Post M.Sc.(Biophysical Sciences) 2017-18
Advance Courses offered in Semester II

1. Topics in Cell Biology - I (Oishee Chakrabarti & Partha Saha)

Oishee:
Protein translocation, protein trafficking (endocytosis, exocytosis, transcytosis), de novo organelle biogenesis, protein quality control (role of internal vesicles), lysosomal biogenesis and degradation.

Partha:
Regulation of cell cycle by cyclin-Cdk, Regulation of Initiation of eukaryotic DNA replication, Replication Licensing, Cell cycle checkpoints, Protein degradation by ubiquitination during cell cycle progression.

2. Topics in Cell Biology – II (Kaushik Sengupta & Chandrima Das)

Kaushik:
Mechanobiology – cytoskeleton and nucleoskeleton, mechanics of cell-cell adhesion and migration, gross cell mechanics, experimental set ups to study biomechanics, disease models.

Chandrima:
Chromatin & Epigenetics: Methods to study chromatin structure, Epigenetics and gene regulation, DNA repair mechanisms in chromatin context, Chromatin dynamics in Stem cell differentiation and cancer, Chromatin as drug target.

3. Membrane Biophysics and Structural Dynamics of Membrane Proteins (H Raghuraman)

Models of biomembranes, Hydrophobic effect, Membrane organization and dynamics, Phase transition of membranes, Model membranes: micelles, reverse micelles, liposomes and Nanodiscs, Membrane proteins & cell surface glycoconjugates, Membrane Dynamics: Edidin & Frye experiment, heterocaryons, Diffusion of membrane components, Membrane domains and lipid rafts: membrane biophysics to cell biology, Hydrophobic mismatch, Membrane asymmetry and lipid polymorphism, Membrane cholesterol and its relevance in health and disease

Techniques in membrane biology

Structures of membrane proteins, How membranes shape protein structures? Lipid-protein interactions, Ion channels and Transporters, G-protein coupled receptors (GPCR).

Books:
1. Biomembranes : A Molecular approach by R.B. Gennis, Springer-Verlag.
2. Membrane Structural Biology – with biochemical and biophysical foundations by Mary Luckey, 2nd edition, 2014, Cambridge University Press.

4. Chromatography and Mass Spectrometry (Soumen K Manna)

Chromatography: General principles of chromatography, common types of chromatography[1], factors affecting chromatographic separation and considerations for choosing mode of chromatography, applications.
Mass Spectrometry: General principles, ion source[2], types of mass analyzers[3], ion fragmentation and rearrangements, mass spectrometry of protein and peptides, mass spectrometry of small molecules, imaging mass spectrometry, applications.

[1]normal phase, reverse phase, HILIC, ion exchange, size exclusion, affinity, GC and chiral.
[2]ESI, APCI, MALDI, EI, DESI, LAESI, FAB, SIMS, NIIMS.
[3]quadrupole, TOF, ion trap, orbitrap, ICR.

5. Synthetic Biology: 21st Century Biological Engineering (Sangram Bagh)

What is synthetic biology? Concept of design based biology. Basic concepts of logic gate circuits. Basic concenpts of genetic network. Genetic switch. Gene circuit design.

Genome engineering tools (Zn-Finger Nuclease, TALEN, Crisper-Cas9 systems) and its application in gene therapy and genetic engineering. Advanced recombinant DNA technology (complex PCR, Gene synthesis, Gibson assembly, Golden Gate assembly, concept of biobricks). Directed evolution techniques. Optogenetics. Artificial Cell.

Computational tools (chemical kinetics modelling, Gillespie methods, concept of steady state and bifurcation, open source tools for gene circuit design and simulation)

Synthetic metabolic engineering and its application in production of drugs and renewable fuel.

Application of synthetic biology in human diseases (cancer, diabetes, infectious disease), cell and gene therapy, tissue engineering, programmed therapeutics, cellular robotics and space missions.

6. Macromolecular Crystallography (Udayaditya Sen & Sampa Biswas)

Structure factors, Atomic scattering factor, temperature factor, structure factor calculation, Phase problem and electron density calculation. Advanced phasing techniques (like MAD/SAD). Phasing by MR, Model building and refinement. Fiber Diffraction.
High throughput crystallography; Cryo-crystallography and its application in trapping reaction intermediates; X-ray crystallography to elucidate structure-function relationship for some important biological pathways; crystallography of large macromolecular assembly.
Crystallization techniques, handling protein crystals using cryo techniques, diffraction data collection, electron density map interpretation, crystallographic data analysis.

7. Advanced biophysical Spectroscopy and imaging (Samita Basu & Padmaja Mishra)

Samita:

Nanosecond to Femtosecond Laser Spectroscopic Techniques and their application to the various prototype and diverse bio-molecules of different sizes related to Biophysical Sciences. The spectroscopic methods we will cover are the following: (i) Time Resolved Fluorescence and Absorption (ii) Circular Dichroism.

Padmaja:

Concepts in Microscopy and imaging: Basic Principle of Optics, Family of Microscope , Optical Microscope Aberrations, Polarized light and its interaction with matter, Detection system image formation and image analysis, Point spread function, Principle of TEM &SEM: development, architecture, vacuum system, power supply, Sample preparation techniques and Application

Single molecule detection (SMD) by fluorescence: Single molecule fluorescence spectroscopy/Microscopy, Technical Challenges, Methods in single molecule detection, Total Internal reflection (TIR) spectroscopy, Types (PTIR, OTIR), Data Processing, analysis and interpretation. Principle of trapping, Design Considerations, Trapping force, Microscope, Objective, Position detection.

8. Drug Discovery: Modern Day Approach (Munna Sarkar)

Pre 20^{th} century drug discovery. Drug discovery pipeline, drug targets and target validation. Methods of lead identification and optimization. Early prediction of ADMET (Absorption, Distribution, Metabolism Excretion and Toxicity). QSAR (Quantitative Structure Activity Relationship) predictions. Lipinski rule of 5. Polar surface area. Blood brain barrier crossing model. Predicting toxicity. Introduction to drug docking and pharmacophore modeling.

Note: Each course consists of 20 lecture hours

Each student has to opt for 4 courses

All courses will be conducted during Jan-March 2018 in Semester II