M.Sc Biotechnology Choice Based Credit System (CBCS) 2015-2016

Semester I (December-2015)

Sr. No.	Course Code	Subject/Title	Credits	Marks Theory	Int Ass
1	BT-111	Cell Biology	04	80	20
2	BT-112	Bio molecules & Metabolism	04	80	20
3	BT-113	Microbiology	04	80	20
4	BT-114	Molecular Biology	04	80	20
5	BT-115	Genetic Engineering	04	80	20
6	BT-116	Lab course-I (Cell Biology, Bio molecules & Metabolism)	04	50	
7	BT-117	Lab course-II (Microbiology, Molecular Biology, Genetic Engineering)	06	50	
	Total		30	600	

Semester II (May-2016)

Sr. No.	Course Code	Subject/Title	Credits	Theory	Int Ass
1	BT-211	Immunology	04	80	20
2	BT-212-214	Bioinformatics/Biology of Infectious Diseases/Diagnostics	04	80	20
3	BT-215	Molecular Human Physiology and Dev. Biology	04	80	20
4	BT-216	Molecular Plant Physiology & Development Biology	04	80	20
5	BT-217	Open elective subject Principles & Applications of Biotechnology	02	40	10
6	BT-218	Foundation course: Communication skills	02	40	10
7	BT-219	Lab course-I (Immunology, Bioinformatics)	04	50	
8	BT-220	Lab course-II (Mol. Human Phys., Mol. Plant Phys.)	04	50	
	Total		28	600	

Semester III (December- 2016)

Sr. No.	Course Code	Subject/Title	Credits	Theory	Int Ass
1	BT-311	Bioprocess Engineering	04	80	20
2	BT-312	Plant Biotechnology	04	80	20
3	BT-313	Animal Biotechnology	04	80	20
4	BT-314	Environmental Biotechnology	04	80	20
5	BT-315	Lab course-I (Bioprocess Engg, Plant Biotech)	04	50	
6	BT-316	Lab course-II (Animal Biotech, Environ Biotech)	04	50	
7	Soft core BT-317-319	Biostats/ Virology/Nano- Biotechnology BT-317/BT-318/ BT-319	04	80	20
		Total	28	600	

Semester IV (May- 2017)

Sr. No.	Course Code	Subject/Title	Credits	Theory	Int Ass
1	BT-411	IPR Bio safety, Ethical, Legal , Social issues In Biotechnology	04	80	20
2	BT-412	Microbial Technology	04	80	20
3	BT-413	Dissertation	20	300	
	Total		28	500	

Total credits=114 Total Marks=2300

M.Sc Agriculture Biotechnology Choice Bases Credit System (CBCS) 2015-16

Semester I (December-2015)

Sr. No.	Course Code	Subject/Title	Credits	Marks Theory	Int Ass
1	ABT-111	Cell Biology	04	80	20
2	ABT-112	Bio molecules & Metabolism	04	80	20
3	ABT-113	Microbiology	04	80	20
4	ABT-114	Molecular Biology	04	80	20
5	ABT-115	Genetic Engineering	04	80	20
6	ABT-116	Lab course-I (Cell Biology, Bio molecules)	04	50	
7	ABT-117	Lab course-II (Microbiology, Molecular Biology, Genetic Engineering)	06	50	
	Total		30	600	

Semester II (May-2016)

Sr. No.	Course Code	Subject/Title	Credits	Theory	Int Ass
1	ABT-211	Plant Tissue Culture	04	80	20
2	ABT-212-214	ABT-212 Bioinformatics/ ABT-213 Green House Management and Plant Protection/ ABT-214 Biomass and Bioenergy	04	80	20
3	ABT-215	Molecular Breeding	04	80	20
4	ABT-216	Plant Molecular Biology	04	80	20
5	ABT-217	Open elective subject: Principles & Applications of Agriculture Biotechnology	02	40	10
6	ABT-218	Foundation course: Communication skills	02	40	10
7	ABT-219	Lab course-I (Plant Tissue Culture, Bioinformatics)	04	50	
8	ABT-220	Lab course-II (Mol. Breeding, Plant Molecular Biology)	04	50	
	Total		28	600	

Semester III (December- 2016)

Sr. No.	Course Code	Subject/Title	Credits	Theory	Int Ass
1	ABT-311	Plant Genetic Engineering	04	80	20
2	ABT-312	Plant Metabolic Engineering & Molecular Farming	04	80	20
3	ABT-313	Genomics and Proteomics	04	80	20
4	ABT-314	Biotic and Abiotic Stress Biology	04	80	20
5	ABT-315	Lab course-I (Plant Genetic Engg, Plant Metabolic Engg & Molecular Farming)	04	50	
6	ABT-316	Lab course-II (Genomics & Proteomics, Biotic & Abiotic Stress Biology)	04	50	
7	Soft core ABT-317-319	Industrial & Food Biotech/ Crop Protection & Integrated Pest Management/ Biostatistics & Agro-economics ABT-317/ABT-318/ ABT-319	04	80	20
		Total	28	600	

Semester IV (May- 2017)

Sr. No.	Course Code	Subject/Title	Credits	Theory	Int Ass
1	ABT-411	IPR Bio safety, Ethical, Legal , Social issues In Agriculture Biotechnology	04	80	20
2	ABT-412	Animal Biotechnology & Immunology	04	80	20
3	ABT-413	Dissertation	20	300	
	Total		28	500	

Total credits=114 Total Marks=2300

Choice Based Credit System (Syllabus 2015-16)

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

Course Title: Cell Biology

MM. Th 80 + IA 20

Course No. BT 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.

Practical

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.

M.Sc. Biotechnology **Semester—I**

Course Title**: Bio-molecules and metabolism** *MM. Th 80 + IA 20*

Course No**. BT 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 others 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. Biotechnology **Semester--I**

Course Title: Microbiology MM. Th 80 + IA 20
Course No. **BT 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 others 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. Biotechnology **Semester I**

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

Course No. BT 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 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 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 & quantification
3. Southern blotting
4. RFLP analysis
5. Isolation and quantification 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

1. Benjamin Lewin. Gene X, 10th Edition, Jones and Barlett Publishers 2010.
2. J D Watson et al., Biology of 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.

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

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

Course No. BT 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

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

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

Choice Based Credit System (Syllabus 2015-16)

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

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

Course No **BT 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

Phylogeny of Immune System
Innate and acquired immunity
Clonal nature of immune response
Organization and structure of lymphoid organs
Cells of the Immune system: Hematopoiesis and differentiation

UNIT II

Nature and Biology of antigens and super antigens
Antibody structure and function, Antibody diversity.
Antigen - antibody interactions
Major histocompatibility complex
B-Iymphocytes, T-Iymphocytes, BCR & TCR, Complement system,

Macrophages, Dendritic cells, Natural killer and Lymphokine-activated killer cells, Eosinophils, Neutrophils and Mast Cells

UNIT III

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, Cell-mediated cytotoxicity; Mechanism of T cell and NK cell mediated lysis, antibody dependent cell mediated cytotoxicity, macrophage mediated cytotoxicity, Hypersensitivity (Type I to Type IV with at least one example)

UNIT IV

Immunological tolerance; Autoimmunity, Transplantation Immunity to infectious agents (interacellular parasites like *M. tuberculosis,* helminthes and viruses); Tumor Immunology; AIDS and other Immunodeficiencies; Hybridoma technology and applications of monoc1onal antibodies

PRACTICALS

Blood film preparation and identification of cells
Lymphoid organs and their microscopic organization

Immunization, Collection of Serum

Double diffusion and Immune-electrophoresis
Radial Immuno diffusion
Purification of IgG from serum

Separation of mononuclear cells by Ficol1-Hypaque
Western-blotting
ELISA
Immunodiagnostics (demonstration using commercial kits) e.g. Widal test for typhoid fever.

REFERENCE BOOKS/ Suggested Readings

12. Kuby Immunology (2006) by Thomas J. Kindt, Richard A. Goldsby, Barbara A. Osborne, Janis Kuby (W.H. Freeman).
13. Immunology- A short course (2009) by Richard Coico, Geoffrey Sunshine (Wiley Blackwell).
14. Fundamentals of immunology (1999) by William Paul (Lippincott Williams & Wilkins).
15. Immunology (2001) by Ivan Maurice Roitt, Jonathan Brostoff, David K. Male (Mosby).
16. Understanding immunology (2007) by Peter John Wood, Dorling KInderseley (Pearson Education, India).
17. Immunology (2007) by Kannan, I (MJP Pulishers, India).

M. Sc. Biotechnology **Semester II**

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

Course No. BT 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 querry 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 PERL in 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:

Computational analysis of genomic and 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 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. Biotechnology Semester - II

Course Title: Biology of Infectious Diseases

MM. Th 80 +IA20 **Course No.BT-213** **Time: 3h**

NOTE: In all Nine questions will be set, Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. Out of remaining eight questions, two questions will be set from each unit. Studentsare requiredto attempt fourquestionsi.e. anyone from each unit.

Theory

UNITI

Bacteria: Representative diseases to be studied in detail are - tetanus, diphtheria, cholera, typhoid, tuberculosis, leprosy, plague, and syphilis. Infections caused by anaerobic bacteria, spirochetes, chlamydia, rickettsiae.

Viruses: Representative diseases to be studied in detail are - viral hepatitis, influenza, rabies, polio and AIDS and viral cancers.

Fungi: Diseases to be taken up in following categories: superficial, subcutaneous, systemic and opportunistic mycoses.

UNITII

Protozoa:Classification, Diseases to be discussed are - amoebiasis, toxoplasmosis, trichomoniasis & leishmaniasis. Parasitic diseases, Classification: Ascariais, Liver fluke, Tape worms, Disease burden and its economic impact, Investigation of epidemics. Replication of DNA, RNA+ve andRNA-ve viruses, retroviruses

UNITIII

Viral vaccines: conventional; killed/attenuated; DNA; peptide; recombinant proteins. Sterilization techniques: biohazard hoods; containment facilities, BSL 2, 3, 4. Bacterial and viral vectors, Biological warfareagents

UNITIV

Mode of action of antibiotics and antiviral: molecular mechanism of drug resistance (MDR)Anti-viral chemotherapy. Anti-fungal chemotherapy. Hospital-acquired infections (nosocomial), immune compromised states Modern approaches for diagnosis of infectious diseases: Basic concepts of gene probes, dot hybridization and PCR assays

Practicals

1. To perform primary and secondary test for identification and classification of bacteria.
2. To perform acid-fast staining of *Mycobacterium smegmatis.*
3. Isolation, characterization and identification of *Staphylococcus.*
4. Isolation, characterization and identification of *E. coli.*
5. To perform and interpret standard procedure used for isolation, characterization and identification of *Bacillus* sp.
6. To perform and interpret standard procedure used for isolation, characterization and identification of *Salmonella* sp.
7. Extraction of total viral RNA from given sample and estimation of its quantity and quality.
8. To perform the antibiotic sensitivity assay with microorganisms and to determine their MIC and MBC .

Recommended Books

1.Jawetz, Melnick, & Adelberg's Medical Microbiology (Lange Basic Science) byGeo. F.Brooks,Janet S. Butel, Stephen A.Morse McGraw-HillMedical; 23 edition

2.Medical Microbiology: with Student Consult by Patrick R. Murray PhD (Author),Ken S. Rosenthal PhDSaunders; 7 edition

3.Mims' Medical Microbiology By (author) Richard Goering, By (author) Hazel Dockrell, By (author) Mark Zuckerman, By (author)Ivan M. Roitt, By (author) Peter L. Chiodini Saunders (W.B.)Co Ltd

M.Sc. Biotechnology Semester - II
Course Title: Diagnostics

MM. Th 80 +IA20 **Course No.BT-214** **Time: 3h**

NOTE: In all Nine questions will be set, Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. Out of remaining eight questions, two questions will be set from each unit. Studentsare requiredto attempt fourquestionsi.e. anyone from each unit.

Theory

UNIT –I

Quality control, GMP and GLP, records. Chromosomal anomalies and disorders : Numerical (polyploidy, aneuploidy, autosomal, sex- chromosomal), Structural (deletion, duplication, translocation, inversion, isochromosome, ring chromosome). Mitochondrial genome and disorders. Genetic Disorders: Single gene Disorders (Cystic Fibrosis, Marfan's syndrome), Multifactorial disorders (Diabetes, Atherosclerosis, Schizophrenia)

.

UNIT-II

Methods for genetic study in man – pedigree analysis, Pedigree construction & family study Complications in pedigree analysis (variable expressivity, heterogeneity, penetrance, anticipation, epigenetics, mosaicism)

Polyclonal and monoclonal antibodies, Karyotype analysis. G-banding, FISH, spectral karyotyping (SKY) andcomparative genomic hybridization(CGH)

UNIT- III

Nucleic acid amplification methods and types of PCR: Reverse Transcriptase-PCR, Real- Time PCR, Inverse PCR, Multiplex PCR, Nested PCR, Alu-PCR, Hot-start, *In situ* PCR, Long-PCR,PCR-ELISA, Ligase Chain Reaction, genetic profiling, single nucleotide polymorphism.

Applications of PCR- PCR based microbial typing: Eubacterial identification based on 16S rRNA sequences- Amplified Ribosomal DNA Restriction analysis (ARDRA)- Culture independent analysis of bacteria- DGGE and TRFLP. Molecular diagnosis of fungal pathogens based on 18S rRNA sequences- Detection of viral pathogens through PCR. RAPD for animal and plants- PCR in forensic science- AmpFLP, STR, MultiplexPCR

UNIT- IV

Cancer cytogenetics. Dynamic mutations. Biochemical diagnostics: inborn errors of metabolism, Haemoglobinopathies, mucopolysaccharidoses, lipidoses, and glycogen storage disorders. Pre-implantation diagnosis,pre-natal diagnosis-chorionic villus sampling, Amniocentesis. Genetic counselling. Introductionto pharmacogenomics andtoxicogenomics

Practicals

1. Isolation of Genomic DNA from Blood sample.
2. To perform PCR, Reverse-PCR, Multiplex PCR and Real-time PCR with genomic DNA.
3. PCR-RFLP of Cyp gene variants.
4. C-peptide test for diabetes.
5. Molecular weight determination by SDS-PAGE.

Recommended Books

Pastemak, An Introduction to Molecular Human Genetics, 2nd Edition, Fritzgarald, 2005.
Mange and Mange, Basic Human Genetics, 2nd Edition, Sinauer Assoc, 1999.
Lewis, Human Genetics, 7th Edition,WCB&McGraw, 2007.
Vogel and Motulsky, Human Genetics, 3rd Edition, SpringerVerlag, 1997.
Strachenand Read, Human Molecular Genetics, 3rd Edition, Garland Sci. Publishing, 2004.
Maroni,Molecular and Genetic Analysis of Human Traits,1st Edition,Wiley-Blackwell, 2001.
How1eyand Mori,TheHuman Genome, Academic Press, 1999.
Strickberger, Genetics,3rdedition,McMillan, 1985.
Snustad &Simmons, Principlesof Genetics,4thEdition, Wiley, 2005. Griffithsetal,Modern genetic analysis, 2nd Edition,Freeman, 2002.
Hartl andJones, Genetics-Principlesand Analysis, 4thEdition,Jones &Bartlett, 1998. Albertset al,Molecular Biologyof TheCell, 2nd Edition , Garland 2007.

Semester—II

M.Sc. Biotechnology MM. Th 80 +IA 20

Course Title: **Molecular Human Physiology and Developmental Biology**

Course No. **BT 215** 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

Sight and perception, hearing and balance, smell, taste, touch, pain, analgesics. Skin, hair. Muscles movement, rheumatoid disorders.

Heart and blood circulation, blood clotting, microvasculature.
Lung surfactants. Body fluids, fluid balance, parenteral
solutions.

UNIT II

Hormones: and homeostasis.

Digestive system, reproductive system, nervous system.

Diseases of the digestive system, breathing, circulation, Mechanisms of drug action

UNIT III

Structure, chemistry, dynamics and regulation of sperm locomotion, capacitation and egg-surface targeting, ovulation and hormonal control in mammals, contraception

Molecular biology, cytology and biochemistry of ovogenesis: transcription on lampbrush chromosomes .Molecular and cellular biology of fertilization: acrosome reaction and signal transduction, monospermy and species-specificity.

Egg activation, early cleavages and blastocyst formation in mammals and biochemical and cellular changes during the passage down the oviduct to the uterus.

UNIT V

Implantation and formation of the placenta in mammals, Gastrulation in mammals-formation of primitive streak, morphogenetic movements and neural induction. Organogenesis and foetal development, Pattern forming genes and expression in Drosophila and mammalian embryos Development of the mammalian brain-cerebral cortex-cell lineages, Lens development-fibre differentiation, programmed cell death (apoptosis). Erythropoeisis, myelopoeisis, Ageing

PRACTICALS

1. Culture in *vitro* of chick embryo by New's technique and neural induction by transplanted Hensen's node.
2. Filter-paper ring culture of chick embryos.

3. Chick embryo limb bud organ culture and observation of cell death in interdigital regions by neutral red staining.
4. Sex-linked inheritance in Drosophila.
5. Non-allelic and allelic interaction in Drosophila.
6. Linkage study in Drosophila.
7. Allelic and heterozygotic frequencies in human populations.
8. Analysis of quantitative traits: frequency distribution, standard deviation and variance.
9. Karyotyping human cells and chromosomal in situ localization of genes.
10.Cell division : mitosis and meiosis.
Mutants of Drosophila. Sex liked lethals in Drosophila

Suggested readings

1. Richard W. Hill, Gordon A. Wyse, Margaret Anderson

   Animal Physiology. 2nd edition. 2008. Sinauer Associates: Sunderland, Massachusetts. 770p. ISBN: (Hardcover) 978-0878933174.
2. Christopher D. Moyes, Patricia M. Schulte, Principles of Animal Physiology. Benjamin Cummings Publisher, 2008
3. Knut Schmidt-Nielsen, Animal Physiology: Adaptation and Environment. Cambridge University Press.
4. Gilbert, Developmental Biology,
5. Tortora, Anatomy and Physiology

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

Course Title: Molecular Plant Physiology and Developmental Biology,
Course No. BT 216 **MM. Th 80 + IA20 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

Increasing crop productivity:

Photosynthesis: Light harvesting complexes; mechanisms of electron transport; photo protective mechanisms; CO 2 fixation-C 3 , C 4 and CAM pathways. Biotechnological strategies for improving photosynthetic CO 2 assimilation in plants: Improving Rubisco activity,

Photorespiration: photo respiratory pathway, Molecular Strategies of bypassing photorespiration.

Nitrogen and Sulphate Metabolism: Nitrate and ammonium assimilation; molecular biology of Nodulation and Nitrogen fixation, uptake, transport and assimilation of sulphate. Improving nitrogen use efficiencies (NUE).

UNIT II

Improving productivity under Climate change Stress Physiology: 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, Physiological and molecular responses of plants to drought, salinity, high temperature and cold stress, Ionic and osmotic homeostasis; Stress perception and stress signaling pathways, Oxidative stress and reactive oxygen species scavenging, functional genomics & metabolomics of stress; Overcoming stress: breeding efforts, marker assisted breeding, transgenic approaches.

UNIT III

Improving quality of Crop plants:

Genetic manipulation primary and secondary metabolites: Genetic manipulation of composition and content of starch, amino acids (lysine and sulfur containing) and oil. Vitamin (vit. A) and minerals (Iron and Zinc), Plants as biofactories, biodegradable plastics,

Genetic manipulation of flavonoid and terpenoid pathways in plants and their value addition with significance in horticulture, agriculture and medicine, edible vaccines.

UNIT IV

Developmental Biology

Polarity, Cell – Cell communication and interaction, Embryonic Pattern Formation – Embryogenesis and early pattern formation in plants. **Post-**

embryonic Development – Regeneration and totipotency; Organ differentiation and development; Maternal gene effects; Zygotic gene effects; Homeotic gene effects in plants;
Oraganisaion of shoot apical meristem (SAM), cytological and molecular analysis of SAM. Organization of root apical meristem, plant stem cells, leaf initiation, phyllotaxy, differentiation of epidermis (with special reference to stomata and trichomes) and mesophyll. **Molecular biology** of Flower initiation and development,

Practicals

Extraction and separation of chlorophyll by chromatography. Absorption and action spectra of chlorophyll.

Demonstration of Hill reaction and Oxygen evolved during photosynthesis Isolation and separation of amino acids by chromatography.
Estimation of enzymes related to nitrogen assimilation.

In vitro pollen germination and pollen tube length measurement. Experiments related to physiological effects of abiotic stresses.

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.
3. V. Raghuvan, Developmental Biology of Flowering Plants. Springer
4. Patterns in plant development by Steeves T A and Sussex IM.
5. Molecular plant development: from gene to plant by Peter Westhoff, Oxford Univ. Press.

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

Course Title: Principles and Applications of Biotechnology
Course No. BT 217 **MM. Th 40+IA 10 Time: 2h**

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**

Molecular cloning tools; Restriction modification systems: Types I, II and III. Mode of action and nomenclature,DNA modifying enzymes and their applications: DNA polymerases, DNA phosphatases, and DNA ligases; Cloning Vectors: Definition and Properties, Plasmid vectors: pBR and pUC series; Bacteriophage lambda and M13 based vectors, Cosmids, BACs, YACs
Use of linkers and adaptors, Expression vectors: E.coli lac and T7 promoter based vectors, yeast YIp, YEp and YCp vectors, Baculovirus based vectors, mammalian SV40 based expression vectors
Methods in Molecular Cloning,Transformation of DNA : Chemical method & Electroporation; Gene delivery: Microinjection, electroporation, biolistic method (gene gun), liposome and viral mediated delivery, *Agrobacterium* mediated delivery,
in vitro culture of plant and animal cells

Unit II

DNA Amplification and DNA sequencing; PCR RT-PCR, Sanger's method of DNA Sequencing: traditional and automated sequencing, Introduction to next generation sequencing, Chromosome walking & jumping, shotgun sequencing; Genomic and cDNA libraries: Preparation and uses; Screening of libraries: Colony hybridization and colony PCR Applications of Recombinant DNA Technology; Products of recombinant DNA technology: Products of human therapeutic interest-insulin, antisense molecules, Applications of recombinant DNA in crop improvement, Gene therapy, Recombinant vaccines, Protein engineering, Site directed mutagenesis and Biosensor technology

SUGGESTED READING

1. Brown TA. (2010). Gene Cloning and DNA Analysis. 6th edition. Blackwell Publishing, Oxford, U.K.
2. Clark DP and Pazdernik NJ. (2009). Biotechnology: Applying the Genetic Revolution. Elsevier Academic Press, USA
.
3. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
.
5. Wiley JM, Sherwood LM and Woolveron CJ. (2008). Prescott, Harley and Klein's Microbiology. McGraw Hill Higher Education

6. Brown TA. (2007). Genomes-3. Garland Science Publishers
.
7. Primrose SB and Twyman RM. (2008). Genomics: Applications in human biology. Blackwell Publishing, Oxford, U.K.

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

Course Title: Communication Skills

Course No. BT 218 ***MM. Th 40+IA 10***

Time: 2h

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.

Choice Based Credit System (Syllabus 2015-16)

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

Course Title: BIOPROCESS ENGINEERING **MM. Th 80 + IA 20**

Course No. BT 311 **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–1 Bioreactors

Design of a basic fermenter, bioreactor configuration, design features, individual parts, baffles, impellers, foam separators, sparger, culture vessel, cooling and heating devices, probes for online monitoring, computer control of fermentation process, measurement and control of process. Reactors for specialized applications: Tube reactors, packed bed reactors, fluidized bed reactors, cyclone reactors, trickle flow reactors, their basic construction and types for distribution of gases.

Unit – 2 Mass Transfers in Reactors

Transport phenomena in fermentation: Gas- liquid exchange and mass transfer, oxygen transfer, critical oxygen concentration, determination of Kla, heat transfer, aeration/agitation, its importance. Sterilization of Bioreactors, nutrients, air supply, products and effluents, process variables and control, scale-up of bioreactors.

Unit – 3 Fermentation Process

Growth of cultures in the fermenter, Importance of media in fermentation, media formulation and modification. Kinetics of growth in batch culture, continuous culture with respect to substrate utilization, specific growth rate, steady state in a chemostat, fed-batch fermentation, yield of biomass, product, calculation for productivity, substrate utilization kinetics. Fermentation process: Inoculum development. Storage of cultures for repeated fermentations, scaling up of process form shake flask to industrial fermentation.

Unit – 4 Downstream Processing

Biomass separation by centrifugation, filtration, flocculation and other recent developments. Cell disintegration: Physical, chemical and enzymatic methods. Extraction: Solvent, two phase, liquid extraction, whole broth, aqueous multiphase extraction. Purification by different methods.

Concentration by precipitation, ultra-filtration, reverse osmosis. Drying and crystallization.

PRACTICALS

1. Isolation of industrially important microorganisms for microbial processes (citric / lactic/ alpha amylase) and improvement of strain for increase yield by mutation.

2. Determination of Thermal Death Point (TDP) and Thermal Death Time (TDT) of microorganisms for design of a sterilizer.

3. [a] Determination of growth curve of a supplied microorganism and also determines substrate degradation profile.
[b] Compute specific growth rate (m), growth yield (Y x/s) from the above.

4. Extraction of Citric acid/Lactic acid by salt precipitation.

5. Monitoring of dissolved oxygen during aerobic fermentation.

6. Preservation of industrially important bacteria by lyophilization.

7. Product concentration by vacuum concentrator

8 Cell disruptions for endoenzymes by sonication.

Suggested readings / References

1. Principles of Fermentation Technology by Stanbury, P.F., Whitekar A. and Hall. 1995., Pergaman. McNeul and Harvey.
2. Fermentations - A practical approach. IRL.
3. Bioprocess Technology: Fundamentals and Applications. Stockholm KTH.
4. Biochemical Reactors by Atkinson B., Pion, Ltd. London.
5. Biotechnology - A Text Book of Industrial Microbiology by Cruger.
6. Fermentation Biotechnology: Industrial Perspectives by Chand.
7. Biochemical Engineering Fundamentals by Bailey and Ollis, Tata McGraw Hill, N.Y.
8. Biotechnology. Volume 3. Edited by H. J. Rehm and G. Reed. Verlag Chemie. 1983.

9. Advances in Biochemical Engineering by T.K. Bhosh, A.Fiechter and N. Blakebrough. Springer Verlag Publications, New York.

10. Biotechnology- A textbook of Industrial Microbiology by Creuger and Creuger, Sinaeur Associates.

11. Bioprocess Engineering Kinetics, Mass Transport, Reactors, and Gene expressions by Veith, W.F., John Wiley and Sons.
12. Applied Microbiology Series.
13. Industrial Microbiology by L.E. Casida, Wiley Eastern

14. Bioseparation: Downstream processing for Biotechnology by Belter, P.A. Cussler, E.L. and Hu, W.S., John Wiley and Sons, N.Y.
15. Separation process in Biotechnolgy by Asenjo, J.A. Eds. Marcel Dekkar, N.Y.
16. Bioprocess Engineering Principles by Doran, Acad. Press, London.
17. Bioreaction Engineering Principles by Nielsen, J. and Villadsen, plenum Press, N.Y.

18. Fermentation, Biocatalysis and bioseparation, Encyclopedia of Bioprocess Technology by Chisti, Y., Vol. 5, John Wiley and Sons, N, Y.

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

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

Course No. BT 312 **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

Conventional Plant Breeding, **Introduction to cell and Tissue Culture**, tissue culture as a technique to produce novel plant and hybrids. Tissue culture media (composition and preparation), Initiation and maintenance of callus and suspension cultures; single cell clones,

Organogenesis; somatic embryogenesis; transfer and establishment of whole plants in soil. Shoot-tip culture: rapid clonal propagation and production of virus-free plants. **Wide hybridization**: Embryo culture and embryo rescue,

Somaclonal and gameto-clonal variation: causes and applications

UNIT II

Protoplast isolation; culture and fusion; selection of hybrid cells and regeneration of hybrid plants; symmetric and asymmetric hybrids, cybrids, Anther, pollen and ovary culture for **production of haploid plants** and homozygous lines, **Cryopreservation**, slow growth and DNA banking for germplasm conservation.

UNIT III

Plant Transformation Technology: basis of tumor formation, hairy root features of Ti and Ri plasmids, mechanisms of DNA transfer, role of virulence genes, use of Ti and Ri as vectors, binary vectors, use of 35S and other promoters, genetic Markers, use of reporter genes, reporter gene with introns, use of scaffold attachment region methods of nuclear transformation, viral vectors and their applications, multiple gene transfer, Vectors-less or direct DNA transfer, particle bombardment, electro-poration, microinjection, transformation of monocots. Transgene

stability and gene silencing.

Chloroplast Transformation: advantages, vectors, success with tobacco and potato.

UNIT IV

Basic Techniques in rDNA Technology Application of Plant Transformation for productivity and performance: Herbicide resistance, phosphoinothricin, glyphosate, sulfonyl urea, atrazine, insect resistance Bt genes, Non-Bt like protease inhibitors, alpha amylase inhibitor, virus resistance, coat protein mediated, nucleocapsid gene, disease resistance, chitinase, 1-3 beta glucanase, RIP, antifungal proteins, thionins, PR proteins, nematode resistance, abiotic 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.

Molecular Marker-aided Breeding: RFLP maps, linkage analysis, RAPD markers, STS, microsatellites, SCAR (sequence characterized amplified regions), SSCP (single strand conformational polymorphism), AFLP, QTL, map based cloning, molecular marker assisted selection.

PRACTICALS

1. Preparation of media
2. Surface sterilization
3. Organ Culture
4. Callus propagation and organogenesis,
5. In vitro induction of roots and transplantation in soil.
6. Protoplast isolation and culture
7. Anther culture, production of Haploids
8. Cytological examination of regenerated plants
9. Agrobacterium culture, selection of transformants, reporter gene (GUS) assay.
10. Developing RFLP and RAPD maps

Text /References

1. Bhojwani SS & Razdan M K . Plant Tissue Culture: Theory and Practice. Elsevier.
2. A Slater, N Scott and Mark Fowler Plant Biotechnology: The genetic manipulation of plants. Oxford University Press, 2003
3. J Hammound, P McGarvey and V. Yusiboy eds. Plant Biotechnology, Springer and Verlag, 2000
4. P K Jaiwal and RP Singh eds. Plant Genetic Engineering. Vols. 1-8 Studium Press LLC, USA.
5. P K Gupta Plant Biotechnology, Rastogi Publication, Meerut.

Semester III

Course Title: Animal Biotechnology ***MM. Th 80 + IA 20***

Course No. BT 313 ***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

Structure and organization of animal cell, Equipments and materials used for animal cell culture technology, Asepatic Technique, Balanced salt solutions and simple growth medium, Chemical, physical and metabolic functions of constituents of culture medium, Role of carbon dioxide, Role of serum and supplements, Serum & protein free defined media and their application, Primary and established cell line cultures, Subculture and Cell Line

UNIT II

Measurement of viability and cytotoxicity, Biology and characterization of the cultured cells, Measuring parameters of growth, Basic techniques of mammalian cell culture in vitro disaggregation of tissue and primary culture maintenance of cell culture cell separation, Scaling-up of animal cell culture, Cell synchronization, Cell cloning and micromanipulation,

UNIT III

Stem cell cultures, Somatic stem cells, Embryonic stem cells and their applications. Cell transformation. Cell culture based vaccines. Transgenic animals, Hybridoma Technology. Production and application of polyclonal and monoclonal antibodies. Applications of animal cell culture.

UNIT IV

Somatic cell genetics, Organ and histolytic cultures, Measurement of cell death Apoptosis, Three dimensional culture & tissue engineering. Application of somatic cell genetics. Factor affecting the cell death.

Practicals

Preparation of tissue culture medium and membrane filtration

Preparation of single cell suspension from spleen and thymus

Cell counting and cell viability

Macrophage monolayer from PEC, and measurement of phagocytic activity

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

Suggested Readings

1. Freshney I. Culture of Animal Cells: A Manual of Basic Technique, 5th Edition Publisher: Wiley-Liss, 2005 ISBN: 0471453293 |

2. Nigel Jen, Animal Cell Biotechnology:Methods and protocols, Humana Press

Semester III
Course Title: ***Environmental Biotechnology*** *MM. Th 80 + IA 20*

BT-314 *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

Environmental Pollution: types of pollution, Methods for the measurement of pollution; Methodology of environmental management - the problem solving approach, its limitations. Air pollution and its control through Biotechnology. Global Environmental Problems: Ozone depletion UV-Br green-house effect and acid rain their impact and biotechnological approaches for management.

UNIT II

Water Pollution and its Control: Water as a scarce natural resource, .need for water management, Measurement of water pollution, sources of water pollution, Waste water collection, Waste water treatment-physical, chemical and biological treatment process. Microbiology of Waste Water Treatments, Aerobic Process; activated sludge, Oxidation ditches, trickling filter, towers, rotating discs, rotating drums oxidation ponds.

UNIT III

Anaerobic Processes: Anaerobic digestion, anaerobic filters Up flow anaerobic sludge blanket reactors. Treatment schemes for waste waters of dairy, distillery, tannery, sugar, antibiotic industries

UNIT IV

Microbiology of degradation of Xenobiotics in Environment Ecological considerations, decay behaviour & degradative plasmids; Hydrocarbons, substituted hydrocarbons, oil, pollution, surfactants, pesticides, Bioremediation of contaminated soils and waste land. Biopesticides in integrated pest management. Solid wastes; sources and management (composting wormicu1ture and methane production)

PRACTICALS

Detection of coliforms for determination of the purify of potable water Determination of total dissolved solids of water

Determination of dissolved oxygen concentration of water sample. Determination of biological oxygen demand (BOD) of a sewage sample. Determination of chemical oxygen demand (COD) of sewage sample Isolation of xenobiont degrading bacteria by selective enrichment techniques Test for degradation of aromatic hydrocarbons by bacteria

Survey of degradative plasmids in microbes growing in polluted environment Effect of sulphur dioxide on crop plants

Estimation of heavy metals in water/soil by Atomic absorption spectrophotometry Estimation of nitrate in drinking water

Study on biogenic methane production in different habitats

Suggested-Readings

1. G M Evans, J C Furlong, Environmental Biotechnology-Theory and Applications, John Wiley & Sons,e-book, 2003.
2. Hans-Joachim Jordening, Josef Winter, Environmental Biotechnology: Concepts and Applications, John –Wileyand Sons, 2006.
3. Indu Shekhar Thakur, Environmental Biotechnology: Basic concepts and Applications, I K InternationalsPvt Ltd., 2006
4. A H Scragg, Environmental Biotechnology, Longman, 1999,
5. Recent reviews from scientific journals.

M. Sc. Biotechnology **Semester--III**
Choice Based Paper
Course Title: Biostatistics **MM. Th80 + IA 20**
Course No. BT 317 **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

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 $\chi 2$
(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. Biotechnology **Semester--III**

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

Course No. BT318 **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.

Unit 1: Introduction

Introduction: History and principles of virology, virus taxonomy, introduction to replication strategies. Structure and morphology of animal and plant viruses, **Infrastructure for virology**: Principles of bio-safety, containment facilities, maintenance and handling of laboratory animals and requirements of virological laboratory.

Unit 2: Virological methods

Culture: Cultivation and purification of viruses; estimation of yields, methods for purification.

Diagnostic methods: Immnuodiagnosis, haemagglutination and haemagglutinationinhibition tests, Complent fixation, flow-cytometry and imuno-histochemistry. **Microscopic techniques**: Fluorescence, confocal and electron microscopic techniques principles and applications. **Nucleic acid based diagnosis**: Nucleic acid hybridization, polymerase chain reaction, Real Time PCR, RT-LAMP microarray and nucleotide sequencing.

Unit 3: Antiviral and Viral Vaccines

Viral Vaccines: Conventional vaccines killed and attenuated, modern vaccines—recombinant proteins, subunits, peptides, DNA vaccines. **Antiviral:** Interferons, designing and screening for antivirals, mechanisms of action, antiviral libraries, antiretrovirals—mechanism of action and drug resistance. **Modern approaches of virus control**: Antisense RNA, siRNA, ribozymes, in silico approaches for drug designing.

Unit 4: Virus Group

Clinical features, epidemiology, diagnosis and treatment of following viral group: Viral Cancers (HPV & EBV), **Viral Hepatitis** (HAV, HBV, HCV & HEV), **Respiratory Viral Diseases** (Influenza, Bird Flu, RSV and PIV), **Viral Haemorrhagic Fevers (**Dengue & Chikungunya**), Viral Encephalitis** (JEV & WNV), **Viral Enteric Diseases** (Rota virus & Polio), **Rabies and HIV/ AIDS**.

Suggested readings

1. Fields Virology Vol 1 and 2. B.N. Fields, D.M. Knipe, P.M. Howley, R.M. Chanock, J.L. Melnick, T.P. Monath, B. Roizman, and S.E. Straus, eds.), 3rd Edition. Lippincott-Raven, Philadelphia, PA
2. Diagnostic Procedures for Viral, Rickettsial, and Chlamydial Infections. Edwin H. Lennette (Editor), David A. Lennette, Evelyne T. (Eds.) Lennette, Evelyne T. Lennette (Editor). Latest edition / Pub. Date: January 1995. Publisher: American Public Health Association Publications.
3. Antiviral Agents, Vaccines, and Immunotherapies. Stephen K. Tyring. Latest edition / Pub. Date: October 2004. Publisher: Marcel Dekker.
4. Antiviral Drug Discovery for Emerging Diseases and Bioterrorism Threats. Paul F. Torrence (Editor). Latest edition / Pub. Date: July 2005. Publisher: Wiley, John & Sons, Incorporated.
5. Viral Hepatitis and Liver disease, A.J. Zuckerman.

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

Course Title: Nano-biotechnology

Course No. BT 319 **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

Bionanotechnology: An Overview From biotechnology to Bio-nanotechnology.

Bio-nanomachines in actions, Molecular recognition & cellular communication Natural Bio-nanomachinery, Protein folding, self assembly and self- organization

UNIT-II

Bio- Nanotechnology: Synthesis, Properties & characterization

Carbon Nanotubes, Gold-, Silver- and Zinc oxide - nanoparticles, Physical, Optical, magnetic, chemical, antimicrobial properties of Nanoparticles and there characterization with XRD, SEM/TEM, UV-Visible spectroscopy techniques, FTIR, Photoluminescence spectroscopy, etc.

UNIT-III

Advances in Biomolecular Design: Molecular Modeling and Biomolecular structure determination, DNA-Protein Nanostructures, DNA directed immobilization, Chip Based DNA detection assays, Microarray Technologies, Luminescent quantum dots for Biological Labeling.

Unit-IV

Bio-nanotechnology Applications: Agricultural Productivity Enrichment; Disease Diagnosis and Screening; Pharmacy & Drug Delivery Systems: Food Processing and Storage; Vector and pest detection and control.

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.

Neelina H. Malsch, Biomedical Nanotechnology, 1st Edition, CRC Press, 2005

Choice Based Credit System (Syllabus 2015-16)

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

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

Course No. BT 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

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. Biotechnology **Semester-- II**
Course Title: Microbial Technology *MM. Th 80 + IA 20*
Course No. ***BT 412*** *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

Microbes in food industries, Preservation of foods by different methods such as high temperature, low temperature, chemical additives and irradiation. Basic concepts of D-value, Z-value, 12-D concept and F-value. Biochemical changes caused by microorganisms, Spoilage of various types of food product (Milk, meat, bread, fruits and vegetables). Food poisoning (Botulism, *Staphylococcal aureus* infection , Salmonellosis, Shigellosis, Food infections caused by *C. jejuni, H. pylori, Y. enterocolitica, V. cholerae*, *V. parahaemolyticus, B. cereus*)and microbial toxins, microbial standards for different foods.

UNIT II

Basic concepts of upstream and downstream processes, Different parts of Bioreactor; aeration and agitation system (e.g. baffles, spargers, impellers); pH, temperature, redox potential and oxygen measurement and its control in a bioreactor; Use of computers in a bioreactor; Microbial production and uses of antibiotics like penicillin, streptomycin, tetracycline, immunosupressor, enzymes like proteases, amylases, cellulases, lipases, glucose isomerases, glucose oxidases, bacterial insecticides and Xanthan gum; Basic concept of Immobilized enzyme technology.

UNIT III

Microbial production of anti-cancer agents and antioxidant drug: production of CoQ10, beta-caretonid, astaxanthine, demethylated colchicines; and its derivative, glucosamine, Steroid transformation, Microbial production of Industrial alcohol , Microbial production of beer, ale, wine, whisky, rum, vodka, brandy, champagne, Microbial production of methanol and

unsaturated fatty acid, Microbial production and uses of riboflavin, Vitamin B12, L-lysine and Glutamic acid production, Use of microbes in mineral recovery.

UNIT IV

Biological warfare agents; Mode of action of antibiotics (acting on cell walls, cell membranes, protein biosynthesis and nucleic acid biosynthesis); antiviral chemotherapy; Anti-fungal chemotherapy, Mechanism of drug-resistance and multiple drug-resistance; Bacterial vaccines: conventional: killed/attenuated; DNA; peptide; recombinant proteins and edible vaccines; Various sterilization techniques: biohazard hood, BSL 1, 2, 3, 4.

PRACTICAL

Production and estimation of antibiotics (Penicillin and Streptomycin)

Production and estimation of
alcohol Operation of bioreactor.

Demonstration of different biosafety levels with at least one example
of pathogenic microorganism exploited in each group.
Demonstration of different sterilization techniques
Isolation of coliforms from the contaminated water and MPN number

REFERENCE BOOKS

Principles of fermentation technology, Stanbury P.F. et al, Butterworth-Heinemann Ltd, Oxford Industrial Microbiology by Casida

Industrial Microbiology by
Cruger Food Microbiology by
Frazier

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

Course Title: Dissertation **Marks : 300**

Course No. BT 413 **(Dissertation: 200 + Viva voce 100)**

Choice Based Credit System (Syllabus 2015-16)

M.Sc. Agriculture 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.

Practical

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.

M.Sc. Agriculture Biotechnology **Semester—I**

Course Title**: Bio-molecules 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 others 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. Agriculture Biotechnology **Semester--I**

Course Title: Microbiology MM. Th 80 + IA 20
Course No. A**BT 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 others 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. 2nd edition. WM.T.Brown Publishers.

2. Black JG. (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. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7 th edition. McGraw Hill Higher Education.

M.Sc. Agriculture Biotechnology **Semester I**

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 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 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 & quantification
3. Southern blotting
4. RFLP analysis
5. Isolation and quantification 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

1. Benjamin Lewin. Gene X, 10th Edition, Jones and Barlett Publishers 2010.
2. J D Watson et al., Biology of 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.

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

Course Title: Genetic engineering ***MM. Th 80 + IA20***

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

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

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

Choice Based Credit System (Syllabus 2015-16)

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

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

Course No. ABT 211

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.

1. Callus induction in tobacco leaf discs and regeneration of shoots,
2. *In vitro* root induction and transplantation of in vitro-raised plants
3. Anther culture
4. 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. Agriculture 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 querry 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 PERL in 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:

- Computational analysis of genomic and 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. Agriculture Biotechnology **Semester II**
Course Title: Green House Management and Plant Protection ***MM. Th 80 + IA 20***
Course No. ABT 213 **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 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. Preplanting 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
To study specialized greenhouse operations.
Formulations of the plant growth media.
To study pest management in green house.
To study water and plant nutrition management.
Harvesting and postharvest handling in green house.
Management of farm records in green house

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

.

M.Sc. Agriculture Biotechnology **Semester II**
Course Title: Biomass and Bioenergy ***MM. Th 80 + IA 20***
Course No. ABT 214 **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 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:

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

References:

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

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

Course Title: Molecular Breeding **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

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 216 **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. Agricultural Biotechnology Semester--II

Course Title: Principle and Applications of Agriculture Biotechnology

MM. Th 40+IA 10

Course No. ABT 217 **Time: 2 h**

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

Plant tissue culture and its application. Recombinant DNA technology and cloning vectors, Different methods of gene transfer in plants (*Agrobacterium* mediated transfers, microinjection, eletroporation, somatic cell hybridization). Development of transgenics for abiotic & biotic stress tolerance

Tools and techniques used in agriculture biotechnology, restriction digestion (restriction endonucleases, types and mechanism), ligases, alkaline phosphatases, polynucleotide kinase, SI nuclease, DNAse, RNAse, scoreable and selectable markers. PCR, C-DNA and genomic libraries

Unit II

Genetic and Molecular basis of Heterosis and Apomixis and their significance, Mutations and polyploidy in crop improvement, Molecular markers, Marker assisted breeding, QTL mapping, Origin, evolution and cultivation practices of the major crop plants

Improvement of crop plants: increase in iron, protein and amino acids, golden rice colours – anthocyanins, betalaines, crocin and crocetins. Flavours–capsaicin, vanillin, stevioside thaumatin. Developing vaccine and plantibodies, terminator technology and male sterility

References:

1. Hou CT, Shaw JF (2009) – Biocatalysis and agricultural biotechnology, CRC Press, USA
2. Agricultural biotechnology, 1st edition, (2008) Rawat H, Oxford Book Co, India.
3. Agrobiotechnology and plant tissue culture, Bhojwani SS, Soh WY, Oxford & IBH Publ, India
4. Agricultural biotechnology, (2005), Kumar HD, Daya Publ House, India
5. Plant molecular breeding, (2009), Newbury HJ, John Wiley and Sons., USA.
6. Embryology of Angiosperms, (2009), S.S. Bhojwani and S.P. Bhatnagar, Vikas Publ House, India.
7. Ashwani Kumar, Shekhawat NS (2009) – Plant tissue culture and molecular markers: theor role in improving crop productivity (IK International) 8. Biotechnology, 4th edition, (2010), H K Das, Wiley India Pvt. Limited, India
8. Biotechnology, 4th edition, (2010), H K Das, Wiley India Pvt. Limited, India

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

Course Title: Communication Skills

Course No. ABT 218 ***MM. Th 40+IA 10***

Time: 2 h

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.

Choice Based Credit System (Syllabus 2015-16)

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:

2. Adrian Slater, Nigel Scott and Mark Fowler, Plant Biotechnology: The genetic manipulation of plants, 1st Edition, Oxford University Press, 2003

3. Edited by BR Jordan, 2nd Edition, The Molecular Biology and Biotechnology of Flowering, CABI, 2006.

4. Jaiwal P K & Singh R P (eds) Plant Genetic Engineering Vol-1 to Vol. 9. Studium Press, USA, 2006.

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

6. 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: Biotic and Abiotic 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**

Course Title: INDUSTRIAL AND FOOD BIOTECHNOLOGY

Course No. ABT 317 **MM. Th 80 + IA20**

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. Agricultural Biotechnology **Semester--III**
Choice Based Paper
Course Title: Crop Protection and Integrated Pest Management **MM. Th80 + IA 20**
Course No. BT 318 **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

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

BOOKS

Dhaliwal GS & Arora R. 2003. Integrated Pest Management – Concepts and Approaches. Kalyani Publ., New Delhi.

Horowitz AR & Ishaaya I. 2004. Insect Pest Management: Field and Protected Crops. Springer, New Delhi.

Ignacimuthu SS & Jayaraj S. 2007. Biotechnology and Insect Pest Management. Elite Publ., New Delhi.

Peshin, R, Dhawan, AK. (Eds.). 2009. Integrated Pest Management, Volume 1: Innovation-Development Process. Springer publishers.

M. Sc. Agricultural Biotechnology **Semester--III**
Choice Based Paper
Course Title: Biostatistics and Agro-economics **MM. Th80 + IA 20**
Course No. BT 319 **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

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. Varience, Skewness and kurtosis.

UNIT II

Elements of probability theory: Definition of probability, classical definitions relative frequency approach and axiomatic approach. Discrete Randam 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 randamised and completely randamised, 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.

BOOKS

Nilabja Ghosh, 2013. India's Agricultural Marketing. Springer.

Bhalla, G. S. and Singh, G. 2012. Economic Liberalisation and Indian Agriculture: A District-Level Study. SAGE publications.

Fukuda-Parr, S. (Ed.). (2012). The gene revolution: GM crops and unequal development. Taylor & Francis.

Bhalla, G. S., & Singh, G. (2001). *Indian agriculture: four decades of development*. Sage Publications.

Frankel, F. R. (2015). *India's Green Revolution: Economic Gains and Political Costs*. Princeton University Press.

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.

Bilgrami, S.A.R. (2000). An introduction to Agricultural Economics (2nd Edition), Himalyan Publishing House, Mumbai.

Sadhu, A.N. and J. Singh (2000) Agricultural problems in India (3rd edition), Himalayan Publishing House, Mumbai.

Sundaram, I.S (2002) Rural Development (4th edition) Himalayan Publishing House, Mumbai.

Reserve Bank of India, Hand Book of Statistics on Indian Economy (Annual).

Soni. R.N. (2000), Leading issues in Agricultural Economics, Arihant press, Jalandar.

Statistical Procedure for Agricultural Research By: Kwanchai A Gomes Arturo A.Gomez, John Wiley and Sons.

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.

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

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

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

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), 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. Agri. Biotechnology **Semester-IV**

Course Title: Animal Biotechnology and Immunology

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

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. Agriculture Biotechnology **Semester-IV**
Course Title: Dissertation **Marks : 300**
Course No. ABT 413 **(Dissertation: 200 + Viva voce 100**