SCHEME OF EXAMINATION
M.Sc. Agriculture Biotechnology
(As per Choice Based Credit System w.e.f. the Academic Year from session 2016)

Program Specific Outcome

PSO1. The M.Sc. Agriculture Biotechnology programme is designed in a way to equip the students with theoretical knowledge, research capability (dissertation work), communication and management skills (IPR Bio safety, Ethical, Legal, Social issues in Ag. Biotech) which, in turn, allow the students to become efficient researchers to start their carrier in research through Ph.D. & other R & D programmes.

PSO2. The course discusses the modern tools and techniques of genomics and isolation and identification of genes. An education in cell biology helps the students to understand the origins of cells and the generation of cell diversity, as well as the common features of cellular structure and function – how they obtain energy, synthesize new molecules, communicate, proliferate and survive. This course will also provide the description of diversified branches of Microbiology.

PSO3. The course discusses about plant tissue culture and its application in crop improvement, Recombinant DNA technology and cloning vectors and different methods of gene transfer in plants. To explain the conventional breeding practices and the advanced strategies using biotechnological approaches. Students will become familiar with a wide variety of bioinformatics tools and softwares and apply these to conduct basic bioinformatics research and thus develop platform for molecular biology experiments.

PSO4. The students will be provided with a firm understanding in the principles and application of agriculture biotechnology. To understand the diversity and complexity of eukaryotic and prokaryotic genomes, their historical as well as evolutionary perspective and techniques commonly employed in studying genomics and proteomics. To learn about plant primary and secondary metabolites, regulation of metabolic pathways, metabolic flux analysis and applications of metabolic flux analysis, methods for the experimental determination of metabolic fluxes. Students will acquire knowledge to develop climate resilient crops.

PSO5. The students will be provided with a firm understanding of the basics of the four primary forms of intellectual property rights, the right of ownership, scope of protection as well as the ways to create and to extract value from IP. They will also learn to identify activities and constitute IP infringements and the remedies available to the IP owner and describe the precautious steps to be taken to prevent infringement of proprietary rights in products and technology development.

The entire course will be of four semesters. Each student earn a minimum of 112 credits over the entire course (Core = 60; Foundation course = 2; Open elective = 6).

M. Sc Agriculture Biotechnology (Semester I & II)

(As per Choice Based Credit System w.e.f. the Academic Year from session 2016)

In Semester I, there would be five core papers (Four Theory Papers and Two Practicals) and in Semester II there would be four core (Four Theory Papers and Two Practicals). Each student will opt for at least one foundation elective (minimum 2 credits) and an open elective course (minimum 3 credits) in Semester II.

M.Sc. Agriculture Biotechnology Choice Bases Credit System (CBCS)

Semester I

Sr. No.	Course Code	Subject/Title	Credits	Marks Theory	Marks Int Ass
1	16ABT21C1	Cell Biology	04	80	20
2	16ABT21C2	Bio molecules & Metabolism	04	80	20
3	16ABT21C3	Microbiology	04	80	20
4	16ABT21C4	Molecular Biology	04	80	20
5	16ABT21C5	Genetic Engineering	04	80	20
6	16ABT21CL1	Lab course-I (Cell Biology, Bio molecules)	04	100	
7	16ABT21CL2	Lab course-II {Microbiology (16ABT21C3), Molecular Biology (16ABT21C4), Genetic Engineering(16ABT21C5)}	04	100	
	Total		28		

Semester II

Sr. No.	Course Code	Subject/Title	Credits	Theory	Int Ass
1	16ABT22C1	Plant Tissue Culture	04	80	20
2	16ABT22C2	Molecular Breeding	04	80	20
3	16ABT22C3	Plant molecular biology	04	80	20
4	16ABT22D1 Or 16ABT22D2 Or 16ABT22D3	Bioinformatics/ Green House Management and Plant Protection/ Biomass and Bio energy	04	80	20
5	Open Elective	To be chosen from the basket of open Electives provided by the university	03		
6	Foundation Course	To be chosen from the basket of Foundation Course provided by the university	02		
7	16ABT22DL	Lab course-I {Plant Tissue Culture	04	100	

		(16ABT22C1)}, {Bioinformatics/ Green House Management and Plant Protection/ Biomass & Bio energy (16ABT22D1/D2/D3}			
8	**16ABT22CL**	**Lab course-II {Mol. Breeding (17ABT22C2), Plant Molecular Biology (17ABT22C3)}**	**04**	**100**	
	Total		**29**		

M. Sc Agriculture Biotechnology (Semester III & IV)

(As per Choice Based Credit System w.e.f. the Academic Year from session 2016)

In Semester III, there would be four core papers (Four Theory Papers and Two Practicals) and in Semester IV, there would be two core (Two Theory Papers and Dissertation). Each student will opt for at least one open elective course (minimum 3 credits) in Semester III.

M.Sc. Biotechnology Choice Based Credit System (CBCS) 2016-2017

Semester III

Sr. No.	Course Code	Subject/Title	Credits	Theory	Int Ass
1	17ABT23C1	Plant Genetic Engineering	04	80	20
2	17ABT23C2	Genomics and Proteomics	04	80	20
3	17ABT23DA1 or 17ABT23DA2	Plant Metabolic Engineering & Molecular Farming (DA1)/Biotic and Abiotic Stress Biology(DA2)	04	80	20
4	17ABT22DB1/DB2/DB3	Industrial & Food Biotech/ Crop Protection & Integrated Pest Management/ Biostatistics & Agro-economics	04	80	20
5	Open Elective	To be chosen from the basket of Open	03		
		Electives course provided by the university			
6	17ABT23CL	Lab course-I (Plant Genetic Engg, Genomics and Proteomics) (17ABT23C1, 17ABT23C2)	04	100	
7	17ABT23DL	Lab course-II 17ABT23DA1/ 17ABT23DA2 and 17ABTDB1/DB2/DB3	04	100	
		Total	27		

Semester IV

Sr. No.	Course Code	Subject/Title	Credits	Theory	Int Assss
1	18ABT24C1	IPR Bio safety, Ethical, Legal , Social issues In Agriculture Biotechnology	04	80	20
2	18ABT24C2	Animal Biotechnology & Immunology	04	80	20
3	18ABT24C3	Dissertation	20	300	
	Total		28		

Total credits=112

AGRICULTURE BIOTECHNOLOGY (SEMESTER-I)

Course Code No. 16 ABT21C1 **MM. Th 80 + IA 20**
Course Title: Cell Biology **Time: 3h**

COURSE OUTCOMES

CO1. An education in cell biology helps the students to understand the origins of cells and the generation of cell diversity, as well as the common features of cellular structure and function – how they obtain energy, synthesize new molecules, communicate, proliferate and survive.

CO2. Students will understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles.

CO3. Students will understand the cellular components underlying mitotic cell division.

CO4. The understanding of cells is used for learning the processes such as, absorption, how electrical signals are carried, secretion, why some things such as lack of oxygen can cause death, etc.

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.

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 and 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

SUGGESTED READINGS

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. Molecular Biology of the gene. Pearson Prentice Hall, USA 2003
4.Benjamin Lewin. Gene X, Jones and Barlett Publishers, 2010.

AGRICULTURE BIOTECHNOLOGY (SEMESTER-I)

Course Code No.16 ABT21C2 **MM. Th 80 + IA 20**

Course Title: Biomolecules & Metabolism **Time: 3h**

COURSE OUTCOMES

CO1. Basic knowledge of structure and functions of major bio-molecules

CO2. Understanding of metabolic pathways (catabolism as well as anabolism), their diversity and how these are specifically regulated and interrelated in different cells

CO3. Practical knowledge and hands on tools and techniques for the characterization of bio-molecules.

CO4. Concepts of enzyme kinetics, regulation and specificity

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.

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, hierarchyin 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, Immobilisedenzymes.

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 andnucleic 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, inborn 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,puritydetermination and quantitation of cholesterol, DNA and mRNA

5.Quantitationof 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 Biochemistry4th 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. Principlesof 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. Biochemistryand Molecular biology***By*** William H. Elliott and Daphne C. Elliott. Oxford University Press.
7. Biochemistry(Hardcover) 3rd Ed**.** ***By*** DonaldJ. Voet and Judith G. Voet. John Wileyand Sons.
8. Biochemistry: Biomolecules, Mechanisms of Enzyme Action and Metabolism Vol 1 (Hardcover) ***By*** D Voet. John Wileyand Sons.
9. Fundamentals of Biochemistry: Life at the Molecular Level [Import] (Hardcover)
By Donald Voet, JudithG. Voetand 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.

AGRICULTURE BIOTECHNOLOGY (SEMESTER-I)

Course Code No.16 ABT21C3 **MM. Th 80 + IA 20**
Course Title: Microbiology **Time: 3h**

COURSE OUTCOMES

CO1. This study provides the description of diversified branches of Microbiology.

CO2. This study provides knowledge on microbial growth and physiology.
CO3. This study provides knowledge on morphology and physiological characteristics of different groups of microorganisms.
CO4. This study throws light on virus cultivation, phages and bacterial/yeast genetics.

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.

UNIT I

The Beginning of Microbiology, Discovery of the microbial world by Antonyvon 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 inmicrobiologylaboratory. 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; Buddingand appendaged bacteria; Spirilla; Spirochaetes; Glidingand sheathed bacteria;Pseudomonads; Lactic andpropionic acid bacteria; Mycobacteria: Rickettsias, Chlamydies and Mycoplasma. Archaea: Archaea as earliest Life forms: Halophiles; Methanogens; Hyperthermophilic archaea; Thermoplasma Eukaryotic: Algae, Fungi, Slime molds andProtozoa.

UNIT IV

Viruses: Structure of Viruses: Capsid symmetry; enveloped and non-enveloped viruses. Isolation purification and cultivation of viruses, Conceptsof Viroids, Virusoids,satellite viruses and Prions; life cycle of RNA phages; Lytic and lysogenic phages (lambda and P1 phage), onestep multiplication curve, Salient featuresof 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 matingexperiments. Genetic systems of Yeast andNeurospora; 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.Acidfast stainand bacterial staining for spores and capsule.
8.Bacterial transformation and transduction
9.Biochemical characterization of selected microbes e.g. *E. coli*
10.Isolationof Plasmids/genomic DNA and DNA agarose gel electrophoresis

Reference Books

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

AGRICULTURE BIOTECHNOLOGY (SEMESTER-I)

Course Code No.16 ABT21C4 **MM. Th 80 + IA 20**
Course Title: Molecular Biology **Time: 3h**

COURSE OUTCOMES

CO1. Describe DNA replication, recombination and repair, transcription and translation
CO2. Discuss the modern tools and techniques of genomics and isolation and identification of genes.
CO3. Understand the biology and application of antisense technologies, biology of cancer

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.

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 designingribozymes, Applications of Antisense andribozyme 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 & quantification
3.Southernblotting
4.RFLP analysis
5.Isolation and quantification of RNA
6.Isolation of polyA + RNA
7.Northernblotting
8.Preparationof probes
9.*In vitro* Transcription
10.*In vitro* translation
11.Metabolic labeling of proteins and immune-precipitation

Suggested readings

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

AGRICULTURE BIOTECHNOLOGY (SEMESTER-I)

Course Code No.16 ABT21C5 **MM. Th 80 + IA 20**
Course Title: Genetic Engineering **Time: 3h**
COURSE OUTCOMES

CO1. Students will become familiar with the tools and techniques of genetic engineering- DNA manipulation enzymes, genome and transcriptome analysis and manipulation tools, gene expression regulation, production and characterization of recombinant proteins.
CO2. This course exposes students to the applications of genetic engineering in biological research.
CO3. Students will be able to perform basic genetic engineering experiments at the end of course.
CO4. Students will acquire knowledge of advances in biotechnology- healthcare, agriculture and environment cleanup via recombinant DNA technology.

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.

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, S1mapping, 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. Cloningin 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

1.S BPrimrose, R M Twyman, and R WOld.Principles of Gene manipulation.S B UniversityPress, 2001
2.BrownTA. Genomes, 3rd Edition,Garland Science 2006.
3.J Sambrookand DWRussel, Molecular Cloning: A laboratoryManual Vols1-3. CSHL, 2001.
4.DM Glover and B D Hames,DNA cloning, Oxford1995.
5.Recent reviews in scientificjournals.

AGRICULTURE BIOTECHNOLOGY (SEMESTER-I)

Lab Course-I (Cell biology, Biomolecules and metabolism)
COURSE OUTCOMES

CO1. Good cell culture practice, including biosafety procedures, control of facilities, equipment, reagents
CO2. Qualitative characteristics of mammalian cell cultures: cell counting and analysis.
CO3. The major stages of the cell cycle (Mitosis, Meiosis).
CO4. Assess the viability and proliferation of cells grown under various experimental conditions using the MTT Cell Proliferation Assay
CO5. Separation of Cells by Velocity Sedimentation, to experimentally study the process of osmosis**.** Isolation, purity determination and quantitation of cholesterol, DNA and mRNA, quantification of proteins/sugars by spectrophotometer methods, purification and characterization of proteins by gel filtration, ion-exchange chromatography

AGRICULTURE BIOTECHNOLOGY (SEMESTER-I)

Lab Course-II (Microbiology, Molecular biology & Genetic Engg.)
COURSE OUTCOMES

CO1. Gram staining to differentiate bacteria into gram-positive and gram-negative bacteria In addition, spore staining, capsule staining as well as acid-fast staining of saprophyte such as *M. smegmatis* is being done.
CO2. Pure culture by streaking method and bacterial CFU enumeration Isolation of bacterial chromosomal and plasmid DNA is being done and their quantification by nanodrop method, UV-visible spectrophotometer and identification on agarose gel electrophoresis.
CO3. Isolation of lamda phage DNA, preparation of competent cells and transformation of competent cells is being performed.
CO4. Gene expression in *E. coli* and analysis of gene product is being performed.
CO5. PCR and reporter Gene assay is being performed. Students can set experiments on Southern blotting, Western blotting, RFLP analysis and isolation/characterization of microbial RNA is being performed.

AGRICULTURE BIOTECHNOLOGY (SEMESTER-II)

Principles and Application of Agriculture Biotechnology-I

COURSE OUTCOMES

CO1. To trained the students about different Tools and techniques used in agriculture biotechnology, Scorable and selectable markers, PCR, C-DNA and genomic libraries.

CO2. To teach about Plant tissue culture and its application in crop improvement, Recombinant DNA technology and cloning vectors and different methods of gene transfer in plants.

CO3. To teach the students about Genetic and Molecular basis of Heterosis and Apomixis and their significance, role of Mutations and polyploidy in crop improvement, Molecular markers and improvement of crop plants for the increase in iron, protein and amino acids.

AGRICULTURE BIOTECHNOLOGY (SEMESTER-II)

Course Code No.17ABT22C1 **MM. Th 80 + IA 20**
Course Title: Plant Tissue Culture **Time: 3h**

COURSE OUTCOMES

CO1. Students would understand the importance of Plant Tissue Culture in various aspects like asceptic culture conditions, culture media, organogenesis, somatic embryogenesis, micro-propagation.
CO2. Students will be able to describe and use of bioreactor for large-scale production of alkaloids and other secondary metabolites through cell culture techniques,
CO3. Students will be able to explain artificial seeds, production of virus free plants, androgenesis and gynogenesis, somaclonal and gametoclonal variations and the production of novel crop plant varieties by using *vitro* pollination and fertilization, somatic hybrids and cybrids and Plant Genetic resources and their cryopreservation.

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.

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 secondarymetabolites.
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 andantibiotics.
2.Surface-sterilization of seeds, establishment of axenic plants, acclimatization of tissue culture plants and establishment in greenhouse.
3.Callusinduction 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.

AGRICULTURE BIOTECHNOLOGY (SEMESTER-II)

Course Code No.17ABT22C2 **MM. Th 80 + IA 20**
Course Title: Molecular Breeding **Time: 3h**

COURSE OUTCOMES

CO1. To explain the conventional breeding practices and the advanced strategies using biotechnological approaches.

CO2. To learn about the selection of suitable genotyping tools for applications including assessment of molecular breeding, conservation genetics, gene flow and quantitative genetics.

CO3. To understand the application of MAS (Marker Assisted Selection) strategies in various plant breeding programmers for the development of new plant varieties with enhanced quality traits.

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.

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 mappingpopulation – Marker Assisted Selection (MAS), screeningand 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, Molecular markers for plant genotyping and germplasm analysis; Fidelity analysis; settling IPR issues; Marker Assisted Breeding in transgenics – herbicide resistance; Pest anddisease resistance; Qualityenhancement 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. Isolation of DNA, DNApurity and quantification tests
2. Agarose gel electrophoresis and restriction mapping of DNA
3. PCR amplification and PCR-based DNA markers.
4. Southern blotting
5. Preparation of probes
6. Phylogenetic relationship, construction of genetic linkage maps using computer softwares.
7. DNA finger printing methods.

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.HenryR. J., Plant Genotyping: The DNA fingerprinting of plants. CABI, New Delhi, 2005.

AGRICULTURE BIOTECHNOLOGY (SEMESTER-II)

Course Code No.17ABT22C3 **MM. Th 80 + IA 20**
Course Title: Plant Molecular Biology **Time: 3h**

COURSE OUTCOMES

CO1. Development of transgenic plants for crop improvement and plant protection
CO2. Understanding of novel plant genes and regulation of their expression
CO3. Major focus of the subject is to develop the laboratory skills

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.

UNIT I

Solute movement; Water relations; Concept of plasticity in plant development; Analyzing 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-Slackpathway; 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-plantsymbiosis; 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 – 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 mutantsinunderstandinghormone action.
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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.
ob Buchanan, Wilhelm Gruissem, Russell Jones, Biochemisrtry and Mol Biol of Plants. John Wiley and Sons,2002.
17.

AGRICULTURE BIOTECHNOLOGY (SEMESTER-II)

Course Code No.17ABT22D1 **MM. Th 80 + IA 20**
Course Title: Bioinformatics **Time: 3h**
COURSE OUTCOMES

- **CO1.** Students will be able to describe and use the biological databases, perform structured query and analyze and discuss the results in biologically significant way.
- **CO2.** Students will acquire knowledge of computer languages- PERL,C, SQL and JAVA and to write programs to solve biological problems
- **CO3.** Students will be able to explain principle, algorithm and different methods of sequence alignments as well as execute alignments to address research problems
- **CO4.** Students will become familiar with a wide variety of bioinformatics tools and softwares and apply these to conduct basic bioinformatics research and thus develop platform for molecular biology experiments

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.

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), Colour, Sound &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 PER Lin Bioinformatics.

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 BLAST; CLUSTAL-X/W; Molecular Phylogeny.

PRACTICALS

1. Computational analysis of genomic and proteomic data.
2. Network search on genomic and proteomic databases.

3. Use of PERL programming for : i) Storing DNA sequence ii)DNA to RNA transcription iii) Counting nucleotides
4. 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 guide to the analysis of genes and proteins 2nd eds. John Wiley
2001
3.JonathanPevsner Bioinformatics and functional genomics Ist Ed. Wiley Liss 2003
4.P E Bourne and H. Weissig Structural Bioinformatics Wiley2003.

AGRICULTURE BIOTECHNOLOGY (SEMESTER-II)

Course Code No. 17ABT22D2 **MM. Th 80 + IA 20**
Course Title: Green House Management & Plant Protection **Time: 3h**

COURSE OUTCOMES

CO1. Trained and skill development of students in various aspects of Plant propagation structures like Green House, hot beds, cold frames and lath houses, fluorescent light boxes and propagating frames, different media and their composition for propagating and growing nursery plants and pre-planting treatments of soil.

CO2. They would be acquainted with basic concepts of sanitation, soil enrichment, water quality and soil pH, physical propagation facilities, propagation media and plant material and the supplementary fertilizers.

CO3. Students will become familiar about plant weeds, protection of plants from weeds, crop-weed competition and weed control methods. Use of herbicides to kill the weeds, biological and integrated weed control and control of diseases by fungicides and antibiotics, host plant resistance, biological control, legislature or insect pests.

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.

UNIT I

Plant propagation structures; Green House, hot beds, cold frames and lath houses. Miscellaneous propagation structures- fluorescent light boxes and propagating frames Carbon dioxide enrichment in green house. Containers for propagating and growing young plants.

UNIT II

Media for propagating and growing nursery plants; Media components: Sand, peat sphagnum moss, vermiculite, pumice, perlite, synthetic plastic aggregates and compost. Mixtures for container growing. Pre-planting treatments of soil and soil mixes, heat treatments, fumigation with chemicals.

UNIT III

Sanitation, soil enrichment and other requirements of propagation: Physical propagation facilities, propagation media and plant material. Supplementary fertilizers controlled release fertilizers. Salinity in soil mixtures, water quality and soil pH. Handling of container grown plants.

UNIT IV

Plant protection from weeds: Types of weeds, crop-weed competition and weed control methods. Classification of herbicides. Working of selective weed killers. Biological and integrated weed control. Plant protection from diseases and interest: Diseases of crops-definition, nature, and causes. Control of diseases by fungicides and antibiotics. Control of insect pests: Principles, physical and mechanical control, cultural control, host plant resistance, biological control, legislature or regulatory method, chemical control and other methods of insect control

PRACTICALS

1.To study specialized greenhouse operations.
2. Formulations of the plant growth media.
3.To study pest management in green house.
4.To study water and plant nutrition management.
5.Harvestingand postharvest handling in green house.
6.Management of farm records in green house

Books

1.Hann J.J., Holley W.D. and K.L. Goldsberry: Greenhouse management
2.Furuta, T. : Nursery management handbook
3.Langhans R.W. :Green house management

AGRICULTURE BIOTECHNOLOGY (SEMESTER-II)

Course Code No.17ABT22D2 **MM. Th 80 + IA 20**
Course Title: Biomass and Bio energy **Time: 3h**

COURSE OUTCOMES

CO1. To learn about different Energy sources like Nuclear energy and Fossil fuel energy, energy plantations, social forestry and Silvi culture energy farms.
CO2. To have knowledge on Biomass, aquatic and terrestrial biomass production of algal and fungal biomass, Organic wastes as a renewable source of energy, sources of wastes and composition of wastes, Bioenergy sources
CO3. To learn about Biomass conversion by Biological process and Non biological process, Biogas production, Hydrogen as a fuel

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.

UNIT I

Energy sources - General account-Nuclear energy and Fossil fuel energy, Non – Nuclear and Non – Fossil fuel energy. Bioenergy-energy plantations, social forestry and Silvi culture energy farms.

UNIT II

Biomass and source of energy: Composition of biomass, aquatic and terrestrial biomass production of algal and fungal biomass, Organic wastes as a renewable source of energy, sources of wastes and composition of wastes.

UNIT III

Bioenergy sources: Petrolieum plants (petro plants) - hydrocarbons for higher plants like *Hevea* and *Euphorbia.* Algal hydrocarbons. Alcohols: Alcohols as a liquid fuel-Hydrolysis of lignocellulosic materials, Ethanol production, fermentation and recovery of ethanol.

UNIT IV

Biomass conversion: Non biological process- Direct combustion (hog fuel), pyrolysis, Gasification and Liquification. Biological process: Enzymatic digestion, aerobic and anaerobic digestion Gaseous fuels: Biogas and hydrogen: Biogas technology benefits from biogas plants. Biogas production: aerobic digestion solubilization, acidogenesis, methanogenesis. Biogas production from different feed stocks like *Salvinia* and *Eichornia.* Hydrogen as a fuel: Photobiological process of hydrogen production. Hydrogenese and hydrogen production

PRACTICALS

1. Formulation of different types of plant growth media.
2. Formulation of different types of microbial growth media.
3. Isolation of cellulose degrading bacteria from the soil.
4. Isolation of biogass producing bacteria from the cattle dung.
5. To study the various methods of biomass measurement
6. Production of ethanol from sucrose by yeast.

References

1. Vepal S Malik & Padma Sridahar: Industrial biotechnology
2. Michael L Mckinney & Robert M Schoch: Environmental science-systems and solutions Kerry Turner R: Sustainable Environment Management
3. Indian Institute of Ecology& Environment Publ.: International Encyclopedia of Ecology and environment Vol.1- 30

AGRICULTURE BIOTECHNOLOGY (SEMESTER-II)

Lab course-I (Plant Tissue Culture, Bioinformatics/ Green House Management and Plant Protection/ Biomass & Bio energy)

COURSE OUTCOMES

CO1. Students will acquire knowledge of computer languages- PERL, C, SQL and JAVA and to write programs to solve biological problems. Students will be able to explain principle, algorithm and different methods of sequence alignments as well as execute alignments to address research problems

CO2. Students will become familiar with a wide variety of bioinformatics tools and softwares and apply these to conduct basic bioinformatics research and thus develop platform for molecular biology experiments

CO3. Students will be familiar with plant weeds, protection from weeds, crop-weed competition and weed control methods. Use of herbicides to kill the weeds, Biological and integrated weed control and control of diseases by fungicides and antibiotics, host plant resistance, biological control, legislature or insect pests. Students will be familiar about different methods of plant propagation structures like Green House, hot beds, cold frames and lath houses, fluorescent light boxes and propagating frames

CO4. Students will be able to apply plant tissue culture techniques for the conservation of endangered plant species and development of crop improvement

CO5. Students will be able to describe and the use of bioreactor for large-scale production of alkaloids and other secondary metabolites through cell culture techniques

AGRICULTURE BIOTECHNOLOGY (SEMESTER-II)

Lab course-II (Mol. Breeding, Plant Molecular Biology, Plant Genetic Engineering)
COURSE OUTCOMES

CO1. The students are expected to understand the different techniques used in Plant Genetic Engineering like Agrobacterium-mediated gene delivery, direct gene transfer methods via PEG-mediated, electroporation, particle bombardment,

CO2. Students will be able to understand about screenable and selectable markers, chloroplast transformation.

CO3. Students would be also trained about agronomical important genes and their mechanism of action against different biotic stresses like viruses, insects, fungal and herbicide resistant plants, different abiotic stresses, their perception and signaling in plants, post-harvest losses,

CO4. Students will be able to understand about increasing crop productivity qualitatively through improvement of seed storage proteins, essential amino acids, vitamins and minerals, biodegradable plastics and edible vaccines, biodegradable plastics, plants as biofactories and biosafety and risk assessment of GM crops.

AGRICULTURE BIOTECHNOLOGY (SEMESTER III)

Principles and Application of Agriculture Biotechnology-II

COURSE OUTCOMES

CO1. The students will be provided with a firm understanding in the principles and application of agriculture biotechnology

CO2. Opportunity for students to understand current barriers to gene discovery and exploitation of crop plants for crop improvement

CO3. Students from other disciplines/departments will get exposure to the basics of principles and application of agriculture biotechnology

AGRICULTURE BIOTECHNOLOGY (SEMESTER III)

Course Code No.17ABT23C2 **MM. Th 80 + IA 20**
Course Title: Genomics and Proteomics **Time: 3h**

COURSE OUTCOMES

CO1. To learn about the recent advances in genomics, transcriptomics and proteomics
CO2. To understand the use of functional genomics and proteomics in agriculture and industry.
CO3. To obtain and analyze information and data relating to specific genes using a number of databases related to plants, microbes and animals, bio-informatics principles and tools and high throughput expression studies.
CO4. To understand the diversity and complexity of eukaryotic and prokaryotic genomes, their historical as well as evolutionary perspective and techniques commonly employed in studying genomics and proteomics

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.

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-16SrRNA 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

1. Preparation of DNA from prokaryotes and eukaryotes.
2. Isolation of plasmids from *E. coli* cells.
3. Agarose gel electrophoresis of plasmid and chromosomal DNA.
4. Protein isolation from different plant tissues.
5. Separation of proteins using SDS-PAGE.
6. Restriction endonuclease digestion of plasmid and chromosomal DNA of *E. coli* cells.
7. Identification of SSR molecular markers from EST using computational approach.

Texts/References:

1. Voet D, Voet JG and Pratt CW, Fundamentals of Biochemistry, 2nd ed.Wiley2006
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

AGRICULTURE BIOTECHNOLOGY (SEMESTER III)

Course Code No.17ABT23DA1 **MM. Th 80 + IA 20**
Course Title: Plant Metabolic Engineering & Molecular Farming **Time: 3h**

COURSE OUTCOMES

CO1. To learn about plant primary and secondary metabolites, regulation of metabolic pathways, metabolic flux analysis and applications of metabolic flux analysis, methods for the experimental determination of metabolic fluxes.
CO2. To learn insight into the fundamentals of metabolic engineering in strain and plant improvement programs to increase the yield of a target product or reduce or eliminate the production of undesired impurities.
CO3. To have knowledge on applications of metabolic engineering in agriculture and industry

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.

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 feedback regulation, Limiting accumulation of end products**). Genetic manipulation** of composition and content of starch, amino acids (lysine and sulfur containing) and oil.

UNIT II

Secondary 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 feedback 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

1.Development of high yielding microbes by mutagenesis.
2.SDS – PAGE for the separation of Proteins.
3.Estimation of proteins by colorimetric methods.
4.Separationand estimation of Chlorophyll Pigments
5.Estimationof soluble sugars by Colorimetric method.
6.Estimationof free fatty acids.
7.Metabolic engineering and bioinformatics tools

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.

AGRICULTURE BIOTECHNOLOGY (SEMESTER III)

Course Code No.17ABT23DA2 **MM. Th 80 + IA 20**
Course Title: Biotic and Abiotic Stress Biology **Time: 3h**

COURSE OUTCOMES

CO1. Students will acquire knowledge to uncover and understand molecular pathways that control plant response to environmental stresses (biotic & abiotic stresses)

CO2. Students will be able to understand to exploit natural resources for the engineering and/or development of plants to face and deliver under sub optimal environmental conditions

CO3. Students will acquire knowledge to develop climate resilient crops

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.

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

Environmental 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. (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-VCHVerlagGmbH &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, John Wiley Publication

AGRICULTURE BIOTECHNOLOGY (SEMESTER III)

Course Code No.17ABT23DB1 **MM. Th 80 + IA 20**

Course Title: Industrial & Food Biotech **Time: 3h**

COURSE OUTCOMES

- **CO1.** Students will acquire knowledge about Industrial and food Biotechnology, industrial and food Biotechnology, applications of biotechnology in industry and food processing and safety regulations.
- **CO2.** Students will acquire knowledge about bio-processing, its principles, media formulations and sterilization, bioprocess control and monitoring variables, different microbial processes, factors affecting downstream processing and recovery of ethanol, organic acids, antibiotics and use of industrial microorganisms.
- **CO3.** Students will be able to understand dairy fermentation and fermented products, microbial enzymes in food processing and concept of modification of microbes to improve the strain.

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.

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

Bio-processing- 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 downstream processing and recovery, Representative 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-alcoholic 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

1. Isolation of industrially important microorganisms for microbial process.
2. Determination of thermal death point and thermal death time of a microorganism for design of a sterilizer.
3. Determination of growth curve of a supplied microorganism and also determines substrate degradation profile.
4. Compute specific growth rate (m), growth yield (Y x/s) from the above.
5. Comparative studies of ethanol production using different substrates.
6. Microbial production of citric acid using *Aspergillus niger*
7. Microbial production of antibiotic (Pencillin)
8. Production and estimation of Alkine Protease
9. Sauer Krant fermentation

Suggested Reading

1. Gautam NC, Food Biotechnology in Comprehensive Biotechnology, Vol 7. Shree Publishers New Delhi 2007
2. Gutierrez-Lopez GF et al., 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.

AGRICULTURE BIOTECHNOLOGY (SEMESTER III)

Course Code No.17ABT23DB2 **MM. Th 80 + IA 20**
Course Title: Crop Protection & Integrated Pest Management **Time: 3h**

COURSE OUTCOMES

CO1. Students will acquire knowledge about Losses in crops due to pests, classification, causes and symptoms of plant diseases, Principles of integrated Pest Management (IPM) and use of IPM to farmers' real-time situations and economic and ecological affects of pesticide use in India.

CO2. To learn about the pathogenocity, mechanism of disease resistance and role of plant breeding for disease and insect resistance and importance of genetic engineering for improvement of disease resistance.

CO3. Students will be able to understand the concept of Genetic engineering and new technologies, Chemical and biological Control strategy for crop protection and myco pesticides.

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.

UNIT I

Losses in crops due to pests, Importance of plant diseases, Classification of plant diseases, Causes and symptoms of plant diseases, Disease epidemics, Prevention of epidemics, Principles of integrated Pest Management (IPM), IPM modules for cotton, IPM modules for sugarcane, IPM practices for Pulse crops, IPM practices for oil crops, Economic and ecological affects of pesticide use in India.

UNIT II

Genetics of pathogenocity, pathotypes, mechanism of disease resistance, breeding for disease and insect resistance, Sear's work on rust resistance in wheat. Genetic engineering for improvement of disease resistance, Genetic manipulation of Crops for insect resistance, Molecular Mechanisms conferring herbicide resistance, transgenic crops

UNIT III

Genetic engineering and new technologies- their progress and limitations in IPM programmes, deployment of benevolent alien genes for pest management; scope and limitations of bio-intensive and ecological based IPM programmes. Application of IPM to farmers' real-time situations

UNIT IV

Chemical Control strategy for crop protection, Biological control-concepts and techniques, Bio-organism for pest Management, Bt based pesticides, Baculovirus pesticides, Mycopesticides, production and formulation technologies

PRACTICALS

1. Study of symptoms, microscopic examination of diseased parts and identification of the pathogens involved in some of the crop diseases.
2. Examination of the organisms used for biological control.
3. Culture techniques for the entomo pathogens.
4. Mass multiplication of biocontrol agents.
5. Study of genetically engineered organisms.
6. Visiting the Agricultural fields for assessing the pest problem.

BOOKS

1. Dhaliwal GS & Arora R. 2003. Integrated Pest Management – Concepts and Approaches. Kalyani Publ., New Delhi.
2. Horowitz AR & Ishaaya I. 2004. Insect Pest Management: Field and Protected Crops. Springer, New Delhi.
3. Ignacimuthu SS & Jayaraj S. 2007. Biotechnology and Insect Pest Management. Elite Publ., New Delhi.
4. Peshin, R, Dhawan, AK. (Eds.). 2009. Integrated Pest Management, Volume 1: Innovation-Development Process. Springer publishers.

AGRICULTURE BIOTECHNOLOGY (SEMESTER III)

Course Code No. 17ABT23DB3 **MM. Th 80 + IA 20**
Course Title: Biostatistics & Agro-economics **Time: 3h**

COURSE OUTCOMES

CO1. Students will acquire knowledge about statistical measures and tools for the analysis of agricultural data

CO2. Students will be able to understand agriculture state of India related policies and its global importance

CO3. Students will be able to analyze and understand the experimental data

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.

UNIT I

Presentation and classification of data: Discrete and continuous variables, frequency distributions, graphical representation of data and other forms of representations. Measures of location and dispersion: Mean, median, mode, quartiles, deciles and persentiles. Variance, skew ness and kurtosis.

UNIT II

Elements of probability theory: Definition of probability, classical definitions relative frequency approach and axiomatic approach. Discrete Random variable, continuous random variable; Binomial Possion and normal distributions and their properties and importance. Small sample theory; F-distribution, students t-distribution Tests for assumed mean, comparison of means two samples. Chi-square distributions. Goodness of fit test. Correlation and regression, Analysis of variance: One-way, two way; field plot designs randomized and completely randomized, latin square, missing plot techniques.

UNIT III

Agricultural finance in India: importance; types or requirements; sources: non-institutional and institutional: existing rural credit delivery system (multi-agency approach); Agricultural marketing in India: Markets and marketing functions, channels of distribution of various commodities; regulated markets and warehousing; Role of Cooperatives in Agriculture.

UNIT IV

Agricultural planning in India: decentralized planning and indicative planning; incentives in agriculture: price and non- price incentive; input subsidies; Agricultural price policy (AP) Nature of demand and supply of agricultural products; Food security in India and public distribution system. An overview of agricultural development; Globalization of India Economy and its effects on Indian Agriculture.

PRACTICALS

1. Methods of central tendency (arithmetic mean, median, mode)
2. Measures of dispersion (standard deviation)
3. Probability theory
4. Problems on Binomial and poisson distribution.
5. Problems on Binomial Normal Distribution.
6. Large sample tests.
7. Small sample tests.
8. Chi square tests, ANOVA– one way & two way classification

BOOKS

1. Nilabja Ghosh, 2013. India's Agricultural Marketing. Springer.
2. Bhalla, G. S. and Singh, G.2012. Economic Liberalisation and Indian Agriculture: A District-Level Study. SAGE publications.
3. Fukuda-Parr, S. (Ed.). (2012). The gene revolution: GM crops and unequal development. Taylor & Francis.
4. Bhalla, G. S & Singh, G. (2001). *Indian agriculture: four decades of development*. Sage Publications.
5. Frankel, F. R. (2015). *India's Green Revolution: Economic Gains and Political Costs*. Princeton University Press.
6. Roy, B. C., & Pal, S. (2006). Investment, agricultural productivity and rural poverty in India. *Indian Agriculture in the New Millennium: Changing Perceptions and Development Policy*, *2*,367.
7. Bilgrami, S.A.R. (2000). An introduction to Agricultural Economics (2nd Edition), Himalyan Publishing House, Mumbai.
8. Sadhu, A.N. and J. Singh (2000) Agricultural problems in India (3rd edition), Himalayan Publishing House, Mumbai.
9. Sundaram, I.S (2002) Rural Development (4th edition) Himalayan Publishing House, Mumbai.
10. Reserve Bank of India, Hand Book of Statistics on Indian Economy(Annual).
11. Soni R.N. (2000), Leadingissues in Agricultural Economics, Arihant press, Jalandar.
12. Statistical Procedure for Agricultural Research By: Kwanchai A Gomes Arturo A. Gomez, John Wiley and Sons.
13. A text book of Agricultural Statistics. By: R. Rangaswamy, New Age International Pvt. Ltd. Statistics for Agricultural Sciences. By: G. Nageswar Rao, Oxford and IBH Publishing Co.

AGRICULTURE BIOTECHNOLOGY (SEMESTER III)

Lab course-I (Plant Genetic Engg, Genomics and Proteomics)

COURSE OUTCOMES

CO1. The students are expected to understand the different techniques used in Plant Genetic Engineering like *Agrobacterium*-mediated gene delivery, direct gene transfer methods via PEG-mediated, electroporation, particle bombardment,

CO2. Students will be able to understand about increasing crop productivity qualitatively through improvement of seed storage proteins, essential amino acids, vitamins and minerals, biodegradable plastics and edible vaccines, biodegradable plastics, plants as bio-factories and bio-safety and risk assessment of GM crops.

CO3. To obtain and analyze information and data relating to specific genes using a number of databases related to plants, microbes and animals, bio-informatics principles and tools and high throughput expression studies.

CO4. To understand the diversity and complexity of eukaryotic and prokaryotic genomes, their historical as well as evolutionary perspective and techniques commonly employed in studying genomics and proteomics

AGRICULTURE BIOTECHNOLOGY (SEMESTER IV)

Course Code No.17ABT24C1 **MM. Th 80 + IA 20**
Course Title: IPR SOCIAL, ETHICAL AND LEGAL ISSUES **Time: 3h**

COURSE OUTCOMES

CO1. Understand the basics of the four primary forms of intellectual property rights, the right of ownership, scope of protection as well as the ways to create and to extract value from IP.
CO2. Compare and contrast the different forms of intellectual property protection in terms of their key differences and similarities.
CO3. Analyze the effects of intellectual property rights on society as a whole.
CO4. Assess and critique some basic theoretical justifications for each form of intellectual property protection.
CO5. Identify activities and constitute IP infringements and the remedies available to the IP owner and describe the precautious steps to be taken to prevent infringement of proprietary rights in products and technology development

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.

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 and Ethical issues -genetic discrimination: insurance and employment, human cloning, foeticide, sex determination. Somatic and germ line gene therapy, clinical trials, ethical committee function.

UNIT III

Bio-safety - Definition, Requirement, Bio-safety containment facilities, biohazards, genetically modified organisms (GMOs), living modified organisms (LMOs), Bio-safety 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 Bio-banking: 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

AGRICULTURE BIOTECHNOLOGY (SEMESTER IV)

Course Code No.17ABT24C2 **MM. Th 80 + IA 20**
Course Title: Animal Biotechnology & Immunology **Time: 3h**
COURSE OUTCOMES

CO1. To describe the structure of animal genes and genomes
CO2. To describe how genes are expressed and what regulatory mechanisms contribute to control of gene expression. To describe basic principles and techniques in genetic manipulation and genetic engineering
CO3. To describe gene transfer technologies for animals and animal cell lines
CO4. To describe techniques and problems both technical and ethical in animal cloning
CO5. To describe the contribution 'functional genomics' is making and is likely to make in animal biotechnology now and in the future

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.

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 histo-compatibility 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, immuno deficiencies, vaccines. Antigen-antibody based diagnostic assays

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) byRichard 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 Publisher
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. AGRICULTURE BIOTECHNOLOGY (SEMESTER-IV)

Course Title: Dissertation **Marks: 300**
Course Code No.17ABT24C3 **(Dissertation: 200 +Viva voce 100)**

Program Specific Outcomes

PSO1 M. Sc. Dissertation is designed in a way to teach and train the students with full practical knowledge in the different research areas of Agriculture Biotechnology in order to make them efficient researchers to start their carrier in research through Ph.D. and other R & D programmes.

PSO2 Students would gain training in the research topics selected from different fields like plant tissue culture, genetic engineering, metabolic engineering, physiology and biochemistry of biotic and abiotic stresses, genomics and proteomics, plant breeding and *in-silico* identification of novel genes and their expression pattern at different growth stages of plants.

PSO3 Students develop understanding about the literature reading and dissertation writing required to carry out a good research in future research endeavors like Ph.D.

PSO4 Find the resources and practical skills required to perform the research process.

PSO5 Statistical analysis, presentation and documentation of research findings.

Course Outcomes

At the end of the dissertation the students will be trained in:

CO1 Theoretical and practical knowledge in the different area of Agriculture Biotechnology to start their carrier in research through Ph.D. and other R & D programmes

CO2 Research topics selected from different fields like plant tissue culture, genetic engineering, metabolic engineering, physiology and biochemistry of biotic and abiotic stresses, genomics and proteomics, plant breeding and *in-silico* identification of novel genes and their expression pattern at different growth stages of plants.

CO3 Students developed understanding about the literature search, reading and dissertation writing.

CO4 Students trained to find the resources needed to perform the research and presentation of research data.