**DEPARTMENT OF BIOTECHNOLOGY**
DELHI TECHNOLOGICAL UNIVERSITY:
DELHI
Established under Govt. of Delhi Act 6 of 2009
Shahbad Daulatpur, Bawana Road, Delhi-110042

# M.Tech. Bioinformatics Scheme

| M.Tech. BIOINFORMATICS SEMESTER I | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course code** | **TYPE** | **SUBJECT NAME** | **CREDIT** | **L** | **T** | **P** | **TOTAL CREDITS** |
| BIO501 | Core | Introduction to Bioinformatics | 4 | 3 | 0 | 2 | 24 |
| BIO505 | Core | Functional Genomics and Proteomics | 4 | 3 | 0 | 2 | |
| BIO507 | Core | Database Management | 4 | 3 | 0 | 2 | |
| BIO509 | Core | Immunoinformatics | 4 | 3 | 0 | 2 | |
| **BIO531** | **DEC** | **Departmental Elective-1** | | | | | |
| BIO5311 | DEC | Pharmacogenomics and Personalized Medicine | 4 | 3 | 1 | 0 | |
| BIO5312 | DEC | Systems Biology | 4 | 3 | 1 | 0 | |
| BI-5313 | DEC | OMICS in Medicine | 4 | 3 | 1 | 0 | |
| BIO5314 | DEC | Biochemical Engineering Principles | 4 | 3 | 1 | 0 | |
| BIO5315 | DEC | Metabolomics | 4 | 3 | 1 | 0 | |
| BIO5316 | DEC | Genomics: From Human Genome Project to Medical Applications | 4 | 3 | 1 | 0 | |
| BIO5317 | DEC | Computer Graphics | 4 | 3 | 1 | 0 | |
| BIO525 | Self-Study | | 2 | 0 | 0 | 4 | |
| **BIO523** | **SEC** | **Skill enhancement course-1** | | | | | |
| BIO5231 | SEC | Bulk Data Mining and Retrieval | 2 | 0 | 0 | 4 | |
| BIO5232 | SEC | Docking and Simulation | 2 | 0 | 0 | 4 | |
| UEC501 | Audit Course | | 0 | 0 | 0 | 0 | |

| M.Tech. BIOINFORMATICS SEMESTER II | | | | | | | |
|---|---|---|---|---|---|---|---|
| **COURSE CODE** | **TYPE** | **SUBJECT NAME** | **CREDIT** | **L** | **T** | **P** | **TOTAL CREDITS** |
| BIO502 | Core | Advances in Bioinformatics | 4 | 3 | 0 | 2 | |
| BIO504 | Core | Advanced Genetic Engineering | 4 | 3 | 0 | 2 | |
| **BIO532** | **Elective 2** | **Department Elective 2** | | | | | |
| BIO5321 | DEC | Drug Design and Delivery | 4 | 3 | 1 | 0 | |
| BIO5322 | DEC | Analysis of Biological Networks | 4 | 3 | 1 | 0 | |
| BIO5323 | DEC | Plant Bioinformatics | 4 | 3 | 1 | 0 | |
| BIO5324 | DEC | Microarray Technology | 4 | 3 | 1 | 0 | |
| BIO5325 | DEC | Biostatistics | 4 | 3 | 1 | 0 | |
| BIO5326 | DEC | Medical Bioinformatics | 4 | 3 | 1 | 0 | |
| BIO5327 | DEC | Neurobiology | 4 | 3 | 1 | 0 | |
| **BIO534** | **Elective 3** | **Department Elective 3** | | | | | |
| BIO5341 | DEC | Python in Bioinformatics | 4 | 3 | 1 | 0 | |
| BIO5342 | DEC | Web Application Development | 4 | 3 | 0 | 2 | 24 |
| BIO5343 | DEC | Cell & Molecular Biology | 4 | 3 | 0 | 2 | |
| BIO5344 | DEC | High-throughput Structural Biology | 4 | 3 | 1 | 0 | |
| BIO5345 | DEC | Metagenomics | 4 | 3 | 1 | 0 | |
| BIO5346 | DEC | Pharmacoinformatics | 4 | 3 | 1 | 0 | |
| BIO5347 | DEC | Combinatorial methods in Biopharmaceuticals | 4 | 3 | 1 | 0 | |
| UCC502 | Research Methodology &IPR | | 4 | 3 | 1 | 0 | |
| BIO546/ BIO548 | SEC 2/ Industrial Training | Skill enhancement course 2/ Industrial Training | | | | | |
| BIO5461 | | Bioinstrumentation | 4 | 0 | 0 | 8 | |
| BIO5462 | | ML in Bioinformatics | 4 | 0 | 0 | 8 | |

| M.Tech. BIOINFORMATICS SEMESTER III | | | | | | | |
|---|---|---|---|---|---|---|---|
| **COURSE CODE** | **TYPE** | **SUBJECT NAME** | **CREDIT** | **L** | **T** | **P** | **TOTAL CREDITS** |
| BIO601 | Core | IPR in Biotechnology | 4 | 3 | 1 | 0 | 16 |
| **UEC601** | **Open Elective 1** | **Open Elective** | | | | | |
| UEC6011 | OEC | Nanotechnology in Healthcare | 4 | 3 | 1 | 0 | |
| UEC6012 | OEC | Image Processing in Healthcare | 4 | 3 | 1 | 0 | |
| UEC6013 | OEC | Artificial Intelligence in Biomedical Engineering | 4 | 3 | 1 | 0 | |
| UEC6014 | OEC | Biosensors | 4 | 3 | 1 | 0 | |
| UEC6015 | OEC | Nanotechnology in Healthcare | 4 | 3 | 1 | 0 | |
| BIO603 | Core | Minor Project / Research Thesis/ Patent | 8 | 0 | 0 | 8 | |

| M.Tech. BIOINFORMATICS SEMESTER IV | | | | | | | |
|---|---|---|---|---|---|---|---|
| **COURSE CODE** | **TYPE** | **SUBJECT NAME** | **CREDIT** | **L** | **T** | **P** | **TOTAL CREDITS** |
| BIO602 | Core | Major project/ Research Thesis/ Patent | 16 | 0 | 0 | 16 | 16 |

**(DEPARTMENT CORE COURSES)**

**FIRST YEAR (Semester 1)**

## INTRODUCTION TO BIOINFORMATICS (BIO-501)

**Details of course:-**

| Course Title | Course Structure | | | Pre-Requisite |
|---|---|---|---|---|
| | L | T | P | |
| Introduction to Bioinformatics | 3 | 0 | 2 | Nil |

**Course Objective**: The objective of the course is to introduce students to the current bioinformatics algorithm concepts and their implementation.

**Course Outcome:**

| S. No. | |
|---|---|
| 1. | To enlist biological databases and identify database types, sequence formats, sequence retrieval, and submission. |
| 2. | To define genomics and recognize the importance of the Human Genome Project. |
| 3. | To perform and apply programming techniques. |
| 4. | To perform Pairwise Sequence Alignment and learn about scoring matrices and the various algorithms involved. |
| 5. | To perform Multiple Sequence Alignment and various algorithms involved. |

| S. No. | Content | Contact Hours |
|---|---|---|
| Unit 1 | **Introduction to Biological Databases** Overview of Biological Databases and their types: NCBI: PubMed, Entrez, Blast, OMIM), Protein Databases. | 9 |
| Unit 2 | **Genomics** Structure of DNA, Polymorphisms in DNA Sequence, Human Genome Project, Complete Genome Sequences, Functional Annotation. | 9 |
| Unit 3 | **Programming for Bioinformatics:** Introduction to programming languages-Functions, Data Types, Data Structures, Arithmetic and Logical operators, Conditionals and Loops, Lists and Arrays, File Handling, | 9 |
| Unit 4 | **Pairwise Sequence Alignment:** algorithms for Local and Global alignment, Scoring matrices (PAM and BLOSUM), Needleman and Wunsch Algorithm, Smith and Waterman Algorithm. | 9 |

| | | |
|---|---|---|
| Unit 5 | **Multiple Sequence Alignment:** S coring matrices and gap penalties, internet resources for multiple sequence alignment, representation, and structural inference. | 9 |
| | Total | 45 |

**Lab Practicals:**

| S. No. | |
|---|---|
| 1. | To explore and utilize biological databases like PubMed, Entrez, BLAST, OMIM, and protein databases. |
| 2. | To visualize DNA structure, analyze SNP data, investigate the Human Genome Project, and annotate gene sequences. |
| 3. | To develop Python programs for bioinformatics tasks, including reading sequence data, calculating GC content, and parsing FASTA files. |
| 4. | To implement and compare the Needleman-Wunsch and Smith-Waterman algorithms for sequence alignment using scoring matrices.. |
| 5. | To conduct and analyze multiple sequence alignments using tools like Clustal Omega, and draw structural and functional inferences. |

**Books:**

| S.No. | Name of Book/Author/Publisher |
|---|---|
| 1. | Hasija, Y., "All About Bioinformatics: From Beginner to Expert", 2023. |
| 2. | Hasija, Y., Chakraborty, R., "Hands on Data Science for Biologists Using Python", 2021. |
| 3. | Tan, T. W., Lee, E. C., "Beginners Guide To Bioinformatics For High Throughput Sequencing", 2018. |
| 4. | Hasija, Y. (Editor), "Translational Biotechnology: A Journey from Laboratory to Clinics", 2021. |
| 5. | Shaik, N., "Essentials of Bioinformatics, Volume II: In silico Life Science: Medicine", 2019. |

## FUNCTIONAL GENOMICS AND PROTEOMICS (BIO-505)

**Details of course:-**

| Course Title | Course Structure | | | Pre-Requisite |
|---|---|---|---|---|
| | L | T | P | |
| Functional Genomics & Proteomics | 3 | 0 | 2 | Nil |

**Course Objective:** Empower students to understand and utilize principles, techniques, and applications of functional genomics and proteomics, fostering expertise in genomic and proteomic analysis for advancing biomedical research and personalized medicine

| Course Outcomes: | |
|---|---|
| 1. | **Deep Understanding**: Grasp principles and classifications, Omics theory, historical context, and modern approaches in functional genomics and proteomics. |
| 2. | **Genome Analysis Proficiency**: Master DNA sequencing, various techniques in functional genomics and proteomics |
| 3. | **Transcriptomics Expertise**: Acquire skills in mRNA profiling, alternative splicing, post-transcriptional modifications, and gene silencing. |
| 4. | **Proteomics Mastery**: Protein separation, identification, quantification, post-translational modifications analysis, and protein aggregation and ubiquitin proteasome system. |
| 5. | **Application of Genomics and Proteomics**: Application of functional genomics in, drug discovery, disease mechanisms, biomarker identification, and personalized medicine. |

| S. No. | Content | Contact Hours |
|---|---|---|
| **Unit 1** | **Introduction to Functional Genomics and Proteomics**: Overview and principles, Gene to genome and Protein to proteome, Omics theory. | **8** |
| **Unit 2** | **Proteomics and Protein Function Analysis**: Protein separation, identification, quantification, post-translational modifications, and functional proteomics approaches | **9** |
| **Unit 3** | **Transcriptomics and Gene Expression Analysis**: mRNA profiling, alternative splicing, post-transcriptional modifications, and regulatory non-coding RNAs. | **9** |
| **Unit 4** | **Genome Analysis Techniques**: DNA sequencing methods, annotation, comparative and evolutionary genomics, and PCR. | **10** |
| **Unit 5** | **Functional Genomics and Proteomics Applications**: Functional annotation, systems biology integration, and applications in drugdiscovery, disease mechanisms, biomarker identification, and personalized medicine. | **9** |
| | Total | **45** |

**Laboratory work:**

| | |
|---|---|
| 1. | To explore various biological databases like NCBI, UniProt, and EMBL, and understand sequence formats and storage (BioEdit). |
| 2 | To implement local and global sequence alignment (BLAST, ClustalW, and EMBOSS), focusing on scoring matrices, gaps, and dynamic programming. |
| 3 | Protein and DNA analysis on gel (Agarose gel electrophoresis and SDS-PAGE) |
| 4 | Real time PCR/PCR- various types and understanding the mechanism of quantification |
| 5 | Microscopy- fluorescence, white field, H&E staining |

**Books:**

| **S.No.** | **Name of Book/Author/Publisher** |
|---|---|
| 1. | "Principles of Functional Genomics and Proteomics" by Karen M. Downes and Martin J. Gannon |
| 2. | "Genome Analysis: A Laboratory Manual" by Gregory J. Hannon and Scott W. Lowe |
| 3. | "Transcriptomics: Methods and Protocols" edited by Michael J. Brownstein and Arkady Khodursky |
| 4. | "Proteomics: From Protein Sequence to Function" by Hubert Rehm and Thomas Letzel |
| 5. | "Functional Proteomics: Methods and Protocols" edited by Vicki Wysocki |
| 6. | "Functional Genomics: Methods and Protocols" edited by Michael J. Brownstein and Arkady Khodursky |

# DATABASE MANAGEMENT (BIO-507)

**Details of course: -**

| Course Title | Course Structure | | | Pre-Requisite |
|---|---|---|---|---|
| | L | T | P | |
| Database Management | 3 | 0 | 2 | Nil |

**Course Objective:**

Understand the principles of database management and data organization.
Learn to design, implement, and manage databases for biological data.
Gain proficiency in SQL and other data manipulation languages.
Explore the use of bioinformatics databases and tools in biotechnology.
Develop skills in data mining and analysis for biotechnological applications.

| Course Outcomes: | |
|---|---|
| 1. | To grasp the essentials of DBMS and recognize their importance and application in biotechnology. |
| 2. | Understanding the types and uses of bioinformatics databases and the significance of data retrieval tools in biotech research. |
| 3. | Learn database design principles and modeling techniques suitable for managing complex biological data. |
| 4. | Acquire skills in data warehousing, data mining, and their application in biotechnological data analysis. |
| 5. | Explore advanced database management topics including big data analytics, cloud |
| | computing, and ethical considerations in data handling. |

| S. No. | Content | Contact Hours |
|---|---|---|
| Unit 1 | **Introduction to Database Management Systems:** Definition, importance, and applications in biotechnology, Types of Databases: Relational, NoSQL, and their relevance to biotech data, Data Models: Hierarchical, Network, Relational, and Object-oriented models | **8** |
| Unit 2 | **Bioinformatics Databases: Biological Data Types:** Genomic, proteomic, metabolomic, and phenotypic data, Public Bioinformatics Databases: NCBI, EMBL-EBI, DDBJ, and their applications, Data Retrieval and Analysis Tools: BLAST, FASTA, and their usage in biotech research | **9** |

| | | |
|---|---|---|
| Unit 3 | **Database Design and Data Modeling:** Entity-Relationship (ER) Model: Conceptual design with ER diagrams, Normalization: Purpose, processes, and implications for biological data, SQL: Basics of Structured Query Language for creating and managing databases. | **9** |
| Unit 4 | **Data Warehousing and Data Mining in Biotechnology:** Data Warehousing Concepts: Architecture, OLAP operations, and use cases in biotech, Data Mining Techniques: Classification, clustering, association analysis in genomic and proteomic databases, Case Studies: Applications of data mining in drug discovery, genomics, and disease prediction. | **10** |
| Unit 5 | **Advanced Topics in Database Management:** Big Data Analytics: Handling large-scale biotech data, tools, and technologies, Cloud Computing and Databases: Cloud storage solutions for bioinformatics data, Ethical and Legal Aspects: Data privacy, security concerns, and regulations in biotechnology data management. | **9** |
| | Total | **45** |

| S. No. | Practicals |
|---|---|
| 1. | To explore and compare different types of databases (Relational and NoSQL) and data models (Hierarchical, Network, Relational, and Object-oriented models). |
| 2. | To navigate public bioinformatics databases and use data retrieval tools like BLAST and |
| 3. | ormalize databases using ER diagrams and SQL. |
| 4. | arehousing and data mining techniques to biotech data. |
| 5. | To handle large-scale biotech data with big data analytics and explore cloud storage ddressing ethical and legal aspects. |

**Books :**

| S.No. | Name of Book/Author/Publisher |
|---|---|
| 1 | Vince Buffalo – Bioinformatics Data Skills– O'Reilly Media 2015. |
| 2 | Abraham Silberschatz, Henry F. Korth, and S. Sudarshan– Database System Concepts – 7th Ed McGraw-Hill Education, 2020 |
| 3 | Jake Chen and Amandeep S. Sidhu– Biological Database Modeling– Artech House, 2007 |

# IMMUNOINFORMATICS (BIO-509)

**Details of course:-**

| Course Title | Course Structure | | | Pre-Requisite |
|---|---|---|---|---|
| | L | T | P | |
| Immunoinformatics | 3 | 0 | 2 | Nil |

**Course Objective:** Equip students with a deep understanding of immunology and advanced predictive modeling for development of novel immuno- therapeutics

| Course Outcomes: | |
|---|---|
| 1 | Understanding basics of immunology, including the role of humoral and cellular immunology. |
| 2 | Exploring advanced immunology: immune mechanisms, hypersensitivity, and health/disease impacts. |
| 3 | Analyzing the role of informatics in HLA supertype prediction, using clustering methods for diversity. |
| 4 | Apply immuno-informatics in vaccines development and personalized medicine. |
| 5 | Mastering in-silico prediction techniques for predicting immunogenicity, using computational tools. Developing predictive modeling skills for immune receptor-peptide binding |

| S. No. | Content | Contact Hours |
|---|---|---|
| Unit 1 | **Fundamentals of Immunology** Overview of the immune system, Innate and adaptive immune system; The Major Histocompatibility Complex (MHC) and allele selection and Antigen presentation. Antibody gene rearrangement, B cell receptor and T cell receptors. | **8** |
| Unit 2 | **Advanced Immunology** Immune effector mechanisms: cytokines, Hypersensitive reactions, The immune system in health and disease: autoimmunity and transplantation immunology, overview of vaccines | **9** |
| Unit 3 | **HLA System and Supertypes** Introduction to the HLA system in model organisms, Defining HLA supertypes, Structural and modeling principles of HLA, Clustering methods for HLA supertypes, Electrostatic distribution maps of HLA alleles | **9** |
| Unit 4 | **In-silico Prediction of Immunogenicity** Overview of in-silico prediction methods, Searching databases for peptide-MHC binding profiles (IPD, IMGT, SYFPEITHI), Application of immuno-informatics in vaccine development and personalized medicine | **10** |
| Unit 5 | **Predictive Modeling and Analysis** Support vector machine for MHC-binding peptides, QSAR models for molecular affinity predictions, Machine learning techniques, Artificial intelligence methods for predicting B and T-cell epitopes | **9** |
| | Total | **45** |

**Books :**

| S.No. | Name of Book/Author/Publisher |
|---|---|
| 1. | Immunology; Richard A. Goldsby, Thomas J. Kindt, Barbara A. Osborne, Janis Kuby; W.H. Freeman & Company, 5th edition, Pages 19-504, 2003. |
| 2. | Roitt's Essential Immunology; Ivan M. Roitt, Peter J. Delves Blackwell Science Ltd., 10th Edition, 2001. |
| 3. | Basic Immunology by A.K. Abbas and A.H. Lichtman. Third edition. Publisher: Saunders W.B. Company ,2010 |
| 4. | How the Immune System Works" by Lauren M. Sompayrac (2019) Publisher: Wiley-Blackwell |
| 5. | "Cancer Immunotherapy"Immune Suppression and Tumor Growth 2nd Edition - June 4, 2013 Editors: George C. Prendergast, Elizabeth M. Jaffee Publisher: Academic Press |
| 6. | Microbial Crosstalk with Immune System by Asmita Das (2022) Academic Press |

**Practical:**

| Sno. | Aims |
|---|---|
| 1 | Elucidating Antibody titre by ELISA method. |
| 2 | Study of Flowcytometry; identification of T cells and their subsets using Flowcytometry |
| 3 | Elucidation of advanced techniques of immune diagnostics like Immuno-electrophoresis |
| 4 | Study of Radial Immunodiffusion as a diagnostic tool. |
| 5 | Study of Double Immunodiffusion as a diagnostic tool. |
| 6 | To perform BLAST and Sequence Alignment. |
| 7 | To predict T cell epitopes |
| 8 | To predict B cell linear and discontinuous epitopes in an antigen sequence. |

**FIRST YEAR (Semester 2)**

**DEPARTMENT CORE COURSE**

## ADVANCES IN BIOINFORMATICS (BIO-502)

**Details of course:-**

| Course Title | Course Structure | | | Pre-Requisite |
|---|---|---|---|---|
| | L | T | P | |
| Advances in Bioinformatics | 3 | 0 | 2 | Nil |

**Course Objective:** The objective of this course is to familiarize students with the role of bioinformatics in understanding, analyzing, and interpreting the complex biological data associated with complex disorders.

| **Course Outcomes:** | |
|---|---|
| 1. | To identify and utilize various genetic databases relevant to complex disorders. |
| 2 | To understand the types and mechanisms of genomic variations in complex disorders and apply bioinformatics tools. |
| 3 | To apply bioinformatics tools for visualizing structural information of proteins and managing pharmacogenomic information. |
| 4 | To conduct phylogenetic analysis and utilize prediction tools for studying genetic relationships in complex disorders. |
| 5 | To understand the role of bioinformatics in the drug discovery and development process for complex disorders. |

| S. No. | Content | Contact Hours |
|---|---|---|
| Unit 1 | Introduction to Complex Disorders and Bioinformatics<br>Overview of complex disorders, SNP databases, Mutation databases, Genetic marker, and microsatellite databases, Nonnuclear and somatic mutation databases. | **8** |
| Unit 2 | Genomic Variations in Complex Disorders<br>Types and mechanisms of genetic variation, Use of bioinformatics tools and databases for mapping genetic variations and mutations. Relationship between polymorphism and genetic variation. | **9** |
| Unit 3 | Bioinformatics Tools and Techniques: PDB, MMDB, Pharmacogenomics and Personalized Medicine: PharmGKB, DrugBank. | **9** |

| | | |
|---|---|---|
| Unit 4 | Molecular Phylogenetics and Genetic Analysis: Phylogenetic prediction, types, tree building methods, and tree interpretation analysis. phylogenetic prediction tools. | **10** |
| Unit 5 | Bioinformatics in Drug Discovery and Development for Complex Disorders: Introduction, Role of bioinformatics in target identification and validation, molecular modeling | **9** |
| | Total | **45** |

| **S. No.** | **Practicals** |
|---|---|
| 1. | To visualize protein structure using PyMol, RasMol and VMD |
| 2. | To map protein interactions using STRING. |
| 3. | To utilize bioinformatics tools like PDB, MMDB, PharmGKB, and DrugBank for pharmacogenomics and personalized medicine. |
| 4. | To perform phylogenetic prediction, tree building, and tree interpretation using phylogenetic prediction tools. |
| 5. | To find the gene information of any human gene and identify cDNA libraries based on and type using CGAP. |

**Books :**

| S.No. | Name of Book/Author/Publisher |
|---|---|
| 1. | Hasija, Y., "All About Bioinformatics: From Beginner to Expert", 2023. |
| 2. | Hasija, Y., Chakraborty, R., "Hands on Data Science for Biologists Using Python", 2021. |
| 3. | "Translational Biotechnology: A Journey from Laboratory to Clinics", Editor: Yasha Hasija, 2021. |
| 4. | Lesk, A. M., "Introduction to Bioinformatics", Oxford University Press, Latest Edition |

# ADVANCED GENETIC ENGINEERING (BIO-504)

**Details of course:-**

| Course Title | Course Structure | | | Pre-Requisite |
|---|---|---|---|---|
| | L | T | P | |
| Advance Genetic Engineering | 3 | 0 | 2 | Nil |

**Course Objective:** This course covers fundamental gene concepts, the molecular mechanism of various diseases of genetic disorders, approaches for identification, epigenetics, risk assessment, and ethical

| **Course Outcomes:** | |
|---|---|
| 1. | To understand basic gene manipulation, inheritance patterns, and the history of genetic diseases. |
| 2 | Explore the molecular basis of both common and rare genetic disorders, including chromosomal aberrations and mutations. |
| 3 | Learn various approaches for identifying genetic disorders, such as linkage mapping, genome-wide association studies, and genome sequencing. |
| 4 | Examine the role of epigenetics in human genetic disorders, including its mechanisms, phenotypic changes, and inheritance patterns. |
| 5 | Gain skills in risk assessment and prediction of genetic disease inheritance, and understand the ethical considerations in genetic disease treatment. |

| S. No. | Content | Contact Hours |
|---|---|---|
| Unit 1 | **Introduction:** Basic concepts of gene manipulation, cohesive and blunt-end cloning, Restriction digestion | **8** |
| Unit 2 | **Modifying the end of DANA:** Restriction enzymes and its classification Modification enzymes, linker, adapter and accurate usage of these enzymes | **9** |
| Unit 3 | **Approaches in gene manipulation:** Restriction mapping, Directional genome walking, Identification and detection of genetic loci causing common and rare genetic disease, genome sequencing, chromosome walking, chromosome painting. | **10** |
| Unit 4 | **Nucleic acid interaction:** Southern hybridization, Colony hybridization, Northern hybridization, South-Western hybridization, Microarray | **9** |
| Unit 5 | **Transgenic technology:** Basis of transgenesis, LOH, Gene delivery | **9** |
| | Total | **45** |

**Practical:**

| S.No. | Practicals |
|---|---|
| **1** | Designing and strategy of gene cloning |
| **2** | Restriction digestion |
| **A.** | Single |
| **B.** | double and partial digestion |
| **C.** | Star activity |
| **3.** | Agarose gel electrophoresis |
| **4.** | Modification of DNA ends |
| **5.** | PCR |

**Books :**

| S.No. | Name of Book/Author/Publisher |
|---|---|
| 1. | GENE CLONING AND DNA ANALYSIS AN INTRODUCTION 7ED (PB 2016) Paperback – 19 January 2016- T.A. Brown Wiely Blackwell |
| 2. | Recombinant DNA: A Short Course Paperback – 15 February 1992 by James D. Watson (Author), |
| 3 | Molecular Cloning part I, II and III- Sambrook et al, Cold Spring Harbour Laboratory |

## RESEARCH METHODOLOGY (UCC-502)

**Details of course:-**

| Course Title | Course Structure | | | Pre-Requisite |
|---|---|---|---|---|
| | L | T | P | |
| Research Methodology | 3 | 1 | 0 | Nil |

**Course Objective:** A research methodology gives research legitimacy and provides scientifically sound findings and helps to keep researchers on track, making the process smooth, effective and manageable.

| Course Outcomes: | |
|---|---|
| 1. | Understand the steps involved in identification and formulation of research problem. |
| 2 | Acquire knowledge about research design and sampling techniques. |
| 3 | Illustrate and interpret data Scientific writing. |
| 4 | Understand the Formulation of scientific communication. |

| | |
|---|---|
| 5 | Interpret results of commonly used statistical analyses using computer application. |

| S. No. | Content | Contact Hours |
|---|---|---|
| Unit 1 | An overview of research methodology: Research concept, steps involved, identification, selection and formulation of research problem, justification, hypothesis; literature collection-textual and digital resources (internet) | **8** |
| Unit 2 | Research design, data collection and interpretation: Research design; sampling techniques, presentation, analysis. | **9** |
| Unit 3 | Interpretation of data Scientific writing: Forms of scientific writing- Article, notes, reports, review article, monographs, dissertations, popular science articles, bibliographies. | **9** |
| Unit 4 | Formulation of scientific communication - Outline preparation, drafting title, sub titles, tables, illustrations; Formatting tables- title, body footnotes; figures & graphs- structure, title and legends, Impact factor, citation indices, plagiarism | **10** |
| Unit 5 | Computer application: MS office, excel, power point, graphics (Sigma plot), statistical software ESPSS) | **9** |
| | Total | **45** |

**Books :**

| S.No. | Name of Book/Author/Publisher |
|---|---|
| 1. | Research Methodology - Methods & Techniques, CR Kothri CR (1990), Vishva Prakashan, New Delhi. |
| 2. | Research methodology for biological sciences, N Gurumani (2007), MJP Publishers, Chennai. |
| 3. | Introduction to Biostatistics, L Forthofer (1995), Academic Press, New York. |
| 4. | Experimental Design & Data Analysis for Biologists. PQ Gerry & JK Michael (2002), Cambridge University Press. |

**2ND YEAR (SEMESTER III)**

**DEPARTMENT CORE COURSE**

**IPR IN BIOTECHNOLOGY (BIO-601)**

**Details of course:-**

| Course Title | Course Structure | | | Pre-Requisite |
|---|---|---|---|---|
| | L | T | P | |
| **IPR in Biotechnology** | **3** | **1** | **0** | **Nil** |

**Course Objective:** Provide students with a comprehensive understanding of intellectual property; patents; trademarks; and biosafety principles.

| Course Outcomes: | |
|---|---|
| **1.** | Understanding the significance of intellectual property and biosafety principles. |
| **2** | Mastering the concept of "prior art" and proficiently conducting patent searches. |
| **3** | Gaining knowledge of patent basics and procedures for effective patent filing. |
| **4** | Developing practical skills in patent filing and understanding patent infringement. |
| **5** | Comprehending biosafety principles and regulations governing production and use of GMO release. |

| S. No. | Content | Contact Hours |
|---|---|---|
| **Unit 1** | **Introduction to Intellectual Property**<br>Types of IP: Patents, Trademarks, Copyright, Industrial Design, Traditional Knowledge, Geographical Indications. | **8** |
| **Unit 2** | **Grant of Patent**<br>Concept of the prior art; rights; and duties; PCT; IPR in bioinformatics; software; Agreement; and treaties: GATT, TRIPS Agreements, WIPO Treaties, Budapest Treaty on international recognition of the deposit of microorganisms; UPOV & Brene conventions. | **9** |

| | | |
|---|---|---|
| **Unit 3** | **Patent filing procedure**<br>Patent application- forms and guidelines; Filing of a patent application; patenting-disclosure/non-disclosure; International requirements; procedures; and costs; Procedure for filing a PCT application. | **9** |
| **Unit 4** | **Biosafety**<br>Introduction; Historical Background; Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals; Biosafety guidelines - Government of India; Definition of GMOs & LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC, etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of National Regulations and relevant International Agreements including Cartagena Protocol. | **10** |
| **Unit 5** | **Research ethics and sustainability**<br>Ethical principles in research; researcher responsibility to the environment; Bioengineering ethics; rights and responsibility; legal protection of IPR and case studies. | **9** |
| | **Total** | **45** |

**Books :**

| **S.No.** | **Name of Book/Author/Publisher** |
|---|---|
| **1.** | IPR biosafety and bioethics by Goel And Parashar; publisher: Pearson Education India |
| **2.** | http://www.wipo.int/portal/index.html.en |
| **3.** | www.patentoffice.nic.in |
| **4.** | http://www.cdc.gov/OD/ohs/symp5/jyrtext.htm |
| **5.** | Intellectual property rights; biosafety and bioethics (Ethical Frontiers) by Dr. Alok kumar srivastav; Dr. Pooja Sharma; Dr. Priyanka das; Dr. Vandita Billore Parashar |
| **6.** | Biosafety; Bioethics and Intellectual Property Rights; Author: Dr. Anil Dusane; Book ID: 2013; ISBN: 978-93-90646-23 |

**SEMESTER 1**

**ELECTIVE -1 (BIO-531)**

# PHARMACOGENOMICS AND PERSONALIZED MEDICINE (BIO-5311)

**Details of course: -**

| **Course Title** | **Course Structure** | | | **Pre-Requisite** |
|---|---|---|---|---|
| | L | T | P | |
| Pharmacogenomics and Personalized Medicine | 3 | 1 | 0 | Nil |

**Course Objective:** Pharmacogenomics and Personalized Medicine course is to educate students on the principles and applications of pharmacogenomics in tailoring medical treatments to individual genetic variations. The course aims to familiarize students with the genetic basis of drug response variability, including pharmacokinetic and pharmacodynamic factors, and to explore how genomic information can be used to optimize drug selection, dosage, and treatment strategies for improved therapeutic outcomes and reduced adverse drug reactions.

| **Course Outcome:** | |
|---|---|
| S. No. | |
| 1. | To demonstrate an understanding of genetic variations influencing drug response, including pharmacokinetic and pharmacodynamic factors, and their impact on individualized treatment outcomes. |
| 2. | To apply pharmacogenomic testing and analysis techniques to predict drug response, optimize drug selection and dosing, and minimize adverse reactions based on individual genetic profiles. |
| 3. | Develop skills in integrating pharmacogenomic information into clinical decision-making processes, including patient assessment, drug therapy management, and treatment plan optimization for personalized medicine approaches. |
| 4. | Critically evaluate ethical, legal, and societal issues related to pharmacogenomics and personalized medicine, including genetic privacy, informed consent, healthcare equity, and the impact of genetic testing on patient care and healthcare policy. |
| 5. | To explore current trends and advancements in pharmacogenomics research and innovative technologies, critically analyze scientific literature, and propose potential applications of pharmacogenomic strategies in improving patient outcomes and healthcare delivery. |

| S. No. | Content | Contact Hours |
|---|---|---|
| Unit 1 | **Fundamentals of Pharmacogenomics:**<br>Introduction to Pharmacogenomics: Concepts and historical perspective, Genetic Polymorphisms and Drug Metabolism, Pharmacokinetics and Pharmacodynamics. | 9 |
| Unit 2 | **Technologies in Pharmacogenomics**:<br>Genomic Technologies: DNA sequencing, microarrays, and SNP analysis; Bioinformatics Tools for Genetic Analysis: Data mining and interpretation of genetic data; Biomarkers and Their Role in Personalized Medicine | 10 |
| Unit 3 | **Pharmacogenomics in Clinical Practice**:<br>Implementing Pharmacogenomic Testing in Clinical Settings: Challenges and Considerations, Drug Labeling and Regulatory Aspects: FDA guidelines, National and International perspectives. | 9 |
| Unit 4 | **Personalized Medicine:**<br>Integrating clinical and environmental factors in personalized medicine, The Future of Personalized Medicine: Next-generation sequencing, CRISPR, Personalized Medicine in Oncology, Cardiovascular Diseases, and Psychiatric Disorders. | 10 |
| Unit 5 | **Ethical, Legal, and Social Implications (ELSI)**:<br>Privacy and Confidentiality of Genetic Information, Direct-to-Consumer Genetic Testing: Pros and cons, Ethical Considerations in Clinical and Research Settings. | 7 |
| | Total | 45 |

**Books :**

| S.No. | Name of Book/Author/Publisher |
|---|---|
| 1. | Pharmacogenomics: Challenges and Opportunities in Therapeutic Implementation by Yui-Wing Francis Lam and Larisa H. Cavallari- Academic Press, 2019 |
| 2. | Principles of Pharmacogenetics and Pharmacogenomics edited by Russ B. Altman, David Flockhart, and David B. Goldstein- Cambridge University Press, 2012 |
| 3. | Essentials of Pharmacogenomics by Daniel L. Hartman and Daniel M. Roden.- Sinauer Associates, 2009 |
| 4. | Clinical Pharmacogenetics by Richard M. Weinshilboum and Liewei Wang- McGraw-Hill Education, 2012 |
| 5. | Pharmacogenomics in Clinical Therapeutics by Yusuke Nakamura and Urs A. Meyer- CRC Press, 2013 |

# SYSTEMS BIOLOGY (BIO-5312)

**Details of course:-**

| Course Title | Course Structure | | | Pre-Requisite |
|---|---|---|---|---|
| | L | T | P | |
| System Biology | 3 | 1 | 0 | Nil |

**Course Objective:** The system biology course seeks to provide students with a holistic understanding of biological systems by integrating knowledge from biology, mathematics, computer science, and statistics. The course objectives include comprehending the complexity of biological networks, learning mathematical and computational modeling techniques, analyzing large-scale biological data, exploring applications in biomedicine and biotechnology, and discussing ethical and societal implications.

| **Course Outcomes:** | |
|---|---|
| 1 | To demonstrate proficiency in systems thinking by analyzing biological systems as interconnected networks of components, understanding emergent properties, and identifying feedback loops and system dynamics. |
| 2 | Develop skills in mathematical and computational modeling techniques, including deterministic and stochastic models, network analysis, and dynamic systems modeling, to describe and simulate biological processes. |
| 3 | Apply statistical methods, machine learning algorithms, and bioinformatics tools to analyze and interpret large-scale biological data sets, such as genomics, proteomics, and metabolomics data. |
| 4 | Integrate knowledge from biology, mathematics, computer science, and statistics to address complex biological questions, design experiments, and develop computational models for understanding and predicting biological phenomena. |
| 5 | Critically evaluate ethical, legal, and societal implications of systems biology research and applications, considering issues related to data privacy, genetic engineering, healthcare decision-making, and the responsible use of technology in biomedicine and biotechnology. |

| S. No. | Content | Contact Hours |
|---|---|---|
| Unit 1 | **Introduction to Systems Biology:**<br>Overview of Systems Biology: Definitions, scope, and importance. Historical Perspectives and Key Concepts. Systems Biology vs. Traditional Molecular Biology Approaches. | **8** |
| Unit 2 | **Biological Networks and Systems:**<br>Types of Biological Networks: Metabolic, Genetic, Protein-Protein Interaction (PPI) Networks. Network Properties and Analysis: Topology, Motifs, and Modules. Introduction to Network Visualization Tools. | **9** |

| | | |
|---|---|---|
| Unit 3 | **Omics Technologies and Systems Integration:**<br>Overview of Omics Technologies: Genomics, Transcriptomics, Proteomics, Metabolomics, Integrative Analysis of Omics Data. | **9** |
| Unit 4 | **Modeling Biological Systems:**<br>Mathematical Modeling in Systems Biology: Deterministic and Stochastic Models, Dynamic Systems and Kinetic Modeling, Simulation of Biological Processes. | **10** |
| Unit 5 | **Systems Biology in Health and Disease:**<br>Systems Pharmacology and Drug Discovery, Systems Biology Approaches to Understanding Disease Mechanisms, Personalized Medicine and Systems Biology. | **9** |
| | Total | **45** |

**Books :**

| S.No. | Name of Book/Author/Publisher |
|---|---|
| 1. | An Introduction to Systems Biology: Design Principles of Biological Circuits by Uri Alon - Chapman and Hall/CRC, 2006 |
| 2. | Systems Biology: A Textbook by Edda Klipp, Wolfram Liebermeister, Christoph Wierling, Axel Kowald, Hans Lehrach, and Ralf Herwig- Wiley-Blackwell, 2016 (2nd Edition) |
| 3. | Systems Biology: Simulation of Dynamic Network States by Bernhard Palsson- Cambridge University Press, 2011 |
| 4. | Ingalls, Brian P. Mathematical Modeling in Systems Biology: An Introduction (1st edition). MIT Press, 2013. |
| 5. | Wilkinson, Darren J. Stochastic Modelling for Systems Biology. Chapman & Hall, 2006. |

# OMICS IN MEDICINE (BIO-5313)

**Details of course:-**

| Course Title | Course Structure | | | Pre-Requisite |
|---|---|---|---|---|
| | L | T | P | |
| OMICS in Medicine | 3 | 1 | 0 | Nil |

**Course Objective:** Empower students with comprehensive knowledge and practical skills in omics technologies for precise disease diagnosis, treatment, and advancing translational medicine.

| **Course Outcomes:** | |
|---|---|
| **1** | **Omics Technology Understanding**: Grasp sequencing, metagenomics, and pharmacogenomics for medical research and practice. |
| **2** | **Infectious Disease Genomics Expertise**: Identify pathogens, understand epidemiology, assess host resistance, and devise strategies against infectious diseases using genomics. |
| **3** | **Genetic Disorder Proficiency**: Detect genetic disorders, understand molecular basis, explore treatments including pharmacogenomics. |
| **4** | **Epigenomics and Non-coding RNAs Comprehension**: Understand their roles in disease, inheritance, and control for medical research and practice. |
| **5** | **Genomics in Clinical Trials Application**: Apply genomics in translational medicine, clinical trials, risk assessment, and prediction with successful case studies exposure. |

| S. No. | Content | Contact Hours |
|---|---|---|
| **Unit 1** | Introduction: Omics concepts and applications, sequencing of Human and other organisms | **8** |
| **Unit 2** | Metagenomics of infectious diseases: Role of Genomics in identification of microbes causing infectious diseases (microbiomes study), molecular epidemiology, host resistance to infection, pathogenicity, combating infectious diseases | **9** |
| **Unit 3** | Detection of genetic disorders: Genomics in detection of genetic disorders and treatment, pharmacogenomics | **9** |
| **Unit 4** | Epigenomics and non-coding RNAs: Role of Epigenomics and non-coding RNAs in disease development, inheritance and control | **10** |
| **Unit 5** | Translational and clinical trials: Genomics in translational and clinical trials, and risk assessments/prediction of genetic diseases with few successful case studies | **9** |
| | Total | **45** |

**Books :**

| S.No. | Name of Book/Author/Publisher |
|---|---|
| 1. | Human Molecular Genetics, Third Edition (2003) T. Strachan and A.P. Read,Garland Science Publication. |
| 2. | Molecular Cell Biology, Sixth Edition (2007) H. Lodish, A. Berk, and C.A.Kaiser, W. H. Freeman & Co Ltd. |
| 3. | Cardiovascular Genetics and Genomics for the Cardiologist (2007) Victor J. Dzau and Choong-Chin Liew, Blackwell Publishing. |
| 4. | Genomics: The Science of Technology Behind the Human Genome Project(1999), Charles R. Cantor and Cassandra L. Smith, John Wiley & Sons, Inc. |
| 5. | A Century of Mendelism in Human Genetics (2005), Milo Keynes, A.W.F.Edwards and Robert Peel, CRC Press. |
| 6. | Genetics and Genomics in Medicine (2014) Strachan T, Goodship J, Chinnery P, Garland Science, first edition, Garland Science, New York, U.S.A |
| 7. | Genomics, personalized medicine and oral disease(2015) First edition, 2015, Springer publisher |

## BIOCHEMICAL ENGINEERING PRINCIPLES (BIO-5314)

**Details of course:-**

| Course Title | Course Structure | | | Pre-Requisite |
|---|---|---|---|---|
| | L | T | P | |
| Biochemical Engineering Principles | 3 | 1 | 0 | Nil |

**Course Objective:** To introduce the key aspects associated with biochemical processes and calculation techniques used in reactor designing and to acquaint the students with fundamentals of the different reaction systems.

| Course Outcomes: | |
|---|---|
| 1 | Understand the Microbial Process Principles. |
| 2 | Analyse the Mathematical modelling and kinetics of microbial growth. |
| 3 | Identify the Sterilization Principles and thermal death kinetics of microorganism. |
| 4 | Compare and contrast the different types of Bioreactor |
| 5 | Understand the Instrumentation and Control of Biochemical process variables. |

| S. No. | Content | Contact Hours |
|---|---|---|
| Unit 1 | Microbial Process Principles: Microbial growth; Synchronous culture, Biomass yield; Energetics of the cells. | **8** |
| Unit 2 | Kinetics of Microbial Growth, Substrate Utilization and Product Formation: Mathematical modelling of microbial growth; Substrate utilization and product formation kinetics; plasmid Instability. | **9** |
| Unit 3 | Sterilization: Principles and mechanism of media sterilization. Thermal death kinetics, Air sterilization. | **9** |
| Unit 4 | Bioreactor Design and Analysis: Bioreactor configuration, Bioreactor design and optimum operations, Basic concept of scale-up of bioreactors, Introduction to design of homogeneous & heterogeneous reaction system. | **10** |
| Unit 5 | Instrumentation and Control: Biochemical process variables and their measurements, Control principles and their application in bioreactors. | **9** |
| | Total | **45** |

**Books :**

| S.No. | Name of Book/Author/Publisher |
|---|---|
| 1. | Introduction to Biochemical Engineering by D.G. Rao. Publisher: Tata McGraw-Hill Education, 2009 |
| 2. | Bioprocess Engineering Principles by P. Doran, Elsevier Science, 2013 |
| 3. | Principles of fermentation technology by Stanbury and Whitaker, Elsevier Science, 2016 |
| 4. | Chemical reaction engineering by O.Levenspiel. Publisher: John Wiley and sons Inc., 1999 |
| 5. | Coulson's and Richardson's Chemical Engineering by J.F. Richardson and D.G. Peacock Publisher: Asian books, 1994 |

## Metabolomics (BIO-5315)

**Details of course:-**

| Course Title | Course Structure | | | Pre-Requisite |
|---|---|---|---|---|
| | **L** | **T** | **P** | |
| Metabolomics | 3 | 1 | 0 | Knowledge of pathways, metabolites, and flux balance |

**Course Objective:** To grasp knowledge about metabolomics and to apply it to various biological applications

| **Course Outcomes:** | |
|---|---|
| **1** | To understand the concept of metabolomics |
| **2** | To appraise various technologies used in metabolomics |
| **3** | To apply metabolomics to biology |
| **4** | To comprehend the concept of metabolic engineering, its principle, technologies and applications |
| **5** | To gain insight into analysis of flux balance |

| **S. No.** | **Content** | **Contact Hours** |
|---|---|---|
| **Unit 1** | Metabolomics: Overview; Background and definitions; Significance of metabolomics | 8 |
| **Unit 2** | Techniques in Metabolomics: Metabolite isolation and analysis by Mass Spectrometry, Metabolite library; HPLC; Capillary electrophoresis coupled with mass spectrometry | 9 |
| **Unit 3** | Applications of Metabolomics with Case Studies: Applications of metabolomics to biology: examples and case studies; Metabolome informatics; Data integration and mining | 9 |
| **Unit 4** | Metabolic Engineering: Introduction; Metabolic pathways; Bioenergetics; Principles of metabolic engineering; Methods of metabolic engineering; Applications | 9 |
| **Unit 5** | Flux Balance Analysis: Metabolic flux analysis; Stoichiometry; Flux balance methods; Group-based flux balance; Metabolic control analysis: overview, control coefficients, methods of measuring control; Flux analysis of networks - top-down approach, bottom-up approach | 10 |
| | **Total** | **45** |

**Books :**

| S.No. | Name of Book/Author/Publisher |
|---|---|
| **1** | Metabolomics: The Frontier of Systems Biology by M Tomita, T. Nishioka. Publisher: Springer |
| **2** | Metabolic Engineering: Principles and Methodologies by G Stephanopoulos. Publisher: Academic Press |
| **3** | Metabolomics: Methods and Protocols by W Weckwerth. Publisher: Humana Press |
| 4. | Metabolic Engineering by SY Lee, ET Papoutsakis. Publisher: CRC Press |
| 5. | Metabolomics, Metabonomics and Metabolite Profiling by WJ Griffiths. Publisher: Royal Society of Chemistry |

## GENOMICS: From human Genome project to medical Application (BIO-5316)

**Details of course:-**

| Course Title | Course Structure | | | Pre-Requisite |
|---|---|---|---|---|
| Genomics. From Human Genome to medical Application | L | T | P | |
| | 3 | 1 | 0 | |

**Course Objective**: The objective of this course to impart knowledge on Human genome project and its application in Infectious disease, genetic disease and cancer

**Course Outcome:**

| S. No. | |
|---|---|
| 1. | To Understand biotechnology and genomics in medicine |
| 2. | To enlist Humangenome project and functional genomics |
| 3. | To illustrate the application of genomics in infectious diseases |
| 4. | Acquire knowledge on application of genomics in genetic disease |
| 5. | To illustrate the application of genomics in cancer |

| S. No. | Content | Contact Hours |
|---|---|---|
| Unit 1 | Biotechnology and Genomics in Medicine: Gene Medicine, Disease Models, Impact of Genomics on Medicine, Molecular Medicines | 9 |
| Unit 2 | Genomics: Human Genome Project Breakthroughs, FunctionalGenomics: Comparative Genomics, Transcriptomics, Proteomics, Mutational Genomics | 9 |
| Unit 3 | Genomics Applications in Infectious Diseases: Identification of causative microbes, molecular epidemiology, host resistance to infection, pathogenicity, combating infectious diseases | 9 |
| Unit 4 | Genomics Applications in Genetic Diseases: Genetic Disorders, detection and treatment of single gene disorders, analysis of polygenic disorders: linkage analysis, Linkage disequilibrium mapping, haplotypes, MHC, pharmacogenomics | 9 |
| Unit 5 | Genomics Applications in Cancer: Molecular basis of cancer, impact of genomics on cancer research, methods for the diagnosis of cancer, approaches to cancer therapy | 9 |
| | Total | 45 |

B**ooks :**

| S.No. | Name of Book/Author/Publisher |
|---|---|
| **1.** | Human Molecular Genetics, Third Edition (2003) T. Strachan and A.P. Read, Garland Science Publication. |
| **2.** | Molecular Cell Biology, Sixth Edition (2007) H. Lodish, A. Berk, and C.A. Kaiser, W. H. Freeman & Co Ltd. |
| **3.** | Cardiovascular Genetics and Genomics for the Cardiologist (2007) Victor J. Dzau and Choong-Chin Liew, Blackwell Publishing. |
| **4.** | Genomics: The Science of Technology Behind the Human Genome Project (1999), Charles R. Cantor and Cassandra L. Smith, John Wiley & Sons, Inc. |

# COMPUTER GRAPHICS (BIO-5317)

**Details of course:**

| Course Title | Course Structure | | | Pre-Requisite |
|---|---|---|---|---|
| Computer Graphics | L | T | P | |
| | 3 | 1 | 0 | NIL |

**Course Objective**:
The objective of this course is to introduce students to the application of computer graphics techniques in bioinformatics, focusing on visualization methods that enhance the understanding and analysis of biological data.

**Course Outcome:**

| S. No. | |
|---|---|
| 1. | Understand the basics of computer graphics and their applications in visualizing bioinformatics data. |
| 2. | Utilize software tools and programming libraries for generating graphical representations of data. |
| 3. | Implement techniques for molecular modeling and visualization of complex biological structures. |
| 4. | Analyze and interpret biological data through visual aids such as heatmaps, phylogenetic trees, and more. |
| 5. | Develop custom visualization tools to aid in the research and presentation of genomic data. |

| S. No. | Content | Contact Hours |
|---|---|---|
| Unit 1 | Introduction to Graphics Systems: Basic concepts in computer graphics, rendering techniques, visualization libraries. | 9 |
| Unit 2 | Visualization of Biological Data: Techniques for visualizing sequences, genomic data, and protein structures. | 9 |
| Unit 3 | Graphical Representation of Data: Use of Python and R for creating plots, charts, and interactive visuals. | 9 |
| Unit 4 | Molecular Graphics: Tools and techniques for the 3D visualization of molecules and cellular structures. | 9 |
| Unit 5 | Advanced Topics in Bioinformatics Graphics: Custom tool development, integrative visuals. | 9 |
| | Total | 45 |

B**ooks :**

| S.No. | Name of Book/Author/Publisher |
|---|---|
| 1. | **Python for Data Analysis** by Wes McKinney |
| 2. | Hasija, Y., Chakraborty, R., "Hands on Data Science for Biologists Using Python", 2021. |
| 3. | **Molecular Modelling for Beginners** by Alan Hinchliffe |

**SEMESTER –II**
**ELECTIVE-2**
**(BIO-532)**

## DRUG DESIGN AND DELIVERY (BIO-5321)

**Details of course:-**

| Course Title | Course Structure | | | Pre-Requisite |
|---|---|---|---|---|
| | L | T | P | |
| Drug Design and Delivery | 3 | 1 | 0 | Nil |

**Course Objective:** Exploring the concepts in Drug Design and Development with emphasis on the role of Bioinformatics in lead identification and lead optimization. Provides in-depth knowledge of the regulations involved in the translation of 'bench to bedside' of a new drug and its IPR regulations.

| Course Outcomes: | |
|---|---|
| 1 | Illustrating the process of drug discovery and discussing the diverse sources of drugs |
| 2 | Examine the traditional vs new-age drug design and development. |
| 3 | Elucidating the receptor theory and role of enzyme kinetics in drug design and development. |
| 4 | Outline the role of clinical trials in the drug development system. |
| 5 | Demonstrating the various drug delivery mechanisms for effective active drug concentration. |

| S. No. | Content | Contact Hours |
|---|---|---|
| Unit 1 | **Introduction to drug discovery and delivery**<br>Drug Discovery and development overview, Source of drugs, molecular screening strategies, traditional drug development; concept of lead identification, Lead optimization, Rational drug design. | **10** |
| Unit 2 | **Drug development methods**<br>Preclinical drug development, traditional drug development; computational drug design, docking, QSAR, and pharmacophore modeling. | **9** |
| Unit 3 | **Pharmacology and Pharmacodynamics**<br>Concept of Receptor Theory; Enzyme kinetics, Enzyme inhibition, Allosteric modulators, Enzymes as drug targets, Agonist and antagonist, Peptidomimetics. | **8** |
| Unit 4 | **Clinical trials in drug development**<br>Phases of Clinical Trials IPR regulations in drug development, Biosafety regulations. | **8** |
| Unit 5 | **Analysis of case studies in drug development** | **10** |

| | | |
|---|---|---|
| | 'Bench to Bedside' translation of drugs, overview of Drug delivery systems, nanomedicine, Case studies of recent advances in drug development. | |
| | Total | **45** |

**Books :**

| S.No. | Name of Book/Author/Publisher |
|---|---|
| 1. | Comprehensive Medicinal Chemistry III 3rd Edition - June 3, 2017<br>Editors: Samuel Chackalamannil, David Rotella, Simon Ward, publisher Elsevier |
| 2. | "Enzyme Inhibitors as Drugs: Volume 1 and Volume 2" Author: Edited by Ernesto Fattorusso and Orazio Taglialatela-Scafati, Publisher:The Royal Society of Chemistry<br>Publication Date: Volume 1: 2019, Volume 2: 2020 |
| 3. | Textbook of Drug Design and Discovery; August 2017<br>Edited By Kristian Stromgaard, Povl Krogsgaard-Larsen, Ulf Madsen publisher; CRC press |
| 4. | "Drug Design: Cutting Edge Approaches" Editors: Edited by S. Joel G. Abraham, Paul A. Selzer, and Lars Olsen, Publisher: Royal Society of Chemistry Publication Date: 2019 |
| 5. | Protein folding and Drug Design, R.A Broglia and L.Serrano, publisher- IOS Press, 2007 |

## ANALYSIS OF BIOLOGICAL NETWORKS (BIO-5322)

**Details of course:-**

| Course Title | Course Structure | | | Pre-Requisite |
|---|---|---|---|---|
| | L | T | P | |
| Analysis of Biological Networks | 3 | 1 | 0 | Knowledge of biological pathways |

**Course Objective:** To be able to analyze various types of biological networks

| Course Outcomes: | |
|---|---|
| 1 | To understand the concept of biological networks |
| 2 | To analyze various networks |

| | |
|---|---|
| 3 | To gain insight into network motifs |
| 4 | To analyze networks through clustering |
| 5 | To appraise various types of biological networks |

| S. No. | Content | Contact Hours |
|---|---|---|
| Unit 1 | **Introduction to the Biological Networks:** Systems Biology, Properties of Biological Networks and Graph Theory - Basic Notation, Special Graphs, Graph Representation and Graph Algorithms | **8** |
| Unit 2 | **Network Analysis:** Global Network Properties, Global Properties of Complex Networks, Models of Complex Networks, Additional Properties of Complex Networks, Statistical Testing of Network Properties, Network Centralities - Centrality Definition, Fundamental Properties Degree, Shortest Path-Based Centralities, Feedback-Based Centralities | **12** |
| Unit 3 | **Network Motifs:** Definitions, Basic Concepts, Motif Statistics, Motif-Based Network Distance, Complexity of Network Motif Detection, Methods and Tools for Network Motif Analysis, Analyses and Applications of Network Motifs | **8** |
| Unit 4 | **Network Clustering:** Network Clustering Problem, Clique-Based Clustering, Centre-Based Clustering | **7** |
| Unit 5 | **Types of Networks:** Signal Transduction and Gene Regulation Networks, Protein Interaction Networks, Metabolic Networks, Phylogenetic Networks, Ecological Networks | **10** |
| | Total | **45** |

**Books :**

| S.No. | Name of Book/Author/Publisher |
|---|---|
| 1. | Introduction to Biological Networks by A Raval, A Ray. Publisher: CRC Press |
| 2. | Biological Networks and Pathway Analysis, Editors: TV Tatarinova, N Yuri. Publisher: Humana Press |

# PLANT BIOINFORMATICS (BIO-5323)

**Details of course:-**

| Course Title | Course Structure | | | Pre-Requisite |
|---|---|---|---|---|
| | L | T | P | |
| Plant Bioinformatics | 3 | 1 | 0 | Nil |

**Course Objective:**This course provides a comprehensive overview of plant bioinformatics, focusing on the analysis of biological data from plants using computational tools. Students will study various bioinformatics methods, data analysis techniques, and applications of bioinformatics in plant sciences.

| **Course Outcomes:** | |
|---|---|
| 1 | Understand the principles and methods of plant bioinformatics. |
| 2 | Learn about various types of biological data from plants and how to analyze them. |
| 3 | Explore bioinformatics tools and resources for plant data analysis. |
| 4 | Analyze applications of bioinformatics in plant breeding, genomics, and biotechnology. |
| 5 | Conduct research and present findings on a specific topic in plant bioinformatics. |

| S. No. | Content | Contact Hours |
|---|---|---|
| Unit 1 | **Introduction to Plant Bioinformatics:** Importance of plant bioinformatics, biological databases , Protein and Gene Information Resources – PIR, SWISSPROT, PDB, genebank. | **9** |
| Unit 2 | **Plant specific Genomic Data and Resources:** HarvEST, TARI Database, Legume Resources, GrainGenes, Maize GDB, Gramene | **9** |
| Unit 3 | **Phylogenetic data and phylogenies:** Software used to discover phylogenies, use and status of specimen data, species distribution, Current priorities in biodiversity informatics, challenges and future prospect | **9** |
| Unit 4 | **KEGG Bioinformatic Resource for Plant Genomic Research:** KEGG tools and Resources, Germplasm Data Management | **9** |
| Unit 5 | **Gene Structure Annotation at Plant GDB:** PlantGDB Resources, Gene Ontology Annotation, Manual Annotations, Computational Annotation Methods | **9** |
| | Total | **45** |

Books :

| S.No. | Name of Book/Author/Publisher |
|---|---|
| 1. | Plant Bioinformatics: Methods and Protocols, David Edwards, Humana Press, 2007. |
| 2. | Plant Genomics: Methods and Protocols, Daryl J. Somers, Peter Langridge and J. Perry Gustafson, Humana Press, 2009. |

# MICROARRAY TECHNOLOGY (BIO-5324)

**Details of course:-**

| Course Title | Course Structure | | | Pre-Requisite |
|---|---|---|---|---|
| | L | T | P | |
| Microarray Technology | 3 | 1 | 0 | Nil |

**Course Objective:** Objective of this course is to get insight into Microarray technology, and types. understanding the data acquisition and application of microarray technology

| Course Outcomes: | |
|---|---|
| 1 | Understand the microarray technology and different type |
| 2 | Illustrate the manufacturing of *in-situ Microarray* |
| 3 | Demonstrate the method of manufacturing of spotted microarray |
| 4 | Analyze the data acquired image data obtained |
| 5 | Outline the applications of microarray technology |

| S. No. | Content | Contact Hours |
|---|---|---|
| Unit 1 | Introduction:Types of microarray, cDNA microarray, oligonucleotide microarray, spotted microarray, In situ synthesized microarray, Hybridization process, DNA microarray database | **8** |
| Unit 2 | In situ synthesized microarray: Method of manufacturing, Phosphoramidite method | **9** |
| Unit 3 | Spotted microarray: Method of manufacturing, Photolithography | **9** |
| Unit 4 | Data acquisition and chip image analysis:Image segmentation, Intensity measurement, Normalization of data, Clustering analysis, Coexpression analysis | **10** |
| Unit 5 | Applications of microarray technology: Differential gene expression analysis, Expression profiling, Genome sequencing, Copy number variation, Alternative splicing detection, Mutation analysis | **9** |
| | Total | **45** |

**Books :**

| S.No. | Name of Book/Author/Publisher |
|---|---|
| 1. | Microarray Data Analysis: Gene Expression Data Analysis. A Beginner's Guide by H. Causton, J. Quackenbush and A. Brazma. Publisher: Blackwell, 2003 |
| 2. | A Practical Approach to Microarray Data Analysis by D.P. Berrar, W. Dubitzky, M. Granzow. Publisher: Springer, 2003 |
| 3. | Data Analysis Tools for DNA Microarrays by S. Drăghici. Publisher: Chapman and Hall/CRC, 2003 |
| 4. | Analysis of Microarray Data: A Network-Based Approach by F. Emmert-Streib and M. Dehmer. Publisher: Wiley-VCH Verlag GmbH & Co., 2008 |

# BIOSTATISTICS (BIO-5323)

**Details of course:-**

| Course Title | Course Structure | | | Pre-Requisite |
|---|---|---|---|---|
| Biostatistics | L | T | P | |
| | 3 | 1 | 0 | |

**Course Objective**: To Know the basic statistical concepts and Interpret results of commonly used statistical analyses in written summaries.

**Course Outcome:**

| S. No. | |
|---|---|
| 1. | Understand the role of Biostatistics and Probability. |
| 2. | To know the basics of Random variable and distribution function. |
| 3. | To gain insight into Probability distributions. |
| 4. | To gain knowledge about Correlation, regression and sampling distributions. |
| 5. | To learn the Knowledge-based exact sampling distributions and small sample test. |

| S. No. | Content | Contact Hours |
|---|---|---|
| Unit 1 | **Descriptive Statistics & Probability:** Measure of central tendency and dispersion, Axiomatic concepts; Conditional probability. Multiplication rule of probability. Baye's rule. | 9 |
| Unit 2 | **Random variable and expectation:** Random variable and distribution function. Mathematical expectation. Statistical parameters. Chebyshev's inequality. | 9 |
| Unit 3 | **Probability distributions:** Binomial, Multinomial, Poisson and Exponential distribution | 9 |
| Unit 4 | **Correlation, regression and sampling distributions:** Method of least square and curve fitting, Probable error, Regression, Statistics and sampling distributions, Tests of significance | 9 |
| Unit 5 | **Exact sampling distributions and small sample test:** The Chi-square distribution. Student's t-distribution. Snedecor's F-distribution. | 9 |
| | Total | 45 |

**Books :**

| S.No. | Name of Book/Author/Publisher |
|---|---|
| 1. | Principles of Biostatistics by Pagano, M. and Gaureau, K. 7th ed., Publisher: Thomson Learning, (2007). |

| | |
|---|---|
| 2. | Statistical Method for Engineering and Sciences by Taneja, H.C. Publisher: IK International, (2009). |
| 3. | Probability and Statistics for Engineers and Scientists by Walpole, R.E., Myers, R.H., Myers, S.L., Ye, K. Publisher: Prentice Hall, Inc. (2002) |
| 4. | Probability and Statistics for Engineers and Scientists by Ross, S.M. 3rd ed. Publisher: Academic Press, (2005). |

## MEDICAL BIOINFORMATICS (BIO-5324)

**Details of course:-**

| **Course Title** | **Course Structure** | | | **Pre-Requisite** |
|---|---|---|---|---|
| Medical Bioinformatics | L | T | P | |
| | 3 | 1 | 0 | Basic bioinformatics |

**Course Objective**: Gain proficiency in biomedical informatics, including bioinformatics tools and medical record system applications, clinical decision support system design, and healthcare delivery standards analysis.

**Course Outcome:**

| S. No. | |
|---|---|
| 1. | Understand the basic concepts in Biomedical Informatics. |
| 2. | Explore and apply the various bioinformatics tools and databases available in NCBI. |
| 3. | Comprehend the applications of medical record system. |
| 4. | Design and develop clinical decision support systems. |
| 5. | Analyze and apply the standards in proper health care delivery. |

| S. No. | Content |
|---|---|
| Unit 1 | **Unit 1: Introduction to Biomedical Informatics**<br>Introduction to Biomedical Informatics, Introduction to medical databases and resources, Overview of biological databases (e.g., GenBank, UniProt, NCBI), Motivating Problems in Healthcare, Seminal Documents and Reports, Resources in the Field, (Organizations, Information, Education) NCBI - Human Genome Project – GenBank - Sequence alignment – BLAST – FASTA –CLUSTALW - Phylogenetic analyses. |
| Unit 2 | **Unit 2: Biomedical Computing**Types of Computers in Biomedical Informatics, Data Storage in Computers, Computer Hardware and Software, Computer Networks, Software Engineering in Biomedical Informatics, Challenges for Biomedical Computing, Introduction to nucleic acid and protein sequence analysis, Pairwise sequence alignment algorithms (e.g., Needleman-Wunsch, Smith-Waterman), Multiple sequence alignment techniques and tools, Protein structure prediction methods, Protein structure prediction and modeling,<br>Protein-protein interaction networks |
| Unit 3 | **Unit 3: Electronic Health Records (EHR) and Transcriptomics**<br>History and Evolution of Health Records, Key Attributes and Definitions of Electronic Health Records (EHR), Benefits and<br>Advantages of HER, Overview of Transcriptomics, Introduction to Microarray Technology and Data Analysis, RNA Sequencing (RNA-Seq) Techniques and Analysis, Differential Gene Expression Analysis Techniques and Applications |
| Unit 4 | **Unit 4: EHR Implementation and Clinical Decision Support** Historical Perspectives and Approaches to EHR Implementation, Medical Errors and Patient Safety, Reminders and Alerts in HER, Computerized Provider Order Entry (CPOE) and Cost-Benefit of EHR |
| Unit 5 | **Unit 5: Secondary Use of Clinical Data and Evidence-Based Medicine**<br>Personal Health Records, Health Information Exchange, Public Health Informatics, Healthcare Quality and Clinical Research Informatics, Evidence-Based Medicine (EBM) and Medical Decision Making, Information Retrieval and Digital Libraries |
| | Total |

| S.No. | Name of Book/Author/Publisher |
|---|---|
| 1. | Edward H. Shortliffe and James J. Cimino, "Biomedical Informatics: Computer Applications in Health Care and Biomedicine (Health Informatics)", 2014, 4th edition, Springer, New York |
| 2. | Rastogi, "Bioinformatics: Methods and Applications: Genomics, Proteomics and Drug Discovery", 2013, 1st edition, Prentice Hall, New Delhi |
| 3. | "Biomedical Informatics: Computer Applications in Health Care and Biomedicine" by Edward H. Shortliffe and James J. Cimino, Publisher: Springer, Edition: 4th Edition (2014) |
| 4. | Transcriptomics and Gene Regulation (Translational Bioinformatics Book 9) 1st ed.<br>2016 Edition, Kindle Edition by Jiaqian Wu (Editor) |

## NEUROBIOLOGY (BIO-5325)

**Details of course:-**

| Course Title | Course Structure | | | Pre-Requisite |
|---|---|---|---|---|
| Neurobiology | L | T | P | |
| | 3 | 1 | 0 | NIL |

**Course Objective:** The objective is to introduce students to the fundamental principles of neuroscience including neuronal structure and function, neural communication, and the organization of nervous system.

| Course Outcome: | |
|---|---|
| S. No. | |
| 1. | Understand brain structure, synapses, receptors, and neurotransmitter functions. |
| 2. | Explain molecular/cellular neurobiology, neural development, and neuroplasticity principles. |
| 3. | Define, analyze pathophysiology, treatments, and societal impact of neurodegenerative disorders. |
| 4. | Describe neuromuscular junctions, pathophysiology, treatments, and neuron-muscle interplay |
| 5. | Explain neuroprotection, neuroprosthetics, neuroinformatics, treatments, and future directions. |

| S. No. | Content | Contact Hours |
|---|---|---|

| | | |
|---|---|---|
| Unit 1 | Introduction: Fine structure of the brain and its function, synapses, receptors and neurotransmitters | 09 |
| Unit 2 | Basic neuroscience: molecular and cellular neurobiology and basic knowledge of general neurobiology | 09 |
| Unit 3 | Neurodegenerative disorders: General description, Alzheimer's disease, Huntington's disease, Poly Q disorders, Amyotrophic Lateral 09Sclerosis (ALS) | 09 |
| Unit 4 | Cross-talk between neurons and muscles: Parkinson's disease, Inclusion body myositis (IBM), Polymyositis (PM) | 09 |
| Unit 5 | Neurotherapeutics and neuroinformatics: Action of biomolecules in neuroprotection, neuroprosthetics | |
| | Total | 45 |

**Books :**

| S.No. | Name of Book/Author/Publisher |
|---|---|
| 1. | Bear, Mark F., Barry W. Connors, and Michael A. Paradiso. Neuroscience: Exploring the Brain, 3rd ed. Baltimore, MD: Lippincott Williams & Wilkins, 2006. ISBN: 9780781760034 |
| 2. | Duane E. Haines PhD FAAAS FAAA (Author), Gregory A. Mihailoff PhD Fundamental Neuroscience for Basic and Clinical Applications, Elsevier |
| 3. | Neuroscience (English, Hardcover, Bear Mark F.), Publisher: Lippincott Williams and Wilkins, ISBN: 9780781778176, 0781778174, Pages: 1008 |

**SEMESTER II**

**ELECTIVE 3 (BIO-534)**

## PYTHON IN BIOINFORMATICS (BIO-5341)

**Details of course:-**

| **Course Title** | **Course Structure** | | | **Pre-Requisite** |
|---|---|---|---|---|
| | L | T | P | |
| Python in Bioinformatics | 3 | 1 | 0 | Nil |

**Course Objective:** The objective of this course is to introduce students to the current bioinformatics algorithms, focusing on Python programming for biological data analysis and its implementation.

| **Course Outcomes:** | |
|---|---|
| 1 | Master basic Python syntax and control structures to manage bioinformatics data. |
| 2 | Understand and apply Python data types and structures for biological computations |
| 3 | Develop Python scripts for automating data retrieval, processing, and visualization in bioinformatics. |
| 4 | Implement and understand sequence alignment algorithms using Python. |
| 5 | Use Python for complex bioinformatics tasks like genome data analysis and protein modeling. |

| **S. No.** | **Content** | **Contact Hours** |
|---|---|---|
| Unit 1 | Python Basics for Bioinformatics Introduction to Python syntax, variables, basic data types (integers, floats, strings), input/output operations, basic file handling. | **8** |
| Unit 2 | Control Structures in Python Conditional statements (if, else, elif), loops (for, while), functions, error and exception handling techniques. Practical examples in biological data processing. | **9** |
| Unit 3 | Data Structures for Bioinformatics in Python Introduction to lists, dictionaries, sets, and tuples. Use of advanced data structures like numpy arrays and pandas DataFrames for handling large datasets typical in bioinformatics. | **9** |
| Unit 4 | Bioinformatics Algorithms with Python Pairwise Sequence Alignment (Local and Global), understanding and implementing the Needleman-Wunsch and Smith-Waterman algorithms in Python. Use of libraries for enhanced computational efficiency. | **10** |
| Unit 5 | Advanced Python Applications in Bioinformatics Multiple Sequence Alignment, using biopython for genomic and proteomic analysis, | **9** |

| | | |
|---|---|---|
| | visualization of biological data with matplotlib and seaborn. | |
| | Total | **45** |

**Books :**

| S.No. | Name of Book/Author/Publisher |
|---|---|
| 1. | Yasha Hasija and Rajkumar Chakraborty– Hands-On Data Science for Biologists Using Python 2021 |
| 2. | Yasha Hasija – All About Bioinformatics From Beginner to Expert 2023 |

## WEB APPLICATION DEVELOPMENT (BIO-5342)

**Details of course:-**

| Course Title | Course Structure | | | Pre-Requisite |
|---|---|---|---|---|
| | L | T | P | |
| Web Application Development | 3 | 0 | 2 | Nil |

**Course Objective:** The objective of this course is to gain insight into web development Technology usin MySQL, Pearl ,Apache.

| Course Outcomes: | |
|---|---|
| 1 | Understandthe concept of server and web technology and development |
| 2 | To comprehend the pearl programming |
| 3 | To demonstrate MySQL and working with data |
| 4 | To gain Insight in to MySQL and perl, server admin |
| 5 | Applications of Apache, installation and handeling |

| S. No. | Content | Contact Hours |
|---|---|---|
| Unit 1 | **Introduction to Concepts:** Servers, HTTP, HTTPS, FTP. Linux and HTML Basics | **8** |
| Unit 2 | **Perl Programming:** Introduction and Installation Data types: Arithmetic and Logical operators, Conditionals and Loops, List and Arrays, Working with files, Regular Expression and Pattern Matching, Bioperl installation and any two related modules | **9** |
| Unit 3 | **MySQL**: CGI and PHP, Installing MySQL, MySQL Programs, Working with Data, MySQL Privileges | **9** |
| Unit 4 | **MySQL and Perl**: Perl DBI, Connect, Statement Handles, Error Handling, Server Admin | **10** |
| Unit 5 | **Apache**: Understanding Apache, Installation, Configuration | **9** |

| | | |
|---|---|---|
| | Total | **45** |

**Practicals :**

1. Brief Overview of Web servers, Web Browsers and Apache HTTP server.
2. Introduction to PERL?, requirements, Why PERL? Basic PERL syntax, tag, Comments in PERL, variables, different operators (arithmetic, assignment, comparison, logical and concatenation).
3. PERL Loops: while, do ... while, for, foreach
4. PERL form handling.
5. PERL functions: Declaring functions, Adding parameters, Returning values.
6. PERL MySQL:Connect, Create, Insert, Select etc.

**Books :**

| S.No. | Name of Book/Author/Publisher |
|---|---|
| 1. | Perl and Apache, Adam McDaniel, Wiley Publishing Inc., 2010 |
| 2. | Developing Web Applications with Apache, MySQL, memcatched and Perl, Patrick Galbraith, Wiley Publishing Inc., 2009 |
| 3. | Beginning Perl for Bioinformatics, James Tisdall, O'Reilly, 1st Edn., 2001. |

# CELL AND MOLECULAR BIOLOGY (BIO-5343)

**Details of course:-**

| Course Title | Course Structure | | | Pre-Requisite |
|---|---|---|---|---|
| | L | T | P | |
| Cell and Molecular Biology | 3 | 0 | 2 | Knowledge of cell structure and biomolecules |

**Course Objective:** To give a detailed perspective of cell communication, proliferation, gene expression and silencing, and basic techniques used in Cell & Molecular Biology

| Course Outcomes: | |
|---|---|
| 1 | To learn the mechanisms of biological processes involved in gene expression |
| 2 | To explain the concept of cell cycle and cell division and the impact of excessive cell proliferation |
| 3 | To comprehend mechanisms of cellular signaling and protein targeting within the cell or to the cell exterior |
| 4 | To gain insight into the strategies for gene silencing |
| 5 | To appraise various Cell & Molecular Biology techniques |

| S. No. | Content | Contact Hours |
|---|---|---|
| Unit 1 | **Gene Expression:** Mechanisms in DNA replication, transcription, post-transcription, translation, post-translation; Operon | **9** |
| Unit 2 | **Cell Proliferation:** Cell Division; Apoptosis; Proto-oncogenes and tumor-suppressor genes in cancer | **8** |
| Unit 3 | **Cell-Cell Communication and Protein Trafficking:** Junctions; Extracellular matrix; Cell adhesion molecules; Cellular signaling; Protein targeting; Vesicular trafficking; Coated vesicles; Structure of cell membrane; Transport across membrane; Receptor-mediated endocytosis | **10** |
| Unit 4 | **Gene Silencing:** Transcriptional and post-transcriptional gene silencing; Antisense RNA technology; RNA interference; Trans-acting ribozymes; Case studies | **8** |
| Unit 5 | **Cell & Molecular Biology Techniques:** FACS; Agarose gel electrophoresis; Polyacrylamide gel electrophoresis; Southern blot hybridization; Northern hybridization; Western blotting; Polymerase Chain Reaction; DNA fingerprinting | **10** |
| | Total | **45** |

**Books :**

| S.No. | Name of Book/Author/Publisher |
|---|---|
| 1. | Molecular Biology of the Gene by JD Watson et al. Publisher: Pearson |
| 2. | Biochemistry by D Voet, JG Voet. Publisher: Wiley |
| 3. | Lewin's Gene XII by Kreb's et al. Publisher: Jones & Bartlett Learning |
| 4. | Cell and Molecular Biology by P Khanna. Publisher: IK Intl. |
| 5. | Cell and Molecular Biology by M Jacob. Publisher: CBS |
| 6. | Karp's Cell and Molecular Biology by G Karp, J Iwasa, W Marshall. Publisher: John Wiley and Sons, Inc. |
| 7. | The Cell: A Molecular Approach by GM Cooper, RE Hausman. Publisher: Sinauer Associates Inc. |
| 8. | Molecular Biology of the Cell by B Alberts, R Heald, A Johnson, D Morgan, M Raff, K Roberts, P Walter. Publisher: Garland Science |
| 9. | Molecular Cell Biology by H Lodish, A Berk, CA Kaiser, M Krieger, A Bretscher. Publisher: WH Freeman |

**Practicals**

1. Genomic DNA isolation
2. Electrophoretic analysis of DNA
3. Quantitative determination of DNA
4. DNA purity determination
5. Quantification of DNA by UV spectrophotometric analysis
6. Quantification of RNA
7. Elution of DNA from gel
8. Polymerase Chain Reaction
9. Cell sorting

## HIGH THROUGHPUT STRUCTURAL BIOLOGY (BIO-5344)

**Details of course:-**

| Course Title | Course Structure | | | Pre-Requisite |
|---|---|---|---|---|
| | L | T | P | |
| High Throughput Structural Biology | 3 | 1 | 0 | Nil |

**Course Objective:** To Know the basic methodology and some advanced techniques used for high throughput in vitro small molecule drug discovery.

| **Course Outcomes:** | |
|---|---|
| 1 | Understand the structural biology and different types of bonds in protein structure. |
| 2 | To know the basics of X-Ray Crystallography and NMR. |
| 3 | To gain insight of optical spectroscopy |
| 4 | To gain knowledge about Potential Energy Minimization and its Function, |
| 5 | To learn the Knowledge-based Protein Modeling |

| **S. No.** | **Content** | **Contact Hours** |
|---|---|---|
| Unit 1 | Introduction: Peptide Bonds, hydrogen bonding, ionic and hydrophobic interactions. Protein Structure: Reverse Turns and Organized Folds, Structure Classification, Folding Mechanisms, Bond lengths, bond angles and torsion angles, Degrees of freedom, Cyclic molecules. Rotation about a bond, Eulerian angles Helices and their notations. Analysis and manipulation of structures, Ramachandran plots, Chaperones and Chaperonins, Structure Determination, Dynamics Simulation, Protein Folding, Nucleic Acid Structure- DNA/RNA, Structural Biology for the Optimization of Gene Therapy Vectors, Hands-on assembly of amino acid and nucleotide dimer CPK models. | **8** |
| Unit 2 | X-Ray Crystallography Computing & NMR Structure Determination: X-ray Crystallography Computing: The Phase Problem, Least Square Solutions, Entropy Maximization, Indirect Methods; NMR Structure Determination: Nuclear Magnetic Resonance, Distance Geometry, Distance-based Modeling, Structural Analysis | **9** |
| Unit 3 | Optical spectroscopy: Absorbance spectrum and melting of a protein, circular dichroism: molecular chirality, structural transitions of macromolecules, and analysis of spectral results, ligand binding, and cell sorting, Circular dichroic spectrum and melting of a protein, radiation, radioactive decay, particle detection, liquid scintillation, surface plasmon resonance, Thermodynamics of macromolecular transitions, Mass spectroscopy: application to complex proteins, Diffraction: overview, crystallization, wave/vector math and scattering, scattering from a periodic lattice, reciprocal space, and symmetry multiwavelength anomalous diffraction and crystallographic statistics. | **9** |
| Unit 4 | Potential Energy Minimization: Potential Energy Function, Local Optimization, Global Optimization, Energy Transformation | **10** |
| Unit 5 | Knowledge-based Protein Modeling: Sequence/Structural Alignment, Fold Recognition/Inverse Folding, Knowledge-based Structural Refinement, Structural Computing, Comparative and ab initio modelling | **9** |
| | Total | **45** |

**Books :**

| S.No. | Name of Book/Author/Publisher |
|---|---|
| 1. | Principles of Biochemistry, D. L. Nelson and M.M. Cox, Lehninger, W. H. Freeman; Fourth Edition, 2004. |
| 2. | Lecture Notes on Computational Structural Biology, Zhijun Wu, World Scientific Publishing Co. Pte. Ltd. 2008. |
| 3. | Principles of Physical Biochemistry K.E van Holde, C.Johnson, and P.Shing Ho Prentice Hall, Second edition, 2005 |
| 4. | The Physical Basis of Biochemistry: The Foundations of Molecular Biophysics, P.R. Bergethon Springer, Corrected edition, 2000 |
| 5. | Structural Genomics and High-Throughput Structural Biology, Michael Sundström, Martin Norin, Aled Edwards, CRC Press, 2006. |

## METAGENOMICS (BIO-5345)

**Details of course:-**

| Course Title | Course Structure | | | Pre-Requisite |
|---|---|---|---|---|
| | **L** | **T** | **P** | |
| Metagenomics | **3** | **1** | **0** | Knowledge of microbes, and basics of genomics and proteomics |

**Course Objective:** To provide a basic understanding of the microbial genome and to apply metagenomic data in the fields of health, agriculture, environmental remediation, and industry

| Course Outcomes: | |
|---|---|
| **1** | To gain a basic understanding of the microbial genome |
| **2** | To appraise experimental methods used in metagenomics |
| **3** | To be able to analyze metagenomic data |
| **4** | To apply technology to ecologically relevant projects |
| **5** | To apply metagenomics in various fields |

| S. No. | Content | Contact Hours |
|---|---|---|
| **Unit 1** | **Microbial Genome:** Bacterial genomes; Basics of genetic analysis; Transposons; Conjugation; Mechanisms of gene regulation | **8** |

| | | |
|---|---|---|
| **Unit 2** | **Metagenomics:** Introduction; Experimental methods used in metagenomics: Cloning the metagenome - Culture-independent technique; Shotgun metagenomics; High-throughput sequencing technologies; Genome sequence analysis; Genome annotation; Comparative nucleic acid analysis; Representational display analysis of genome comparisons; Estimation of taxonomic diversity | **10** |
| **Unit 3** | **Analysis of Metagenomic Data:** Functional characterization of metagenomic samples; Comparative metagenomics; Metatranscriptomics; Metaproteomics; MicroRNA expression profiling; Splicing Regulatory Network; Integrative Analysis of CLIP-Sequence Data; Gene prediction; Computational challenges in metagenomics | **9** |
| **Unit 4** | **Projects in Metagenomics:** Projects in metagenomics; The Acid Mine Drainage Project; The Sargasso Sea Metagenomic Survey; The Soil-Resistome Project; Human-Microbiome Project; Viral metagenomics | **8** |
| **Unit 5** | **Metagenomics Applications with Case Studies:** Applications of metagenomics in health, disease diagnosis, forensics, agriculture, environmental remediation, industrial biotechnology, bioprospecting; Community analysis; Reverse vaccinology; Microbial genomics for antibiotic target discovery; Functional genomics of *Helicobacter pylori*, *Streptomyces coelicolor*, *Bacillus subtilis, Plasmodium falciparum, Trypanosoma* | **10** |
| | **Total** | **45** |

**Books :**

| S.No. | Name of Book/Author/Publisher |
|---|---|
| **1** | The New Science of Metagenomics by N Grossblatt. Publisher: National Academic Press, Washington. |
| **2** | Functional Microbial Genomics: Methods in Microbiology by B Wren, N Dorrell. Publisher: Academic Press Inc |
| **3** | Metagenomics, Methods and Protocols by S Wolfgang, D Rolf. Publisher: Springer |

# PHARMACOINFORMATICS (BIO-5346)

| Course Title | Course Structure | | | Pre-Requisite |
|---|---|---|---|---|
| **Pharmacoinformatics** | **L** | **T** | **P** | |
| | **3** | **1** | **0** | **Nil** |

**Course Objective:** To provide basic training of bioinformatics tools application in drug discovery and development process with emerging strategies and tools of computer aided drug design

| **Course Outcomes:** | |
|---|---|
| 1. | Understand the Classification of drugs and \simulation in drug designing |
| 2. | To gain knowledge about Pharmacokinetics. |
| 3. | Illustrate pharmacodynamics and drug receptor action |
| 4. | Summarize therapeutic index and importance of drug design |
| 5. | Compare and contrast the type of pharmacoinformatics |

| S. No. | Content | Contact Hours |
|---|---|---|
| Unit 1 | Introduction and Classification of drugs, Molecular descriptors, Structural genomics: Approaches, Structural genomics effort, Protein structural initiative, structural genomics consortium, Impact of structural genomics. Target study: Nucleus as target, coding and noncoding RNA, SNP analysis. Molecular modeling and simulation in drug designing. | 9 |
| Unit 2 | Introduction to Pharmacokinetics: Compartment model study, Pharmacokinetic parameters, Absorption, Distribution, Metabolism, Excretion, Multiple doses, Salt factor, Bioavailability. Bioactive conformation of the molecules, Crystallography, energy minimized and bioactive conformation | 9 |
| Unit 3 | Pharmacodynamics: Drug receptor action Drug-drug interaction, Polymorphism and drug metabolism, Drug potency and efficacy, Receptor effector coupling, Spare receptors. | 9 |
| Unit 4 | Therapeutic index; Types of drug design: Strucure based, | 9 |

| | | |
|---|---|---|
| | ligand based, fragment based, metabolites and their importance in drug design; | |
| Unit 5 | Pharmacoinformatics: Chemogenomics, chemoinformatics, immunoinformatics, cancer informatics, neuroinformatics, toxico informatics, Tools used in pharmacoinformatics, Case studies and applied pharmacoinformatics. | 9 |
| | Total | 45 |

**Books:**

| **S.No.** | **Name of Book/Author/Publisher** |
|---|---|
| 1 | Chemical Genomics and Proteomics by Zanders Edward D., Humana Press |
| 2 | Modern Methods of Drug Discovery by Hillisch, Alexander, Birkhauser Verlag . |
| 3. | Drug Discovery 2Strategies and Methods by Makriyannis, Alexandros, Wiley-VCH |

## COMBINATORIAL METHODS IN BIOPHARMACEUTICAL (BIO-5347)

| **Course Title** | **Course Structure** | | | **Pre-Requisite** |
|---|---|---|---|---|
| **Combinatorial Methods in Biopharmaceutical** | **L** | **T** | **P** | |
| | **3** | **1** | **0** | **Nil** |

**Course Objective:**

This course provides a comprehensive overview of biopharmaceuticals, focusing on the scientific principles, development, production, and application of pharmaceutical products derived from biological sources.

| Course Outcomes: | |
|---|---|
| **1.** | Understand the principles and processes of biopharmaceutical production. |
| **2.** | Learn about drug discovery and development in the biopharmaceutical industry. |
| | Explore applications of biopharmaceuticals in medicine and other fields. |
| | Analyze the regulatory and quality control aspects of biopharmaceuticals |
| | Conduct research and present findings on a specific topic in biopharmaceuticals |

| S. No. | Content | Contact Hours |
|---|---|---|
| **Unit 1** | **Introduction:** Pharmaceutical Industry & Development of Drugs; Types of Therapeutic Agents and Their Uses; Economics and Regulatory Aspects. | **9** |
| **Unit 2** | **Drug Action, Metabolism And Pharmacokinetics :**Mechanism Of Drug Action; Physico-Chemical Principles Of Drug Metabolism; Radioactivity; Pharmacokinetics. | **9** |
| **Unit 3** | **Manufacture Of Drugs, Process And Applications :**Types of Reaction Process And Special Requirements For Bulk Drug Manufacture. | **9** |
| **Unit 4** | **Biopharmaceuticals**: Various Categories of Therapeutics like Vitamins, Laxatives, Analgesics, Contraceptives, Antibiotics, Hormones and Biologicals. | **9** |
| **Unit 5** | **Drug safety evaluation:** Strategy and Phasing for Drug Safety, Acute Toxicity Testing in Drug Safety Evaluation, Special Concerns for the Preclinical Evaluation of Biotechnology Products. | **9** |
| | **Total** | **45** |

| S.No. | Name of Book/Author/Publisher |
|---|---|
| **1** | "Biopharmaceuticals: Biochemistry and Biotechnology" by Gary Walsh |
| **2** | "Enumerative Combinatorics, Volume 1" by Richard P. Stanley |
| **3.** | "Bioprocess Engineering: Principles, Practice and Economics" by Arthur T. Johnson |

**SEMESTER III**

**OPEN ELECTIVE- 1 (UEC-601)**

**NANOTECHNOLOGY IN HEALTHCARE (UEC-6011)**

**Details of course:**

| **Course Title** | **Course Structure** | | | **Pre-Requisite** |
|---|---|---|---|---|
| | L | T | P | |
| Nanotechnology in Healthcare | 3 | 1 | 0 | Nil |

**Course Objective:** Objective of this course is understanding of Nanotechnology in healthcare with current biomedical applications and advanced diagnostics.

| **Course Outcomes:** | |
|---|---|
| 1 | Understanding of nanotechnology and pharmaceutical applications. |
| 2 | Illustrate the immunoassay techniques and nanomaterials implementations. |
| 3 | To explain application of improved medical diagnostics |
| 4 | Demonstrate various application of prosthetics and Medical implants |
| 5 | To comprehend diagnostic methods and stem cell technology |

| **S. No.** | **Content** | **Contact Hours** |
|---|---|---|
| Unit 1 | **Nanotechnology in Pharmaceutical Applications:** Human anatomy – Form function and physiology – Developmental prolog - principle of development – Neurophysiology – sensory physiology and muscle physiology - Trends in nanobiotechnology - Protein- and peptide-based compounds for cancer, diabetes, infectious diseases and organ transplant-therapeutic classes- focused pharmaceutical delivery systems | **8** |
| Unit 2 | **Immunoassay Techniques:** Understanding of antibody-based diagnostic techniques (immunoassay) - micro- and nano-immunosensors- Bio-Barcode Assay- use of magnets, gold, DNA and antibodies- therapies and diagnostics for cancer and central nervous system disorders. | **9** |
| Unit 3 | **Improved Medical Diagnostics:** Improved diagnostic products and techniques- in vivo imaging capabilities by enabling the detection of tumors, plaque, genetic defects and other disease states-ability to control or manipulate on the atomic scale- Nanobots | **9** |

| | | |
|---|---|---|
| Unit 4 | **Prosthetic and Medical Plants:** New generations of prosthetic and medical implants- artificial organs and implants- artificial scaffolds or biosynthetic coatings- biocompatibility and reduced rejection ratio- retinal, cochlear, and neural implants, repair of damaged nerve cells, and replacements of damaged skin, tissue, or bone. | **10** |
| Unit 5 | **Methods for Diagnosis:** Animation of the PCR - DNA Profiling - Cantilever Sensors - Targeted Drug Delivery - Magnetic Nanoparticles - Cancer cell targeting - Stem Cell Scaffolds - | **9** |
| | Total | **45** |

| **S.No.** | **Name of Book/Author/Publisher** |
|---|---|
| 1. | Chemical Sensors and Biosensors; Brian, R Eggins; Wiley; New York, Chichester; 2002 |
| 2. | Biosensors and modern biospecific analytical techniques, Wilson & Wilson's Comprehensive Analytical Chemistry; Ed. L Gorton; Elsevier, Amsterdam, London; 2005 |
| 3. | The Immunoassay Handbook; Ed. David Wild; 3rd ed.; Amsterdam: Elsevier; 2005. |

# IMAGE PROCESSING IN HEALTHCARE (UEC-6012)

**Details of course:-**

| Course Title | Course Structure | | | Pre-Requisite |
|---|---|---|---|---|
| | L | T | P | |
| Image Processing in Healthcare | 3 | 1 | 0 | Nil |

**Course Objective:** To study Image processing Image enhancement and image analysis in various diagnostics in medical sciences.

| Course Outcomes: | |
|---|---|
| 1. | Identify the different parts of the human visual system,image processing systems |
| 2. | Enlist the different types of imaging techniques used in medical imaging . |
| 3. | Analyze and identify the different mathematical operations applied on digital images |
| 4. | Compare the different methods of image enhancement, deduce mathematical solutions for the same |
| 5. | Identify the type of mathematical operation(s) to be digital image processing |

| S. No. | Content | Contact Hours |
|---|---|---|
| Unit 1 | **Photography and film image:** Principle of photography and radiographic film image, Introduction to digital image processing: | 8 |
| Unit 2 | **Image enhancement:** Spatial Domain-Point processing techniques,. Image Compression: Fundamentals of Image compression models,. | 11 |
| Unit 3 | **Basic principles of image segmentation and its transforms**: Representation and description in image processing, | 8 |
| Unit 4 | **Introduction to computed tomography:** Principle and configurations/generations, detectors, data acquisition system, spiral CT, scanner parameters, Image quality and artifacts | 8 |
| Unit 5 | **Radiation therapy:** Radiotherapy principles, dosage data for clinical applications (ISODOSE charts) | 10 |
| | Total | **45** |

**Books:**

| S.No. | Name of Book/Author/Publisher |
|---|---|
| 1. | Digital Image Processing, Gonzalez and Woods- Pearson Education |
| 2. | Fundamentals of Digital Image Processing, A.K. Jain –P.H.I |
| 3. | Digital Image Processing and Analysis, Chanda Majumder- Printice Hall India. |
| 4. | Digital Image Processing and Computer Vision, Sonka, Hlavac,Boyle- Cenage earning. |
| 5. | Digital Image Processing, William Pratt- John Wiley |
| 6. | Dowsett, Kenny & Johnston, “The Physics of Diagnostic Imaging”, Chapman & Hall Medical, |
| 7. | Massey & Meredith, “Fundamental Physics of Radiology”, John Wright & Sons. |

## ARTIFICIAL INTELLIGENCE IN BIOMEDICAL ENGINEERING (UEC-6013)

**Details of course:-**

| Course Title | Course Structure | | | Pre-Requisite |
|---|---|---|---|---|
| | L | T | P | |
| Artificial Intelligence in Biomedical Engineering | 3 | 1 | 0 | Nil |

**Course Objective:**

Understand the fundamentals of artificial intelligence (AI) and machine learning (ML) techniques and their relevance to biomedical applications.

Apply AI algorithms to medical data, including electronic health records, medical imaging, and genomics.

Evaluate the ethical and regulatory implications of AI in healthcare.

Develop critical thinking skills to address challenges specific to AI in biomedical contexts. 5.Collaborate on interdisciplinary projects that integrate AI and biomedical

| Course Outcomes: | |
|---|---|
| 1 | Demonstrate a comprehensive understanding of AI concepts and their relevance to biomedical engineering. |
| 2 | Apply machine learning algorithms to analyze and interpret biomedical data. |
| 3 | Design and implement AI solutions to address specific challenges in healthcare and medical research. |
| 4 | Evaluate the ethical implications of AI technologies in the biomedical field. |
| 5 | Communicate effectively about AI concepts and applications in biomedical engineering. |

| S. No. | Content | Contact Hours |
|---|---|---|
| Unit 1 | **Introduction to AI and Biomedical Applications**<br>Historical overview of AI, Biomedical use cases, Ethical considerations | **8** |
| Unit 2 | **Data Preprocessing and Feature Engineering**<br>Data cleaning and normalization, Feature extraction, Handling missing data | **9** |
| Unit 3 | **Supervised Learning Algorithms**<br>Linear regression, Logistic regression, Decision trees and random forests | **9** |
| Unit 4 | **Unsupervised Learning, Clustering and Deep Learning for Medical Imaging**<br>K-means clustering, Hierarchical clustering, Principal component analysis (PCA), Convolutional neural networks (CNNs), Transfer learning, Image segmentation | **10** |
| Unit 5 | **Ethics, Bias, and Future Trends**<br>Ethical considerations in AI, Addressing bias in healthcare AI, Future directions in AI research | **9** |
| | **Total** | **45** |

**Books :**

| S.No. | Name of Book/Author/Publisher |
|---|---|
| 1. | Dmnna L. Hudson and Maurice B. Coten., "Neural Networks and Artificial Intelligence for Biomedical Engineering", Prentice Hall of India. Pvt. Ltd., New Delhi |
| 2. | Riza C. Berkan and Sheldon L. Trubatch., "fuzzy systems Design Principles", Standard Publishers and Distributors, Delhi. |
| 3. | Abraham Kanded and Gideon Langholz, "Fuzzy Control Systems", CRC Press, Boca Raton. |
| 4. | R. Jang, C.T sun and B. Mizutani, "Neuro, Fuzzy and soft computing", Prentice Hall of India. Pvt. Ltd., New Delhi. |
| 5. | Artificial Intelligence: A Modern Approach by Stuart Russell and Peter Norvig |
| 6. | Machine Learning: A Probabilistic Perspective by Kevin P. Murphy |
| 7. | Deep Learning by Ian Goodfellow, Yoshua Bengio, and Aaron Courville |

## BIOSENSORS (UEC-6014)

**Details of course:-**

| Course Title | Course Structure | | | Pre-Requisite |
|---|---|---|---|---|
| | L | T | P | |
| Biosensors | 3 | 1 | 0 | Nil |

**Course Objective:** The objective of this course is to impart education in Biosensing technology, their working, applications and future perspective.

| Course Outcomes: | |
|---|---|
| 1 | Define biosensors and understand its history, properties, design features and the biological component. |
| 2 | Distinguish between different type of biosensors like amperometric and potentiometric biosensor and detecting of various cations using calirometric biosensor |
| 3 | Show overview of sensors and transducers measurement systems their Classification and Important design considerations |
| 4 | List examples of biosensors with the relatable opportunities and obstacles. And also learning about miniaturized devices designing in nanobiotechnology |
| 5 | Discuss the Future of Biosensors and Transducers and The importance of computers in sensor and transducer technology, |

| S. No. | Content | Contact Hours |
|---|---|---|
| Unit 1 | **Introduction** A historical perspective; Definition and Expanding Needs of Biosensors; Advantages and limitations; Biosensor Economics; various components of biosensors | **8** |

| | | |
|---|---|---|
| Unit 2 | **Types of Biosensors** Biocatalysts based biosensors, bio affinity based biosensors & microorganisms based biosensors, biologically active material and analyte. Types of membranes used in biosensor constructions | **9** |
| Unit 3 | **Transducers in Biosensors** Various types of transducers; principles and applications; Bio-, chemi-, and lector chemiluminescence for fiber-optic biosensors; Fluorescence-based fiber-optic biosensors | **9** |
| Unit 4 | **Electrical Signal Detection in Biological Systems** Silicon, glass and metal electrodes, amplifier design. Bioelectronic device production: microelectronic fabrication methods as adapted to bioelectronics, hard and soft lithography, bio-compatibility of materials. Existing types of Biosensors: Miniaturisation and micro-systems including sensing using optical techniques, field effect transistors, ion-selective and enzymatic sensitive electrodes, as well as impedance monitoring. Deriving a complete kinetic model; Kinetic modeling in other types of biosensors- | **10** |
| | Potentiometric enzyme electrodes, Optical and photometric biosensors, Immunosensors | |
| Unit 5 | **Application and Uses of Biosensors-**Biosensors in medicine and health care (For glucose monitoring and for DNA analysis. Analysis of the neural cell impulse signal and neural signal processing) biosensors for agriculture and food; Low cost- biosensor for industrial processes for online monitoring; biosensors for environmental monitoring. | **9** |
| | Total | **45** |

**Books :**

| S.No. | Name of Book/Author/Publisher |
|---|---|
| 1. | Rajmohan Joshi, Biosensors (1e), Gyan Books, 2006 |
| 2. | Cooper J.M. and Anthony E.G, Biosensors (2e), Oxford University Press, 2004. |
| 3. | Turner A.P.F, Karube.I and Wilson,G.S, Biosensors Fundamentals and applications, Oxford Univ. Press, 1990 |
| 4. | Sadana.A, Biosensors: Kinetics of Binding and Dissociation Using Fractals (1e), Elsevier B.V, 1995 |
| 5. | Ashok M and Kim Rogers, Enzyme & Microbial Biosensors: Techniques and Protocols (Methods in Biotechnology) (1e), Humana Press, 1998. |
| 6. | Ashok M and Kim Rogers, Affinity Biosensors: Techniques and Protocols (Methods in Biotechnology) (1e), Humana Press, 1998 |
| 7. | Damia Barcelo, Biosensors for the Environmental Monitoring of Aquatic Systems: Bioanalytical and Chemical Methods for Endocrine Disruptors (1e), Springer, 2009. |

## SKILL ENHANCEMENT COURSE-1 (SEMESTER -1) (BIO-523)

## BULK DATA MINING AND RETRIEVAL (BIO-5231)

**Details of course:-**

| Course Title | Course Structure | | | Pre-Requisite |
|---|---|---|---|---|
| | L | T | P | |
| Bulk Data Mining and Retrieval | 0 | 0 | 4 | Nil |

**Course Objective:** This course introduces advanced data mining techniques with a focus on applications in bioinformatics. Students will learn to handle, analyze, and interpret large datasets typical in genomics, proteomics, and other bioinformatics-related fields.

| S. No. | Course Outcome |
|---|---|
| 1 | Understand the fundamental concepts and algorithms of data mining. |
| 2 | Apply data mining techniques to solve biological problems. |
| 3 | Develop skills in using software tools and programming for data mining in bioinformatics. |
| 4 | Critically analyze and interpret results from bioinformatics data mining. |
| 5 | Implement data mining projects from conception to execution |

| S. No. | Practicals |
|---|---|
| 1. | **Retrieval from Public Repositories**: Access and download large-scale datasets from platforms like Kaggle or Google BigQuery. |
| 2. | **Data Preprocessing and Format Conversion**: Convert and clean data formats (e.g., JSON to CSV) using Python. |
| 3. | **Database Queries for Data Mining**: Use SQL and NoSQL queries to extract data from structured and unstructured databases. |
| 4. | **Text Mining and Analysis:** Apply natural language processing tools to perform sentiment analysis and keyword extraction from texts. |
| 5. | **Visualization of Big Data**: Create interactive visualizations and dashboards using tools like Tableau or Python libraries. |

**Books :**

| S.No. | Name of Book/Author/Publisher |
|---|---|
| 1 | Yasha Hasija and Rajkumar Chakraborty– Hands-On Data Science for Biologists Using Python -2022 |
| 2 | Yasha Hasija – All About Bioinformatics From Beginner to Expert, 2021 |
| 3. | Jiawei Han, Micheline Kamber, and Jian Pei- Data Mining: Concepts and Techniques, 2011 |
| 4. | Nathan Marz and James Warren- Big Data: Principles and best practices of scalable real-time data systems, 2015 |

## DOCKING & SIMULATION (BIO-5232)

**Details of course:-**

| Course Title | Course Structure | | | Pre-Requisite |
|---|---|---|---|---|
| | L | T | P | |
| Docking and Simulation | 0 | 0 | 4 | Nil |

**Course Objective**: This course will equip students with foundational knowledge and practical skills in computational docking and simulation for molecular interactions. Emphasize hands-on experience with simulation tools to model and analyze biological processes, enhancing problem-solving abilities in drug discovery and research.

| S. No. | Course Outcome: |
|---|---|
| 1. | Explain principles and types of molecular docking. |
| 2. | Identify uses of simulation software in molecular interaction analysis. |
| 3. | Discuss various methods used in molecular simulations. |
| 4. | Describe techniques for data analysis in molecular simulations. |
| 5. | Define advanced techniques used in detailed molecular simulations. |

| S. No. | Content |
|---|---|
| **Experiment 1** | To perform virtual screening against a large library of compounds to identify potential leads. |
| **Experiment 2** | To analyze the binding affinity and orientation of a ligand to a protein receptor using docking software |

| | |
|---|---|
| **Experiment 3** | To evaluate and interpret the docking results using scoring functions to determine th e most favorable binding configurations (ADMET). |
| **Experiment 4** | To conduct molecular dynamics simulations to observe and analyze the real-time interaction between an enzyme and a substrate. |
| **Experiment 5** | To perform MM/GBSA/PBSA energy decomposition to understand the contribution of individual residues to the overall binding energy of a complex. |

**Books :**

| S.No. | Name of Book/Author/Publisher |
|---|---|
| 1. | Andrew R. Leach - Molecular Modeling: Principles and Applications, 2nd Edition, Prentice Hall, 2001 |
| 2. | M. P. Allen and D. J. Tildesley - Computer Simulation of Liquids, 2nd Edition, Oxford University Press, 2017 |
| 3. | Schrödinger, LLC – The PyMOL Molecular Graphics System, Version 2.0, Schrödinger, LLC, 2020 |

**SKILL ENHANCEMENT COURSE-2 (BIO-546/BIO548)**

**(SEMESTER-2)**

**Bioinstrumentation (BIO-5461)**

| **Course Title** | **Course Structure** | | | **Pre-Requisite** |
|---|---|---|---|---|
| **Bioinstrumentation** | L | T | P | |
| | 0 | 0 | 8 | Nil |

**Course Objective:** Development of technologies that measure and manipulate biological systems. It involves the use of instruments to record and transmit physiological information.

| **Course Outcomes:** | |
|---|---|
| 1. | Discuss the principle of centrifugation and its types. |
| 2. | List uses of electrophoretic techniques underlying electrophoresis systems. |
| 3. | Discuss chromatographic methods. |
| 4. | Explain spectroscopic and diffraction techniques. |
| 5. | Define optical techniques like microscopy. |

| **S. No.** | **Content** | **Contact Hours** |
|---|---|---|
| Unit 1 | **Centrifugation: Basic principle and application,** Analytical and Preparative centrifuges and ultra centrifugation. | 8 |
| Unit 2 | **Electrophoretic Techniques:** Paper and gel electrophoresis, Immuno electrophoresis, isoelectric focusing, two-dimensional electrophoresis, capillary electrophoresis. | 8 |
| Unit 3 | **Chromatographic Methods:** Paper, TLC gas chromatography, gel filtration, ion exchange chromatography, affinity chromatography and HPLC, FPLC. | 8 |
| Unit 4 | **Spectroscopy:** UV, visible and NIR, spectrofluorimetry, Atomic absorption spectrophotometry, Mass Spectrometry, Infrared Spectroscopy, | 8 |
| Unit 5 | **Microscopy:** Principle, parts, types and functioning of Microscope, Optical and Electron Microscopy, Transmission and Scanning Electron Microscopy, Fluorescence microscopy, Confocal microscopy. | 8 |
| | Total | **40** |

**Books:**

| S.No. | Name of Book/Author/Publisher |
|---|---|
| 1 | Principles and Techniques of Practical Biochemistry by Keith Wilson and JohnWalker, Cambridge University Press. |
| 2 | Biophysical Chemistry: The conformation of Biological Macromolecules by C.R.Cantor and P.R. Schimmel. Publisher: W.H. Freeman. |
| 3. | Essentials of Biophysics by P. Narayanan. Publishers: New Age InternationalPublishers. |
| 4. | Introduction to Spectroscopy by D.L. Pavia, G.M. Lampman and G. S. Kriz. Publisher: Brooks Cole |
| 5. | Physical Chemistry of Macromolecules by C. Tanford. Publisher: John Wiley and Sons Inc. |

## MACHINE LEARNING IN BIOINFORMATICS (BIO-5462)

**Details of course:-**

| Course Title | Course Structure | | | Pre-Requisite |
|---|---|---|---|---|
| | L | T | P | |
| Machine learning in Bioinformatics | 0 | 0 | 8 | Nil |

**Course Objective:** To introduce the fundamentals of machine learning and its application in bioinformatics. This includes understanding data structures, analysis, visualization, and the implementation of various machine learning algorithms for bioinformatics data.

| S. No. | Course Outcome |
|---|---|
| 1 | Understand and apply data analysis techniques using Python |
| 2 | Perform data visualization and principal component analysis |
| 3 | Implement machine learning algorithms for pattern recognition. |
| 4 | Utilize deep learning and neural networks in bioinformatics applications. |
| 5 | Apply machine learning techniques to bioinformatics data. |

| S. No. | Content | Contact Hours |
|---|---|---|
| 1 | Basics of Data and Operations: Introduction to Python, Data Types, Data Structures, NumPy, Pandas | 8 |
| 2 | Data Visualization and Principal Component Analysis: Matplotlib, Seaborn, PCA Theory and Application | 8 |
| 3 | Machine Learning Algorithms: Supervised vs Unsupervised Learning, Logistic Regression, Decision Trees | 8 |
| 4 | Deep Learning and Neural Networks: Fundamentals, TensorFlow, | 8 |

| | | |
|---|---|---|
| | Keras, CNNs, RNNs | |
| 5 | Applications in Bioinformatics: NLP, Clustering, Classification, Gene Expression Analysis | 8 |
| Total Contact Hours | | 40 |

**Books :**

| S.No. | Name of Book/Author/Publisher |
|---|---|
| 1 | Yasha Hasija and Rajkumar Chakraborty– Hands-On Data Science for Biologists Using Python, 202 |
| 2 | Yasha Hasija – All About Bioinformatics From Beginner to Expert, 2021 |