**PH 525: Biological Physics (3-0-0: 3)**

**Physical Biology**

Physical biology of the cell, the stuff of life: four great classes of macromolecules, different physical models in biology, quantitative models and the power of idealization: springiness of stuff, the unifying ideas of biology, mathematical toolkit, biology by the numbers, cells and their contents: an ode to E. Coli, cells and structures within them. **[7L]**

**Thermodynamics of Living Systems**

Energy and the life of cells, equilibrium models: proteins in equilibrium, cells in equilibrium, minimizing the potential energy, the mathematics of superlatives, Hooke’s law: actin to lipids, entropy and hydrophobicity, gibbs and the calculus of equilibrium, an ode to ΔG, the statistical mechanics of gene expression, Boltzmann distribution & entropy, osmotic pressure & forces: interstrand interactions of DNA, law of mass action, applications of the calculus of equilibrium, random walks and structure of macromolecules, DNA as a random chain, single molecule mechanics.

**[8L]**

**Dynamics of Biomolecules**

The mathematics of water: water as a continuum, F=ma for fluids, the Newtonian fluid and the Navier–Stokes equations, fluid dynamics of blood, life at low eynold’s number, diffusion in the cell, diffusive dynamics: Fick’s law, the Smoluchowski equation, the Einstein relation, biological statistical dynamics, molecular motors, translational motors: myosin, biased random walk. **[8L]**

**Biological Electricity & Quantum Biology**

The charge on DNA and proteins, electrostatics for salty solutions: the charged life of a protein, Poisson–Boltzmann equation, viruses as charged spheres, the role of electricity in cells, the charge state of the cell, the action potential, quantum mechanics for biology: photosynthesis, the particle in a box model, bioenergetics of photosynthesis, vision: microbial phototaxis and manipulating cells with light, relationship between eye geometry and resolution, photoreceptor cell. **[8L]**

**Physical Methods in Biology and Medicine**

X-ray crystallography, fluorescence spectroscopy, electron microscopy, nuclear magnetic resonance, atomic force microscopy, tomography, sonograms, radiation therapy, pacemakers. **[5L]**

**Text Books & References**

1. P. Nelson, “Biological Physics: Energy, Information, Life”, W. H. Freeman.
2. R. Cotterill, “Biophysics: An Introduction”, Willey.
3. R. Glaser, “Biophysics”, Springer.
4. R. Nossal and H. Lecar, “Molecular & Cell Biophysics”, Addison-Wesley.
5. C. R. Cantor and P. R. Schimmel, “Biophysical Chemistry: vol. I, II & III”, W. H. Freeman.