Name ___________________________________

Exam IV - Review Questions

Potentially useful facts:

Ideal Gas Law constant, R = 8.314 J/(mol•K) = 0.08206 (L•atm)/(mol•K)

Faraday's Constant, $F = 9.65 \times 10^4$ J/mol•V

1. We learned earlier in the semester that the First Law of Thermodynamics states that the total energy of the universe is a constant and therefore all processes involving energy must do so by transforming energy from one form to another. In our discussions of pumps, signal transduction pathways and molecular motors, we saw numerous examples of free energy transformations. Describe the free energy transformations that take place for each of the following systems:
    a. The bacterial flagellum:
    b. Lactose permease:
    c. The SERCA pump:
    d. Bacteriorhodopopsin:
    e. Kinesin:

2. In the August 8, 2010 issue of *Science* magazine a report with the following title appeared: "The crystal structure of a sodium galactose transporter reveals mechanistic insights into Na^+/sugar symport" (*Science 321*, 810-814). And in class we discussed that the Na^+/K^+ ATPase pump maintains a Na^+ concentration of 14 mM on the cytoplasmic side of the membrane relative to a 143 mM concentration on the outside of the cell membrane.
    a. In which direction does the Na^+/galactose transporter transport galactose? What evidence do you have for your claim?
    b. If the plasma membrane potential is -60 mV, with the outside more positive than the cytoplasmic side, what ratio of galactose concentration, inside to outside, can be maintained across the plasma membrane at 37°C?

3. The action potential of nerve cells involves both Na^+ and K^+ gated channels. Describe the events that lead to both the opening and closing of these channels:
   a. opening:

   b. closing:

4. In class we focused on four examples of signal transduction pathways. Based the descriptions below, identify the components for each pathway that fit the descriptions. “None” is a valid option:

signal	EGF	epinephrine	angiotensin II	insulin
Type of receptor (7TM or tyrosine kinase)				
Secondary Messenger				
Pathway involves a G-protein (Yes/No)				
Pathway involves an Pleckstrin domain (Yes/No)				
Protein Kinase				

5. In our discussions we have run across multiple examples of *P-loop NTPases*. Describe an example that uses each of the following nucleotides. Also describe what happens when the NDP is exchanged for NTP:

System Description	Example
GTP	
ATP	

6. A major theme of the signal transduction pathways is *signal amplification*. Describe what this means and how it works.

7. Both the myosin and kinesin motor proteins move along tracks. For *each*, describe the following:

	Myosin	Kinesis
a. The name of the track		
b. The subunit composition of the track		
c. The conditions which favor their formation		
d. The conditions which favor their dissolution		

8. In our discussions we have encountered examples of the involvement signal transduction pathways and molecular motors in diseases. Explain the molecular role that each of the following has in relationship to a disease and the associated signal transduction pathway or molecular motor:
   a. Taxol:

   b. The Ras protein:

   c. Tumor repressor genes:

   d. Chlolera toxin:

9. Describe the model that explains how the free energy of a membrane proton gradient is coupled to the rotation of the bacterial flagellum. The same model can also be applied to describing the rotation of