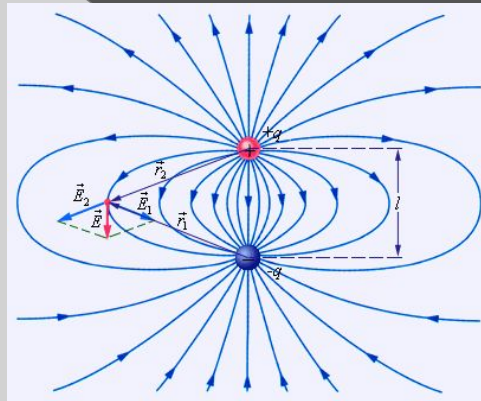


ELECTRICAL POTENTIALS OF THE CELL

Electric field. Coulomb's law.

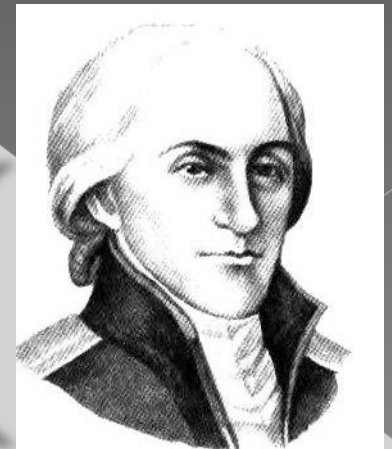
Electric field is the kind of matter by means of which the charged objects interact with each other.



Coulomb law defines the value of electric force F acting between the two electric charges q_1 and q_2

Here k is the constant determined by the measure units chosen and r is the distance between the charges.

$$F = k \cdot \frac{q_1 \cdot q_2}{r^2}$$

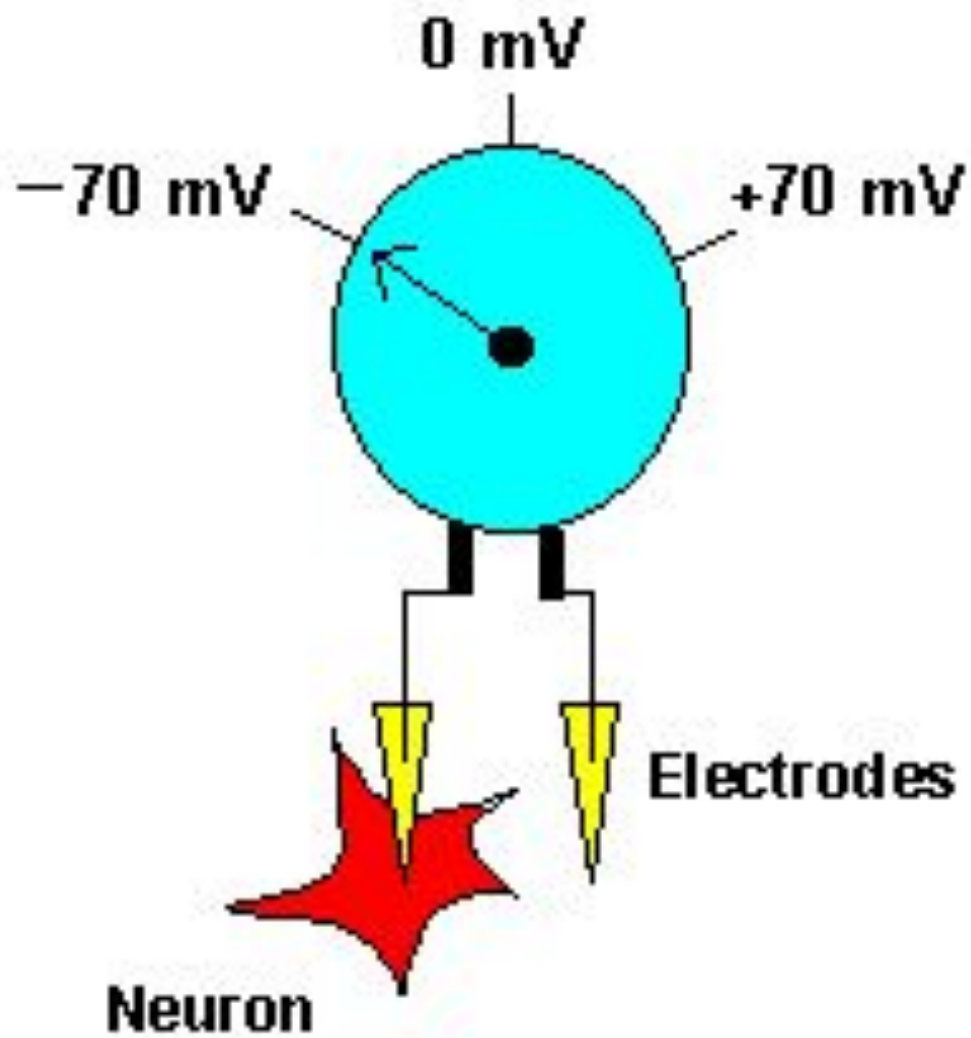


The electric field intensity E at any point is defined as the electric force F that would be exerted on the unit positive charge q placed at this point

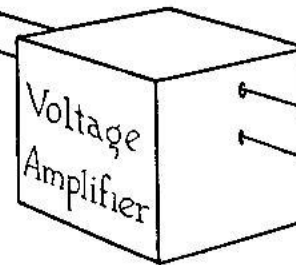
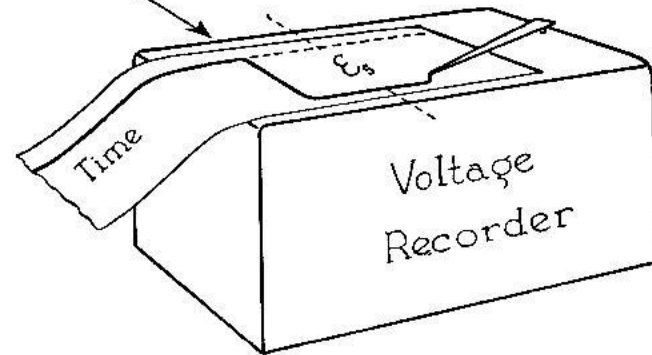
$$E = \frac{F}{q}$$

The electric potential ϕ (voltage) at any point equals the electrostatic potential energy W_p that the unit positive charge q would have at this point

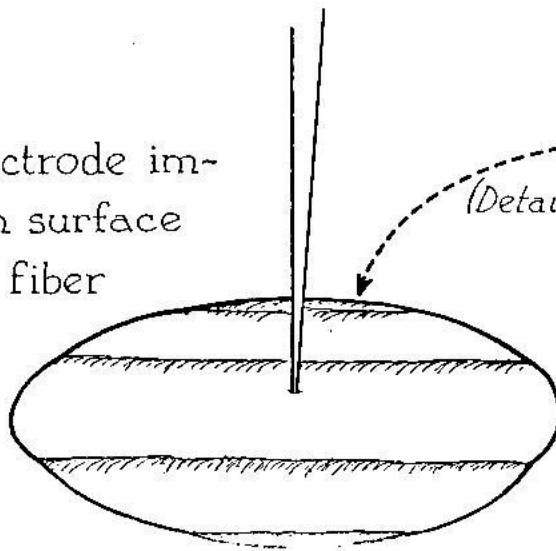
$$\phi = \frac{W_p}{q}$$



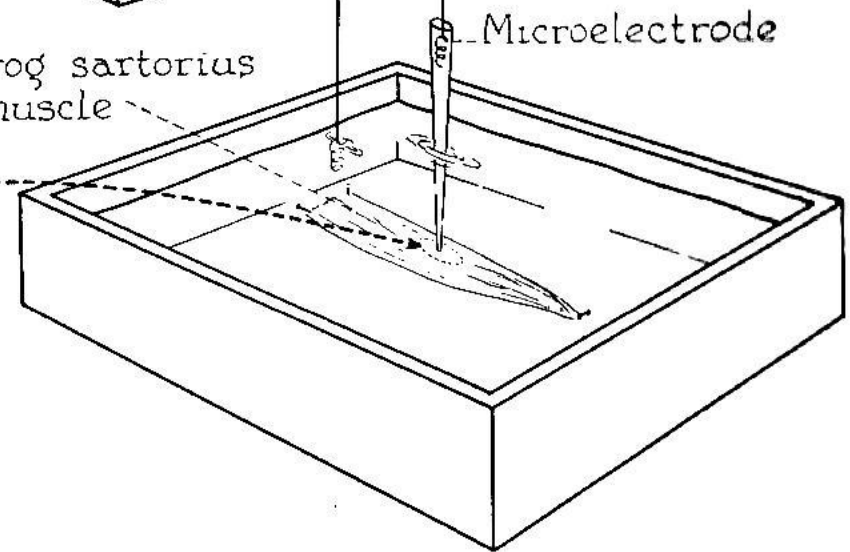
Cell impaled

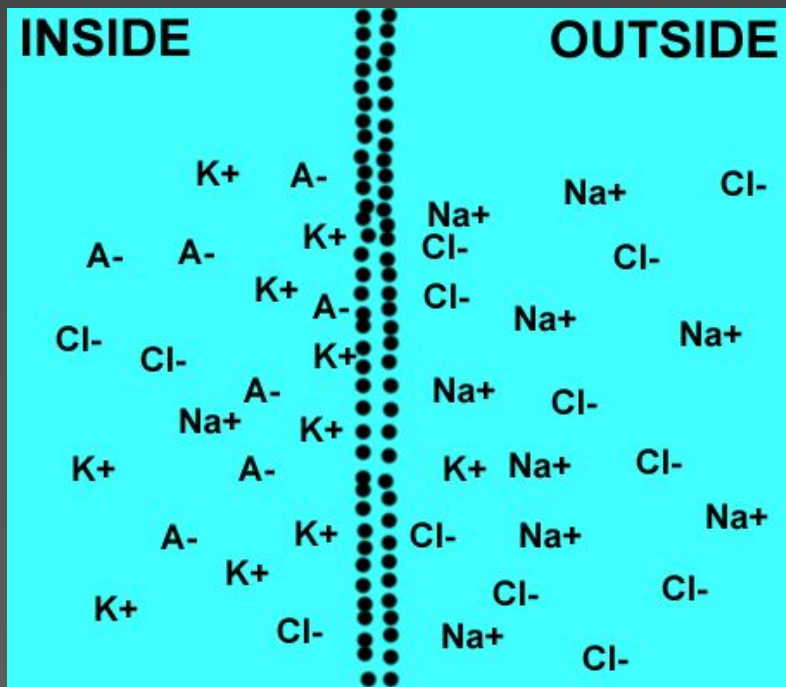
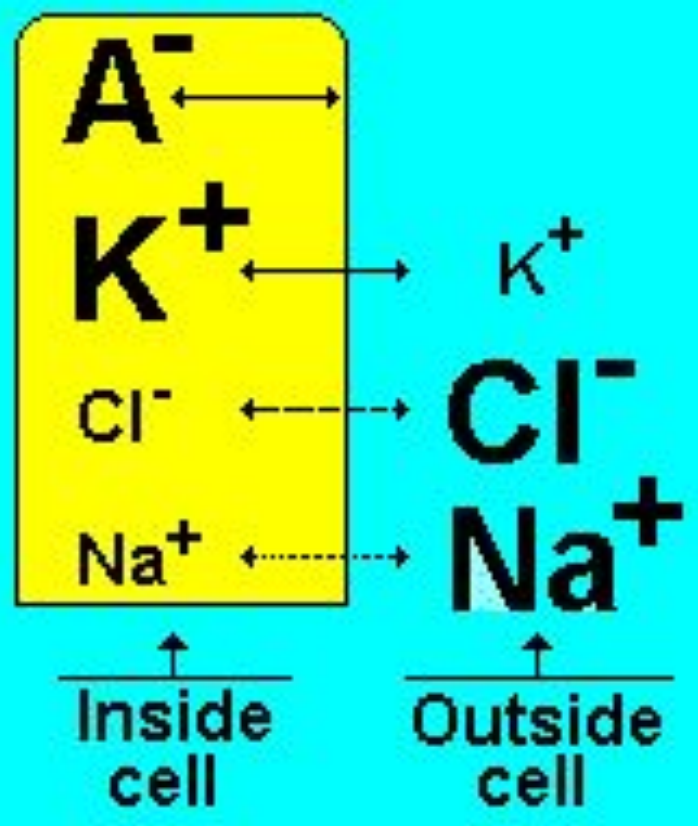


Microelectrode im-
paled in surface
muscle fiber



Frog sartorius
muscle





**With no channels,
there is no diffusion force.**

Kind of ions		Cell protoplasm	Extracellular fluid
Cations	Sodium	12	145
	Potassium	155	4
	Others	-	5
Anions	Chloride	4	120
	Bicarbonate	8	27
	Others (A^-)	155	7

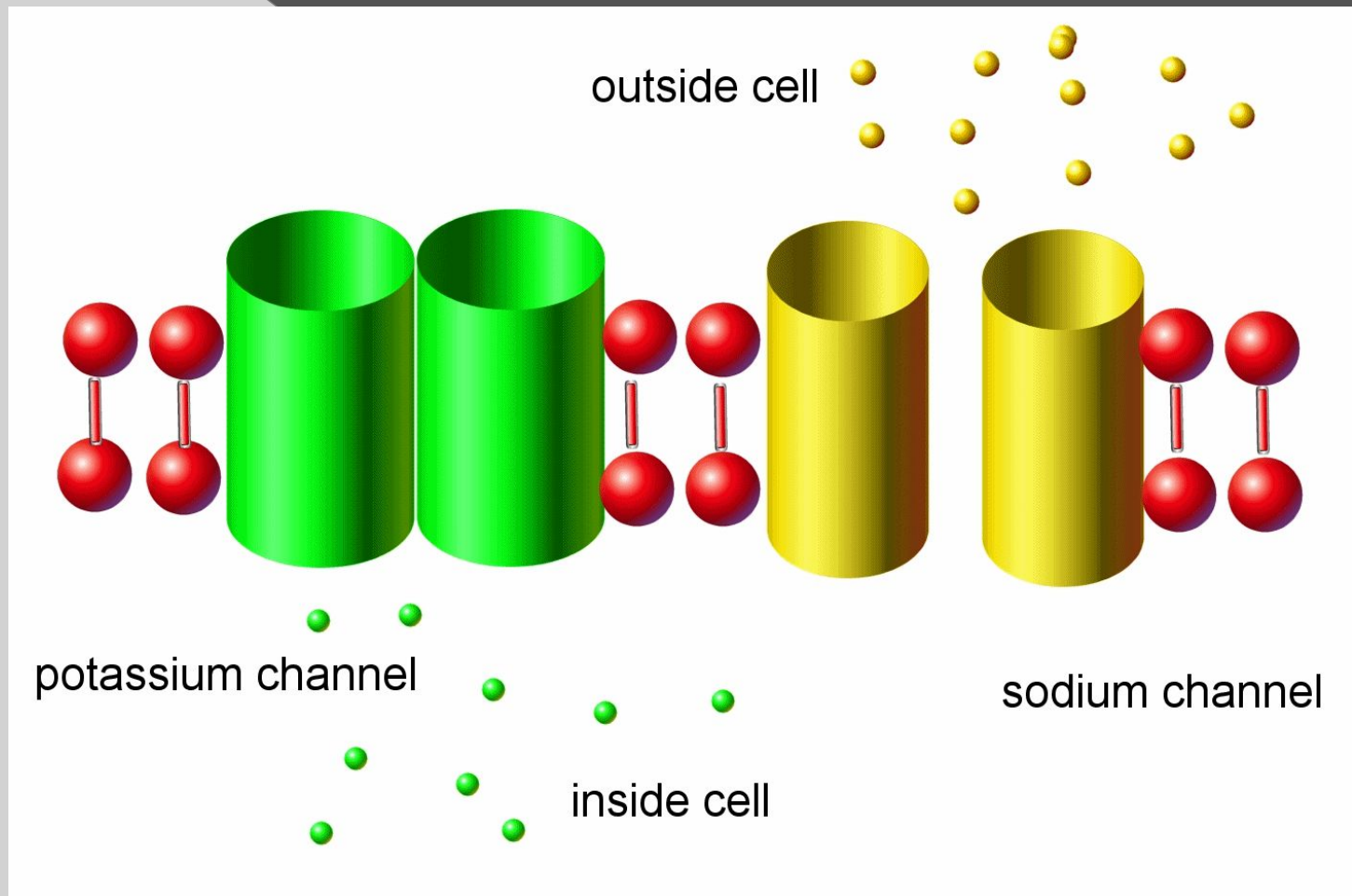
$$E = - \frac{RT}{zF} \ln \frac{P_K [K^+]_i + P_{Na} [Na^+]_i + P_{Cl} [Cl^-]_o}{P_K [K^+]_o + P_{Na} [Na^+]_o + P_{Cl} [Cl^-]_i}$$

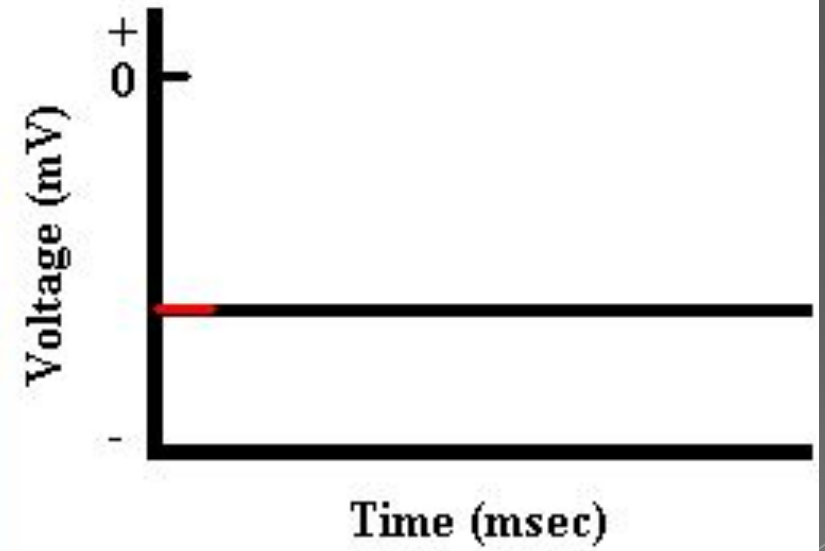
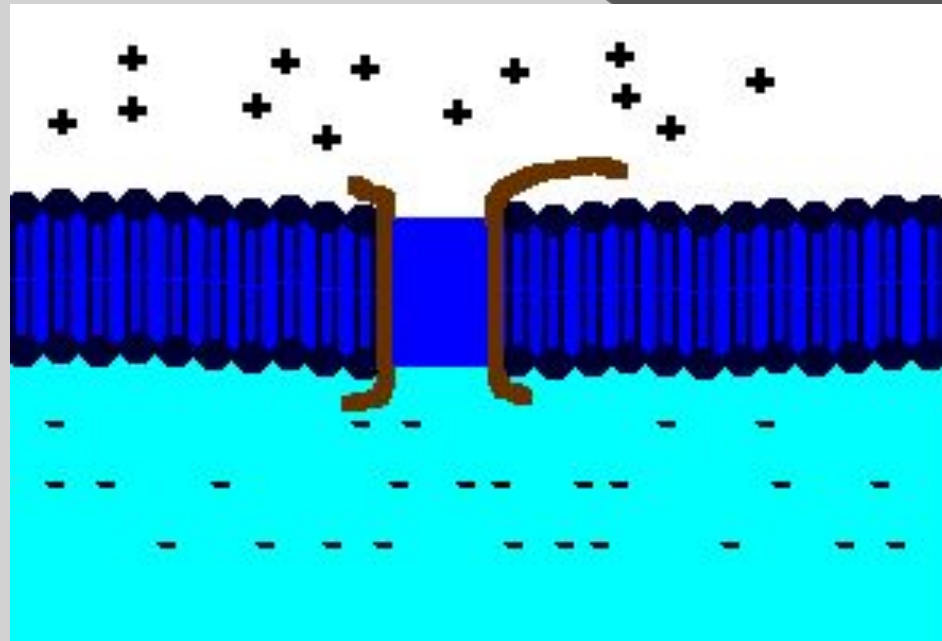
Goldman-Hogkin equation for membrane potential

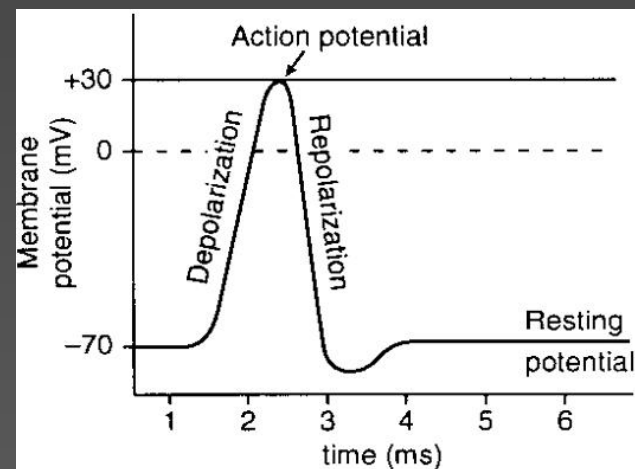
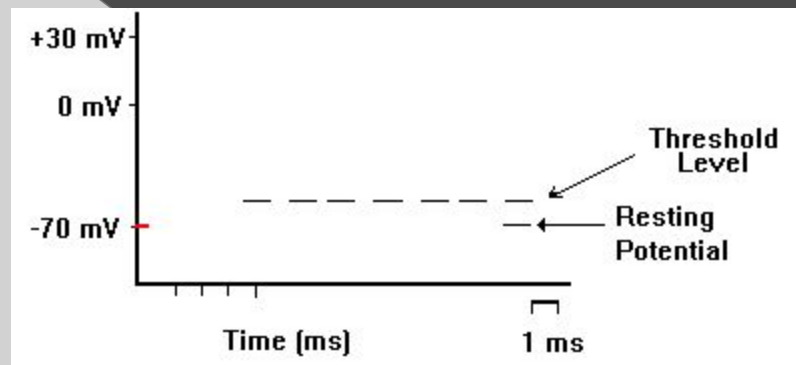
Nernst equation for membrane potential

$$E = - \frac{RT}{zF} \ln \frac{[K^+]_i}{[K^+]_o}$$

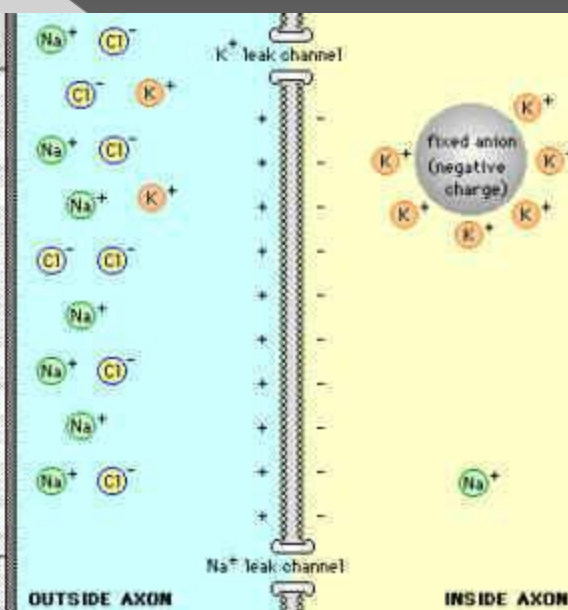
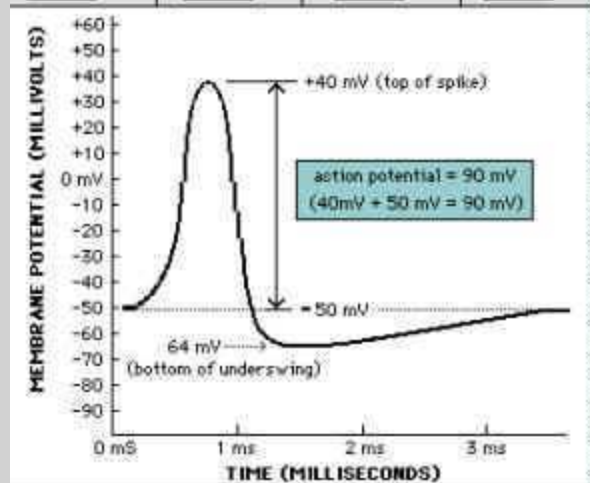
$$E_m = \frac{RT}{zF} \ln \left(\frac{P_K[K^+]_{\text{out}} + P_{\text{Na}}[\text{Na}^+]_{\text{out}} + P_{\text{Cl}}[\text{Cl}^-]_{\text{in}}}{P_K[K^+]_{\text{in}} + P_{\text{Na}}[\text{Na}^+]_{\text{in}} + P_{\text{Cl}}[\text{Cl}^-]_{\text{out}}} \right)$$

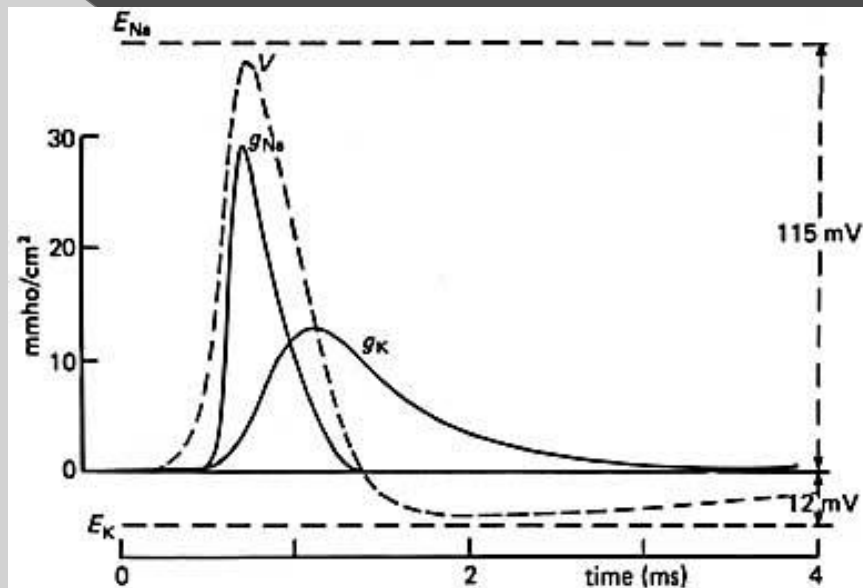






resting potential	top of spike	action potential	underswing
-50 mV	+40 mV	90 mV	-64 mV





Sodium/Potassium Neuronal Membrane Permeability

