BIOINFORMATICS

Course Structure

COURSE NO.	COURSE TITLE	CREDITS	SEM
BIF 501@/ ❶ FSC 604/ MBB 555/ ABT 608	INTRODUCTION TO BIOINFORMATICS	2+1	I
BIF 502@	ADVANCED BIOINFORMATICS	2+1	I
BIF 503@	TECHNIQUES IN BIOINFORMATICS	0+2	II
BIF 504**/ ❷ BIOCHEM 501	BASIC BIOCHEMISTRY	3+0	I, II
BIF 505**/ ❸ STAT 532	STATISTICS FOR BIOLOGICAL SCIENCES	2+1	I
BIF 506	CONCEPTS IN COMPUTING	2+2	I
BIF 507*	PROGRAMMING LANGUAGES FOR BIOINFORMATICS	2+2	I
BIF 508**/ ❹ MBB 502/ BIOCHEM 504	FUNDAMENTALS OF MOLECULAR BIOLOGY	3+0	I
BIF 509**/ ❸ STAT533	MATHEMATICS FOR BIOLOGICAL SCIENCES	2+0	I
BIF 510/ ❺ MBB 512/ BIOCHEM 506	IMMUNOLOGY AND MOLECULAR DIAGNOSTICS	2+1	II
BIF 511	INTRODUCTION TO DATABASE SYSTEMS	2+1	II
BIF 512*	COMPUTATIONAL AND SYSTEM BIOLOGY	2+2	II
BIF 513*	BIOMOLECULAR SEQUENCE ANALYSIS	1+1	I
BIF 514	DYNAMIC WEB-DESIGN	1+2	I
BIF 515*	BIOLOGICAL DATABANKS AND DATA MINING	1+2	II
BIF 516*	MOLECULAR MODELLING AND DRUG DESIGN	2+2	I
BIF 517**/ ❻ MBB508	GENOMICS AND PROTEOMICS	2+1	I
BIF 518	PHARMACOGENOMICS AND IPR	2+1	II
BIF 591	MASTER'S SEMINAR	1	I, II
BIF 599	MASTER'S RESEARCH	20	

* Compulsory for Master's programme; ** May be taken as Minor/Supporting course

@ Courses open to all PG students of other departments/colleges only

Minor Subject for BIF students – Molecular Biology & Biotechnology or Biochemistry with BIF 504/BIOCHEM 501 and BIF 517/ MBB 508

Supporting Subject for BIF students – STAT 532 and STAT 533

To be taught by: ❶ Molecular Biology, Biotechnology & Bioinformatics; ❷ Biochemistry; ❸ Statistics; ❹ Bioinformatics, Biochemistry, Molecular Biology & Biotechnology; ❺ Veterinary Microbiology; ❻ Bioinformatics, Molecular Biology & Biotechnology

BIOINFORMATICS

Course Structure

BIF 501/   **INTRODUCTION TO BIOINFORMATICS**   **2+1**   **SEM - I**
MBB 555/   (To be taught jointly by Bioinformatics and Molecular
ABT 608   Biology & Biotechnology)
FSC 604

Objective

To impart an introductory knowledge about the subject of Bioinformatics to the students studying any discipline of science.

Theory

UNIT-I: Introduction, biological databases – primary, secondary and structural, Protein and Gene Information Resources – PIR, SWISSPROT, PDB, GenBank, DDBJ. Specialized genomic resources.

UNIT-II: DNA sequence analysis, cDNA libraries and EST, EST analysis, pair wise alignment techniques, database searching, multiple sequence alignment.

UNIT-III: Secondary database searching, building search protocol, computer aided drug design – basic principles, docking, QSAR.

UNIT-IV: Analysis packages – commercial databases and packages, GPL software for Bioinformatics, web-based analysis tools.

Practical

- Usage of NCBI resources
- Retrieval of sequence/structure from databases
- Visualization of structures
- Docking of ligand receptors
- BLAST exercises.

Suggested Readings

Attwood TK & Parry-Smith DJ. 2003. *Introduction to Bioinformatics*. Pearson Edu.

Rastogi SC, Mendiratta N & Rastogi P. 2004. *Bioinformatics: Concepts, Skills and Applications*. CBS.

BIF 502   **ADVANCED BIOINFORMATICS**   **2+1**   **SEM - I**

Objective

To understand the usage of advanced techniques in Bioinformatics.

Theory

UNIT-I: Biological databases, database hierarchies, sequence and structure databases. Pair wise sequence alignment and database similarity searching: global and local alignments, matrices, gap penalties and statistical significance.

UNIT-II: Multiple sequence alignment and phylogenetic analysis, Microarray technology: applications, analysis of data, clustering analysis. Pharmacogenomics: introduction, applications, Genome for medicine, current and future perspectives.

UNIT-III: System modeling and metabolomics – concepts and principles. Nutrigenomics: system biology in nutrition and health arena.

UNIT-IV: Genome annotation, EST clustering, protein modeling and design.

Practical

- Development of small database
- Phylogenetic analysis
- Microarray data analysis (sample data from open sources)
- Other practical exercises based on above topics

Suggested Readings

Baxevanis AD & Ouellette BFF. 2001. *Bioinformatics: a Practical Guide to the Analysis of Genes and Proteins*. Wiley Interscience.

Mount DW Cold. 2001. *Bioinformatics: Sequence and Genome Analysis*. Spring Harbor.

Stekel D. 2003. *Microarray Bioinformatics*. Cambridge University Press.

Tomita M & Nishioka T. 2005. *Metabolomics: The Frontier of Systems biology*. Springer Verlag.

Wong SHY. 2006. *Pharmacogenomics and Proteomics: Enabling the Practice of Personalized Medicine*. American Association for Clinical Chemistry.

BIF 503   **TECHNIQUES IN BIOINFORMATICS**   **0+2**   **SEM - II**

Objective

To explore the usage of various Open source software for Bioinformatics applications

Practical

UNIT-I: Gene Information Resources: GenBank, EMBL, Protein Information Resources: Swiss-Prot, BLOCKS, Gene Prediction Tools: GENSCAN, GRAIL.

UNIT-II: Structural Databases: PDB, CSD, RELIBASE, REBASE, File Format Converter Tools: BABEL, ReadSeq, NCBI Resources.

UNIT-III: Visualization tools – RasMol, QMol, SwissPDB, Pymol, Modeling Tools: MODELLER, SwissPDB, Geno3D, Docking Tools: Chimera, Dock, AutoDock, GRAMM, Hex, Argus Lab.

UNIT-IV: Proteomics Tools: EXPASY, CDART, 3D-Structure Optimization Tools, Sequence Analysis Tools: BLAST, FASTA, EMBOSS, TCOFFEE, Phylogenetic Analysis Tools: Phylip, NTSYS, CLUSTALW/CLUSTALX, BIOEDIT.

Suggested Readings

Software Manuals and Help files.

BIF 504/   **BASIC BIOCHEMISTRY**   **3+0**   **SEM - I, II**
BIOCHEM 501   (To be taught by Biochemistry)

Objective

To provide elementary knowledge/overview of structure, functions and metabolism of biomolecules.

Theory

UNIT-I: Scope and importance of biochemistry in agriculture; acid base concept and buffers; pH; hydrogen bonding; hydrophobic, electrostatic and van der Waals forces; General introduction to physical techniques for determination of structure of biopolymers.

UNIT-II: Classification, structure and function of carbohydrates, lipids, amino acids, proteins, and nucleic acids; Biomembranes.

UNIT-III: Fundamentals of thermodynamics; Enzymes: classification, factors affecting enzyme activity, enzyme kinetics, Structure and biological functions of vitamins and hormones.

UNIT-IV: Metabolism of carbohydrates, lipids, proteins and nucleic acids. Mitochondrial Electron transport chain and oxidative phosphorylation; DNA replication, transcription and translation; recombinant DNA technology.

Suggested Readings

Conn EE & Stumpf PK. 1987. *Outlines of Biochemistry*. John Wiley.

Metzler DE. 2006. *Biochemistry*. Vols. I, II. Wiley International.

Nelson DL & Cox MM. 2004. *Lehninger Principles of Biochemistry*. 4th Ed. MacMillan.

Voet D, Voet JG & Pratt CW. 2007. *Fundamentals of Biochemistry*. John Wiley.

BIF 505/   **STATISTICS FOR BIOLOGICAL SCIENCES**   **2+1**   **SEM - I**
STAT 532   (To be taught by Statistics)

Objective

To understand the basic principles of statistics and mathematics and their applications in relation to Biological system.

Theory

UNIT-I: Introduction to Statistical Bioinformatics, Principles of sampling from a population; Random sampling.

UNIT-II: Frequency distributions: Graphical representations and Descriptive measures; Standard Probability Distributions; Correlation and regression analysis.

UNIT-III: Hypothesis testing; Markov Models, Cluster Analysis: Hierarchical and Non-Hierarchical methods.

UNIT-IV: Phylogenetic Analysis Tools: Maximum Likelihood, Parsimony methods.

Practical

- Computational exercises on Random Sampling
- Construction and representation of frequency distributions
- Descriptive measures
- Probability distribution

Suggested Readings

Gupta SC & Kapoor VK. 2000. *Fundamentals of Mathematical Statistics: A Modern Approach*. S. Chand & Co.

Warren JE & Gregory RG. 2005. *Statistical Methods in Bioinformatics*. Springer.

BIF 506	CONCEPTS IN COMPUTING	2+2	SEM - I

Objective

The objective of this course is to introduce the basic concepts of computing with introduction to OS, graphics, networking and client-server technologies.

Theory

UNIT-I: Fundamentals of Computing; Introduction to Operating Systems: WINDOWS, UNIX/Linux operating systems; Computer Security (hacking, cracking), Computer Viruses.

UNIT-II: Computer Graphics: Visualization techniques - Software and Hardware, Interactive Graphics; Viewing in three dimension; Raster algorithms; Rendering; Animation; Image Processing with emphasis on biological systems.

UNIT-III: Computer Networking, Security of the network, Fire-walls, Network Goals, Applications Network, Network architecture, Hierarchical networks, Ethernet and TCP/IP family of protocols.

UNIT-IV: Use of INTERNET and WWW, Internet services.

Practical

- MS-Windows
- Linux, UNIX
- Network design
- Internet search
- Graphics and animation

Suggested Readings

David FR. 1997. *Procedural Elements for Computer Graphics*. WCB/McGraw-Hill.

Foley JD & Van Dam A. 1982. *Fundamentals of Interactive Computer Graphics*. Addison-Wesley.

James FK & Keith WR. 2006. *Computer Networking: A Top-Down Approach Featuring the Internet*. Prentice Hall.

Siever E. 2005. *Linux in a Nutshell*. O'Reilly.

BIF 507	PROGRAMMING LANGUAGES FOR BIOINFORMATICS	2+2	SEM - I

Objective

Programming is a very significant area for bioinformatics and this course gives an understanding for logics of programming and command-line and graphical GDIs.

Theory

UNIT-I: Programming in C: Pointers, pointers to functions, macro programming in C, graphs, data structure - linked list, stack, queue, binary trees, threaded binary trees.

UNIT-II: File and exception handling in C, Programming in Visual Basic: Introduction to Application Development using Visual Basic; Working with Code and Forms.

UNIT-III: Variables, Procedures and Controlling Program Executor; Standard Controls; Data Access Using Data Control; Connecting to Database using VB.

UNIT-IV: Introduction to JAVA, variables, constants, control structures, input output, classes. Jar and Java applets.

Practical

- Programming in C and Visual basic with special reference to database linking
- Small Java applets

Suggested Readings

Brian WK & Ritchie DM. 1988. *C Programming Language*. Prentice Hall.

Kanetkar. 2002. *Let us C*. BPB Publ.

Microsoft Developers Network (MSDN Digital Library). 2006. Microsoft.

BIF 508/   **FUNDAMENTALS OF MOLECULAR**   **3+0**   **SEM - I**
MBB 502/   **BIOLOGY**
BIOCHEM 504   (To be taught jointly by Bioinformatics, Biochemistry and Molecular Biology & Biotechnology)

Objective

To familiarize the students with the basic cellular processes at molecular level.

Theory

UNIT-I: Historical developments of molecular biology; nucleic acids as genetic material, chemistry, structure and properties of DNA and RNA.

UNIT-II: Genome organization in prokaryotes and eukaryotes; repetitive and non-repetitive DNA, satellite DNA; DNA replication, DNA polymerases, topoisomerases, DNA ligase, reverse transcriptase, nucleases and restriction enzymes; site directed mutagenesis, molecular mechanism of mutation, DNA repair mechanisms.

UNIT-III: Ribosomes structure and function, organization of ribosomal proteins and RNA genes, transcription, RNA editing, RNA processing, etc; Genetic code, aminoacyl tRNA synthases' inhibitors of replication, transcription and translation.

UNIT-IV: Translation and post translational modifications; Regulation of gene expression in prokaryotes and eukaryotes.

Suggested Readings

Lewin B. 2008. *Gene IX*. Peterson Publications/ Panima.

Malacinski GM & Freifelder D. 1998. *Essentials of Molecular Biology*. 3rd Ed. Jones & Bartlett Publ.

Nelson DL & Cox MM. 2007. *Lehninger's Principles of Biochemistry*. W.H. Freeman.

Primrose SB. 2001. *Molecular Biotechnology*. Panima.

Watson JD, Bakee TA, Bell SP, Gann A, Levine M & Losick R. 2008. *Molecular Biology of the Gene*. 6th Ed. Pearson Edu. International.

BIF 509/   **MATHEMATICS FOR BIOLOGICAL**   **2+0**   **SEM - I**
STAT 533   **SCIENCES**
           (To be taught by Statistics)

Objective

To understand and apply fundamental concepts of mathematics as applicable in Biology and to acquaint about theoretical concepts of algebra and geometry and numerical methods.

Theory

UNIT-I: Coordinate geometry with basic concepts of 2D and 3D geometry, Vector algebra – Addition and subtraction of vectors, Dot and cross product, Scalar triple product.

UNIT-II: Matrix algebra: basic definitions, matrix operations, transpose of a matrix, inverse of matrix, eigen values, Boolean algebra. Geometric and Arithmetic Progression.

UNIT-III: Solution of equation by bisection method, Iteration method, Newton Raphson method, numerical differentiation.

UNIT-IV: Numerical integration- Trapezoidal rule, Simpson's 1/3 and 3/8 rules, Runga Kutta method of nth order. Fast Fourier transformation.

Suggested Readings

Babu CA & Seshan CR. 2006. *New Engineering Mathematics*. Narosa Publ.

Datta KB. 2002. *Matrix and Linear Algebra*. Prentice Hall.

Narayan S. 1980. *Matrix Algebra*. S. Chand & Co.

Rao S. 2006. *Numerical Methods for Scientists and Engineers*. Prentice Hall.

BIF 510/   **IMMUNOLOGY AND MOLECULAR DIAGNOSTICS** **2+1**   **SEM - II**
MBB 512/   (To be taught by Veterinary Microbiology)
BIOCHEM 506

Objective

To discuss the application of various immunological and molecular diagnostic tools.

Theory

UNIT-I: History and scope of immunology; Components of immune system: organs, tissues and cells, Immunoglobulin structure and functions; Molecular organization of immunoglobulins and classes of antibodies.

UNIT-II: Antibody diversity; antigens, haptens, antigen-antibody interactions; immunoregulation and tolerance; Allergies and other hypersensitive responses; Immunodeficiency; Vaccines.

UNIT-III: Application of immunology, immunological techniques, Principles of ELISA and its applications; Monoclonal antibodies and their uses, molecular diagnostics; Introduction to the basic principles of molecular technology and techniques used for pathogen detection.

UNIT-IV: Basics and procedures of PCR, PCR based and hybridization based methods of detection, microarrays based detection, multiplexing etc, detection of soil borne and seed born infections, transgene detection in seed, planting material and processed food, molecular detection of varietal impurities and seed admixtures in commercial consignments.

Practical

- Preparation of buffers and reagents
- Serological tests such as bacterial slide agglutination, latex agglutination and agar gel immunodiffusion
- Immunoassays including ELISA, western blotting, and fluorescent antibody test
- Hybridoma technique for production of monoclonal antibodies
- Recombinant protein antigen- production and immunization of laboratory animals
- Extraction of DNA/RNA from pathogenic microorganisms, PCR, genotyping, diagnosis, etc.

Suggested Readings

Bloom BR & Lambert P-H. 2002. *The Vaccine Book*. Academic Press.
Elles R & Mountford R. 2004. *Molecular Diagnosis of Genetic Disease*. Humana Press.
Kindt TJ, Goldsby RA & Osbrne BA. 2007. *Kuby's Immunology*. WH Freeman.
Levine MM, Kaper JB, Rappuoli R, Liu MA & Good MF. 2004. *New Generation Vaccines*. 3rd Ed. Informa Healthcare.
Lowrie DB & Whalen R. 2000. *DNA Vaccines*. Humana Press.
Male D, Brostoff J, Roth DB & Roitt I. 2006. *Immunology*. Elsevier.
Rao JR, Fleming CC & Moore JE. 2006. *Molecular Diagnostics*. Horizon Bioscience.
Robinson A & Cranage MP. 2003. *Vaccine Protocols*. 2nd Ed. Humana Press.
Spinger TA, 1985. *Hybridoma Technology in Biosciences and Medicine*. Plenum Press.

BIF 511   INTRODUCTION TO DATABASE SYSTEMS   2+1   SEM - II

Objective

To familiarize the concept of RDBMS and to apply the database techniques to biological databanks.

Theory

UNIT-I: Data Abstraction; Data Models; Instances and Schemes; E-R Model - Entity and entity sets; Relations and relationship sets; E-R diagrams; Reducing E-R Diagrams to tables; Network Data Model: Basic concepts; Hierarchical Data Model: Basic Concepts.

UNIT-II: Multimedia Databases - Basic Concepts and Applications; Indexing and Hashing; Basic concepts (ISAM, B+ Tree indexed files, B Tree indexed files, Static Hash functions, Dynamic Hash functions); Text Databases; Introduction to Distributed Database Processing, Data Security.

UNIT-III: MySQL/MS-Access - Select Statements; Data Definition Statements; Data Manipulation Statements; Data Control Statements; Other Database Objects (Views, Sequences, Synonyms); Introduction to Application Development using Visual Basic; Working with Code and Forms; Variables.

UNIT-IV: Procedures and Controlling Program Executor; Standard Controls; Data Access Using Data Control; Connecting to Oracle Database using Visual Basic.

Practical

- Practical exercise using MySQL

- Design of database in MS-Access and MySQL
- Database linking

Suggested Readings

Date CJ. 1986. *Introduction to Database Systems*. Addison-Wesley.
Korth H & Silberschatz A. 2002. *Database System Concepts*. McGraw- Hill.
Martin D. 1986. *Advanced Database Techniques*. MIT Press.

BIF 512   COMPUTATIONAL AND SYSTEM BIOLOGY 2+2   SEM - II

Objective

To understand the computational aspects of structural biology; to familiarize the usage of software for 3D structures of nucleic acids and proteins and to translate the sequence to protein structure.

Theory

UNIT-I: Methods of single crystal X-ray Diffraction of macromolecules, NMR of macromolecules Anatomy of Proteins - Ramachandran plot, Secondary structures, Motifs, Domains, Tertiary and quaternary structures.

UNIT-II: Anatomy of DNA: A, B, Z DNA, DNA bending etc.; RNA structure; Structure of Ribosome; Principles of Protein Folding; Structural data banks - Protein Data Bank, Cambridge small molecular crystal structure data bank.

UNIT-III: Methods for Prediction of Secondary and Tertiary structures of Proteins, DNA, RNA, Fold recognition, *Ab initio* methods for structure prediction; Homology modeling, Methods for comparison of 3D structures of proteins.

UNIT-IV: Molecular interactions of Protein – Protein with special reference to signal transduction and antigen-antibody interaction, Protein - DNA, Protein - carbohydrate, DNA - small molecules. System modeling and metabolomics– concepts and principles.

Practical

- Usage of software for above topics
- Molecular Visualization tools: RasMol, QMol, Swiss PDB, Pymol
- Biomolecular Interaction Databases: BIND, DIP
- Structure Similarity Search Tools: CN3D, Vast Search

Suggested Readings

Fall CP. 2002. *Computational Cell Biology*. Springer.
Tsai CS. 2003. *Computational Biochemistry*. John Wiley & Sons.
Waterman MS. 1995. *Introduction to Computational Biology: Maps, Sequences and Genomes*. CRC Press.

BIF 513   BIOMOLECULAR SEQUENCE ANALYSIS   1+1   SEM - I

Objective

To understand the local and multiple alignment concepts and to carry out multiple sequence alignment.

Theory

UNIT-I: Analysis of protein and nucleic acid sequences, multiple alignment programs.

UNIT-II: Development of programs for analysis of nucleic acid sequences, Use of EMBOSS package.

UNIT-III: Phylogenetic analysis – Elements of phylogenetic analysis, tree interpretation, tree data analysis, alignment – building data model.

UNIT-IV: Extraction of phylogenetics data sets, Distance and character based methods.

Practical

- EMBOSS
- File Format Converter Tools: BABEL, ReadSeq
- Phylogenetic Analysis Tools: Phylip, NTSYS, PAUP
- CLUSTALW/CLUSTALX

Suggested Readings

Baxevanis AD & Ouellettee BFF. 2001. *Bioinformatics: a Practical Guide to the Analysis of Genes and Proteins*. Wiley Interscience.
Mount DW. 2001. *Bioinformatics: Sequence and Genome Analysis*. Spring Harbor, CSHL Press.
Nei M & Kumar S. 2000. *Molecular Evolution and Phylogenetics*. Oxford Univ. Press.

Salemi M & Vandamme AM. 2003. *The Phylogenetic Handbook – A Practical Approach to DNA and Protein Phylogeny*. Oxford Univ. Press.

BIF 514   **DYNAMIC WEB-DESIGN**   **1+2**   **SEM - I**

Objective

This course teaches the basic principles and application of various technologies used in creation of dynamic web content.

Theory

UNIT-I: *PERL:* Strings, Numbers, and Variables. Variable Interpolation, Basic Input and Output, File handles, Making Decisions, Conditional Blocks, Loops, Combining Loops with Input, Standard Input and Output, Finding the Length of a Sequence File.

UNIT-II: Pattern Matching, Extracting Patterns, Arrays, Arrays and Lists, Split and Join, Hashes, A Real-World Example, BioPERL; Applications.

UNIT-III: Creation, hosting and maintenance of web-site using HTML, XML, ASP, JSP.

UNIT-IV: Creation, hosting and maintenance of web-site PHP, PERL and CGI.

Practical

- Creation of Web-based applications, interactive and dynamic webpages
- Connecting databases using CGI scripting
- Creation and maintenance of web-sites using HTML, XML, ASP, PHP, PERL and CGI
- Retrieval of specific information from web-sites using CGI scripts

Suggested Readings

Moorhouse M & Barry P. 2004. *Bioinformatics, Biocomputing and Perl: An Introduction to Bioinformatics*. John Wiley & Sons.

Tisdall JD. 2001. *Beginning Perl for Bioinformatics*. O'Reilly.

BIF 515   **BIOLOGICAL DATA BANKS AND DATA MINING**   **1+2**   **SEM - II**

Objective

To understand the biological databases – types and formats and to learn the retrieval, deposition and analysis of sequences and structures from biological databanks.

Theory

UNIT-I: Data warehousing, data capture, data analysis; Introduction to Nucleic Acid and Protein Data Banks; Nucleic acid sequence data banks: Genbank, EMBL nucleotide sequence data bank.

UNIT-II: AIDS Virus sequence data bank, rRNA data bank, Protein sequence data banks: NBRF-PIR, SWISSPROT, Signal peptide data bank; Database Similarity Searches.

UNIT-III: BLAST, FASTA, PSI-BLAST algorithms; Pair wise sequence alignment - NEEDLEMAN and Wunsch, Smith Waterman algorithms; Multiple sequence alignments - CLUSTAL, Patterns, motifs and Profiles in sequences.

UNIT-IV: Derivation and searching; Derived Databases of patterns, motifs and profiles: Prosite, Blocks, Prints-S, Pfam, etc.; Primer Design.

Practical

- Gene Information Resources
- Protein Information Resources
- Structural Databases
- Sequence Analysis and Database Similarity Search Tools: BLAST, PHI-BLAST, PSI-BLAST, FASTA, EMBOSS, CLUSTAL, TCOFFEE
- Use of similarity, homology and alignment tools

Suggested Readings

Letovsky S. (Ed).1999. *Bioinformatics: Databases and Systems*. Kluwer.

LeÛn D & Markel S. 2003. *Sequence Analysis in a Nutshell: A Guide to Common Tools and Databases*. O'Reilly.

NCBI (www.ncbi.nlm.nih.gov).

PUBMED (www.pubmedcentral.nih.gov) and database web-sites.

BIF 516   **MOLECULAR MODELLING AND DRUG DESIGN**   **2+2**   **SEM - I**

Objective

To understand the Modelling of small molecules; to understand the computational chemistry principles and to familiarize the role of computers in drug-discovery process.

Theory

UNIT-I: Concepts of Molecular Modelling, Molecular structure and internal energy, Application of molecular graphics.

UNIT-II: Energy minimization of small molecules, Use of Force Fields and MM methods, Local and global energy minima. Techniques in MD and Monte Carlo. Simulation for conformational analysis, *Ab initio*, DFT and semiempirical methods.

UNIT-III: Design of ligands, Drug-receptor interactions, Classical SAR/QSAR, Docking of Molecules.

UNIT-IV: Role of computers in chemical research; Structure representation, SMILES; Chemical Databases, 2D and 3D structures, reaction databases, search techniques, similarity searches; Chemoinformatics tools for drug discovery.

Practical

- Modelling Tools: MODELLER, Geno3D
- Docking Tools: Chimera, Dock, AutoDock Tools, GRAMM, Hex, ArgusLab
- 3D-Structure Optimization Tools: CHEMSKETCH, CHEM 3D, ISIS Draw, CHEMDRAW

Suggested Readings

Bunin BA. 2006. *Chemoinformatics: Theory, Practice and Products*. Springer.
Gasteiger J & Engel T. 2003. *Chemoinformatics: A Textbook*. Wiley-VCH.
Hinchliffe A. 2003. *Molecular Modelling for Beginners*. John Wiley & Sons.
Leach AR. 1996. *Molecular Modelling: Principles and Applications*. Longman.

BIF 517/   **GENOMICS AND PROTEOMICS**   **2+1**   **SEM - I**
MBB 508   (To be taught jointly by Bioinformatics and Molecular Biology & Biotechnology)

Objective

To familiarize the students about the genomic and proteomic concepts and usage of various algorithms and programmes in analysis of genomic and proteomic data.

Theory

UNIT-I: Genomics: Whole genome analysis and comparative genomics, classical ways of genome analysis, large fragment genomic libraries; Physical mapping of genomes; Genome sequencing, sequence assembly and annotation.

UNIT-II: Functional genomics: Candidate gene identification, DNA chips, Mutants and RNAi, Metabolomics for elucidating metabolic pathways, etc.

UNIT-III: Proteomics - Introduction to basic proteomics technology, Bio-informatics in Proteomics, Gene to Protein Function: a Roundtrip, Proteome analysis.

UNIT-IV: Linkage analysis, genotyping analysis, pharmacogenomics, human/plant genome and science after genomic era; Applications of genomics and proteomics in agriculture, human health and industry.

Practical

- Gene Prediction Tools: GENSCAN, GRAIL, FGENESH
- NCBI Genomic Resources
- Proteomics Tools: EXPASY, CDART

Suggested Readings

Azuaje F & Dopazo J. 2005. *Data Analysis and Visualization in Genomics and Proteomics*. John Wiley & Sons.
Brown TA. 2007. *Genome III*. Garland Science Publ.
Campbell AM & Heyer L. 2004. *Discovery Genomics, Proteomics and Bioinformatics*. Pearson Edu.
Gibson G & Muse SV. 2004. *A Primer of Genome Science*. Sinauer Associates.
Jollès P & Jörnvall H. 2000. *Proteomics in Functional Genomics: Protein Structure Analysis*. Birkhäuser.
Kamp RM. 2004. *Methods in Proteome and Protein Analysis*. Springer.
Primrose SB & Twyman RM. 2007. *Principles of Genome Analysis and Genomics*. Blackwell.
Sensen CW. 2005. *Handbook of Genome Research*. Vols. I, II. Wiley CVH.

BIF 518   PHARMACOGENOMICS AND IPR   2+1   SEM - II

Objective

To understand the translation of Bioinformatics into commercial gains; to familiarize the concepts of microarray – data acquisition and analysis and learn the IPR issues in Biological sciences with special emphasis on bioinformatics.

Theory

UNIT-I: Bioinformatics companies, Genomes, transcriptomes and proteomes – their applications in medicine and agriculture, disease monitoring, profile for therapeutic molecular targeting.

UNIT-II: Diagnostic drug discovery and genomics. Pharmacogenomics and its application. SNPs and their applications. Microarray and genome wide expression analysis: Introduction to basic microarray technology, Bioinformatics in microarrays, Getting started – target selection.

UNIT-III: Customised microarray design, Image processing and quantification, Normalization and filtering, Exploratory statistical analysis, Public Microarray data resources.

UNIT-IV: Patenting and data generation from patent literature for commercial benefits. IPR, and bioinformatics. Bioinformatics patents.

Practical

- Microarray Analysis Tools: MAGICTool
- Stanford Microarray Database
- Gene Expression Omnibus
- Creation of an On-line company

Suggested Readings

Blalock EM. 2003. *A Beginner's Guide to Microarrays*. Springer.

Catania M. 2006. *An A-Z Guide to Pharmacogenomics*. American Association for Clinical Chemistry.

Chakraborty C & Bhattachary A. 2005. *Pharmacogenomics.* Biotech Books.

Stekel D. 2003. *Microarray Bioinformatics*. Cambridge University Press.

BIOINFORMATICS

List of Journals

- Bioinformatics - Oxford University Press
- BMC Bioinformatics - BioMed Central
- Briefings in Bioinformatics - Oxford University Press
- Briefings in Functional Genomics and Proteomics - Oxford University Press
- Computers in Biology and Medicine – Elsevier
- Journal of Bioinformatics and Computational Biology (JBCB) – World Scientific Publishers
- Journal of Biomedical Informatics – Elsevier
- Journal of Computational Biology - Mary Ann Liebert, Inc. publishers
- Journal of Molecular Modelling – Springer
- Nucleic Acids Research – Oxford Press
- Protein Engineering, Design and Selection *(PEDS)* – Oxford Press

e-Resources

- Bioinformatics.Org: The Open-Access Institute - http://bioinformatics.org/
- European Molecular Biology Network - http://www.embnet.org/
- European Bioinformatics Institute -http://www.ebi.ac.uk/
- The European Molecular Biology Laboratory - http://www.embl.org/
- International Society for Computational Biology - http://www.iscb.org/
- National Center for Biotechnology Information - http://www.ncbi.nlm.nih.gov/
- ExPASy Proteomics Server - http://us.expasy.org/
- Mouse Genome Informatics - http://www.informatics.jax.org/
- Center for Molecular Modeling - http://cmm.info.nih.gov/modeling/
- RCSB PDB - http://www.rcsb.org/pdb
- Bioinformatics resources - http://www.biochem.ucl.ac.uk/bsm/BCSB/bioinfo_resources/bioinform_res.htm
- South African National Bioinformatics Institute - http://www.sanbi.ac.za/
- Swiss Institute of Bioinformatics - http://www.isb-sib.ch/
- Protein Structure Prediction Center - http://predictioncenter.llnl.gov/
- Programs for Genomic Applications -http://www.nhlbi.nih.gov/resources/pga/
- Computational Molecular Biology At NIH - http://molbio.info.nih.gov/molbio/
- Gene Ontology Home - http://www.geneontology.org/
- All About The Human Genome Project (HGP) - http://www.genome.gov/
- UCSC Genome Browser - http://genome.ucsc.edu/

MOLECULAR BIOLOGY AND BIOTECHNOLOGY

Course Structure

COURSE NO.	COURSE TITLE	CREDITS	SEM
MBB 501*	PRINCIPLES OF BIOTECHNOLOGY	3+0	I
MBB 502*/ ❶ BIOCHEM 504/ BIF 508	FUNDAMENTAL OF MOLECULAR BIOLOGY	3+0	I
MBB 503	MOLECULAR CELL BIOLOGY	3+0	II
MBB 504	PLANT TISSUE CULTURE AND GENETIC TRANSFORMATION	2+1	II
MBB 505*	TECHNIQUES IN MOLECULAR BIOLOGY - I	0+3	I
MBB 506/MICRO 505	INDUSTRIAL BIOTECHNOLOGY	2+1	II
MBB 507	MOLECULAR BREEDING	2+0	II
MBB 508/ ❷ BIF 517	GENOMICS & PROTEOMICS	2+1	I
MBB 509	TECHNIQUES IN MOLECULAR BIOLOGY - II	0+3	II
MBB 510	BIOSAFETY, IPR AND BIOETHICS	2+0	I
MBB 511/ ❸ ABT 616	ANIMAL BIOTECHNOLOGY	3+0	I
MBB 512/ ❹ BIOCHEM 506/ BIF 510	IMMUNOLOGY AND MOLECULAR DIAGNOSTICS	2+1	II
MBB 513	NANO-BIOTECHNOLOGY	3+0	I
MBB 514/ ❺ FST 519	FOOD BIOTECHNOLOGY	2+1	I
MBB 515/ ❻ FSC 509	BIOTECHNOLOGY OF HORTICULTURAL CROPS	2+1	II
MBB 553*/ ❼ STAT 534/ FST 531/ SOC 512	BIOSTATISTICS AND COMPUTERS	2+1	I
MBB 555/ ❽ BIF 501/ ABT 608/ FSC 604	INTRODUCTION TO BIOINFORMATICS	2+1	I
MBB 556	ENVIRONMENTAL BIOTECHNOLOGY	3+0	II
MMB 591	MASTER'S SEMINAR	1	I, II
MMB 599	MASTER'S RESEARCH	20	I, II
MBB 601	ADVANCES IN PLANT MOLECULAR BIOLOGY	3+0	I
MBB 602	ADVANCES IN GENETIC ENGINEERING	3+0	I
MBB 603	ADVANCES IN MICROBIAL BIOTECHNOLOGY	3+0	II
MBB 604/ ❻ VSC 604/ FLA 605	ADVANCES IN CROP BIOTECHNOLOGY	3+0	I
MBB 605/ ❾ BIOCHEM 606/ PP 602	ADVANCES IN FUNCTIONAL GENOMICS, PROTEOMICS AND METABOLOMICS	3+0	II
MBB 606	COMMERCIAL PLANT TISSUE CULTURE	2+0	I
MBB 607/ ❸ ABT 707	ADVANCES IN ANIMAL BIOTECHNOLOGY	2+0	II
MBB 691	DOCTORAL SEMINAR I	1	I, II

MBB 692	DOCTORAL SEMINAR II	1	I, II
MMB 699	DOCTORAL RESEARCH	45	I, II

	SERVICE COURSE		
PSMA 606	BIOTECHNOLOGY IN PLANTATION CROPS AND SPICES	1+1	II
PP 603	MOLECULAR APPROACHES FOR IMPROVING PHYSIOLOGICAL TRAITS (IN PART)	2+1	I

* Compulsory for Master's programme; Compulsory for Doctoral programme - Any two courses of 600 series + Compulsory courses of M. Sc., if not studied earlier

To be taught by: ❶ Bioinformatics, Biochemistry, Molecular Biology & Biotechnology; ❷ Bioinformatics, Molecular Biology & Biotechnology; ❸ Animal Biotechnology; ❹ Veterinary Microbiology; ❺ Molecular Biology & Biotechnology; ❻ Molecular Biology & Biotechnology; ❼ Statistics; ❽ Bioinformatics, Molecular Biology & Biotechnology; ❾ Biochemistry, Molecular Biology & Biotechnology, Plant Physiology

MOLECULAR BIOLOGY AND BIOTECHNOLOGY

Course Contnts

MBB 501   **PRINCIPLES OF BIOTECHNOLOGY**   3+0   SEM - I

Objective

To familiarize the students with the fundamental principles of Biotechnology, various developments in Biotechnology and its potential applications.

Theory

UNIT-I: History, scope and importance; DNA structure, function and metabolism.

UNIT-II: DNA modifying enzymes and vectors; Methods of recombinant DNA technology; Nucleic acid hybridization; Gene libraries; PCR amplification; Plant and animal cell and tissue culture techniques and their applications.

UNIT-III: Molecular markers and their applications; DNA sequencing; Applications of gene cloning in basic and applied research; Genetic engineering and transgenics; Introduction to Genomics, transcriptomics and proteomics.

UNIT-IV: General application of biotechnology in Agriculture, Medicine, Animal husbandry, Environmental remediation, Energy production and Forensics; Public perception of biotechnology; Bio-safety and bioethics issues; Intellectual property rights in biotechnology.

Suggested Readings

Becker JM, Coldwell GA & Zachgo EA. 2007. *Biotechnology – a Laboratory Course*. Academic Press.

Brown CM, Campbell I & Priest FG. 2005. *Introduction to Biotechnology*. Panima Publ.

Brown TA. *Gene Cloning and DNA Analysis*. 5th Ed. Blackwell Publ.

Dale JW & von Schantz M. 2002. *From Genes to Genomes: Concepts and Applications of DNA Technology*. John Wiley & Sons.

Gupta PK. 2004. *Biotechnology and Genomics*. Rastogi Publ.

Sambrook J, Fritsch T & Maniatis T. 2001. *Molecular Cloning – a Laboratory Manual*. 2nd Ed. Cold Spring Harbour Laboratory Press.

Singh BD. 2007. *Biotechnology Expanding Horiozon*. Kalyani Publ.

MBB 502/   **FUNDAMENTALSOFMOLECULARBIOLOGY**   3+0   SEM - I

BIOCHEM 504/   (To be taught jointly by Molecular Biology & Biotechnology, Biochemistry and

BIF508   Bioinformatics)

Objective

To familiarize the students with the basic cellular processes at molecular level.

Theory

UNIT-I: Historical developments of molecular biology; nucleic acids as genetic material, chemistry, structure and properties of DNA and RNA.

UNIT-II: Genome organization in prokaryotes and eukaryotes; repetitive and non-repetitive DNA, satellite DNA; DNA replication, DNA polymerases, topoisomerases, DNA ligase, reverse transcriptase, nucleases and restriction enzymes; site directed mutagenesis, molecular mechanism of mutation, DNA repair mechanisms.

UNIT-III: Ribosomes structure and function, organization of ribosomal proteins and RNA genes, transcription, RNA editing, RNA processing, etc; Genetic code, aminoacyl tRNA synthases' inhibitors of replication, transcription and translation.

UNIT-IV: Translation and post translational modifications; Regulation of gene expression in prokaryotes and eukaryotes.

Suggested Readings

Lewin B. 2008. *Gene IX*. Peterson Publ. / Panima.

Malacinski GM & Freifelder D. 1998. *Essentials of Molecular Biology*. 3rd Ed. Jones & Bartlett.

Nelson DL & Cox MM. 2007. *Lehninger's Principles of Biochemistry*. W.H. Freeman.

Primrose SB. 2001. *Molecular Biotechnology*. Panima.

Watson JD, Bakee TA, Bell SP, Gann A, Levine M & Losick R. 2008. *Molecular Biology of the Gene*. 6th Ed. Pearson Edu.

MBB 503   MOLECULAR CELL BIOLOGY   3+0   SEM - II

Objective

To familiarize the students with the cell biology at molecular level.

Theory

UNIT-I: General structure and constituents of cell; Similarities and distinction between plant and animal cells; Cell wall, cell membrane, structure and composition of biomembranes, cell surface related functions.

UNIT-II: Structure and function of major organelles: Nucleus, Chloroplasts, Mitochondria, Ribosomes, Lysosomes, Peroxisomes, Endoplasmic reticulum, Microbodies, Golgi apparatus, Vacuoles, etc.

UNIT-III: Organellar genomes and their manipulation; Ribosomes in relation to cell growth and division; Cyto-skeletal elements.

UNIT-IV: Cell division and regulation of cell cycle; Membrane transport; Transport of water, ion and biomolecules; Signal transduction mechanisms; Protein targeting.

Suggested Readings

Gupta PK. 2003. *Cell and Molecular Biology*. 2nd Ed. Rastogi Publ.

Lodish H. 2003. *Molecular Cell Biology*. 5th Ed. W.H. Freeman & Co.

Primrose SB. 2001. *Molecular Biotechnology*. Panima.

MBB 504   PLANT TISSUE CULTURE AND GENETIC   2+1   SEM - II
**   TRANSFORMATION**

Objective

To familiarize the students and provide hands on training on various techniques of plant tissue culture, genetic engineering and transformation.

Theory

UNIT-I: History of plant cell and tissue culture; Culture media; Various types of culture; callus, suspension, nurse, root, meristem, etc.; *In vitro* differentiation: organogenesis and somatic embryogenesis; Plant growth regulators: mode of action, effects on *in vitro* culture and regeneration; Molecular basis of plant organ differentiation.

UNIT-II: Micropropagation; Anther and microspore culture; Somaclonal variation; *In vitro* mutagenesis; *In vitro* fertilization; *In vitro* germplasm conservation; Production of secondary metabolites; Synthetic seeds.

UNIT-III: Embryo rescue and wide hybridization; Protoplast culture and regeneration; Somatic hybridization: protoplast fusion, cybrids, asymmetric hybrids, etc.

UNIT-IV: Methods of plant transformation; Vectors for plant transformation; Genetic and molecular analyses of transgenics; Target traits and transgenic crops; Biosafety issues, testing of transgenics, regulatory procedures for commercial approval.

Practical

- Laboratory set-up.
- Preparation of nutrient media; handling and sterilization of plant material; inoculation, subculturing and plant regeneration.
- Anther and pollen culture.
- Embryo rescue.
- Suspension cultures and production of secondary metabolites.
- Protoplast isolation, culture and fusion.
- Gene transfer using different methods, reporter gene expression, selection of transformed tissues/plants, molecular analysis.

Suggested Readings

Bhojwani SS. 1983. *Plant Tissue Culture: Theory and Practice*. Elsevier.

Christou P & Klee H. 2004. *Handbook of Plant Biotechnology*. John Wiley & Sons.

Dixon RA. 2003. *Plant Cell Culture*. IRL Press.

George EF, Hall MA & De Klerk GJ. 2008. *Plant Propagation by Tissue Culture*. Agritech Publ.

Gupta PK. 2004. *Biotechnology and Genomics*. Rastogi Publ.

Herman EB. 2005-08. *Media and Techniques for Growth, Regeneration and Storage*. Agritech Publ.

Pena L. 2004. *Transgenic Plants: Methods and Protocols*. Humana Press.

Pierik RLM. 1997. *In vitro Culture of Higher Plants*. Kluwer.
Singh BD. 2007. *Biotechnology: Expanding Horiozon.* Kalyani.

MBB 505   **TECHNIQUES IN MOLECULAR**   **0+3**   **SEM - I**
                   BIOLOGY-I
                   (Pre-requisite MBB 501)

Objective

To provide hands-on training on basic molecular biology techniques.

Practical

UNIT-I: Good lab practices; Biochemical techniques: Preparation of buffers and reagents, Principle of centrifugation, Chromatographic techniques (TLC, Gel Filtration Chromatography, Ion exchange Chromatography, Affinity Chromatography).

UNIT-II: Gel electrophoresis- agarose and PAGE (nucleic acids and proteins); Growth of bacterial culture and preparation of growth curve; Isolation of plasmid DNA from bacteria; Growth of lambda phage and isolation of phage DNA; Restriction digestion of plasmid and phage DNA; Isolation of high molecular weight DNA and analysis.

UNIT-III: Gene cloning – Recombinant DNA construction, transformation and selection of transformants; PCR and optimization of factors affecting PCR.

UNIT-IV: Dot blot analysis; Southern hybridization; Northern hybridization; Western blotting and ELISA; Radiation safety and non-radio isotopic procedure.

Suggested Readings

Ausubel FM, Brent R, Kingston RE, Moore DD, Seidman JG, Smith JA & Struhl K. 2002. *Short Protocols in Molecular Biology*. John Wiley.

Kun LY. 2006. *Microbial Biotechnology*. World Scientific.

Sambrook J, Russel DW & Maniatis T. 2001. *Molecular Cloning: A Laboratory Manual*. Cold Spring Harbour Laboratory Press.

MBB 506/MICRO 505   **INDUSTRIAL BIOTECHNOLOGY**   **2+1**   **SEM - II**
                         (To be taught jointly byMBB&B & Microbiology)

Objective

To familiarize students about microbial processes/systems/activities for the development of industrially important products/ processes.

Theory

UNIT-I: Introduction, scope and historical developments; Isolation, screening and genetic improvement and maintenance of industrially important organisms.

UNIT-II: Types fermentation systems; Bioreactor designs and operations; Production of primary and secondary metabolites e.g alcohol, organic acids, organic solvents, amino acids, enzymes, antibiotics.

UNIT-III: Production of fermented beverages, single cell protein; Recombinant DNA technology based products, Biotransformation.

UNIT-IV*:* Overproduction of metabolites; Metabolic engineering of microbes for production of novel products for industry; Downstream processing; Immobilization of cells/enzymes.

UNIT-V: Industrial biotechnology for pollution control, treatment of industrial and other wastes, Production of eco-friendly chemicals e.g biopesticides, bio-insecticides, bio-fertilizers, bio-fuels, etc.

Practical

- Isolation of industrially important microorganisms, their maintenance and improvement.
- Production of industrial compounds such as alcohol, beer, citric acid, lactic acid and their recovery.
- Study of bio-reactors and their operations.
- Production of biofertilizers.
- Immobilization of cells and enzymes, studies on its kinetic behavior.

Suggested Readings

Cruger W & Cruger A. 2004. *Biotechnology – A Textbook of Industrial Microbiology,* Panima.

Huffnagle GB & Wernick S. 2007. *The Probiotics Revolution: The Definitive Guide to Safe, Natural Health*. Bantam Books.

Kun LY. 2006. *Microbial Biotechnology*. World Scientific.

Primrose SB. 2001. *Molecular Biotechnology*. Panima.
Ward OP. 1989. *Fermentation Biotechnology*, Prentice Hall.

MBB 507   **MOLECULAR BREEDING**   **2+0**   **SEM - II**

Objective

To familiarize the students about the use of molecular biology tools in plant breeding.

Theory

UNIT-I: Principles of plant breeding; Breeding methods for self and cross pollinated crops; Heterosis breeding; Limitations of conventional breeding; Aspects of molecular breeding.

UNIT-II: Development of sequence based molecular markers - SSRs and SNPs; Advanced methods of genotyping; Mapping genes for qualitative and quantitative traits.

UNIT-III: QTL mapping using structured populations; AB-QTL analysis; Association mapping of QTL; Fine mapping of genes/QTL; Map based gene/QTL isolation and development of gene based markers; Allele mining by TILLING and Eco-TILLING; Use of markers in plant breeding.

UNIT-IV: Marker assisted selection (MAS) in backcross and heterosis breeding; Transgenic breeding; Foreground and background selection; MAS for gene introgression and pyramiding: MAS for specific traits with examples.

Suggested Readings

Chittaranjan K. 2006-07. *Genome Mapping and Molecular Breeding in Plants*. Vols. I-VII. Springer.
Newbury HJ. 2003. *Plant Molecular Breeding*. Blackwell Publ.
Weising K, Nybom H, Wolff K & Kahl G. 2005. *DNA Fingerprinting in Plants: Principles, Methods and Applications*. Taylor & Francis.

MBB 508/   **GENOMICS AND PROTEOMICS**   **2+1**   **SEM - I**
BIF 517   (To be taught jointly by Molecular Biology & Biotechnology and Bioinformatics)

Objective

To familiarize the students about the genomic and proteomic concepts and usage of various algorithms and programmes in analysis of genomic and proteomic data.

Theory

UNIT-I: Genomics: Whole genome analysis and comparative genomics, classical ways of genome analysis, large fragment genomic libraries; Physical mapping of genomes; Genome sequencing, sequence assembly and annotation.

UNIT-II: Functional genomics: Candidate gene identification, DNA chips, Mutants and RNAi, Metabolomics for elucidating metabolic pathways, etc.

UNIT-III: Proteomics - Introduction to basic proteomics technology, Bio-informatics in Proteomics, Gene to Protein Function: a Roundtrip, Proteome analysis.

UNIT-IV: Linkage analysis, genotyping analysis, pharmacogenomics, human/plant genome and science after genomic era; Applications of genomics and proteomics in agriculture, human health and industry.

Practical

- Gene Prediction Tools: GENSCAN, GRAIL, FGENESH
- NCBI Genomic Resources
- Proteomics Tools: EXPASY, CDART

Suggested Readings

Azuaje F & Dopazo J. 2005. *Data Analysis and Visualization in Genomics and Proteomics*. John Wiley & Sons.
Brown TA. 2007. *Genome III*. Garland Science Publ.
Campbell AM & Heyer L. 2004. *Discovery Genomics, Proteomics and Bioinformatics*. Pearson Edu.
Gibson G & Muse SV. 2004. *A Primer of Genome Science*. Sinauer Associates.
Jollès P & Jörnvall H. 2000. *Proteomics in Functional Genomics: Protein Structure Analysis*. Birkhäuser.
Kamp RM. 2004. *Methods in Proteome and Protein Analysis*. Springer.
Primrose SB & Twyman RM. 2007. *Principles of Genome Analysis and Genomics*. Blackwell.
Sensen CW. 2005. *Handbook of Genome Research*. Vols. I, II. Wiley CVH.

MBB 509   **TECHNIQUES IN MOLECULAR**   **0+3**   **SEM - II**
BIOLOGY -II
(Pre-requisite MBB 505)

Objective

To provide hands-on training on various molecular techniques used in molecular breeding and genomics.

Practical

UNIT-I: Construction of gene libraries; Synthesis and cloning of cDNA and RTPCR analysis; Real time PCR and interpretation of data.

UNIT-II: Molecular markers (RAPD, SSR, AFLP etc) and their analysis; Case study of SSR markers (linkage map, QTL analysis etc); SNP identification and analysis; Microarray studies and use of relevant software.

UNIT-III: Proteomics (2D gels, mass spectrometry, etc.); RNAi (right from designing of construct to the phenotyping of the plant); Yeast 1 and 2-hybrid interaction.

UNIT-IV: Generation and screening of mutants; Transposon mediated mutagenesis.

Suggested Readings

Ausubel FM, Brent R, Kingston RE, Moore DD, Seidman JG, Smith JA & Struhl K. 2002. *Short Protocols in Molecular Biology*. Wiley.

Caldwell G, Williams SN & Caldwell K. 2006. *Integrated Genomics: A Discovery-Based Laboratory Course*. John Wiley.

Sambrook J, Russel DW & Maniatis T. 2001. *Molecular Cloning: a Laboratory Manual*. Cold Spring Harbour Laboratory Press.

MBB 510   **BIOSAFETY, IPR AND BIOETHICS**   **2+0**   **SEM - I**

Objective

To discuss about various aspects of biosafety regulations, IPR and bioethic concerns arising from the commercialization of biotech products.

Theory

UNIT-I: Biosafety and risk assessment issues; Regulatory framework; National biosafety policies and law, The Cartagena protocol on biosafety, WTO and other international agreements related to biosafety, Cross border movement of germplasm; Risk management issues - containment.

UNIT-II: General principles for the laboratory and environmental biosafety; Health aspects; toxicology, allergenicity, antibiotic resistance, etc; Impact on environment: gene flow in natural and artificial ecologies; Sources of gene escape, tolerance of target organisms, creation of superweeds/superviruses, etc.

UNIT-III: Ecological aspects of GMOs and impact on biodiversity; Monitoring strategies and methods for detecting transgenics; Radiation safety and nonradio isotopic procedure; Benefits of transgenics to human health, society and the environment.

UNIT-IV: The WTO and other international agreements; Intellectual properties, copyrights, trademarks, trade secrets, patents, geographical indications, etc; Protection of plant variety and farmers right act; Indian patent act and amendments, patent filing; Convention on biological diversity; Implications of intellectual property rights on the commercialization of biotechnology products.

Suggested Readings

Singh BD. 2007. *Biotechnology: Expanding Horizon*. Kalyani.

http://patentoffice.nic.in

www.wipo.org

www.dbtindia.nic.in

www.dbtbiosafety.nic.in

MBB 511/   **ANIMAL BIOTECHNOLOGY**   **3+0**   **SEM - I**
ABT 616   (To be taught by Animal Biotechnology)

Objective

Intended to provide an overview and current developments in different areas of animal biotechnology.

Theory

UNIT-I: Structure of animal cell; History of animal cell culture; Cell culture media and reagents, culture of mammalian cells, tissues and organs, primary culture, secondary culture, continuous cell lines, suspension cultures, somatic cell cloning and hybridization, transfection and transformation of cells, commercial scale production of animal cells, application of animal cell culture for *in vitro* testing of drugs, testing of toxicity of environmental pollutants in cell culture, application of cell culture technology in production of human and animal viral vaccines and pharmaceutical proteins.

UNIT-II: Introduction to immune system, cellular and hormonal immune response, history of development of vaccines, introduction to the concept of vaccines, conventional methods of animal vaccine production, recombinant approaches to vaccine production, hybridoma technology, phage display technology for production of antibodies, antigen-antibody based diagnostic assays including radioimmunoassays and enzyme immunoassays, immunoblotting, nucleic acid based diagnostic methods, commercial scale production of diagnostic antigens and antisera, animal disease diagnostic kits, probiotics.

UNIT-III: Structure of sperms and ovum, cryopreservation of sperms and ova of livestock, artificial insemination, super ovulation, *in vitro* fertilization, culture of embryos, cryopreservation of embryos, embryo transfer, embryo-splitting, embryo sexing, transgenic manipulation of animal embryos, different applications of transgenic animal technology, animal viral vectors, animal cloning basic concept, cloning from- embryonic cells and adult cells, cloning of different animals, cloning for conservation for conservation endangered species, ethical, social and moral issues related to cloning, *in situ* and *ex situ* preservation of germplasm, *in utero* testing of foetus for genetic defects, pregnancy diagnostic kits, anti-fertility animal vaccines, gene knock out technology and animal models for human genetic disorders.

UNIT-IV: Introduction to different breeds of cattle, buffalo, sheep, goats, pigs, camels, horses, canines and poultry, genetic characterization of livestock breeds, marker assisted breeding of livestock, introduction to animal genomics, different methods for characterization of animal genomes, SNP, STR, QTL, RFLP, RAPD, genetic basis for disease resistance, Transgenic animal production and application in expression of therapeutic proteins. Immunological and nucleic acid based methods for identification of animal species, detection of meat adulteration using DNA based methods, detection food/feed adulteration with animal protein, identification of wild animal species using DNA based methods using different parts including bones, hair, blood, skin and other parts confiscated by anti-poaching agencies.

Suggested Readings

Gordon I. 2005. *Reproductive Techniques in Farm Animals*. CABI.
Kindt TJ, Goldsby RA & Osbrne BA. 2007. *Kuby Immunology*. WH Freeman.
Kun LY. 2006. *Microbial Biotechnology*. World Scientific.
Levine MM, Kaper JB, Rappuoli R, Liu MA, Good MF. 2004. *New Generation Vaccines*. 3rd Ed. Informa Healthcare.
Lincoln PJ & Thomson J. 1998. *Forensic DNA Profiling Protocols*. Humana Press.
Portner R. 2007. *Animal Cell Biotechnology*. Humana Press.
Spinger TA. 1985. *Hybridoma Technology in Biosciences and Medicine*. Plenum Press.
Twyman RM. 2003. *Advanced Molecular Biology*. Bios Scientific.

MBB 512/	**IMMUNOLOGY AND**	**2+1**	**SEM - II**
BIOCHEM 506/	**MOLECULAR DIAGNOSTICS**		
BIF 510	(To be taught by Veterinary Microbiology)		

Objective

To discuss the application of various immunological and molecular diagnostic tools.

Theory

UNIT-I: History and scope of immunology; Components of immune system: organs, tissues and cells, Immunoglobulin structure and functions; Molecular organization of immunoglobulins and classes of antibodies.

UNIT-II: Antibody diversity; antigens, haptens, antigens- antibody interactions; immunoregulation and tolerance; Allergies and other hypersensitive responses; Immunodeficiency; Vaccines.

UNIT-III: Application of immunology, immunological techniques, Principles of ELISA and its applications; Monoclonal antibodies and their uses, molecular diagnostics;

Introduction to the basic principles of molecular technology and techniques used for pathogen detection.

UNIT-IV: Basics and procedures of PCR, PCR based and hybridization based methods of detection, microarrays based detection, multiplexing etc, detection of soil borne and seed born infections, transgene detection in seed, planting material and processed food, molecular detection of varietal impurities and seed admixtures in commercial consignments.

Practical

- Preparation of buffers and reagents.
- Serological tests such as bacterial slide agglutination, latex agglutination and agar gel immunodiffusion.
- Immunoassays including ELISA, western blotting, and fluorescent antibody test.
- Hybridoma technique for production of monoclonal antibodies.
- Recombinant protein antigen- production and immunization of laboratory animals.
- Extraction of DNA/RNA from pathogenic microorganisms, PCR, genotyping, diagnosis, etc.

Suggested Readings

Bloom BR & Lambert P-H. 2002. *The Vaccine Book*. Academic Press.
Elles R & Mountford R. 2004. *Molecular Diagnosis of Genetic Disease*. Humana Press.
Kindt TJ, Goldsby RA & Osbrne BA. 2007. *Kuby's Immunology*. WH Freeman.
Levine MM, Kaper JB, Rappuoli R, Liu MA & Good MF. 2004. *New Generation Vaccines*. 3rd Ed. Informa Healthcare.
Lowrie DB & Whalen R. 2000. *DNA Vaccines*. Humana Press.
Male D, Brostoff J, Roth DB & Roitt I. 2006. *Immunology*. Elsevier.
Rao JR, Fleming CC & Moore JE. 2006. *Molecular Diagnostics*. Horizon Bioscience.
Robinson A & Cranage MP. 2003. *Vaccine Protocols*. 2nd Ed. Humana Press.
Spinger TA, 1985. *Hybridoma Technology in Biosciences and Medicine*. Plenum Press.

MBB 513   NANO-BIOTECHNOLOGY   3+0   SEM - I

Objective

Understanding the molecular techniques involved in structure and functions of nano-biomolecules in cells such as DNA, RNA and proteins.

Theory

UNIT-I: Introduction to Biomacromolecules: The modern concepts to describe the conformation and dynamics of biological macromolecules: scattering techniques, micromanipulation techniques, drug delivery applications etc.

UNIT-II: Cellular engineering: signal transduction in biological systems, feedback control signaling pathways, cell-cell interactions etc. Effects of physical, chemical and electrical stimuli on cell function and gene regulation.

UNIT-III: Chemical, physical and biological properties of biomaterials and bioresponse: biomineralization, biosynthesis, and properties of natural materials (proteins, DNA, and polysaccharides), structure-property relationships in polymeric materials (synthetic polymers and structural proteins); Aerosol properties, application and dynamics; Statistical Mechanics in Biological Systems.

UNIT-IV: Preparation and characterization of nanoparticles; Nanoparticular carrier systems; Micro- and Nano-fluidics; Drug and gene delivery system; Microfabrication, Biosensors, Chip technologies, Nano- imaging, Metabolic engineering and Gene therapy.

Suggested Readings

Nalwa HS. 2005. *Handbook of Nanostructured Biomaterials and their Applications in Nanobiotechnology*. American Scientific Publ.
Niemeyer CM & Mirkin CA. 2005. *Nanobiotechnology*. Wiley Interscience.

MBB 514/   FOOD BIOTECHNOLOGY   2+1   SEM - I
FST 519   (To be taught by Molecular Biology & Biotechnology)

Objective

This is a special course designed for students of FST to acquaint with the fundamentals and application of biotechnology in relation to raw materials for food processing, nutrition, food fermentations, waste utilization and better use of genetic resources.

Theory

UNIT-I: Prospects of biotechnology- definition, history, scope and applications, Application of biotechnology in food (food industries), pharmaceuticals and agriculture, food/plant waste utilization, biogas plants; organisms and their utilization for the production of fermented foods and beverages.

UNIT-II: Structure and function of nucleic acids; Recombinant DNA technology: restriction and other DNA modifying enzymes, vectors, DNA libraries, gene cloning, PCR, gene expression, etc.

UNIT-III: Applications of genetical control mechanism in industrial fermentation process, (induction, manipulation and recombination); Biomass production by using various microorganisms; Cell and tissue culture, Secondary metabolites synthesis; Transgenic organisms (GMOs): methods, applications, safety aspects, etc.

UNIT-IV: Biotechnology for enhancing quality attributes of food; Enzyme biotechnology; Enzyme immobilization techniques and their applications in food industry; Microbial transformations; Potential impact and future aspects of biotechnology in food industry.

Practical

Study of auxotroph, Micropropogation through tissue culture, Strain improvement through U.V. mutation, Mutagenesis using chemical mutagens (ethidium bromide), Isolation and analysis of genomic DNA from *E.coli* and *Bacillus cereus,* Isolation of protoplasts, Introduction to the techniques of ELISA / Southern blot / DNA fingerprinting / Agarose gel electrophoresis, etc.

Suggested Readings

Bains W. 1993. *Biotechnology from A to Z.* Oxford Univ. Press.

Joshi VK & Pandey A.1999. *Biotechnology: Food Fermentation*. Vols. I, II. Education Publ.

Knorr D.1982. *Food Biotechnology*. Marcel Dekker.

Lee BH. 1996. *Fundamentals of Food Biotechnology*. VCH.

Perlman D. 1977-1979. *Annual Reports of Fermentation Processes*.

Prescott SC & Dunn CG. 1959. *Industrial Microbiology*. McGraw Hill.

Ward OP. 1989. *Fermentation Biotechnology*. Prentice Hall.

MBB 515/ FSC 509	BIOTECHNOLOGY OF HORTICULTURAL CROPS	2+1	SEM - II

(To be taught by Molecular Biology & Biotechnology)

Objective

Understanding the principles, theoretical aspects and developing skills in biotechnology of horticultural crops.

Theory

UNIT-I : Harnessing bio-technology in horticultural crops, influence of plant materials, physical, chemical factors and growth regulators on growth and development of plant cell, tissue and organ culture.

UNIT-II: Callus culture – types, cell division, differentiation, morphogenesis, organogenesis, embryogenesis, artificial seeds.

UNIT-III: Use of bioreactors and *in vitro* methods for production of secondary metabolites, suspension culture, nutrition of tissues and cells, regeneration of tissues, ex vitro, establishment of tissue cultured plants, rapid clonal propagation.

UNIT-IV: Physiology of hardening - hardening and field transfer, organ culture – meristem, embryo, anther, ovule culture, embryo rescue, somaclonal variation, haploids, *in vitro* mutation, , cryopreservation.

UNIT-V: Wide hybridization, *in vitro* pollination and fertilization, protoplast culture and fusion, identification of somatic hybrids and cybrids, genetic engineering and transformation, use of molecular markers, achievements of biotechnology in horticultural crops.

Practical

An exposure to low cost, commercial and homestead tissue culture laboratories, media preparation, inoculation of explants for clonal propagation, callus induction and culture, regeneration of plantlets from callus, sub-culturing, techniques on anther, ovule, embryo culture, somaclonal variation, protoplast isolation and culture, genetic transformation.

Suggested Readings

Bajaj YPS. (Ed.). 1989. *Biotechnology in Agriculture and Forestry*. Vol. V, *Fruits*. Springer.

Brown TA. 2001. *Gene Cloning and DNA Analysis and Introduction.* Blackwell Publ.

Chopra VL & Nasim A. 1990. *Genetic Engineering and Biotechnology – Concepts, Methods and Applications.* Oxford & IBH.

Gorden H & Rubsell S. 1960. *Hormones and Cell Culture.* AB Book Publ.

Keshavachandran R & Peter KV. 2008. *Plant Biotechnology: Tissue Culture and Gene Transfer.* Orient & Longman (Universal Press).

Keshavachandran R, Nazeem PA, Girija D, John PS & Peter KV. 2007. *Recent Trends in Biotechnology of Horticultural Crops.* Vols. I, II. New India Publ. Agency.

Parthasarathy VA, Bose TK, Deka PC, Das P, Mitra SK & Mohanadas S. 2001. *Biotechnology of Horticultural Crops.* Vols. I-III. Naya Prokash.

Pierik RLM. 1987. *In vitro Culture of Higher Plants.* Martinus Nijhoff Publ.

Skoog F & Miller CO. 1957. *Chemical Regulation of Growth and Formation in Plant Tissue Culture in vitro. Symp. Soc. Exp. Biol.* 11: 118-131.

Vasil TK, Vasi M, While DNR & Bery HR.1979. *Somatic Hybridization and Genetic Manipulation in Plants. Plant Regulation and World Agriculture.* Planum Press.

Williamson R. 1981-86. *Genetic Engineering.* Vols. I-V. Academic Press.

MBB 553/ **STAT534/** **FST531/** **SOC512**	**BIOSTATISTICS AND COMPUTERS** (To be taught by Statistics)	**2+1**	**SEM - I**

Objective

This is a course of applied Statistics to be taken by M.Sc. students of Biotechnology, FST and Sociology departments of CoBS&H. They are exposed to various statistical methods to analyze their experimental data.

Theory

UNIT-I: Aims, scope and idea of elementary statistics; Measures of central tendency and dispersion, skewness and kurtosis.

UNIT-II: Concept of probability and probability laws, mathematical expectation, moments, moments generating function; Standard probability distributions- Binomial, Poisson and Normal distributions.

UNIT-III: Tests of significance based on Z, χ^2, t and F statistics; Correlation and regression, curve fitting by least squares methods.

UNIT-IV: Basic principles, organization and operational aspects of computers, operating systems. Introduction to MS-Office, MS-Word, MS-Excel. Statistical Data analysis based on above topics through MS-Excel.

Practical

- Data analysis using probability, test of significance
- Correlation and regression analysis
- Usage of MS-Windows
- Exercises on test processing, spreadsheet and DBMS
- SPSS

Suggested Readings

Agarwal BL. 2003. *Basic Statistics.* New Age.

Gupta SP. 2004. *Statistical Methods.* S. Chand & Sons.

Dutta NK. 2002. *Fundamentals of Bio-Statistics.* Kanishka Publ.,Wiley Eastern.

MBB 555/ **BIF 501/** **ABT 608/** **FSC 604**	**INTRODUCTION TO BIOINFORMATICS** (To be taught jointly by Molecular Biology & Biotechnology, Bioinformatics)	**2+1**	**SEM - I**

Objective

To impart an introductory knowledge about the subject of bioinformatics to the students studying any discipline of science.

Theory

UNIT-I: Introduction, biological databases – primary, secondary and structural, Protein and Gene Information Resources – PIR, SWISSPROT, PDB, genebank, DDBJ. Specialized genomic resources.

UNIT-II: DNA sequence analysis, cDNA libraries and EST, EST analysis, pairwise alignment techniques, database searching, multiple sequence alignment.

UNIT-III: Secondary database searching, building search protocol, computer aided drug design – basic principles, docking, QSAR.

UNIT-IV: Analysis packages – commercial databases and packages, GPL software for Bioinformatics, web-based analysis tools.

Practical

- Usage of NCBI resources
- Retrival of sequence/structure from databases
- Visualization of structures
- Docking of ligand receptors
- BLAST exercises.

Suggested Readings

Attwood TK & Parry-Smith DJ. 2003. *Introduction to Bioinformatics*. Pearson Edu.

Rastogi SC, Mendiratta N & Rastogi P. 2004. *Bioinformatics: Concepts, Skills and Applications*. CBS.

MBB 556	ENVIRONMENTAL BIOTECHNOLOGY	3+0	SEM - II

Objective

To apprise the students about the role of biotechnology in environment management for sustainable eco-system and human welfare.

Theory

UNIT-I: Basic concepts and environmental issues; types of environmental pollution; problems arising from high-input agriculture; methodology of environmental management; air and water pollution and its control; waste water treatment - physical, chemical and biological processes; need for water and natural resource management.

UNIT-II: Microbiology and use of micro-organisms in waste treatment; biodegradation; degradation of Xenobiotic, surfactants; bioremediation of soil & water contaminated with oils, pesticides & toxic chemicals, detergents etc; aerobic processes (activated sludge, oxidation ditches, trickling filter, rotating drums, etc); anaerobic processes: digestion, filteration, etc.

UNIT-III: Renewable and non-Renewable resources of energy; energy from solid waste; conventional fuels and their environmental impact; biogas; microbial hydrogen production; conversion of sugar to alcohol; gasohol; biodegradation of lignin and cellulose; biopesticides; biofertilizers; composting; vermiculture, etc.

UNIT-IV: Treatment schemes of domestic waste and industrial effluents; food, feed and energy from solid waste; bioleaching; enrichment of ores by microorganisms; global environmental problems: ozone depletion, UV-B, greenhouse effects, and acid rain; biodiversity and its conservation; biotechnological approaches for the management environmental problems.

Suggested Readings

Evans GM & Furlong JC. 2002. *Environmental Biotechnology: Theory and Application*. Wiley International.

Jordening H-J & Winter J. 2006. *Environmental Biotechnology: Concepts and Applications*. Wiley-VCH Verlag.

MBB 601	ADVANCES IN PLANT MOLECULAR BIOLOGY	3+0	SEM - I

(Pre-requisite MBB 501)

Objective

To discuss the specialized topics and recent advances in the field of plant molecular biology.

Theory

UNIT-I: *Arabidopsis* in molecular biology, Forward and Reverse Genetic Approaches, Transcriptional and post-transcriptional regulation of gene expression, isolation of promoters and other regulatory elements.

UNIT-II: RNA interference, Transcriptional gene silencing, Transcript and protein analysis, use of transcript profiling to study biological systems.

UNIT-III: Hormone regulatory pathways: Ethylene, Cytokinin, Auxin and ABA, SA and JA; ABC Model of Floral Development, Molecular basis of self incompatibility, Regulation of flowering: photoperiod, vernalization, circadian rhythms.

UNIT-IV: Molecular biology of abiotic stress responses: Cold, high temperature, submergence, salinity and drought; Molecular Biology of plant-pathogen interactions, molecular biology of *Agrobacterium* Infection, Molecular biology of *Rhizobium* infection (molecular mechanisms in symbiosis), Programmed cell death in development and defense.

Suggested Readings

Buchanan B, Gruissen W & Jones R. 2000. *Biochemistry and Molecular Biology of Plants*. American Society of Plant Physiologists, USA.

Lewin B. 2008. *Gene IX*. Peterson Publications/ Panima.

Malacinski GM & Freifelder D. 1998. *Essentials of Molecular Biology*. 3rd Ed. Jones & Bartlett Publ.

Nelson DL & Cox MM. 2007. *Lehninger's Principles of Biochemistry*. WH Freeman & Co.

Watson JD, Bakee TA, Bell SP, Gann A, Levine M & Losick R. 2008. *Molecular Biology of the Gene*. 6th Ed. Pearson Edu.

MBB 602   **ADVANCES IN GENETIC ENGINEERING**   **3+0**   **SEM – I**
(Pre-requisite MBB 501)

Objective

To discuss the specialized topics and advances in field of genetic engineering and their application in plant improvement.

Theory

UNIT-I: General overview of transgenic plants; Case studies: Genetic engineering of herbicide resistance, Transgenic plants resistant to insects/pests, Genetic engineering of abiotic stress tolerance, Engineering food crops for quality, Genetically engineered pollination control, Induction of male sterility in plants.

UNIT-II: Molecular farming of plants for applications in veterinary and human medicine systems: Boosting heterologous protein production in transgenics, Rapid production of specific vaccines, High-yield production of therapeutic proteins in chloroplasts.

UNIT-III: Recent developments in plant transformation strategies; Role of antisense and RNAi-based gene silencing in crop improvement; Regulated and tissue-specific expression of transgenes for crop improvement; Gene stacking; Pathway engineering; Marker-free transgenic development strategies; High throughput phenotyping of transgenic plants.

UNIT-IV: Field studies with transgenic crops; Environmental issues associated with transgenic crops; Food and feed safety issues associated with transgenic crops; Risk assessment of transgenic food crops.

Suggested Readings

Christou P & Klee H. 2004. *Handbook of Plant Biotechnology*. John Wiley & Sons.

Specific journals mentioned later.

MBB 603   **ADVANCES IN MICROBIAL**   **3+0**   **SEM - II**
      BIOTECHNOLOGY
(Pre-requisite MBB 501)

Objective

To discuss specialized topics about industrially important microorganisms.

Theory

UNIT-I: Fermentative metabolism and development of bioprocessing technology, processing and production of recombinant products; isolation, preservation and improvement of industrially important microorganisms.

UNIT-II: Immobilization of enzymes and cells; Batch, plug flow and chemostate cultures; Computer simulations; Fed-batch and mixed cultures; Scale-up principles; Down stream processing etc.

UNIT-III: Current advances in production of antibiotics, vaccines, and biocides; Steroid transformation; Bioreactors; Bioprocess engineering; Production of non-microbial origin products by genetically engineered microorganisms.

UNIT-IV: Concept of probiotics and applications of new tools of biotechnology for quality feed/food production; Microorganisms and proteins used in probiotics; Lactic acid bacteria as live vaccines; Factors affecting delignification; Bioconversion of substrates, anti-nutritional factors present in feeds; Microbial detoxification of aflatoxins; Single cell protein, Bioinsecticides; Biofertilizers; Recent advances in microbial biotechnology.

Suggested Readings

Specific journals and published references.

MBB 604/	**ADVANCES IN CROP BIOTECHNOLOGY**	**3+0**	**SEM – I**

(Pre-requisite MBB 501)

VSC604/
FLA 605

Objective

To discuss specialized topics on the application of molecular tools in breeding of specific crops.

Theory

UNIT-I: Conventional versus non-conventional methods for crop improvement; Present status and recent developments on available tissue culture, transformation, molecular marker and genomic tools for crop improvement.

UNIT-II: Genetic engineering for resistance against abiotic (drought, salinity, flooding, temperature, etc) and biotic (insect pests, fungal, viral and bacterial diseases, weeds, etc) stresses; Genetic Engineering for increasing crop productivity by manipulation of photosynthesis, nitrogen fixation and nutrient uptake efficiency; Genetic engineering for quality improvement (protein, essential amino acids, vitamins, mineral nutrients, etc); edible vaccines, etc.

UNIT-III: Molecular breeding: constructing molecular maps; integrating genetic, physical and molecular maps; diversity assessment and phylogenetic analysis; molecular tagging of genes/traits; selected examples on marker assisted selection of qualitative and quantitative traits.

UNIT-IV: Discussion on application of molecular, transformation and genomic tools for the genetic enhancement in some major cereal, legume, oilseed, vegetable and horticultural crops.

Suggested Readings

Specific journals and published references.

MBB 605/	**ADVANCES IN FUNCTIONAL GENOMICS,**	**3+0**	**SEM - II**
BIOCHEM 606/	**PROTEOMICS AND METABOLOMICS**		
PP 602			

(Pre-requisite MBB 501)
(To be taught jointly by Molecular Biology & Biotechnology,
Biochemistry, Plant Physiology)

Objective

To discuss recent advances and applications of functional genomics and proteomics in agriculture, medicine and industry.

Theory

UNIT-I: Genome sequencing and functional genomics; Human, animal, plant, bacterial and yeast genome projects; genome annotation; *ab initio* gene discovery; functional annotation and gene family clusters; etc.

UNIT-II: Functional analysis of genes; RNA-mediated interference; gene knockoffs; Gene traps/ T-DNA insertion lines; homologous recombination; microarray profiling; SAGE; SNPs/variation; yeast-two hybrid screening; gene expression and transcript profiling; EST contigs; EcoTILLING; allele/gene mining; synteny and comparative genomics; Genome evolution, speciation and domestication etc.

UNIT-III: Proteomics: protein annotation; protein separation and 2D PAGE; mass spectroscopy; protein microarrays; protein interactive maps; structural proteomics: protein structure determination, prediction and threading, software and data analysis/ management, etc.

UNIT-IV: Metabolic pathway engineering, Discussion on selected papers on functional genomics, metabolomics, proteomics, integrative genomics etc.

Suggested Readings

Specific journals and published references.

MBB 606   **COMMERCIAL PLANT TISSUE CULTURE**   **2+0**   **SEM – I**
(Pre-requisite MBB 501)

Objective

To discuss the commercial applications of plant tissue culture in agriculture, medicine and industry.

Theory

UNIT-I: Micropropagation of commercially important plant species; plant multiplication, hardening, and transplantation; genetic fidelity; scaling up and cost reduction; bioreactors; synthetic seeds; management and marketing.

UNIT-II: Production of useful compounds via biotransformation and secondary metabolite production: suspension cultures, immobilization, examples of chemicals being produced for use in pharmacy, medicine and industry.

UNIT-III: Value-addition by transformation; development, production and release of transgenic plants; patent, bio-safety, regulatory, environmental and ethic issues; management and commercialization.

UNIT-IV: Some case studies on success stories on commercial applications of plant tissue culture. Visits to some tissue culture based commercial units/industries.

Suggested Readings

Specific journals and published references.

MBB 607/   **ADVANCES IN ANIMAL BIOTECHNOLOGY**   **2+0**   **SEM - II**
ABT707   (To be taught by Animal Biotechnology)
(Pre-requisite MBB 501)

Objective

Intended to provide cutting edge knowledge on advances in different areas of animal biotechnology.

Theory

UNIT-I: Advances in animal cell culture technology, suspension culture technology, advances in commercial scale productions of mammalian cells.

UNIT-II: Advances in cell cloning and cell hybridization, advances in monoclonal antibody production technology, Advances in diagnostic technology, Computational vaccinology, reverse genetics based vaccines.

UNIT-III: Advances in embryo manipulation, knock out and knock in technology, advances in animal cloning technology, stem cell technology, Advances in development of animal models for human diseases using transgenic animal technology.

UNIT-IV: Advances in genetic basis for animal disease resistance, Molecular methods for animal forensics, Advances in animal genomics, proteomics.

Suggested Readings

Selected articles from journals.

PLANT MOLECULAR BIOLOGY & BIOTECHNOLOGY

List of Journals

- Advances in Botanical Research
- Advances in Enzyme Regulation
- Advances in Enzymology
- Advances in Genetics
- Agricultural and Biological Research
- Analytical Biochemistry
- Annals of Botany
- Archives of Biochemistry and Biophysics
- Archives of Microbiology
- Biochemical and Biophysical Research Communication
- Biochemical Genetics
- Biochemistry
- Biotechnology and Bioengineering
- Critical Reviews in Plant Sciences
- Crop Science
- EMBO Journal
- Euphytica
- Genetic and Plant Breeding
- Genome
- Indian Journal of Genetics and Plant Breeding
- Journal of Biotechnology
- Journal of Experimental Botany
- Journal of General Microbiology
- Journal of Heredity
- Journal of Plant Biochemistry and Biotechnology
- Journal of Plant Biology
- Molecular and Cellular Biochemistry
- Molecular Breeding
- Molecular Genetics and Genomics
- Nature
- Nature Biotechnology
- Plant Cell
- Plant Molecular Biology
- Plant Physiology
- Plant Physiology and Biochemistry
- Proceedings of The National Academy of Sciences (USA)
- Science
- Trends in Biochemical Sciences
- Trends in Biotechnology
- Trends in Cell Biology
- Trends in Food Science and Technology
- Trends in Genetics
- Trends in Microbiology
- Trends in Plant Sciences

e-Resources

- National Center for Biotechnology Information
  - http://www.ncbi.nlm.nih.gov/
- The World Wide Web Virtual Library: Biotechnology.
  - http://www.cato.com/biotech/

- The Transgenic/Targeted Mutation Database (TBASE)
  - http://www.bis.med.jhmi.edu/Dan/tbase/tbase.html
- Primer on Molecular Genetics
  - http://www.bis.med.jhmi.edu/Dan/DOE/intro.html.
- Bioportal
  - http://bioportal.gc.ca/english/BioPortalHome.asp
- Access Excellence
  - http://www.gene.com/ae
- BioTech Biosources Database: Indiana University
  - http://biotech.chem.indiana.edu/
- Information Systems for Biotechnology
  - http://gophisb.biochem.vt.edu/
- All About The Human Genome Project (HGP)
  - http://www.genome.gov/
- *Human Genome Project at the Sanger Institute*
  - http://www.sanger.ac.uk/HGP/
- UCSC Genome Browser
  - http://genome.ucsc.edu/
- Gramene
  - www.gramene.org/
- The Institute for Genomic Research
  - www.tigr.org

Suggested Broad Topics for Master's and Doctoral Research

- Micropropagation of important crop plants, cash crops, ornamentals, forest and horticultural trees, medicinal and aromatic plants.
- Development of transgenics in field crops for resistance against biotic and abiotic stresses, and to improve the nutritional quality, etc.
- DNA fingerprinting of important plant species and germplasm.
- Development of molecular markers (SNP, SSR, transposable elements, etc) and their utilization for genetic diversity and phylogenetic analysis.
- Molecular mapping and marker-assisted selection for major-gene traits in crop species.
- Value-addition including biopesticides, biofertilizers, biofuels, biodegradable plastics, secondary metabolites, etc.
- Genome sequencing and functional analysis of genes of important organisms.
- Allele mining, proteomics, genomics and metabolic engineering for crop improvement.
- Immobilization of enzymes/microorganisms.
- Protein engineering.
- To develop crops with improved mineral (Fe, Zn, Vitamin A, etc) bioavailbility.
- Biodiversity and conservation of endangered plant species.
- Bioprocess engineering and down stream processing.