MEMBRANE POTENTIAL

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MEMBRANE POTENTIAL

- Electrical potential which exists across cell membrane
- Types
  - Resting Membrane Potential
  - Action potential
  - Electrotonic potential

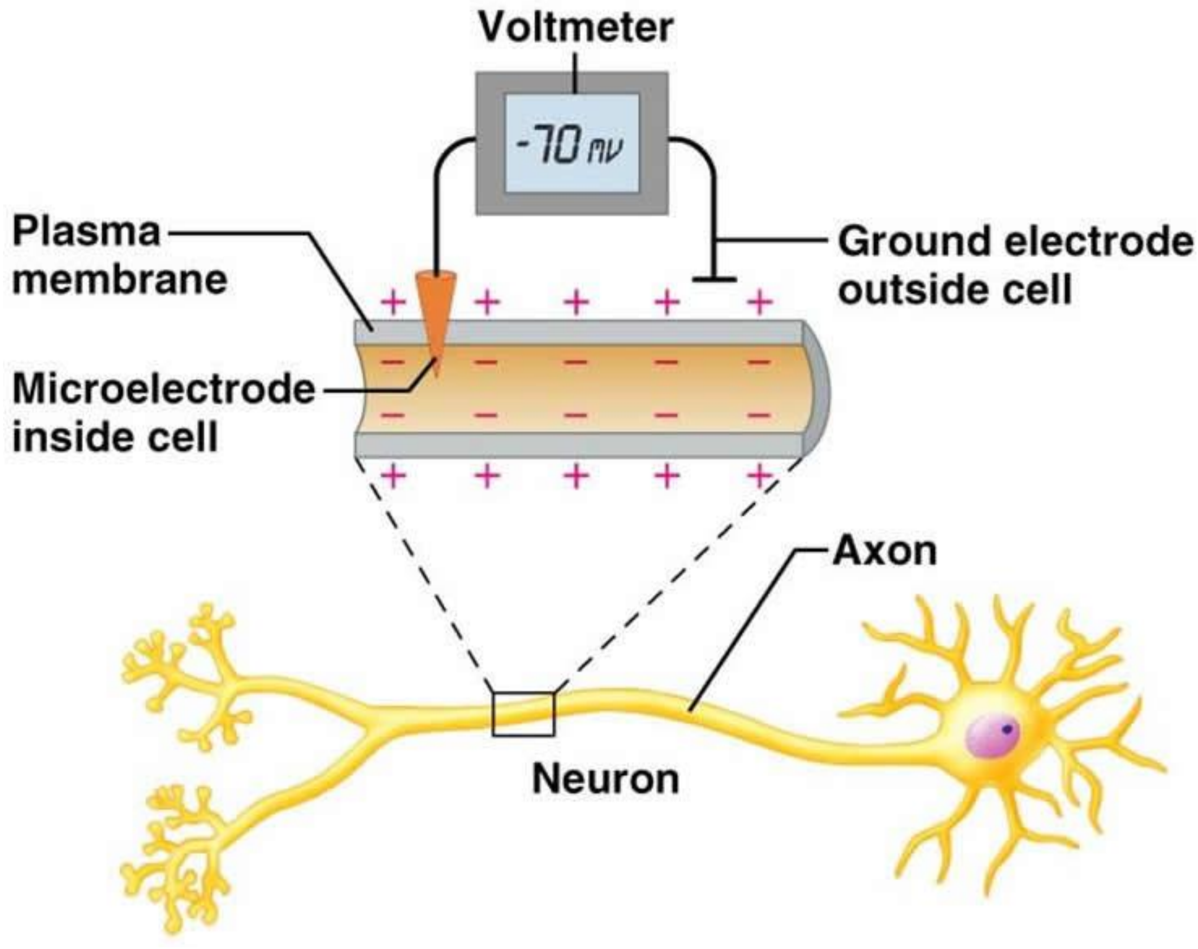
RESTING MEMBRANE POTENTIAL

- Membrane potential which exists across the cell membrane under resting condition with inside of the cell negatively charged with respect to outside
- By convention ECF is assigned a voltage of zero and the polarity (positive or negative) of the membrane potential is stated in terms of excess charge on inside of the cell

RESTING MEMBRANE POTENTIAL

- Magnitude varies in different cells
- RMP of neuron -70mV
- ie, ICF has an excess of negative charge and the potential difference across the membrane has a magnitude of 70mV

RESTING MEMBRANE POTENTIAL



FACTORS CONTRIBUTING TO RMP

- **2 Major factors**
- 1. Selective permeability of cell membrane & and diffusion of ion across the membrane, along the concentration gradient.
- 2. Sodium Potassium ATPase pump

SELECTIVE PERMEABILITY OF MEMBRANE

- Diffusion of ions along the concentration gradient
- Gibbs- Donnan Membrane Equilibrium
- Nernst Equation
- Goldmann Constant Field Equation

How concentration gradient creates membrane potential?

INSIDE	OUTSIDE
K	

DISTRIBUTION OF MAJOR IONS ACROSS PLASMA MEMBRANE

Ion	Concentration (mM)	
	Inside	Outside
Na^+	15	150
K^+	150	5.5
Cl^-	9	125

+ ZOOM

MAGNITUDE OF RMP

- Determined by
- 1. Difference in specific ionic conc. in ECF & ICF
- 2. Difference in membrane permeability to different ions

GIBBS- DONNAN EQUILIBRIUM

- Explain how uneven distribution of ions is maintained under resting condition
- Gives conc. of various ions and substance across semi permeable membrane

GIBBS- DONNAN EQUILIBRIUM

- When there is an ion on one side of the membrane that cannot diffuse through the membrane, the distribution of ions to which membrane is affected in a predictable way

- For e.g., the negative charge of a non diffusible anion hinders diffusion of diffusible cation & favors diffusion of diffusible anion

GIBBS- DONNAN EQUILIBRIUM

x	y
K+	K+
Cl- Prot-	Cl-

GIBBS- DONNAN EQUILIBRIUM

- $[K^+ x] > [K^+ Y]$
- $[K^+ x] + [Cl^- X] + [Prot^- X] >$

  $[K^+ Y] + [Cl^- Y]$

$$\frac{[K^+ x]}{[K^+ Y]} = \frac{[Cl^- Y]}{[Cl^- X]}$$

- [K^+ x]

How concentration difference produce membrane potentials?

Inside	outside
K	k
Na	Na

NERNST POTENTIAL

- Diffusion potential level across a membrane that exactly opposes the net diffusion of a particular ion through the membrane is called Nernst potential
- Equilibrium potential for any ion - that is, electrical potential necessary to balance a given ion concentrations gradient across a membrane so that net flux of ion is zero

NERNST POTENTIAL

Nernst equation

$$E = -\frac{RT}{zF} \ln \frac{[ion]_{in}}{[ion]_{out}}$$

for a monovalent ion
at 37oC

$$E = -61.5 \log \frac{[ion]_{in}}{[ion]_{out}}$$

GOLDMAN – KATZ EQUATION

$$V_{\mathrm{m}} = \frac{RT}{F} \ln\left(\frac{p_{\mathrm{K}}[\mathrm{K}^+]_{\mathrm{o}} + p_{\mathrm{Na}}[\mathrm{Na}^+]_{\mathrm{o}} + p_{\mathrm{Cl}}[\mathrm{Cl}^-]_{\mathrm{i}}}{p_{\mathrm{K}}[\mathrm{K}^+]_{\mathrm{i}} + p_{\mathrm{Na}}[\mathrm{Na}^+]_{\mathrm{i}} + p_{\mathrm{Cl}}[\mathrm{Cl}^-]_{\mathrm{o}}} \right)$$