Summary of formulas and constants used in biochemistry

Constants

$$R = 0.008314\ kJ \cdot mol^{-1} \cdot K^{-1}$$
$$T\ in\ K = T\ in\ ^{\circ}C + 273.15$$

Free energy

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

Free energy and concentration:

$$aA + bB \rightleftarrows cC + dD$$
$$\Delta G^{\circ\prime} = -RTln\left(K_{eq}\right) = -RTln\left(\frac{[A]_{eq}^{a}[B]_{eq}^{b}}{[C]_{eq}^{c}[D]_{eq}^{d}}\right)$$
$$\Delta G = \Delta G^{\circ\prime} + RTln\left(\frac{[A]^{a}[B]^{b}}{[C]^{c}[D]^{d}}\right)$$

The standard state condition is defined as all products and reactants at 1 M, 25C, 1 atm pressure, pH 7.0.

Binding

For the reaction:

$$M + X \rightleftarrows M \cdot X$$
$$K_{eq} = K_{association} = K_a = \frac{[M \cdot X]}{[M][X]}$$

You can write this reaction as a dissociation reaction as well (generally preferred by biochemists)

$$M \cdot X \rightleftarrows M + X$$
$$K_{eq} = K_{dissociation} = K_D = \frac{[M][X]}{[M \cdot X]}$$

Written this way, K_D has units of concentration and thus measures the concentration at which the reaction will be 50% bound and 50% unbound.

$$\theta = \frac{[MX]}{[M] + [MX]} = \frac{1}{1 + K_D/[X]}$$

pH:

$$M \cdot H \overset{K_a}{\rightleftarrows} M + H^+$$

$$K_a = \frac{[M][H^+]}{[M \cdot H]}$$

$$pH = -log_{10}\left([H^+]\right);\ pK_a = -log_{10}\left(K_a\right)$$

$$\theta = \frac{[M \cdot H]}{[M] + [M \cdot H]} = \frac{1}{1 + K_a/[H^+]} = \frac{1}{1 + 10^{(pH - pK_a)}}$$