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

Program Specific Outcome

PSO1. An education in cell biology will impart knowledge to the students to understand origins of cells and the generation of cell diversity, as well as the common features of cellular structure and function – how they obtain energy, synthesize new molecules, communicate, proliferate and survive. It will also emphasis on the fundamental importance of cell biology in modern science, particularly in relation to cell technologies and health. Basic knowledge of structure and functions of major bio-molecules will be taught. Understanding of metabolic pathways (catabolism as well as anabolism), their diversity and how these are specifically regulated and interrelated in different cells.

PSO2. Students will understand the importance of microbiology which is an integrated part of Biotechnology. All the genetic manipulation of genes is carried primarily with the help of micro-organisms, hence, understanding the growth kinetics, their physiology and genetics is needed for better understanding the Molecular biology and genetic engineering. Students will become familiar with the tools and techniques of genetic engineering- DNA manipulation enzymes, genome and transcriptome analysis and manipulation tools, gene expression regulation, production and characterization of recombinant proteins

PSO3. An education on developmental biology will impart extensive knowledge to the students with basic concepts that occur within all living organisms, and fundamental processes of fertilization of an egg cell and its step-by-step transformation into the fascinating complexity of a whole organism. By studying developmental biology along with physiology students will gain an understanding of the causes, diagnosis and treatment of disease, and how they affect different parts of the body. Developmental Biology along with Physiology addresses the key challenge of population health.

PSO4. Students will imbibe the importance of plant biotechnology regarding basic as well as advance knowledge about the in vitro culture, maintenance and preservation of plant cells, tissues and organs. The techniques of haploid, triploid and somatic hybrid plant production and their manipulation for quantitative and qualitative improved traits. Molecular Plant Physiology and Developmental Biology course provides an insight for manipulation of vital plants processes to enhance photosynthesis, to overcome photorespiration, improving nutrient use efficiency and nitrogen fixation. Further, course exposes the students to the 'omics' studies of various abiotic stress responses and development of stress resistant crop plants to boost their production in era of global climatic change. The molecular basis of division and differentiation of plant stem cells into different plant organs has also been covered in this course.

PSO5. The main outcome of the course is to provide basic understanding of immunology and immune responses in response to various infectious and non infectious diseases. Immunology is important subject of Biotechnology, which can help us to better understand human health. This paper can also facilitate to clear NET and JRF exam as many questions are being asked on immunology. In fact, immunology and biology of infectious diseases are two core subjects of Medical Microbiology/Biotechnology that provide a scaffold of medical research. By studying 'Diagnostics', the main goal is to provide the basic idea of diagnosis of infectious as well as non-infectious diseases so that early treatment is initiated to avoid unnecessary morbidity and mortality. The major outcome to study the environmental biotechnology is to understand the current applications of biotechnology to environmental quality evaluation, monitoring and remediation of contaminated environments. An education in environmental biotechnology aid the students to identify and implement solutions to these problems and mitigation of human impact on the environment. Interdisciplinary nature of the bioinformatics course offers substantial understanding of both the biological sciences and the physical and mathematical sciences.

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

M. Sc Biotechnology (Semester I & II)

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

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

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

Semester I **Marks**

Sr. No.	Course Code	Subject/Title	Credits	Theory	Int Ass
1	16CBT21C1	Cell Biology	04	80	20
2	16CBT21C2	Bio molecules & Metabolism	04	80	20
3	16CBT21C3	Microbiology	04	80	20
4	16CBT21C4	Molecular Biology	04	80	20
5	16CBT21C5	Genetic Engineering	04	80	20
6	16CBT21CL1	Lab course-I (Cell Biology, Bio molecules & Metabolism) 16BT21C1, C2	04	100	
7	16CBT21CL2	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	16CBT22C1	Immunology	04	80	20
2	16CBT22C2	Plant Biotechnology	04	80	20
3	16CBT22C3	Environmental Biotechnology	04	80	20
4	16CBT22D1 or D2 or D3	Bioinformatics (D1)/Biology of Infectious Diseases (D2)/ Diagnostics(D3)	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	16CBT22DL	Lab course-I (Immunology, Bioinformatics/Biology of Infectious diseases), 16CBT22C1, 16CBT22D1	04	100	
8	16CBT22CL	Lab Course-II (Plant Biotech., Environmental Biotech.) 16CBT22C2, C3	04	100	
	Total		29		

M. Sc Biotechnology (Semester III & IV)

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

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

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

Semester III

Sr. No.	Course Code	Subject/Title	Credits	Theory	Int Ass
1	17CBT23C1	Bioprocess Engineering	04	80	20
2	17CBT23C2	Animal Biotechnology	04	80	20
3	17CBT23DA1 Or 17CBT23DA2	Molecular Human Physiology and Dev. Biology/ Molecular Plant Physiology & Development Biology	04	80	20
4	17CBT23DB1/ DB2/ DB3	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	17CBT23CL	Lab course-I 17CBT23C1, C2	04	100	
7	17CBT23DL	Lab course-II Based on 17CBT23DA1/DA2 and DB1/DB2/DB3	04	100	
		Total	27		

Semester IV

Sr. No.	Course Code	Subject/Title	Credits	Theory	Int Ass
1	17CBT24C1	IPR Bio safety, Ethical, Legal , Social issues In Biotechnology	04	80	20
2	17CBT24C2	Microbial Technology	04	80	20
3	17CBT24C3	Dissertation	20	300	
	Total		28		

Total credits=112

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

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

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

Course Code No. 16CBT21C1 **Time: 3h**

COURSE OUTCOMES

CO1. Students will know about the cell and its biology, which will help the students to understand the origins of cells and the generation of cell diversity, as well as the common features of cellular structure and function – how they obtain energy, synthesize new molecules, communicate, proliferate and survive.

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

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

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

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

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

BOOKS

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.

Semester—I
M.Sc. Biotechnology
Course Title: Bio-molecules and metabolism
Course Code No. 16CBT21C2

MM. Th 80 + IA 20 Time: 3h

COURSE OUTCOMES

CO1. Basic knowledge of structure and functions of major bio-molecules will make the students to understand and implement the acquired knowledge in future.
CO2. Understanding of metabolic pathways (catabolism as well as anabolism), their diversity and how these are specifically regulated and interrelated in different cells
CO3. Practical knowledge and hands on tools and techniques for the characterization of bio-molecules will help the students in advanced research programs
CO4. Concepts of enzyme kinetics, regulation and specificity

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

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.

Semester--I

M. Sc. Biotechnology
Course Title: Microbiology **MM. Th 80 + IA 20**
Course Code No. 16CBT21C3 **Time: 3h**

COURSE OUTCOMES

CO1. Student will understand the diversified branches of microbiology
CO2. Student will know the theoretical and practical aspects of microbial growth and physiology
CO3. Students will learn about the morphology and physiological characteristics of different groups of microorganisms
CO4. This course will make the students to understand virus cultivation, phages and bacterial/yeast genetics

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

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. 5th edition McMillan.
5.Willey JM, Sherwood LM and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.

M.Sc. Biotechnology

Semester I
Course Title: Molecular Biology **MM. Th 80 + IA 20**
Course Code No. 16CBT21C4 **Time: 3hTheory**

COURSE OUTCOMES

CO1. Students will learn DNA replication, recombination and repair, transcription and translation

CO2. Students will be aware of the modern tools and techniques of genomics and isolation and identification of genes

CO3. Students will understand the biology and application of antisense technologies and biology of cancer

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

UNIT I

DNA Replication: Prokaryotic and eukaryotic DNA replication, Mechanics of DNA replication, enzymes and accessory proteins involved in DNA replication and DNA repair. Transcription: Prokaryotic transcription, Eukaryotic transcription, RNA polymerase, General and specific transcription factors, Regulatory elements in mechanisms of transcription regulation, Transcriptional and post-transcriptional gene silencing

Modifications in RNA: 5 '-Cap formation, Transcription termination, 3'-end processing and polyadenylation, Splicing, Editing, Nuclear export of mRNA, mRNA stability

UNIT II

Translation : Prokaryotic and eukaryotic translation, the translation machinery, Mechanisms of initiation, elongation and termination, Regulation of translation, co- and post translational modifications of proteins.

Protein Localization: Synthesis of secretory and membrane protein, Import into nucleus, mitochondria, chloroplast and peroxisomes, Receptor mediated endocytosis

Oncogenes and Tumor Suppressor Genes: Viral and cellular oncogenes, tumor suppressor genes from humans, Structure, Function and mechanism of action of pRB and p53 tumor suppressor proteins

UNIT III

Antisense and Ribozyme Technology: Molecular mechanism of antisense molecules, inhibition of splicing, polyadenylation and translation, disruption of RNA structure and capping, Biochemistry of ribozyme; hammer head, hairpin and other ribozymes, strategies for 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. 16CBT21C5 **Time: 3h**

COURSE OUTCOMES

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

NOTE: In all nine questions will be set, two from each unit and one compulsory question of short answer type covering all the units. Students are required to attempt one compulsory question and four 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 throughT-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 and Isolation of plasmid DNA.
2. Isolation of lambda phage DNA.
3. Agarose gel electrophoresis and restriction mapping of DNA
4. Construction of restriction map of plasmid DNA.
5. Cloning in plasmid/phagemid vectors.
6. Preparation, of helper phage and its titration
7. Preparation of single stranded DNA template
8. DNA sequencing
9. Gene expression in E. coli and analysis of gene product
10. 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 (Session 2016)

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

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

Course Code No 17CBT22C1 **Time: 3h**

COURSE OUTCOMES

CO1. Students will understand the basic concept of innate and acquired immunity.
CO2. Students will gain knowledge about immunoglobulin structures and diversity of antibodies, morphology and functions of various immune cells such as dendritic cells, macrophages, neutrophils and their association with MHC molecules will be studied.
CO3. This study will make the students to understand the basic mechanisms of hypersensitivity responses and their associations with different diseases.
CO4. The main goal of the course is to provide basic understanding of immunology and immune responses in response to various infectious and non infectious diseases.

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 Immuno deficiencies; Hybridoma technology and applications of monoc1onal 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 Ficol1-HypaqueWestern-blotting, ELISA
7. Immunodiagnostics (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
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 KInderseley (Pearson Education, India)
6. Immunology (2007) by Kannan, I (MJP Pulishers, India).

M.Sc. Biotechnology Semester--II
Course Title: Plant Biotechnology **MM. Th 80 + IA 20**
Course Code No 17CBT22C2 **Time: 3 h**

COURSE OUTCOMES

CO1. Students will learn the principals and technical advances behind the *in vitro* culture of plant cells and rDNA techniques
CO2. Students will learn the applications of plant transformation for improving the productivity and performance of plants under biotic and abiotic stresses
CO3. Students will understand the use of antisense technologies for improvement of crop plants

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, electroporation, microinjection, transformation of monocots. Transgenic 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 II

Course Title: Environmental Biotechnology **MM. Th 80 + IA 20**
Course Code No 17CBT22C3 **Time: 3h**

COURSE OUTCOMES

CO1. The student will be able to evaluate the potential of biodegradation of organic pollutants, taking microbial and physical/chemical environments, as well as the chemical structure of the compound itself, into consideration

CO2. Students will understand the phenomenon of phytoremediation for the decontamination of soil and water, wetlands as treatment processes, biofilms/biofilters for vapor-phase wastes, and composting

CO3. Students will learn about the environmental quality evaluation, monitoring, and remediation of contaminated environments

CO4. Students will learn about the use of biosensors in environmental analysis, environmental engineering.

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

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 –Wiley and Sons, 2006.
3. Indu Shekhar Thakur, Environmental Biotechnology: Basic concepts and Applications, I K Internationals Pvt. Ltd., 2006
4. A H Scragg, Environmental Biotechnology, Longman, 1999,
5. Recent reviews from scientific journals.

M. Sc. Biotechnology Semester II

Course Title: Bioinformatics **MM. Th 80 + IA 20**
Course Code No 17CBT22D1 **Time: 3h**

COURSE OUTCOMES

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

NOTE: In all nine questions will be set, two from each unit and one compulsory question of short answer type covering all the units. Students are required to attempt one compulsory question and four 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, Needleman Wusch & Smith Waterman algorithms. Analysis of computational complexities and the relative merits and demerits of each method. Theory of scoring matrices and their use for sequence comparison; 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 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 Code No 17CBT22D2 **Time: 3 h**

COURSE OUTCOMES

CO1. Students will learn about different biosafety levels such as BSL-I, BSL-II, BSL-III and BSL-IV
CO2. Students will understand the mode of actions of antibiotics such as Penicillin, streptomycin, amikacin, amphoterricin B, nystatin, etc. will be studied
CO3. Students will acquire knowledge about infections such as *Pseudomonas aeruginosa, Staphylococcus aureus*, etc.
CO4. The course will make the students to learn various diagnostic techniques such as PCR, RT-PCR, Real-time PCR.

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: Ascariais, 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 warfareagents

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 +IA 20**

Course Code No 17CBT22D3 **Time: 3h**

COURSE OUTCOMES

CO1. The students will learn about the chromosomal and mitochondrial disorders and quality control of pharmaceutical products

CO2. The students will learn the theoretical and practical aspects of human genetics.

CO3. The students will understand different types of NAA tests for the diagnosis of microorganisms of medical importance and in forensic science.

CO4. This course will describe pharmaco-genomics and toxic genomics.

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

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, 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. Introduction to pharmaco genomics and toxico-genomics

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. Pastemak, An Introduction to Molecular Human Genetics, 2nd Edition, Fritzgarald, 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. Strachen and 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, The Human Genome, Academic Press, 1999.
5. Strickberger, Genetics,3rd edition, McMillan, 1985.

6. Snustad & Simmons, Principles of Genetics,4thEdition, 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. 17CBT23C1 **Time: 3h**

COURSE OUTCOMES

CO1. Students will gain knowledge of bioreactor
CO2. Students will understand the application and functioning of bioreactors
CO3. This course will make the students to understand the downstream procedure and fermenter waste treatment

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

Principles of Fermentation Technology by Stanbury, P.F., Whitekar A. and Hall. 1995., Pergaman. McNeul and Harvey.

1. Fermentations - A practical approach. IRL.
2. Bioprocess Technology: Fundamentals and Applications. Stockholm KTH.

3. Biochemical Reactors by Atkinson B., Pion, Ltd. London.
4. Biotechnology - A Text Book of Industrial Microbiology by Cruger.
5. Fermentation Biotechnology: Industrial Perspectives by Chand.
6. Biochemical Engineering Fundamentals by Bailey and Ollis, Tata McGraw Hill, N.Y.
7. Biotechnology. Volume 3. Edited by H. J. Rehm and G. Reed. Verlag Chemie. 1983.
8. Advances in Biochemical Engineering by T.K. Bhosh, A.Fiechter and N. Blakebrough. Springer Verlag Publications, New York.
9. Biotechnology- A textbook of Industrial Microbiology by Creuger and Creuger, Sinaeur Associates.
10. Bioprocess Engineering Kinetics, Mass Transport, Reactors, and Gene expressions by Veith, W.F., John Wiley and Sons.
11. Applied Microbiology Series.
12. Industrial Microbiology by L.E. Casida, Wiley Eastern
13. Bioseparation: Downstream processing for Biotechnology by Belter, P.A. Cussler, E.L. and Hu, W.S., John Wiley and Sons, N.Y.
14. Separation process in Biotechnolgy by Asenjo, J.A. Eds. Marcel Dekkar, N.Y.
15. Bioprocess Engineering Principles by Doran, Acad. Press, London.
16. Bioreaction Engineering Principles by Nielsen, J. and Villadsen, plenum Press, N.Y.
17. 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 **MM. Th 80 + IA 20**
Course Code No. 17CBT23C2 **Time: 3h**

COURSE OUTCOMES

CO1. Students will understand the structure of animal genes and genomes.
CO2. Students will understand how genes are expressed and what regulatory mechanisms contribute to control of gene expression.
CO3. Students will understand basic principles and techniques in genetic manipulation and genetic engineering.
CO4. Students will understand gene transfer technologies for animals and animal cell lines.
CO5. Students will understand the techniques and problems both technical and ethical in animal cloning.

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:

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

Semester—III

Course Title: Molecular Human Physiology and Developmental Biology MM. Th 80 +IA 20
Course Code No. 17CBT23DA1 Time: 3h

COURSE OUTCOMES

CO1. Students will understand and gain knowledge of developmental biology along with physiology and fundamental processes of fertilization of an egg cell and its step-by-step transformation into the fascinating complexity of a whole organism.
CO2. Developmental biology along with physiology offers the student an opportunity to explore and integrate the biological and behavioural sciences.
CO3. By studying developmental biology along with physiology students will gain an understanding of the causes, diagnosis and treatment of disease, and how they affect different parts of the body.
CO4. Students will gain a knowledge base in cell and molecular biology, and anatomy and physiology

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 inmammals-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-cerebralcortex-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.
11. 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—III
Course Title: Molecular Plant Physiology and Developmental Biology **MM. Th 80 + IA2**
Course Code No. 17CBT23DA2 **Time: 3h**

COURSE OUTCOMES

CO1. Students will gain knowledge about photosynthesis, nutrient uptake and assimilation, and know how to bypass the photorespiration
CO2. Students will understand the mechanism of crop stress tolerance to various abiotic stresses
CO3. Students will understand the molecular basis of development of various plant organs

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- C3, C4 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.

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.

Semester--III Choice Based Paper

Course Title: Biostatistics **MM. Th80 + IA 20**
Course Code No. 17CBT23DB1 **Time: 3h**

COURSE OUTCOMES

CO1. Students will understand and apply statistical methods for the design of biomedical research and analysis of biomedical research data
CO2. Students will learn the use of mathematical and statistical theory and application of biostatistical methods; use & interpret results from specialized computer software for the management and statistical analysis of research data
CO3. Students will learn to participate in a research team setting in study design, data coordination and management and statistical analysis and reporting of study results
CO4. Students will participate in a research team for the development and evaluation of new and existing statistical methodology

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 Semester—III
Course Title: VIROLOGY **MM. Th 80 + IA 20**
Course Code No. 17CBT23DB2 **Time: 3h**

COURSE OUTCOMES

CO1. Students will gain knowledge about the basic concepts of virology
CO2. Students will learn the virological techniques for diagnosis
CO3. Students will gain knowledge about various viral groups and viral treatment

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

Unit I

Introduction: 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 II

Culture: Cultivation and purification of viruses; estimation of yields, methods for purification. Diagnostic methods: Immnuodiagnosis, haemag glutination and haemagglutin ationinhibition 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 III

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 IV

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.

PRACTICALS

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 Immunoflourescence assay (DFA and IFA) for the virus detection.
8) Heamagglutination assay & Heamagglutination 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.
2. Antiviral Agents, Vaccines, and Immunotherapies. Stephen K. Tyring. Latest edition / Pub. Date: October 2004. Publisher: Marcel Dekker.
3. Antiviral Drug Discovery for Emerging Diseases and Bioterrorism Threats. Paul F. Torrence (Editor). Latest edition / Pub. Date: July 2005. Publisher: Wiley, John & Sons, Incorporated.
4. Viral Hepatitis and Liver disease, A.J. Zuckerman.

M. Sc. Biotechnology Semester-III
Course Title: Nano-biotechnology **MM. Th 80 + IA 20**
Course Code No. 17CBT23DB3

Time: 3h

COURSE OUTCOMES

CO1. Students will understand the fundamental principles of nanotechnology and their application to biomedical engineering.
CO2. Students will gain knowledge about state-of-the-art nano-fabrication methods
CO3. This course will offer students a comprehensive package of knowledge about the characterization methods for nanomaterials, critiquing nanomaterial safety and handling methods required during characterization

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

1. Chemical Synthesis of Gold nanopartices
2. Chemical synthesis of Zinc oxide nanopartices
3. Green synthesise of Silver nanopartices
4. Green synthesise of Zinc oxide nanopartices
5. Characterization of Gold nanopartices
6. Characterization of Zinc oxide nanopartices

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. 18CBT24C1 **MM. Th 80 + IA 20**
Time: 3hrs.

COURSE OUTCOMES

CO1. Students will gain knowledge about the basics of the four primary forms of intellectual property rights, the right of ownership, scope of protection as well as the ways to create and to extract value from IP. Students will able to compare and contrast the different forms of intellectual property protection in terms of their key differences and similarities.
CO2. Students will gain knowledge to analyze the effects of intellectual property rights on society as a whole.
CO3. This course will provide complete package to the students to identify activities and constitute IP infringements and the remedies available to the IP owner and describe the precautious steps to be taken to prevent infringement of proprietary rights in products and technology development

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-- IV**

MM. Th 80 + IA

Course Title: Microbial Technology | ***20***

Course Code No. 18CBT24C2 | ***Time: 3h***

COURSE OUTCOMES

CO1. Students will gain basic information of microbial cultures, sterilization methods and enzyme production

CO2. Students will learn about the bio-safety guidelines

CO3. Students will understand the mechanism of drug resistance

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 Co Q10, 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

Semester-IV

Course Title: Dissertation

Marks : 300(Dissertation: 200 + Viva voce 100)

Course Code No. 18CBT24C3

Program Specific Outcomes

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

PSO2 Students would gain train in the research areas selected from different fields of biotechnology like animal biotechnology, microbiology, environmental biotechnology, genetic engineering, plant biotechnology, parasitology, virology, nanotechnology and *in-silico* identification and validation of novel proteins.

PSO3 Students can develop understanding about the literature and dissertation writing required to carry out a good research during their Ph.D.

PSO4 Find the different resources needed to perform the research.

PSO5 Statistical analysis, presentation and documentation of research findings.

Course Outcomes

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

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

CO2 Research topics selected from different fields like animal biotechnology, microbiology, environmental biotechnology, genetic engineering, plant biotechnology, parasitology, virology, nanotechnology and in-silico identification and validation of novel proteins.

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

CO4 Students trained to find the resources needed to perform the research process and presented their findings.