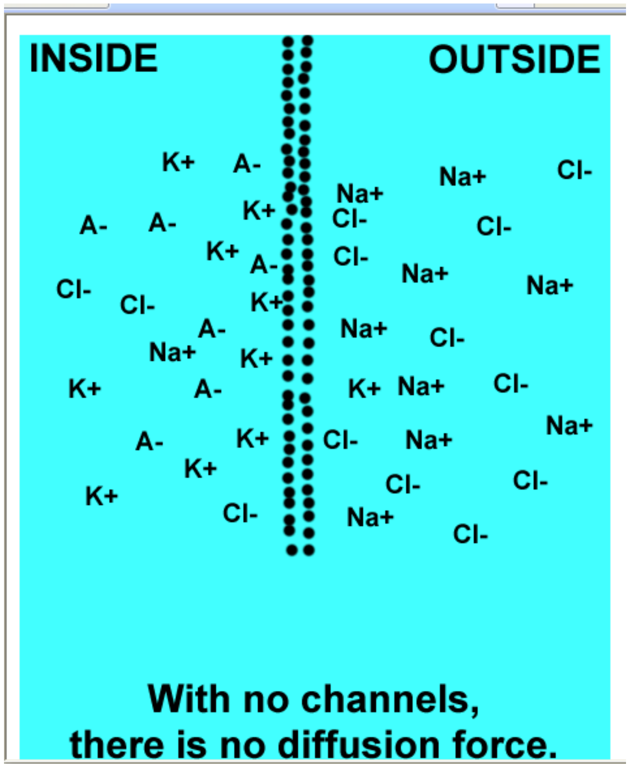
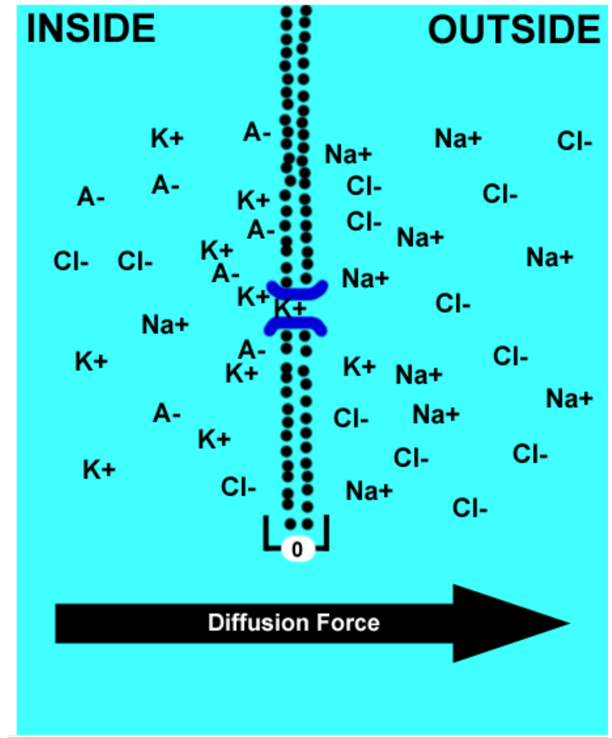
Animation:

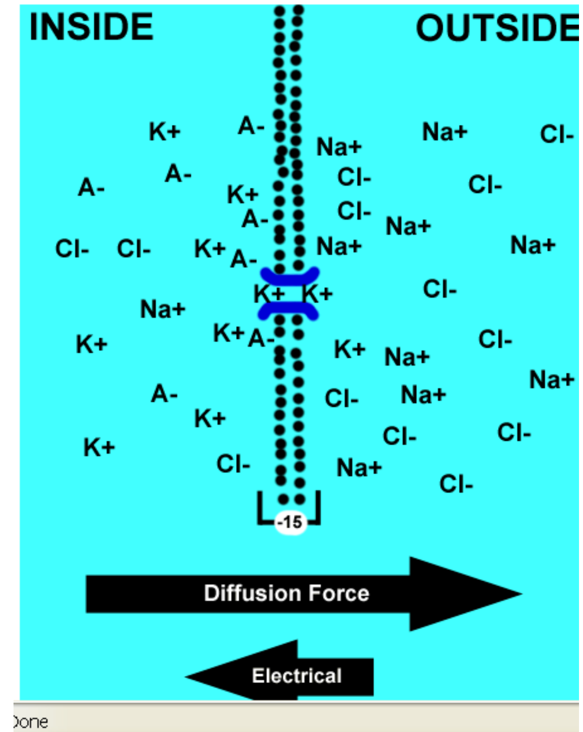
http://carbon.cudenver.edu/~bstith/membrpotential.gif



First, the Na K pump has set up concentration gradients

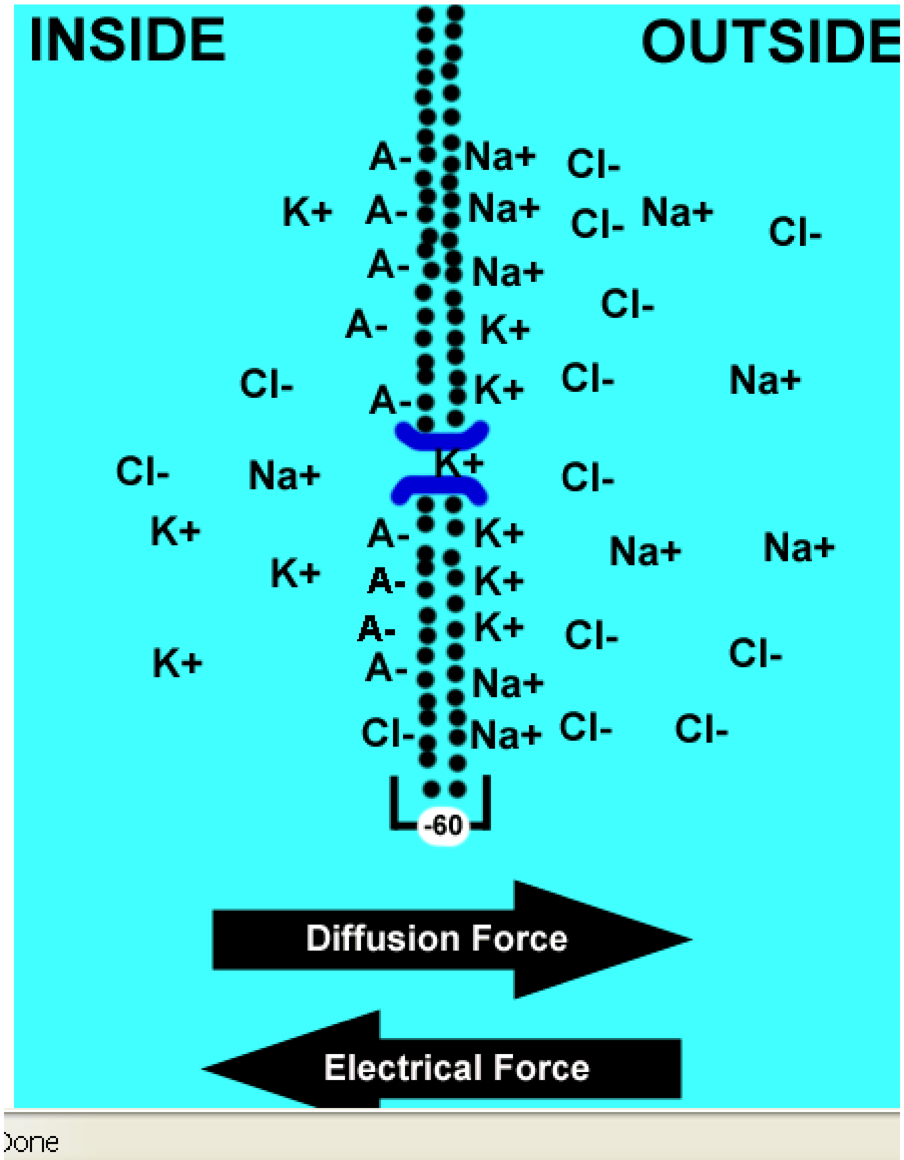


Now, a few K channels open and K moves down its conc gradient. The Big arrow represents the force due to the concentration (or chemical) gradient



As K+ moves out, the inside becomes negative so the force due to the electrical gradient appears and grows **(positive K wants to move back into the cell where there are excess negative charges)**

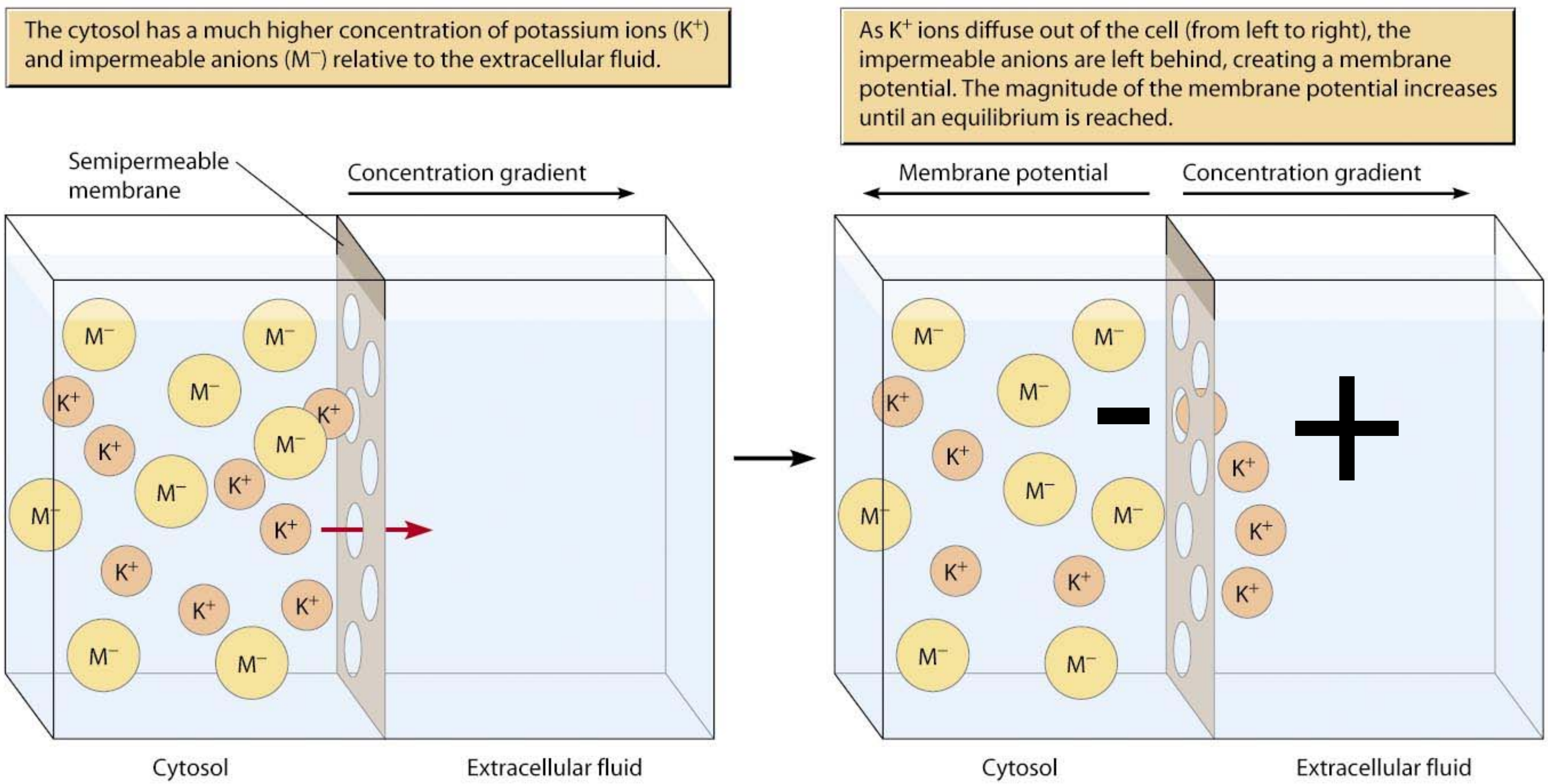
Brad Stith Univ CO Denver



At equilibrium

- Finally, K reaches equilibrium as the growing force due to the electrical gradient becomes equal and opposite to the chemical/concentration gradient.
- This occurs when **the membrane potential** (estimated by the Nernst equation) reaches about -60 mV
- …at this membrane potential, the electrical force is going to be equal in size to the chemical force (see the arrows)—this is the **equilibrium potential for Potassium (V_K or E_K)**

Textbook illustrates K ion reaching equilibrium, setting up of membrane potential…pg 367-369



Few K channels open, K begins to move down its concentration gradient

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As K+ moves to right, this sets up a potential difference, right side becomes +, and K now wants to return to the negative left side

Other animations of development of membrane potential and the equilibrium potential (use these from your computer)

1. http://www.sinauer.com/cogneuro/animation_page.html?file=cogneuro_0A02.swf&TB_iframe=true&height=450&width=450
2. http://bcs.whfreeman.com/thelifewire/content/chp44/4401s.swf Click on "Animation," and then "Narrated." Note that there is an error here as they use "diffusional force" but remember that diffusion is due to three forces: the force due to the chemical or concentration gradient, the electrical force and the force due to convection (a solvent drags the ion along- ignored here). So, instead of "diffusional force," they should use "chemical or concentration force." Also, note that there is a quiz on this web site. However, the last question notes a correct answer that is incorrect. The negative membrane potential is mostly due to the K ion efflux from the cell; the contribution of the negative ions (protein, chloride) is called a Donnan potential and is relatively small.
3. In another animation, http://courses.washington.edu/conj/membpot/changepotential.htm, the author shows that the most permeant ion determines the membrane potential. In a resting cell, K is the most permeant so its movement out of the cell is largely responsible for setting the membrane potential (say, -60 mV) near the equilibrium potential for K (around -90 mV). But, open a sodium channel and the membrane potential goes toward the equilibrium potential for sodium (around +20 mV). Or open a chloride channel, and the membrane potential goes toward the equilibrium potential for chloride.
4. http://courses.washington.edu/conj/membpot/equilpot.htm.