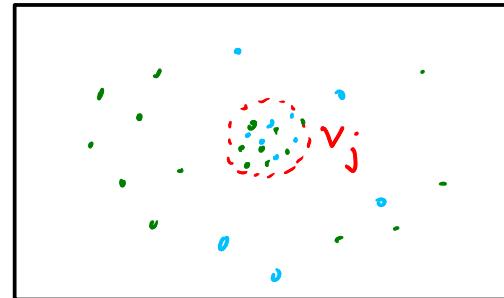


$$\frac{\Omega_{ji}}{\Omega_{ij}}$$



$n_\alpha = \#$ molec. of type α inside
 $N_\alpha - n_\alpha = " "$ " " outside

$\alpha = 1, 2, \dots, \#$ diff. types

for impermeable molec. n_α is fixed

$$\frac{\Omega_{ji}}{\Omega_{ij}} = e^{-\beta(-k_B T \ln \frac{6_j}{6_i})} \quad 6_j = \# \text{ micro states in state } j$$

$$6_i \approx \left(\frac{N_{\text{pos}, \alpha}^{\text{in}, i}}{n_\alpha} \right) \left(\frac{N_{\text{pos}, \alpha}^{\text{out}, i}}{N_\alpha - n_\alpha} \right) (\dots) (\dots)$$

dilute approx:

$$N_{\text{pos}, \alpha}^{\text{in}, i} \gg n_\alpha \gg 1$$

$$N_{\text{pos}, \alpha}^{\text{in}, i} = \frac{V_i}{V_{\text{mol}, \alpha}}$$

↑ molec. volume of type α

$$N_{\text{pos}, \alpha}^{\text{out}, i} = \frac{V_{\text{tot}} - V_i}{V_{\text{mol}, \alpha}}$$

giant multip. for all types α

$$\text{approx: } \ln \left(\frac{M}{m} \right) \approx -m \ln \frac{m}{M} \quad m \gg 1, M \gg 1, M \gg m$$

$$\ln 6_i \propto - \sum_\alpha \left[n_\alpha \ln \frac{n_\alpha V_{\text{mol}, \alpha}}{V_i} + (N_\alpha - n_\alpha) \ln \frac{(N_\alpha - n_\alpha) V_{\text{mol}, \alpha}}{V_{\text{tot}} - V_i} \right]$$

$$\frac{\Omega_{ji}}{\Omega_{ij}} = e^{-\beta(-k_B T \ln 6_j - (-k_B T \ln 6_i))}$$

$$\xrightarrow[t \rightarrow \infty]{} p_i^s = \frac{e^{-\beta(-k_B T \ln 6_i)}}{Z} = \frac{e^{\ln 6_i}}{Z}$$

Compare to:

$$\frac{\Omega_{ji}}{\Omega_{ij}} = e^{-\beta(E_j - E_i)} \xrightarrow{t \rightarrow \infty} p_i^s = \frac{e^{-\beta E_i}}{Z}$$

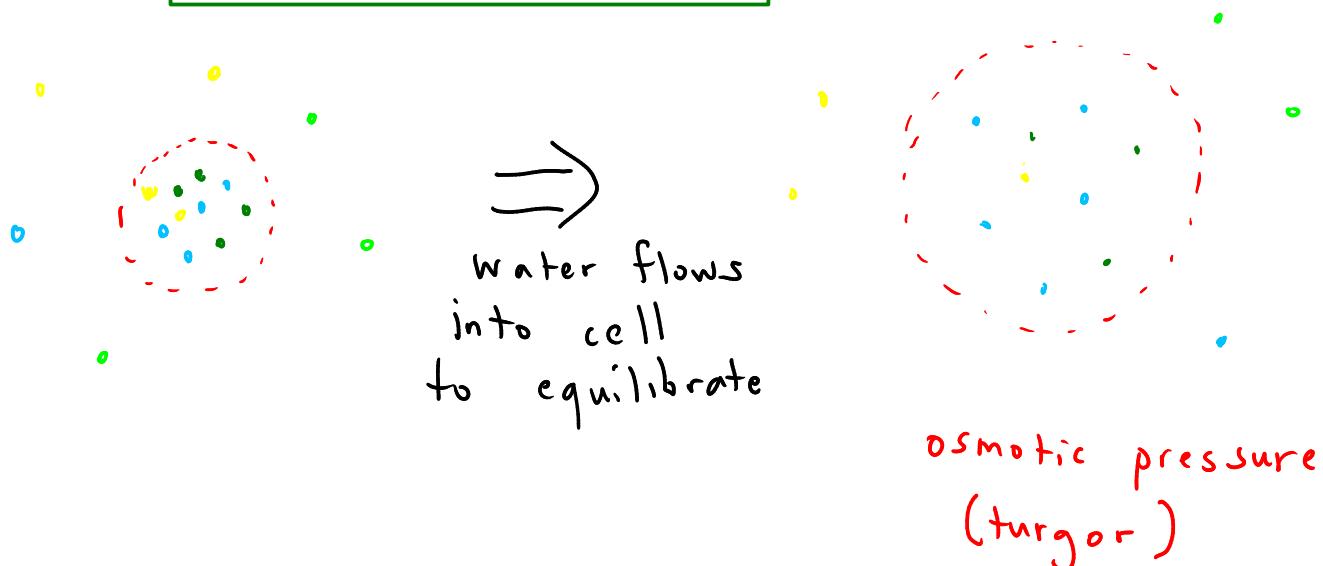
to find most likely state i (highest p_i^s)
 we need to largest value of $\ln g_i$

$$\frac{d}{dV_i} \ln g_i = 0 \Rightarrow \text{simplify}$$

$$\Rightarrow \sum_{\alpha} \left[-\frac{n_{\alpha}}{V_i} + \underbrace{\frac{(N_{\alpha} - n_{\alpha})}{V_{t_0+} - V_i}}_{C_{\alpha}^{\text{out}}} \right] = 0$$

$\underbrace{C_{\alpha}^{\text{in}}}_{\text{inside conc. of type } \alpha}$
 $\underbrace{C_{\alpha}^{\text{out}}}_{\text{outside conc. of type } \alpha}$

$$\Rightarrow \sum_{\alpha} C_{\alpha}^{in} = \sum_{\alpha} C_{\alpha}^{out} \quad \text{in equilibrium}$$



⇒ All cells w/ flexible membranes need to have mechanisms to regulate this stress (i.e. transporters of molec. across membranes)

II. Charged particles + transport across membranes

Starting point: in a cell many molecules are charged but there is an approx. balance b/t total positive & neg. charges (both inside & outside cell)

