Cell Volume Control and Electrical Properties of Cell Membranes


Cell Physiology
- Cells are semipermeable
- Ions and molecules apply pressure on the cell depending on their concentrations
- Cell volume assumed to be constant
- Main ions present: Na⁺, K⁺, Cl⁻

Interaction of Electrical and Osmotic Effects
- Electrical effect of trapped charged molecules creates osmotic effects
- Positive charges balance out negative charges
- Large negative charges more impactful than direct osmotic effect
- Capacitance, flux of ions in cell assumed to be 0

Ion Movement across the Membrane
- Ionic current across membrane creates voltage
- Ion diffusion facilitated by ion pumps
- Na⁺ pumped out/K⁺ pumped in to maintain cell volume

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- Electrical effect of trapped charged molecules creates osmotic effects
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Overall Effect of Direct and Indirect Osmotic Pressure

Hodgkin-Huxley Equation: Nerve Action Potential
- Neurons change membrane conductances of Na⁺ and K⁺ creating pulse shaped potentials known as action potentials

Hodgkin-Huxley Postulates

Potassium Channels
- K⁺ channel has 4 gates, open or closed
  - Gates are identical
  - Gates operate independently
  - Rate constant for opening/closing is a function of voltage

Sodium Channels
- Each Na⁺ gate open or closed
  - 4 gates not identical and two different types
  - M gates open in response to increasing voltage
  - H gates close in response to increasing voltage

References

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Potentialities, g, are affected by membrane potential as the Hodgkin-Huxley m-, h-, and n-gates open and close

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