M. Sc. Agricultural Biotechnology

Course Contents

First Year

Semester I

S.No.	Course No	Course	Periods		Evaluation Scheme		
			The	Practical	Th.	IA	Total
1	ABT-111	Cell Biology	4	4	80	20	100
2	ABT-112	Bio-molecules and metabolism	4	4	80	20	100
3	ABT-113	Microbiology	4	4	80	20	100
4	ABT-114	Bio-statistic	4	4	80	20	100
5	ABT-115	Molecular Biology	4	4	80	20	100
6	ABT-116	Communication Skill	2				25
7	ABT-117	Lab. Course I (Cell biology, Bio-molecules)		4X3			50
8	ABT-118	Lab. Course II (Microbiology, Molecular Biology, Bio-statistic)		4X3			50
					Grand Total		625

Semester II

S. No.	Course No	Course	Periods		Evaluation Scheme		
			Th.	Practical	Th.	IA	Total
1	ABT-211	Immunology	4	4	80	20	100
2	ABT-212	Bioinformatics	4	4	80	20	100
3	ABT-213	Enzymology	4	4	80	20	100
4	ABT-214	Plant Mol. Biol.	4	4	80	20	100
5	ABT-215	Nano Biotechnology	4	4	80	20	100
6	ABT-216	Seminar					25
7	ABT-217	Lab Course-I Immunology, Bioinformatics, Nano-biotechnology		4x3			50
8	ABT-218	Lab Course-II Plant Mol. Biol., Enzymology		4x3			50
					Grand Total		625

Second Year

III semester

S. No.	Course No	Course	Periods Th.	Practical	Theo.	IA	Total
1	ABT-311	Plant Tissue Culture	4	4	80	20	100
2	ABT-312	Molecular Breeding	4	4	80	20	100
3	ABT-313	Genomics and Proteomics	4	4	80	20	100
4	ABT-314	Genetic Engineering	4	4	80	20	100
5	ABT-315	Biotic and abiotic stress biology	4	4	80	20	100
6	ABT-316	Seminar					25
7	ABT-317	**Lab. Course I** Plant tissue culture, Mol. Breeding, Genomics and Proteo-mics		4x3			50
8	ABT-318	**Lab. Course II** Genetic Engineering, Stress Biology,		4x3			50
		Grand Total					625

IV semester

S. No.	Course No.	Course	Periods Th.	Practical	Theo.	IA	Total
1	ABT-411	Plant Genetic Engineering	4	4	80	20	100
2	ABT-412	Plant Metabolic Engineering and Molecular Farming	4	4	80	20	100
3	ABT-413	Industrial & Food Biotech.	4	4	80	20	100
4	ABT-414	Biodiversity, IPR, Biosafety and Bioethics	4	4	80	20	100
5	ABT-415	Lab Course I		4x4			100
6	ABT-416	Summer training/ report/viva					50
		Grand Total					550

The theory and practical exams of 4th semester be completed in all circumstances by March. The project work will be done between April to July for three months. The project work can be done in any lab/Industry in India.
****Theo – Theory, IA- Internal Assessment**

M.Sc. Agricultural Biotechnology Semester--I

Course Title: Cell Biology MM. Th 80 + IA 20

Course No. ABT 111 **Time: 3h**

NOTE: In all ten questions will be set, two from each unit. Students are required to attempt five questions i.e. one from each unit.

Theory

UNIT I

Diversity of cell size and shape.
Cell Theory.
Structure of Prokaryotic and Eukaryotic cells- Isolation and growth of cells.
Microscopic techniques for study of cells.
Sub-cellular fractionation and criteria of functional integrity

UNIT II

Cellular organelles- Plasma membrane, cell wall, their structural organization, Mitochondria, Chloroplast; Nucleus and other organelles and their organization.
Transport of nutrients, ions and macromolecules across membrane.

UNIT III

Cellular energy transactions - role of mitochondria and chloroplast
Cell cycle - molecular events and model systems
Cellular responses to environmental signals in plants and animals- mechanisms of signal transduction

UNIT IV

Cell motility - cilia, flagella of eukaryotes and prokaryotes
Biology of cancer
Metabolite pathways and their regulation
Biosynthesis of proteins in Eukaryotic cell, Co- and post-translational modification, intracellular protein traffic.

UNIT V

Cellular basis of differentiation and development-mitosis, gametogenesis and

fertilization. Development in Drosophila and Arabidopsis, Spatial and temporal regulation of Gene expression.
Brief introduction to the Life Cycle and Molecular Biology of some important pathogen of AIDS, Malaria, Hepatitis, Tuberculosis, Filaria, Kalazar.

Practicals

Microscopy: Bright field, phase contrast & Fluorescence Microscopy.
Microtomy
Instrumental methods for Cell Biology
Sub cellular fractionation and marker enzymes.
Histochemical techniques
Mitosis & Meiosis

Texts/References:

1. Lodish *et al*., Molecular cell Biology, 4th Edition, W.H. Freeman & Company, 2000.
2. Smith & Wood, Cell Biology, 2nd Edition, Chapman & Hall, London, 1996.
3. Watson *et al*., Molecular Biology of the gene, 5th Edition, Pearson Prentice Hall. USA, 2003.
4. B. M. Turner, Chromatin & Gene regulation, 1st Edition, Wiley- Blackwell, 2002.
5. Benjamin Lewin, Gene IX, 9th Edition, Jones and Barlett Publishers, 2007.

M. Sc. Agricultural Biotechnology Semester--I

Course Title**: Biomolecules and metabolism** MM. **Th 80 + IA 20**

Course No. ABT 112 **Time: 3h**

NOTE: In all ten questions will be set, two from each unit. Students are required to attempt five questions i.e. one from each unit.

Theory

UNIT I

Chemical foundations of Biology –pH, pK, acids, bases, buffers, weak bonds, covalent bonds. Principles of thermodynamics. Classes of organic compounds and functional groups-atomic and molecular dimensions, space filling and ball and stick models. Macro molecular and supra molecular assemblies.

UNIT I I

Amino acids and peptides-classification, chemical reactions and physical properties

Sugars - classification and reactions, Heterocyclic compounds-and secondary metabolites in living systems - nucleotides, pigments, isoprenoids, Separation techniques for different biomolecules

UNIT III

Physical techniques in proteins, nucleic acids and polysaccharides structure analysis (UV, IR, NMR, LASER, MASS, Fluorescence spectroscopy, Differential calorimetry,
X - ray Crystallography, Ultra Centrifugation, Electron cryomicrography, Scanning Tunneling microscopy.

UNIT IV

Lipids- classification, structure and functions
Proteins-protein and protein legand interactions, end group analysis, hierarchy in structure, Ramachandran map.
Conformational properties of polynucleotides, Polysaccharides - types, secondary and tertiary structural features, analysis- theoretical and experimental;
Protein folding – biophysical and cellular aspects.

UNIT V

Water and its properties, enzymes coenzymes, metabolism of carbohydrate, amino acids and lipids, in born errors of metabolism.
Bio-energetics and oxidative phosphorylation. Blood clotting – biochemistry, body fluids – pH and acid base balance and their importance in clinical biochemistry, muscle contraction. Techniques in the study of proteins, carbohydrates and lipids.

Practicals

Titration of amino acids
Colorimetric determination of pK
Model building using space filling/ball and stick models
Reactions of amino acids, sugars and lipids
Isolation, purity determination and quantitation of cholesterol, DNA and mRNA
Quantitation of Proteins and Sugars
Analysis of oils-iodine number, saponification value, acid number
UV, Visible, Fluorescence and IR spectroscopy, Absorption spectra
Separation techniques - Centrifugation, Chromatography (Gel permeation, Ion exchange, TLC etc. and Electrophoresis

Texts/References:

1. V.Voet and J.G.Voet, Biochemistry, 3rd edition, John Wiley, New York, 2004.
2. A.L. Lehninger, Principles of Biochemistry, 4th edition, W.H Freeman and Company, 2004.
3. L. Stryer, Biochemistry, 5th edition, W.H. Freeman and Company, 2002.

M.Sc. Agricultural Biotechnology **Semester I**

Course Title: Microbiology **MM. Th 80 + IA 20**

Course No. ABT 113 **Time: 3h**

NOTE: In all ten questions will be set, two from each unit. Students are required to attempt five questions i.e. one from each unit.

Theory

UNIT I

The Beginning of Microbiology: Discovery of the microbial world by Antony van Leeuwenhoek: Controversy over spontaneous generation, Role of microorganisms in transformation of organic matter and in the causation of diseases Development of pure culture methods Enrichment culture methods, developments of microbiology in the twentieth century. Methods in Microbiology Pure culture techniques; Theory and practice of sterilization; Principles of microbial nutrition Construction of culture media; Enrichment culture techniques for isolation of chamoautotrophs,' chemoheterotrophs and photosynthetic microorganisms. Microbial Evolution, Systematic and Taxonomy, Evolution of earth and earlier life forms; Primitive organisms and their metabolic strategies and molecular coding; New approaches to bacterial taxonomy classification including ribotypeing Ribosomal RNA sequencing; Characteristics of primary domains Taxonomy, Nomenclature and Bergey's Manual

UNIT II

Microbial Growth The definition of growth, mathematical expression of growth, mathematical expression of growth, growth curve, measurement of growth and growth yields; Synchronous growth; Continuous culture; Growth as affected by environmental factors like temperature, acidity, alkalinity, water availability and oxygen; Culture collection and maintenance of cultures

Overview of Basic Metabolism & Microbial Nutrition

Metabolic Diversity among Microorganisms Photosynthesis in microorganisms; Role of Chlorophylls, carotenoids and phycobilins; Calvin cycle; Chemolithotrophy; Hydrogen - iron - nitrite - oxidizing bacteria; Nitrate and sulfate reduction; Methanogenesis and acetogenesis; Fermentations - diversity, syntrophy, role of anoxic decompositions; Nitrogen metabolism;" Nitrogen fixation; Hydrocarbon transformation

UNIT III

Prokaryotic Diversity Bacteria: Purpl and green bacteria; Cyanobacteria;

Homoacetogenic bacteria; Acetic acid bacteria; Budding and appendaged bacteria; Spirilla; Spirochaetes; Gliding and sheathed bacteria; Pseudomonads; Lactic and propionic acid bacteria; Endospore forming rods and cocci: Mycobacteria: Rickettsias, Chlamydies and Mycoplasma. Archaea: Archaea as earliest Life forms: Halophiles; Methanogens;' Hyperthermophilic urchaea; Thermoplasma, Eukaryotic: Algae, Fungi, Slime molds and Protozoa.

UNIT IV

Viruses: Bacterial, Plant, Animal and Tumor viruses; Discovery, classification and structure of viruses; Lysogeny: DNA viruses: Positive strand Negative strand, and double stranded RNA viruses; Replication: Examples of Herpes, Pox, Adenoviruses, Retroviruses, Viroids and Prions

Prokaryotic Cells: Structure-function Cell walls of eubacteria (peptidoglycan) and related molecules; Outer-membrane of Gram negative bacteria; Cell wall and cell membrane synthesis; Flagella and motility; Cell inclusions like end spores, gas vesicles, Chemotherapy/Antibiotics

Antimicrobial agents; Sulfa drugs; Antibiotics: Pencillins and Cephalosporins; Broad spectrum antibiotics; Antibiotics from prokaryotes; Antifungal antibiotics; Mode of action; Resistance to antibiotics

UNIT V

Genes, Mutation and. Mutagenesis UV and chemical mutagenesis Types of mutation; Ames test for mutagenesis; Methods of genetic analysis

Bacterial Genetic System Transformation, Conjugation, Transduction, Recombination, Plasmids and Transposons, Bacterial genetics map with reference to E.coli

Viruses and Their Genetic System Phage I and its life cycle: RNA phages RNA viruses; Retroviruses

Genetic systems of Yeast and Neurospora

Extra-Chromosomal Inheritance

Practicals

Preparation of liquid and solid media for growth of microorganisms

Isolation and maintenance .of organisms by plating, streaking and serial dilution methods. Slants and stab cultures. Storage of microorganisms

Isolation of pure cultures from soil and water

Growth; Growth curve; Measurement of bacterial' population by turbidometry and serial dilution methods. Effect of temperature, pH and carbon und nitrogen sources on growth.

Microscopic examination of bacteria, yeast and molds and study of organisms by Gram stain, Acid fast stain and staining for spores

Study of mutations by Ames test.

Assay of antibiotics und demonstration of antibiotic resistance

Analysis of water for potability and determination of MPN

Bacterial transformation

Biochemical characterization of selected microbes

Transduction
One step growth curve of coliphage
Isolation of Plasmids
$^{14}C0_2$ fixation by photosynthetic microbes

Texts/References:

1. Pelczar MJ Jr., Chan ECS and Kreig NR. Microbiology, 5th Edition, Tata McGraw Hill, 1993.
2. Maloy SR, Cronan JE Jr., and Freifelder D, Microbial Genetics, Jones Bartlett Publishers, Sudbury, Massachusetts, 2006.
3. Crueger and A Crueger, (English Ed., TDW Brock); Biotechnology: A textbook of Industrial Microbiology, Sinaeur Associates, 1990.
4. G Reed, Prescott and Dunn's, Industrial Microbiology, 4th Edition, CBS Publishers, 1987.
5. M.T. Madigan and J.M. Martinko, Biology of Microorganisms, 11th Edition, Pearson Prentice Hall, USA, 2006.

M.Sc. Agricultural Biotechnology — Semester I

Course Title: Biostatistics — **MM. Th 80 + IA 20**
Course No. ABT 114 — **Time: 3h**

NOTE: In all ten questions will be set, two from each unit. Students are required to attempt five questions i.e. one from each unit.

Theory

Unit I

Permutation and Combination, Functions, limits and continuity, Exponential and Logarithmic functions, Vector and Matrices, Algebra of matrices, Determinants and their simple properties, Rank of matrix, Consistency of system of linear equations and solution of linear system of equations. Characteristic equation, Eigen values and Eigen vectors,

Unit II

Differential Calculus, Rules of differentiation, Derivatives of implicit functions, Parametric differentiation, Higher derivatives Taylor's theorem, Maclaurin's theorem (without proofs), Maxima and minima, Partial differentiation
Integration, Integration by parts, Definite integral, Properties of definite integrals,
Differential Equations: Separable variable, homogenous, exact and linear equations of second order.

Unit III

Concepts in statistics, Types of Data, presentation of data, types of graphics, relative frequency, cumulative frequency, Measurement of central tendency, Measures of variation, coefficient of variation, Measures of Skewness and Kurtosis, Probability and its applications, Laws of Addition and Multiplication, Compound probability, Baye's Theorem

Unit IV

Random Variables and Distributions. Binomial, Poisson, Exponential and Normal Distributions and their applications. Samples and Sampling Distribution, Standard Error, significance level, Degrees of freedom, Tests of significance, tests for proportion, t and F tests Confidence Intervals

Unit V

Contingency tables of χ^2 (Chi square) tests of goodness of fit and homogeneity.
Correlation: Simple, Partial and Multiple Correlation, Methods of averages and least squares, polynomial fitting, Regression Analysis. Analysis of variance for one and two way classification Design of experiments, randomization, replication local control, completely randomized and randomized block design.

PRACTICALS

Descriptive statistics: Systematic tabular summarization of data (before analysis), measures of central tendency, measures of dispersion, measures of skewness (using calculators).
Correlations (product-moment coefficient, Spearman's rank coefficient) and regression (linear regression, curve fitting).
Data presentation (tables/figures) : 1-D and 2-D bar charts, pie diagrams, graphs (using computer software packages).
Statistical distributions: fitting discrete uniform, binomial, Poisson and normal probability distributions to given data
Testing of hypotheses: Tests of significance (mean, standard deviation, correlation coefficient), chi-squared test for goodness of fit, test for independence of attributes, non-parametric tests (run test) using calculators and printed tables and using minitab sampling (drawing random samples using random numbers, tables, chits, computer programmes for random number generation), design of experiments, ANOVA (one-way and two-way).

Texts/References:

1. P.S.S. Sundar Rao, P.H.Richard, J.Richard, An introduction to Biostatistics, Prentice Hall of India(P) Ltd., New Delhi, 2003.
2. Rangaswamy, R, A text book of Agricultural Statistics, New Age International (P) Ltd., New Delhi. 2000.
3. Gupta S.P, Statistical Methods, Sultan Chand & Sons, New Delhi. 2005.

4. Panse V.G.Panse, Sukhatme P.V, Statistical methods for Agricultural Workers, ICAR Publications, New Delhi, 2000
5. Jerrold H. Zar, Bio Statistical Analysis, Tan Prints(I) Pvt. Ltd., New Delhi, 2003.
6. Chandel, S.R.S, A Hand Book of Agricultural Statistics, Achal Prakashan Mandir, Kanpur, 1999.

M.Sc. Agricultural Biotechnology — Semester--I

Course Title: Molecular Biology — MM. Th 80 + IA 20

Course No. ABT 115 — Time: 3h

NOTE: In all ten questions will be set, two from each unit. Students are required to attempt five questions i.e. one from each unit.

Theory

UNIT I

DNA Replication: Prokaryotic and eukaryotic DNA replication, Mechanics of DNA replication, enzymes and accessory proteins involved in DNA replication and DNA repair.
Transcription: Prokaryotic transcription, Eukaryotic transcription, RNA polymerase, General and specific transcription factors, Regulatory elements in mechanisms of transcription regulation, Transcriptional and post-transcriptional gene silencing
Modifications in RNA: 5'-Cap formation, Transcription termination, 3'-end processing and polyadenylation, Splicing, Editing, Nuclear export of mRNA, mRNA stability

UNIT II

Translation: Prokaryotic and eukaryotic translation, the translation machinery, Mechanisms of initiation, elongation and termination, Regulation of translation, co- and post translational modifications of proteins.
Protein Localization: Synthesis of secretory and membrane protein, Import into nucleus, mitochondria, chloroplast and peroxisomes, Receptor mediated endocytosis
Oncogenes and Tumor Suppressor Genes: Viral and cellular oncogenes, tumor suppressor genes from humans, Structure, Function and mechanism of action of pRB and p53 tumor suppressor proteins

UNIT III

Antisense and Ribozyme Technology: Molecular mechanism of antisense molecules, inhibition of splicing, polyadenylation and translation, disruption of RNA structure and capping, Biochemistry of ribozyme; hammer head, hairpin and other ribozymes, strategies for designing ribozymes, Applications of Antisense and ribozyme technologies
Homologous Recombination: Holliday junction, gene targeting, gene disruption, FLP/FRT and' Cre/Lox recombination, RecA and' other recombinases

Molecular Mapping of Genome: Genetic and physical maps, physical mapping and map-based cloning, choice of mapping population, Simple sequence repeat loci, Southern and fluorescence in situ hybridization for genome analysis, Chromosome micro dissection and micro cloning.

UNIT IV

Molecular markers in genome analysis: RFLP, RAPD and AFLP analysis, Molecular markers linked to disease resistance genes, Application of RFLP in forensic, disease. prognosis, genetic counseling, Pedigree, varietal etc. Animal trafficking and poaching; Germplasm maintenance, taxonomy and Bio-diversity

UNIT V

Genome Sequencing: Genome sizes., organelle genomes, Genomic libraries, YAC, BAC libraries, Strategies for sequencing genome, Packaging, transfection and recovery of clones, Application of Sequencing sequence information for identification of defective genes

PRACTICALS

Isolation of genomic DNA
Southern blotting
RFLP analysis
Isolation of RNA
Isolation of polyA + RNA
Northern blotting
Preparation of probes
In vitro Transcription
In vitro translation
Metabolic labeling of proteins and immuno precipitation

Text/References:

1. Benjamin Lewin, Gene IX, 9th Edition, Jones and Barlett Publishers, 2007.
2. J.D. Watson, N.H. Hopkins, J.W Roberts, J. A. Seitz & A.M. Weiner; Molecular Biology of the Gene, 6th Edition, Benjamin Cummings Publishing Company Inc, 2007.
3. Alberts et al; Molecular Biology of the Cell, 4th edition, Garland, 2002.

M.Sc. Agricultural Biotechnology **Semester--I**

Course No. ABT 116 MM**. 25**

Course Title: Communication Skills **Time: 0.30min**
NOTE: Seminars

Lectures: preparation, objective/s, concepts, contents, sequence, formal proof, interrelationships, logic, conclusions, time management, using audiovisual aids.
Giving a talk: body language: extempore and prepared talks.
Preparing for interviews, CV/biodata.
Vocabulary: word power, pronunciations, guessing the meaning of words from the context and body language and using a dictionary
Review of basic and grammar Punctuation marks: comma, colon, semicolon, full stop, inverted comma.
Avoiding repetitious statements, double positives, double negatives, circular arguments.
Dealing with questions: avoiding circumvention and circular arguments; answering after breaking down long questions into parts.
MS power point-based presentations.
Analysis of formal presentations in the course 3a in terms of actual presentations.

M.Sc. Agricultural Biotechnology **Semester--II**

Course Title: Immunology MM. **Th 80 + IA 20**

Course No. ABT 211 **Time: 3h**

NOTE: In all ten questions will be set, two from each unit. Students are required to attempt five questions i.e. one from each unit.

Theory

UNIT I

Introduction, Phylogeny of Immune System- Innate and acquired immunity, Clonal nature of immune response, Organization and structure of lymphoid organs, Nature and Biology of antigens and super antigens.

UNIT II

Antibody structure and function, Antigen-antibody interactions, Major histo-compatibility complex, BCR & TCR, generation of diversity. Complement system, Cells of the Immune system: Hematopoiesis and differentiation

UNIT III

Lymphocyte trafficking, B-Iymphocytes, T-Iymphocytes, Macrophages, Dendritic cells, Natural killer and Lymphokine -activated killer cells, Eosinophils, Neutrophils and Mast Cells

Regulation of immune response: Antigen processing and presentation, generation of humoral and cell mediated immune responses: Activation of B- and T- Lymphocytes.

UNIT IV

Cytokines and their role in immune regulation:T-cell regulation, HHC restriction Immunological tolerance

Cell - mediated cytotoxicity; Mechanism of T cell and NK cell mediated lysis, antibody dependent cell mediated cytotoxicity, macrophage mediated cytotoxicity

Hypersensitivity

UNIT V

Autoimmunity, Transplantation, Immunity to infectious agents (interacellular parasites, helminthcs & viruses), Tumor Immunology, AIDS and other Immunodeficiency, Hybridoma Technology and Monoc1onal antibodies

PRACTICALS

Blood film preparation and identification of cells
Lymphoid organs and their microscopic organization
Immunization, Collection of Serum
Double diffusion and Immune-electrophoresis
Radial Immuno diffusion
Purification of IgG from serum
Separation of mononuclear cells by Ficol1-Hypaque
Con-A induced proliferation of thymocytes (by MTT method)
Western-blotting
ELISA
Hapten Conjugation and quantitation
Immunodiagnostics (demonstration using commercial kits)

Texts/References

1. Kuby, RA Goldsby, Thomas J. Kindt, Barbara, A. Osborne Immunology, 6th Edition, Freeman, 2002.
2. Roitt IM, Brostoff J and Male D, Clinical Immunology, 6th Edition, Gower Medical Publishing, London, 2002.
3. Janeway et al., Immunobiology, 4th edition, Current biology publications. 1999.
4. Paul, Fundamental of Immunology, 4th edition, Lippencott Raven, 1999

M.Sc. Agricultural Biotechnology Semester--II

Course Title: Bioinformatics MM. **Th 80 + IA 20**

Course No. ABT 212 **Time: 3h**

NOTE: In all ten questions will be set, two from each unit. Students are required to attempt five questions i.e. one from each unit.

Theory

UNIT I

Computers: An overview of computers, microcomputers, VDUs and printer. What is programming? Algorithms. Languages and packages: Introduction to MS Office, MS

Access, Front Page and introduction to C, Java and SQL (structured querry language) Handling arrays, procedures, Colour, sound and graphics. Use of standard packages.

UNIT II

Introduction to PERL: Scalar variables, strings and numbers, Assignment statements, Arrays, Hashes, Operators, Input from file, Standard Input, Conditional and logical operators, loops, I/O, Input from file named in command line, Regular expression, Pattern matching, Meta symbols, Pattern modifiers, Subroutines.
Applications of PERL in Bioinformatics: Storing DNA sequence, DNA to RNA transcription, Finding motifs, Counting nucleotides, Generating random numbers, simulating DNA mutation, generating random DNA, Analyzing DNA

UNIT III

Biological Sequence Databases: Overview of various primary and secondary databases that deal with protein and nucleic acid sequences. Databases to be covered in detail are GenBank, EMBL, DDBJ, Swiss Prot, PIR, and MIPS for primary sequences. Various specialized databases like TIGR, Hovergen, TAIR, PlasmoDB, ECDC etc., will also be discussed. Preliminary ideas of query and analysis of sequence information.

UNIT IV

Sequence Comparison Methods: Method for the comparison of two sequences viz., Dot matrix plots, Needleman Wusch & Smith Waterman algorithms. Analysis of computational complexities and the relative merits and demerits of each method. Theory of scoring matrices and their use for sequence comparison.

UNIT V

Database Search Algorithms: Methods for searching sequence databases like FASTA and BLAST algorithms. Statistical analysis and evaluation of BLAST results.
Pattern Recognition Methods in Sequence Analysis: Concept of a sequence pattern, regular expression based patterns. The use of pattern databases like PROSITE and PRINTS. Concept of position specific weight matrices and their use in sequence analysis. Theory of profiles and their use with special reference to PSIBLAst. Markov chains and Markov models and their use in gene finding. Concept of HMMS, the Forward backward and the Viterbi algorithm. The Baum Welch algorithm for training a HMM. Use of profile HMM for protein family classification.

Practical

Computational modeling of genomic proteomic, evolutionary tree designing on databases, network search on genomic and proteomic databases.

Texts/References:

1. David W. Mount. Bioinformatics: Sequence and Genome Analysis, 2nd Edition, CSHL Press, 2004.
2. A. Baxevanis and F. B. F. Ouellette, Bioinformatics: a practical guide to the analysis of genes and proteins, 2nd Edition, John Wiley, 2001.
3. Jonathan Pevsner, Bioinformatics and Functional Genomics, 1st Edition, Wiley-Liss. 2003.
4. P. E. Bourne and H. Weissig. Structural Bioinformatics. Wiley. 2003.
5. C. Branden and J. Tooze. Introduction to Protein Structure, 2nd Edition, Garland Publishing, 1999.

M.Sc. Agricultural Biotechnology Semester--II

Course Title: Enzymology MM. Th 80 + IA 20

Course No. ABT 213 **Time: 3h**

NOTE: In all ten questions will be set, two from each unit. Students are required to attempt five questions i.e. one from each unit.

Theory

UNIT I

Enzymes: Introduction and scope, Nomenclature, Mechanism of Catalysis, Chemical and Physical properties of enzymes. Information from composition and sequence, Structural Details: Determining the Molecular Weight, Size and Shape by modern technique; De Novo structure prediction from sequence; Solution structure from NMR measurements; Solution of X-ray diffraction pattern, Modeling from a close homolog, Comparing different structures.

UNIT II

Enzyme Kinetics: Single substrate steady state kinetics; King-Altman's method; Inhibitors and activators; Multi-substrate systems; Effect of pH and temperature; Allosteric enzymes, Mnemonical enzyme.

UNIT III

Immobilization of Enzymes: Advantages, Carriers, adsorption, covalent coupling, cross-linking and entrapment methods, Micro-environmental effects Enzyme Reactors: reactors for batch/continuous enzymatic processing, Choice of reactor type; idealized enzyme reactor systems; Mass Transfer in Enzyme Reactors; Steady state analysis of mass transfer and biochemical reaction in enzyme reactors.

UNIT IV

Bio-process Design: Physical parameters, reactor operational stability; Immobilized cells. Types of enzyme preparations and their characterization

Enzymes in food, fodder, textile and tanning industry, medicine, production of biodetergents.

UNIT V

Challenges and future trends: Enzyme catalysis in organic media; Catalytic antibodies and Non-protein biomolecules as catalysts, Biocatalysts from Extreme Thermoph!lic and Hyperthermophilic Archaea and Bacteria..

PRACTICALS

Electrophoresis of Proteins - native and under denaturing conditions
N- and C- terminal analysis of proteins
Peptide mapping
Separation techniques (HPLC, GPC, FPLC)
Chemical modification of proteins
Enzyme: purification and kinetic analysis
Hydrodynamic properties measurement and applications
Methods for immobilization of enzymes
Techniques for analysis of Secondary, tertiary and quaternary structures of proteins
Electrophoresis of DNA linear, circular and super coiled
Protein-DNA interaction
Nucleic acid hybridization
Determination of Tm of nucleic acid

M.Sc. Agricultural Biotechnology Semester--II

Course Title: Plant Molecular Biology MM. **Th 80 + IA 20**

Course No. ABT 214 **Time: 3h**

NOTE: In all ten questions will be set, two from each unit. Students are required to attempt five questions i.e. one from each unit.

Theory

Unit I

General Aspects; Novel features of plant growth and development; Concept of plasticity in plant development; Analyzing plant growth; Seed Germination and Seedling Growth; Mobilization of food reserves during seed germination; Tropisms; Hormonal control of

seed germination and seedling growth. Floral Induction and Development; Photoperiodism and its significance; Vernalization and hormonal control; Inflorescence and floral determination; Molecular genetics of floral development and floral organ differentiation; Sex determination.

Unit II

Carbon Assimilation; Light absorption and energy conversion; Calvin Cycle; Hatch-Slack pathway; Reductive pentose phospha tem pathway; Carbon dioxide uptake and assimilation; Photorespiration; Glycolate metabolism. Molecular biology of photosynthetic processes

Nitrogen Fixation -- Symbiotic and non-symbiotic nitrogen fixation; Role of lectins; nod genes; nif genes; Structure, function and regulation of nitrogenase; Leghaemoglobin; Nodulins; Molecular aspects of regulation and enhancement of nitrogen fixation. Mycorrhizal-plant symbiosis.

Unit III

Nitrogen, sulphur and phosphorus metabolism: General aspects of nitrogen economy, Nitrate reduction, Pathways of ammonia assimilation, transamination, Regulation of nitrogen assimilation, uptake, transport and assimilation of sulphate and phosphate.

Long-distance Transport Mechanisms – Turgor and stomatal movements; Solute movement; Source-sink relationship; Water relations.

Unit IV

Senescence and Programmed Cell Death (PCD) – Senescence and its regulation; Hormonal and environmental control of senescence; PCD in the life cycle of plants.

Signal Transduction – Basic concepts; Receptors and G-proteins; Cyclic AMP cascade; Phospholipid and Ca^{2+}-calmodulin cascade; MAP kinase cascade; Two-component sensor-regulator system; Sucrose sensing mechanism

.

Unit V

Biosynthesis of Plant Hormones and Elicitors; Structure and metabolism of auxins, gibberellins, cytokinins, abscisic acid, ethylene, brassinosteroids, salicylic acid, jasmonates and related compounds.

Molecular Mechanism of Hormone Action – Hormone signal perception, transduction and gene regulation; Role of mutants in understanding hormone action.

Light Control of Plant Development – Discovery of phytochromes and cryptochromes, their structure, biochemical properties and cellular distribution; Molecular mechanisms of light perception, signal transduction and gene regulation; Biological clocks and their genetic and molecular determinants.

Practicals

1. Plant DNA extraction, digestion of DNA with restriction enzymes, agarose gel electrophoresis.
2. Polymerase chain reaction to amplify a plant gene.
3. Homogenization of leaves, sub-cellular fractionation by differential centrifugation, chloroplast purification, SDS-PAGE analysis of chloroplast proteins.
4. RNA extraction, Agarose gel electrophoresis of RNA, RT-PCR analysis of a plant gene.

Texts/References:

1. Edited by Garry C Whitelam and Karen J Halliday, Light and Plant Development, Oxford Ames, Iowa: Blackwell Pub., 2007.
2. Esau's Plant Anatomy; Meristems, Cells, and Tissues of the Plant Body: Their Structure, Function, and Development, 3rd Edition, John Wiley & Sons, 2006.
3. Thomas L Rost, Michael G Barbour, Terence M Murphy and C Ralph, Stocking Plant Biology (with InfoTrac), 2005.
4. Martin J Ingrouille and William Eddie, Plants: Diversity and Evolution
5. Bingru Huang, Plant-Environment Interactions, 3rd Edition, CRC Press, 2006.
6. Pamela C Ronald, Plant-Pathogen Interactions, 1st Edition, Humana Press, 2006.

M.Sc. Agricultural Biotechnology — Semester--II

Course Title: Nano Biotechnology — MM. Th 80 + IA 20

Course No. ABT 215 — **Time: 3 hrs.**

NOTE: In all ten questions will be set, two from each unit. Students are required to attempt five questions i.e. one from each unit.

Theory

UNIT-I

Bionanotechnology: An Overview: What can engineers learn from biology? From biotechnology to Bio-nanotechnology. Bio-nanomachines in actions A Molecular recognition: How molecular recognition underlies cellular communication, material transfer into and within cells, and biotransformation. Information: How information is stored in the cell and how it is read?

UNIT-II

Biophysics: Bioelectromagnetism, bioenergetics, biomechanics, Neuro transport, Biological Rhythyms. **Modern Biomaterials:** Proteins, Nucleic acids, Lipids,

Polysaccharides. **Biomolecular Design and Biotechnology:** Molecular Modeling and Biomolecular structure determination.

UNIT-III

Structural Principles of Bionanotechnology: Natural Bionano-machinery, Hierarchical strategy, raw materials, Protein folding, self assembly and self-organization, molecular recognition and flexibility.

UNIT-IV

Functional Principles of Bionanotechnology: Information driven Nano assembly, Energetics, chemical transformation, regulation, Biomolecular motors, Biomolecular sensing, self replication and machine- phase Bionanotechnology.

Unit-V

Bionanotechnology Today and Future: Basic capabilities, Nanomedicine today, DNA computers, hybrid materials, artificial life and biosensors

Texts/References:

1. Gero Decher, Joseph B. Schlenoff, Multilayer Thin Films, Wiley- VCH Verlag, GmbH & Co. KGaA, 2003.
2. David S. Goodsell, Bionanotechnology: Lessons from Nature, 1st Edition, Wiley-Liss, 2004.
3. Neelina H. Malsch, Biomedical Nanotechnology, 1st Edition, CRC Press, 2005.

M.Sc. Agricultural Biotechnology Semester--III

Course Title: Plant Tissue Culture **MM. Th 80 + IA 20**

Course No. ABT 311 **Time: 3hrs**

NOTE: In all ten questions will be set, two from each unit. Students are required to attempt five questions i.e. one from each unit.

Theory

Unit I

History of plant cell and tissue culture, Culture media; Various types of cultures: callus, cell suspension, nurse, root, meristem, *In Vitro* differentiation: Organogenesis and somatic embryogenesis; Molecular basis of plant organ differentiation Micro-propagation – plant multiplication, hardening, transplantation, genetic fidelity, scale up and cost reduction, bioreactor, artificial seeds; Applications of tissue culture: Virus elimination by shoot tip culture;

Unit II

In vitro pollination and fertilization, Wide hybridization and Embryo rescue, Androgenesis: Anther and pollen culture, Gynogenesis-ovule and ovary culture, dihaploids, their applications in genetics and plant breeding;

Unit III

Protoplast isolation and purification; Protoplast viability test; Protoplast culture and regeneration; Somatic hybridization - methods and applications; Cybrids, Somaclonal and gametoclonal variations, *In vitro* selection.

Unit IV

Large-scale production of alkaloids and other secondary metabolites through cell culture techniques; high yielding cell lines, factors effecting production, Biotransformation, elicitors induced production, Hairy root culture and production of secondary metabolites. Immobilization of plant cells.

Unit V

Plant Genetic resources, Germplasm conservation and cryopreservation, cryoprotectants, Gene bank, Some case studies on success stories on commercial application of plant tissue culture.

Practicals

1. Preparation of Murashige and Skoog medium, stocks of macronutrients, micro-nutrients, vitamins and hormones, autoclaving, filter sterilization of hormones and antibiotics.
2. Surface-sterilization of seeds, establishment of axenic plants, acclimatization of tissue culture plants and establishment in greenhouse.
3. Callus induction in tobacco leaf discs, regeneration of shoots, root induction, role of hormones in morphogenesis.
4. Anther culture
5. Protoplast isolation viability test and culture

Texts/References:

1. R.H.Smith, Plant Tissue Culture: Techniques and Experiments, Academic Press, San Diego. 1992.
2. S S Bhojwani and M K Razdan, Plant Tissue Culture, Elsevier Publ.

M.Sc. Agricultural Biotechnology **Semester--III**

Course Title: **Molecular Breeding** **MM. Th 80 + IA 20**

Course No. ABT 312 **Time: 3hrs**

NOTE: In all ten questions will be set, two from each unit. Students are required to attempt five questions i.e. one from each unit.

Theory

Unit I

Conventional methods for crop improvement: Principles of plant breeding, Breeding methods for self and cross pollinated crops, Heterosis breeding, Mutation breeding, Limitations of conventional breeding

Unit II

Plant Genome – Nuclear and cytoplasmic; Significance of organelle genomes; Genome size and sequence components; Modern gene concept - Gene structure, structural and functional genes. Molecular markers: Definition, properties, kinds of molecular markers: – Restriction based and PCR based; RFLP: methodology and applications, RAPD & AFLP: Principles, methodology and applications, Development of SCAR and SSR markers. Other markers: CAPS, SNP, Comparison of different marker systems

Unit III

Gene flow in plants – Development of mapping population – Marker Assisted Selection (MAS), screening and validation; Trait related markers and characterization of genes involved; Mapping genes on specific chromosomes; QTL mapping; Gene pyramiding; Transcript mapping techniques. Development of ESTs

Unit IV

Molecular markers for plant genotyping and germplasm analysis; Fidelity analysis; settling IPR issues; Marker Assisted Breeding in transgenics – herbicide resistance; Pest and disease resistance; Quality enhancement etc. Allel mining, TILLING, EcoTILLING.

Unit V

Recent advances – Non gel based techniques for plant genotyping – Homogenous assays – Qualitative/Real Time assays; DNA Chip and its technology.

Practicals
1. DNA extraction and DNA estimation from plants
2. PCR analysis,
3. DNA finger printing methods, RAPD, SSR.

Texts/References:
1. Anolles, G. C. and Gresshoff, P.M., DNA markers – protocols, applications and overviews. Wiley – Liss, New York, 1997
2. Clark, D. P., Molecular Biology, Elsevier, USA, 2005.
3. Henry R. J., Plant Genotyping: The DNA fingerprinting of plants. CABI, New Delhi, 2005.

M.Sc. Agricultural Biotechnology Semester--III

Course Title: Genomics and Proteomics MM. Th 80 + IA 20

Course No. ABT 313 **Time: 3h**

NOTE: In all ten questions will be set, two from each unit. Students are required to attempt five questions i.e. one from each unit.

Theory

Unit I
Introduction
Structural organization of genome in Prokaryotes and Eukaryotes; Organelle DNA-mitochondrial, chloroplast; DNA sequencing principles and translation to large scale projects; Recognition of coding and non-coding sequences and gene annotation; Tools for genome analysis-RFLP, DNA fingerprinting, RAPD, PCR, Linkage and Pedigree analysis-physical and genetic mapping: **Physical mapping of genome:** Conventional cytogenetics, Physical mapping by restriction hybridization analysis, FISH and related techniques, Chromosome painting and microdissection, Long range physical mapping Contig assembly, Chromosome walking and map-based cloning.

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Unit II

Genome sequencing projects

Microbes, plants and animals; Accessing and retrieving genome project information from web; Identification and classification using molecular markers-16S rRNA typing/sequencing, EST's and SNP's.

Comparative-genomics

Introduction, comparative genomics of plants, cereal and legume comparative genomics

Evolutionary Genomics

Introduction to genome evolution, Acquisition of new genes, Evolution of non-coding regions, Molecular phylogenetics and applications, Evolution of multigene families in the genome

Unit III

Proteomics

Protein analysis (includes measurement of concentration, aminoacid composition, N-terminal sequencing); 2-D electrophoresis of proteins; Microscale solution isoelectric-focusing; Peptide fingerprinting; LC/MS-MS for identification of proteins and modified proteins; MALDI-TOF; SAGE and Differential display proteomics, Protein-protein interactions, Yeast two hybrid system.

Unit IV

Pharmacogenetics

High throughput screening in genome for drug discovery identification of gene targets, Pharmacogenetics and drug development

Unit V

Functional genomics and proteomics

Introduction, Strategies to find functional genes in the genome, Gene tagging strategies and application. ESTs and its utility in genomics, Differential gene profiling methods, DNA chips/Microarrays, SAGE and SNPs analysis, Protein and peptide microarray-based technology; PCR-directed protein *in situ* arrays; Structural proteomics

Texts/References:

1. Voet D, Voet JG & Pratt CW, Fundamentals of Biochemistry, 2nd ed. Wiley 2006
2. Brown TA, Genomes, 3rd ed. Garland Science 2006
3. Campbell AM & Heyer LJ, Discovering Genomics, Proteomics and Bioinformatics, 2nd ed. Benjamin Cummings 2007
4. Primrose S & Twyman R, Principles of Gene Manipulation and Genomics, 7th ed, Blackwell, 2006
6. Glick BR & Pasternak JJ, Molecular Biotechnology, 3rd ed, ASM Press, 1998

M.Sc. Agricultural Biotechnology Semester--III

Course Title: Genetic engineering MM. Th 80 + IA 20

Course No. ABT 314 **Time: 3h**

NOTE: In all ten questions will be set, two from each unit. Students are required to attempt five questions i.e. one from each unit.

Theory

UNIT I

Scope of Genetic Engineering, Milestones in Genetic Engineering
Isolation of enzymes, DNA sequencing, synthesis and mutation, detection and separation cloning, gene expression. Cloning and patenting of life forms. Genetic engineering guidelines, Molecular Tools and Their Applications, Restriction enzymes, modification enzymes, DNA and RNA markers

UNIT II

Nucleic Acid Purification, Yield Analysis, Nucleic Acid Amplification and its Applications, Gene Cloning Vectors, Restriction Mapping of DNA Fragments and Map Construction, Nucleic Acid Sequencing, cDNA Synthesis and Cloning , mRNA enrichment, reverse transcription, DNA primers, linkers, adaptors and their chemical synthesis, Library construction and screening, Alternative Strategies of Gene Cloning

UNIT III

Cloning interacting genes-Two-and three hybrid systems, cloning differentially expressed genes. Nucleic acid microarray arrays, Site-directed Mutagenesis and Protein Engineering , How to Study Gene Regulation? DNA transfection, Northern blot, Primer extension, S1 mapping, RNase protection assay, Reporter assays, Expression strategies for heterologous genes, Vector engineering and codon optimization, host engineering,in vitro transcription and translation, expression in bacteria expression in yeast, expression in insect cells, expression in mammalian cells, expression in plants.

UNIT IV

Processing of recombinant proteins: Purification and refolding, characterization of recombinant proteins, stabilization of proteins.
Phage Display, T-DNA and Transposon Tagging
Role of gene tagging ingene analysis, T-DNA and Transposon Tagging, Identification and isolation of genes through T-DNA or Transposon.

UNIT V

Transgenic and gene knockout technologies
Targeted gene replacement, chromosome engineering.
Gene therapy: Vector engineering strategies of gene delivery, gene

replacement/augmentation, gene correction, gene editing, gene regulation and silencing.

PRACTICALS

Bacterial culture and antibiotic selection medias. Prepration of competent cells.
Isolation of plasmid DNA.
Isolation of lambda phage DNA .
Quantitation of nucleic acids.
Agarose gel electrophoresis and restriction mapping of DNA
Construction of restriction map of plasmid DNA.
Cloning In plasmid/phagemid vectors.
Preparation, of helper phage and its titration\
Preparation of single stranded DNA template
DNA sequencing
Gene expression in E. coli and analysis of gene product
PCR and Reporter Gene assay (Gus/CAT/b-GAL)

Text/References:

1. S.B. Primrose, R.M. Twyman and R.W.Old; Principles of Gene Manipulation. 6th Edition, S.B.University Press, 2001.
2. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.
3. Brown TA, Genomes, 3rd ed. Garland Science 2006
4. Selected papers from scientific journals.
5. Technical Literature from Stratagene, Promega, Novagen, New England Biolab etc.

M.Sc. Agricultural Biotechnology Semester--III

Course Title: Abiotic and biotic stress biology **MM. Th 80 + IA 20**
Course No. ABT 315 **Time: 3hrs**

NOTE: In all ten questions will be set, two from each unit. Students are required to attempt five questions i.e. one from each unit.

Theory

Unit I

Climate change: impact of global climate change on agricultural production, reduced green house gas emission from agri-practices, UV-B radiation, Ozone depletion; Green house effect; effect of increased CO_2 and high O_3 on crop productivity and target for crop biotechnology, Exploition of plant –microbes partnership for improving biomass and

remediation: Biocomposting; Biofertilizers; Slow release fertilizers, Vermiculture; Organic farming; Biopesticides: microbes and plants, Biominearlization

Unit II

Pollution

Enviromental pollution; Source of pollution; Air, water as a source of natural resource; Hydrocarbons, substituted hydro carbons; Oil pollution; Surfactants; Pesticides; Measurement of pollution; Water pollution; Biofilm; Soil pollution; Radioactive pollution; Impact of pollutants; Measurement techniques; Pollution of milk and aquatic animals

Unit III

Control, remediation and management

Waste water collection; control and management; Waste water treatment; Sewage treatment through chemical, microbial and biotech techniques; Anaerobic processes; Anaerobic filters; Anaerobic sludge blanket reactors; Bioremediation of organic pollutants and odorous compounds; Use of bacteria, fungi, plants, enzymes, and GE organisms; Plasmid borne metabolic treatment; Bioaugmentation; Treatment for waste water from dairy, distillery, tannery, sugar and antibiotic industries, solid waste treatment

Unit III

Abiotic stress –Physiological and molecular responses of plants to water stress, salinity stress, temperature stress – heat and cold, Photooxidative stress, stress perception and stress signaling pathways, Ionic and osmotic homeostasis, reactive oxygen species scavenging, functional genomics, metabolomics and system biology of stress, miRNA in abiotic stress, Overcoming stress: breeding efforts, marker assisted breeding, transgenic approaches.

Unit IV

Introduction to plant nutrition; Mineral availability, uptake of minerals; Responses of plants to nutrient deficiency - Phosphorous and Iron deficiencies, heavy metal stress and non optimal pH-acid and calcareous soil, aluminum tolerance, Physiological and molecular biology of heavy metal tolerance. Bioremediation of contaminated soils and waste land; Bioremediation of contaminated ground water; Macrophytes in water treatment; Phytoremediation of soil metals

Unit V

Biotic stress - plant interaction with bacterial, viral and fungal pathogens and herbivores, plant responses to pathogen and herbivores– biochemical and molecular basis of host plant resistance – toxins of fungi and bacteria – systemic and induced resistance –

pathogen derived resistance – signaling - gene for gene hypothesis – genetic engineering for biotic stress resistance – gene pyramiding, biotic stress associated miRNA.

Practicals

1. Laboratory techniques to measure water and nutrient uptake in plants.
2. Methods to measure various physiological processes (photosynthesis, transpiration, gas exchange, stomatal conductance, epicuticular wax, Chlorophyll stability index, cell membrane stability) in plants – methods to quantify endogenous hormones (auxin, ABA etc.,) and Proline in plants
3. Rapid screening tests for abiotic stress tolerance (drought, salinity - PEG, Mannitol & NaCl)
4. Estimation of antioxidants and antioxidant enzymes - Ascorbate, Superoxide dismutase, Catalase, and Peroxidase
5. Major insect, nematode pests and diseases of crop plants – study of phytotoxaemia and other categories of insect damage in crop plants
6. Toxin – production - extraction - purification - selection of toxin resistant calli- assay of toxins to pathogens - bioassay for PR protein - culturing and isolation of *Bt* - bioassay techniques

Texts/References:

1. U. Chakraborty, Bishwanath Chakraborty, 2005. Stress biology, Vidhyasekaran, P. 2007. Narosa Publishing House
2. Handbook of molecular technologies in crop disease management, Haworth Food & Agricultural Products Press, New York.462 p
3. Taiz and Zeiger, Plant Physiology, 3rd Edition, Panima Publishing Corporation, New Delhi, 2003.
4. Buchnan, B. B., Gruissem, W. and Jones, R. L., Biochemistry and molecular biology of plants. American Society for Plant Physiologists, Rockville, USA. 2000.
5. Gatehouse, A. M .R., Hilder, V. A. and Boulter, D., Plant Genetic manipulation for crop protection In: Biotechnology in Agriculture Series (Eds.) Vol. 7 CAB International, Wallingford, UK. 266p. 1992
6. Panda N. and G.S.Khush, Host plant resistance to insects. CAB International, Walling Ford. 431p, 1995
7. Persely, G. J. (Ed.), Biotechnology for integrated pest management.CAB International, Wallingford, UK. 475p, 1996.
8. Persely, G. J. (Ed.), Biotechnology for integrated pest management.CAB International, Wallingford, UK. 475p, 1996
9. Slater, A., Scott, N. and Fowler, M., Plant biotechnology –The genetic manipulations of plants. Oxford University press. 346p, 2003.
10. Vidhyasekaran, P., Fungal pathogenesis in plants and crops:Molecular biology and host defense mechanisms, Marcel Dekkar Inc., New York. 624p, 1997
11. Vidhyasekaran, P., Bacterial Disease Resistance in Plants: Molecular Biology and Biotechnological Applications, Haworth Food & Agricultural Products Press, New York.452p, 2005.

12. Zuckerman B.M. and Rohde, R. A. (Eds.), Plant parasitic Nematodes, Vol. III, Academic press, London 508p. 1981.
13. Pessarakli, M., Handbook of Plant and Crop stress, 2nd Edition, Marcel Dekker Inc. New York1999
14. K.V. Madhava Rao, A.S. Raghavendra and K. Janardhan Reddy, Physiology and Molecular Biology of Stress Tolerance in Plants. Springer, Netherlands. 2006
15. Satoh, K. and Murata, N., Stress responses of photosynthetic organisms, Elsevier, Amsterdam. 1998
16. MetCalfe and Eddy Inc., Wastewater Engineering: Treatment, Disposal and Reuse", 4th Edition, McGraw Hill Book Co., 2003
17. Mackenzie L. Davis and David A. Cornwell, Introduction to Environmental Engineering, 4th Edition, McGraw Hill Book Co., 2006.
18. R.M.Maier, I.L.Pepper and C.P.Gerba, Elsevier, Environmental Microbiology: A Laboratory Manual, 2nd Edition, Academic Press, 2004.
19. B.C.Bhattacharyya and R.Banerjee, Environmental Biotechnology, Oxford University Press

M.Sc. Agricultural Biotechnology Semester--IV

Course Title: Plant Genetic Engineering **MM. Th 80 + IA 20**
Course No. ABT 411 **Time: 3hrs**

NOTE: In all ten questions will be set, two from each unit. Students are required to attempt five questions i.e. one from each unit.

Theory

Unit I

Agrobacterium-plant interaction; Virulence; Ti and Ri plasmids; Opines and their significance; T-DNA transfer; Disarming the Ti plasmid, *Agrobacterium*-mediated gene delivery, Cointegrate and binary vectors and their utility; Flower dip transformation, Direct gene transfer - PEG-mediated, electroporation, particle bombardment and alternative methods; Screenable and selectable markers; Monocot transformation, Promoters and poly A signals, Characterization of transgenics; Chloroplast transformation: advantages, vectors and successes; Marker-free methodologies; Gene stability and gene silencing, gene stacking,

Unit II

Bacterial resistance, Viral resistance : coat protein mediated, nucleocapsid gene, Fungal diseases: chitinase, 1-3 beta glucanase, RIP, antifungal proteins, thionins, PR proteins, Insect pests resistance: Bt genes, Non-Bt like protease inhibitors, alpha amylase inhibitor,

nematodes resistance and herbicide resistance: phosphoinothricin, glyphosate, sulfonyl urea, atrazine, Drought, salinity, thermal stress, flooding and submergence tolerance, post-harvest losses, long shelf life of fruits and flowers: use of ACC synthase, Polygalacturanase, ACC oxidase, male sterile lines: bar and barnase systems.

Unit III

Genetic engineering for increasing crop productivity: enhancing photosynthetic, nutrient use and nitrogen fixing efficiencies of plants, manipulation of plant architecture and flowering behavior

Unit IV

Genetic Engineering for quality improvement: Seed storage proteins; essential amino acids, Vitamins and minerals, heterologous protein production in transgenic plants for agriculture, industry and pharmaceuticals uses, biodegradable plastics, Plants as biofactories

Unit V

Role of antisense and RNAi in crop improvement, regulated and tissue specific expression of transgenes for crop improvement, Terminator gene technology, Environmental issues associated with transgenic crops, food safety issues and risk assessment of transgenic food crops.

Practicals

1. Isolation of plasmids with reporter (*gus*) gene,
2. Preparation of microprojectiles, transformation using a particle gun, GUS staining.
3. Leaf disc transformation using *Agrobacterium*, establishment of transgenic plants, and GUS staining or GFP viewing.
4. DNA extraction from transgenic plants, DNA estimation, PCR analysis,
5. Southern blot analysis to prove T-DNA integration,
6. RTPCR to study transgene expression,
7. Western blotting to study the accumulation of transgene-encoded protein.

Texts/References:

1. Adrian Slater, Nigel Scott and Mark Fowler, Plant Biotechnology: The genetic manipulation of plants, 1st Edition, Oxford University Press, 2003
2. Edited by BR Jordan, 2nd Edition, The Molecular Biology and Biotechnology of Flowering, CABI, 2006.
3. Jaiwal P K & Singh R P (eds) Plant Genetic Engineering Vol-1 to Vol. 9. Studium Press, USA

3. Denis Murphy, Plant Breeding and Biotechnology: Societal Context and the Future of Agriculture, Cambridge University Press, 2007.

M.Sc. Agricultural Biotechnology Semester--IV

Course Title: Metabolic Engineering and Molecular Farming, MM- Th 80 + IA 20
Course No. ABT 412 Time: 3hrs

NOTE: In all ten questions will be set, two from each unit. Students are required to attempt five questions i.e. one from each unit.

Theory

UNIT I

Basic concepts of Metabolic Engineering – Overview of cellular metabolism; Different models for cellular reaction.
PRIMARY METABOLITES giving special attention to sugars, amino acids and lipids: The basic structure, The biochemical pathway, Carbon flow, Different regulatory points (regulation at enzyme level and whole cell level, Alteration of feed back regulation, Limiting accumulation of end products), Genetic manipulation of starch, amino acids and oil content in plants and their value addition with significance in horticulture, agriculture and medicine

UNIT II

SEECONDARY METABOLITES giving special emphasis to following components of Flavanoid pathway, Terpenoid pathway, Polyketoid pathway: The basic structure, The biochemical pathway, Carbon flow, Different regulatory points (regulation at enzyme level and whole cell level, Alteration of feed back regulation, Limiting accumulation of end products), Genetic manipulation of flavonoid pathway, Terpenoid and Polyketoid pathways in plants and their value addition with significance in horticulture, agriculture and medicine

UNIT III

Metabolic Profiling & Transcription Factors for Metabolic Engineering
Metabolic Engineering to improve tolerance of plants to abiotic factors/climate change

UNIT IV

Metabolic flux - Integration of anabolism and catabolism, metabolic flux distribution analysis bioprocess, material balance, kinetic types, equilibrium reaction. Experimental determination method of flux distribution, metabolic flux analysis and its applications, Metabolic engineering with Bioinformatics, Analysis of metabolic control and the structure, metabolic networks, metabolic pathway synthesis algorithms

UNIT V

Applications of Metabolic Engineering - in pharmaceuticals (edible vaccines, plantibodies etc), chemical bioprocess, food technology, nutriceuticals, agriculture, biofuels, and biomass conversion. Bioenergy generation, Bioethanol and biohydrogen;

Practical

Development of high yielding microbes/plants by chemical mutagens:
Development technique for production for transgenic microbes/plant:
Cloning technique used in secondary metabolite expression in microbes/plants.
Secondary metabolite extraction and purification from microbes/plants.

Texts/References:

1. Gregory N. Stephanopoulos, Aristos A. Aristidou, Metabolic Engineering – Principles and Methodologies, 1st Edition, Jens Nielsen Academic Press, 1998
2. Jaiwal P K, Plant Genetic Engineering: Vol 8-9, Metabolic Engineering and Mol Farming (2005), Studium Press. USA
3. Gerhard Gottschalk, Bacterial Metabolism, 2nd Edition, SpringerVerlag, 1986
4. S. A. Teukolsky, W. T. Vellerling, B. P. Flannery, W. H. Press, Numerical Recipes in C, Cambridge University Press, 1993

M.Sc. Agricultural Biotechnology Semester--IV

Course Title: Industrial and Food Biotechnology **MM- Th 80 + IA 20**
Course No. ABT 413 **Time: 3hrs**

NOTE: In all ten questions will be set, two from each unit. Students are required to attempt five questions i.e. one from each unit.

Unit I

Industrial and Food Biotechnology; Introduction; History; Importance; Applications of biotechnology in food processing; Significant advances; Recent developments; Risk factors; Safety regulations etc.

Unit II

Bioprocessing – Basic principles in bioprocess technology; Media Formulation; Sterilization; Thermal death kinetics; Batch and continuous sterilization systems; Bioprocess control and monitoring variables such as temperature, agitation, pressure, pH Microbial processes-production, optimization, screening, strain improvement, factors affecting down stream processing and recovery; Representative examples of ethanol, organic acids, antibiotics etc. Industrial use of micro organisms; Microbes exploited commercially- *Saccharomyces, Lactobacillus, Penecillium, Acetobactor, Bifidobacterium, Lactococcus, Streptococcus* etc, Dairy fermentation and fermented products

Unit III

Microbial enzymes in food processing; Industrial production of enzymes -proteases and cellulases; Food and beverage fermentation- alcoholic and non alcoholic beverages; Food additives and supplements – probiotics, health care products, vitamins and antibiotics; Fuels and industrial chemicals- Alkanes, industrial ethanol etc.

Unit IV

Modification of microbes/enzymes – Strain improvement, enzyme/ cofactor engineering; Technologies for microbial inactivation; Applications in product development/improvement.

Unit V

Cell immobilization for product enhancement – Classic examples; Biosensors and Bioprocess monitoring; Model systems and process control

Practical

Isolation of industrially important microorganisms for microbial processes
Determination of thermal death point (TDP) and thermal death time (TOT) of microorganism for design of a sterilizer
(a) Determination of growth curve of a supplied microorganism and also determines substrate degradation profile.
(b) Compute specific growth rate (m), growth yield (Yx/s) from the above
Comparative studies of Ethanol production using different substrates
Microbial production of Citric acid usin Aspergillus niger.
Microbial production of antibiotics (Penicillin)
Production and estimation of Alkaline Protease
Sauer Krant fermentation

Texts/References:

1. Gautam, N. C., Food Biotechnology in Comprehensive Biotechnology, Vol. 6., Shree Publishers, New Delhi, 2007
2. Gutierrez – Lopez, G. F. *et. al*., Food Science and Food Biotechnology. CRC Publishers, Washington, 2003
3. Maheshwari, D. K. et. al., Biotechnological applications of microorganisms, IK . International, New Delhi, 2006
4. Stanbury, P. F. et. al., Principles of Fermentation Technology, 2nd Edition, Elsevier, UK, 1995.
5. Waites, M. J. et. al., Industrial Biotechnology: An Introduction, Blackwell publishing, UK, 2007.

M.Sc. Agricultural Biotechnology Semester--IV

Course Title: IPR, Biosafety & Biodiversity **MM- Th 80 + IA 20**
Course No. ABT 414 **Time: 3hrs**

NOTE: In all ten questions will be set, two from each unit. Students are required to attempt five questions i.e. one from each unit.

Theory

Unit I

Introduction to Intellectual Property

Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of GMOs, IP as a factor in R&D; IPs of relevance to Biotechnology and few Case Studies

Agreements and Treaties

History of GATT & TRIPS Agreement; Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty; PCT; Indian Patent Act 1970 & recent amendments

Unit II

Basics of Patents and Concept of Prior Art

Introduction to Patents; Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; Specifications: Provisional and complete; Forms and fees, Invention in context of "prior art"; Patent databases; Searching, International Databases; Country-wise patent searches (USPTO, esp@cenet(EPO), PATENTScope(WIPO), IPO, etc.)

Unit III

Patent filing procedures

National & PCT filing procedure; Time frame and cost; Status of the patent applications filed; Precautions while patenting – disclosure/non-disclosure; Financial assistance for

patenting - introduction to existing schemes, Patent licensing and agreement, Patent infringement- meaning, scope, litigation, case studies

Unit IV

Biosafety

Introduction; Historical Backround; Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels; Biosafety Levels of Specific Micro-organisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals; Biosafety guidelines - Government of India; Definition of GMOs & LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of National Regulations and relevant International Agreements including Cartegana Protocol.

Unit V

Biodiversity

Biodiversity Legislation in India; Indian Biodiversity Act and provisions on crop genetic resources. Convention on Biological Diversity (CBD) and Cartegena protocol on Biosafety; Biodiversity Act 2002; Agricultural biodiversity; International Treaty on Plant Genetic Resources for Food and Agriculture (PGRFA); Conservation strategies for seed gene bank; Climate change and conservation of plant genetic resources; Global efforts for management of crop genetic resources; Strategies on PVFR and Biodiversity Acts; Impact of GE crops on Biodiversity. Functions of International union for the protection of new varieties of plants (UPOV); International treaties relating to Biodiversity; Tutorials shall comprise of Seminars, Group Discussions based on recent case studies.

Texts/References:

1. BAREACT, Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., 2007
2. Kankanala C., Genetic Patent Law & Strategy, 1st Edition, Manupatra Information Solution Pvt. Ltd., 2007

Important Links:

http://www.w3.org/IPR/
http://www.wipo.int/portal/index.html.en
http://www.ipr.co.uk/IP_conventions/patent_cooperation_treaty.html
www.patentoffice.nic.in
www.iprlawindia.org/ - 31k - Cached - Similar page
http://www.cbd.int/biosafety/background.shtml
http://www.cdc.gov/OD/ohs/symp5/jyrtext.htm
http://web.princeton.edu/sites/ehs/biosafety/biosafetypage/section 3.html