DELHI TECHNOLOGICAL UNIVERSITY
Department of Biotechnology
M.Tech.

Bioinformatics

SCHEME & SYLLABUS (as per CBCS and NEP 2020)

With effect from : Academic Year-2024-25

DEPARTMENT OF BIOTECHNOLOGY

M. Tech. BOINFORMATICS

SEMESTER I										
Course Code	**Course Name**	**Course Type**	**Credit**	**L-T-P**	**Total Credits**	**CWS**	**PRS/ STS/ CMS**	**MTE**	**ETE**	**PRE**
	Core Courses									
BIO501	Introduction to Bioinformatics	DCC-1	4	3-0-2		15	25	20	40	-
BIO503	Functional Genomics and proteomics	DCC-2	4	3-0-2		15	25	20	40	-
BIO505	Database Management	DCC-3	4	3-0-2		15	25	20	40	-
BIO507	Immunoinformatic	DCC-4	4	3-0-2		15	25	20	40	-
	Departmental Elective - I				**24**					
BIO511	Pharmacogenomics and personalized medicine	DEC-1	4	3-1-0		25	-	25	50	-
BIO513	Systems biology			3-1-0		25	-	25	50	-
BIO515	OMICS in Medicine			3-1-0		25	-	25	50	-
BIO517	Biochemical Engineering principles			3-1-0		25	-	25	50	-
BIO519	Data Analysis for Biologists			3-0-2		15	25	20	40	-
	Skill Enhancement Course - 1									
BIO541	Bulk Data mining and Retrieval	SEC-1	2	0-0-4		-	50	-	-	50
BIO543	Docking and simulation			0-0-4		-	50	-	-	50
	Self-Study Course									
BIO551	Seminar	SSC	2			-	40	-	-	60
BIO553	MOOC									
	Audit Course									
UEC501	English for Research Paper Writing	AUC	Non-Credit	2-0-0		25	-	25	50	-
UEC503	Disaster Management			2-0-0		25	-	25	50	-
UEC505	Sanskrit for Technical Knowledge			2-0-0		25	-	25	50	-
UEC507	Value Education			2-0-0		25	-	25	50	-
UEC509	Constitution of India			2-0-0		25	-	25	50	-
UEC511	Pedagogy Studies			2-0-0		25	-	25	50	-
UEC513	Stress Management by Yoga			1-0-2		15	25	20	40	-

UEC515	Personality Development through Life Enlightening Skills			2-0-0		25	-	25	50	-
UEC517	Indian Music			1-0-2		15	25	20	40	-
UEC519	Sports and Rehabilitation			1-0-2		15	25	20	40	-
UEC521	Multi-Dimensional Poverty Indices for Developing Countries			1-0-2		15	25	20	40	-
SEMESTER II										
Course Code	**Course Name**	**Course Type**	**Credit**	**L-T-P**	**Total Credits**	**CWS**	**PRS/ STS/ CMS**	**MTE**	**ETE**	**PRE**
	Core Courses									
BIO502	Advances in Bioinformatics	DCC-5	4	3-0-2		15	25	20	40	-
BIO504	Advance Genetic Engineering	DCC-6	4	3-0-2		15	25	20	40	-
	Departmental Elective - 2									
BIO520	Drug Design and Delivery	DEC-2	4	3-1-0		25	-	25	50	-
BIO522	Analysis of Biological systems			3-1-0		25	-	25	50	-
BIO524	Biostatistics			3-1-0		25	-	25	50	-
BIO526	Medical Bioinformatics			3-1-0		25	-	25	50	-
BIO528	Neurobiology			3-1-0		25	-	25	50	-
	Departmental Elective - 3									
BIO530	Python in Bioinformatics	DEC-3	4	3-1-0	**24**	25	-	25	50	-
BIO532	Cell & Molecular Biology			3-1-0		25	-	25	50	-
BIO534	High throughput structural Biology			3-1-0		25	-	25	50	-
BIO536	Pharmacoinformatic			3-1-0		25	-	25	50	-
BIO538	Combinatorial methods in Biopharmaceuticals			3-1-0		25	-	25	50	-
	Skill Enhancement Course - 2 /Industrial Training									
BIO540	Industrial Training	SEC-2	4	0-0-8		**-**	**50**	**-**	**-**	**50**
BIO542	Bioinstrumentation			0-0-8		**-**	**50**	**-**	**-**	**50**
BIO544	Web application Development			3-1-0		25	-	25	50	-
UCC502	Research Methodology and IPR	UCC	4	3-1-0		25	-	25	50	-

SEMESTER III										
Course Code	**Course Name**	**Course Type**	**Credit**	**L-T-P**	**Total Credits**	**CWS**	**PRS/ STS/ CMS**	**MTE**	**ETE**	**PRE**
	Core Course				**16**					
BIO601	IPR in Biotechnology & Biosafety	DCC-7	4	3-1-0		25	-	25	50	-
	Open Elective									
OBT601	Human Nutrition	OEC	4	3-1-0		25	-	25	50	-
BIO603	Minor Project/Research Thesis/Patent	DCC-8	8	-		**-**	**40**	**-**	**-**	**60**
SEMESTER IV										
Course Code	**Course Name**	**Course Type**	**Credit**	**L-T-P**	**Total Credits**	**CWS**	**PRS/ STS/ CMS**	**MTE**	**ETE**	**PRE**
BIO604	Major Project/Research Thesis/Patent	DCC-9	16	-	**16**	**-**	**-**	**-**	**-**	**100**

Program Outcomes

1. **Scholarship of Knowledge:** Acquire in-depth knowledge of a specific discipline or professional area, including a more comprehensive and global perspective, with an ability to discriminate, evaluate, analyze, and synthesize existing and new knowledge and integrate the same to enhance understanding.
2. **Critical Thinking:** Critically analyze complex engineering problems and apply independent judgment when synthesizing information to make intellectual and creative advances in conducting research in a broader theoretical, practical, and policy context.
3. **Problem-Solving:** Think laterally and initially, conceptualize and solve engineering problems, evaluate a wide range of potential solutions for those problems, and arrive at feasible, optimal solutions after considering public health and safety, cultural, societal, and environmental factors in the core areas of expertise.
4. **Research Skill:** Extract information pertinent to unfamiliar problems through literature surveys and experiments; apply appropriate research methodologies, techniques, and tools; design and conduct experiments; analyze and interpret data; demonstrate higher-order skill and view things in a broader perspective; contribute individually or in group(s) to the development of scientific, technological knowledge in one or more domains of engineering.
5. **Usage of modern tools:** Create, select, learn, and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling, to complex engineering activities with an understanding of the limitations.
6. **Collaborative and Multidisciplinary work:** Possess knowledge and understanding of group dynamics, recognize opportunities and contribute positively to collaborative-multidisciplinary scientific research, demonstrate a capacity for self-management and teamwork, and make decisions based on open-mindedness, objectivity, and rational analysis to achieve common goals and further their own and others' learning.
7. **Project Management and Finance:** Demonstrate knowledge and understanding of engineering and management principles and apply them to work as a team member and leader. Manage projects efficiently in respective disciplines and multidisciplinary environments after considering economic and financial factors.
8. **Communication:** Communicate confidently and effectively with the engineering community and society regarding complex engineering activities, such as comprehending and writing effective reports and design documentation by adhering to appropriate standards, making effective presentations, and giving and receiving clear instructions.
9. **Lifelong Learning:** Recognize the need for and have the preparation and ability to engage in lifelong learning independently, with enthusiasm and commitment to continuously improving knowledge and competence.
10. **Ethical Practices and Social Responsibility:** Acquire professional and intellectual integrity, a professional code of conduct, ethics of research and scholarship, consideration of the impact of research outcomes on professional practices, and an understanding of the responsibility to contribute to the community for the sustainable development of society.
11. **Independent and Reflective Learning:** Observe and critically examine the outcomes of one’s actions, make corrective measures, and learn from mistakes without depending on external feedback.

(DEPARTMENT CORE COURSES)

FIRST YEAR (Semester 1)

INTRODUCTION TO BIOINFORMATICS (BIO501)

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.	
CO1	To enlist biological databases and identify database types, sequence formats, sequence retrieval, and submission.
CO2	To define genomics and recognize the importance of the Human Genome Project.
CO3	To perform and apply programming techniques.
CO4	To perform Pairwise Sequence Alignment and learn about scoring matrices and the various algorithms involved.
CO5	To perform Multiple Sequence Alignment and various algorithms involved.

CO-PO Articulation matrices

Course	PO 1	PO 2	PO 3
CO1	3	3	3
CO2	3	2	3
CO 3	3	3	3
CO4	2	2	3
CO 5	3	2	3

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

PO2: An ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirement in the appropriate bachelor program.

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.

References:

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 (BIO503)

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:	
CO1	**Deep Understanding**: Grasp principles and classifications, Omics theory, historical context, and modern approaches in functional genomics and proteomics.
CO2	**Genome Analysis Proficiency**: Master DNA sequencing, various techniques in functional genomics and proteomics
CO3	**Transcriptomics Expertise**: Acquire skills in mRNA profiling, alternative splicing, post-transcriptional modifications, and gene silencing.
CO4	**Proteomics Mastery**: Protein separation, identification, quantification, post-translational modifications analysis, and protein aggregation and ubiquitin proteasome system.
CO5	**Application of Genomics and Proteomics**: Application of functional genomics in, drug discovery, disease mechanisms, biomarker identification, and personalized medicine.

CO-PO Articulation matrices

Course	PO 1	PO 2	PO 3
CO1	3	2	3
CO2	3	2	3
CO 3	3	3	3
CO4	2	2	3
CO 5	3	2	3

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Note: Program mat add up to three additional POs approved by BOS of the department.

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 drug discovery, 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

References:

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 (BIO505)

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:	
CO1	To grasp the essentials of DBMS and recognize their importance and application in biotechnology.
CO2	Understanding the types and uses of bioinformatics databases and the significance of data retrieval tools in biotech research.
CO3	Learn database design principles and modeling techniques suitable for managing complex biological data.
CO4	Acquire skills in data warehousing, data mining, and their application in biotechnological data analysis.
CO5	Explore advanced database management topics including big data analytics, cloud computing and ethical consideration in data handling.

CO-PO Articulation matrices

Course	PO 1	PO 2	PO 3
CO1	2	3	3
CO2	3	2	3
CO 3	2	3	3
CO4	2	2	3
CO 5	3	3	3

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PO2: An ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirement in the appropriate bachelor program.

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.

References:

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 (BIO507)

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:	
CO1	Understanding basics of immunology, including the role of humoral and cellular immunology.
CO2	Exploring advanced immunology: immune mechanisms, hypersensitivity, and health/disease impacts.
CO3	Analyzing the role of informatics in HLA supertype prediction, using clustering methods for diversity.
CO4	Apply immuno-informatics in vaccines development and personalized medicine.
CO5	Mastering in-silico prediction techniques for predicting immunogenicity, using computational tools. Developing predictive modeling skills for immune receptor-peptide binding

CO-PO Articulation matrices

Course	PO 1	PO 2	PO 3
CO1	**2**	**3**	**3**
CO2	**3**	**3**	**3**
CO 3	**3**	**2**	**3**
CO4	**2**	**2**	**3**
CO 5	**3**	**2**	**3**

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PO2: An ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirement in the appropriate bachelor program.

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**

References:

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:

S. no.	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 (BIO502)

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:	
CO1	To identify and utilize various human genetic variation databases, including SNP and mutation databases.
CO2	To analyze biological sequences to predict functional consequences of coding and non-coding polymorphisms.
CO3	To gain practical skills in retrieving and analyzing large-scale genomic data.
CO4	To apply machine learning techniques such as supervised and unsupervised methods to solve problems in bioinformatics and data mining.
CO5	To gain practical insights through case studies in genomic data analysis.

CO-PO Articulation matrices

Course	PO 1	PO 2	PO 3
CO1	2	2	3
CO2	3	2	3
CO 3	3	3	3
CO4	2	2	3
CO 5	3	2	3

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

PO2: An ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirement in the appropriate bachelor program

S. No.	Content	Contact Hours
Unit 1	**Human Genetic Variation**: Databases of human genetic variation, SNP databases, Mutation databases, Tools for SNP and mutation visualization, 10,000 human genome database	**8**
Unit 2	**Biological Sequence Analysis & Characterization**: Predictive Functional Analysis of coding and non- polymorphisms, Amino Acid Properties and Consequences of Substitutions	**9**
Unit 3	**Bulk Data Retrieval**: Ensembl BioMart, UCSC Genome COSMIC, ArrayExpress, The Cancer Genome Atlas (TCGA)	**9**
Unit 4	**Soft Computation**: Mach ne learning; Supervised and Unsupervise Methods; Artificial Neural Networks, support vector machines, fuzz logic, applications to data mining and bioinformatics.	**10**
Unit 5	**Case Studies in Genomic Data Analysis:** Real-World Applications of Genomic Data	**9**
	Total	**45**

S.No.	Practicals
1.	To study SNP and Mutation Databases.
2.	To study visualization tools like PDB, PyMOL, MMDB.
3	To utilize databases like Ensembl BioMart, UCSC Genome Browser, COSMIC, ArrayExpress, TCGA
4	Machine Learning algorithms- Supervised, Unsupervised and Reinforcement
5	Genomic Data Analysis Using Real-World Case Studies

References:

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 (BIO504)

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:	
CO1	To understand basic gene manipulation, inheritance patterns, and the history of genetic diseases.
CO2	Explore the molecular basis of both common and rare genetic disorders, including chromosomal aberrations and mutations.
CO3	Learn various approaches for identifying genetic disorders, such as linkage mapping, genome-wide association studies, and genome sequencing.
CO4	Examine the role of epigenetics in human genetic disorders, including its mechanisms, phenotypic changes, and inheritance patterns.
CO5	Gain skills in risk assessment and prediction of genetic disease inheritance, and understand the ethical considerations in genetic disease treatment.

CO-PO Articulation matrices

Course	PO 1	PO 2	PO 3
CO1	2	3	3
CO2	3	2	3
CO 3	3	2	3
CO4	2	2	3
CO 5	3	2	3

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

Po2: An ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirement in the appropriate bachelor program.

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
3.	Single
4.	double and partial digestion
5.	Star activity
6.	Agarose gel electrophoresis
7.	Modification of DNA ends
8.	PCR

References:

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

2ND YEAR (SEMESTER III)

DEPARTMENT CORE COURSE

IPR IN BIOTECHNOLOGY & BIOSAFETY (BIO601)

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:	
CO1	Understanding the significance of intellectual property and biosafety principles.
CO2	Mastering the concept of "prior art" and proficiently conducting patent searches.
CO3	Gaining knowledge of patent basics and procedures for effective patent filing.
CO4	Developing practical skills in patent filing and understanding patent infringement.
CO5	Comprehending biosafety principles and regulations governing production and use of GMO release.

CO-PO Articulation matrices

Course	PO 1	PO 2	PO 3
CO1	**3**	**2**	**3**
CO2	**3**	**2**	**3**
CO 3	**3**	**3**	**3**
CO4	**2**	**2**	**3**
CO 5	**3**	**2**	**3**

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

Po2: An ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirement in the appropriate bachelor program.

S. No.	Content	Contact Hours
Unit 1	**Introduction to Intellectual Property** Types of IP: Patents, Trademarks, Copyright, Industrial Design, Traditional Knowledge, Geographical Indications.	8
Unit 2	**Grant of Patent** 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** 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** 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** Ethical principles in research; researcher responsibility to the environment; Bioengineering ethics; rights and responsibility; legal protection of IPR and case studies.	9
	Total	45

References :

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

PHARMACOGENOMICS AND PERSONALIZED MEDICINE (BIO511)

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.	
CO1	To demonstrate an understanding of genetic variations influencing drug response, including pharmacokinetic and pharmacodynamic factors, and their impact on individualized treatment outcomes.
CO2	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.
CO3	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.
CO4	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.
CO5	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.

CO-PO Articulation matrices

Course	PO 1	PO 2	PO 3
CO1	2	2	3
CO2	3	2	3
CO 3	3	3	3
CO4	2	2	3
CO 5	3	2	3

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

PO2: An ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirement in the appropriate bachelor program.

S. No.	Content	Contact Hours
Unit 1	**Fundamentals of Pharmacogenomics:** Introduction to Pharmacogenomics: Concepts and historical perspective, Genetic Polymorphisms and Drug Metabolism, Pharmacokinetics and Pharmacodynamics.	9
Unit 2	**Technologies in Pharmacogenomics**: 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**: 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:** 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)**: Privacy and Confidentiality of Genetic Information, Direct-to-Consumer Genetic Testing: Pros and cons, Ethical Considerations in Clinical and Research Settings.	7
	Total	45

References:

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 (BIO513)

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:	
CO1	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.
CO2	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.
CO3	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.
CO4	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.
CO5	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.

CO-PO Articulation matrices

Course	PO 1	PO 2	PO 3
CO1	2	2	3
CO2	3	2	3
CO 3	3	3	3

CO4	**2**	**2**	**3**
CO 5	**3**	**3**	**3**

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

PO2: An ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirement in the appropriate bachelor program.

S. No.	Content	Contact Hours
Unit 1	**Introduction to Systems Biology:** 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:** 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:** Overview of Omics Technologies: Genomics, Transcriptomics, Proteomics, Metabolomics, Integrative Analysis of Omics Data.	**9**
Unit 4	**Modeling Biological Systems:** 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:** Systems Pharmacology and Drug Discovery, Systems Biology Approaches to Understanding Disease Mechanisms, Personalized Medicine and Systems Biology.	**9**
	Total	**45**

References:

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 (BIO515)

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:	
CO1	**Omics Technology Understanding**: Grasp sequencing, metagenomics, and pharmacogenomics for medical research and practice.
CO2	**Infectious Disease Genomics Expertise**: Identify pathogens, understand epidemiology, assess host resistance, and devise strategies against infectious diseases using genomics.
CO3	**Genetic Disorder Proficiency**: Detect genetic disorders, understand molecular basis, explore treatments including pharmacogenomics.
CO4	**Epigenomics and Non-coding RNAs Comprehension**: Understand their roles in disease, inheritance, and control for medical research and practice.
CO5	**Genomics in Clinical Trials Application**: Apply genomics in translational medicine, clinical trials, risk assessment, and prediction with successful case studies exposure.

CO-PO Articulation matrices

Course	PO 1	PO 2	PO 3
CO1	3	3	3
CO2	3	2	3
CO 3	3	3	3
CO4	2	3	3
CO 5	3	2	3

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

PO2: An ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program The mastery should be at a level higher than the requirement in the appropriate bachelor program.

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**

References:

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 (BIO517)

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:	
CO1	Understand the Microbial Process Principles.
CO2	Analyse the Mathematical modelling and kinetics of microbial growth.
CO3	Identify the Sterilization Principles and thermal death kinetics of microorganism.
CO4	Compare and contrast the different types of Bioreactor
CO5	Understand the Instrumentation and Control of Biochemical process variables.

CO-PO Articulation matrices

Course	PO 1	PO 2	PO 3
CO1	**3**	**2**	**3**
CO2	**3**	**2**	**3**
CO 3	**2**	**3**	**3**
CO4	**2**	**2**	**3**
CO 5	**3**	**2**	**3**

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

PO2: An ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirement in the appropriate bachelor program.

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**

References:

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 References, 1994

DATA ANALYSIS FOR BIOLOGISTS (BIO519)

Details of course:-

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Data Analysis for Biologists	3	0	2	Basic knowledge of biology, genomics, and introductory programming

Course Objective: This course aims to equip students with essential data analysis skills, focusing on the utilization of biological databases, sequence alignment techniques, and data preprocessing methods. It introduces fundamental machine learning concepts for interpreting biological datasets and enhances practical problem-solving abilities through real-world case studies. By the end of the course, students will develop a strong foundation in computational tools and analytical approaches for biological data analysis.

Course Outcome:	
S.No.	
CO1	To understand the role of biological databases and their applications in data analysis.
CO2	To analyze and apply sequence alignment techniques.
CO3	To develop skills in data preprocessing and cleaning.
CO4	To explore machine learning techniques for analyzing and interpreting biological datasets.
CO5	To gain practical insights through case studies in biological data analysis.

CO-PO Articulation matrices:-

Course	PO 1	PO 2	PO 3
CO1	**3**	**3**	**3**
CO2	**3**	**2**	**3**
CO 3	**2**	**3**	**3**
CO4	**2**	**2**	**3**
CO 5	**3**	**2**	**3**

PO1: Ability to independently carry out research /investigation and development work to solve practical problems

PO2: Ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirement in the appropriate

bachelor program.

S. No.	Content	Contact Hours
Unit 1	**Introduction to Data Analysis for Biologists:** Overview of Biological Databases and their types, Scope and Importance.	**8**
Unit 2	**Sequence Alignment:** Extraction of complete Genome Sequences, Conservation, Concepts of homologs, orthologs and paralogs, Algorithms of Pairwise and Multiple Sequence Alignment.	**9**
Unit 3	**Data Preprocessing and Cleaning:** Handling missing data, normalization, transformation, dealing with outliers.	**9**
Unit 4	**Machine Learning in Biology:** Overview of supervised and unsupervised learning, clustering, classification, dimensionality reduction.	**10**
Unit 5	**Case Studies in Biological Data Analysis:** Real-world examples of Biological data analysis.	**9**
	Total	**45**

S. No.	Practical's
1.	To explore and utilize biological databases like PubMed, Entrez, BLAST, OMIM, and protein databases.
2.	To conduct and analyze pairwise and multiple sequence alignments using tools like Clustal Omega.
3.	To perform data retrieval and preprocessing using real-world biological datasets from NCBI, Ensembl, or GEO databases.
4.	To study Machine Learning algorithms- Supervised, Unsupervised and Reinforcement
5.	To analyze real-world biological datasets using computational tools to interpret biological data.

References:

S.No.	Name of Book/Author/Publisher
1.	"Introduction to Statistical Analysis in Biology" by M. Whitlock and D. Schluter. Publisher: Oxford University Press
2.	Hasija, Y., "All About Bioinformatics: From Beginner to Expert", 2023.

3.	Hasija, Y., Chakraborty, R., "Hands on Data Science for Biologists Using Python", 2021.

SEMESTER –II ELECTIVE-2

DRUG DESIGN AND DELIVERY (BIO520)

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:	
CO1	Illustrating the process of drug discovery and discussing the diverse sources of drugs
CO2	Examine the traditional vs new-age drug design and development.
CO3	Elucidating the receptor theory and role of enzyme kinetics in drug design and development.
CO4	Outline the role of clinical trials in the drug development system.
CO5	Demonstrating the various drug delivery mechanisms for effective active drug concentration.

CO-PO Articulation matrices

Course	PO 1	PO 2	PO 3
CO1	3	3	3
CO2	3	3	3
CO 3	2	3	3

CO4	**2**	**2**	**3**
CO 5	**3**	**2**	**3**

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

PO2: An ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirement in the appropriate bachelor program.

S. No.	Content	Contact Hours
Unit 1	**Introduction to drug discovery and delivery** 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** Preclinical drug development, traditional drug development; computational drug design, docking, QSAR, and pharmacophore modeling.	**9**
Unit 3	**Pharmacology and Pharmacodynamics** 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** Phases of Clinical Trials IPR regulations in drug development, Biosafety regulations.	**8**
Unit 5	**Analysis of case studies in drug development** 'Bench to Bedside' translation of drugs, overview of Drug delivery systems, nanomedicine, Case studies of recent advances in drug development.	**10**
	Total	**45**

References:

S.No.	Name of Book/Author/Publisher
1.	Comprehensive Medicinal Chemistry III 3rd Edition - June 3, 2017 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 Publication Date: Volume 1: 2019, Volume 2: 2020
3.	Textbook of Drug Design and Discovery; August 2017 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 (BIO522)

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:	
CO1	To understand the concept of biological networks
CO2	To analyze various networks
CO3	To gain insight into network motifs
CO4	To analyze networks through clustering
CO5	To appraise various types of biological networks

CO-PO Articulation matrices

Course	PO 1	PO 2	PO 3
CO1	**2**	**3**	**3**
CO2	**3**	**2**	**3**
CO 3	**3**	**3**	**3**
CO4	**2**	**2**	**3**
CO 5	**3**	**2**	**3**

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

PO2: An ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirement in the appropriate bachelor program.

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**

References:

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

BIOSTATISTICS (BIO524)

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.	
CO1	Understand the role of Biostatistics and Probability.
CO2	To know the basics of Random variable and distribution function.
CO3	To gain insight into Probability distributions.
CO4	To gain knowledge about Correlation, regression and sampling distributions.
CO5	To learn the Knowledge-based exact sampling distributions and small sample test.

CO-PO Articulation matrices

Course	PO 1	PO 2	PO 3
CO1	**2**	**2**	**3**
CO2	**3**	**2**	**3**
CO 3	**3**	**3**	**3**
CO4	**2**	**2**	**3**
CO 5	**3**	**2**	**3**

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

PO2: An ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirement in the appropriate bachelor program.

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

References**:**

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 (BIO526)

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.	
CO1	Understand the basic concepts in Biomedical Informatics.
CO2	Explore and apply the various bioinformatics tools and databases available in NCBI.
CO3	Comprehend the applications of medical record system.
CO4	Design and develop clinical decision support systems.
CO5	Analyze and apply the standards in proper health care delivery.

CO-PO Articulation matrices

Course	PO 1	PO 2	PO 3
CO1	**2**	**3**	**3**
CO2	**3**	**2**	**3**
CO 3	**2**	**3**	**3**
CO4	**2**	**2**	**3**
CO 5	**3**	**2**	**3**

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

PO2: An ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirement in the appropriate bachelor program.

S. No.	Content	Contact hours
Unit 1	**Unit 1: Introduction to Biomedical Informatics** 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, Protein-protein interaction networks	
Unit 3	**Unit 3: Electronic Health Records (EHR) and Transcriptomics** History and Evolution of Health Records, Key Attributes and Definitions of Electronic Health Records (EHR), Benefits and 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** 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	

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. 2016 Edition, Kindle Edition by Jiaqian Wu (Editor)

NEUROBIOLOGY (BIO528)

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.	
CO1	Understand brain structure, synapses, receptors, and neurotransmitter functions.
CO2	Explain molecular/cellular neurobiology, neural development, and neuroplasticity principles.
CO3	Define, analyze pathophysiology, treatments, and societal impact of neurodegenerative disorders.
CO4	Describe neuromuscular junctions, pathophysiology, treatments, and neuron-muscle interplay
CO5	Explain neuroprotection, neuroprosthetics, neuroinformatics, treatments, and future directions.

CO-PO Articulation matrices

Course	PO 1	PO 2	PO 3
CO1	**3**	**2**	**3**
CO2	**3**	**2**	**3**
CO 3	**3**	**3**	**3**
CO4	**2**	**2**	**3**
CO 5	**3**	**2**	**3**

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

PO2: An ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirement in the appropriate bachelor program.

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

References:

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

PYTHON IN BIOINFORMATICS (BIO530)

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:	
CO1	Master basic Python syntax and control structures to manage bioinformatics data.
CO2	Understand and apply Python data types and structures for biological computations
CO3	Develop Python scripts for automating data retrieval, processing, and visualization in bioinformatics.
CO4	Implement and understand sequence alignment algorithms using Python.
CO5	Use Python for complex bioinformatics tasks like genome data analysis and protein modeling.

CO-PO Articulation matrices

Course	PO 1	PO 2	PO 3
CO1	2	3	3
CO2	3	2	3
CO 3	3	3	3
CO4	2	2	3
CO 5	3	2	3

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

PO2: An ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirement in the appropriate bachelor program.

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, visualization of biological data with matplotlib and seaborn	**9**
	Total	**45**

References:

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

CELL AND MOLECULAR BIOLOGY (BIO532)

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:	
CO1	To learn the mechanisms of biological processes involved in gene expression
CO2	To explain the concept of cell cycle and cell division and the impact of excessive cell proliferation
CO3	To comprehend mechanisms of cellular signaling and protein targeting within the cell or to the cell exterior
CO4	To gain insight into the strategies for gene silencing
CO5	To appraise various Cell & Molecular Biology techniques

CO-PO Articulation matrices

Course	PO 1	PO 2	PO 3
CO1	**2**	**2**	**3**
CO2	**3**	**3**	**3**
CO 3	**3**	**3**	**3**
CO4	**2**	**2**	**3**
CO 5	**3**	**2**	**3**

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

PO2: An ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirement in the appropriate bachelor program.

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**

References:

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 (BIO534)

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:	
CO1	Understand the structural biology and different types of bonds in protein structure.
CO2	To know the basics of X-Ray Crystallography and NMR.
CO3	To gain insight of optical spectroscopy
CO4	To gain knowledge about Potential Energy Minimization and its Function,
CO5	To learn the Knowledge-based Protein Modeling

CO-PO Articulation matrices

Course	PO 1	PO 2	PO 3
CO1	3	3	3
CO2	3	2	3
CO 3	3	2	3
CO4	2	2	3
CO 5	3	2	3

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

Po2: An ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirement in the appropriate bachelor program.

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**

References:

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.

PHARMACOINFORMATICS (BIO536)

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:	
CO1	Understand the Classification of drugs and \simulation in drug designing
CO2	To gain knowledge about Pharmacokinetics.
CO3	Illustrate pharmacodynamics and drug receptor action
CO4	Summarize therapeutic index and importance of drug design
CO5	Compare and contrast the type of pharmacoinformatics

CO-PO Articulation matrices

Course	PO 1	PO 2	PO 3
CO1	**2**	**3**	**3**
CO2	**2**	**2**	**3**
CO 3	**3**	**2**	**3**
CO4	**2**	**2**	**3**
CO 5	**3**	**2**	**3**

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

Po2: An ability to write and present a substantial technical report/document.

PO3 : Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirement in the appropriate bachelor program.

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

References**:**

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 (BIO538)

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:	
CO1	Understand the principles and processes of biopharmaceutical production.
CO2	Learn about drug discovery and development in the biopharmaceutical industry.
CO3	Explore applications of biopharmaceuticals in medicine and other fields.
CO4	Analyze the regulatory and quality control aspects of biopharmaceuticals
CO5	Conduct research and present findings on a specific topic in Biopharmaceuticals

CO-PO Articulation matrices

Course	PO 1	PO 2	PO 3
CO1	**3**	**2**	**3**
CO2	**3**	**2**	**3**
CO 3	**2**	**3**	**3**
CO4	**2**	**2**	**3**
CO 5	**3**	**2**	**3**

PO1: An ability to independently carry out research /investigation and development work to solve practical problems
PO2: An ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirement in the appropriate bachelor program.

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 DrugMetabolism; 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 (OBT601)

NANOTECHNOLOGY IN HEALTHCARE (OBT601)

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:	
CO1	Understanding of nanotechnology and pharmaceutical applications.
CO2	Illustrate the immunoassay techniques and nanomaterials implementations.
CO3	To explain application of improved medical diagnostics
CO4	Demonstrate various application of prosthetics and Medical implants
CO5	To comprehend diagnostic methods and stem cell technology

Articulation matrices

Course	PO 1	PO 2	PO 3
CO1	2	3	3
CO2	3	2	3
CO 3	2	2	3
CO4	2	2	3
CO 5	3	2	3

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

PO2: An ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirement in the appropriate bachelor program.

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**

References:

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.

SKILL ENHANCEMENT COURSE-1 (SEMESTER -1)

BULK DATA MINING AND RETRIEVAL (BIO541)

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
CO1	Understand the fundamental concepts and algorithms of data mining.
CO2	Apply data mining techniques to solve biological problems.
CO3	Develop skills in using software tools and programming for data mining in bioinformatics.
CO4	Critically analyze and interpret results from bioinformatics data mining.
CO5	Implement data mining projects from conception to execution

CO-PO Articulation matrices

Course	PO 1	PO 2	PO 3
CO1	**2**	**2**	**3**
CO2	**3**	**2**	**3**
CO 3	**3**	**3**	**3**
CO4	**2**	**2**	**3**
CO 5	**3**	**2**	**3**

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

PO2: An ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirement in the appropriate bachelor program.

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.

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 (BIO543)

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:**
CO1	Explain principles and types of molecular docking.
CO2	Identify uses of simulation software in molecular interaction analysis.
CO3	Discuss various methods used in molecular simulations.
CO4	Describe techniques for data analysis in molecular simulations.
CO5	Define advanced techniques used in detailed molecular simulations.

CO-PO Articulation matrices

Course	PO 1	PO 2	PO 3
CO1	**2**	**3**	**3**
CO2	**3**	**2**	**3**
CO 3	**3**	**2**	**3**
CO4	**3**	**2**	**3**
CO 5	**3**	**2**	**3**

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

PO2: An ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirement in the appropriate bachelor program.

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.

References:

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

(SEMESTER-2)

Bioinstrumentation (BIO-542)

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:	
CO1	Discuss the principle of centrifugation and its types.
CO2	List uses of electrophoretic techniques underlying electrophoresis systems.
CO3	Discuss chromatographic methods.
CO4	Explain spectroscopic and diffraction techniques.
CO5	Define optical techniques like microscopy.

CO-PO Articulation matrices

Course	PO 1	PO 2	PO 3
CO1	**3**	**3**	**3**
CO2	**3**	**3**	**3**
CO 3	**3**	**3**	**3**
CO4	**2**	**2**	**3**
CO 5	**3**	**2**	**3**

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

PO2: An ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirement in the appropriate bachelor program.

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**

References:

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.

WEB APPLICATION DEVELOPMENT (BIO-544)

Details of course: -

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Web Application Development	3	1	0	Nil

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

Course Outcomes:	
CO1	Understandthe concept of server and web technology and development
CO2	To comprehend the pearl programming
CO3	To demonstrate MySQL and working with data
CO4	To gain Insight in to MySQL and perl, server admin
CO5	Applications of Apache, installation and handeling

CO-PO Articulation matrices

Course	PO 1	PO 2	PO 3
CO1	2	2	3
CO2	3	2	3
CO 3	3	2	3
CO4	2	2	3
CO 5	3	2	3

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

PO2: An ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirement in the appropriate bachelor program.

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.

References :

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.