Problem Set 8 (**Due October 30th**)

1. What factors influence flux for non-mediated diffusion.

2. Describe how aquaporin is selective for H_2O.

3. Sodium has a much smaller ionic radius than potassium; this suggests that it should be able to fit through the pore formed by potassium channels. What are two reasons why sodium is not transported by these proteins?

4. What role do the P, N, and A domains of P-type ATPases play in ion transport.

5. Chemical potential (ΔG):
   a. If the sodium ion concentration inside the cell is 50mM and outside it is 560 mM, determine the minimum membrane potential that would be needed to drive sodium transport out of the cell. Remember that body temperature is 37 °C.
   b. Imagine an antiport system uses a pH gradient across the membrane to transport sodium against its chemical gradient. If the $[Na^+]_{out}$ = 100 mM and $[Na^+]_{in}$ = 300 mM, calculate the pH gradient that would be necessary to overcome the unfavorable transport of Na^+ AND provide an additional 1 kJ mol^{-1} of energy. Assume that $\Delta E = 0$.
   c. What other transport mechanism might be able to pump sodium against its chemical gradient?

6. Regarding nerve impulses
   a. How do ligand gated and voltage gated ion channels work together to facilitate nerve impulses? In your answer, think critically about what depolarization and hyperpolarization mean and why each occur.
   b. Clearly describe what affect valinomycin, a K^+ ionophore, would have on nerve impulses.

7. You isolate a new strain of bacteria that has evolved to rely heavily on leucine and ethylene glycol for energy. Of course, these molecules need to get inside the cell to be useful. One of these molecules enter in a mediated fashion and the other through passive diffusion.
   a. Based on the experimental data below, determine which is which.
   b. For the passive diffuser, determine the permeability coefficient. Assume that $[A]_{in}$ is equal for all trials.
   c. For the mediated diffuser, determine K_t and J_{max}.

Leucine	
Concentration (μM)	Initial Uptake Rate (μM s^{-1})
1	110
2	220
5	480
10	830
30	1700
100	2600
500	3100
1000	3200

Ethylene glycol	
Concentration (mM)	Initial Uptake Rate (mM s^{-1})
0.5	50
1	110
5	220
10	480
50	830
100	1709.8

8. GPCR:
    a. Clearly describe how GPCRs work. In your description, make sure to comment on the different types of alpha subunits (i.e. G_s, G_i, G_q) and any structural changes that are important for function.
    b. Discuss the parallel role of PLC and AC in GPCR nucleated signal transduction cascades.

9. Calcium as a secondary messenger:
    a. Calcium is released by an IP3 gated Calcium Channel in the ER. Clearly explain what this means and why it is relevant.
    b. Describe how Ca^{+2} is able to activate kinases. In your answer, please discuss the relevant calcium binding motif.

10. How is the insulin signal propagated to the nucleus? Please clearly articulate how the insulin receptor works and how the signal is passed on to IRS-1. I don't expect you to know the names of other proteins involved, but be familiar with how the signal is propagated.