DEPARTMENT OF MOLECULAR BIOLOGY AND BIOTECHNOLOGY

PROGRAMMES:

1. M.Sc.(Ag)
2. Ph.D.

COURSE REQUIREMENTS:

M.Sc.

Field of Specialization	Tissue Culture, Molecular Markers, Industrial Biotechnology and Genetic Engineering
Core Courses	MBB 511, MBB 512 MBB 513 and MBB 523
Optional Courses	MBB 521, MBB 522, MBB 524, MBB 525,MBB 526, MBB 531, MBB 532, MBB 533, MBB 534, MBB 535, MBB 536, MBB 541, MBB 591
Minor & Supporting Courses	STAT511, PPHY521, PPHY512, PBG 512 or as per decision of advisory committee in view of research problem.
Non Credit Compulsory Courses	PGS 502,PGS 503
Deficiency Courses	AGRON111, AGRON211, AGRON311, AGRON312, SCHEM 111, HORT 211,PBG211 or as deemed suitable by advisory committee

Ph.D.

Field of Specialization	Tissue Culture, Molecular Markers, Industrial Biotechnology and Genetic Engineering
Core Courses	MBB 611 and MBB 612
Optional Courses	MBB 621, MBB 622, MBB 623, MBB 624, MBB 641, MBB 691, MBB 692
Minor & Supporting Courses	STAT613**,** PPHY621, HORT 625, PBG 622 or as per decision of advisory committee in view of research problem.
Non Credit Compulsory Courses	PGS 502, PGS 503(Exempted if done in M.Sc.)
Deficiency Courses	AGRON111, AGRON211, AGRON311, AGRON312,SCHEM 111, HORT 211, PBG211, HORT 312 or as deemed suitable by advisory committee

Course Structure – At a Glance

S.No.	CODE	COURSE TITLE	CREDITS	SEMESTER/YEAR	REMARKS
M.Sc. Courses					
1.	MBB 511*	PRINCIPLES OF BIOTECHNOLOGY	2+1	I	Core
2.	MBB 512*	FUNDAMENTALS OF MOLECULAR BIOLOGY	3+0	I	Core
3.	MBB 513	MOLECULAR CELL BIOLOGY	3+0	II	Optional
4.	MBB 521	GENERAL BIOCHEMISTRY	2+1	I	Compulsory
5.	MBB 522	PLANT TISSUE CULTURE & GENETIC TRANSFORMATION	2+1	II	Optional
6.	MBB 523*	TECHNIQUES IN MOLECULAR BIOLOGY	1+2	II	Core
7.	MBB 524	GENOMICS & PROTEOMICS	3+0	II	Optional
8.	MBB 525	IMMUNOLOGY AND MOLECULAR DIAGNOSTICS	2+1	II	Optional
9.	MBB 526/ PBG511	PRINCIPLES OF GENETICS	2+1	II	Optional
10.	MBB 531	NANO-BIOTECHNOLOGY	3+0	III	Optional
11.	MBB 532	INTRODUCTION TO BIOINFORMATICS	2+1	III	Optional
12.	MBB 533	ENVIRONMENTAL BIOTECHNOLOGY	3+0	III	Optional
13.	MBB 534	PRINCIPLES OF MICROBIOLOGY	2+1	III	Optional
14.	MBB 535	INDUSTRIAL BIOTECHNOLOGY	2+1	III	Optional
15.	MBB 536	BIOSAFETY, IPR AND BIOETHICS	3+0	III	Optional
16.	MBB 541	COMPREHENSIVE	Non-credit	-	-
17.	MBB 591	MASTER'S SEMINAR	1+0	III	Compulsory
18.	MBB 599	MASTER'S RESEARCH	20	IV	Compulsory
Ph.D. Courses					
1	MBB 611*	ADVANCES IN PLANT MOLECULAR BIOLOGY	3+0	I	Core
2	MBB 612*	ADVANCES IN CROP BIOTECHNOLOGY	3+0	I	Core

3	MBB 621	ADVANCES IN GENETIC ENGINEERING	3+0	II	Optional
4	MBB 622	ADVANCES IN MICROBIAL BIOTECHNOLOGY	2+1	II	Optional
5	MBB 623	COMMERCIAL PLANT TISSUE CULTURE	2+1	II	Optional
6	MBB 624	ADVANCES IN FUNCTIONAL GENOMICS AND PROTEOMICS	3+0	II	Optional
7	MBB 641	COMPREHENSIVE	Non-credit	-	-
8	MBB 691	DOCTORAL SEMINAR I	1+0	III	Compulsory
9	MBB 692	DOCTORAL SEMINAR II	1+0	IV	Compulsory
8	MBB 699	DOCTORAL RESEARCH	45		Compulsory

DESCRIPTION OF COURSES

POSTGRADUATE COURSES:

MBB 511 PRINCIPLES OF BIOTECHNOLOGY (2+1)*

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 and function.

UNIT II - DNA modifying enzymes and vectors; Methods of recombinant DNA technology; Nucleic acid hybridization; Gene libraries; PCR amplification;Plant and animal cell, 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; 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.

Practical

i.Isolation of genomic and plasmid DNA

ii.Gel electrophoresis techniques

iii.Restriction enzyme digestion, ligation, theoretical demonstration of transformation and screening of transformants

iv.PCR and molecular marker analysis

v.Plant tissue culture: media preparation, cell and explant culture, regeneration and transformation.

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 512 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 513 MOLECULAR CELL BIOLOGY (3+0)*

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 521 GENERAL BIOCHEMISTRY (2+1) Compulsory

Objective

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

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. DNA replication, transcription and translation; recombinant DNA technology, Nutritional aspects of carbohydrates, lipids, proteins and minerals.

Practical

i. Preparation of standard and buffer solutions.
ii. Extraction and estimation of sugars and amino acids.
iii Estimation of proteins by Lowry's method.
iv. Estimation of DNA and RNA by Diphenylamine and orcinol methods.
v. Estimation of ascorbic acid.
vi. Separation of biomolecules by TLC and paper chromatography
vii. Demonstration of GLC and HPLC.

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.
Seth P and Khandelwal SK.2008. Biochemical Analysis. Himanshu Publications.
Voet D & Voet JG. Biochemistry. 3rd Ed. Wiley International.

MBB 522 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

i. Laboratory set-up.

ii. Preparation of nutrient media; handling and sterilization of plant material; inoculation, subculturing and plant regeneration.

iii.Anther and pollen culture.

iv. Embryo rescue.

v. Suspension cultures and production of selected secondary metabolites.

vi.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 523 TECHNIQUES IN MOLECULAR BIOLOGY (1+2)

Objective

To provide hands on training on basic molecular biology techniques.

Theory

UNIT I

Purification of proteins by different methods, theory of extraction procedures, centrifugation principles, salting- out salting –in, dialysis, gel filtration, ion-exchange chromatography, electrophoresis, molecular weight determination, western-blotting

UNIT II- Introduction to molecular markers such as RAPD, RFLP, SSR. Dot blot analysis; Southern hybridization; Northern hybridization; Western blotting

Practical

UNIT I

Good lab practices; Biochemical techniques: Preparation of buffers and reagents.Gel electrophoresis- agarose and PAGE (nucleic acids and proteins);

UNIT II

Growth of bacterial culture and preparation of growth curve; Isolation of plasmid DNA from bacteria; Restriction digestion of plasmid DNA; Isolation plant DNA and its purity analysis.

UNIT III

Gene cloning – genetic transformation and selection of transformants; PCR and optimization of factors affecting PCR and RAPD analysis

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 524 GENOMICS AND PROTEOMICS (3+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

General uses and application of Crystallograpgy. enzymes engineering, design and construction of novel enzymes

UNIT V

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 525 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

i. Preparation of buffers and reagents.

ii. Immunoblotting, immunoelectrophoresis and fluorescent antibody test.

iii. Enzyme immunoassays including ELISA western blotting.

iv. Extraction and identification of DNA/RNA of pathogenic organisms.

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.

BB 526 PRINCIPLES OF GENETICS (2+1)

Objective

This course is aimed at understanding the basic concepts of genetics, helping students to develop their analytical, quantitative and problem-solving skills from classical to molecular genetics.

Theory

UNIT I

Early concepts of inheritance; Discussion on Mendel's paper; Sex determination, differentiation and sex-linkage, Sex-influenced and sex-limited traits; Linkage, recombination and genetic mapping in eukaryotes, Somatic cell genetics.

UNIT II

Structural and numerical changes in chromosomes; Nature, structure and replication of the genetic material; Organization of DNA in chromosomes; Mutations and mutagenic agents.

UNIT III

Genetic code and protein biosynthesis; Gene regulation, Genes in development; Extra chromosomal inheritance, Male sterility and incompatibility; Recombination in bacteria, fungi and viruses, tetrad analysis.

UNIT IV

Inheritance of quantitative traits; Concepts in population genetics; Genes and behavior; Genetics and evolution; Recombinant DNA technology; Genetic fine structure analysis, Split genes, Transposable genetic elements, Overlapping genes, Pseudogenes, Oncogenes, Gene families; An overview of some recent discoveries in the field of genetics.

Practical

i. Laboratory exercises in probability and chi-square.
ii. Demonstration of genetic principles using laboratory organisms.
iii. Chromosome mapping using three point test cross.
iv. Tetrad analysis.
v. Induction and detection of mutations through genetic tests.
vi. Pedigree analysis in humans.
vii. Numerical problems on Hardy Weinberg Equilibrium, Quantitative inheritance and Molecular genetics.

Suggested Readings

Klug WS & Cummings MR. 2003 Concepts of Genetics. Peterson Education.
Lewin B. 2008. Genes IX. Jones & Bartlett Publ.
Russell PJ. 1998. Genetics. The Benzamin/Cummings Publ. Co.
Strickberger MW.1990. Genetics. Collier MacMillan.
Tamarin RH. 1999. Principles of Genetics. Wm. C. Brown Publs.
Uppal S, Yadav R, Subhadra & Saharan RP. 2005. Practical Manual on Basic and Applied Genetics. Dept. of Genetics, CCS HAU Hisar.

MBB 531 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 532 INTRODUCTION TO BIOINFORMATICS (2+1)

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

i. Usage of NCBI resources

ii. Retrival of sequence/structure from databases

iii. Visualization of structures

iv. Docking of ligand receptors

v. 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.

MBB 533 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, 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 micro-organisms; global environmental problems: ozone depletion, UV-B, greenhouse effects, and acid rain; biodiversity and its conservation; biotechnological approaches for the management of 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 534 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/plants and animals.

Practical

i. Methods of isolation, purification and maintenance of microorganisms from different environments (air, water, soil, milk and food).

ii. Enrichment culture technique – isolation of asymbiotic, symbiotic nitrogen fixing bacteria. Isolation of photosynthetic bacteria.

iii. Use of selective media, antibiotic resistance and isolation of antibiotic producing microorganisms.

iv. 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.

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 535 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 and their 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

i. Isolation of industrially important microorganisms, their maintenance and improvement.
ii. Production of industrial compounds such as alcohol/citric acid/ lactic acid and their recovery.
iii. Study of bio-reactors and their operations.
iv. Production of biofertilizers.
v. Experiments on microbial fermentation process, harvesting purification and recovery of end products.

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 536 BIOSAFETY, IPR AND BIOETHICS (3+0)

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 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

Ph.D. COURSES:

MBB 611 ADVANCES IN PLANT MOLECULAR BIOLOGY (3+0)*

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. 3rdEd. 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 Education.

MBB 612 ADVANCES IN CROP BIOTECHNOLOGY (3+0)*

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 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.

BB 621 ADVANCES IN GENETIC ENGINEERING (3+0)

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.

UNIT V

Functional analysis of genes; RNA-mediated interference; gene knockoffs; Gene traps/ T-DNA insertion lines; homologous recombination; microarray profiling

Suggested Readings

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

MBB 622 ADVANCES IN MICROBIAL BIOTECHNOLOGY (2+1)

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.

Practical

i. Enrichment culture and isolation of agriculturally important microorganisms
ii. Isolation of antibiotic producing microorganisms
iii. Isolation of industrially important microorganisms, their maintenance and improvement.
iv. Production of industrial compounds such as industrial alcohol/ citric acid/lactic acid and their recovery.
v. Study of bio-reactors and their operations.
vi. Demonstration of bioinsecticides / biofertlizers production.

MBB 623 COMMERCIAL PLANT TISSUE CULTURE (2+1)

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.

Practical

i. Laboratory set-up, preparation of nutrient media; handling and sterilization of plant material; inoculation, subculturing and plant regeneration.
ii. Case studies of commercial plant regeneration system of important aromatic/ medicinal plants

Suggested Readings

Specific journals and published references.

MBB 624 ADVANCES IN FUNCTIONAL GENOMICS AND PROTEOMICS (3+0)

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; microarrayprofiling; 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 II: 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.