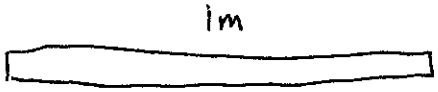
Homework # 1

Nelson 4.3



a.) $\zeta D = K_B T$

$\zeta = 6\pi\eta R$

$D = \frac{K_B T}{6\pi\eta R}$ estimate $R = 50$ nm from figure 2.19

$\eta = 10^{-3}\ Kg^{-1} s^{-1}$ for water

$$D = \frac{4.1 \times 10^{-21}\ J}{6\pi\left(10^{-3}\ Kg\ m^{-1}s^{-1}\right)\left(50 \times 10^{-9} m\right)} = 4.4 \times 10^{-12}\ m^2 s^{-1} = 4.4\ \mu m^2 s^{-1}$$

b.) $\frac{dc}{dt} = D\frac{d^2c}{dx^2}$, in steady state $\frac{d^2c}{dx^2} = 0$ so $c(x)$ is linear

$c(x) = C_0'(L - x)$ x in μm

$C_0' = \frac{C_0}{10^6\ \mu m} = \frac{C_0}{L}$

$j = -D\frac{dc}{dx} = DC_0' = \frac{DC_0}{L}$

c.) $v = 400\ mm\ day^{-1} = 4.6\ \mu m\ s^{-1}$

$J_{obs} = C_0 v$

d.) $\frac{J_{diffus}}{J_{obs}} = \frac{DC_0'}{vC_0} = \frac{\left(4.4\ \mu m^2 s^{-1}\right)\left(\frac{C_0}{10^6\ \mu m}\right)}{\left(4.6\ \mu m\ s^{-1}\right)C_0} \sim 10^{-6}$

There must be active transport