

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

Semester I

Marks

Sr. No.	Course Code	Subject/Title	Credits	Theory	Int Ass
1	16BT21C1	Cell Biology	04	80	20
2	16BT21C2	Bio molecules & Metabolism	04	80	20
3	16BT21C3	Microbiology	04	80	20
4	16BT21C4	Molecular Biology	04	80	20
5	16BT21C5	Genetic Engineering	04	80	20
6	16BT21C6	Lab course-I (Cell Biology, Bio molecules & Metabolism) 16BT21C1-2	04	100	
7	16BT21C7	Lab course-II (Microbiology, Molecular Biology, Genetic Engineering) 16BT21C3-C5	04	100	
	Total		28		

Semester II

Sr. No.	Course Code	Subject/Title	Credits	Theory	Int Ass
1	17BT22C1	Immunology	04	80	20
2	17BT22C2	Plant Biotechnology	04	80	20
3	17BT22C3	Environmental Biotechnology	04	80	20
4	17BT22D1	Bioinformatics/Biology of Infectious Diseases/Diagnostics	04	80	20
5	Open Elective	To be chosen from the basket of open Electives provided by the university	03		
6	Foundation Course	To be chosen from the basket of Foundation Course provided by the university	02		
7	17BT22C4	Lab course-I (Immunology, Bioinformatics/Biology of Infectious diseases), 17BT22C1, 17BT22D1	04	100	
8	17BT22C5	Lab course-II (Plant Biotech., Environmental Biotech.) 17BT22C2, C3	04	100	
	Total		29		

Semester III

Sr. No.	Course Code	Subject/Title	Credits	Theory	Int Ass
1	17BT23C1	Bioprocess Engineering	04	80	20
2	17BT23C2	Animal Biotechnology	04	80	20
3	17BT23D1	Molecular Human Physiology and Dev. Biology/ Molecular Plant Physiology & Development Biology	04	80	20
4	17BT23D2	Biostatistics/ Virology/Nano- Biotechnology	04	80	20
5	Open Elective	To be chosen from the basket of Open Electives course provided by the university	03		
6	17BT23C3	Lab course-I (Two hard core) 17BT23C1-C2	04	100	
7	17BT23C4	Lab course-II (Two soft core) 17BT23D1-D2	04	100	
	Total		27		

Semester IV

Sr. No.	Course Code	Subject/Title	Credits	Theory	Int Ass
1	18BT24C1	IPR Bio safety, Ethical, Legal , Social issues In	04	80	20

		Biotechnology			
2	18BT24C2	Microbial Technology	04	80	20
3	18BT24C3	Dissertation	20	300	
	Total		28		

Total credits=112

Choice Based Credit System (Syllabus 2016-18)

M.Sc. Biotechnology

Semester--I

Course Title: Cell Biology

MM.Th 80 + IA 20

Course Code No. 16BT21C1

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 Code No. 16BT21C2

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, Isoelectric 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 Code No. 16BT21C3

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, Chlamydiae 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 Code No. 16BT21C4

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 Code No. 16BT21C5

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 (2016-2017)

M.Sc. Biotechnology
Course Title: Immunology

Semester--II
MM. Th 80 + IA 20

Course Code No 17BT22C1

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-lymphocytes, T-lymphocytes, 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 (intercellular parasites like *M. tuberculosis*, helminthes and viruses); Tumor Immunology; AIDS and other Immunodeficiencies; Hybridoma technology and applications of monoclonal antibodies

PRACTICALS

1. Blood film preparation and identification of cells
2. Lymphoid organs and their microscopic organization
3. Immunization, Collection of Serum

4. Double diffusion and Immune-electrophoresis Radial Immuno diffusion
5. Purification of IgG from serum
6. Separation of mononuclear cells by Ficoll-Hypaque Western-blotting
7. ELISA
8. Immunodiagnosics (demonstration using commercial kits) e.g. Widal test for typhoid fever.

REFERENCE BOOKS/ 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. Fundamentals of immunology (1999) by William Paul (Lippincott Williams & Wilkins).
4. Immunology (2001) by Ivan Maurice Roitt, Jonathan Brostoff, David K. Male (Mosby).
5. Understanding immunology (2007) by Peter John Wood, Dorling K. Inderseley (Pearson Education, India).
6. Immunology (2007) by Kannan, I (MJP Publishers, India).

M.Sc. Biotechnology Semester--II

Course Title: Plant Biotechnology

MM. Th 80 + IA 20

Course Code No 17BT22C2

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, phosphinothricin, 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 II

Course Title: Environmental Biotechnology

MM. Th 80 + IA 20

Course Code No 17BT22C3

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 wormiculture and methane production)

PRACTICALS

1. Detection of coliforms for determination of the purify of potable water Determination of total dissolved solids of water.
2. 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.
3. Survey of degradative plasmids in microbes growing in polluted environment Effect of sulphur dioxide on crop plants.
4. Estimation of heavy metals in water/soil by Atomic absorption spectrophotometry Estimation of nitrate in drinking water
5. 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 II

MM. Th 80 + IA

20

Course Title: Bioinformatics

Course Code Course Code No 17BT22D1

Time: 3h

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

Theory

UNIT I

Computers: An overview of computers, architecture; generations. What is programming? Algorithms. Introduction to MS Office. MS Access, Front Page and introduction to C, Java and SQL (structured query language). Introduction to computer networking, topology, networking protocol (FTP; TCP/IP), 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,
(iv)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 1st 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

Course Code

No 17BT22D1

MM. Th 80 +IA20

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. Students are required to attempt four questions i.e. anyone from each unit.

Theory

UNIT I

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.

UNIT II

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

UNIT III

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

UNIT IV

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) by Geo. F. Brooks, Janet S. Butel, Stephen A. Morse McGraw-Hill Medical; 23 edition
2. Medical Microbiology: with Student Consult by Patrick R. Murray PhD (Author), Ken S. Rosenthal PhD Saunders; 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 Code No 17BT22D1

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. Students are required to attempt four questions i.e. any one 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) and comparative 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, Multiplex PCR

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. Introduction to pharmacogenomics and toxicogenomics

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

1. Pasternak, An Introduction to Molecular Human Genetics, 2nd Edition, Fritzsche, 2005. Mange and Mange, Basic Human Genetics, 2nd Edition, Sinauer Assoc, 1999.
2. Lewis, Human Genetics, 7th Edition, WCB&McGraw, 2007.
3. Vogel and Motulsky, Human Genetics, 3rd Edition, Springer-Verlag, 1997.
4. Strachan and Read, Human Molecular Genetics, 3rd Edition, Garland Sci. Publishing, 2004. Maroni, Molecular and Genetic Analysis of Human Traits, 1st Edition, Wiley-Blackwell, 2001. Howley and Mori, The Human Genome, Academic Press, 1999.
5. Strickberger, Genetics, 3rd Edition, McMillan, 1985.
6. Snustad & Simmons, Principles of Genetics, 4th Edition, Wiley, 2005. Griffiths et al, Modern genetic analysis, 2nd Edition, Freeman, 2002.
7. Hartl and Jones, Genetics-Principles and Analysis, 4th Edition, Jones & Bartlett, 1998. Alberts et al, Molecular Biology of The Cell, 2nd Edition, Garland 2007.

M.Sc. Biotechnology

Semester—III

Course Title: BIOPROCESS ENGINEERING

MM. Th 80 + IA 20

Course Code No. 17BT23C1

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 $K_L a$, 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 from 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 (μ), 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.

Semester III

Course Title: Animal Biotechnology

Course Code No. 17BT23C2

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

Structure and organization of animal cell, Equipments and materials used for animal cell culture technology, Aseptic 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:

1. Preparation of tissue culture medium and membrane filtration
2. Preparation of single cell suspension from spleen and thymus
3. Cell counting and cell viability
4. Macrophage monolayer from PEC, and measurement of phagocytic activity
5. Trypsinization of monolayer and sub culturing
6. Cryopreservation and thawing
7. Measurement of doubling time
8. Role of serum in cell culture
9. Preparation of metaphase chromosomes from cultured cells
10. Isolation of DNA and demonstration of apoptosis of DNA laddering
11. MTT assay for cell viability and growth
12. 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

M.Sc. Biotechnology

**Semester—III
MM. Th 80 +IA
20**

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

Course Code No. **17BT23D1**

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). Erythropoiesis, myelopoiesis, 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.
11. Mutants of *Drosophila*. Sex linked 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—III

Course Title: Molecular Plant Physiology and Developmental Biology,

Course Code No. 17BT23D1

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; CO₂ fixation-C₃, C₄ and CAM pathways. Biotechnological strategies for improving photosynthetic CO₂ 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 CO₂ and high O₃ 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;

Organisaion 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

1. Extraction and separation of chlorophyll by chromatography. Absorption and action spectra of chlorophyll.
2. Demonstration of Hill reaction and Oxygen evolved during photosynthesis Isolation and separation of amino acids by chromatography.
3. Estimation of enzymes related to nitrogen assimilation.
4. 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--III

Choice Based Paper

Course Title: Biostatistics

MM. Th80 + IA 20

Course Code No. 17BT23D2

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 χ^2
(Chi square), Random Variables and Distributions, Binomial, Poisson,
Exponential and Normal Distributions and their applications, Correlation: Simple, Partial and Multiple Correlation, Methods of averages and least squares, polynomial fitting.

Unit III

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

Unit IV

Differential Calculus, Rules of differentiation, Derivatives of implicit functions, Parametric differentiation, Higher derivatives, Maxima and minima, Partial differentiation Integration, Integration by parts, Definite integral, Properties of definite integrals, Differential Equations,

Separable variable, homogenous, exact and linear equations of second order.

PRACTICALS

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

BOOKS

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

M.Sc. Biotechnology

Course Title: VIROLOGY

Course Code No.
17BT23D2

Semester—III

MM. Th 80 + IA 20

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: Immunodiagnosis, haemagglutination and haemagglutinationinhibition tests, Complement fixation, flow-cytometry and immuno-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**.

Practical for Virology

- 1) Glassware decontamination, washing, sterilization, packing and sterile handling.
- 2) Media and reagents preparation, sterility checks.
- 3) Sample collection, transport and processing for virus isolation.
- 4) Maintenance of cell cultures.
- 5) Preparation of primary cell culture.
- 6) ELISA for virus detection.
- 7) Direct and indirect Immunofluorescence assay (DFA and IFA) for the virus detection.
- 8) Haemagglutination assay & Haemagglutination Inhibition assay (HA & HI) for the virus detection.
- 9) PCR & RT-PCR for virus detection.
- 10) Complement Fixation test for virus detection.
- 11) Rapid test for virus detection.

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

Course Title: Nano-biotechnology

Course Code No. 17BT23D2

Semester-III

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 NaturalBio-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.

Practicals

Chemical Synthesis of Gold nanoparticles.

Chemical synthesis of Zinc oxide nanoparticles.

Green synthesise of Silver nanoparticles.

Green synthesise of Zinc oxide nanoparticles.

Characterization of Gold nanoparticles.

Characterization of Zinc oxide nanoparticles.

SUGGESTED BOOKS

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

M. Sc. Biotechnology

Semester-IV

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

Course Code No. 18BT24C1

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

Course Title: Microbial Technology

Course Code No. 18BT24C2

Semester-- IV

MM. Th 80 + IA

20

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, immunosuppressor, 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.

REFERENCE BOOKS

- 1) Principles of fermentation technology, Stanbury P.F. et al, Butterworth-Heinemann Ltd, Oxford Industrial Microbiology by Casida.
- 2) Industrial Microbiology by Cruger Food Microbiology by Frazier.

M. Sc. Biotechnology

Course Title: Dissertation

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Semester-IV

Marks : 300

(Dissertation: 200 + Viva voce 100)