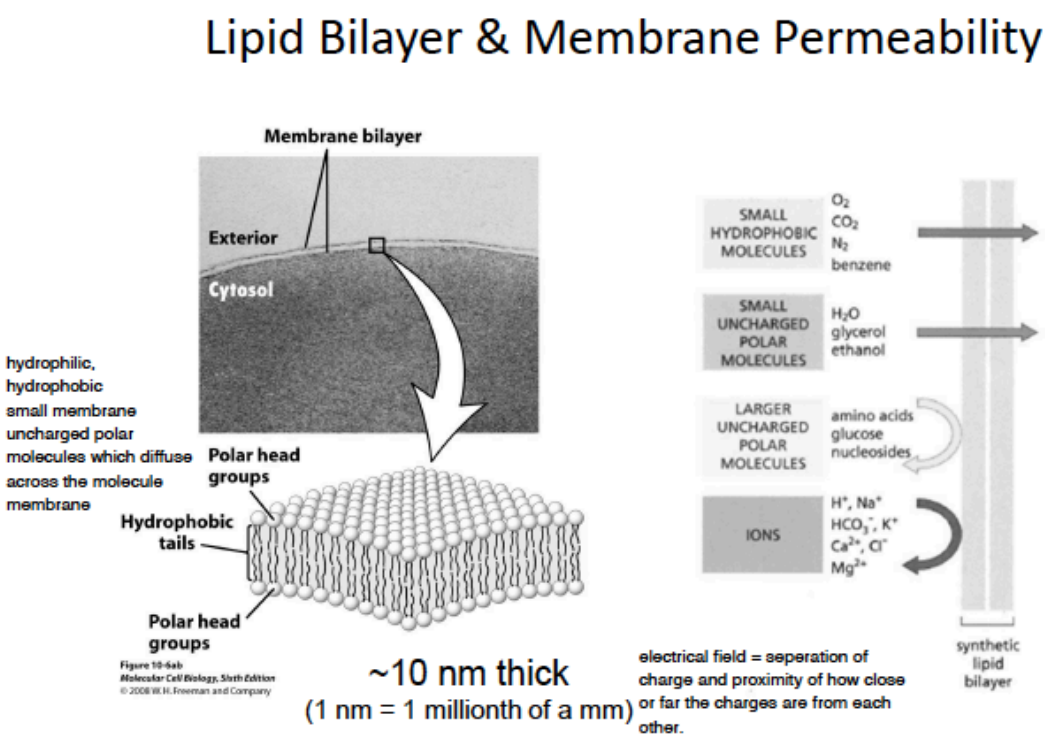
ELECTROPHYSIOLOGY

Lecture 1 – single cell electrophysiology, concepts and methods



- electrical field = separation of charge and proximity of how close or far the charges are from each other.
- The more lipid soluble and lighter weight the smaller the permeability
- The electrical field of the membrane being large causes a change in the voltage and is strong and large enough to cause deformation in proteins.

<u>Transmembrane proteins allow solutes to cross cell membranes</u>

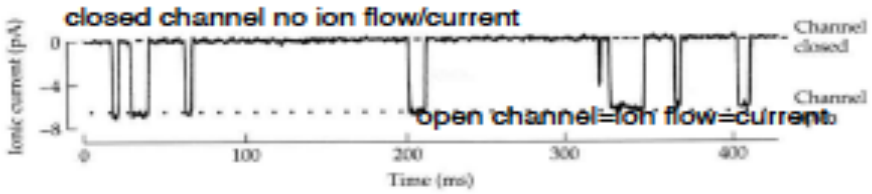
- Cholesterol provides structure and stability
- Aquaporins=water reabsorption and water transport
- Simple passive diffusion ie. Oxygen
- Symport = movement of ions (eg. sodium) into the same direction
- Antiport = movement of ions in the opposite direction.

<u>Movement of charged solutes</u>

- Electrochemical gradient has 2 components
    1. Concentration gradient – chemical
       - ion/solutes moves down the conc gradient
    2. Membrane potential – electrical
       -influenced by electrical field across the membrane

Nature of ion channels in cell membranes

- Leakage channels always open
- 3 types of Gated ion channels:
    1. **voltage gated**
       - activated by change in electrical field
    2. **ligand gated**
       - conformational change causing them to open
       - binds to receptor on the extracellular site. Ach released
    3. **stretch activated**
       - mechanical stress, mechanosensitive, categorise in selectivity the way the channels open.
       - Mechanically gated – hair cells, K+ flows in causing membrane potential.



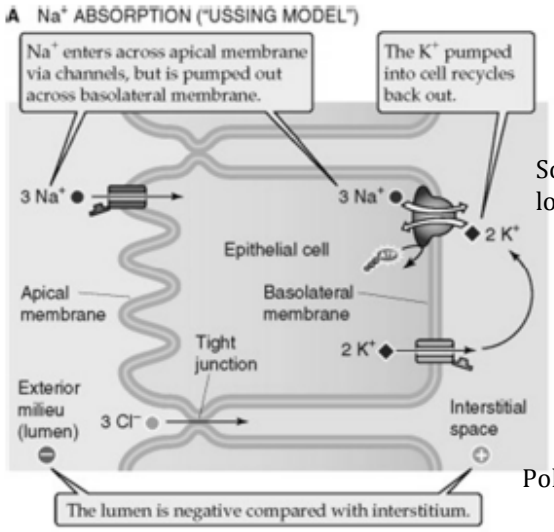
Ionic current flow in response to channel

will switch on / off when needed. **gating**

Ion channels and membrane potentials are important in ALL cells

- Membrane potential is a major force on ions and molecules in all cells
- Osmotic balance in cells – ions are most abundant dissolved soutes
- Ion flows and voltages can control fluid flows in specialized epithelia – sectreion and absorption
- Ion flows and voltages control many other phenomena :
    - sensory signaling
    - force generation – calcium (smooth, skeletal and cardiac muscle)
    - intracellular enzyme cascades – involved in signaling
    - gene expression, cell growth and cell death.

Salt and Fluid transport by epithelia



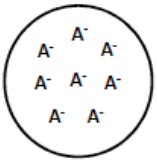
Sodium/ potassium pump keeps intracellular Na low and there is downward flow of ions.

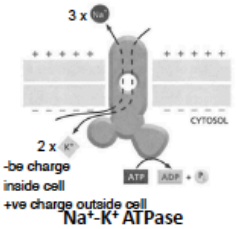
Polarity of interstitial space increases

Na^+ transport → Trans-epithelial voltage → drive Cl^- flux → ↑ osmolarity → Fluid transport

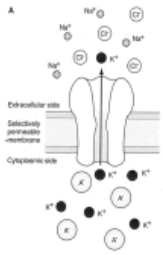
Establishing a membrane potential

- Trapped organic anions (Gibbs-Donnan effect)
- Na^+/K^+ pump - Na^+/K^+ concentration gradients – net electrical negativity
- Cell membrane preferentially permeable to K^+





Na^+-K^+ ATPase



-ve charge inside cell and +ve charge outside the cell.