Sl No	Course code	Name of the courses	Credit
1	PBC	Principles of Biochemistry	6
2	PPC	Principles of Physical Chemistry	6
3	SCB	Structural and Computational Biology	6
4	ALP	Advanced Laboratory Practices	6

Syllabus

Semester I

1. Principles of Biochemistry (PBC)

Basic Biochemistry – Biomolecules in water, protein and carbohydrate (complex) solutions, pH, pK, shifts in pK, enzymes, co-enzymes, vitamins, glycolysis, ATP cycle, TCA cycle, oxidative phosphorylation, biosynthesis / degradation of amino acids & proteins, biosynthesis of lipids and carbohydrates, hormone and growth factors.

Cell as unit, identification, characterisation, function of cellular organelles, Golgi, ER, lysozome, mitochondria, cell-membrane, Cell-cell communication, cell-signalling, basics of immune system.

DNA as the Genetic material, Mutations in the genetic material, Mendelian inheritance, Chromosomal inheritance, Eukaryotic genome organization, Gene, Introns, Repetitive DNA seq, Gene duplication and Pseudogenes, Core Histones and Linker histones, Euchromatin vs. Heterochromatin, DNA methylation, Introduction to epigenetics.

Replication, Transcription and Translation.

Chemical Thermodynamics and its application in Biological Processes (biomolecular recognition, protein folding etc), Use of energy in cellular reactions, Chemical equilibrium and kinetics and its application in biological processes (gene regulation, kinetic proof reading, cancer pathways, enzyme kinetics, biological switch, circadian rhythm), Application of chemical tools in biology.

Diffusion, Osmosis, Osmotic pressure, osmoregulation, surface tension, dialysis, adsorption, viscosity, thermal conduction, colloids, sedimentation.

2. Principles of Physical Chemistry (PPC)

Definition of life from chemical and physical perspective, Basic thermodynamics, chemical equilibrium of reactions in gas & solution phase chemical reaction dynamics (Introduction to reaction kinetics, complex reaction, Steady-State, equilibrium, chain reaction, catalysis, etc.), and reaction rate theory (Transition State and Collision theory).

Introduction to quantum mechanics: Historical development of quantum theory, properties of particles and waves, wave mechanics and applications to simple systems—the particle in a box, the harmonic oscillator, the rigid rotor and the hydrogen atom.

Basic Principles of Molecular Spectroscopy: Rotational, Vibrational and Electronic Spectroscopy; Linear and Nonlinear Scattering of Light; Excited State Properties of Molecules; Spin Resonance Spectroscopy; Solid Stateand Surface Spectroscopy.

Nanoscience and Nanotechnology: What is nanoscience and nanomaterials? Historical background of the field nanoscience and nanotechnology; Optical, electrical, and magnetic properties of nanomaterials; different nanomaterials (organic vs. inorganic); common roots of nanomaterials synthesis; Surface modification for specific targeting, Principle of photon therapy, Surface Plasmon Resonance (SPR), Nanomaterials based optics and spectroscopy, applications in sensing, diagnostics, and remediation.

Recapitulation about radioactivity - classification of the nuclides, natural decay chain; Radioactive decay modes - secular and transient equilibrium; Introduction to Nuclear Reactions - Q-values, threshold energy, cross section, excitation functions; Different types of detectors, Nuclear Activation and its applications; Clinical and other applications of radionuclide, radiotracer technique.

Interaction of electromagnetic radiation with matter – Cross-sections –Attenuation and mass energy absorption coefficients

Radiation quantities and units –Particle & Energy flux and fluence–flux and fluence –Interaction of Radiation with Cells, LET – Biological Effects of Radiation, Dosimetry – Energy imparted – Absorbed dose – Kerma-Exposure –Dose equivalent – Charged particle equilibrium (CPE) –Ambient and directional dose equivalents [$(H^*(d)$ and $H'(d)$]

3. Structural and Computational Biology (SCB)

Nucleic acids, Watson-Crick and non-Watson Crick basepair, DNA double helical and multistranded structures, RNA structural features.

External and internal coordinate system, non-covalent interactions stabilizing biomolecules, amino acids, peptide, proteins, secondary, tertiary, quaternary structure of protein.

Structure determination: Basics of Crystallography, NMR, Site-directed spin labelling and EPR (SDSL-EPR)

Brief introduction to Bioinformatics and Biological databases, Sequence Alignment (Pair-wise and Multiple), Scoring matrices (BLOSUM62, PAM etc.), Database similarity searching by available tools like FASTA, BLAST etc., Phylogenetic Tree construction; Next Generation Sequencing. Introduction to biological databases.

Perl Programming Language and its application in Bioinformatics.

Molecular modelling software, basic statistics, regression and curve-fitting, some probability and statistical methods (such as Measures of central tendency, probability, probability distributions, Binomial distribution, Normal distribution, Poisson distribution, calculation of errors etc.). Introduction to Computation with Matlab. Matrix handling, plotting, statistical analysis.

4. Advanced Laboratory Practices (ALP)

i. Biochemical and Molecular Biology Techniques (BMBT)

Separation techniques: Electrokinetics methods: electrophoresis, electrophoretic mobility (EPM), factors affecting EPM, Paper, PAGE, Capillary, Iso-Electric focusing, applications in biology and medicine. HPLC: mobile phase systems, modes of operations, application, Hydrodynamics method: fundamental principles, Centrifugation, Ultracentrifugation and their applications in molecular weight, size determination. Viscosity and its application.

Technique in molecular biology: DNA detection, RNA detection, Protein detection, cloning, PCR, and related methods.

ii. Spectroscopy and Imaging Techniques (SIT)

Circular dichroism, Infrared spectroscopy including basic principles of FTIR, Raman spectroscopy.

Basic principles of imaging techniques: SEM, TEM, wide-field fluorescence microscopy, confocal scanning microscopy and fluorescence correlation spectroscopy.

iii. Radiological safety (Radiation Protection Standards, Principles of Monitoring and Protection).

iv. Biostatistics.