<table>
<tr><td colspan="3">LS 405A CHEMISTRY OF MACROMOLECULES 2 Credits
Name of the Faculty Member: Prof. Sneha Sudha Komath* & Dr. Karunakar Kar</td></tr>
<tr><td colspan="3">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 biological macromolecules. 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 (upto the higher secondary school level) is presumed for students starting this course.</td></tr>
<tr><th colspan="2">Topics</th><th>Faculty Name/ Contact Hours (Total 28 h)</th></tr>
<tr><td colspan="2">Thermodynamics:</td><td>8 hours</td></tr>
<tr><td rowspan="2">Revisiting basic concepts of thermodynamics:</td><td>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.</td><td>2 (KK)</td></tr>
<tr><td>Predicting which way is downhill and the concept of entropy of a system. Gibbs free energy and its relationship with enthalpy and entropy of a system. Equilibrium and the concept of standard state. Biochemical standard state and the equilibrium constant (K_{eq}).</td><td>2 (KK)</td></tr>
<tr><td rowspan="4">Applications of thermodynamic principles to biological reactions</td><td>Application of Hess' law to biologically relevant chemical reactions. Coupled biochemical reactions.</td><td>1 (KK)</td></tr>
<tr><td>Examples of biochemical equilibria. Ligand binding to biological macromolecules. The association/ dissociation constants and their determination (Scatchard equation).</td><td>1 (KK)</td></tr>
<tr><td>Ionic product of water. Acid-base equilibria and the Henderson-Hasselbach equation. pKa and pI of amino acids and their relevance. Buffers and their importance for biochemistry.</td><td>1 (KK)</td></tr>
<tr><td>Chemical potential and ionic equilibria. Donnan membrane equilibrium and its significance. Nernst Equation and its significance.</td><td>1 (KK)</td></tr>
<tr><td colspan="2">Kinetics</td><td>3 hours</td></tr>
<tr><td rowspan="2">Revisiting basic concepts of kinetics</td><td>Path dependence of kinetics of chemical processes. Activation energy, transition states and intermediates. Rates, rate constants, and rate equations for first order, second order and pseudo first order reactions.</td><td>1 (KK)</td></tr>
<tr><td>Half-life of first and second order reactions and their significance. Rates of reversible reactions and the principle of microscopic reversibility.</td><td>1 (KK)</td></tr>
<tr><td>Application of kinetics to biochemical reactions</td><td>Equilibrium versus the steady state approximation; their applications in enzyme catalyzed reactions.</td><td>1 (KK)</td></tr>
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Quantum mechanics		**9 hours**
A historical introduction to the field	Understanding the break between classical and quantum physics.	**1 (SSK)**
Basic concepts of quantum mechanics	Introduction to the idea of the wave-particle duality and the time-independent Schrödinger's equation.	**1 (SSK)**
	Significance of boundary conditions for the concept of quantization. Wavefunctions and orbitals.	**1 (SSK)**
Applications of quantum theory	A particle in one, two and three-dimensional boxes and its implications for the understanding of the H-atom. Absorption spectra of atoms and molecules using such simple approximations.	**3 (SSK)**
	Energy and wavefunctions of the H-like atoms. Radial distribution functions and shapes of orbitals. Ionic potential and electronegativity.	**3 (SSK)**
Organic chemistry		**5 hours**
Revisiting concepts of physical organic chemistry	Molecular orbitals. Conjugation, aromaticity and resonance. Inductive effects. Hydrogen bonding. Hydrophobicity.	**2 (KK)**
Application of organic chemistry to biology	Substitution (S_N1, S_N2), Elimination (E1, E2), Rearrangement and Addition reactions; Free radical reactions	**2 (KK)**
	Exploring reaction mechanisms in biology	**1 (KK)**
Coordination chemistry		**3 hours**
Revisiting concepts of coordination chemistry	Coordination bonds and metal-ligand interactions; Hard-soft acid-base (HSAB) theory	**1 (SSK)**
Application of coordination chemistry to understand biology	Coordination geometries; Jahn-Teller Distortion; porphyrins as ligands in proteins (hemoglobin, cytochromes)	**1 (SSK)**
	Metal ions in biology	**1 (SSK)**

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.