Bio 5312 January 25, 2016
Problem Set-2 **due Monday Feb. 1**
Lohman

1. Consider the equilibrium

$$M + X \leftrightarrow MX$$

If the standard state free energy change is $\Delta G^\circ = -14.2$ kcal/mol for a 1 M standard state at 25˚C, for all components what is the standard state free energy change for a 1 mM standard state for all components?

2. Consider the protonation equilibrium

$$M + H \leftrightarrow MH$$

If the standard state free energy change for this reaction is –9.0 kcal/mol for a 1M standard state at 25˚C for all components, calculate the free energy change when both M and MH are 1M, but a pH of 7 is maintained?

3. A protein, P, has 10 sites for a ligand, L.

a.) How many different configurations of the protein can occur in which 4 ligands are bound?

b.) If L binds independently and identically to the 10 sites, with site binding constant κ, obtain an expression for the overall macroscopic binding constant, β_3 for the equilibrium

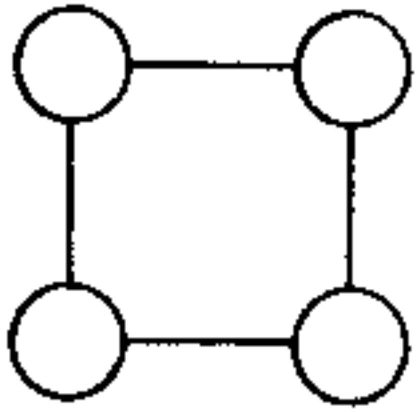
$$3\,L + P \leftrightarrow PL_3$$

c.) Obtain an expression for the step-wise macroscopic binding constant, K_6, for the equilibrium:

$$L + PL_5 \leftrightarrow PL_6$$

d.) For a protein with **n** independent and identical binding sites, what is the value of the ratio of the step-wise macroscopic binding constants, K_1/K_n?

4. A homo-tetrameric protein (identical subunits) has a square structure with four binding sites for a ligand X, one site per subunit without cooperativity. X binds to each subunit with a different site binding constant, κ_i. (i.e., κ_1, κ_2, κ_3, κ_4).



a.) Write expressions for the binding polynomial (molecular partition function) and <X> for this tetrahedral system in terms of:

i. the overall or stoichiometric binding constants, β_i (i.e., β_1, β_2, β_3 and β_4) and the free ligand concentration, x.

ii. the step-wise macroscopic binding constants, K_i (i.e., K_1, K_2, K_3, K_4) and x.

iii. the step-wise microscopic binding constant, k_i (i.e., k_1, k_2, k_3, k_4) and x.

iv. the site binding constants, κ_i (i.e., κ_1, κ_2, κ_3, κ_4) and x.

v. the site binding constants, if all $\kappa_i = \kappa$.

b.) Obtain expressions for the macroscopic constants, β_i and K_i and the step-wise microscopic constants k_i in terms of κ_i.