

PHY2707 Cellular and Molecular Biophysics I

Course description:

This course investigates the physical properties of biomolecules with emphasis on principles of equilibrium and non-equilibrium thermodynamics and statistical mechanics that can be used to describe quantitatively biological structure and function. Through rigorously introduced new concepts and theories, and an extensive use of examples from literature, students will gain an understanding of the general importance and broad applicability of Physical Laws to life sciences. Student participation includes reading and preparing papers assigned for discussion in each lecture.

Specific topics will vary and may include:

- Molecular associations: statistical mechanics of associations, ligand binding, allosteric interactions; MWC, KNF and SK models; hemoglobin, GPCRs, allosteric enzymes [CG]
- Fundamental rate processes: exponential relaxations, activation energy, Kramers' theory for barrier crossing, single-molecule kinetics [CG]
- Association kinetics: diffusion limit, ligand-binding to proteins, DNA and membrane receptors, reduction of dimensionality [CG]
- Multi-state kinetics: 3-state model, separation of time-scales, pathway counting, multi-subunit kinetics [AH]
- Random walks: diffusion, "stretched kinetics", detailed balance, fluctuation-dissipation theorem [AH]
- Fluctuations in biology: breaking of thermodynamic equilibrium, linear noise approximation, models of gene expression noise, fundamental limits on stochastic control [AH]

Prerequisites:

There are no particular prerequisites other than basic undergraduate physics, chemistry and mathematics courses.

Textbook:

"Molecular and Cellular Biophysics" by Meyer Jackson

Grading scheme:

Class participation: 10% (Students are required to read assigned papers to be discussed in lectures.

Submitting a critical 1-page discussion of the respective paper will be required 24h before each class.)

Assignments: 30% (Three equally weighted homework assignments.)

Research Paper Report & Presentation: 20%

Final Exam: 40%

Time/place:

Lectures: Thursday 1pm – 3pm MP505

Office hours: Thursday, 3pm-4pm, MP313