

FALL 2006 – TENTATIVE COURSE OUTLINE

ABE 591T Introduction to Biophysics (3 credits)

Instructor: Dr. Joseph Irudayaraj
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Course Objectives

- Understand the concepts behind forces that drive atoms and molecules
- Develop quantification skills in describing molecular motion and interaction
- Learn to apply the concepts and methodologies to solve problems in Biology and Chemistry

Text: Molecular Driving Forces by Ken Dill and Sarina Bromberg (Taylor and Francis Group)

Grading: Homework (30%), Mid-term Exam (15%), Research paper (15%), Final Project and Presentation (40%)

Tentative Outline: Each topic is dealt with at an introductory level with sufficient examples from the literature as well as from problems in the text. Homeworks will ensure that the concepts learnt are applied to solving problems that are practical, realistic, and interesting (may be!)

Module 1: Basics of Heat, work, and energy, Entropy, heat capacity

- Heat flow, conservation laws, energy of atoms and molecules

Module 2: Thermodynamic driving forces, Free energies, Maxwell's relations

- Thermodynamic dynamic forces, thermal, mechanical, and chemical equilibria, thermodynamic logic, free energy definition, entropy switching

Module 3: Chemical Equilibria between liquids, solids, and gases; Solvation and transfer of molecules between phases

- Equilibria of atomic structures, temperature dependence of equilibrium. Chemical potential, solvation, transfer in solution, dimerization in solution

Module 4: Physical kinetics, Chemical kinetics and transitions to understand the dynamic diffusion process

- Forces that cause molecules to flow, Linear laws, Source and sink, Einstein-Smoluchowski's eqn., Concepts in fluctuation-Dissipation, Rates and kinetics, Speed of catalysis

Module 5: Electrostatic potential, Electrochemical equilibria

- Electrostatic potential and fields, Dipoles as separated charges, method of image charges, Electrochemical potentials in ionic solutions, Voltage-gated ion channels, Electrostatic gradients and ion flow, Charge shielding

Module 6: Intermolecular interactions

- Short-ranged and long-ranged repulsion and attraction, van der Waals Gas model

Module 7: Adsorption and Binding

- Binding and adsorption processes, saturable processes, Transition stabilization

Module 8: Cooperative ligand binding

- Binding polynomials, Intermediate binding states, Oxygen binding to Hemoglobin, Constructing binding rules and probability

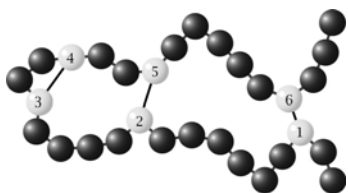
Module 9: Conformations of polymers and biomolecules

- Chain conformation, Conformation via diffusion model, Polymer dynamics, conformation and folding of proteins and DNA

Research Paper: Each student (or a team of 2) will prepare a research paper with a well laid out problem statement, hypothesis, and methodology. Pros and cons of the proposed methodology should be discussed. Students are encouraged to explore the strangest of hypotheses (should be related) [Max 6 pages]

Final Project and Presentation: Teams (2-3 students) will prepare a proposal with a well laid out hypothesis, methods and analysis, and results and discussion. Teams have the flexibility to choose any system they deem appropriate (or from their field of research – to make it easier). A 15 minute presentation (**or** a class poster session) is required. Final project report is due on the last day of class

Prerequisites: Graduate or senior standing in Sciences/Engineering or consent of the Instructor



For details please contact Dr. Irudayaraj at josephi@purdue.edu