I. Membrane Structure and Function
- A. Lipid structures
  1. Phospholipids
  2. Sterols
  3. Proteins

The physical concept of hydrophobicity was explored by example, including predictive models and experimental descriptions of protein structure in membranes.
- B. Fluidity

The interplay between temperature and fludity was explored from experimental examples.

II. Molecular Motion
- A. Diffusion
  1. Einstein's explanation of Brownian motion
  2. Membrane partitioning

Einstein's explanation was the starting point of a mathematical description of the flux of neutral solutes, in solution (Fick's equations) and across membranes.

II. Diffusive and Advective Transport
- A. Time dependence of diffusion
  1. Long-distance transport
  2. Limitations of cell size
- B. Volvox as a model system
  1. Flagellar-mediated advective flow
  2. Advective contributions to transport

Diffusion alone is not sufficient. Mixing by advective transport is crucial, but does not lend itself to simple mathematical analysis. Recent research on multi-cellular Volvox colonies demonstrate its importance in a relatively easily modeled system.

IV. Gramicidin Channel
- A. Historical
  1. Antibiotic
  2. Bioenergetics
- B. Channel properties
  1. Current-voltage relations
  2. Ionic motion
  3. Ion properties, permeability and conductance

We explored the underlying causes of the flux of charged ions, in solution and across membranes (Goldman equation), including a physical explanation of Stoke's radius, all important to the understanding of ion flux through channels.

V. Potassium Channel
- A. Channel structure and the mechanism of selectivity

The concepts of ion selectivity rely heavily on an understanding of the remarkable energetics and steric nature of ionic hydration.

VI. Arsenate transport
- A. Historical and environmental overview of arsenicals
  - 1. Chemistry and redox properties
  - 2. Toxicology
- B. ATPase and channel mediated arsenic extrusion
  - 1. ars operon of E. coli
  - 2. other transport mechanisms

We explored the bioenergetics of oxidative phosphorylation, using the bacterial system as an experimental tool to assess the driving forces for arsenic extrusion.

VII. Spider Venom
- A. Mechanosensitive Channels
  - 1. Methods of measurement (patch clamp)
- B. Biological examples of mechanosensation
  - 1. Hypoosmotic downshock
    - a. pressure-volume relations
  - 2. *Eschericia coli* mechanosensitive channels: cloning and phenotype
  - 3. Mechanosensitive channels in cellular growth
- C. Spider Venom (GsMTx4)
  - 1. Mechanism of action: Membrane disruption

The discovery of the specific inhibitor of mechanosensitive channels, GsMTx4 from Tarantula spiders presages a new era of discovery, unraveling the divers roles of mechanosensitive channels.

VII. Olfaction
- A. Overview of environmental sensing
- B. Insects as a model system
- C. CO_2-sensing

Receptor-transduction-outcome pathways were explored using insect sensilla as an example, with emphasis on the experimental techniques – electrophysiology, oocyte expression, and patch clamp– used to characterize the complete system.

VIII. Light-activated channels
- A. Introduction to algal vision
  - 1. Phototactic responses
  - 2. Ultrastructure and photobiological properties
- B. Bacteriorhodopsin
  - 1. Identification of putative channels by heterologous expression and analysis in Xenopus laevis
- C. A working model of vision and signal transduction in a protist

The integration of ion transport to create a system of vision and response.

Assignments and Grading:

Three term assignments (short work problems):	30% (10% each)
Two term tests:	50% (lowest, 10%; highest, 40%)
Final exam:	20%

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10 December 2007