Programme Outcomes, Programme Specific Outcomes and Course Outcomes
For PG Diploma Programme

Programme Name: **PG Diploma in Bioinformatics**
Number of Semesters: 2

Department of Bioinformatics
University of North Bengal
West Bengal, INDIA

Programme Outcomes:

Bioinformatics is an emerging branch in the field of life science. Bioinformatics is information technology applied to the management and analysis of biological data with the aid of computers. It is the science of using information to understand biology. It is a field in which biological information 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 online 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 the disease related problems at 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 establish genomic library.
• Find homology for studying evolutionary relationship 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 the recent years in this age of 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		
Course Code	Course Name	Course Outcomes
DBI-101	Fundamentals of Cell Biology, Genetics and Molecular Biology	Knowledge gained: • Basic concept of cell biology with emphasis on structure and function different cellular organelles. • Different cellular pathways involved in various biological processes. • Concept of gene and genetic materials. Principles of inheritance and extension of Mendel's law. • Cell division process and molecular basis of cell division. • Genetic and physical mapping. • Different types of markers. • Gene amplification and PCR. Skills gained: • The knowledge of molecular basis of different cellular organelles. • The concepts of central dogma which gives the idea of translation of DNA sequence to protein sequences. • Knowledge of law of inheritance and genetic variability • Theoretical basis of cell division and its molecular basis • Genetic and physical mapping • Application of gene amplification and PCR Competency developed: • Structure and function of different cellular organelles • Significance of various cellular pathways and their details study for complex diseases • Cell division concepts and its molecular basis • Importance of different markers in gene mapping and other biological study.
DBI-102	Introduction to Basic Bioinformatics	Knowledge gained: • Bioinformatics – an Overview, Definition and History. Information Networks –Internet in • Bioinformatics, Evolution of Bioinformatics – Scope – Potentials of Bioinformatics, Human Genome Project • Introduction to Biological Databases: NCBI, EMBL, PIR, SWISS-Prot, PubChem • Compound, KEGG-Pathway, ChEMBL, BindingDB. Analysis of Three Dimensional Structures of Proteins, RCSB-PDB. Primary and Secondary database • Various file formats for bio-molecular sequences: genbank, fasta, gcg, msf, nbrf-pir etc. • Basic concepts of sequence similarity, identity and homology, definitions of homologues, orthologues, paralogues. • Scoring matrices: basic concept of a scoring matrix, PAM and BLOSUM series • Pairwise and Multiple sequence alignments: basic concepts of sequence alignment, Use of pairwise alignments and

		Multiple sequence alignment for analysis of Nucleic acid and protein sequences and interpretation of results. • Sequence-based Database Searches: what are sequence-based database searches, BLAST and FASTA algorithms, various versions of basic BLAST and FASTA • Phylogeny: Phylogenetic analysis, Definition and description of phylogenetic trees and various types of trees, Method of construction of Phylogenetic trees [distance based method (UPGMA, NJ), Maximum Parsimony and Maximum Likelihood method] • Codon usage analysis and its implications in modern biology Skills gained: • Concepts and overview for Bioinformatics for solving biological problems • Importance of bioinformatics in biological sciences • Biological database handling and database management of different biological database • Retrieval of biological data from different public domain database • Understanding different file format for storing biological data • Application of different software for analyzing biological data Competency developed: • Application of bioinformatics for solving different biological problems • Data handling process and data retrieval process from different biological databases • Usage of different software for analyzing biological data
DBI-103	Basic Computer Application and Programming	Knowledge gained: • Fundamentals of Computer, Basic Applications of Computer; Components of Computer System. • Concept of Computing, Data and Information • Basics of Operating System; Popular Operating Systems (Windows, Linux, DOS); • Data structure and its relevance to biological science • Communication using the Internet: Basic of Computer networks; LAN, MAN, WAN; • Concept of Internet; WWW and Web Browsers; Search Engines; Understanding URL • Design & Structure of biological databases • Introduction to PERL as scripting language; variables; Array; Initialization and manipulation • Arithmetic and logical operators; Conditional statement and Loops; Regular Expressions; Function and subroutines • Application of PERL in Bioinformatics; concatenating DNA fragments; DNA to RNA; Reading protein Files; Finding motifs; ORFs; DNA to protein • Use of R-Programming for statistical analysis, data structure, regex, functions, loops and if statements Skills gained: • Basic Applications of Computer; Components of Computer System. • Concept of Internet; WWW and Web Browsers; Search Engines • Data analysis by different computational techniques

		• Concepts of computer programming languages like C, JAVA helps in solving different complex problem in biology or data analysis • Writing scripting for different data analysis • Command line scripting in DOS and LINUX • Writing script in R programming to solve biological problem. Competency developed: • Understanding of basic computer operating system and function of different components of computer • Writing script in different programming language help in solving different problems related to complex biological data • Communication of different web sources using World Wide Web and basic knowledge of LAN, WAN, MAN. • Data sharing over internet connection connected through LAN
DBI-104	Basic techniques in Cytology and Molecular Biology (Practical)	Knowledge gained: • Orcein and Feulgen staining of metaphase plates; preparation of karyotype and idiogram. • Study of Meiotic chromosome complements. • Restriction digestion and electrophoresis • Isolation of genomic and plasmid DNA. • PCR and RAPD analysis. • PCR primer designing; Plasmid vector designing; • Probability and chi-square test for genetic analyses for goodness of fit. Skills gained: • The knowledge of molecular basis of different cellular organelles. • The concepts of central dogma which gives the idea of translation of DNA sequence to protein sequences. • Knowledge of law of inheritance and genetic variability • Theoretical basis of cell division and its molecular basis • Genetic and physical mapping • Application of gene amplification and PCR Competency developed: • Structure and function of different cellular organelles • Significance of various cellular pathways and their details study for complex diseases • Cell division concepts and its molecular basis • Importance of different markers in gene mapping and other biological study.
DBI-105	Bioinformatics methods and application	Knowledge gained: • Retrieval of DNA/RNA/protein sequences from databases; Biological sequence editing and analysis; Data mining tools • Exploring the integrated database system at NCBI server and querying the PUBMED and GenBank databases using the ENTREZ search engine • Sequence alignment: database searches (BLAST, FASTA etc.),

		PSA and MSA • Phylogenetic tree construction, Bootstrapping • Gene Identification and Function Prediction • Comparative Genome analysis, alignment and visualization • Codon Usage analysis bias prediction Skills gained: • Concepts and overview for Bioinformatics for solving biological problems • Importance of bioinformatics in biological sciences • Biological database handling and database management of different biological database • Retrieval of biological data from different public domain database • Understanding different file format for storing biological data • Application of different software for analyzing biological data Competency developed: • Application of bioinformatics for solving different biological problems • Data handling process and data retrieval process from different biological databases • Usage of different software for analyzing biological data
DBI-106	Bioinformatics Programming (Practical)	Knowledge gained: • Basic Unix/Linux commands and Scripting • Basic PERL programming; Designing PERL program for analysis of nucleotide and protein sequences; Uses of Scalar and Array Variables to manipulate DNA/RNA/Protein sequence data • Reading a sequence data from a file and writing the results to a file; Concatenation DNA fragments, Transcribing DNA into RNA; Calculating the Reverse complement of a DNA strand; Uses of subroutine to read FASTA files • Uses of Bioperl modules for sequence manipulation, accessing local database • R scripting, Use of R for graph plotting, Heatmap construction, Gene expression analysis using R. Skills gained: • Basic Applications of Computer; Components of Computer System. • Concept of Internet; WWW and Web Browsers; Search Engines • Data analysis by different computational techniques • Concepts of computer programming languages like C, JAVA helps in solving different complex problem in biology or data analysis • Writing scripting for different data analysis • Command line scripting in DOS and LINUX • Writing script in R programming to solve biological problem. Competency developed:

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		Semester II
DBI-201	Genomics and Proteomics	Knowledge gained: • Nucleic acids and their structure; synthesis, modification and repair of DNA; repetitive and unique DNA sequences; split genes, overlapping genes and pseudo-genes. Plasmids, IS elements; transposons and retro-elements • Gene Identification: Genome information and special features, coding sequences (CDS), untranslated regions (UTR's), cDNA library, expressed sequence tags (EST). • Gene expression and DNA Microarray: Introduction, Basic steps for gene expression, concept of microarrays; gene expression analysis, Public Microarray data sources • DNA sequencing methods: manual and automated methods. Chain termination method; Basecalling and sequence accuracy. Quality assessment, NGS data assembly, annotation, Polymorphisms, Single Nucleotide Polymorphhisms (SNPs) • Proteomics: Definition–Transcriptomics; Proteomics, metabolomics. Techniques of proteomics – 2D PAGE, Mass spectrophotometer–(MALDI–TOF) MS, Protein Micro array in protein expression, profiling Skills gained: • Concepts of nucleotide base pairs and their arrangements throughout genome sequences • Replication process of DNA and RNA during cell division • Different techniques for generating biological data like genome sequences, gene expression data, proteomics data • Application of different bioinformatics techniques for analysing biological experimental data Competency developed: • DNA sequences and genome sequences analysis and their importance in different biological processes • Importance of SNPs in disease study • Study the variation in DNA and genome helps in understanding biological processes • Function of protein in different biological process and the

		relation between genome sequences and protein sequences
DBI-202	Structural Bioinformatics	Knowledge gained: • Proteins: Amino acid components and structural features; Primary, secondary, tertiary, quarternary and supra-molecular structures; Non-covalent interactions in relation to structural conformation; Ramachandran plots; Amino acid sequencing and purification strategies • Methods for determining structure of biomolecules (X-ray, CD, NMR, IR, UV Visible, Fluorescence, SEM etc) and their limitations. • Prediction of protein structure from sequences, Homology modeling, functional sites, Protein folding problem, Secondary structure analysis and prediction, motifs, profiles, patterns and fingerprints search, protein structural databases (PDB), Purpose of 3-D structure comparison and concepts, RMSD, Z-score • Molecular Interaction Fields and Docking, Concept of Active Site of Enzymes, Protein-Protein and Protein-Ligand Docking; Basics of Molecular simulation, Computer Aided Drug Designing Skills gained: • Molecular basis of protein structure and their function • 3-d structure prediction followed by secondary structure of protein from amino acid sequence • Exploring different methods of protein tertiary structure prediction • Validation of protein structure based on different measure of statistics to get biologically significant structure • Understanding of Ramachandran plot for validating protein structure • Protein- protein interaction study • Simulation of all possible conformations to get optimized and stable form of protein-protein interaction complex Competency developed: • Computational methods for predicting protein secondary and tertiary structure prediction • Validation of predicted structure of protein • Visualization of protein structure in three dimensional form

		• Concept of Active Site of Enzymes, Protein-Protein and Protein-Ligand Docking; Basics of Molecular simulation, Computer Aided Drug Designing • Prediction of protein structure from sequences, Homology modeling, functional sites.
DBI-203	Biostatistics and Database Management Systems (Theoretical)	Knowledge gained: • Measure of central tendency and dispersion; Concept of Correlation and Regression. Types of Data: Concepts of population and sample, quantitative and qualitative data, cross-sectional and time-series data • Statistics and Sampling, Student's t2 test, X2 test, F-test • Concept of Set and matrices • Introduction; Characteristics of Database approach; Advantages of using DBMS approach; Data models, schemas and instances; Database System Architecture. • SQL Data Definition and Data Types; Specifying basic constraints in SQL; Basic queries in SQL; Insert, Delete and Update statements in SQL. • Data Storage and Querying: Storage and File Structure, Indexing and Hashing, Query Processing, Query Optimization. Skills gained: • Calculation processes of arithmetic mean, geometric mean, harmonic mean, median, mode etc. and other measures of central tendency and their application in real life • Quantitative measures of dispersion of variables and their real life applications • Different testing procedures for hypothesis testing • Different operation un matrix analysis • Data storage and data management in database • Writing script using SQL for creating, manipulating and deleting data from database Competency developed: • Calculation processes of arithmetic mean, geometric mean, harmonic mean, median, mode etc. and other measures of central tendency and their application in real life • Quantitative measures of dispersion of variables and their real life applications • Different testing procedures for hypothesis testing • Different operation un matrix analysis • Data storage and data management in database • Writing script using SQL for creating, manipulating and

		deleting data from database
DBI-204	Genomics & Proteomics (Practical)	Knowledge gained: • Exploring the Gene expression databases like GEO • Analysis of a sample microarray data. • Assembling and editing of Genomic data; Genome alignment and analysis tools- BWA (BurrowsWheeler Aligner), SAMtools, GATK (The Genome Analysis Toolkit), IGV (Integrative Genomics Viewer) • NGS Data analysis; Data quality assessment; De-novo Genome assembly • Genome Annotation • Use of PAUP for Phylogenetic analysis based on RAPD Data. Skills gained: • Concepts of nucleotide base pairs and their arrangements throughout genome sequences • Replication process of DNA and RNA during cell division • Different techniques for generating biological data like genome sequences, gene expression data, proteomics data • Application of different bioinformatics techniques for analysing biological experimental data Competency developed: • DNA sequences and genome sequences analysis and their importance in different biological processes • Importance of SNPs in disease study • Study the variation in DNA and genome helps in understanding biological processes • Function of protein in different biological process and the relation between genome sequences and protein sequences
DBI-205	Structural bioinformatics (Practical)	Knowledge gained: • Separation of amino acid mixture by chromatography • SDS-PAGE analysis of proteins • Protein Structure Determination, Homology modelling • Evaluation and Validation of protein models • Molecular visualization tools,3D Represenation • Structural analysis, Domain and motif identification, Ligplot interactions • Molecular Docking • Basic MD simulation with Gromacs.

		Skills gained: • Molecular basis of protein structure and their function • 3-d structure prediction followed by secondary structure of protein from amino acid sequence • Exploring different methods of protein tertiary structure prediction • Validation of protein structure based on different measure of statistics to get biologically significant structure • Understanding of Ramachandran plot for validating protein structure • Protein- protein interaction study • Simulation of all possible conformations to get optimized and stable form of protein-protein interaction complex Competency developed: • Computational methods for predicting protein secondary and tertiary structure prediction • Validation of predicted structure of protein • Visualization of protein structure in three dimensional form • Concept of Active Site of Enzymes, Protein-Protein and Protein-Ligand Docking; Basics of Molecular simulation, Computer Aided Drug Designing • Prediction of protein structure from sequences, Homology modeling, functional sites.
DBI-206	Biostatics & Database Creation (Practical)	Knowledge gained: • Use of spreadsheet for data handling and graph plotting • Formulating and interpreting the result of a statistical test, measures of central tendency, measures of dispersion, measures of skewness • Creating database, Selecting database, Deleting database, Creating table, Modifying Table, Deleting table • SQL; Basic SQL commands; Inserting, updating and deleting records, retrieving records; Using Joins – joining a table to itself, joining multiple tables • Search engine Page design using HTML and PhP and connecting them to database • Submitting sequence data to NCBI database. Skills gained: • Calculation processes of arithmetic mean, geometric mean, harmonic mean, median, mode etc. and other measures of central tendency and their application in real life • Quantitative measures of dispersion of variables and their real life applications

		• Different testing procedures for hypothesis testing • Different operation un matrix analysis • Data storage and data management in database • Writing script using SQL for creating, manipulating and deleting data from database Competency developed: • Calculation processes of arithmetic mean, geometric mean, harmonic mean, median, mode etc. and other measures of central tendency and their application in real life • Quantitative measures of dispersion of variables and their real life applications • Different testing procedures for hypothesis testing • Different operation un matrix analysis • Data storage and data management in database • Writing script using SQL for creating, manipulating and deleting data from database