CHEM 4420 Thermodynamics of Membrane Transport Dr. Stone

Exam Memory Bank

$V_0 = \frac{V_{max} \times [S]}{K_m + [S]}$	$\Delta G^{\circ'} = -nF\Delta E^{\circ'}$	R = 8.314J/molxK
$V_{max} = k_{cat} \times E_t$	$\Delta G^{\circ'} = -RTlnK_{eq}^{\circ'}$	F = 96,500J/Vxmol
$k_{cat} = \frac{kT}{h} \times e^{\frac{-G^*}{RT}}$	$\Delta G_t = RTln\frac{c_2}{c_1}$	Boltzman constant, k=1.381×10^{-23} J/K
$\Delta G = \Delta H - T\Delta S$	$\Delta G_t = RTln\frac{c_2}{c_1} + ZF\Delta\psi$	Plank's constant, h=6.626×10^{-34} Jxsec
		Avogadro's number, 6.02×10^{23}/mol
		ln x=2.303$\log_{10}$x
		calorie=4.184J

1. Most cells have intracellular Na^+ concentrations of 8 mM, compared to the extracellular concentrations of 140 mM.

a. Calculate the Gibb's free energy change for the movement of Na^+ from the inside of the cell to the outside, for a cell with a membrane potential of 70 mV (the cell is negative on the inside).

b. Is energy required for this process to occur? Be able to explain your answer.

2. The K^+/Na^+ ATPase is a primary active transporter. About 25% of a human's resting energy is used for these transporters. Hydrolysis of ATP releases approximately 30kJ of energy. How many ATP are required to move 3 sodium ions out of a cell and 2 potassium ions inside a cell. The membrane potential is 50 mV (inside negative). The concentrations of sodium ions are inside :12 mM, outside: 140 mM. The concentrations of potassium ions are inside: 120 mM, outside: 8 mM

Step 1: Calculate the ΔG_t for Na^+, multiply by the three moles of Na+ being moved.

Step 2: Calculate the ΔG_t for K^+, multiply by the two moles of K+ being moved.

Step 3: Add ΔG_t for Na^+ and ΔG_t for K^+

Step 4: Divide the total by 30kJ that will be the number of ATP required.

Step 5: Compare this value to the published value.

3. Glucose can be accumulated at higher concentrations inside an intestinal cell with a secondary active transporter. (Glucose/Na+ transporter). In these cells, ATP is used to move sodium ions outside the cells and then the sodium ions flow into the cell. The energy of the sodium flowing is then used to cotransport glucose against its concentration gradient. Given the following concentrations: sodium inside 12 mM, sodium outside 150mM, how much excess glucose can be accumulated in the cell? The membrane potential is 60 mV, with the inside being negative.

Step 1: Calculate the free energy available (ΔG_t) when sodium moves from the outside (150mM) to the inside (12 mM).

Step 2: Use the free energy calculated in step 1 and solve the ΔG_t equation for the ratio of (C_2/C_1) for glucose. Report this ratio.