Outline

Nernst Potential

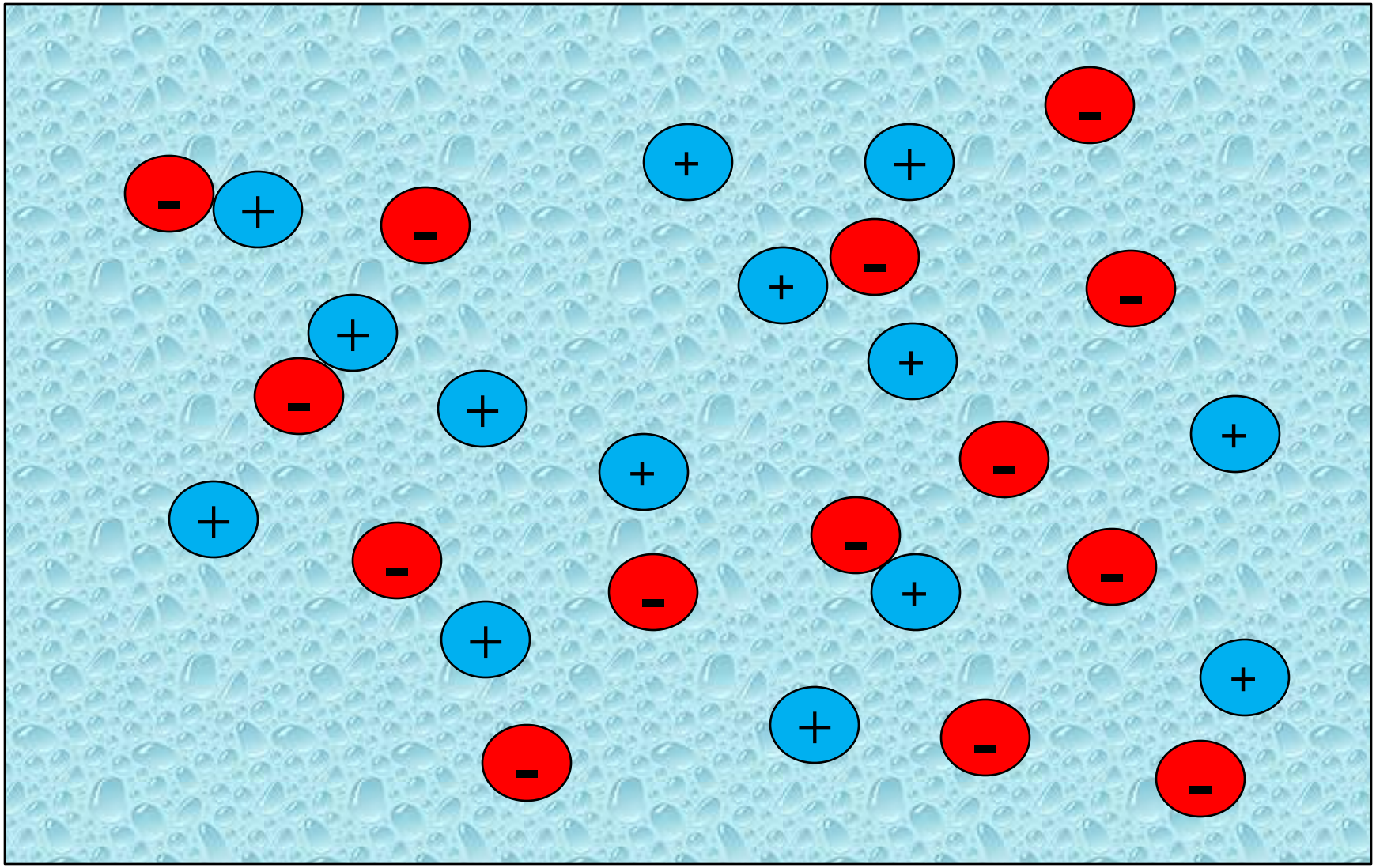
Office hours Thursday after spring break 4-5.30

Nernst Potential

Difference in electrostatic potential across a membrane. c_1 and c_2 are concentrations of ions on either side of the membrane

$$\Delta V = \frac{k_B T}{q} \ln\left(\frac{c_2}{c_1}\right)$$

Fluid with KCl dissolved.



Biology Background
Different # of Ions in a Cell than outside

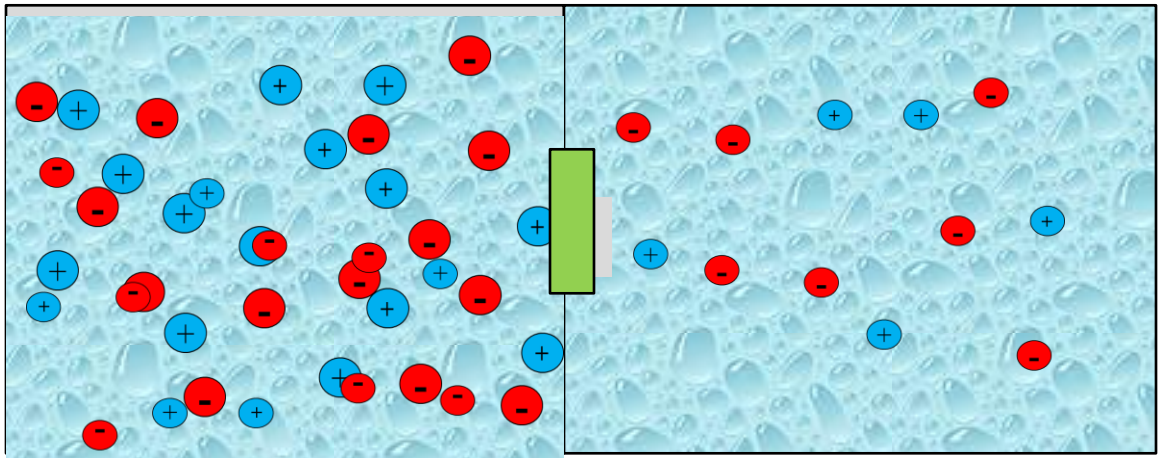
Table 4.1-1: Intra- and extracellular ion concentrations

Ion species	**Concentration inside cell**	**Concentration outside cell**
Na^+	15 mM	150 mM
K^+	150 mM	6 mM
Cl^-	9 mM	125 mM
Ca^{++}	100 **n**M	1.2 mM

http://watcut.uwaterloo.ca/webnotes/Pharmacology/page-4.1.html

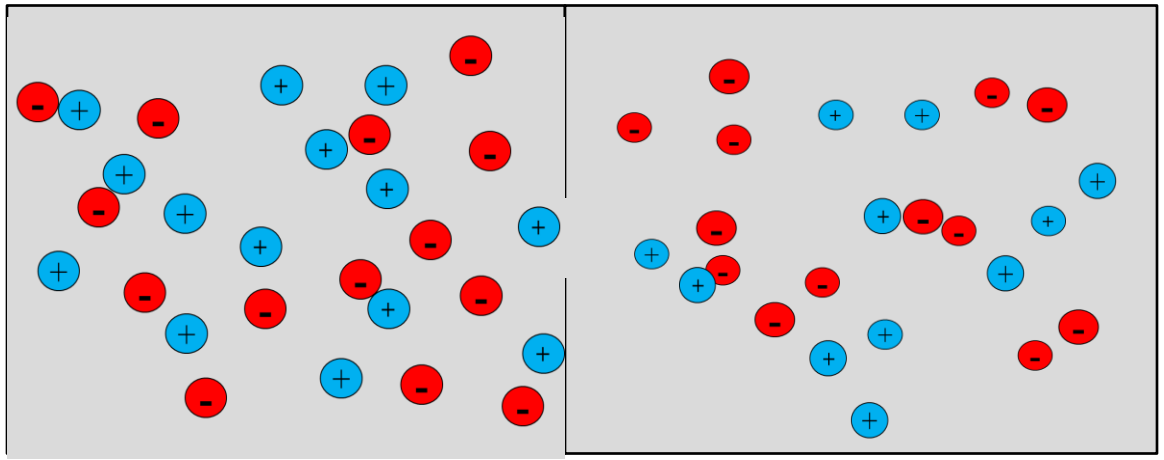
Does this concentration difference lead to an electrostatic potential?

1. Yes
2. No
3. Depends



Does opening a channel lead to a potential difference?

1. Yes
2. No
3. Depends



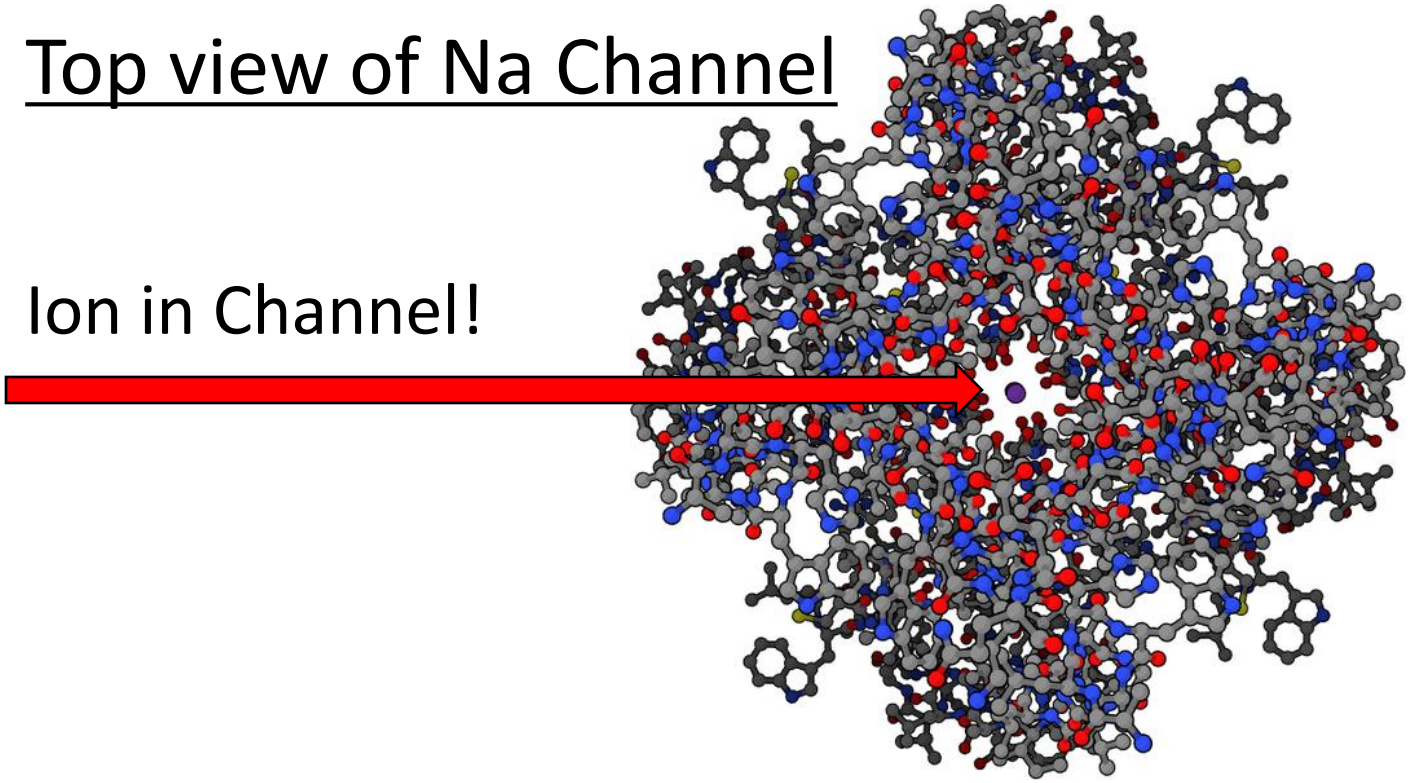
Biology Background:

Ion Channels that only let Potassium through (channels for other types of ions also exist)

http://www.rcsb.org/pdb/explore/jmol.do?structureId=1BL8&bionumber=1

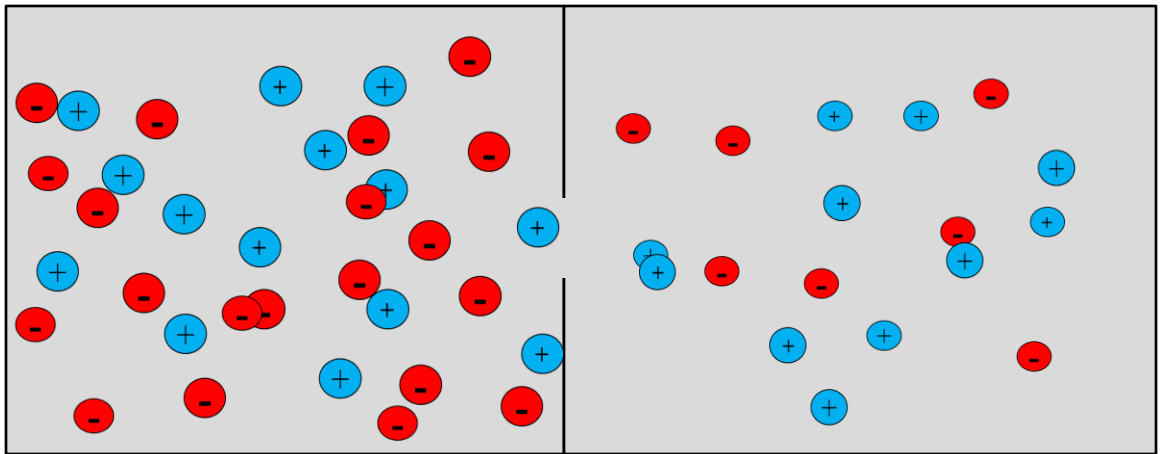
Top view of Na Channel

Ion in Channel!



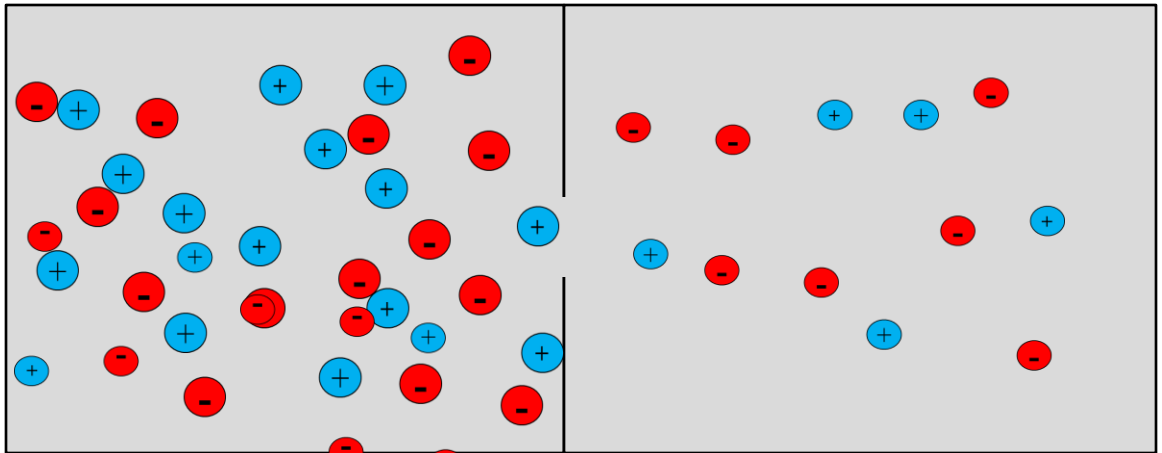
Below you see a membrane that has a channel that is permeable for one of the ions only.

1. The membrane is permeable to positive ions
2. The membrane is permeable to negative ions
3. Depends on the initial distribution of ions
4. other



Two boxes one starting with 18 red and blue molecules, the other with 6 of each kind. Membrane has a channel THAT IS ONLY PERMEABLE to blue molecules. At the start (shown)

1. Blue molecule are equally likely to enter the channel on each side
2. Blue molecules are 3 times more likely to enter the channel on the right
3. Blue molecules are 3 times more likely to enter the channel on the left
4. Not enough information

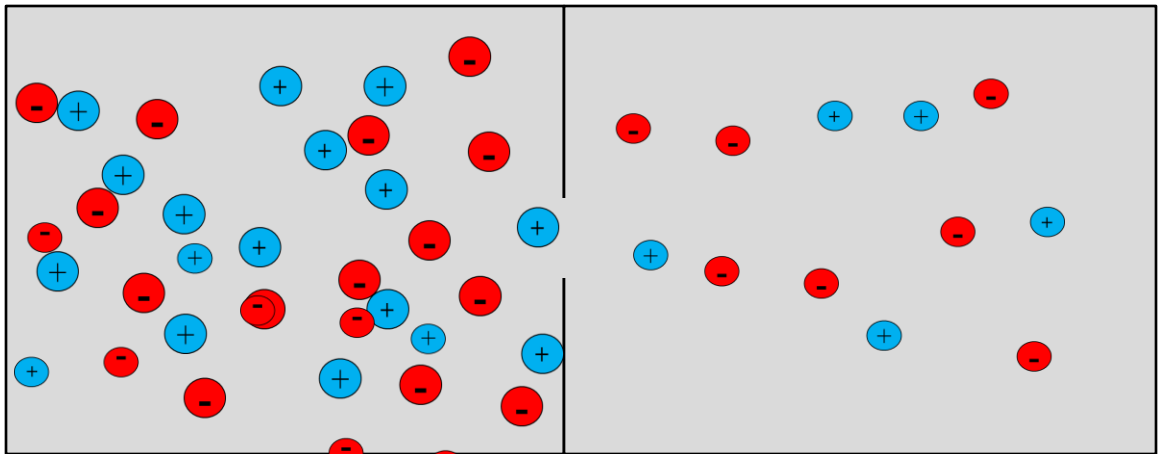


Sketch equilibrium state

- Electric fields?
  1. None
  2. Near membrane
  3. everywhere

Quantifying the electrostatic energy penalty: how much more (or less) likely is it for an ion to have an electrostatic energy of E_1 compared to E_0

1. $P = e^{\frac{E_1 - E_0}{k_B T}}$
2. $P = e^{-\frac{E_1 - E_0}{k_B T}}$
3. $P \sim e^{\frac{E_1}{E_0}}$
4. $P \sim e^{-\frac{E_1}{E_0}}$
5. Need more information



Nernst Equation

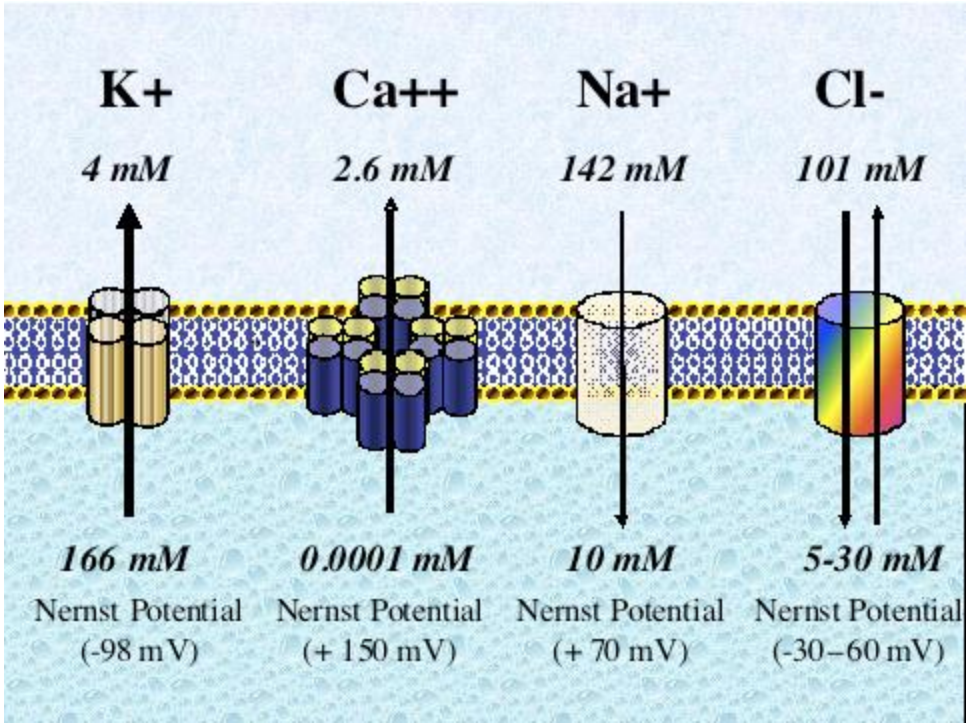
- Diffusion: Concentration gradient in the presence of ion channel -> ions flow to equilibrate concentration
- Electrostatic potential: only one ion species can flow -> electrostatic potential builds up -> makes it less likely for ions to keep flowing across channel

$$\Delta V = \frac{k_B T}{q} \ln\left(\frac{c_2}{c_1}\right)$$

Nernst

- Depends on the potential difference
- Requires selective ion channels

Ions in a Cell



http://www.dev.urotoday.com