

DELHI TECHNOLOGICAL UNIVERSITY
SCHEME OF TEACHING AND EVALUATION
MASTER OF TECHNOLOGY IN BIOINFORMATICS (BIO)

The following alphanumeric coding scheme has been adopted

Core Courses XXXYMN

Elective Courses XXXYCMN

XXX abbreviates a particular M. Tech. program, Y – (5 for M. Tech. 1 st year, 6 for M. Tech. 2 nd year),

C – credit of the course (4/3/2),

MN – Subject code (Odd number for odd semester and even number for even semester courses)

Semester-I														
	S. No.	Course Code	Course Name	Type/ Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE	Total Credits
Group A	1	BIO501	Introduction to Bioinformatics	Core	4	3	0	2	15	25	20	40	-	17
	2	BIO503	Advanced Proteomics	Core	4	3	0	2	15	25	20	40	-	
Group B	3	BIO5401/5403/.....	Elective 1	Elective	4	3/4	0	2/0	15/20	25/-	20/30	40/50	-	
	4	BIO5301/5303/.....	Elective 2	Elective	3	3	0/1	2/0	15/20	25/-	20/30	40/50	-	
	5	BIO5201/5203/..... /UEC5201/5203/.....	Elective 3/ University Elective I	Elective	2	2	0	0	20	-	30	50	-	
Semester-II														
	S. No.	Course Code	Course Name	Type/ Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE	Total Credits
Group C	1	BIO502	Advances in Bioinformatics	Core	4	3	0	2	15	25	20	40	-	17
	2	BIO504	High Throughput Structural Biology	Core	4	3	0	2	15	25	20	40	-	
Group D	3	BIO5402/5404/.....	Elective 4	Elective	4	3/4	0	2/0	15/20	25/-	20/30	40/50	-	

Commented [SR1]: All will change

Commented [SR2]: All will change

Commented [3]:

	4	BIO5302/5304/.....	Elective 5	Elective	3	3	0	0	20	-	30	50	-	
	5	BIO5202/5204/...../ UEC5202/5204/.....	Elective 6/ University Elective II	Elective	2	2	0	0	20	-	30	50	-	
Semester-III														
	S.No.	Course Code	Course Name	Type/ Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE	Total Credits
	Track 1													12
Group E	1	BIO651	Research Project	Core	2 ¹ 2	0	0	2 ¹ 2	0	-	0	100	0	
	Track 2													
	1	BIO601	Major Project I	Core	3						40	60		12
	2	BIO6401/6403/.....	Elective 7	Elective	4	3/4	0	2/ 0	15/ 20	25/ 0	20/ 30	40/50	-	
	3	BIO6301/6303/.....	Elective 8	Elective	3	3	0	0	20	0	30	50	-	
4	BIO6201/6203/.....	Elective 9	Elective	2	2	0	0	20	-	30	50	-		
Semester-IV														
	S.No.	Course Code	Course Name	Type/ Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE	Total Credits
Group F	Track 1													
	1	BIO652	Research Project	Core	2 ¹ 2	0	0	2 ¹ 2	0	-	0	100	0	12
	Track 2													
	1	BIO602	Major Project II	Core	2 ¹ 2	0	0	2 ¹ 2	0	-	0	100	0	12

LIST OF ELECTIVES :													
	S.No.	Course Code	Course Name	Type/Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE
Elective 1	1	BIO5401	Computer Graphics	Elective	4	3	0	2	15	25	20	40	-
	2	BIO5403	Computer Aided Drug Design		4	3	0	2	15	25	20	40	-
	3	BIO5405	Pharmacogenomics and Personalized Medicine		4	3	0	2	15	25	20	40	-
	4	BIO5407	OMICS in Medicine		4	4	0	0	20	-	30	50	-
	S.No.	Course Code	Course Name	Type/Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE
Elective 2	1	BIO5301	Data Warehousing and Data Mining	Elective	3	3	0	0	20	-	30	50	-
	2	BIO5303	Genomics: From Human Genome Project to Medical Applications		3	3	0	0	20	-	30	50	-
	3	BIO5305	Combinatorial Methods in Biopharmaceuticals		3	3	0	0	20	-	30	50	-
	4	BIO5307	Microarray Technology		3	3	0	0	20	-	30	50	-
	S.No.	Course Code	Course Name	Type/Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE
	1	BIO5201	Open Area Seminar - I		2	2	0	0		-	100		-
Elective 3	2	BIO5203	Analysis of Biological System	Elective	2	2	0	0	20	-	30	50	-
	3	BIO5205	Plant Bioinformatics		2	2	0	0	20	-	30	50	-
	4	BIO5207	Database Management System		2	2	0	0	2	-	100	-	-
	S.No.	Course Code	Course Name	Type/Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE

Elective 4	1	BIO5402	Advanced Genetic Engineering	Elective	4	3	0	2	15	25	20	40	-
	2	BIO5404	Systems Biology		4	3	0	2	15	25	20	40	-
	3	BIO5406	Web Application Development		4	3	0	2	15	25	20	40	-
	4	BIO5408	Image Processing in Medicine		4	4	0	0	20	-	30	50	-
	S.No.	Course Code	Course Name	Type/Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE
Elective 5	1	BIO5302	Minor Project	Elective	3	3	0	0	-	-	40	60	-
	2	BIO5304	Medical Bioinformatics		3	3	0	0	20	-	30	50	-
	3	BIO5306	Pharmacoinformatics		3	3	0	0	20	-	30	50	-
	4	BIO5308	Immunoinformatics		3	3	0	0	20	-	30	50	-
	S.No.	Course Code	Course Name	Type/Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE
Elective 6	1	BIO5202	Open Area Seminar-II	Elective	2	2	0	0	-	-	100		-
	2	BIO5204	Python programming for Bioinformatics		2	2	0	0	20	-	30	50	-
	3	BIO5206	Bioethics and IPR		2	2	0	0	20	-	30	50	-
	4	BIO5208	Perl Programming for Bioinformatics		2	2	0	0	20	-	30	50	-
	S.No.	Course Code	Course Name	Type/Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE
E I	1	BIO6401	Drug Design and Discovery	Elective	4	3	0	2	15	25	20	40	-

SEMESTER I

Courses

BIO501 Introduction to Bioinformatics

Overview of the biological databases and their types, Sequence Formats & storage along with Sequence submission to sequence Database, computational genomics, Human Genome Project, Gene ontology, Pairwise and Multiple sequence alignment, Local and Global alignment, Scoring matrices, Gaps, Dot Plots. Dynamic programming Approach: Needleman and Wunsch Algorithm, Smith and waterman Algorithm, Heuristic Approach: BLAST, FASTA. Methods for multiple sequence alignment.

Practicals

1. Inter-conversion different sequence file format
2. Database Searching using Entrez and SRS
3. Study of Databases and Data retrieval
4. Dot Matrix Alignments
5. Needleman Wunsch Alignments.
6. Smith Waterman Alignments
7. Multiple Sequence Alignment

Suggested Books:

1. Arthur M. Lesk ,Introduction to Bioinformatics, Oxford University Press, 2003.
2. David W. Mount ,Sequence and Genome Analysis , Cold Spring Harbor Laboratory, 2004.
3. Andreas D. Baxevanis, B. F. Francis Ouellette, Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, Wiley-Interscience, 2004.
4. D Higgins, W Taylor ,Sequence structure and Database, Oxford press ,2003.

BIO503 Advanced Proteomics

The Introduction of this subject includes the information of proteome and the Genome, life and death of a protein, its modular structure and various functional protein families. It would be giving insights for the need, scope and the challenges of proteomics. The Strategies required for protein separation like Two-dimensional polyacrylamide gel electrophoresis for proteome analysis, a brief history of 2-DE, 2-DE with immobilized pH gradients, sample preparation, solubilisation, Reduction, The first dimension: IEF with IPG, Equilibration between dimensions and the second dimension: SDS-PAGE, resolution, reproducibility of 2-DE, liquid chromatography in proteomics. In the next section the subject covers how to detect proteins in polyacrylamide gels and on electroblot membranes with Organic dyes, silver and reverse stains, Colloidal dispersion stains, organic fluorophore stains and metal chelate stains. This chapter further gets into Image analysis of two-dimensional gels and learning Data acquisition, digital image processing, Protein spot detection and quantification, Gel matching, Data analysis and presentation. The students will study how to enhance the high-throughput proteome analysis, the impact of stable isotope labelling, Sample

preparation and two-dimensional gel separation. Other techniques like Mass spectrometry which includes protein identification using MS data, protein identification using MS/MS data. And a little overview to Protein modification in proteomics, phosphor-proteins, glycoproteins, and Ubiquitin etc. Next it includes protein – protein interaction and its technique like Yeast two hybrid, Co-Precipitation, Phage Display, Phylogenetic Profile, Domain fusion, Gene Neighborhood, Gene Cluster, Mirror Tree. And students also learn analysis of genome wide Protein-Protein Interactions in yeast, Genome wide yeast two hybrid analysis of other organisms and Protein fragment complementation assays. Last section comprises of functional proteomics and introduction, types, detection and quantification of proteins bound to protein chips, also the emerging proteins chips technologies.

Practicals:

1. Isolation of protein
2. Protein estimation
3. SDS- PAGE
4. Antibody staining
5. Protein interaction
6. Database analysis

Suggested Books:

1. S.R. Pennington and M.J. Dunn, Proteomics: From Protein Sequence to Function, Viva Books Private Limited ,2001.
2. Daniel C. Liebler, Introduction to Proteomics, Humana Press, 2002.
3. A.M. Campbell, Discovering Genomics, Proteomics & Bioinfo ,C.S.H. Press, 2003.
4. C Saccone, G Pesole, Handbook of Comparative Genomics: Principles and Methodology, Wiley-LISS Publication ,2003.
5. S.R. Pennington, M.J. Dunn , Proteomics: From Protein Sequence to Function, Viva Books Private Limited ,2001.

BIO5401 Computer Graphics

The introduction to graphic Systems and its various types like, Refresh CRT, raster-scan displays, DVST, plasma displays and LCD. Also the introduction to input devices and the functions and working provided by them, including the example like image scanners, touch panels, Input modes, request mode and event mode. The basics of output primitives like Points, lines, DDA, Bresenham line & circle drawing algorithm and ellipse generation. Along with output, filled area primitives are also included in this like scan line polygon fill algorithm, inside outside tests, boundary fill algorithm with understanding of Line width, color, gray levels and character attributes. In the next section it have basics of two-dimensional geometric transformation including translation, rotation, fixed point scaling and general scaling direction. The viewing pipeline, window viewpoint transformation and Line clipping algorithms. The next unit is based on three dimensional concepts like Polygon surfaces, plane equation, curved lines, quadric surfaces, spline representation and specification. Other things include Bezier curves and surfaces, B-splines and surfaces, Displaying spline curves and surfaces and Horner's rule The viewing methods of 3 D transformations includes viewing co-ordinates, transformation from world to viewing co-ordinates, parallel and perspective projections, Back face detection, depth-buffer and A-buffer methods.

In the end the syllabus includes the representation of 3D Object by Visible Surface Algorithms, Curves and Surfaces in Computer Graphics, also introduction to the Ray Tracing and Radiosity methods, Anti-aliasing, Shadow generation, Texture mapping, Effects, Fractals, and Image Coding.

Practicals:

1. Standard functions in the 'c' graphics module -Introduction to pixels, drawing various geometric objects, filling polygons, images etc.
2. Implementation of the basic line drawing algorithm and the Circle drawing algorithm using DDA, Midpoint algorithm, Bresenham's algorithm etc.
3. Polygon filling using seed fill, scan line algorithm etc.
4. Clipping algorithms -Cohen-Sutherland algorithm, LiangBarsky algorithm etc.
5. 2D and 3D Transformations -Translation, scaling, rotation etc.
6. Projections - Parallel and perspective projections and their types. Curve fitting -Cubic curves (Bezier curves, spline curves etc.)
7. Lighting and Shading -Implementing Phong illumination model, Gouraud and Phong shading, Animation.
8. Image processing demonstration

Suggested Books:

1. D.Hearn and M.P. Baker ,Computer Graphics C version, Pearson Publication,1987
2. S.Harryton ,Computer Graphics - A programming approach, Mc Graw Hill Education , 1987
3. David F. Roger , Procedural Elements of Computer Graphics, Mc-Graw Hill Education, 1997

BIO5403 Computer Aided Drug Design

The subject starts with the introduction to CADD, SBDD and Representation of Molecular Structures, Chemical Nomenclature and Structure Representation, Processing Constitutional Information, Representation of 3D Structures, Molecular Shape Analysis, and representation of Chemical Reactions. Then next it have Virtual screening which includes Chemoinformatics in Lead Discovery, Computational Chemistry, Molecular Complexity and Screening Set Design. There are Algorithmic Engines in Virtual Screening and students learn the strengths and Limitations of Pharmacophore-Based Virtual Screening. Moving towards the lead discovery part which comprises of High Throughput Screening, Hit and Lead Discovery, Enhancing Hit Quality and Diversity within Assay Throughput Constraints, Molecular Graphics, Molecular Dynamics and Simulation of Lead. Also get to understand the Molecular Diversity in Lead Discovery from Quantity to Quality and In Silico Lead Optimization.The next part include Databases and Libraries like PubChem, PubEchm-BioAssay, Pharma Project, Drug Bank, WOMBAT: World of Molecular Bioactivity, Cabinet - Chemical and Biological Informatics Network. It gives Structure Modification in Chemical Databases, Rational Design of GPCR-specific Combinational Libraries Based on the Concept of Privileged and Substructures. The last and the main part of the Molecular docking & Simulation in which students study de novo pharmacophore elucidation/ drug design for structurally well-defined receptor targets like HIV protease inhibition, ER antagonism, H2 receptor antagonism. The introduction to Chirase inhibition (quinoline derivative antibiotics), ACE inhibition and docking like macromolecule-ligand docking, docking algorithms and AUTODOCK. The syllabus also includes Molecular dynamic

simulations, relative energy, energy minimization methods, ligand binding free energy calculations (both simulation and empirical methods), intermolecular interactions, forces related to drug binding, force-field calculation including solvation, role of solubility in drug binding and pKa, Poisson-Boltzmann Surface Area (PBSA), AMBER, GROMOS and GROMACS.

Practicals:

1. To perform the homology modeling of a protein by using the MODELLER software.
2. To evaluate the 3D structure of a protein by using the different tools on the SAVS server.
3. To find the active site/cavity in a receptor by using the SURFACE RACER program.
4. To draw the chemical structures by using the ChemSketch/ChemDraw software.
5. To perform the de novo Drug Designing by using the LIGBUILDER software.
6. To perform the protein-ligand docking by using the HEX program.
7. To perform the protein-protein docking by using the AUTOCOCK software.
8. To perform the virtual screening of ligands by using the DOCK program.
9. To perform the Quantitative Structure-Activity Relationship (QSAR) analysis by using the DRAGON software.
10. To perform the Pharmacophore modeling of ligands by using the LigandScout program.

Suggested Books:

1. B.Wang, S.Ekins Computer Applications in Pharmaceutical Research and Development, John Wiley & Sons India Pvt. Ltd,2006
2. R.V. Gadag and A. Nityananda Shetty ,Engineering Chemistry,I.K. International Publishing House Pvt. Ltd,2014
3. Juan Alvarez and Brian Shoichet,Virtual Screening in Drug Discovery, CRC Press,2005
4. Donald T. Haynie ,Biological Thermodynamics,Cambridge University Press India Private Limited,2008

BIO5405 Pharmacogenomics and Personalized Medicine

The course gives introduction to pharmacogenomics, its historical perspectives and current status. It covers an important topic like The Human genome or Computational genome analysis. Further it gives functional analysis of Gene Variation & Genotyping Techniques with aspects influencing method of selection, SNP Genotyping and TaqMan Genotyping. Next it provides insights of Pharmacogenomics in drug discovery and the need of protein structure information, variation in drug targets-the scale of problem, mutation of drug targets leading to change in the ligand binding pocket and PharmGKB.

Practicals:

1. Accessing, querying and becoming comfortable with the interface of pharmacogenomics based databases: UCSC, NCBI dbSNP, HapMap and resequencing databases, 1000 Genomes, PharmGKB - a publicly available Internet tool to aid researchers in understanding how genetic variation among individuals contributes to differences in reactions to drugs and Drug Bank
2. Use of PGx pipeline 1.0 Server

3. Statistical data management using SAS: Data Collection and Entry, Data Storage and Transferal, Data Analysis & Data Exposition
4. Understand and run Warfarin dosing algorithm using web based interfaces Sequence variation analysis

Suggested Books:

1. Licinio, Julio and Ma-Li Wong, Pharmacogenomics: The Search for the Individualized Therapies”, Wiley-VCH, 2002
2. Chakrabarthy, Chiranjib and Bhattacharyya, Pharmacogenomics: An Approach to New Drugs Development, Atane, 2004.
3. Mark A. Rothstein, Pharmacogenomics: Social, Ethical and Clinical Dimensions, Wiley-Liss, 2003.
4. QYan Pharmacogenomics in Drug Discovery & Development, Humana Press, 2008

BIO5407 OMICS in Medicine

The introduction to Omics concepts and applications, with sequencing of Human and other organisms. It help students understand the role of Genomics in identification of microbes causing infectious diseases (microbiomes study), molecular epidemiology, host resistance to infection, pathogenicity and combating infectious diseases. It explains how genomics helps in detection of genetic disorders, treatment and pharmacogenomics. The understanding of role of Epigenomics and non-coding RNAs in disease development, inheritance and control. The last part includes genomics in translational and clinical trials, and risk assessments/prediction of genetic diseases with few successful case studies.

Suggested Books:

1. T. Strachan and A.P. Read ,Human Molecular Genetics, Garland Science Publication, 2003
2. H. Lodish, A. Berk, and C.A. Kaiser, Molecular Cell Biology, W. H. Freeman & Co Ltd, 2007
3. Victor J. Dzau and Choong-Chin Liew, Cardiovascular Genetics and Genomics for the Cardiologist Blackwell Publishing, 2007
4. Charles R. Cantor and Cassandra L. Smith, Genomics: The Science of Technology Behind the Human Genome Project, John Wiley & Sons, 1999.
5. M Keynes, A.W.F. Edwards and R Peel ,A Century of Mendelism in Human Genetics, CRC Press, 2005
6. T Strachan , J Goodship, P Chinnery , Genetics and Genomics in Medicine, Garland Science, 2014
7. Stephen T Sonis, Genomics, personalized medicine and oral disease, Springer publisher, 2015

BIO5301 Data Warehousing and Data Mining

The course starting with the data warehousing Components like Building and Mapping the Data Warehouse to a Multiprocessor Architecture, DBMS Schemas for Decision Support like Data Extraction, Cleanup, and Transformation Tools like Metadata, reporting, Query tools and Applications like Online Analytical Processing (OLAP) and Multidimensional Data Analysis. Next in course is data mining functionalities like Data Pre-processing, Data Cleaning, Data Integration and Transformation which includes Data Reduction, Data Discretization and Concept Hierarchy Generation. Then the students will get to know Efficient and Scalable Frequent Item set in Mining Methods and Various Kinds of Association Rules like Association Mining to Correlation Analysis and Constraint-Based Association Mining.

The course will also include the issues regarding Classification and Prediction like Classification by Decision Tree, Bayesian Classification, Rule Based Classification, Classification by Back propagation, Support Vector Machines, Associative Classification, Lazy Learners and Other Classification Methods, Evaluating the Accuracy of a Classifier or Predictor, Ensemble Methods like Model Selection Cluster Analysis: - Types of Data in Cluster Analysis. The course ends with Practical Factors used Prior to Data Mining, Differential Gene Expression, Discriminant Analysis, Gene Annotation, Pathway Analysis, Microarray and Data Mining Applications.

Suggested Books:

1. J Han, M Kamber, Data Mining Concepts and Techniques, Elsevier, 2008
2. A Berson, Stephen J. Smith, Data Warehousing, Data Mining & OLAP, McGraw – Hill Publication, 2007
3. K.P. Soman, S Diwakar, V. Ajay, Insight into Data mining Theory and Practice, Prentice Hall of India, 2006.
4. G. K. Gupta, Introduction to Data Mining with Case Studies, Prentice Hall of India, 2006.
5. Pang-Ning Tan, M Steinbach, V Kumar, Introduction to Data Mining, Pearson Education, 2007.

BIO5303

Genomics: From Human Genome Project to Medical Applications

Introduction to the terms like Gene Medicine, Disease Models and understanding the impact of Genomics on Medicine, and Molecular Medicines. Understanding the Human Genome Project Breakthroughs and Functional Genomic including Comparative Genomics, Transcriptomics, Proteomics, and Mutational Genomics. The course also includes the Genomics Applications in Infectious Diseases topic which helps in identification of causative microbes, molecular epidemiology, host resistance to infection, pathogenicity and combating infectious diseases.

Genomics Applications in Genetic Diseases, detection and treatment of single gene disorders, analysis of polygenic disorders, linkage analysis, Linkage disequilibrium mapping, haplotypes, MHC, and pharmacogenomics. Next it has genomics Applications in Cancer which includes molecular basis of cancer, impact of genomics on cancer research, methods for the diagnosis of cancer and approaches to cancer therapy.

Suggested Books:

1. T. Strachan and A.P. Read, Human Molecular Genetics, Garland Science Publication, 2003
2. H. Lodish, A. Berk, and C.A. Kaiser, Molecular Cell Biology, W. H. Freeman & Co Ltd, 2007
3. Victor J. Dzau and Choong-Chin Liew, Cardiovascular Genetics and Genomics for the Cardiologist, Blackwell Publishing, 2007
4. Charles R. Cantor and Cassandra L. Smith, Genomics: The Science of Technology Behind the Human Genome Project, John Wiley & Sons, 1999

BIO5305

Combinatorial Methods in Biopharmaceuticals

Introduction to the Original Combinatorial Chemist, Biopolymers which constitute natural libraries, Selection and evolution. Includes the expression of genetic information Combinatorial assembly of antibody gene and Molecular solutions to Combinatorial problems. It also gives introduction to the synthetic peptide libraries which have Solid-Phase peptide synthesis and Peptide on pins like topic. Other iterative deconvolution strategies, examples of Split/Couple/Mix Peptide Libraries:- Positional Scanning, the course gives insights to topics like Polystyrenes, PEG, Grafted supports,

Coupling strategies, New resins and linkers, Ring, forming cleavage. The students will also learn about the Polyethylene glycols, Dendrimers Fluorous synthesis, and Solutions like Phase parallel synthesis scavenging resins, Ion Exchange resins, Supported reagents, Fluorous reagents, Solid phase extraction, Gas Phase separation. In the last section we have Product identification, Gel Phase NMR, High resolution magic angle spinning NMR on-bead infrared Spectroscopy, Mass Spectroscopy, Non Spectroscopic Methods, Product identification, Gel Phase NMR, High resolution magic angle spinning NMR on-bead infrared Spectroscopy, Mass Spectroscopy and Non Spectroscopic Methods.

Suggested Books

1. F Hicham, Combinatorial Chemistry, Oxford University Press, 2000
2. Block J.H. and Beale, J.M., Wilson & Gisvolds Text book of Organic Medicinal and Pharmaceutical Chemistry, Lippincott Williams & Wilkins, 2004
3. Fassina, G., Combinatorial Chemistry and Technologies: Methods and Applications, CRC Press, 2005
4. G Jung, Combinatorial Chemistry: Synthesis, Analysis, Screening, WILEY-VCH, 2001
5. K. C. Nicolaou, Handbook of Combinatorial Chemistry: Drugs, Catalysts, Materials, Wiley-VCH, 2002

BIO5307

Microarray Technology

Starting with the types of microarray like cDNA microarray, oligonucleotide microarray, spotted microarray and In situ synthesized microarray along with them Hybridization process and DNA microarray database. In In situ synthesized microarray student will study method of manufacturing and Phosphoramidite method. Spotted microarray include method of manufacturing, and Photolithography. The next section includes image segmentation, intensity measurement, Normalization of data, Clustering and Coexpression analysis. And the last section comprises of Applications of microarray technology which includes Differential gene expression analysis, Expression profiling, Genome sequencing, Copy number variation, Alternative splicing detection, and Mutation analysis.

Suggested Books:

1. H. Causton, J. Quackenbush, A. Brazmam, Microarray Data Analysis: Gene Expression Data Analysis. A Beginner's Guide, Blackwell, 2003
2. D.P. Berrar, W. Dubitzky, M. Granzow, A Practical Approach to Microarray Data Analysis, Springer, 2003
3. S. Drăghici, Data Analysis Tools for DNA Microarrays, Chapman and Hall/CRC, 2003
4. F. Emmert-Streib, M. Dehmer, Analysis of Microarray Data: A Network-Based Approach, Wiley-VCH Verlag GmbH & Co., 2008

BIO5201 Open Area Seminar - I

BIO5203

Analysis of Biological Networks

At first there is introduction to the biological networks which includes Systems Biology, Properties of Biological Networks and Graph Theory which have Basic Notation, Special Graphs, Graph Representation and Graph Algorithms. The next section is about the network analysis in which students read about Global Network Properties, Global Properties of Complex Networks, Models of Complex Networks, Additional Properties of Complex Networks, and Statistical Testing of Network Properties. It also has Network

Centralities in which Centrality Definition and Fundamental Properties Degree and Shortest Path-Based Centralities and Feedback-Based

Centralities are studied. The course also include network motifs as topic which include Definitions and Basic Concepts, Motif Statistics and Motif- Based Network Distance, Complexity of Network Motif Detection, Methods and Tools for Network Motif Analysis, Analyses and Applications of Network Motifs. The next topic is network clustering in which students will study Network Clustering Problem, Clique-Based Clustering, and Centre-Based Clustering. The last section of the course is about Signal Transduction and Gene Regulation Networks, Protein Interaction Networks, Metabolic Networks, Phylogenetic Networks and Ecological Networks.

Suggested Books:

1. A Raval, A Ray, Introduction to Biological Networks, Chapman and Hall/CRC, 2013
2. Tatiana V. Tatarinova, Y. Nikolsky, Biological Networks and Pathway Analysis, Humana Press, 2017

BIO5205 Plant Bioinformatics

Introduction to Plant Bioinformatics and explain importance of plant bioinformatics includes biological databases and Protein and Gene Information Resources like PIR, SWISSPROT, PDB and genebank. Comprises of Plant specific Genomic Data and Resources like HarvEST, TARI Database, Legume Resources, GrainGenes, Maize GDB and Gramene. Phylogenetic data and phylogenies Software used to discover phylogenies, use and status of specimen data, species distribution, Current priorities in biodiversity informatics, challenges and future prospect. The course also introduce KEGG tools and Resources and Germplasm Data Management. In the last section the course talks about PlantGDB Resources, Gene Ontology, Manual Annotations, and Computational Annotation Methods.

Suggested Books:

1. D Edwards, Plant Bioinformatics: Methods and Protocols, Humana Press, 2007
2. Dary I. J. Somers, P. Langridge and J. Perry Gustafson, Plant Genomics: Methods and Protocols, Humana Press, 2009.

BIO5207 Database Management System

Introduction to DBMS vs. File-system, Data models, architecture (2-Tier & 3-Tier), Database users and DBA. Understanding the Database Design: Design issue, E R Model: entity, entity set, attribute (single valued, multivalued, simple, composite & derived), Constraints – Mapping cardinalities, Keys, ER Diagram: Basic structure, Mapping, Specialization, Generalization, Weak entity Relational Model: Database schema & instance. The students will learn relation: schema & instance, attribute, domain, tuple, domain constrains, arity & cardinality of relation, integrity constraint, key constrains (super key, candidate key, primary key), Foreign Key Constraints. SQL: DDL (Create, Alter, Drop), DML (Insert, Update, Delete) & Concept of DCL. The last section would include Aggregation Functions (max, min, avg and sum). Nested query and Normalization: Different anomalies in designing a Database, Normalization concept. 1NF, 2NF & 3NF

Suggested Books:

1. A Silberschatz, Henry F. Korth, and S. Sudarshan ,Database System Concepts , Mc Graw-Hill Publication , 2010
2. J Gehrke, R Ramakrishnan,Database Management Systems,Mc Graw-Hill Education,2003

SEMESTER II**BIO502 Advanced Bioinformatics**

Human Genetic Variation and its Databases, Tools for SNP and mutation visualization, Biological Sequence Analysis & Characterization which includes Predictive Functional Analysis of coding and non-polymorphisms, Also include Amino Acid Properties and Consequences of Substitutions, Relationship between genotypes and phenotypes; Monogenic and complex disorders; Interplay of genetic and environmental factors; Integration of clinical and molecular data; Understanding the factors influencing disease susceptibility, Soft computation, machine learning, Supervised and Unsupervised Methods, Pharmacogenomics and Pharmacogenetics

Practicals:

1. SNP and Mutation Databases
2. Gene Ontology
3. Predictive Functional Analysis of SNPs – SIFT; PolyPhen
4. Pharmacogenomics Databases

Suggested Books

1. F Dardel, F Képès, N Hardy ,Bioinformatics: Genomics and Post-Genomics,John Wiley & Sons India Pvt Ltd,2006
2. N J Chikhale,V S Gomase, Bioinformatics:Theory and Practice, Himalaya Publication House,2007
3. Campbell ,Heyer,Discovering Genomics, Proteomics and Bioinformatics,Pearson Education,2006
4. N J Chikhale,V S Gomase ,Proteomics: Theory and Practice, Himalaya Publication House,2009
5. Christoph W. Sensen ,Essentials of Genomics and Bioinformatic, John Wiley & Sons India Pvt Ltd, 2003

BIO504 High-throughput Structural Biology

Introduction to the Peptide Bonds, hydrogen bonding, ionic and hydrophobic interactions. Introduction to 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. A brief description of X-ray Crystallography Computing: The Phase Problem, Least Square Solutions, Entropy Maximization, and Indirect Methods. Also explains NMR Structure Determination: Nuclear Magnetic Resonance, Distance Geometry, Distance-based Modeling, and Structural Analysis. This section gives description about Optical spectroscopy including 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. The next section of course explains Mass spectroscopy: application to complex proteins and gives Diffraction overview, crystallization, wave/vector math and scattering, scattering from a periodic lattice, reciprocal space, and symmetry multi wavelength anomalous diffraction and Crystallographic statistics. Potential Energy Function, Local Optimization, Global Optimization, Energy Transformation. Knowledge-based Protein Modeling: Sequence/Structural Alignment, Fold Recognition/Inverse Folding, Knowledge-based Structural Refinement, Structural Computing, Comparative and ab initio modelling

Practicals:

1. Chemical modification of proteins.
2. Peptide mapping.
3. Analysis of amino acid composition.
4. Analysis and interpretation of spectrophotometric data for denaturation studies.
5. Analysis of CD data.
6. Analysis and interpretation of NMR data
7. Crystallization of Lysozyme – pH driven and salt driven crystallization. Effect of
8. concentration. BMCD.
9. Analysis and interpretation of X-Ray crystallographic data.
10. Public domain software for structure modeling and visualization.

Suggested Books

1. D. L. Nelson and M.M. Cox, Lehninger, W. H. Freeman, Principles of Biochemistry, 2004
2. M Sundström, M Norin, A Edwards, Structural Genomics and High-Throughput Structural Biology, CRC Press, 2006.
3. P.R. Bergethon, The Physical Basis of Biochemistry: The Foundations of Molecular Biophysics, Springer, 2000.
4. K.E van Holde, C. Johnson, P. Shing Ho, Principles of Physical Biochemistry, Prentice Hall, 2005.
5. Zhijun Wu, Lecture Notes on Computational Structural Biology World, Scientific Publishing Co. Pvt. Ltd, 2008.

BIO5402

Advanced Genetic Engineering

Course includes of core techniques in gene manipulation which involves various steps such as Core techniques in gene manipulation: Cutting and joining DNA, introduction of DNA into cells, Isolation, sequencing and synthesis of gene. Cloning strategies, construction of genomic libraries and cDNA libraries. Probe construction, recombinant selection and screening, Analysis of expression, Analysis of recombinant DNA, site-directed mutagenesis, altered expression and engineering genes. DNA amplification using polymerase chain reaction, Key concepts, Analysis of amplified products, Applications of PCR; Ligase chain reaction. Expression systems and their applications, E.coli, Streptomyces, Yeast, Baculovirus and animal cells as cloning hosts, Sequencing methods. Transfection techniques, Gene silencing techniques, Gene knockouts and gene therapy, Differential gene expression and protein array, Protein-protein interactions, DNA-Protein interactions. Somatic and germ line therapy-in vivo and ex vivo, Transgenic. Applications of Genetic Engineering: Pharming, Genetically Engineered Foods, Biofuels, Designer Babies.

Practicals:

1. Designing and strategy of gene cloning
2. Restriction digestion
 - (a) single
 - (b) double and partial digestion
 - (c) Star activity
3. Agarose gel electrophoresis
4. Modification of DNA ends
5. PCR

Suggested Books:

1. RN Old,SB.Primrose, Principles of gene manipulation, Blackwell Scientific Publications, 1994
2. DM. Glover, BD. Hames,DNA cloning I & II, IRL Press, 1995
3. MA. Innis, DH.Gelfand , JJ. Sninsky ,PCR strategies, Academic Press, 1995
4. D.Balasubramanian ,Concepts in Biotechnology – Editors, University Press ,1996.

BIO5404

Systems Biology

Systems Biology, Fundamentals: Overview of Gene Control, working of Genetic Switches, introductory systems. Biology The biochemical paradigm, genetic paradigm and the systems paradigm. Kinetics: Equilibrium Binding and Co-operativity, Michaelis-Menten Kinetics, identical and independent binding sites Identical and interacting binding sites, non-interacting binding sites. Genetic switch in Lambda Phage -Noise-based Switches and Amplifiers for Gene Expression. Gene Regulators. Synthetic genetic switches. Ecoli chemotaxis –biological oscillators- genetic oscillators - The Origin and Consequences of Noise in Biochemical Systems. Developmental Systems Biology, Building an Organism Starting From a Single Cell, Quorum Sensing, Programmed Population Control by Cell-Cell Communication and Regulated Killing, Drosophila Development. Establishment of Developmental Precision and Proportions in the Early Drosophila embryo. Gene expression networks, Gene regulation at a single cell level- Transcription Networks -basic concepts -coherent Feed Forward Loop (FFL) and delay gate -The incoherent FFL -Temporal order, Signaling networks and neuron circuits -Aspects of multi-stability in gene networks.

Practicals:

1. Gene and Protein data handling
2. Genome Database navigation
3. Alignment and phylogeny
4. Ortholog identification
5. Large scale domain analysis
6. Downloading and manipulating transcriptomes
7. Transcriptome metaFanalysis
8. CisF regulatory element search algorithms
9. Interactome analysis and protein interaction domains

10. Motif searching for key interaction sequences

Suggested Books

1. U Alon, An Introduction to Systems Biology: Design Principles of Biological Circuits, Chapman & Hall/CRC Press , 2006.
2. Darren J Wilkinson, Stochastic Modelling for Systems Biology, CRC Press, 2018

BIO5406 Web Application Development

Introduction to basic concepts of Servers, HTTP, HTTPS, FTP. Linux and HTML. 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, Bio-perl installation and any two related modules. MySQL CGI and PHP, Installing MySQL, MySQL Programs, Working with Data, MySQL Privileges MySQL and Perl: Perl DBI, Connect, Statement Handles, Error Handling, Server Admin. Apache Understanding Apache, Installation, Configuration.

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
3. in PERL, variables, different operators (arithmetic, assignment, comparison, logical and concatenation).
4. PERL Loops: while, do ... while, for, foreach
6. PERL form handling
7. PERL functions: Declaring functions, Adding parameters, Returning values.
8. PERL MySQL: Connect, Create, Insert, Select etc.

Suggested Books:

1. Adam McDaniel, Perl and Apache : Your visual blueprint for developing dynamic web content , Wiley Publishing Inc., 2010
2. James Tisdall, Beginning Perl for Bioinformatics, O'Reilly Media, 2001.
3. Patrick Galbraith, Developing Web Applications with Apache, MySQL, memcached and Perl, Wiley Publishing Inc., 2009

BIO5408 Image Processing in Medicine

Photography and film image: Principle of photography and radiographic film image, image quality factors (resolution, contrast, noise), Visual perception, structure and image formation in the eye, Introduction to digital image processing: Image acquisition and processing, uniform and Non-Uniform Sampling, Quantization, Image formats Image enhancement: Spatial Domain-Point processing techniques, histogram processing, Frequency Domain techniques- Basics

of Fourier transform, 2D-DFT, Low pass and high pass filters, Noise removal, Homomorphic filters. Image Compression: Fundamentals of Image compression models, Techniques of Lossless and Lossy Compression. Basic principles of image segmentation and its transforms: Representation and description in image processing, special imaging techniques: Cineradiography, stereoscopic radiography, magnification radiography, microradiography, neutron radiography. Fluoroscopy and angiography, Digital subtraction angiography (DSA), Infrared Imaging and thermography. Introduction to computed tomography: Principle and configurations/generations, detectors, data acquisition system, spiral CT, scanner parameters, CT Number Reconstruction techniques, Radon Transform, Filtered Backprojection, Reconstruction techniques, Image quality and artifacts, Clinical applications of CT Multi-detector computed tomography (MDCT), CT-Angiography. Radiation therapy: Radiotherapy principles, dosage data for clinical applications (ISODOSE charts), radiation therapy planning, collimators and beam direction devices, dose measurement and treatment planning, teleisotope units, safety protocols & protection.

Suggested Books:

1. Gonzalez, Woods ,Digital Image Processing, - Pearson Education,2008
2. A.K. Jain ,Fundamentals of Digital Image Processing, Printice Hall Inc, 1989
3. C Majumder , Digital Image Processing and Analysis ,Printice Hall India,2011
4. Sonka, Hlavac,Boyle,Digital Image Processing and Computer Vision,Cenage learning,2008
5. William K. Pratt ,Digital Image Processing, John Wiley& Sons, Inc,2001

BIO5302 Minor Project

BIO5304 Medical Bioinformatics

An Overview- Introduction, Problems in health care motivating biomedical informatics, Seminal documents and reports, Resources of field - organizations, information, education. Biomedical Computing-Types of Computers, Data Storage in Computers, Computer Hardware and Software, Computer Networks, Software Engineering, Challenges for Biomedical Computing Electronic Health Records: Clinical Data and Workflow, History and Perspective of the Health (Medical) Record, Potential Benefits of the Electronic Health Record, Definitions and Key Attributes of the EHR, EHR Examples, Nursing Informatics Clinical Decision Support; EHR Implementation: Historical Perspectives and Approaches, Medical Errors and Patient Safety, Reminders and Alerts, Computerized Provider Order Entry (CPOE), Implementing the EHR, Use and Outcomes of the EHR, Cost-Benefit of the HER Secondary Use of Clinical Data: Personal Health Records, Health: Info. Exchange, Public Health, Health Care Quality, Clinical Research, Personal Health Records, Health Information Exchange, Public Health Informatics, Health Care Quality, Clinical Research Informatics Evidence-Based Medicine and Medical Decision Making: Definitions and Application of EBM, Interventions, Diagnosis, Harm and Prognosis, Summarizing Evidence, Putting Evidence into Practice, Limitations of EBM Information Retrieval and Digital Libraries: Information Retrieval, Knowledge-based Information, Content, Indexing, Retrieval, Evaluation, Digital Libraries Imaging Informatics and Telemedicine: Imaging in Health Care, Modalities of Imaging, Digital Imaging, Telemedicine: Definitions and Barriers, Efficacy of Telemedicine.

Suggested Books:

1. J.van Bommel , M.A. Musen , Mark Musen, Handbook of Medical Informatics, Springer-Verlag ,2002

2. Eta S. Berner, M. J. Ball , Clinical Decision Support Systems : Theory and Practice (Health Informatics),Springer-Verlag, New York Inc,1999

BIO5306 Pharmacoinformaics

Curriculum covers wide range of subjective description on the whole topic to provide well-covered knowledge on the subject. It includes following sub-divisions; Introduction and Classification of drugs which covers basic information on molecular descriptors, structural genomics and its approaches, efforts and its impact. To know about protein structural initiative and structural genomics consortium. Our target study of the subject includes; nucleus as target, coding and noncoding RNA, SNP analysis, molecular modelling and simulation in drug designing. Next module is based on pharmacokinetics and pharmacodynamics, including its introduction, compartment model study, pharmacokinetic parameters, absorption, distribution, metabolism, excretion, multiple doses, salt factor and bioavailability. Bioactive conformation of the molecules, crystallography, energy minimization and bioactive conformation. Pharmacodynamics includes drug receptor action, drug-drug interaction, polymorphism, and drug metabolism, Drug potency and efficacy, Receptor effector coupling, Spare receptors. Therapeutic index, Types of drug design, Structure-based, ligand based, fragment based, metabolites and their importance in drug design and pharmaco-informatics includes tools, cancer informatics, neuro-informatics and related case studies.

Suggested Books:

1. Hillisch, Alexander, Modern Methods of Drug Discovery, Birkhauser Verlag,2003
2. Makriyannis, Alexandros, Drug Discovery : Strategies and Methods,Wiley-VCH,1990
3. Edward D Zanders, Chemical Genomics and Proteomics , Humana Press,2012

BIO5308 Immunoinformatics

Immuno-informatics course begins with an overview of immune system, basic information relating antigen, antibodies, the complement system, Antigen-Antibody Reactions, The Major Histocompatibility Complex, allele selection, Antigen Presentation, TAP, T cell receptors followed by advance immunology which includes Immune Effector Mechanisms: Cytokines and Chemokines, Hypersensitive Reactions. The Immune system in Health and Disease: Autoimmunity, Transplantation Immunology, Classification of Vaccine. HLA system in model organism defining HLA Supertypes in: HLA-Structural and Modeling Principles, HLA Super types by GRID/CPCA and Hierarchical Clustering Methods, Structural Basis for HLA-A2 Supertypes, Clustering of MHC Peptide-Binding Repertoires, HLA Alleles-Electrostatic Distribution Maps. In-silico prediction of immunogenicity searching (IPD, IMGT, SYFPEITHI) predicting Peptide-MHC binding Profiles, Machine Learning Techniques for MHC Binders, Artificial Intelligence Methods for Predicting T-Cell Epitopes, MHC-Class I and II Binding Affinity. MHC- Molecular Affinity and QSAR Models, Support Vector Machine for MHC-Binding Peptides, Static Energy Analysis of MHC Class I and Class II Peptide-Binding Affinity, Nonlinear Predictive Modeling of MHC Class II-Peptide Binding Using Bayesian, Neural Networks.

Suggested Books:

1. Richard A. Goldsby, Thomas J. Kindt, Barbara A. Osborne, Janis Kuby,Immunology,W.H. Freeman & Company, 2003.
2. Ivan M. Roitt, Peter J. Delves ,Roitt's Essential Immunology,Blackwell Science Ltd, 2001.

3. Darren R. Flower ,Immunoinformatics: predicting Immunogenicity in-silico Humana Press,2002

BIO5202 Open Air Seminar-II

BIO5204 Python programming for Bioinformatics

This course includes modules. First module provides general introduction on how to run python and its working environment. Second modules includes introduction to Strings, Lists, Tuples, Dictionaries, Numbers, Files. Syntax rules such as Indentation, Line Structure, Block structure, Special objects will be addressed in third module of this course. Conditionals, Loops-while loop, for loop, more about loops will be covered here in fourth module. Functions and exceptions will be explained in next two modules and final module includes introduction to biopython, BioSeq and BioSeqRecord Modules, Using Seq class, sequences reading and writing, BioSwissProtSProt and BioWWExPASy, Regular expressions in Python, Running Blast and Clustalw.

Suggested Books:

1. M. L.Model ,Bioinformatics programming using python,Shroff Publishers,2010
2. S Bassi, Python for Biologists, CRC press,2009

BIO5206 Bioethics and IPR

Introduction to ethics and bioethics which includes ethical theories and ethical, legal and socio-economic aspects relating to use of genetic information, gene therapy, stem cell research, genetic engineering. Next section of this course introduces to biosafety issues in biotechnology, safety protocols, biosafety levels, biosafety guidelines and regulations; types of biosafety containment, Types of IPR, patents, copy rights, trade marks, importance of IPR, special application of Indian patent laws, PR in research. final section includes Stages of Clinical trials, protection of rights of subjects in clinical trial cohorts, challenges for the Pharmaceutical and Biotechnological industries and marketing of drugs; Case studies for discussing legal and socioeconomic impacts of biotechnology.

Suggested Books:

1. M. W. Martin,R.Schinzinger,Ethics in engineering, Tata McGraw- Hill,2003.
2. A. Sasson,Biotechnologies and Development, UNESCO Publications, 1988
3. A Biotechnologies in developing countries present and future, UNESCO Publishers, 1993

BIO5208 Perl Programming for Bioinformatics

Basic Linux & Command line, Introduction and rationale, Strings & Variables, lists and arrays, hashes, Control statements, Regular Expressions, Scope, functions & subroutines, Scope & packages, packages & Modules, Data structures & Computational complexity, Dynamic Programming & Sequence alignment, Object Oriented Programming.

Suggested Books.

1. J Tisdall ,Beginning Perl for bioinformatics, O'Reilly publishing, 2001

SEMESTER III

BIO651 Research Project

BIO601 Major Project-I

BIO6401 Drug Design and Discovery

This course explains the basics of drug discovery and high throughput screening systems followed by approached to new drug discovery which includes alternative strategies in lead identification, lead optimization, preclinical studies and development. This section comprises of concepts of receptor theory, lead compound discovery of receptor agonists and antagonists receptor complexes and allosteric modulators, pharmacophore-based ligand libraries, QSAR; peptidomimetics; molecular mechanics, protein folding, docking, pharmacophore models, quantum mechanics in drug design. Last section includes Clinical trials, Patenting; New age drugs-synthetic vaccine design; personalized medicine.

Practicals:

2. To perform BLAST and Sequence Alignment.
3. To study Protein Structure and Families.
4. To perform Protein structure modelling (Homology Modelling).
5. To predict B cell linear and discontinuous epitopes in an antigen sequence.
6. To predict T cytotoxic cell epitopes in an antigen sequence.
7. To perform inhibitor studies
8. To study receptor ligand interaction by docking.
9. To predict protein three-dimensional structure.

Suggested Books:

1. C. Hansch, Comprehensive Medicinal Chemistry, Academic Press, 1990.
2. M. Sandler, H. J. Smith ,Design of Enzyme Inhibitors as Drugs, Oxford Univ. Press, 1989.
3. J. Matsoukas, T. Mavromoustakos, Drug Discovery and Design: Medical Aspects, IOS Press, 2002.
4. D R. Flower, Drug Design: Cutting Edge Approaches, The Royal Society of Chemistry, Cambridge, 2002.
5. R. A. Broglia, L. Serrano, Protein Folding and Drug Design, IOS Press, 2007.

BIO6403 Neurobiology

This course explains the fine structure of brain and its function further elaborating role of receptors, synapses and neurotransmitters. This course covers the basic understanding and knowledge of molecular and cellular neurobiology along with general description of neurodegenerative disorders Alzheimer's disease, Huntington's disease, Poly Q disorders, Amyotrophic Lateral Sclerosis (ALS) Cross talk between neurons and muscles: Parkinson's disease, Inclusion body myositis (IBM), Polymyositis (PM). It also includes Neurotherapeutics and Neuroinformatics Action of bio molecules in neuroprotection, neuroprosthetics.

Practicals:

1. Morphology of Neurons
2. Structure of brain
3. Propagation and transfection in neuronal cell lines
4. Propagation and transfection in neuronal cell lines
5. Case Studies

Suggested Books:

1. Mark F Bear, Neuroscience, Lippincott Williams and Wilkins,2015
2. Mark F Bear, Barry W. Connors, Michael A. Paradiso,Neuroscience: Exploring the Brain, Lippincott Williams & Wilkins, 2006,
3. Duane E. Haines,Gregory A. Mihail, Fundamental Neuroscience for Basic and Clinical Applications, Elsevier,2017

BIO6405 Cell and Molecular Biology

This course begins with explaining the cellular architecture of prokaryotic and eukaryotic cell, extracellular matrix, cell junctions, cell cycle. Cell signaling and protein trafficking which includes mechanisms involved in cell-cell signaling, Long distance and short distance signaling, Intracellular signaling proteins, Secondary messengers, Protein targeting to various organelles, Vesicular trafficking will be explained here. This course also elaborates on mechanism and regulation of DNA replication, Transcription, Translation of DNA, causes of DNA damage and its mechanism of repair. Techniques used in molecular biology such as Agarose gel electrophoresis, Polyacrylamide gel electrophoresis, Polymerase Chain Reaction, DNA sequencing, Protein sequencing, Recombinant DNA technology, DNA fingerprinting and Oligonucleotide synthesis included in last section of this course.

Practicals:

1. Isolation of DNA and RNA
2. Plasmid DNA isolation
3. mRNA Purification
4. Electrophoresis
5. Quantification of DNA and RNA

6. Restriction Digestion
7. Mutation

Suggested Books:

1. D. Voet ,J.G. Voet ,Biochemistry,John Wiley & Sons, 2010
2. J.E. Kreb's et al,Lewin's Gene XI, Jones & Bartlett Learning, 2013
3. T.A. Brown ,Genomes , John Wiley and Sons Inc , 2003
4. Malacinski ,Essentials of Molecular Biology,Jones and Barlett Publ., 2005

BIO6407 Biostatistics

The course begins with the description of statistics and probability which includes central tendency and dispersion, Axiomatic concepts of Conditional probability. Multiplication rule of probability, The Baye's rule. The concept of random variables, distribution function and mathematical expectations of statistical parameters are explained in next section. Probability distributions which includes Binomial, Multinomial, Poisson and Exponential distribution will be addressed in this section. Correlation, regression and sampling distributions includes method of least square and curve fitting, Probable error, Regression, Statistics and sampling distributions come under this sections. Finally explaining significance of exact sampling distributions using Chi-square distribution test, Student's t-distribution test and Snedecor's F-distribution test.

Suggested Books:

1. M Pagano, K Gaureau, Principles of Biostatistics ,Thomson Learning, 2007.
2. S M Ross,Probability and Statistics for Engineers and Scientists,Academic Press, 2005.
3. R E Walpole, R H Myers, S L Myers, K Ye, Probability and Statistics for Engineers and Scientists ,Prentice Hall, Inc. 2002
4. H C Taneja,Statistical Method for Engineering and Sciences, IK International, 2009.

BIO6301 Nanotechnology in Health Care

This course comprises of five sections. First section discuss the basics of human anatomy, physiology and protein- and peptide-based compounds for cancer, diabetes, infectious diseases, organ transplant and therapeutic classes-focused pharmaceutical delivery systems. Second section elaborates on different immunoassay techniques such as antibody based method (ELISA), immune-sensors and Bio-Barcode assay for diagnostics for cancer and central nervous system disorders. Third section takes into account improved diagnostic products and techniques allows in vivo imaging enabling the detection of tumors, plaque, genetic defects and other disease states, ability to control or manipulate at atomic scale, Nano-bot medical devices, logic and intelligence embedded into medical devices, standalone sensing and computing devices. Fourth section includes new generations prosthetic and medical implants like artificial organs and implants, artificial scaffolds or biosynthetic coatings. Final section consists of methods for Diagnosis such as DNA profiling, cantilever sensors, targeted drug delivery, magnetic nanoparticles, Electrochemical Impedance Spectroscopy (EIS).

Suggested Books:

1. Brian, R Egging ,Chemical Sensors and Biosensors,Wiley publication,2002
2. Ed. L Gorton ,Biosensors and modern biospecific analytical techniques, Wilson & Wilson's Comprehensive Analytical Chemistry, Elsevier ,2005
3. Ed. David Wild ,The Immunoassay Handbook, Elsevier; 2005

BIO6303 Resource Planning and Management in Bioinformatics

Course includes Introduction to Fundamentals of Resource management practices. Which includes tour to bioinformatics web sites, Biological databases and software an overview, Open source movement, Bioinformatics Resource utilization and commercialization, Networking and Super Computing resources- worldwide and India specific facilities, Clinical applications of bioinformatics. Bioinformatics resource management: the key-issues (piracy, hacking and data mining), Data Security and integration in Pharma Industry, tools and techniques. Bioinformatics Resources as a business practice: The bioinformatics market- Bioinformatics companies and products, commercialization of bioinformatics' resources, funding agencies for bioinformatics projects, models of technology transfer & licensing. Commercial & Financial aspects of Bioinformatics: Concepts of software product, Market and process economics Financial appraisal of bioinformatics projects cash flow, diagram, ROR, discounted ROR etc., Architecture of a typical bioinformatics business plan. TRIPS agreement: IPR issues in relation to software products/ processes; Architecture of Patent application, Biotechnology & Bioinformatics Related issues of Public Concern Bioethics.

Suggested Books:

1. A Leon, ERP Demystified, Tata McGraw Hill, 1999
2. Joseph A. Brady, Ellen F. Monk, Bret J. Wangner, Concepts in Enterprise Resource Planning, Thomson Learning, 2001
3. BAREACT, Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., 2007

BIO6305 Advanced Drug Delivery Systems

First section of this course includes introduction to dendrimers and methods use to synthesize dendrimers along with application and biocompatibility of dendrimers in gene transfection. Description of micro-fabricated drug delivery systems such as micro-needles, micro-pumps, micro-valves, implantable microchips covered in next section of this course along with the properties of each of these systems. Polymeric nano-systems, Liposomes and antibodies based delivery systems for site specific targeted delivery of drugs will be addressed in the next section of this course followed by the final section which includes virus based nanoparticles, its modification by bio-conjugation and describing the concepts of tumour targeting in-vivo and the use of biomedical imaging.

Suggested Books:

1. M. Salzman, Drug Delivery: Engineering Principles for Drug Therap,yOxford University Press, 2001
2. A.M. Hillery, Drug Delivery and Targeting, CRC Press, 2002

3. B. Wang, Drug Delivery: Principles and Applications, Wiley Interscience, 2005

BIO6307 Artificial Intelligence

An Introduction to AI including the basic definition and motivation for computer assisted decision making, Knowledge representation- Production rules, Frames, Predicate calculus and Semantic nets, Knowledge acquisition, reasoning methodologies- Problem representation, Search, Dempster-shafer theory, Evaluation. Expert systems Basic concepts of Expert system, Structure of Expert system, Working, Types, Benefits, Problems and limitations of Expert system. Alternative approaches: Genetic algorithm- Genetic operators, Evolution strategies, Probabilistic systems- Bayesian approaches, parameter estimation, Discriminant analysis, regression analyser, Hybrid systems- Hybrid system approaches, components of hybrid system, design methodologies, Pattern recognition- Statistical and Syntactic recognition.

Advanced intelligent systems: Objectives of neural network, Early models, Basic concepts, Classes of neural network, Learning – Supervised and unsupervised learning methods, Design, Validation and Evaluation.

Fuzzy systems in medicine: Fuzzy machine and signal processing – Unsupervised brain tumor segmentation using fuzzy techniques, Neuro-fuzzy knowledge processing, Neuro- fuzzy control and hardware in medical application.

Suggested Books:

1. Donna L. Hudson, Maurice E. Cohen, Neural Networks and Artificial Intelligence for Biomedical Engineering, IEEE press, 2000
2. E. Turban, Jay E. Aronson, Decision Support Systems and Intelligent Systems, Prentice-Hall, 2001
3. Fuzzy and Neuro- Fuzzy systems in medicine edited by H.N Teodorescu, A. Kandel, L.C Jain, CRC Press, 1999.
4. Pattern Recognition for Medical Imaging, Anke Meyer-Base, Elsevier, Academic Press, 2004

BIO6201 Design and Analysis of Algorithms

Introduction to different algorithms and fundamentals of these algorithms in problem solving followed by analysis of algorithms including mathematical analysis of Non-recursive and Recursive algorithm such as Fibonacci Numbers, empirical analysis and visualization, analysis on algorithms would require various sort and search methods which includes Brute Force method, Selection Sort and Bubble Sort, Sequential Search and Brute-force string matching, Divide and conquer, Merge sort, Quick Sort, Binary Search, Binary tree, Traversal and Related Properties, Decrease and Conquer, Insertion Sort, Depth first Search and Breadth First Search. This course includes number of techniques and methods like Transform and conquer, Pre-sorting, Balanced Search trees, AVL Trees, Heaps and Heap sort, Dynamic Programming, Warshall's and Floyd's Algorithm, Optimal Binary Search trees, Greedy Techniques, Prim's Algorithm, Kruskal's Algorithm, Dijkstra's Algorithm, Huffman trees, Backtracking, n-Queen's Problem, Hamiltonian Circuit problem, Subset-Sum problem, Branch and bound, Assignment problem, Knapsack problem, Traveling salesman problem in order to design different algorithms.

Suggested Books:

1. D C Kozen, Design and analysis of algorithms ,Cornell , 1990
2. T H Corman,R L Rivest ,Introduction to algorithms ,PHI publications,2009
3. GS Baluja,Data structure through C : a practical approach, Dhanpat Rai & Co, 2012

BIO6203 Molecular Evolution

This course includes Changing concepts along with the theories and evidences of evolution of life forms on Earth followed by the forces responsible for evolution. These forces includes domestication, mutation, recombination, selection and speciation. Next section of this course focuses on role of genome duplications, transposable elements, noncoding RNAs and epigenetic mechanism in regulation of gene expression and genome evolution. Final section of this course includes the origin and evolution of genes and proteins, changes in structures and functions along with the current approaches to study evolutions.

Suggested Books:

1. D Graur D, W H Li , Fundamentals of molecular Evolution, SINAUER ASSOCIATES, INC, Sunderland,1991
2. W H Li ,Molecular Evolution, SINAUER ASSOCIATES, INC,Sunderland, Massachusetts,1997
3. D Graur ,Molecular and Genome Evolution, Oxfrd University Press,2016
4. L Bromham L, An Introduction to Molecuar Evolutionand Phylogenetics, Oxford University Press,2015

BIO6205 Molecular and Cellular Biophysics

Basic concepts in atomic and molecular structures including brief introduction to molecular orbitals theories, types of bonds and interactions involved. Detailed study of nucleic acids (DNA,RNA), their types and structures, conformational parameters and geometries, rotational isomers, polymorphism and supercoiling, base pairing and stacking. Introduction to polypeptides (proteins and peptides) including properties of amino acids, titration curves of amino acids, principles behind ionization equilibria in proteins followed by structural studies of proteins in terms of structural level of proteins, forces stabilizing different levels, conformational structure, properties and transitions in biomolecules (alpha keratin, collagen, actin, conformation of globular proteins, haemoglobin , myoglobin). Structural analysis of cell membranes and ion channels covering components, properties (elastic, electrical, fluidic phase), organisation of lipids and proteins in membrane, electrostatic interaction and diffusion across membrane followed by molecular basis of ions channels together with their types, structure and role in transport.

Suggested Books:

1. E A Ackerman, Ellis, L.E.E. & L E Williams , Biophysical Science, Prentice-Hall Inc,1979
2. C Barrow, Physical Chemistry For Life Sciences, McGraw-Hill.1974
3. V A Bloomfield, R E Harrington , Biophysical chemistry, W.A.Freeman and co,1975
4. I A V Bulter,D E Noble, Progress in Biophysics and Molecular Biology (all volumes) pergamon, Oxford,1976

BIO6207 Entrepreneurship

Introduction to small scale industries including their types, characteristics, their role on national economy, Government policies and stages in starting these small scale industries. Identification of project for these small scale industries based

on field studies, assess the viability of project, formulation methods and evaluation methods. Identification of project is followed by collection of information, preparation of project reports and balanced sheets, demand analysis, expected cost, planning and production control, sales and purchases, material balance and output methods and finally the project planning and control using financial functions cost of capital approach based on Economic evaluation, risk analysis, capital expenditures, policies and practices in public enterprises. Profit planning and programming, planning cash flow, capital expenditure and operations. control of financial flows, control and communication. Introduction to Laws concerning entrepreneurs, Partnership laws, business ownership laws , sales and income taxes and workman compensation act. Role of various national and state agencies which render assistance to small scale industries.

Suggested Books:

1. J Forbat, Entrepreneurship, New Age International,2008
2. Havinal, Veerbhadrappa, Management and Entrepreneurship,New Age International,2009
3. Joseph, L. Massod, Essential of Management, Prentice Hall of India,2000

Semester IV

BIO652 Research Project

BIO602 Major Project II