PLANT MOLECULAR BIOLOGY AND BIOTECHNOLOGY
Course Structure –at a Glance

CODE	COURSE TITLE	CREDITS
MBB 501*	PRINCIPLES OF BIOTECHNOLOGY	2+1
MBB 502*	FUNDAMENTALS OF MOLECULAR BIOLOGY	3+0
MBB 503*	MOLECULAR CELL BIOLOGY	3+0
MBB 504	PLANT TISSUE CULTURE & GENETIC TRANSFORMATION	2+1
MBB 505*	TECHNIQUES IN MOLECULAR BIOLOGY 1	0+3
MBB 506	MICROBIAL/INDUSTRIAL BIOTECHNOLOGY	2+1
MBB 507	MOLECULAR MARKERS IN CROP IMPROVEMENT	2+1
MBB 508	GENOMICS & PROTEOMICS	2+0
MBB 509	TECHNIQUES IN MOLECULAR BIOLOGY II	0+3
MBB 510	BIOSAFETY, IPR AND BIOETHICS	2+0
MBB 511	ANIMAL BIOTECHNOLOGY	3+0
MBB 512	IMMUNOLOGY AND MOLECULAR DIAGNOSTICS	2+1
MBB 513	NANO-BIOTECHNOLOGY	3+0
MBB 552 LINKED TO BIOCHEM 501	GENERAL BIOCHEMISTRY	3+0
MBB 553 LINKED TO STAT 511	BIOSTATISTICS AND COMPUTERS/STATISTICAL METHODS FOR APPLIED SCIENCES	2+1
MBB 554	PRINCIPLES OF MICROBIOLOGY	3+1
MBB 555	INTRODUCTION TO BIOINFORMATICS	1+1
MBB 556	ENVIRONMENTAL BIOTECHNOLOGY	3+0
MBB 557	PLANT MOLECULAR GENETICS	2+1
MBB 558	ENZYMOLOGY	1+1
MBB 591	MASTER'S SEMINAR	1+0
MBB 599	MASTER'S RESEARCH	20
MBB 601	ADVANCES IN PLANT MOLECULAR BIOLOGY	3+0
MBB 602	ADVANCES IN GENETIC ENGINEERING	3+0
MBB 603	ADVANCES IN MICROBIAL BIOTECHNOLOGY	3+0
MBB 604	ADVANCES IN CROP BIOTECHNOLOGY	3+0
MBB 605	ADVANCES IN FUNCTIONAL GENOMICS AND PROTEOMICS	2+0

CODE	COURSE TITLE	CREDITS
MBB 606	COMMERCIAL PLANT TISSUE CULTURE	2+0
MBB 607	ADVANCES IN ANIMAL BIOTECHNOLOGY	2+0
MBB 608	BIOTECHNOLOGY IN BIODIVERSITY	2+0
MBB 609	TECHNIQUES IN MOLECULAR BIOLOGY II	0+2
MBB 610	ANALYTICAL METHODS IN BIOTECHNOLOGY	2+1
MBB 611	ADVANCES IN BIOINFORMATICS	1+1
MBB 691	DOCTORAL SEMINAR I	1+0
MBB 692	DOCTORAL SEMINAR II	1+0
MBB 699	DOCTORAL RESEARCH	45

* Compulsory for M.Sc. Programme

** Compulsory for Ph.D programme

Minor Departments **9**

Genetics and Plant Breeding

Biochemistry

Statistics

Supporting Departments **5**

Biotechnology

Non credit compulsory courses

CODE	COURSE TITLE	CREDITS
PGS 501	LIBRARY AND INFORMATION SERVICES	0+1
PGS 501	LIBRARY AND INFORMATION SERVICES	0+1
PGS 502	TECHNICAL WRITING AND COMMUNICATION SKILLS	0+1
PGS 503 (e-course)	INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE	1+0
PGS 504	BASIC CONCEPTS IN LABORATORY TECHNIQUES	0+1
PGS 505 (e-course)	AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES	1+0
PGS 506 (e-course)	DISASTER MANAGEMENT	1+0

MBB 501 PRINCIPLES OF BIOTECHNOLOGY 2+1

Objective

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

Unit I

History, scope and importance: DNA structure, function and metabolism, C values and plant genomes, Repetitive and coding sequences

Unit II

Restriction enzymes, DNA modifying enzymes, Vectors, Methods of recombinant DNA technology, Nucleic acid hybridization, Gene libraries, DNA cloning, Applications of rDNA technology

Unit III

Introduction to Molecular markers, Nucleic acid hybridization and RFLP marker, CR based markers (RAPDS, ISSR, SCAR, SSR), AFLP, Single Nucleotide Polymorphism (SNPs), DNA sequencing – methods, Automatic sequencing methods, Genetic engineering and transgenics, Genomics, transcriptomics and proteomics

Unit IV

General application of biotechnology in Agriculture, Medicine, Animal husbandry, Environmental remediation, Energy production and Forensics

Practical

Isolation of genomic and plasmid DNA, Gel electrophoresis techniques, Restriction enzyme digestion, ligation, transformation and screening of transformants, PCR and molecular analysis.

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 Pub.

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

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 Publications.

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 Publishers.

MBB 502 Fundamentals of Molecular Biology 3+0

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; Chromatin structure and function; DNA replication; DNA polymerases, topoisomerases, DNA ligase, etc; Molecular basis of mutations; DNA repair mechanisms.

Unit III

Transcription process; RNA processing; Reverse transcriptase; RNA editing; Ribosomes structure and function; Organization of ribosomal proteins and RNA genes; Genetic code; Aminoacyl tRNA synthases.

Unit IV

Translation and post-translational modifications; Operon concept; Attenuation of *trp* operon; important features of gene regulation in eukaryotes.

Suggested Readings

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

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

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

W.H. Freeman & Co.

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 Education International.

MBB 503 MOLECULAR AND CELL BIOLOGY 3+0

Objective

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

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.

Alberts B et al; Molecular Biology of the Cell; 4th Ed.

MBB 504 PLANT TISSUE CULTURE AND GENETIC TRANSFORMATION 2+1

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 cloning and vector construction, 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 BIOLOGY -I 0+3

Objective

To provide hands on training on basic molecular biology techniques.

Unit I

Good lab practices; Biochemical techniques: Preparation of buffers and reagents, Principle of centrifugation, Chromatographic techniques (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

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 MICROBIAL/INDUSTRIAL BIOTECHNOLOGY 2+1

Objective

To familiarize about the various microbial processes/systems/activities, which have been used for the development of industrially important products/processes.

Theory

UNIT I

Introduction, scope and historical developments; Isolation, screening and genetic improvement (involving classical approaches) of industrially important organisms.

UNIT II

Primary metabolism products, production of industrial ethanol as a case study; Secondary metabolites, bacterial antibiotics and non ribosomal peptide antibiotics; Recombinant DNA technologies for microbial processes; Strategies for development of industrial microbial strains with scale up production capacities; Metabolic pathway engineering of microbes for production of novel product for industry.

UNIT III

Microbial enzymes, role in various industrial processes, production of fine chemicals for pharmaceutical industries; Bio-transformations, Bioaugmentation with production of vitamin C as a case study; Bioreactors, their design and types; Immobilized enzymes based bioreactors; Microencapsulation technologies for immobilization of microbial enzymes.

UNIT IV

Industrial biotechnology for pollution control, treatment of industrial and other wastes, biomass production involving single cell protein; Bioremediation of soil; Production of eco-friendly agricultural chemicals, biopesticides, bio-herbicides, 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, Experiments on microbial fermentation process, Harvesting purification and recovery of end products., Immobilization of cells and enzymes, Studies on its kinetic behavior, Growth analysis and biomass estimation, Determination mass transfer co-efficients.

Suggested Readings

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.

MBB 507 MOLECULAR MARKERS IN CROP IMPROVEMENT 2+1

Theory

Unit I

DNA marker techniques, PCR and hybridization based methods, Methods of physical mapping – Restriction mapping, DNA fingerprinting and foot printing methods, Southern, Northern and Western Hybridizations, ESTs,

Unit II

Development of sequence based molecular markers - SSRs and SNPs; Advanced methods of genotyping; Mapping genes for qualitative and quantitative traits. Principles of Genetic linkage map construction, Relation between Genetic maps and physical maps

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.

Practicals

Extraction of DNA and quantitation, Restriction Digestion of Genomic DNA, Southern transfer, RFLP Southern Hybridization: Washing of Blots and autoradiography Filter stripping and reuse of the blot, Western blotting, PCR amplification of insert DNA for using as RFLP probe, RAPDs with two arbitrary primers, Set up the PCR reaction with SSR primers, Purity testing of hybrids with mol markers, MAS for BLB resistance, Genotyping and phenotyping data collection, Use of various software like NTSys for data analysis

Suggested Readings

G. Caetano-Anolles and P.M. Gresshoff . DNA Markers, Wiley

R.L. Philips and I.K. Vasil. DNA-based markers in plants, Kluwer

K.Weising, H.Nybom, K.Wolff and W.Meyer. DNA Fingerprinting in plants and fungi, CRC

H.J. Newbury. Plant Molecular Breeding, Blackwell

P.Christou and H.Klee. Handbook of Plant Biotechnology vols 1 & 2, Wiley

MBB 508 GENOMICS AND PROTEOMICS 2+0

Objective

To familiarize the students with recent tools used for genome analysis and their applications.

Theory

UNIT I

Structural genomics: Classical ways of genome analysis, large fragment, genomic libraries; Physical mapping of genomes; Genome sequencing, sequence assembly and annotation; Comparative genomics, etc.

UNIT II

Functional genomics: DNA chips and their use in transcriptome analysis; Mutants and RNAi in functional genomics; Metabolomics and ionomics for elucidating metabolic pathways, etc.

UNIT III

Proteomics - Protein structure, function and purification; Introduction to basic proteomics technology; Bio-informatics in proteomics; Proteome analysis, etc.

UNIT IV

Applications of genomics and proteomics in agriculture, human health and industry.

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 Education.

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 BIOLOGY-II 0+3

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

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 non-radio 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

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-spliting, 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 18 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 MOLECULAR DIAGNOSTICS 2+1

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 chemistry, structure and functions; Molecular organization of immunoglobulins and classes of antibodies.

UNIT II

Antibody diversity; antigens, haptens, antigens- antibody interactions; immuno-regulation and tolerance; Allergies and hypersensitive response; Immunodeficiency; Vaccines; Immunological techniques.

UNIT III

Immunological application in plant science, monoclonal antibodies and their uses, molecular diagnostics. Introduction to the basic principles of molecular technology and techniques used in pathogen detection, Principles of ELISA and its applications in viral detection.

UNIT IV

Basics and procedures of PCR, Real time 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, Immunoblotting, immunoelectrophoresis and fluorescent antibody test, Enzyme immunoassays including ELISA western blotting, Extraction and identification of DNA/RNA of pathogenic organisms, Restriction hybridoma technique and production of monoclonal antibodies, Immunogenic proteins, expression and immunogenecity studies, Purification of immunogenic protein and immunization of laboratory animals.

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

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 552 BASIC BIOCHEMISTRY 2+1

Theory

Unit I

Scope and importance of biochemistry in agriculture; Fundamental principles governing life; structure of water; 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 and biomembranes, amino acids, proteins, and nucleic acids.

Unit III

Structure and biological functions of vitamins, enzymes classification and mechanism of action; regulation, factors affecting enzyme action. Fundamentals of thermodynamic principles applicable to biological processes, Bioenergetics.

Unit IV

Metabolism of carbohydrates, photosynthesis and respiration, oxidative phosphorylation, lipids, proteins and nucleic acids, Secondary Metabolites – origin, functions and metabolism

Practical

Preparation of standard and buffer solutions, Extraction and estimation of sugars and amino acids, Estimation of proteins by Lowry's method., Estimation of DNA and RNA by Diphenylamine and orcinol methods, Estimation of ascorbic acid, Separation of biomolecules by TLC and paper chromatography.

Suggested Readings

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

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

Nelson DL & Cox MM. 2004. *Lehninger's Principles of Biochemistry* MacMillan.

Voet D & Voet JG. *Biochemistry*. 3rd Ed. Wiley International.

STAT 511 STATISTICAL METHODS FOR APPLIED SCIENCES 2+1

Theory

UNIT I

Classification, tabulation and graphical representation of data. Box-plot, Descriptive statistics. Exploratory data analysis; Theory of probability. Random variable and mathematical expectation.

UNIT II

Discrete and continuous probability distributions: Binomial, Poisson, Negative Binomial, Normal distribution, Beta and Gamma distributions and their applications. Concept of sampling distribution: chi-square, *t* and *F* distributions. Tests of significance based on Normal, chi-square, *t* and *F* distributions. Large sample theory.

UNIT III

Introduction to theory of estimation and confidence-intervals. Correlation and regression. Simple and multiple linear regression model, estimation of parameters, predicted values and residuals, correlation, partial correlation coefficient, multiple correlation coefficient, rank correlation, test of significance of correlation coefficient and regression coefficients. Coefficient of determination. Polynomial regression models and their fitting. Probit regression analysis by least squares and maximum likelihood methods, confidence interval for sensitivity; Testing for heterogeneity.

UNIT IV

Non-parametric tests - sign, Wilcoxon, Mann-Whitney U-test, Wald Wolfowitz run test, Run test for the randomness of a sequence. Median test, Kruskal- Wallis test, Friedman two-way ANOVA by ranks. Kendall's coefficient of concordance.

UNIT V

Introduction to multivariate analytical tools- Hotelling's T2 Tests of hypothesis about the mean vector of a multinormal population. Classificatory problems and discriminant function, D2-statistic and its applications; Cluster analysis, principal component analysis, canonical correlations and Factor analysis.

Practical

Exploratory data analysis, Box-Cox plots; Fitting of distributions ~Binomial, Poisson, Negative Binomial, Normal;, Large sample tests, testing of hypothesis based on exact sampling distributions ~ chi square, t and F, Confidence interval estimation and point estimation of parameters of binomial, Poisson and Normal distribution, Correlation and regression analysis, fitting of orthogonal polynomial regression; applications of dimensionality reduction and discriminant function analysis; Nonparametric tests.

Suggested Readings

Anderson TW. 1958. *An Introduction to Multivariate Statistical Analysis*.

John Wiley.

Dillon WR & Goldstein M. 1984. *Multivariate Analysis - Methods and* 15 *Applications*. John Wiley.

Goon AM, Gupta MK & Dasgupta B. 1977. *An Outline of Statistical Theory*. Vol. I. The World Press.

Goon AM, Gupta MK & Dasgupta B. 1983. *Fundamentals of Statistics*.

Vol. I. The World Press.

Hoel PG. 1971. *Introduction to Mathematical Statistics*. John Wiley.

Hogg RV & Craig TT. 1978. *Introduction to Mathematical Statistics*.

Macmillan.

Morrison DF. 1976. *Multivariate Statistical Methods*. McGraw Hill.

Siegel S, Johan N & Casellan Jr. 1956. *Non-parametric Tests for Behavior Sciences*. John Wiley.

Learning Statistics: http://freestatistics.altervista.org/en/learning.php.

Electronic Statistics Text Book:

http://www.statsoft.com/textbook/stathome.html

MBB 553 BIOSTATISTICS AND COMPUTERS 2+1

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, ÷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.

MBB 554 PRINCIPLES OF MICROBIOLOGY 2+1

Objective

To acquaint the students with history, classification and role of microbiology in agriculture, food and environment.

Theory

UNIT I

Development of Microbiology in the 18th and 19th century. Morphology, structure and function of prokaryotic and eukaryotic cell. Archea. Classification of prokaryotes – Basic principles and techniques used in bacterial classification.

UNIT II

Evolutionary relationship among prokaryotes. Phylogenetic and numerical taxonomy. Use of DNA and r-RNA sequencing in classifications.

UNIT III

Study of major groups of bacteria belonging to Gracilicutes, Firmicutes, Tanericutes and Mendosicutes.

UNIT IV

Viruses – morphology, classification and replication of plant, animal and bacterial viruses. Cultivation methods of viruses. Immune response – specific and non-specific resistance. Normal microflora of human body; some common bacterial and viral diseases of humans and animals.

Practical

Methods of isolation, purification and maintenance of microorganisms from different environments (air, water, soil, milk and food). Enrichment culture technique – isolation of asymbiotic, symbiotic nitrogen fixing bacteria. Isolation of photosynthetic bacteria, Use of selective media, antibiotic resistance and isolation of antibiotic, producing microorganisms. Morphological, physiological and biochemical characterization of bacteria.

Suggested Readings

Brock TD. 1961. *Milestones in Microbiology*. Infinity Books.

Pelczar ML Jr. 1997. *Microbiology*. Tata McGraw Hill. 23

Stainier RY, Ingraham JL, Wheelis ML & Painter PR. 2003. *General Microbiology*. MacMillan.

Tauro P, Kapoor KK & Yadav KS. 1996. *Introduction to Microbiology*.

Wiley Eastern.

MBB 555 INTRODUCTION TO BIOINFORMATICS 1+1

Theory

Unit I

Introduction, biological databases – Introduction to protein primary structure, secondary structure , Protein structural domains, Ramachandran Plot, Protein structure prediction and modeling, Docking l, Protein and Gene Information Resources – PIR, SWISSPROT, PDB, GenBank, 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

Molecular phylogenetics, Molecular clock hypothesis, Building dendrograms, Computer aided drug design, computer aided drug design – basic principles, QSAR.

Unit IV

Analysis packages –PHYLIP, Primer design, 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 Education.

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

D.W. Mount, Bioinformatics: Sequence and Genome Analysis by Bioinformatics: Sequence and Genome Analysis, CSHL

BMB 556 ENVIRONMENTAL BIOTECHNOLOGY 3+0

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, 24 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 557 PLANT MOLECULAR GENETICS 2+1

Theory

Unit I

Model systems for understanding molecular genetics- Molecular basis of Mendelian inheritance- Molecular events in cell division- Genome organization in prokaryotes and eukaryotes- Development of gene concept- Gene interactions and biosynthetic pathways- Fine structure analysis of gene

Unit II

Molecular basis of crossing over and genetic recombination- Mechanisms of gene transfer in bacteria- Gene mapping in prokaryotes and eukaryotes- Molecular basis of mutagenesis- DNA repair mechanisms- Molecular basis of structural and numerical chromosomal aberrations

Unit III

Transposable genetic elements in prokaryotes and eukaryotes- Molecular basis of qualitative and quantitative inheritance- Molecular basis of cytoplasmic inheritance- Molecular basis of heterosis-Transfer of genetic information and expression

Unit IV

Regulation of gene expression in prokaryotes and eukaryotes- Differential regulation of gene expression in eukaryotes-Genetics of populations- Molecular changes underlying evolution

Practical

Chromosome staining and visualization by simple microscope and electron microscope, Events in mitosis and meiosis; Problems on Mendelian genetics ; Isolation of genomic and plasmid DNA; Digestion of DNA with restriction enzymes and resolution of fragments by electrophoresis; Construction of recombinant plasmid; Measurement of growth rate; Bacterial transformation; Selection of recombinants; Use of Lambda vector for cloning; Different types of molecular markers - RAPD, RFLP, SSRs, etc.

Suggested Readings

B.D. Singh, *Molecular Genetics*, Kalyani Publishers, New Delhi.

Strickberger MW L.H., *Genetics 3/e,* Prentice Hall.

Hartwell, L.Hood, M.L.Goldberg, A.E. Reynolds, L.M. Silver and R.C. Veres, *Genetics: From Genes to Genomes,* McGraw Hill

B.Lewin, *Genes IX*, Pearson Publishers

MBB 558 ENZYMOLOGY 1 +1

Theory

Unit I

Enzyme nomenclature and classification, General properties of enzymes like effect of pH, temperature ions, etc., Extraction, assay and purification of enzymes

Unit II

Steady state kinetics, Michaelis-Menten, Lineweaver-Buke, Eeadie –Hofstee and Hanes - Wolf equations

Unit III

Enzyme inhibitors, Pre-steady state kinetics, Enzyme specificity, Evidences for enzyme-substrate complexes, Nucleophilic and electrophilic attacks, Role of metal ions in enzyme catalysis, Mechanism of enzyme action e.g. Lysozyme, chymotrypsin, DNA polymerases, RNase, etc., Zymogen and enzyme activation

Unit IV

Allosteric interactions and product inhibition, Enzyme induction and repression, Membrane bound enzymes, Chemical nature and organization – isozymes – catalysis, Chemical and industrial application of enzymes, Immobilization of enzymes and their applications, Ribozymes and their applications, Enzyme engineering , Biotechnology of enzymes – Medical, industrial and analytical application of enzymes, Abzymes

Practicals

Enzyme preparation- purification procedures; Experiments on kinetics – effect of pH, and temperature; Determination of V_{max} and K_m ; Detection of isozymes on gel by staining(3) Nitrate reductase activity determination; Assay of Glutamate dehydrogenase/Urease/Alkaline phosphatase; Enzyme immobilization methods

Suggested Readings

Bergmeyer HU. 1983. *Method of Enzymatic Analysis Vol.II*, Verlag Chemie, Academic Press, NY

R.A. Copland Enzymes, Wiley VCH

Fundamentals of Enzymology, N.C. Price C.L.Stevens, Oxford

Biochemistry 5th, Berg JM, Tymoczko JL, Stryer L & Clarke ND - 2000. W.H. Freeman & Co.

MBB 601 ADVANCES IN PLANT MOLECULAR BIOLOGY 3+0

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.

MBB 602 ADVANCES IN GENETIC ENGINEERING 3+0

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 BIOTECHNOLOGY 3+0

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

Theory

Unit I

Conventional versus non-conventional methods for crop improvement; Present status and recent developments on available molecular marker, transformation 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 field crops such as rice, wheat, cotton, maize, soybean, oilseeds, sugarcane etc.

Suggested Readings

Specific journals and published references.

MBB 605 ADVANCES IN FUNCTIONAL GENOMICS AND PROTEOMICS 2+0

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

Discussion on selected papers on functional genomics, proteomics, integrative genomics etc.

Suggested Readings

Specific journals and published references.

MBB 606 COMMERCIAL PLANT TISSUE CULTURE 2+0

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

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.

MBB 608 BIOTECHNOLOGY IN BIODIVERSITY 2+0

Theory

Unit I

Plant Genetic resources (PGR) and their importance – Agrobiodiversity and centres of origin – Primary and secondary centres, base for reconstruction and reconstellation of new cultivars – exploration and collection –exploration missions- importance of explorations and case studies , Collection: Patterns of variation and genetic makeup Entering the collected material in gene banks, Handling the site data – Conservation : ex situ conservation, gene pool establishment, in situ conservation, conservation of wild relatives and land races, community based plant conservation, participatory conservation methods,

Unit II

Methods of crop diversity analysis, Characterization- taxonomic, using plant descriptors, biochemical, using isozymes and DNA markers, DNA fingerprinting methods, Utilization- types of collection- PGR exchange, national and international formalities ,

Unit III

MTA, primary and secondary evaluations, crop genetic resources network; International and National, Role of IARCs in PGR conservation, CBD and Caratgena protocol on Biodiversity, National Biodiversity Board and Act, Economic evaluation of biodiversity

Unit IV

Conservation and biodiversity assessment- IPR- issues and concerns, implications of WTO, GATTT and TRIPS , PVR and CBD on PGR, Comparison of plant protection/registration system across the world, SWOT of Indian act, Transgenics and conservation and evaluation,

Suggested Readings

K V Krishnamurthy. An advanced text book on biodiversity, principles and practice: Oxford & IBH Publ.

K C Agrawal .Biodiversity, Agrobios-India

Tangadurai D & T Pullaiah. Genetic resources and biotechnology

Lindsey A. Biotechnology and Plant genetic resources:

Agrawal. Biodiversity:

MBB 609 TECHNIQUES IN MOLECULAR BIOLOGY-II 0+2

Practical

Unit I

Methods of DNA isolation, Construction of gene libraries; Synthesis of cDNA and cloning methods, Construction of dendrograms based on similarity matrix

Unit II

Molecular markers (RAPD, SSR, AFLP etc) and their analysis; Case study of SSR markers, Use of NTSys software, DNA star and Biosuite software for DNA sequence analysis.

Unit III

Genotyping and phenotyping for linkage map and QTL analysis etc; Software for linkage map and QTL analysis, SNP identification and analysis,

Unit IV

High througput analysis for genotyping using SSRs, Automated DNA sequencing, Basics of Proteomics, Basics of RT PCR and microarray analysis.

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 610 ANALYTICAL METHODS IN BIOTECHNOLOGY 2 + 1

Theory

Unit I

Beer-Lambert law and Spectrophotometry, Flourimetry, Principles of centrifugation - Sedimentation principle and analysis, Ultracentrifugation methods- Cs Cl gradient centrifugation, Setting up of sucrose gradients for centrifugation, Optical rotation and polarimetry, ORD and CD,

Unit II

Principles and Methods of chromatography, affinity chromatography, Gas liquid chromatography(GLC), HPLC, Gel Filtration, Ultra filtration, Principles of Electrophoresis, Pulse Field Gel Electrophoresis, Dialysis, Lyophilization, Flourescence *in situ* hybridization (FISH),

Unit III

Basic aspects of Oligonucleotide synthesis, peptide synthesis, DNA and protein sequencing methods, PCR and Real time PCR, Differential display and subtractive DNA hybridization studies, Basics of Cell sorting

Unit IV

Basics of radioactivity and autoradiography, Safety aspects of radiation, Principles of ELISA and Monoclonal Ab production, Electron Microscopy.

Practical

1. Verification of Beer-Lambert law using spectrophotometer, Subcellular fractionation procedure - Isolation of nuclei, chloroplasts and mitochondria, Identification of the cell organelle, and products of plant cells (2), DNA isolation and quantitation, PCR Methods, ELISA, Microscopy: simple and compound, phase contrast and Electron Microscopy, Affinity chromatography (2), DNA hybridization

Suggested Readings:

New developments to be downloaded from the internet.

MBB 611 ADVANCES IN BIOINFORMATICS 1+1

Theory

Unit I

Bioinformatics and computing for innovative scientific discovery, Data application and management, Databases in biology – DNA and Proteins, BLAST, Multiple sequence alignment, Similarity index

Unit II

Sequencing genomes: physical mapping, genome structure, genome annotation including gene finding tools, understanding the cell / organisms: regulatory pathways and networks, simulations,

Unit III

Molecular Phylogenetic: relations between organisms and evolutionary questions, Phylogenetic trees, Construction of dendrograms, computational models of evolution, Biomolecular computing: DNA Structures, Genome annotation, Gene finding software

Unit IV

Protein structures, protein folding, inverse folding, molecular mechanics,Ramachandran plot, docking Pair-wise alignment, similarity searches, multiple sequence alignment, pattern discovery (motifs etc.), Primer designing, Gene Expression Analysis, HMMs , clustering, tree inference

Suggested Readings

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

Pearson Education.

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

D.W. Mount, Bioinformatics: Sequence and Genome Analysis by Bioinformatics: Sequence and Genome Analysis, CSHL

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.

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