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

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

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

NOTE: In all nine questions will be set, two from each unit and one compulsory question of short answer type covering all the units. Students are required to attempt one compulsory question and four others selecting at least one from each unit. All questions are of equal marks.

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 Cellular organelles- Plasma membrane, cell wall and their structural organization,

UNIT II

Cellular organelles- Mitochondria, Chloroplast; Nucleus and other organelles and their organization, Transport of nutrients, ions and macromolecules across membrane. Cellular energy transactions - role of mitochondria and chloroplast, Metabolite pathways and their regulation.

UNIT III

Cell cycle - molecular events and model systems
Cellular responses to environmental signals in plants and animals- mechanisms of signal transduction. Cell motility - cilia, flagella of eukaryotes and prokaryotes, Biology of cancer,

UNIT IV

Cellular basis of differentiation and development- 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

1. Microscopy: Bright field, phase contrast & Fluorescence Microscopy.
2. Microtomy
3. Instrumental methods for Cell Biology
4. Sub cellular fractionation and marker enzymes.
5. Histochemical techniques

6. Mitosis & Meiosis

TEXTS/REFERENCES

1. Lodish et al., Molecular Cell Biology Freeman and Company 2000.
2. Smith and Wood. Cell Biology, Chapman and Halls 1996
3. Watson et al. Molicular Biology of the gene. Pearson Prentice Hall, USA 2003
4. Benjamin Lewin. Gene X, Jones and Barlett Publishers, 2010.

M.Sc. Agri. Biotechnology Semester—I

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

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

NOTE: In all nine questions will be set, two from each unit and one compulsory question of short answer type covering all the units. Students are required to attempt one compulsory question and four other questions selecting at least one from each unit. All questions are of equal marks.

Theory

UNIT I

Chemical foundations of Biology–pH, pK, acids, bases, buffers, stabilizing interactions (van der Waals, electrostatic, hydrogen bonding, hydrophobic interactions, weak bonds, covalent bonds). Principles of thermodynamics, Macro molecular and supra molecular assemblies. Amino acids and peptides-classification and properties, Sugar- classification and reactions.

UNIT II

Polysaccharides- Composition, structure and functions,
Proteins: Classification, hierarchy in structure, Ramachandran Plot,
Nucleic acids-Classification, structure, functions
Type and classification of enzymes, coenzyme, enzyme kinetics (Michaelis-Menten equation, Km, Vmax, turnover number), LB plots, Enzyme inhibition, allosteric enzymes, Immobilised enzymes.

UNIT III

Bio-physical techniques in proteins, nucleic acids and polysaccharides structure analysis (UV/Visible, IR, NMR, LASER, MASS-spectrometry, Fluorescence spectroscopy, X - ray Crystallography, Cryoelectrom microscopy, Isothermal Calorimetry (ITC), Surface Plasmon Resonance, Techniques in separation and characterization of protein and nucleic acid: Chromatography techniques (affinity, ion-exchange, gel filtration, HPLC, Hydrophobic electrophoresis, Iso-electric focussing, 2DE, MudPIT.

UNIT IV

Protein folding: biophysical and cellular aspects
Metabolism of carbohydrate (Glycolysis, Pentose phosphate pathway, Glycogen metabolism, Gluconeogenesis, Citric acid cycle). Lipids (Alpha and beta oxidation of fatty acids, Ketobodies, fatty acid biosynthesis) Metabolism of amino acids and nucleotides, in born errors of metabolism; Electron transport and oxidative phosphorylation.

Practicals

1. Titration of amino acids
2. Colorimetric determination of pK.
3. Reactions of amino acids, sugars and lipids

4. Isolation, purity determination and quantitation of cholesterol, DNA and mRNA
5. Quantitation of Proteins and Sugars,
6. Analysis of oils-iodine number, saponification value, acid number
7. UV/Visible, IR and Fluorescence spectroscopy, Absorption spectra,
8. Separation techniques and characterization of protein and nucleic acid: Chromatography techniques: Centrifugation, Chromatography (Ion-exchange, gel permeation, TLC etc.) and Electrophoresis,

Suggested Readings:

1. Lehninger Principles of Biochemistry 4th Ed ***By*** David L. Nelson and Michael M. Cox, WH Freeman and Company.
2. Chemistry of Biomolecules: an Introduction (Paperback) ***By*** Richard J. Simmonds. Publisher: Royal Society of Chemistry
3. Principles of Biochemistry (Hardcover) ***By*** Geoffrey Zubay. Publisher: McGraw Hill College.
4. Biochemistry ***By*** Lubert Stryer. WH Freeman and Co.
5. Biochemistry: The Molecular Basis of Life (Paperback) ***By*** Trudy McKee and James R McKee. Publisher: McGraw-Hill Higher education.
6. Biochemistry and Molecular biology ***By*** William H. Elliott and Daphne C. Elliott. Oxford University Press.
7. Biochemistry (Hardcover) 3rd Ed**.** ***By*** Donald J. Voet and Judith G. Voet. John Wiley and Sons.
8. Biochemistry: Biomolecules, Mechanisms of Enzyme Action and Metabolism Vol 1 (Hardcover) ***By*** D Voet. John Wiley and Sons.
9. Fundamentals of Biochemistry: Life at the Molecular Level [Import] (Hardcover) ***By*** Donald Voet, Judith G. Voet and Charlotte W. Pratt. Publisher: Wiley.
10. Principles of Biochemistry (Paperback) ***By*** Robert Horton, Laurence A Moran, Gray Scrimgeour, Marc Perry and David Rawn. Pearson Education.
11. Biochemistry ***By*** U. S. Satyanarayana
12. Outlines of Biochemistry ***By*** Eric C Conn, PK Stumpf, G Bruening and Ray H. Doi. John Wiley & Sons.

M.Sc. Agri. Biotechnology **Semester--I**
Course Title: Microbiology *MM. Th 80 + IA 20*
Course No. **ABT 113** Time: 3h

NOTE: In all nine questions will be set, two from each unit and one compulsory question of short answer type covering all the units. Students are required to attempt one compulsory question and four other questions selecting at least one from each unit. All questions are of equal marks.

Theory

UNIT I

The Beginning of Microbiology Discovery of the microbial world by Antony von Leeuwenhoek: spontaneous generation versus biogenesis, Developments of microbiology in the twentieth century. Development of microbiology as a discipline, establishment of fields of medical microbiology, immunology and environmental microbiology with special reference to the work of following *Scientists* : Joseph Lister, Paul Ehrlich, Edward Jenner,Louis Pasteur, Robert Koch, Martinus W. Beijerinck, Sergei N. Winogradsky, Alexander Fleming, Selman A. Waksman, Elie Metchnikoff, Norman Pace, Carl Woese and Ananda M. Chakraborty. Overview of scope of Microbiology; Basic sterilization techniques in microbiology laboratory.
Systematic and Taxonomy, Microbial evolution, Systemics and taxonomy, Evolutionary chronometers, Ribosomal RNA oligonucleotide sequencing, signature sequencing and protein sequencing, Basic concept of Bergey's Manual of systemic bacteriology

UNIT II

Microbial Growth The definition of growth, mathematical expression of growth and generation time, specific growth rate, Synchronous growth; Batch and Continuous culture; Diauxic growth, Growth affected by environmental factors like temperature, pH, water availability, radiation, pressure and oxygen concentration, anaerobic culture. Determination of microbial growth by different methods.Culture collection, and preserving and stocking of pure cultures, pure culture concept, nutritional classification of microorganisms on basis of carbon, nitrogen and electron sources, Different types of bacterial culture media, Calvin cycle and Reductive TCA cycle; Hydrogen, iron and nitrite oxidizing bacteria; Nitrate and sulfate reduction

UNIT III

Prokaryotic Diversity Bacteria: Purple 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; Mycobacteria: Rickettsias, Chlamydies and Mycoplasma. Archaea:
Archaea as earliest Life forms: Halophiles; Methanogens; Hyperthermophilic archaea; Thermoplasma
Eukaryotic : Algae, Fungi, Slime molds and Protozoa.

UNIT IV

Viruses: Structure of Viruses: Capsid symmetry; enveloped and non-enveloped viruses. Isolation purification and cultivation of viruses, Concepts of Viroids, Virusoids, satellite viruses and Prions; life cycle of RNA phages; Lytic and lysogenic phages (lambda and P1 phage), one step multiplication curve, Salient features of TMV, T4 phages, ΦX174 , Hepatitis B virus, Retro viruses.

Prokaryotic Cells: Capsule, Glycocalyx, S-Layer, Detailed structure of Cell walls of Gram positive and Gram negative bacteria, LPS, protoplasts, spheroplasts, L-forms, Flagella and motility, Cell membranes of eubacteria and archaeobacteria, Endospores: structure , functions and stages, mesosomes, bacterial chromosomes, pili, plasmids and transposons. Different types of Mutation and. Ames test for mutagenesis. Bacterial Transformation, Conjugation, Transduction, Interrupted mating experiments.

Genetic systems of Yeast and Neurospora; Extra-Chromosomal Inheritance

Practicals

1. Light microscope demonstration
2. Isolation of pure culture by streaking method.
3. CFU enumeration by spread plate method.
4. Measurement of microbial growth by turbidometry methods.
5. Effect of temperature, pH and carbon and nitrogen sources on growth.
6. Microscopic examination of bacteria by Gram stain,
7. Acid fast stain and bacterial staining for spores and capsule.
8. Bacterial transformation and transduction
9. Biochemical characterization of selected microbes e.g. *E. coli*
10. Isolation of Plasmids/genomic DNA and DNA agarose gel electrophoresis

REFERENCE BOOKS

1. Atlas RM. (1997). Principles of Microbiology. 2 nd edition. WM.T.Brown Publishers.
2. Black JG. (2008). Microbiology: Principles and Explorations. 7 th edition. Prentice Hall
3. Pelczar Jr MJ, Chan ECS, and Krieg NR (2004) Microbiology. 5 th edition Tata McGraw Hill.
4. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). General Microbiology. 5 th edition McMillan.
5. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7 th edition. McGraw Hill Higher Education.

M.Sc. Agri Biotechnology

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

Course No. ABT 114 **Time: 3h**

Theory

NOTE: In all nine questions will be set, two from each unit and one compulsory question of short answer type covering all the units. Students are required to attempt one compulsory question and four other questions selecting at least one from each unit. All questions are of equal marks.

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

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

1. Isolation & quantification of genomic DNA
2. Plasmid isolation
3. Southern blotting
4. RFLP analysis
5. Isolation of RNA
6. Isolation of polyA + RNA
7. Northern blotting
8. Preparation of probes
9. *In vitro* Transcription
10. *In vitro* translation

11. Metabolic labeling of proteins and immune-precipitation

Suggested readings

a. Benjamin Lewin. Gene X, 10th Edition, Jones and Barlett Publishers 2010.
b. J D Watson et al., Biology of Gene, 6th Edition, Benjamin Cummings publishers Inc. 2007
c. Alberts et al., Molecular Biology of the Cell, Garland, 2002
d. Primose SB, Molecular Biotechnology, Panima, 2001.

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

Choice Based Paper

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

Course No. ABT 115 **Time: 3h**

NOTE: In all nine questions will be set, two from each unit and one compulsory question of short answer type covering all the units. Students are required to attempt one compulsory question and four other questions selecting at least one from each unit. All questions are of equal marks.

Theory

Unit I

Sample size estimation and Design of experiments, randomization, replication local control, completely randomized and randomized block design. Types of data, tabular and graphical presentation of data. Measures of location, dispersion and correlation. Measures of central tendency. Mean, mode, median, quartiles, Measures of dispersion—range, standard deviation and error, Regression Analysis, Analysis of variance (ANOVA) for one and two way classification, Probability and statistical inference.

Unit II

Concept and probability distribution. Normal distribution—density curves, applications and statistical tables. Concept of significance tests, tests for proportion, students t and F tests Contingency tables of χ^2 (Chi square), Random Variables and Distributions, Binomial, Poisson, Exponential and Normal Distributions and their applications, Correlation: Simple, Partial and Multiple Correlation, Methods of averages and least squares, polynomial fitting.

Unit III

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 IV

Differential Calculus, Rules of differentiation, Derivatives of implicit functions, Parametric

differentiation, Higher derivatives, 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.

PRACTICALS

1. Calculation for statistical significance in the given data for Student paired and unpaired t-test.
2. Applying ANOVA to the given set of concentration Vs time data of two drug formulations to comment about their bio-equivalence.
3. Applying ANOVA to the given set of treatments Vs cultivar data of agricultural crops for statistical significance.
4. Applying Duncan's multiple range test (DMRT) and/or Tukey's test on given set of data.
5. Construction of diagrams and graphs (line and bar graphs) for statistically significant population in given set of data.

BOOKS

1 Statistical Analysis of Non normal data, By: J.V. Deshpande, A.P. Gore, A. Shanubhogue, New Age International Publishers Ltd.
2 Statistical methods in Animal Sciences, By : V.N. Amble, Indian Society Agricultural Statistics (New Delhi)
3 Statistical Procedure for Agricultural Research By: Kwanchai A Gomes Arturo A.Gomez, John Wiley and Sons.
4 A text book of Agricultural Statistics. By: R. Rangaswamy, New Age International Pvt. Ltd.
5 Statistics for Agricultural Sciences.By: G. Nageswar Rao,Oxford and IBH Publishing Co.
6. SP Gupta, Statistical Methods S Chand and Sons 2004.
7. B L Agarwal, Basic Statistics, New Age. 2003.

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

Course Title: Communication Skills

Course No. ABT 116 ***MM. 50***

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. Agri. Biotechnology **Semester--II**

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

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

NOTE: In all nine questions will be set, two from each unit and one compulsory question of short answer type covering all the units. Students are required to attempt one compulsory question and four other questions selecting at least one from each unit. All questions are of equal marks.

Theory

UNIT I

Scope and Milestones in Genetic Engineering

Genetic engineering guidelines, Molecular Tools and Their Applications, Restriction enzymes, modification enzymes, DNA and RNA markers, 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 II

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 III

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 in gene analysis, 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

1. Bacterial culture and antibiotic selection media. Preparation of competent cells.
2. Isolation of plasmid DNA.
3. Isolation of lambda phage DNA.
4. Agarose gel electrophoresis and restriction mapping of DNA
5. Construction of restriction map of plasmid DNA.
6. Cloning in plasmid/phagemid vectors.
7. Preparation, of helper phage and its titration\
8. Preparation of single stranded DNA template
9. DNA sequencing
10. Gene expression in E. coli and analysis of gene product
11. PCR and Reporter Gene assay (Gus/CAT/b-GAL)

Suggested Readings

a. S B Primrose, R M Twyman, and R W Old. Principles of Gene manipulation. S B University Press, 2001
b. Brown T A. Genomes, 3rd Edition, Garland Science 2006.
c. J Sambrook and DW Russel, Molecular Cloning: A laboratory Manual Vols1-3. CSHL, 2001.
d. DM Glover and B D Hames, DNA cloning, Oxford 1995.
e. Recent reviews in scientific journals.

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

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

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

NOTE: In all nine questions will be set, two from each unit and one compulsory question of short answer type covering all the units. Students are required to attempt one compulsory question and four other questions selecting at least one from each unit. All questions are of equal marks.

Theory

UNIT I

Computers:

An overview of computers, architecture; generations. What is programming? Algorithms. Introduction to MS Office. MS access, Front page and introduction to C, Java and SQL (structured query language). Introduction to computer networking, topology, networking protocol (FTP; TCP/IP). Color, sound and graphics

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, Subroutines. Applications of PERL in bio-informatics.

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.

UNIT IV

Sequence Comparison Methods:

Method for the comparison of two sequences viz., Dot matrix plots, NeedlemanWusch & SmithWaterman algorithms. Analysis of computational complexities and the relative merits and demerits of each method. Theory of scoring matrices and their use for sequence comparison; Statistical analysis and evaluation of FASTA & BLAST; CLUSTAL-X/W; Molecular Phylogeny.

Practicals:

- Computational analysis of genomic proteomic data.
- Network search on genomic and proteomic databases.
- Use of PERL programming for : i) Storing DNA sequence ii) DNA to RNA transcription iii) Counting nucleotides,

- Phylogenetic tree construction.
- **Suggested Readings**
- 1. David W. Mount Bioinformatics: Sequence and Genome Analysis CSHL Press, 2004
- 2. A. Baxevanis and FBF Ouellette, Bioinformatics: A practical guid to the analysis of genes and proteins 2nd eds. John Wiley 2001
- 3. Jonathan Pevsner Bioinformatics and functional genomics Ist Ed. Wiley Liss 2003
- 4. P E Bourne and H. Weissig Structural Bioinformatics Wiley 2003.

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

Course Title: Molecular Breeding **MM. Th 80 + IA 20**
Course No. ABT 213 **Time: 3hrs**

NOTE: In all nine questions will be set, two from each unit and one compulsory question of short answer type covering all the units. Students are required to attempt one compulsory question and four other questions selecting at least one from each unit. All questions are of equal marks.

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. Plant Genome – Nuclear and cytoplasmic; Significance of organelle genomes; Genome size and sequence components; Modern gene concept - Gene structure, structural and functional genes.

Unit II
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, Gene flow in plants – Development of mapping population – Marker Assisted Selection (MAS), screening and validation;

Unit III
Trait related markers and characterization of genes involved; Mapping genes on specific chromosomes; QTL mapping; Gene pyramiding; Transcript mapping techniques. Development of ESTs Unit IVMolecular 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,

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

Practicals

1. DNA extraction, purification and 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, application 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--II

Course Title: Plant Molecular Biology MM. **Th 80 + IA 20**
Course No. ABT 214 **Time: 3h**

NOTE: In all nine questions will be set, two from each unit and one compulsory question of short answer type covering all the units. Students are required to attempt one compulsory question and four other questions selecting at least one from each unit. All questions are of equal marks.

Theory

Unit I
Solute movement; Water relations; Concept of plasticity in plant development; Analysing plant growth; Mobilization of food reserves during seed germination; Hormonal control of seed germination and seedling growth; Tropisms. Floral Induction and Development; Photoperiodism and its significance; Inflorescence and floral determination; Molecular genetics of floral development and floral organ differentiation; Sex determination; Source-sink relationship

Unit II
Carbon Assimilation; Carbon dioxide uptake and assimilation; Calvin Cycle; Hatch-Slack pathway; Reductive pentose phosphate pathway; Photorespiration; Glycolate metabolism; Molecular biology of photosynthetic processes

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

Unit III

Signal Transduction – Basic concepts; Receptors and G-proteins; Cyclic AMP cascade; Phospholipid and Ca^{2+}-calmodulin cascade; MAP kinase cascade; Sucrose sensing mechanism.
Senescence and Programmed Cell Death (PCD) – Senescence and its regulation; Hormonal and environmental control of senescence; PCD in the life cycle of plants.

Unit IV
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.

Practicals

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

Suggested Readings

1. Lincoln Taiz, Eduardo Zeiger, Plant Physiology, Sinauer Associates, 2010.
2. Bob Buchanan, Wilhelm Gruissem, Russell Jones, Biochemisrtry and Mol Biol Of Plants. John Wiley and Sons, 2002.

M.Sc. Agriculture Biotechnology Semester—II
Choice based paper
Course Title: Plant Tissue Culture **MM. Th 80 + IA 20**
Course No. ABT 215

Time: 3hrs

NOTE: In all nine questions will be set, two from each unit and one compulsory question of short answer type covering all the units. Students are required to attempt one compulsory question and four other questions selecting at least one from each unit. All questions are of equal marks.

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

Unit III

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 IV

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, micronutrients, 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 and regeneration of shoots,
4. *In vitro* root induction and transplantation of in vitro-raised plants
5. Anther culture
6. 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: Plant Genetic Engineering **MM. Th 80 + IA 20**

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

NOTE: In all nine questions will be set, two from each unit and one compulsory question of short answer type covering all the units. Students are required to attempt one compulsory question and four other questions selecting at least one from each unit. All questions are of equal marks.

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; Gene stability and gene silencing, gene stacking,

Unit II

Viral resistance: coat protein mediated, nucleocapsid gene, antisense and RNAi, **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.

Unit III

Drought, salinity, thermal stress, flooding and submergence tolerance: perception and signaling of stress**,** osmoprotectants, stress proteins, oxidative stress**, 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 IV

Genetic engineering for increasing crop productivity: enhancing photosynthetic, nutrient use and nitrogen fixing efficiencies of plants, **Genetic Engineering for quality improvement**: Seed storage proteins; essential amino acids, Vitamins and minerals, heterologous protein production in transgenic plants, biodegradable plastics, Plants as biofactories, Biosafety and risk assessment of GM 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. RT-PCR 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, 2006.
4. Denis Murphy, Plant Breeding and Biotechnology: Societal Context and the Future of Agriculture, Cambridge University Press, 2007.
5. P K Gupta Plant Biotechnology, Rastogi Publication, Meerut, India.

M. Sc. Agri. Biotechnology **SEMESTER-III**

Course Title: Plant Metabolic Engineering & Mol. Farming **MM. Th 80 + IA 20**
Course No. -ABT 312 **Time: 3hrs**

NOTE: In all nine questions will be set, two from each unit and one compulsory question of short answer type covering all the units. Students are required to attempt one compulsory question and four other questions selecting at least one from each unit. All questions are of equal marks.

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 composition and content of starch, amino acids (lysine and sulfur containing) and oil.

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 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 IV

Metabolic Engineering to improve tolerance of plants to abiotic factors/climate change, biodegradable plastics. Applications of Metabolic Engineering - in pharmaceuticals (edible vaccines, plantibodies etc), 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.

Suggested Readings

1. Gregory N. Stephanopoulos, Aristos A. Aristidou , Jens Nielsen. Metabolic Engineering:Principles and Methodologies
2. J. Nielsen , Metabolic Engineering, Springer, 2001
3. Reviews from Metabolic Engineering journal, Elsevier
4. P K Jaiwal (ed), Plant Genetic Engineering Vols. 7 & 8: Metabolic Engineering and Molecular Farming- I and II, Studium Press LLC, USA. 2006.

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

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

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

NOTE: In all nine questions will be set, two from each unit and one compulsory question of short answer type covering all the units. Students are required to attempt one compulsory question and four other questions selecting at least one from each unit. All questions are of equal marks.

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 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..

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; **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; 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

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

Practicals

RAPD

Identification of SSR molecular markers from EST using computational approach.

PAGE and SDS-PAGE

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
5. Glick BR & Pasternak JJ, Molecular Biotechnology, 3rd ed, ASM Press, 1998

M.Sc. Agricultural Biotechnology **Semester--III**
Course Title: Abiotic and biotic stress biology **MM. Th 80 + IA 20**
Course No. ABT 314 **Time: 3hrs**

NOTE: In all nine questions will be set, two from each unit and one compulsory question of short answer type covering all the units. Students are required to attempt one compulsory question and four other questions selecting at least one from each unit. All questions are of equal marks.

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.

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

Waste water collection; control and management; Waste water treatment; Sewage treatment through chemical, microbial and biotech techniques; 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 drought, salinity, heat and cold stress, Ionic and osmotic homeostasis; Stress perception and stress signaling pathways, Oxidative stress and 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.

Responses of plants to nutrient deficiency - Phosphorous and Iron deficiencies; Physiological and molecular biology of heavy metal tolerance; Bioremediation of contaminated soils and waste land; Bioremediation of contaminated ground water; Phytoremediation of soil metals

Unit IV

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. 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
2. Rapid screening tests for abiotic stress tolerance (drought, salinity - PEG, Mannitol & NaCl)
3. Estimation of antioxidants and antioxidant enzymes - Ascorbate, Superoxide dismutase, Catalase, and Peroxidase
4. Major insect, nematode pests and diseases of crop plants – study of phytotoxaemia and other categories of insect damage in crop plants
5. 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

Suggested readings

1. Pareek, A.; Sopory, S.K.; Bohnert, H.J.; Govindjee (Eds.) Abiotic Stress Adaptation in Plants, Springer, 2010,
2. Heribert Hirt, Plant Stress Biology: From Genomics to Systems Biology, Copyright Wiley-VCH Verlag GmbH & Co. 2010
3. Tuteja N, Sarvajeet Singh Gill, Tuteja R (Editors) Omics and Plant Abiotic Stress Tolerance (2011), Bentham Science Publishers, UAE & USA. (eISBN: No.: 978-1-60805-058-1)
4. Narendra Tuteja, Sarvajeet Singh Gill, Antonio F Tubercio and Renu Tuteja (Editors) Improving Crop Resistance to Abiotic Stress (2011) Volume 1 & 2, Wiley Wiley-VCH Verlag GmbH & Co. Weinheim, Germany, ISBN 978-3-527-32840-6
5. David M. Orcutt, Erik T. Nilsen, The Physiology of Plants Under Stress: Soil and Biotic Factors, Volume 2, Jon Wiley Publ.

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

Choice based paper

Course Title: INDUSTRIAL AND FOOD BIOTECH.

Course No. ABT 315 **MM. Th 80 + IA 20**

Time: 3hrs.

NOTE: In all nine questions will be set, two from each unit and one compulsory question of short answer type covering all the units. Students are required to attempt one compulsory question and four others selecting at least one from each unit. All questions are of equal marks.

Theory:

UNIT I

Industrial and food Biotechnology: Introduction, history, importance, applications of biotechnology in industry and food processing, significant advances, recent developments, risk factors, safety regulations.

UNIT II

Bioprocessing- Basic principles in bioprocess technology, media formulation, sterilization, thermal death kinetics, batch and continous 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, Representive examples of ethanol, organic acids, antibiotics etc. Industrial microorganisms, microbes exploited commercially- Saacharomyces, Lactobacillus, Pencillium, Acetobactor, Bifidobacterium, Lactococcus, Streptococcus, etc. Dairy fermentation and fermented products.

UNIT III

Microbial enzymes in food processing, Industrial production of enzymes, Food and Beverages fermentation- alcoholic and non-alcholic beverages, Food additives and supplements- probiotics, health care products, vitamins and antibiotics, Fuel and industrial chemicals –alkanes, industrial ethanol etc.

UNIT IV

Modification of microbes, /enzymes-strain improvement, enzymes/cofactor engineering, Technologies for microbial inactivation, Applications in product development and improvement. Cell immobilization for product enhancement-Classical examples, Biosensor and Bioprocess monitoring, model systems and process control.

Practicals:

Isolation of industrially important microorganisms for microbial process.

Determination of thermal death point and thermal death time of a microorganism for design of a sterilizer.

Determination of growth curve of a supplied microorganism and also determine substrate degradation profile.

Compute specific growth rate (m), growth yield (Y x/s) from the above

Comparative studies of ethanol production using different substrates.
Microbial production of citric acid using Aspergillus niger
Microbial production of antibiotic (Pencillin)
Production and estimation of Alkine Protease
SauerKrant fermentation.

Suggested Reading

1. Gautam NC, Food Biotechnology in Comprehensive Biotechnology, Vol 7. Shree Publishers NeW Delhi 2007
2. Gutierrez-Lopez GF et el., Food Science and Food Biotechnology, CRC Press, Washington, 2003.
3. Maheshwari DK et al., Biotechnological application of microorganisms, IK International New Delhi 2006.
4. Stanbury PF et al., Principles of Fermentation Technology, Elsevier UK, 1995.
5. Waites M J et al Industrial Biotechnology: An introduction. Blackwell Pub. UK, 2007.

M. Sc. Agri. Biotechnology Semester-IV

Course Title: Animal Biotechnology and Immunology
Course No. ABT 411 **MM. Th 80 + IA 20**
Time: 3hrs.

NOTE: In all nine questions will be set, two from each unit and one compulsory question of short answer type covering all the units. Students are required to attempt one compulsory question and four others selecting at least one from each unit. All questions are of equal marks.

Theory

Unit I

History of animal cell culture, Cell culture media and equipments, Culture of animal cells, tissues and organs, primary culture, secondary culture, continuous cell lines, suspension cultures, somatic cell cloning and hybridization, transfection and transformation of cells, commercial scale production of animal cells. Applications of animal cell cultures.

Unit II

Structure of sperm and ova, cryopreservation of sperm and ova of livestock, artificial insemination, super ovulation, *in vitro* fertilization, cryopreservation and culture of embryo, embryo transfer, embryo splitting, embryo sexing, transgenic manipulation of animal embryos. Different applications of transgenic animal technology. Animal cloning: basic concept, cloning of embryonic and adult cells.

Unit III

History and scope of immunology, components of immune system: organ tissues and cells. Nature and Biology of antigens and super antigens, Antibody structure and function, Antibody diversity, Antigen - antibody interactions, Major histocompatibility complex, Regulation of immune response: Antigen processing and presentation, generation of humoral and cell mediated immune responses: Activation of B and T Lymphocytes; Cytokines and their role in immune regulation,

UNIT IV

Cell-mediated cytotoxicity; Mechanism of T cell and NK cell mediated lysis, antibody dependent cell mediated cytotoxicity, macrophage mediated cytotoxicity, Hypersensitivity, Immunological tolerance; Autoimmunity, immunodeficiencies, vaccines. Antigen-antibody based diagnostic assays.

Practicals
ANIMAL BIOTECHNOLOGY
Preparation of single cell suspension from spleen and thymus
Cell counting and cell viability

Trypsinization of monolayer and sub culturing
Cryopreservation and thawing
Measurement of doubling time
Role of serum in cell culture
Preparation of metaphase chromosomes from cultured cells
Isolation of DNA and demonstration of apoptosis of DNA laddering
MTT assay for cell viability and growth
Cell fusion with PEG

IMMUNOLOGY

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
Western-blotting
ELISA

Suggested Readings

1. Kuby Immunology (2006) by Thomas J. Kindt, Richard A. Goldsby, Barbara A. Osborne, Janis Kuby (W.H. Freeman).
2. Immunology- A short course (2009) by Richard Coico, Geoffrey Sunshine (Wiley Blackwell).
3. Understanding immunology (2007) by Peter John Wood, Dorling KInderseley (Pearson Education, India).
4. Immunology (2007) by Kannan, I (MJP Pulishers,
5. Freshney I. Culture of Animal Cells: A Manual of Basic Technique, 5th Edition Publisher: Wiley-Liss, 2005 ISBN: 0471453293 |
6. Nigel Jen, Animal Cell Biotechnology:Methods and protocols, Humana Press
7. Gordon I 2005, Reproductive Techniques in farm animals CABI.

M. Sc. Agri. Biotechnology **Semester-IV**

Choice Based Paper 1

Course Title: IPR, BIOSAFETY, SOCIAL & ETHICAL ISSUES IN BIOTECHNOLOGY

Course No. ABT 412 **MM. Th 80 + IA 20**

Time: 3hrs.

NOTE: In all nine questions will be set, two from each unit and one compulsory question of short answer type covering all the units. Students are required to attempt one compulsory question and four others selecting at least one from each unit. All questions are of equal marks.

Theory:

UNIT I

IPR - patents and copyrights. Patentability of life forms with special reference to Microorganisms, Pharmaceutical industries, Biodiversity, Naturally occurring substances. GMO, Human genome and IPR. Issue on IPR in Public-Private partnership. Availabilities of Patent facilitating funds, Substantive Patent Law Treaty (SPLT), World patent, European Patent

UNIT II

Social- genetic discrimination: insurance and employment, human cloning, foeticide, sex determination.

Ethical: somatic and germ line gene therapy, clinical trials, ethical committee function. Social and ethical issues

UNIT III

Bio-safety - Definition, Requirement, Bio-safety containment facilities, biohazards, genetically modified organisms (GMOs), living modified organisms (LMOs), Biosafety for human health and environment designing and management of laboratory and culture room as per the norm of GLP, GMP and FDA.

UNIT IV

Management-Planning, Organizing, Leading & Controlling; Concepts and characteristics of information; Importance of MIS; Communication - type, channels & barriers; Financial management, planning and *control,* Characteristics of agricultural products; Problems of processed food marketing; Procurement & distribution systems; Location factors and other problems in processing of agricultural products.

Suggested Reading

1. Peter Dabrock, Jochen Taupitz , Jens Ried (Editor) Trust in Biobanking: Dealing with Ethical, Legal and Social Issues in an Emerging Field of Biotechnology. Springer, 2012.
2. Robert A. Bohrer, A Guide to Biotechnology Law and Business, Carolina Academic Press, 2007.
3. Richard Sherlock & JD Morrey, Ethical Issues in Biotechnology, 2002.
4. Selected papers from scientific journals and websites

M.Sc. Agricultural Biotechnology **Semester—IV**
Choice Based Paper II
Course Title: Nano-biotechnology **MM. Th 80 + IA 20**

Course No. ABT 413 **Time: 3hrs**

NOTE: In all nine questions will be set, two from each unit and one compulsory question of short answer type covering all the units. Students are required to attempt one compulsory question and four other questions selecting at least one from each unit. All questions are of equal marks.

Theory

UNIT I

Nanotechnology- The Nano-Bio interface; **Bionanotechnology: An overview-** From Biotechnology to Bionanotechnology. **Bio-nanomachines in action**- A molecular recognition: How molecular recognition underlies cellular communication, material transfer into and within cells, and biotransformation. **Biophysics:** Bio-electromagnetism, bioenergetics, biomechanics, neurotransport, biological rhythyms. **Modern Biomaterials:** Proteins, Nucleic Acids, Lipids and Polysaccharides.

UNIT II

Nanomaterials - [Natural nanomaterials, engineered nanomaterials (Carbon based nanomaterials; Metal based nanomaterials, Dendriemers, composites)]; Preparation of different nanomaterials (Gold, Silver and Zinc oxide nanoparticles etc.) Criteria for suitability of nanostructures for biological applications.

UNIT III

Nanomaterials and plant interactions- Nanomaterials for crop improvement [carbon based nanomaterials, magnetic nanomatertials, metal based nanomaterials (Gold, Palladium and silver nanoparticles); metal oxide based nanomaterials (ZnO & TiO_2 nanoparticles)]; **Nanoparticles driven genetic engineering for crop improvement** - nanoparticles as transgene vehicles for developing transgenic plants with novel properties. Other developments in the agricultural sector due to nanotechnology.

UNIT IV

Plant diseases-control and remedy through nanotechnology: Nan-formulations for the control of plant diseases; nanoparticles for the control of plant diseases and pest incidences in plants (Silver nano-particles & Nano-Silver-Silica composites); nano-silica, TiO_2, carbon & magnetic nanoparticles. Detection of plant diseases through nanotechnology

SUGGESTED BOOKS

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. Agri. Biotechnology **Semester-IV**

Course Title: Dissertation
Course No. ABT 414 **MM. 200 (Dissertation 150 +viva voce 50)**