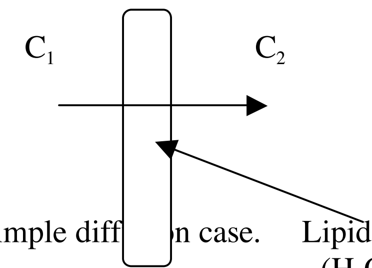
Chem 431A-L28-F'07 wednesday	Last time: transport thermodynamics
admin: Inclass Quiz 10 . Online quiz9 deadline is Monday (Chapt 11). In class quiz is Friday (membranes, transport) Review guide for final (65pts) posted today	Today: problem solving + review (ask me how you are doing) Fri: talk + survey + quiz

Last time:

For a solution: G = RTlnC so ΔG between 2 sides of memb: final – initial
$\Delta G = G_f - G_i = RT\ln C_f - RT\ln C_i = RT\ln(C_f/C_i)$



Simple diffusion case. Lipid bilayer membrane (H_2O diffuses easily!)

Process:
$C_1 \rightarrow C_2$ net charge transport

2 different aspects:
rate (kinetics) & spontaneity(thermodynamics)
$J=-P(C_2-C_1)$
(1)$\Delta G= RT\ln(C_f/C_i)$
(2)$\Delta G= RT\ln(C_f/C_i) + ZF\Delta Y$
(3)$\Delta G= RT\ln(C_f/C_i) + \Delta G'$

permeability(deps on S solubility in memb.)

coupled chem rxns

3 kinds of diffusion-driven transport

simple (nonmediated)	facilitated (mediated) (transporters,permeases)	
ΔG'=0, "passive"	carrier	channel(pore)
slow	fast	very fast

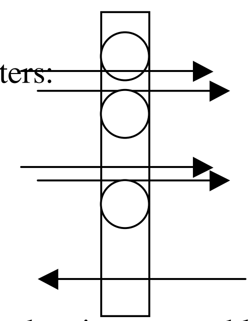
factors to distinguish
speed, specificity
saturatable or not?
Competitive?
Can be inactivated?

Transporters are not really enzymes but function similarly (lower activation energy, can be inactivated or modified)

Kinds of transporters:

Uniport
Cotransporters:
Symport

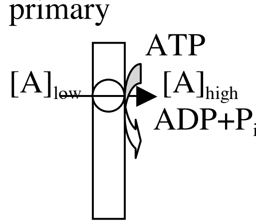
Antiport



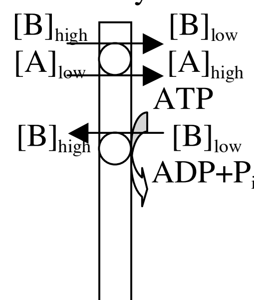
Symports and antiports are obligatory.

Active transport: coupled reactions usu. to ATP hydrolysis.

primary



secondary



In secondary active transport, the transport of A is by symport driven by B gradient kept high by another active transport mechanism

Problem solving practice:

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Consider: note: T = 298, R = 8.314 J/mol K , 1 C-V = 1 joule; $\Delta G = 2.303RT\log C_2/C_1 + ZF\Delta\Psi + \Delta G'$

1) A neutral solute crosses a membrane by passive diffusion. If its concentration is 1 mM on the left side and 100 mM on the right side, what is the free energy change for the transport of 1 mole of solute from left to right?	$\Delta G = RT \ln C_2/C_1 =$ (8.314J/molK)(298K)ln(100/1)=+11,400 J/mol = +11.4 kJ/mol (non spontaneous)
2) K^+ ions cross a membrane from inside (140mM K^+) to outside (4mM K^+) by facilitated diffusion (via a pore). The membrane potential is 100 mV (+ on the right side of the membrane). Is the process of crossing from inside to outside spontaneous?	$\Delta G = RT \ln C_2/C_1 + ZF(\Psi_2 - \Psi_1) =$ (8.314J/molK)(298K)ln(4/140)+(+1)(96500)(.1V) =-8.81 kJ/mol +9.65 kJ/mol = +0.84 kJ/mol (nonspont)
3) Consider the Na^+/K^+ -ATPase transport system. For every ATP hydrolyzed, 3 Na^+ ions move out of the cell and 2 K^+ ions move into the cell. The membrane potential is -70 mV (that is, - on the inside and + on the outside). The standing concentrations of the relevant ions are: $[K^+]_{out}$ = 4mM, $[K^+]_{in}$ = 140 mM, $[Na^+]_{out}$ = 145mM, $[Na^+]_{in}$ = 12mM. Note also: $ATP^{4-} + H_2O \rightarrow ADP^{3-} + HPO_4^{2-} + H^+$ $\Delta G'$= -30.5 kJ/mol What is $\Delta G'$ for this transport? (assume pH =7)	$\Delta G = 2\ RT \ln\{[K^+]_i/[K^+]_o\} + 3\ RT \ln\{[Na^+]_o/[Na^+]_i\}$ + 2(+1)(96500C/mol)(-0.070V) +3(+1)(96500C/mol)(+.070V)+(-30.5kJ/mol) = +12.2 kJ (non spontaneous at std conditions of ATP and ADP and Pi. They must be at non std conditions in the cell to make the $\Delta G'$ for ATP hydrolysis to be negative enough to allow for the ion pumping. Recall: $\Delta G' = \Delta G°' + RT\ln Q$ where Q = [ADP][Pi]/[ATP]

Resting membrane potential $\Delta\Psi$ of a cell: Consider: $\Delta G = RT \ln (C_2/C_1) + ZF\Delta\Psi$ at equilibrium (assuming only passive diffusion) $\Delta G = 0 = RT \ln(C_2/C_1) + ZF\Delta\Psi$ solve for ΔY: $\Delta\Psi = -(RT/ZF)\ln(C_2/C_1)$ "Nernst Equation" magnitude: $\Delta\Psi = -2.303(RT/ZF)\log(C_2/C_1) = (60mV/Z) \log(C_2/C_1)$ let's draw it. For example, $[K]_1$ = 10mM. $[K]_2$=1mM what is the resting potential? For example: $pH_1 = 2$, $pH_2 = 10$, what is $\Delta\Psi$?	For K^+ example: $\Delta\Psi = -2.303(RT/ZF)\log(C_2/C_1)$ $= (60mV/Z) \log(C_2/C_1)$ =60mV(log(1/10)= -60 mV it must be + in the side that's low in $[K^+]$ for the system to be at equilibrium. pH example: $\Delta\Psi = -2.303(RT/ZF)\log(C_2/C_1)$ $= -2.303(RT/ZF)\log([H^+]_2/[H^+]_1)$ $=60mV pH_1 - pH_2 = 60mV (\Delta pH)$ =60mV(10-2)=480mV .+ on the high pH side