Postgraduate Diploma Course in Condensed Matter Physics 2015-2016

Biological Physics (CMP-BIO) (12 lectures = 18 hrs)

1) Introduction to Molecular Biophysical Chemistry:

Topics will include (but not limited to ...):

* Central dogma of molecular biology (directional flow of genetic information)
* Transcription/Translation
* RNA world hypothesis
* Explore other theories of origin of life.
* Explore the rich physical chemistry of biological systems: quantum mechanics of DNA repair to ice nucleating proteins to anti-freeze proteins ..

2) Introduction to Structural Molecular Biology:

Topics will include (but not limited to ...):

* Structure and Function of Proteins and Nucleic Acids
* Proteins: structure, function and enzyme catalysis
* Structure and Function of Membrane Proteins.

3) Protein Folding:

Topics will include (but not limited to ...):

* Hydrophobic effects in water and other solvents
* The protein folding problem
* Molecular interactions in biological systems: van der Waals, hydrogen bonding etc
* Balance of entropy vs enthalpy in the process
* Theories of hydrophobic effects

4) Protein Dynamics:

Topics will include (but not limited to ...):

* Hierarchy of timescales in the motion of proteins.
* Importance of different timescales in various biological processes
* Enzyme catalysis: lock and key vs induced fit models
* Allostery in regulation
* How to probe protein dynamics: experimental and theoretical approaches
* Molecular Dynamics vs NMR experiments

5) Proteins and DNA in Aqueous Solution in the Cell:

Topics will include (but not limited to ...):

* Water as an active medium affecting structure and dynamics of biomolecules
* Solvent effects on dielectric constant, viscosity and subsequent effects on proteins
* Hydrophobicity scales of amino acids
* Chemical Equilibria associated with titratable sites of biomolecules
* pKas of RNA, DNA and amino acids

6) Statistical Models of Polymers:

Topics will include (but not limited to ...):

* Static properties of polymers
* Freely jointed chain, Gaussian Chain, Rouse Chain model.
* Brownian motion: Langevin Equation, Smuchowski Equation

7) In Silico Modeling of Biological Systems:

* Monte Carlo and Molecular dynamics as applied to biological systems
* Sampling issues: replica exchange, order parameters etc
* Chemical reactions: QM/MM methodologies
* Coarse grained models for biomolecular modeling.
* Visualization in VMD - computer lab sesion

8) Experimental Methods in Biophysics (External Lecturer)

9) 2 Lectures will be dedicated to presentations by students based on specific articles
in the area of biophysics from either experimental/theoretical approaches.