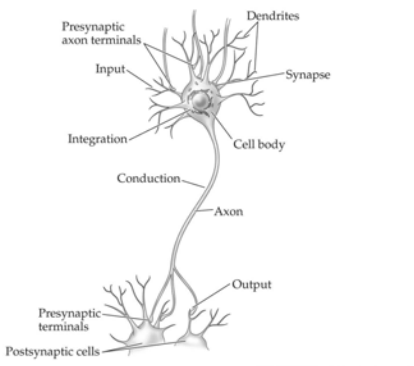
Electrophysiology and neurotransmission

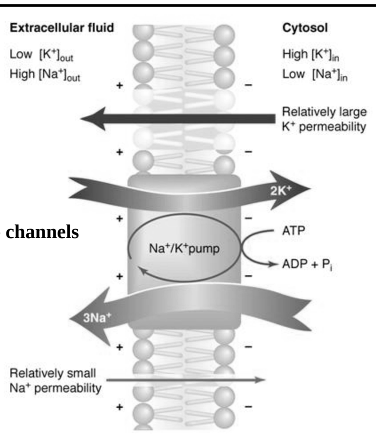
- *State how movement of Na^{+}, K^{+}, Ca^{2+} or Cl^{-} across a cell membrane will affect membrane potential.*
- *Explain the ionic basis for the resting membrane potential.*
- *Diagram a neuron and identify specialization.*
- *Describe the ionic basic for a graded potential,, EPSP, IPSP and action potential.*

Neuron basic structure and cell specializations



Maintenance of ion distributions by

Na+/K+ ATPase
leaky K+ channels
leaky Na+,Ca+,Cl- channels



There are two primary determinants of the resting membrane potential.

1. Concentration of ions inside and outside the cell.
2. Permeability of the membrane to these ions.

- Inside the neuron is high in K^+ and low in Na^+.
- Outside the neuron it's opposite, high in Na^+, low in K^+.
- At rest, the permeability of the membrane is high for K^+ and very low for Na^+ and Cl^-.

For the moment we will assume that the permeability of the membrane to Na^+ and Cl^- is **zero.**

Membrane potential would be = E_{K+}

K^+ is the most permeable to a cell membrane,but the Na^+, Ca^{++}, Mg^{++} and Cl^- permeability is actually **not zero.**

Use **Goldman-Hodkin-Katz equation** to calculate membrane potential based on permeabilities of multiple ions.

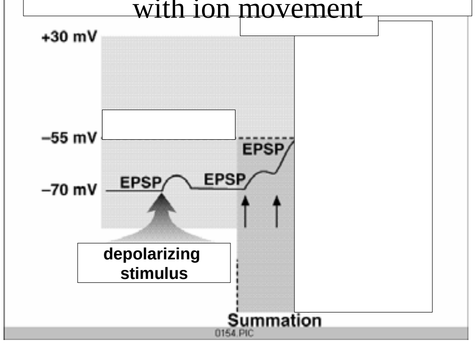
$$V_m = \frac{RT}{F} \log \frac{P_K[K^+]_{out} + P_{Na}[Na^+]_{out} + P_{Cl}[Cl^-]_{in}}{P_K[K^+]_{in} + P_{Na}[Na^+]_{in} + P_{Cl}[Cl^-]_{out}}$$

$$V_m = \frac{RT}{F} \log \frac{1[K^+]_{out} + 0.01[Na^+]_{out}}{1[K^+]_{in} + 0.01[Na^+]_{in}}$$

$$V_m = 60 \log \frac{5 + (0.01 \times 145)}{150 + (0.01 \times 15)}$$

= - 82 mV

Membrane potential changes with ion movement



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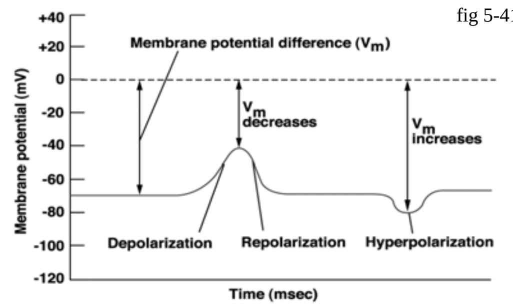
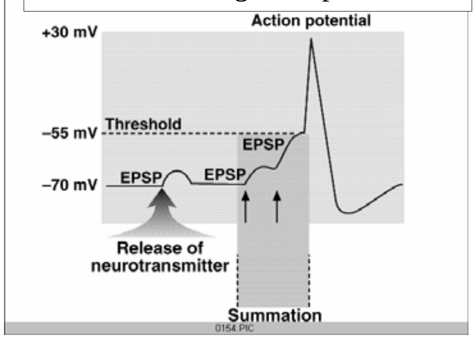
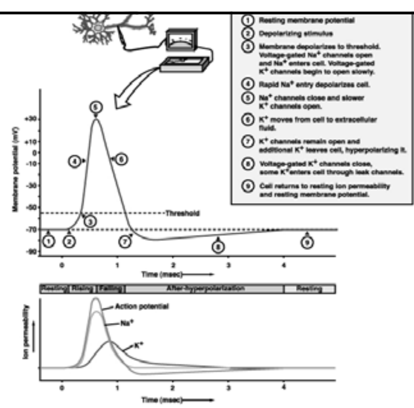


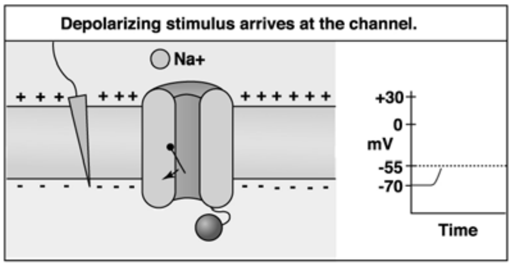
- Depolarization: ↓ Vm, ICF becomes more positive
- Repolarization: return to resting membrane potential
- Hyperpolarization: ↑ Vm; ICF becomes more negative

Summation of graded potentials



Graded potential changes *can* cause action potential





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