PSYC 460 -- Dr. King

Clarification of "Equilibrium"

Point 1) Begin by thinking that Na+ doesn't much care what K+ or Cl- is doing, etc. As far as diffusion is concerned, this is true. As far as the electric (electrostatic) force is concerned, it is not. A positive charge is a positive charge, and it doesn't matter who's carrying it.

Point 2) For every ion there is a membrane potential at which it would be at equilibrium. I.e., diffusion and electrostatic force are in balance with each other. This is called its equilibrium potential. It depends on concentration inside and outside the membrane (determining how much "diffusion pressure" there is), and it's charge (determining how it reacts to the electric field across the membrane).

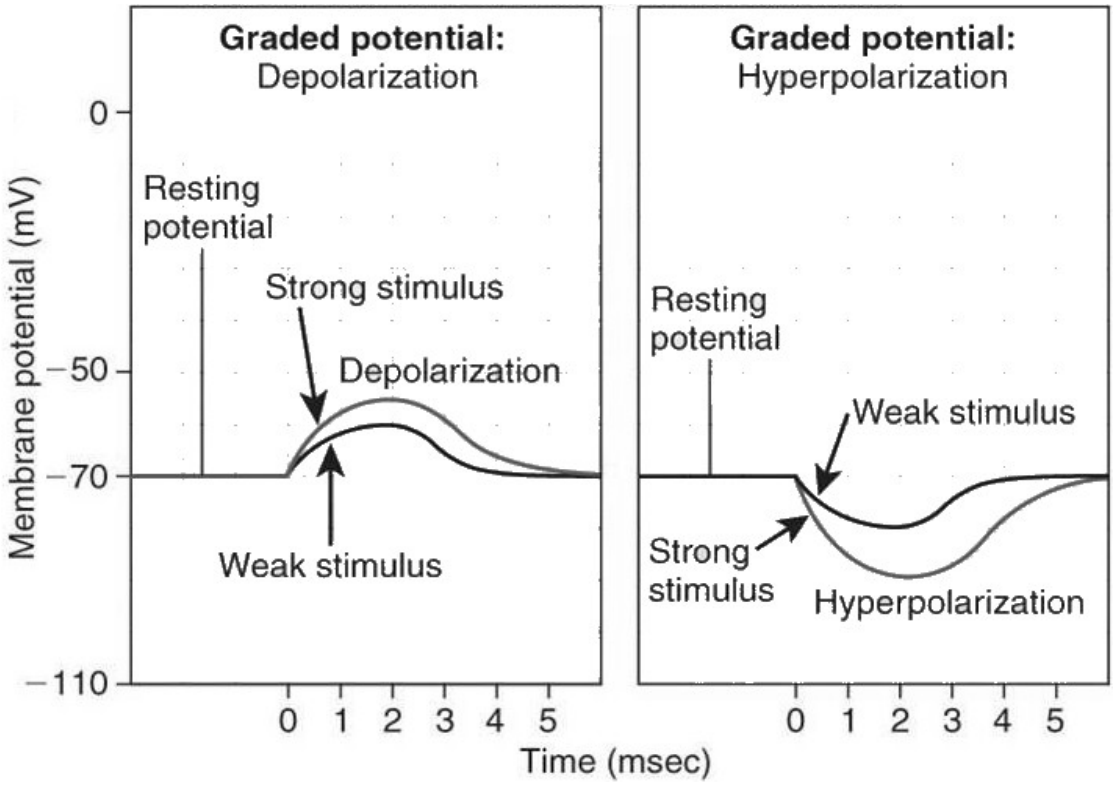
Point 3) Ions "want" to move in such a way that they make the membrane potential the same as their equilibrium potential. (Note: Positive ions move in to make the membrane more positive inside and move out to make the make the membrane more negative inside. Negative ions do the reverse.)

Point 4) For any ion, the equilibrium potential can be calculated using the Nernst equation, *which you do not need to memorize or know how to use!*

$$E = \frac{RT}{zF} \ln \frac{[\text{ion outside cell}]}{[\text{ion inside cell}]} = 2.303 \frac{RT}{zF} \log_{10} \frac{[\text{ion outside cell}]}{[\text{ion inside cell}]}.$$

Point 5) The resting membrane potential is about -70mV, negative inside the cell membrane.

Point 6) Depolarization vs. Hyperpolarization.



Point 7) The case for chlorine ions or chloride, Cl-.

a) equilibrium potential = -70mV
b) chloride is at equilibrium when the membrane is at resting potential - no net movement
c) if the membrane depolarizes, Cl- will tend to move into the cell, which will bring the membrane back to resting potential
d) if the membrane hyperpolarizes, Cl- will tend to move out of the cell, which will bring the membrane back to resting potential
e) chloride ions "want" the membrane stabilized at the resting potential

Point 8) The case for potassium ions, K+.

a) equilibrium potential = -90mV
b) K+ is out of equilibrium when the membrane is at resting potential - it "wants" to move out
c) if given the chance, K+ will move out of the cell, making the inside of the cell more negative, until its equilibrium potential of -90mV is reached - hyperpolarization
d) potassium ions "want" to hyperpolarize the membrane

Point 9) The case for sodium ions, Na+.

a) equilibrium potential = +55mV
b) Na+ is WAY out of equilibrium when the membrane is at resting potential - it "want's to move in
c) if give the chance, Na+ will move into the cell, making the inside of the cell more positive, until its equilibrium potential of +55mV is reached - depolarization
d) sodium ions "want" to depolarize the membrane