11/11/19 : pKa VALUES AND ENERGETICS

EQUILIBRIUM CONSTANT DESCRIBES ΔG° : BINDING AT REFERENCE CONDITION OF 1 M EVERYTHING

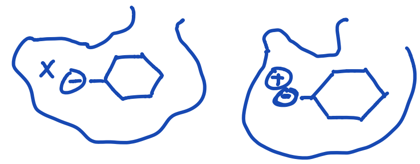
$$\Delta G = \Delta G^\circ + RT\ln\left(\frac{[M][X]}{[MX]}\right)$$

@ K_D, $\Delta G = \emptyset$:

$$0 = \Delta G^\circ + RT\ln\left(\frac{[M][X]}{[MX]}\right)$$

$$-RT\ln\left(\frac{[M][X]}{[MX]}\right) = \Delta G^\circ$$

$$-RT\ln(K_D) = \Delta G^\circ$$



IMPROVED ΔG, LOWER K_D.

LETS US RELATE ENERGETICS TO EQUILIBRIUM CONSTANTS

pKa AND pH ARE SPECIAL CASES OF EQUILIBRIUM CONSTANTS

$$pK_a = -\log_{10}(K_a)$$

$K_{ACID} \rightarrow K_{D,\,PROTON}$

$$10^{-pK_a} = K_a$$

$$-RT\ln(10^{-pK_a}) = \Delta G \longrightarrow pK_a \cdot RT \cdot \ln(10) = \Delta G$$

A SHIFT IN pK_a IS PROPORTIONAL TO A SHIFT IN ENERGY.

A STEP IN pH IS PROPORTIONAL TO CHEMICAL POTENTIAL.

$$\mu_i = RT\ln(C_i) \qquad pH = -\log_{10}[H^+] \rightarrow \mu = -RT\ln(10)\,pH$$

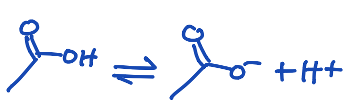
ASSUMING IDEALITY

pKa VALUES MEASURE CHANGES IN ENVIRONMENT.

$$pK_{a,OBS} = pK_{a,MODEL} + \frac{\Delta G_{ENV}}{RT\ln(10)}$$

COULOMB

pKa ASP IS 4.0:



YOU OBSERVE pKa IN PROTEIN OF 2.0.

IS THIS <u>FAVORABLE</u> COULOMB INTERACT OR UNFAVORABLE DEHYDRATION?

$$2 = 4 + \frac{\Delta G_{ENV}}{RT\ln(10)}$$

$$(-2)(RT\ln(10)) = \Delta G_{ENV}$$

$$-11.4\,\frac{kJ}{mol} = \Delta G_{ENV}$$