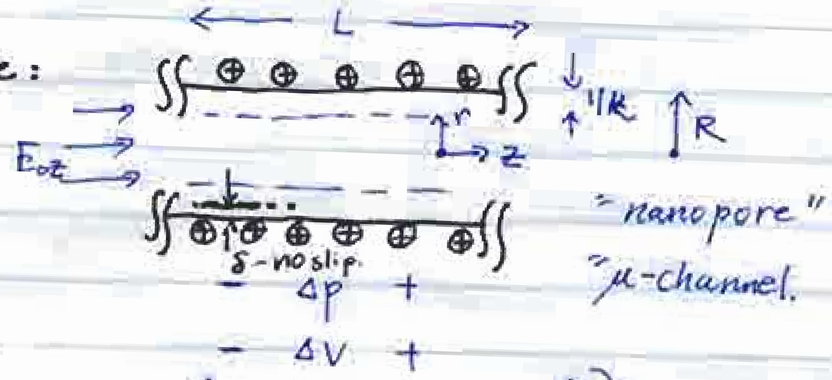
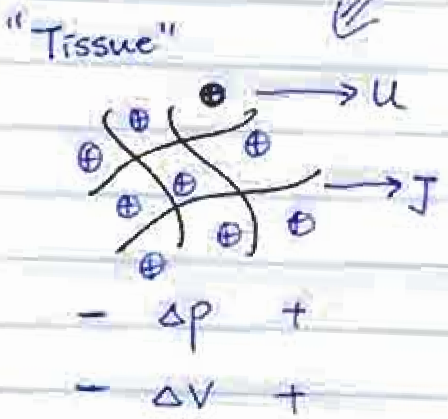
Today Ⓘ Summarize "Capillary Electro-osmosis" 11/17/04
(prob. 6.2.1): BC's; solution

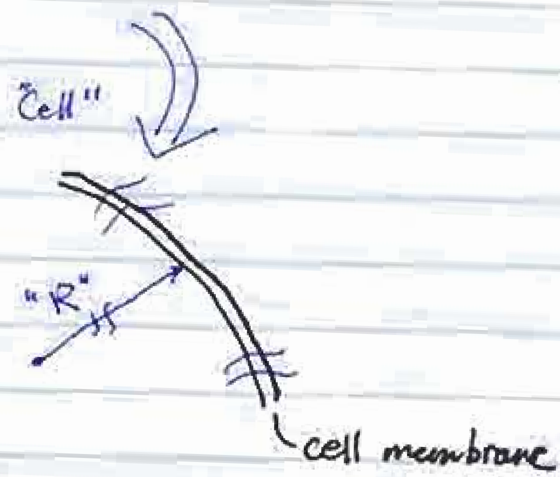
Ⓘ Applications: Electrokinetics @ the molecular, cell, tissue levels

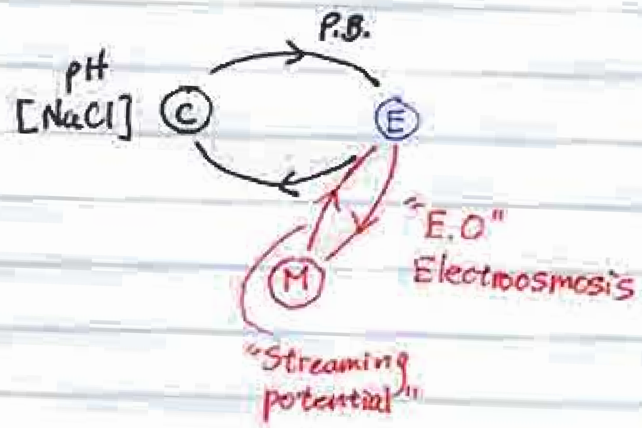
Ⓘ Begin Electrophoresis < "Free" / "Zone"

Last Time:



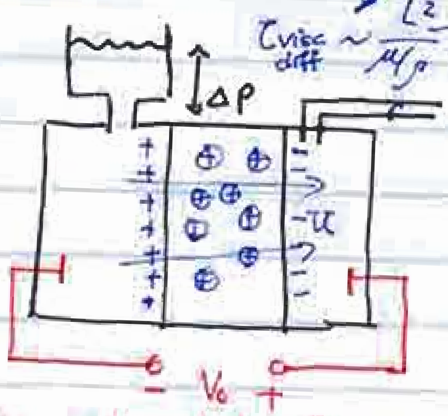






$$\rho \frac{dv}{dt} = \mu \nabla^2 v$$

$$\tau_{visc\ diff} \sim \frac{L^2}{\mu/\rho} \sim R.$$



$$\begin{bmatrix} U \\ J \end{bmatrix} = \begin{bmatrix} -k_{11} & k_{12} \\ k_{21} & k_{22} \end{bmatrix} \begin{bmatrix} \nabla p \\ \nabla V \end{bmatrix}$$

V_0 induced by U
measure V_0 @ $i \simeq 0$

⑦ $\left[0 = -\nabla p + \mu \nabla^2 \underline{v} + \rho_e \underline{E}\right]_z$ $\qquad \dfrac{\partial p}{\partial z} = \dfrac{1}{r}\left[\dfrac{\partial}{\partial r} r \left[\mu \dfrac{\partial V_z(r)}{\partial r} + \varepsilon E_r E_z\right]\right]$

⑧ $\nabla \cdot \underline{v} = 0$

↑ Integrate Twice

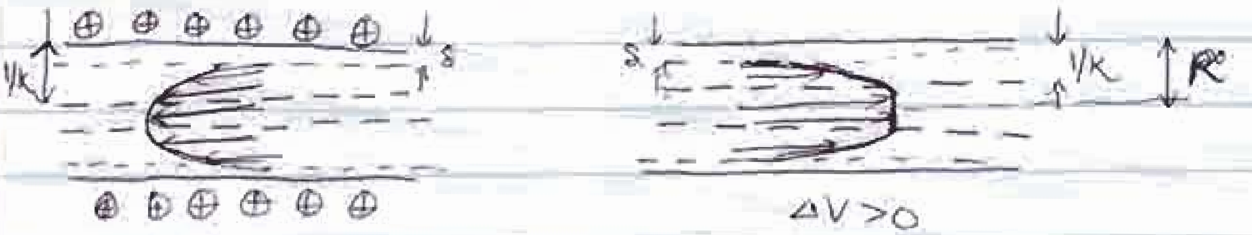
Since $1/\kappa$ can vary depending on concentrations within couple of μm's from the wall, no slip plane very important.

B.C. @ $r = 0$, $\dfrac{\partial V_z(r)}{\partial r} = 0 = \dfrac{\partial \Phi(r)}{\partial r}$ (symmetry)

@ wall; a few molecular diameters away from wall

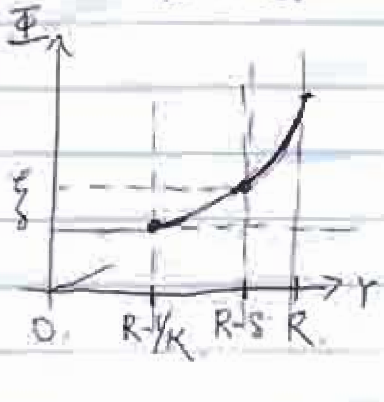
$V_z(R-\delta) = 0$; $\Phi(R-\delta) = $ "ζ" Zeta

$$\Rightarrow V_z(r) = \left(\frac{r^2 - (R-\delta)^2}{4\mu}\right)\left(\frac{\Delta p}{L}\right) + \frac{\varepsilon}{\mu}\left(\zeta - \Phi(r)\right)\left(\frac{\Delta V}{L}\right)$$

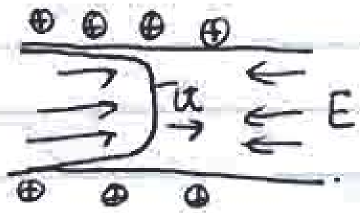


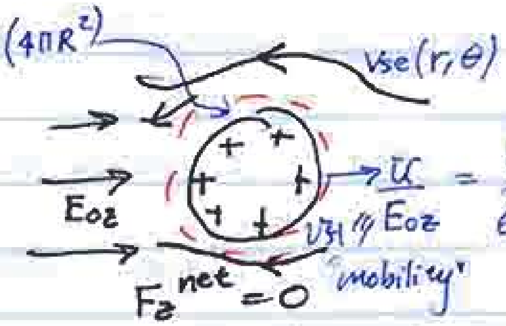
$\Delta p > 0$
$(\Delta V = 0)$

$\Delta V > 0$
$(\Delta p = 0)$



Fluid is attracting counter-ion, push others ...



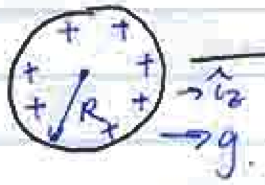


$\frac{U}{E_{oz}} = \frac{Q E_{oz}}{6\pi R \mu}$ "mobility"

$F_z^{net} = 0$

$= Q E_{oz} - 6\pi R U \mu$

"Stoke's Drag"



$U = \frac{mg}{6\pi R \mu}$

- Electric shear on particle
- Viscous shear on double layer.

$F_z^{net} = 0 = mg - 6\pi R U \mu$ (falling down).

F_z^{net}