CENTRE FOR BIOINFORMATICS
M. D. UNIVERSITY, ROHTAK

PH.D. COURSE WORK SCHEME AND SYLLABUS OF EXAMINATION

Program Specific Outcomes: The students upon completion of Ph.D. coursework in Bioinformatics will be able to:

PSO1 Produce a well-developed research proposal.

PSO2 Select an appropriate methodology with which to conduct the research and defend the methodology of their selection.

PSO3 Understand the various techniques required to carry out the research.

PSO4 Explore the resources needed to perform the research process and perform proper documentation of their findings.

PSO5 Present and report their research in acceptable manner for the Life Sciences research community.

S. No.	Paper Code	Paper title	Credits	Internal Evaluation	External evaluation	Total
1	17BINPC1	Computational and Systems Biology	4	20	80	100
2	17BINPC2	Structural Bioinformatics	4	20	80	100
3	17BINPC3	Research methodology	4	20	80	100
4	17BINPC4	Review Writing and Presentation	3	-	75	75
5	17BINPC5	Seminar	1	25	-	25
Total						**400**

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Course Title: Computational & Systems biology

Course Code: 17BINPC1

By the end of the course the students will be able to:

- **CO1** Discuss the concepts underlying systems biology.
- **CO2** Explain working knowledge of the modeling that underpins much of systems biology.
- **CO3** Exhibit strong skills in critical analysis and synthesis of scientific information using different computational tools.

Credit: 4 0 0
MM. Th 80+ IA 20
Time: 3 Hours

Note for Examiner: Examiner should set 2 questions from each unit. Each question shall carry 16 marks. Students will have to attempt atleast one question from each unit.

Unit-1
Biological data
Types of biological data (various omics)
Biological Databases: Nucleic acid and protein sequence and protein structure databases Overview of available Bioinformatics resources on the web.

Unit-2
DNA sequence analysis
Sequence annotation and sequence analysis-Phylogeny of gene (blast, fasta, HMMer) and residue conservation. Primer design and Tm Calculation, DNA Restriction pattern analysis. Condon bias and its effect on the protein expression with reference to various expression system.

Unit-3
Bioinfo tools 2 Protein sequence and structure insights (PSSI)
X-ray, NMR, Comparative modeling, ab initio, threading methods.
Structure refining techniques Energy minimization approaches (Steepest descent, Conjugate gradient etc), Basis of Molecular dynamics simulations and its application.

Unit-4
Introduction to Systems Biology-I (SB)
Principles of Networks – Graph Theory and information theory of molecular systems
Types of biological networks.

Unit-5
Basics of Systems Biology-II (SB)
Biological Network Databases Genomic networks (Gene regulation)
Protein-protein interaction networks; Biochemical flux networks

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Students are advised to consult relevant journal articles and reviews to gather the recent information on the above mentioned topics

Course Title: Structural Bioinformatics

Course Code: 17BINPC2

By the end of the course the students will be able to:

- **CO1** Account for the structure of proteins, DNA and RNA
- **CO2** Model the novel protein structures and simulate the structures using molecular dynamics applications.
- **CO3** Explain basic principles of experimental methods used for the determination of the structure of macromolecules.
- **CO4** Use computer programs to visualize three-dimensional structures and analyze the relationship between structure and function.
- **CO5** Perform Docking studies and access various online tools and databases for the purpose of *in silico* drug designing.

Credit: 4 0 0
MM. Th 80+ IA 20
Time: 3 Hours

Note for Examiner:Examiner should set 2 questions from each unit. Each question shall carry 16 marks. Students will have to attempt atleast one question from each unit.

Unit-1
Protein Structure Prediction Introduction, Protein Stability and Folding, Application of Hydrophobicity, Superposition of Structures, DALI methods, Evolution of Protein Structures, CASP, Secondary Structure Prediction, Homology Modelling, Fold Recognition, ROSETTA, LINUS.

Unit-2
Molecular Modeling and Dynamics
Introduction, Molecular Dynamics using simple molecules, Signification of Times steps & Temperature Conformational energy calculations and molecular dynamics, Docking by Energy minimization, Ramachandran Plot.

Unit-3
Drug Discovery and Development
Drug Discovery Cycle, The Lead compound, Pharmacophore, Bioinformatics in drug discovery and development, chemical databases, ADME and Toxicity, Virtual Screening, Molecular Docking, Structure and Ligand Based Drug Designing, Case studies.

Unit-4

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Structural Bioinformatics Tools

Tools for Molecular Visualization and Analysis:RASMOL, PYMOL, VMD, SWISS-PDB Viewer. Molecular Modeling and Docking: Swiss-Model, Arguslab, Hex, DOCK and Autodock. Online Tools: Biology Workbench, Marvin Sketch, Chemskech, pubchem.

Unit-5

Quantitative tools

Introduction to QSAR methodologies, Types of QSAR methods – 2D, 3D, 4D, 5D and 6D-QSAR methodologies, Descriptors classification, Application of QSAR in molecular design.

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Course Title: Research Methodology

Course Code: 17BINPC3

By the end of the course the students will be able to:

- **CO1** Write research project and be acquainted with the research process, types of research, research models and basic format of report writing.
- **CO2** Apply various types of Centrifugation and Chromatography techniques.
- **CO3** Discuss the basic properties and structure of biopolymers.
- **CO4** Discuss the concept of spectroscopy and its application in life sciences.

Credit: 4 0 0
MM. Th 80+ IA 20
Time: 3 Hours

Note for Examiner:Examiner should set 2 questions from each unit. Each question shall carry 16 marks. Students will have to attempt atleast one question from each unit.

Unit-1
Colloidal solutions of biopolymers and their electrochemical properties, Hydrodynamic properties;
Viscosity, diffusion etc of biopolymers; Molecular weight determination, osmotic pressure, reverse osmosis and Donnan effect, Structure of biomembranes and heir electrochemical properties, membrane potential, action potential and propagation of impulses; PPI

Unit-2
Electrophoresis; different methods of electrophoresis for protein, nucleic acids, small molecular weight compounds and immune precipitates (Immuno electrophoresis). Peptide mapping and combination of electrofocussing and SDS-PAGE. Blotting techniques (Northern, Southern and western blotting); RT-PCR

Unit-3
Theory of centrifugation and application to biological systems. Rotors angle/vertical/zonal/continous flow centrifuge, differential centrifugation density gradient centrifugation. Ultra centrifugation principle and application. Chromatography – adsorption, affinity, partition, Ion-exchange, gelpermeation, GLC, TLC, RPC, HPLC etc.

Unit -4
Introduction to principles and applications of (a)Spectroscopic methods (UV, Vis, IR,

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Fluorescence, ORD, CD, & PAS) (b)NMR, ESR & Mass spectrometery, Use of radioactive and stable isotopes and their detection in biological systems.

Unit-5

Automatic analyzer for amino acids, protein sequencer, peptide synthesizer & nucleic acid synthesizer. Cell sorters and their applications. Theory of lyophilization and its applications to biological systems. Introduction to principles and working of light and electron microscope.

Students are advised to consult relevant journal articles and reviews to gather the recent information on the above mentioned topics