LS 405: CHEMISTRY OF BIOMOLECULES (credit: 02)
(Being merged with Biochemistry)

Prof. Sneha Sudha Komath* & Dr. Karunakar Kar

Course Objectives **Credit: 02**

Biological systems are guided by the same rules that govern chemical processes making it important for students of life sciences to develop an appreciation of the chemistry of biomolecular interactions. Providing a good grounding in the basics of biophysical chemistry, organic reaction mechanisms and bioinorganic chemistry is essential. This course is designed to introduce perspectives of chemistry in the study of biomolecules for students of Life Sciences at the Masters-level. An elementary knowledge of chemistry is presumed for students starting this course.

S. no.	Topic	Name of the Faculty	No. of lectures
1	***Equilibrium Thermodynamics:*** Energy and its importance for all processes. The relevance of thermodynamics in the study of biological processes. Some basic concepts: defining a system, universe, state functions and path functions and their significance for understanding biological processes. The first law of thermodynamics. Work done and the concept of enthalpy in chemical reactions. Specific heats and their significance.		1
2	Application of Hess' law to biologically relevant chemical reactions. Predicting which way is downhill and the concept of entropy of a system. Understanding what is free about free energy. Gibbs energy and its relationship with enthalpy and entropy of a system. The biochemical standard state. Coupled biochemical reactions.		1
3	Reversible reactions at equilibrium. The equilibrium constant. Relationship between standard state Gibbs energy and equilibrium constant. Temperature dependence of the equilibrium constant and van't Hoff equation.		**1**
4	Understanding different types of chemical equilibria. Ligand binding to macromolecules. The binding constant. The binding equation and different ways of analyzing binding data. Ionic product of water. Acid-base equilibria.		1
5	Acid-base equilibria and the Henderson and Hasselbach equation. Buffers and their importance. pKa of amino acids and their relevance. Using these concepts in understanding why discontinuous buffer system is used in SDS-PAGE.		1

6	Chemical potential and ionic equilibria. Donnan membrane equilibrium and its significance. Nernst Equation and chemical equilibrium.		1
7	***Kinetics*** Path dependence of kinetics of chemical processes. Activation energy, transition states and intermediates. Rates and rate constants for first order, second order and pseudo first order reactions. Writing rate equations- the differential method and the integration method.		1
8	Half-life of first and second order reactions and their significance. The principle of microscopic reversibility and its relevance. Writing rate equations for reversible reactions. The concept of pre-equilibria versus the steady state approximation.		2
9	***Quantum mechanics and spectroscopy*** Understanding the break between classical and quantum physics. Introduction to the idea of the wave-particle and Schrödinger's equation. Significance of boundary conditions for quantization. The idea of wavefunctions and orbitals. A particle in one and three-dimensional box and its implications for the understanding of the H-atom. Energy and wavefunctions of the H-like atoms. Radial distribution functions. Molecular orbital theory and orbital hybridization. The interaction of light with matter.		6
10	***Physical organic chemistry*** Conjugation, aromaticity and resonance. Inductive effects. Hydrogen bonding. Hydrophobicity.		1
11	***Some important reaction mechanisms in organic chemistry*** S_N1, S_N2, E1, E2, electrophilic addition reactions; Free radical reactions		3
12	Common reaction mechanisms encountered in biological reactions		3
13	***Basic principles of bioinorganic chemistry*** Coordination bonds and metal-ligand interactions. Metalloproteins and metalloenzymes. Role of metal ions in biological electron transfer systems.		4

Suggested Readings:

1) Atkins' Physical Chemistry
2) A guidebook to mechanism in organic chemistry by Peter Sykes
3) Advanced Inorganic Chemistry by Cotton and Wilkinson

Other standard reading material as per requirement will be suggested during classroom discussions.