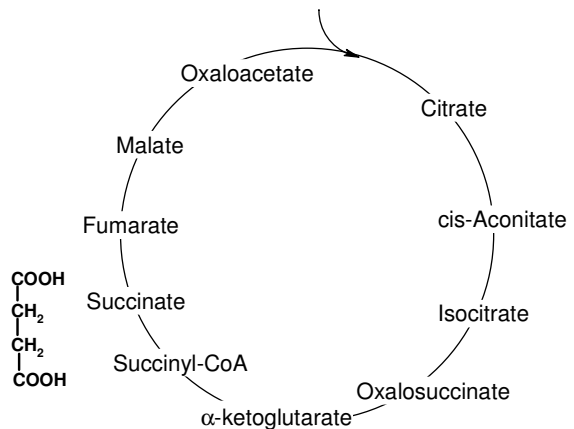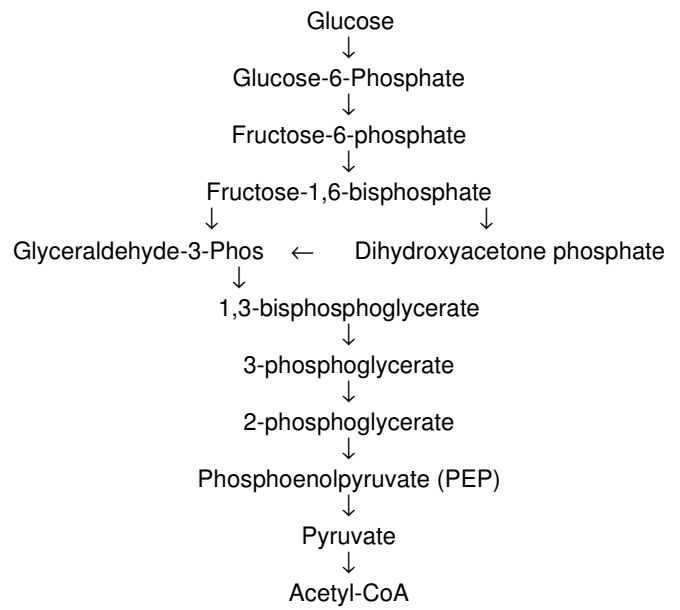## Free Energy of hydrolysis (kJ/mol):

phosphoenolypyruvate	-61.9
ATP→ADP	-30.0
Glucose-1-P	-20.9
Glucose-6-P	-12.5

Free Energy of Oxidation/Reduction 1/2 reactions:

$FAD+2H^+ + 2e^- \leftrightarrow FADH_2$	0.0 kJ/mol
Pyruvate $+ 2H^+ + 2e^- \leftrightarrow$ lactate	+35.5 kJ/mol
$NAD^+ + H^+ + 2e^- \leftrightarrow NADH$	+60.5 kJ/mol

pyruvate, glyceraldehyde-3-phosphate, Acyl-CoA, ketoglutarate

Glycolysis and TCA Cycle:

Glucose
↓
Glucose-6-Phosphate
↓
Fructose-6-phosphate
↓
Fructose-1,6-bisphosphate
↓ ↓
Glyceraldehyde-3-Phos ← Dihydroxyacetone phosphate
↓
1,3-bisphosphoglycerate
↓
3-phosphoglycerate
↓
2-phosphoglycerate
↓
Phosphoenolpyruvate (PEP)
↓
Pyruvate
↓
Acetyl-CoA

TCA Cycle: Oxaloacetate, Citrate, cis-Aconitate, Isocitrate, Oxalosuccinate, α-ketoglutarate, Succinyl-CoA, Succinate, Fumarate, Malate

Glycogen Metabolism

Glycogen, [glycogen synthase], [glycogen phosphorylase], P_i, Glucose-1-P