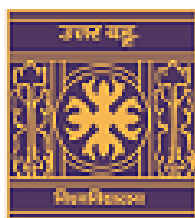


**Programme Outcomes,
Programme Specific Outcomes and
Course Outcomes For
PG Programmes**

Programme Name: M.Sc. in Bioinformatics

Number of Semesters: 4



"সমানো মন্ডল সমিতি সমানী"

Department of Bioinformatics
University of North Bengal
West Bengal, INDIA

Programme Outcomes

Bioinformatics is a multi-disciplinary subject in the field of life science. Bioinformatics is information technology applied to the management and analysis of biological data with the aid of computational and statistical techniques. It is the science of using information to understand biology. In this field biological information is collected, compared, studied and analyses to find the interrelation between them for solving structural, functional and evolutionary problems using computational technologies. The biological information stored in various databases is available in web through internet. Bioinformatics refers to the creation and development of databases, software, computational and statistical techniques and theory to solve problems generated from the management and analysis of biological data. On the other hand, computational biology refers to the hypothesis-based investigation of a specific biological problem using computers, carried out with experimental or simulated data, with the primary goal of discovery and the advancement of biological knowledge. Bioinformatics solves the following problems and put more emphasis on understanding disease related problems at the molecular level.

- Protein sequencing, Nucleic acid sequencing and their analysis.
- Find proteins, their interaction, activity, modification and function.
- Elucidation of function of a molecule based on its structure.
- Gene expression, analysis, prediction and establishing a genomic library.
- Find homology for studying evolutionary relationships among different species.
- Molecular modelling and molecular dynamics methods to study structure from sequence.
- Drug designing and discovery from data of functional genomics and proteomics.

In recent years in this age of the Internet and sequenced genome we have more information at our fingertips than ever before. Organizing this entire data and combating information overload is becoming more and more important. Utilization of computational power has solved this problem to some extent. The course covers the principles and computational methods used to search and compare DNA, RNA and proteins, cast as biological "sequences". The course explains why they can give us answers to fundamental biological questions important to fields such as Cell Biology, Biochemistry and Medical science.

Programme Specific Outcomes

To build in candidates a strong foundation in interdisciplinary sciences such as Computer Sciences and Biological Sciences, to develop accelerated and precise technologies for industrial problems, and prepare them for productive careers in fields of biotechnology, pharmaceutical, bioinformatics, Research, and healthcare industries

Strengthening ongoing university research in the area of bioinformatics, in particular and life science in general. Further it will be helpful in creating an advanced research facility to carry out research in frontier areas of bioinformatics, biotechnology, and molecular modelling.

To address the challenges arising from the huge amount of genomic data and to overcome by analyzing and individualizing the corresponding drug responses towards appropriate drug specified dosages.

Course outcomes	
Semester I	
BINF-CT-101	Fundamentals of Cell Biology and Genetics
<u>Knowledge acquired:</u> <ol style="list-style-type: none"> (1) Important functions of the cell, its microscopic structure (2) Understand the basic molecular genetics mechanisms about the structure and function of the cells (3) Gain insight into the most significant molecular biology-based methods used today to expand our understanding of biology. <u>Skills gained:</u> <ol style="list-style-type: none"> (1) Able to explain genetic disorders in humans and the genes responsible for it (2) Ability to design experiments to understand molecular-level interactions and their relation to the biological system <u>Competency Developed:</u> <ol style="list-style-type: none"> (1) Employ critical thinking and scientific knowledge to design experiments, carry out, record, and analyze the results 	
BINF-CT-102A & BINF-CT-102B	Molecular Biology & Biochemistry
<u>Knowledge gained:</u> <ul style="list-style-type: none"> • Basic knowledge in general molecular biology • The students will be acquainted with the characteristic features, classifications, structures and functions of biomolecules in a living cell • Machinery of gene expression and factors involved in gene regulation of prokaryotes and eukaryotes <u>Skills gained:</u> <ul style="list-style-type: none"> • They will also get acquainted with the different laboratory techniques used to learn the concepts in molecular biology through different experiments • Gain knowledge about the dynamics of enzyme, its reactions, and its computational design <u>Competency developed:</u> <ul style="list-style-type: none"> • students will understand the principles of engineering the proteins as per the industry requirement 	
BINF-CT-103A & BINF-CT-103B	Basic Bioinformatics & Basic Computer Application
<u>Knowledge gained:</u> <ul style="list-style-type: none"> • students will understand the essential features of the interdisciplinary field of science for better understanding biological data. • Students will know about the biological concepts and relevant database workout for research entries. • Concept of Similarity, Identity and Homology, Global Alignment, Local Alignment, Sequence assembly, Gene prediction, Protein Structure Prediction, Methodologies <u>Skills gained:</u>	

<ul style="list-style-type: none"> • Students will look at a biological problem from a computational point of view. • Retrieve and analyze the biological sequences by using tools and software's. <p>Competency developed:</p> <ul style="list-style-type: none"> • Application of bioinformatics for solving different biological problems • Data handling process and data retrieval process from different biological databases 	
BINF-CP-104	Fundamentals of cell biology and genetics (Practical)
	<p><u>Knowledge acquired:</u></p> <ol style="list-style-type: none"> (1) Important functions of the cell, its microscopic structure (2) Understand the basic molecular genetics mechanisms about the structure and function of the cells (3) Gain insight into the most significant molecular biology-based methods used today to expand our understanding of biology. <p><u>Skills gained:</u></p> <ol style="list-style-type: none"> (1) Able to explain genetic disorders in humans and the genes responsible for it (2) Ability to design experiments to understand molecular-level interactions and their relation to the biological system <p><u>Competency Developed:</u></p> <ol style="list-style-type: none"> (2) Employ critical thinking and scientific knowledge to design experiments, carry out, record, and analyze the results
BINF-CP-105	Biochemistry and Molecular Biology (Practical)
	<p>Knowledge gained:</p> <ul style="list-style-type: none"> • Basic knowledge in general molecular biology • The students will be acquainted with the characteristic features, classifications, structures and functions of biomolecules in a living cell • Machinery of gene expression and factors involved in gene regulation of prokaryotes and eukaryotes <p>Skills gained:</p> <ul style="list-style-type: none"> • They will also get acquainted with the different laboratory techniques used to learn the concepts in molecular biology through different experiments • Gain knowledge about the dynamics of enzyme, its reactions, and its computational design <p>Competency developed:</p> <ul style="list-style-type: none"> • students will understand the principles of engineering the proteins as per the industry requirement
BINF-CP-106	Basic Bioinformatics and Computer application (Practical)
	<p>Knowledge gained:</p> <ul style="list-style-type: none"> • students will understand the essential features of the interdisciplinary field of science for better understanding biological data.

- Students will know about the biological concepts and relevant database workout for research entries.
- Concept of Similarity, Identity and Homology, Global Alignment, Local Alignment, Sequence assembly, Gene prediction, Protein Structure Prediction, Methodologies

Skills gained:

- Students will look at a biological problem from a computational point of view.
- Retrieve and analyse the biological sequences by using tools and software's.

Competency developed:

- Application of bioinformatics for solving different biological problems

Data handling process and data retrieval process from different biological databases

Semester II

BINF-CT-201	Genomics and Proteomics
<p><u>Knowledge acquired:</u></p> <ol style="list-style-type: none"> (1) Understand how all the genes in a genome act and how their products interact to produce a functional organism (2) Different methods of sequencing, microarrays, protein fingerprints and the role of bioinformatics tools applied to analyze these <p><u>Skills gained:</u></p> <ol style="list-style-type: none"> (1) Able to explain the genomic and proteomic strategies and apply bioinformatics tools for the same <p><u>Competency Developed:</u></p> <ol style="list-style-type: none"> (1) Formulate and assess experimental design for solving theoretical and experimental problems in Genomics and Proteomics fields 	
BINF-CT-202	Basic statistical techniques for Bioinformatics
<p><u>Knowledge acquired:</u></p> <ol style="list-style-type: none"> (1) statistical estimation procedure for estimating parameter with reference to biological data, (2) hypothesis testing procedure considering the problem of simultaneous hypothesis testing, (3) sampling and resampling techniques. <p><u>Skills gained:</u></p> <ol style="list-style-type: none"> (1) biological data analysis with the help of linear estimation techniques, (2), Inference of biological events with help of statistical inference and, (3) application of sampling techniques in biological data analysis. <p><u>Competency Developed:</u></p> <ol style="list-style-type: none"> (1) Applying the concepts of statistical inference, estimation for real biological problem 	

	<p>(2) Learn the ability to analyze complex real-life data</p> <p>(3) Create the ability of algorithm development with the help of statistical as well as computational techniques.</p>
BINF-CT-203	Computer programming for Bioinformatics
<p><u>Knowledge acquired:</u></p> <p>(1) basic concepts of algorithm writing and flowchart</p> <p>(2) Programming script writing using C, JAVA, PERL</p> <p>(3) Usage of programming script for bioinformatics data analysis.</p> <p><u>Skills gained:</u></p> <p>(1) stepwise algorithm development</p> <p>(2) syntax of C, JAVA, PERL programming and,</p> <p>(3) defining and calling function/subroutine in programming.</p> <p><u>Competency Developed:</u></p> <p>(1) Ability to develop algorithm for solving complex biological problem</p> <p>(2) Writing problem specific script for biological data analysis</p> <p>Writing programming script for algorithm development</p>	
BINF-CP-204	Data analysis in Genomics and Proteomics (Practical)
<p>Knowledge acquired:</p> <p>(1) Principles of several important analytical methods that are relevant to a functional genomics approach</p> <p>Skills gained:</p> <p>(1) Technical skills and knowledge development on versatile techniques in omics</p> <p>(2) Being able to: design and conduct a proteomics experiment, including the mass spectrographic analysis; explain how the data should be analyzed</p> <p>Competency Developed:</p> <p>(1) Suggesting and outlining a solution to theoretical and experimental problems in Genomics, Transcriptomics, and Proteomics fields</p>	
BINF-CP-205	Basic statistical techniques (Practical)
<p>Knowledge acquired:</p> <p>(1) statistical estimation procedure for estimating parameter with reference to biological data,</p> <p>(2) hypothesis testing procedure considering the problem of simultaneous hypothesis testing,</p> <p>(3) sampling and resampling techniques.</p> <p>Skills gained:</p> <p>(1) biological data analysis with the help of linear estimation techniques,</p> <p>(2), Inference of biological events with help of statistical inference and,</p> <p>(3) application of sampling techniques in biological data analysis.</p> <p>Competency Developed:</p> <p>(7) Applying the concepts of statistical inference, estimation for real biological problem</p> <p>(8) Learn the ability to analyze complex real-life data</p> <p>(9) Create the ability of algorithm development with the help of statistical as well as computational techniques.</p>	

BINF-CP-206	Computer programming (Practical)
<p><u>Knowledge acquired:</u></p> <ol style="list-style-type: none"> (1) basic concepts of algorithm writing and flowchart (2) Programming script writing using C, JAVA, PERL (3) Usage of programming script for bioinformatics data analysis. <p><u>Skills gained:</u></p> <ol style="list-style-type: none"> (1) stepwise algorithm development (2) syntax of C, JAVA, PERL programming and, (3) defining and calling function/subroutine in programming. <p><u>Competency Developed:</u></p> <ol style="list-style-type: none"> (1) Ability to develop algorithm for solving complex biological problem (2) Writing problem specific script for biological data analysis (3) Writing programming script for algorithm development 	

Semester III

BINF-CT-301	Structural Bioinformatics
<p>Knowledge acquired:</p> <ol style="list-style-type: none"> (1) Understand how the Biomolecules act and how their products interact (2) Learn different computational resources available for Structural Bioinformatics <p>Skills gained:</p> <ol style="list-style-type: none"> (1) Able to explain the structural Bioinformatics strategies and apply bioinformatics tools for the same <p>Competency Developed:</p> <ol style="list-style-type: none"> (2) Formulate and assess experimental design for solving theoretical and experimental problems in Structural Bioinformatics 	
BINF-CT-302	Database management systems
<p><u>Knowledge acquired:</u></p> <ol style="list-style-type: none"> (1) Web page designing using CSS, HTML, PhP, (2) database development and management using SQL, ORACLE, (3) establishment the connectivity of webpage with database. <p><u>Skills gained:</u></p> <ol style="list-style-type: none"> (1) development of webtool, (2) database development, and, (3) integration of webpage and database. <p><u>Competency Developed:</u></p> <ol style="list-style-type: none"> (1) Creation of biological database and its management (2) Webpage development as graphical interface of algorithm and database integration with the webtool for storing data. 	

BINF-ET-303	Elective Theory Course (Any one of the following)
BINF-ET-303A	Evolutionary Biology
<p><u>Knowledge acquired:</u></p> <p>(1) Concepts of molecular evolution and the nature of data for deriving molecular phylogeny</p> <p>(2) logical basis and computational details of various tree-building algorithms and associated methods of hypothesis testing, as well as novel applications of phylogenetic analysis in various fields of biology</p> <p><u>Skills gained:</u></p> <p>(1) Able to analyse the genomic data using phylogenetics and infer the evolutionary explanation of a biological phenomenon</p> <p><u>Competency Developed:</u></p> <p>(1) Application of statistical approaches and models for phylogenetic analysis and tree reconstruction</p> <p>(2) An ability to apply knowledge of computing, biology, statistics and mathematics appropriate to the discipline</p>	
BINF-ET-303B	NGS and expression data analysis
<p><u>Knowledge acquired:</u></p> <p>(1) Strong foundation for principles, methods and concepts of sequencing, Impact of transcriptomics on biology</p> <p>(2) Comprehend the ideas of Genome projects of model organisms , Next Generation Sequencing technology</p> <p>(3) Methods for analyzing the Gene expression, Differential expression, Allele-specific expression and Statistcal considerations</p> <p><u>Skills gained:</u></p> <p>(1) Skills for Big Data handling and analysis including NGS, Microarray, RNA-Seq data</p> <p>(2) Understand basic use of R statistical package in biological data</p> <p><u>Competency Developed:</u></p> <p>(1) Provide the competence to use NGS technology within life science ranging from microbiology to human biology.</p>	
BINF-ET-303C	Advance computer programming for Bioinformatics
<p><u>Knowledge acquired:</u></p> <p>(1) basic of python and R programming,</p> <p>(2) importing different function/package for biological data analysis.</p> <p><u>Skills gained:</u></p> <p>(1) complex data analysis using different modules of python</p> <p>(2) implementing statistical methods using R packages for analyzing biological data.</p> <p><u>Competency Developed:</u></p> <p>(1) Solving the biological problem using python modules</p> <p>(2) Implementing statistical application for solving biological problems using R packages.</p>	

BINF-ET-303D	Data mining and Machine learning techniques for Bioinformatics
<p><u>Knowledge acquired:</u></p> <ol style="list-style-type: none"> (1) data analysis with machine learning techniques, (2) different data mining techniques with application in biological data mining, (3) validation of techniques using proper validation procedure. <p><u>Skills gained:</u></p> <ol style="list-style-type: none"> (1) machine learning techniques to solve biological problems, (2) mining information from biological data, and, <p><u>Competency Developed:</u></p> <ol style="list-style-type: none"> (1) Biological data analysis using supervised and unsupervised techniques for better understanding of biological events (2) Integration of biological data using machine learning and data mining techniques. 	
BINF-CP-304	Structural Bioinformatics (Practical)
<p><u>Knowledge acquired:</u></p> <ol style="list-style-type: none"> (1) Understand how the Biomolecules act and how their products interact (2) Learn different computational resources available for Structural Bioinformatics <p><u>Skills gained:</u></p> <ol style="list-style-type: none"> (1) Able to explain the structural Bioinformatics strategies and apply bioinformatics tools for the same <p><u>Competency Developed:</u></p> <ol style="list-style-type: none"> (1) Formulate and assess experimental design for solving theoretical and experimental problems in Structural Bioinformatics 	
BINF-CP-305	Database management systems (Practical)
<p><u>Knowledge acquired:</u></p> <ol style="list-style-type: none"> (1) Web page designing using CSS, HTML, PhP, (2) database development and management using SQL, ORACLE, (3) establishment the connectivity of webpage with database. <p><u>Skills gained:</u></p> <ol style="list-style-type: none"> (1) development of webtool, (2) database development, and, (3) integration of webpage and database. <p><u>Competency Developed:</u></p> <ol style="list-style-type: none"> (1) Creation of biological database and its management (2) Webpage development as graphical interface of algorithm and database integration with the webtool for storing data. 	

BINF-EP-306	Corresponding to Elective Paper BINF-ET-303
	<p>Evolutionary Biology (Practical)</p> <p><u>Knowledge acquired:</u></p> <p>(1) Measuring the rate of evolution and concept of molecular clock hypothesis (2) Various algorithms and their comparison for deducing phylogenetic tree among species</p> <p><u>Skills gained:</u></p> <p>(1) Able to analyse the genomic data using phylogenetics and infer the evolutionary explanation of a biological phenomenon</p> <p><u>Competency Developed:</u></p> <p>(1) Application of statistical approaches and models for phylogenetic analysis and tree reconstruction (2) An ability to apply knowledge of computing, biology, statistics and mathematics appropriate to the discipline</p>
	<p>NGS and expression data analysis (Practical)</p> <p><u>Knowledge acquired:</u></p> <p>(1) Handling of gene expression database (2) Workflow of next-generation sequencing data analysis and gene expression data analysis</p> <p><u>Skills gained:</u></p> <p>(1) Skills for Big Data handling and analysis including NGS, Microarray, RNA-Seq data (2) Understand basic use of R statistical package in biological data</p> <p><u>Competency Developed:</u></p> <p>(1) Provide the competence to use NGS technology within life science ranging from microbiology to human biology.</p> <p>Advance computer programming for Bioinformatics (Practical)</p> <p><u>Knowledge acquired:</u></p> <p>(1) basic of python and R programming, (2) importing different function/package for biological data analysis.</p> <p><u>Skills gained:</u></p> <p>(1) complex data analysis using different modules of python (2) implementing statistical methods using R packages for analyzing biological data.</p> <p><u>Competency Developed:</u></p> <p>(1) Solving the biological problem using python modules</p>

	(2) Implementing statistical application for solving biological problems using R packages.
	Data mining and Machine learning techniques for Bioinformatics (Practical)
	<p><u>Knowledge acquired:</u></p> <ul style="list-style-type: none"> (1) data analysis with machine learning techniques, (2) different data mining techniques with application in biological data mining, (3) validation of techniques using proper validation procedure. <p><u>Skills gained:</u></p> <ul style="list-style-type: none"> (1) machine learning techniques to solve biological problems, (2) mining information from biological data, and, <p><u>Competency Developed:</u></p> <ul style="list-style-type: none"> (1) Biological data analysis using supervised and unsupervised techniques for better understanding of biological events (2) Integration of biological data using machine learning and data mining techniques.

Semester IV

BINF-CT-401	Research Methodology and Scientific Writing
	<p><u>Knowledge acquired:</u></p> <ul style="list-style-type: none"> (1) Understand different scientific research designs and methods (2) Learn how to set up a research study (3) Understand correct ways to refer to and cite from scientific literature <p><u>Skills gained:</u></p> <ul style="list-style-type: none"> (1) Discuss and explain differences between different research methods (2) Perform literature reviews and reference relevant scientific literature (3) Formulate a research plan <p><u>Competency Developed:</u></p> <ul style="list-style-type: none"> (1) Critically assess different research designs (2) Analyze, set as contrast, compare and review scientific literature (3) Discuss own view in relation to the published research

BINF-CT-402	Bioethics , Biosafety and IPR
<p><u>Knowledge acquired:</u></p> <ol style="list-style-type: none"> (1) Understand the Ethical aspects that the biologist needs to have (2) Learn about the safety precautions that need to be taken in the laboratory (3) Understand the IPR and how to get patents for the discovery <p><u>Skills gained:</u></p> <ol style="list-style-type: none"> (1) Able to explain the Bioethics, Biosafety, and IPR strategies <p><u>Competency Developed:</u></p> <ol style="list-style-type: none"> (1) Formulate and assess experimental design for solving theoretical and experimental problems in Bioethics, Biosafety, and IPR 	
BINF-ET-403	Elective Theory Course (Any one of the following)
BINF-ET-403A	Chemo-informatics and Drug designing
<p><u>Knowledge acquired:</u></p> <ol style="list-style-type: none"> (1) Understand how to deal with drug targets and drugs (2) Learn how drugs and its targets interact (3) Learn different computational resources available for Structural Bioinformatics <p><u>Skills gained:</u></p> <ol style="list-style-type: none"> (1) Able to explain the Cheminformatics strategies and apply Cheminformatics tools for the same <p><u>Competency Developed:</u></p> <p>Formulate and assess experimental design for solving theoretical and experimental problems in Cheminformatics</p>	
BINF-ET-403B	System Biology
<p><u>Knowledge acquired:</u></p> <ol style="list-style-type: none"> (1) Application of mathematical approaches for biological problem solving (2) Biological network construction techniques (3) Biological relevance with respect to network inference <p><u>Skills gained:</u></p> <ol style="list-style-type: none"> (1) Statistical techniques for complex data analysis (2) Nodes and edges in graph theory. <p><u>Competency Developed:</u></p> <ol style="list-style-type: none"> (1) Graph theory to visualize the network 	
BINF-ET-403C	Web-based Programming

Knowledge acquired:

- (1) Web page designing using CSS, HTML, PHP,
- (2) database development and management using SQL, ORACLE,
- (3) establishment the connectivity of webpage with database.

Skills gained:

- (1) development of webtool,
- (2) database development, and,
- (3) integration of webpage and database.

Competency Developed:

- (1) Creation of biological database and its management

Webpage development as graphical interface of algorithm and database integration with the webtool for storing data.

BINF-ET-403D

Python programming for bioinformatics

Knowledge acquired:

- (1) basic concepts of algorithm writing and flowchart
- (2) Programming script writing using python
- (3) Usage of programming script for bioinformatics data analysis.

Skills gained:

- (1) stepwise algorithm development
- (2) syntax of python programming and,
- (3) defining and calling function/subroutine in programming.

Competency Developed:

- (1) Ability to develop algorithm for solving complex biological problem
- (2) Writing problem specific script for biological data analysis
- (3) Writing programming script for algorithm development