JECRC UNIVERSITY

School of Sciences
Course Structure and Syllabus
M. Sc. Biotechnology

M.Sc BIO-TECHNOLOGY

SEMESTER – I		
Code	**Title of Course**	**Credits**
MBI001A	BIOCHEMISTRY	4
MBI002A	MICROBIOLOGY	4
MBI003A	IMMUNOLOGY	4
MBI004A	MOLECULAR BIOLOGY	4
MBI005A	Laboratory Exercises of Biochemistry, Microbiology and Immunology	12
	Total Credits	**28**
SEMESTER – II		
MBI006A	BIOTECHNIQUES AND BIOINFORMATICS	4
MBI007A	BIOSAFETY, BIOETHICS AND IPR, BIOSTATISTICS	4
MBI008A	GENETIC ENGINEERING	4
MBI009A	BIOPROCESS ENGINEERING	4
MBI010A	Laboratory Exercises of Genetic and Bioprocess Engineering	12
	Total Credits	**28**
SEMESTER – III		
MBI011A	ENVIRONMENTAL BIOTECHNOLOGY	4
MBI012A	PLANT BIOTECHNOLOGY	4
MBI013A	IMMUNOTECHNOLOGY AND ANIMAL BIOTECHNOLOGY	4
MBI014A	RESEARCH METHODOLOGY	4
MBI015A	Environmental, Plants, Animals and Immunological Techniques Practicals	12
	Total Credits	**28**
SEMESTER –IV		
MBI016A	Review Writing	8
MBI017A	Dissertation	18
MBI018A	Seminar	2
	Total Credits	28
	Total Credits of All Four Semesters	**112**

M.Sc BIOTECHNOLOGY

SEMESTER – I		
Code	**Title of Course**	**Credits**
MBI001A	BIOCHEMISTRY-I	4
MBI002A	MICROBIOLOGY	4
MBI003A	IMMUNOLOGY	4
MBI004A	MOLECULAR BIOLOGY	4
MBI005A	Laboratory Exercises of Biochemistry, Microbiology and Immunology	6
	Total Credits	**22**

MBI001A: BIOCHEMISTRY-I Credit(s):4

Unit 1

Chemical foundation of biology: pH, acids, bases, chemical bonding, properties of water, Gibbs free energy, High energy compounds, ATP Cycle, classification of high energy compounds,

Unit 2

Carbohydrates: Classification and properties of carbohydrates, mono (glucose, galactose and fructose) di (lactose, maltose, and sucrose), poly (starch, glycogen, cellulose). Physical and chemical properties of carbohydrates, Mutarotation, Osozone formation etc. Metaboism of carbohydrates, Glycolysis, TCA, Gluconeogenesis, Glycogenesis, Glycogenolysis, glyoxalate cycle, anaerobic oxidation of glucose, alternative oxidation pathway of glucose

Unit 3

Lipids: Classification, Structure and biological function of fatty acids, triacylglycerols, phospholipids, steroids. Physico-chemical properties and analysis of fats and oils, Structure and functions of prostaglandins, thromboxanes, cholesterol, properties of oil and fats, acid value, iodine number, Saponification number, beta, alpha, and omega oxidation of fatty acids, cholesterol biosynthesis, fatty acids synthesis

Unit 4

Amino acids: Classification; Structure and physicochemical properties; Peptides Peptide bonds, Proteins–Classification. Primary structure of proteins and its sequence determination

Proteins: Secondary (Ramachandran plot), tertiary and quaternary structural features of proteins; Primary structure, Bonds responsible for protein stability. Myoglobin, hemoglobin, fibrous proteins (collagen, keratins, silk fibroin), transamination, urea cycle,

deamination oxidative and non oxidative, regulation of urea cycle.

Unit 5

Nucleic Acids: Structure of purines, pyrimidine, nucleosides, and nucleotides. Structure, properties and functions of nucleic acids (DNA, RNA), Different forms of DNA and RNA. Three dimensional structure of tRNA, Isolation of nucleic acids, Denaturation and renaturation of nucleic acids, cot curves. C value paradox. Denovo synthesis of purine and pyrimidine and its degradation. Salvage pathway.

Suggested Readings

1. Textbook of Biochemistry. 1968 by West and Todd (MacMillan)
2. Principles of Biochemistry. 1993 by A.L. Lehninger, Nelson and Cox (C.B.S., India).
3. Principles of Biochemistry General Aspects. 1983 by Smith et al., (McGraw Hill)
4. Biochemistry (2nd edition) by Donald Voet and Judith Voet.
5. Biochemistry (4th edition) by L. Stryer (Free man).
6. Textbook of Biochemistry with Clinical Correlation (4th edition) by Thomas M. Devlin.
7. Biochemistry by Zubay.
8. Nucleic acid Biochemistry and Molecular Biology by Main Waring et al., (Blackwell).
9. Biochemistry, 2nd edition by Albert L. Lehninger. 1978. Kalyani Publishers, New Delhi.
10. Biochemical calculations, Irwin H.Segel, John Wiley and sons Inc
11. Organic Chemistry, DJ Cram and GS Hammond

MBI002A: MICROBIOLOGY Credit(s): 4

Unit-1

Introduction to Microbiology: Historical background & scope, Prokaryotic and Eukaryotic cell structures, Difference between prokaryotic and eukaryotic organisms.
Classification of microorganism: Classification of Bacteria: Basic principle and techniques used in bacterial classification. The five-kingdom concept of classification, archaeobacteria, eubacteria and eukaryotes; Morphology and fine structure of bacteria, General structure and features.

Unit-2

Microbial genetics recombination: Transformation, transduction, conjugation, Nutritional requirements and nutritional classification of microorganisms: principle of microbial nutrition, Nitrogen fixation, Photosynthesis
Microbial Growth: The definition of growth, growth curve, bacterial generation time, Synchronous growth curve, Continuous culture; Growth as affected by environmental factors like temperature, acidity, alkalinity, water availability and oxygen, Different effects of physical and chemical factors on microbial growth.

Unit-3

Methods in Microbiology: Sterilization techniques- Physical and chemical methods; Preparation of culture media, Different types of media- simple, complex and defined, Pure culture techniques- isolation, cultivation, enumeration and preservation of microbes.
Chemotherapeutic agents: Antimicrobial agents; Sulfa drugs; Antibiotics - Penicillin and Cephalosporin; Classification of Antibiotics, Broad and narrow spectrum antibiotics; Antibiotics from prokaryotes; Antifungal and antiviral antibiotics, mode of action of antibiotics; Resistance to antibiotics, origin of drug resistance, mechanism of drug resistance, antimicrobial susceptibility test.

Unit-4

Host-Parasite Relationships: Normal micro flora of skin, oral cavity, Gastrointestinal tract; Entry of pathogens into the host; colonization and factors predisposing to infections; types of toxins and their structure; Mode of actions; Virulence and Pathogenesis.
Microbial Diseases: Respiratory infections caused by bacteria and viruses; Tuberculosis; Sexually transmitted diseases including AIDS; Diseases transmitted by animals, insects and ticks, food and water borne diseases; Pathogenic fungi; Emerging and resurgent infectious diseases.

Unit-5

Viruses: Discovery, General characteristics, Morphology, Classification and structure of plant, animal and bacterial viruses, Structure and morphology of bacteriophages, lytic and lysogenic cycle.

Suggested Readings

1. Alcamo 's Fundamental of Microbiology, (2004); Pommerville et al.
2. Microbiology (2004); Tortora, F.
3. Foundation in Microbiology (1996);Talaro & Talora.
4. Food Microbiology (2004); Adam, M.R.
5. Principles of Microbiology (1994); Atlas, R.M.
6. Pharmaceuticals Microbiology (2003); Purohit & Saluja.
7. Brock Biology of Microbiology, Martinko, M.T & Parker,J.
8. Microbiology, L.M. Prescott, J.P. Harley and D.A. Klein, 7/e, 2007. McGraw Hill, Boston.
9. Fundamental Principles of Bacteriology, A.J. Salle, 1999. Tata McGraw – Hill Publishing Company Limited, New Delhi.
10. Medical Microbiology, D. Greenwood, R. Slack and J. Peutherer, 1997. ELST with Churchill Livingstone, Hong Kong.
11. Microbial Eco logy. Fundamentals and Applications, R. M. Atlas and R. Bartha, 2000.
12. Microbiology, M.J. Pelzer Jr., E.C.S. Chan and N.R. Kreig, 1993. McGraw Hill Inc., New York.
13. Microbial Functional Genomics, J. Zhou, D.K. Thomson. Y. Xu. J.M. Tiedje. J. Wiley, 2004.
14. General microbiology, R.Y. Ingraham, J.L. Wheelis, M.L. and Painter, P.R. The MacMillian Press Ltd.
15. Brock Bio logy of microorganism, M.T. Martinko, J.M. and Parker, J. Prentice- Hall.

16. Microbial Genetics, Malo y, S.R., Cronan, J.E. Jr and Freifelder, D.Jones, Bartlett Publishers.
17. Microbiology-A Laboratory Manual, cappuccino, J.G. Sherman, N. Addison Wesley.
18. Microbiological Applications (A Laboratory Manual in General microbiology) Benson, H.J. WCB: Wm C Brown Publishers
19. General Microbiology, Stainer, RY, Ingraham, JL, Wheelis, ML., and Painter, PR. The Macmillan Press Ltd., (2000).
20. Microbiology, Davis BD et al., Harper and Row, (1990).
21. Microbiology-Principles and exploration, Black JG, Prentice Hall, (1999).
22. Microbial Biotechnology, Glazer AN, Nikaido H, WH Freeman and Company, (1995).

MBI003A: IMMUNOLOGY **Credit(s): 4**

Unit-1

Introduction: Scope of immunology, Types: Innate and acquired immunity. Features of immune response: Memory, Specificity and recognition of self and non-self, Clonal nature of immune response,

Humoral and Cell mediated immune responses, Cells of the immune system: Hematopoiesis and differentiation, B-lymphocytes, T-lymphocytes, mononuclear phagocytes, macrophages, dendritic cells, natural killer cells and lymphocyte activated killer cells, neutrophils, eosinophils, basophils, mast cells & denditic cells, lymphocyte trafficking.

Organs of the immune system: Primary and secondary lymphoid organs: Thymus, Bone marrow, lymphatic system, lymph nodes, spleen, Mucosal Associated Lymphoid Tissue (MALT), Cutaneous-Associated Lymphoid Tissues.

Unit-2

Antigen: Immunogenicity v/s antigenicity, factors affecting immunogenicity, nature of immunogen, biological system, epitopes, haptens and antigenicity, pattern recognition receptors, super antigens.

Immunoglobulins: Structure of antibody, function and synthesis, antibody mediated effectors functions, antibody classes and biological activities, antigenic determinants on Immunoglobulins, Immunoglobulins super families. Production and applications of monoclonal antibodies (by hybridoma technology).

Antigen-Antibody interactions: Strength of interaction, cross reactivity, precipitate, reaction, agglutination reaction, radio immunoassay, Enzyme Linked Immunosorbent Assay, chemiluminescence, ELISPOT assay, western blot, immunoprecipitation, immunofluorescence, flow cytometry and flourescence.

Unit-3

Major histocompatibility complex: General organization, MHC molecules: structure & genes, their mode of antigen presentation and interaction, cellular distribution of MHC, regulation of MHC expression and disease susceptibility. Antigen Processing and Presentation: role of antigen presenting cells, endogenous antigens: cytosolic pathway; exogenous antigens: endocytic pathway. T-Cell receptor complex, T- Cell accessory

membrane molecules, activation o f T-cells, organization and arrangement of T-receptor genes B-cell receptor complex, activation and proliferation of B-cells, regulation of B- cell development.

Cytokines: Structure and functions, cytokine receptors, signal transductions mediated by cytokine receptors, cytokine regulation of immune responses, cytokine related diseases and therapeutic applications of cytokines.

Complement system: Function, components, activation, regulation and deficiencies of complement. Cytotoxic T-cell and their mechanism of action, NK cell and mechanism of target cell destruction. Antibody dependent cell mediated cytotoxicity. Inflammation: its mediator and the process, cell-adhesion molecules and their role in inflammation, lymphocyte homing, tissue injury and immune response leading to an inflammatory reaction, role of anaphylatoxins, granulocyte in inflammatory process. Hypersensitivity reaction: Definition, IgE mediated hypersensitivity, mechanism of mast cell degranulation, mediators of type I reactions and consequences. Type II reactions, immune complex mediated hypersensitivity and delayed type hypersensitivity.

Unit-4

Immune response to infectious diseases: Bacteria, viruses and intracellular parasites. Vaccines: Active and Passive Immunization Types of Vaccines- Inactivate Attenuated, Purified macromolecules and Recombinant-vector, DNA, Synthetic peptide, Multivalent subunit Vaccines. Immunodeficiency Syndrome: Primary Immunodeficiency and Secondary Immunodeficiency and their diagnosis and therapeutic approaches. Autoimmunity: Organ specific diseases, systemic disease, mechanism of autoimmunity, treatment of autoimmune diseases.

Unit-5

Transplantation immunology: immunologic basis of graft rejection, immune suppression and immune tolerance. Tumor immunology: cancer definition, malignant transformation of cells, oncogenes and cancer induction, tumor antigens, tumor evasion of the immune system, cancer immunotherapy.

Suggested Readings

1. Molecular bio logy o f the Cell, Alberts B., Bray D., Lewis J., Ralf M., Roberts K. and Watson J.D., Garland Publishing Inc. (2001).
2. Kuby Immunology, Goldsby R.A., Kindt Thomas J., Osbarne B.A., WH Freeman & Company, (2000).
3. Immunology-Understanding the Immune System Elgert K.D, Wiley Liss, (1996).
4. Roitt's essential Immunology, Roitt I.M. and Delves P.J., Blackwell Science Ltd., (2001).
5. Immunology 6th Edit ion, Roitt I., Brostoff J. and Male D., Mosby Harcourt Publishers, (2001).
6. Immuno-biology, Janeway CA and Paul Travers 1994.
7. Immunological techniques, D.M. Weir, 1992.
8. Current Protocols in Immunology 3 Volumes, Wiley Publications 1994.
9. Monoclonal Antibodies: Principles and Practice, J. W. Goding, 1983. Academic Press
10. Hybridoma Technology in the Biosciences and medicine, T.A. Springer, 1985. Plenum

Press NY.
11. Vaccines, New Approaches to immunization, F.Brown, R.M.Chanock, KA Lerner, 1986. Coldspring Harborolab.
12. Topley and Wilson principles of bacteriology, Virology and immunology, G. Wilson, A. Miles, M.T. Paker, 1984. Arnold, Heineman.
13. Basic and Clinical Immunology, D.P. Stities and J.D. Stobo
14. Immunology- A short Course, Eli Benamini, Richard Coico, Geoffrey Sunshine.
15. Immunology by Tizzard
16. Fundamentals of Immunology, William Paul.
17. Immunology by Abbas.

MBI004A: MOLECULAR BIOLOGY **Credit(s): 4**

Unit-1

Nuclear organization: Chromosomal DNA and particles, nucleosides. Modern Concept of gene organization, Chromosomal replication, synthesis and processing (DNA replication, Enzymology of DNA replication), DNA repair

Gene mutation: Types of mutations, Molecular mechanism of mutations Chromosomal mutations: changes in the structure of chromosome and changes in number of chromosomes, polyploidy, Frame shift Mutation, point mutation, non sense mutation

Unit-2

Transcription and Transcriptional control: Structure of bacterial RNA polymerase, Transcription events, and sigma factor cycle, Eukaryotic RNA polymerase, Promoter sequences, TATA box, Hogness Box, CAAT box, Enhancers, upstream activating sequences, Initiation and termination of transcription factor, RNA processing in Prokaryotes Vs Eukaryotes, Spliceosome.

Unit-3

Translation: Prokaryotic and Eukaryotic translation, Structure of DNA and its physico-chemical properties. Prokaryotic and eukaryotic DNA replication- DNA polymerases and proteins involved in DNA synthesis and their specific roles. Structure and properties of RNA polymerases in prokaryotes and eukaryotes, General and specific transcription factors, Mechanism of transcription and post transcriptional modifications of RNAs, RNA editing.

Features of genetic code, amino-acyl syntheses and charging of t-RNA, prokaryotic and eukaryotic translation, regulation of translation.

Unit-4

Regulation of gene expression: prokaryotic gene expression with reference to inducible and repressible operons. Concept of eukaryotic gene regulation, Antisense RNA and RNA interference. Applications of antisense and ribozyme technologies Importance of genome projects, human genome project, Sequence component of eukaryotic genome, satellite, microsatellite and minisatellite DNA; physical mapping by building clone contigs, genomic libraries, YAC, BAC libraries. General organization of human genome.

Unit-5

Basic knowledge of the principles and applications of Microscopy: Light, Phase contrast, fluorescence, Electron microscopy (SEM, TEM), Chromatography
Electrophoresis-General principle, application and types, Centrifugation: Basic principles, common centrifuges used in laboratory (ultra centrifuges)
Spectroscopic methods: Principle and applications of UV-visible, IR, NMR, ES Round, X- ray, spectroscopy

Suggested Readings

1. Sharma V.K: techniques in Microscopy and Cell bio logy Tata McGraw Hill, 1991
2. Alberts et al: Molecular biology o f the cell,
3. Garland, 1989: Biochemical Technique: Theory & Practical, Waveland press
4. Wilson & Walker: Practical Biochemistry, Cambridge university press
5. Jayraman: Laboratory Manual in Biochemistry
6. Demain & Davies: Manual of Industrial Microbiology & Biotech 2nd edt.

MBI005A: Laboratory Exercises of Biochemistry, Microbiology and Immunology Credit(s): 6

1. To determine λmax of Protein
2. λmax of DNA
3. Separation of Amino acids using paper chromatography
4. Qualitative analysis of carbohydrates
5. Qualitative analysis of Fats and Oil
6. Qualitative analysis of Protein
7. Preparation of Buffers
8. Verification of Lambert and Beer law
9. Calibration of Spectrometer
10. Sterilization and preparation of media, Enumeration of bacteria and fungi from soil, water.
11. Environmental samples - soil, water and air. Techniques for pure culture - streaking, pour plate and spread plate.
12. Isolation and maintenance of organisms by plating, streaking and serial dilution method, slant and stab cultures, storage of microorganisms.
13. Preparation of Liquid and Solid media for growth of microorganisms.
14. Stains and staining techniques, simple staining, negative staining, acid fast, spore, endospore staining, capsule staining & differential staining Techniques.
15. Bacterial growth - Growth curve, factors affecting bacterial growth - pH, Temperature, Carbon and Nitrogen source and Salinity.

16. Measurement of bacteria population by turbidometry and serial dilution methods.
17. Biochemical tests for identification of bacteria.
18. Antimicrobial assay, phenol coefficient, agar plate sensitive method.
19. Cultivation and morphology of molds and yeast
20. Assay of antibiotics and demonstration of antibiotic resistance
21. Bacterial transformation.
22. One Step growth curve of coli phage.
23. Antimicrobial activity o f certain plant extracts.
24. Effect of UV radiation on bacteria.
25. Cell counting and cell viability.
26. Blood cell analysis
27. Lymphocyte subset identification and enumeration
28. Separation of serum components by electrophoresis
29. Immunodiffussion
30. Radial immunodiffusion test
31. Immuno electrophoresis
32. ELISA
33. Differential WBC count.
34. The effect of hypertonic, hypotonic and isotonic environment on human RBC
35. Ouchterlony technique

SEMESTER – II		
MBI006A	BIOTECHNIQUES AND BIOINFORMATICS	4
MBI007A	BIOSAFETY, BIOETHICS AND IPR, BIOSTATISTICS	4
MBI008A	GENETIC ENGINEERING	4
MBI009A	BIOPROCESS ENGINEERING	4
MBI010A	Laboratory Exercises of Genetic and Bioprocess Engineering	6
	Total Credits	**22**

MBI006A: BIOTECHNIQUES AND BIOINFORMATICS **Credit(s): 4**

Unit-1

Basic knowledge of the principles and applications of Microscopy: Simple microscopy, Phase contrast microscopy and electron microscopy (TEM and SEM). Sedimentation- Sedimentation velocity, preparative and analytical ultracentrifugation techniques

Electrophoresis- General principle, 2D gel electrophorasis, paper electrophorasis, SDS PAGE, application and types, Spectroscopic methods: Principle and applications of UV-

visible, IR, X-ray, Red and Blue shift, basic structure of spectrophotometer, B bands and R bands, various transitions in compounds, vibrational spectroscopy, different vibrations

Unit-2

Chromatography- General principles and applications of – Adsorption chromatography, Ion-exchange chromatography, Thin-layer chromatography, Hydrophobic chromatography, Gas-liquid chromatography, HPLC, Affinity chromatography, Paper chromatography. Radioisotopic Techniques: Types of radioisotopes used in Biochemistry, units of radioactivity measurements, isotopes commonly used in biochemical studies – 32P, 35S, 14C and 3H), application of isotopes, Autoradiography: Biological hazards of radiation and safety measures in handling radioisotopes; Biological applications

Unit-3

Centrifugation: Basic principles; Mathematics & theory (RCF, Sedimentation coefficient etc); Types of centrifuge Microcentrifuge, High speed & Ultracentrifuges; Preparative centrifugation; Differential & density gradient centrifugation; Applications (Isolation of cell components); Analytical centrifugation; Determination of molecular weight by sedimentation velocity & sedimentation equilibrium methods.

Unit-4

Concept of database management: brief idea of data types, data structures, searching, sorting, designing a database, genomic, proteomic, and metabolic pathways databases.

Computer analysis of genetic sequences: general concepts of sequence analysis, identification of functional sequences, homology, brief idea of BLAST, ENTREZ, and PuBMed.

Unit-5

Proteomics: basic issues and concepts, protein sequences and alignment, protein structure prediction. Bioinformatics tools in drug design

Suggested Readings

1. 1. Textbook of optics and atomic physics – P.P. Khandelwal (Himalaya Publishing House

2. Nuclear physics an introduction – S.B. Patel (New Age International) Biophysics – Pattabhi and Gautham (Narosa Publishing House)

3. Instrumentation measurements and analysis – Nakara, Choudhari (Tata Mc Graw Hill)

4. Handbook of analytical instruments – R.S. Khandpur (Tata Mc Graw Hill)

5. Perspectives of modern physics – Arthur Beiser (Mc Graw Hill)

6. Introduction to atomic spectra – H.E. White (Mc Graw Hill)

7. Molecular cell biology – Ladish, Berk, Matsudara, Kaiser, Krieger, Zipursky, Darnell (W.H. Freeman and Co.)

8. Biophysics - Cotrell (Eastern Economy Edition)

9. Clinical Biophysics –Principles and Techniques- P. Narayanan (Bhalani Pub., Mumbai

MBI007A: BIOSAFETY, BIOETHICS AND IPR BIOSTATISTICS Credit(s): 4

Unit-1

Biosafety- definitions - DBT guidelines on biosafety in conducting research in biology/biotechnology - Regulations of Genetically modified Organisms in India- Biosafety regulation for transgenic plants and animals - labeling of GM foods

Unit-2

IPR-Definition-Different forms of IPR - Benefits of IPR system; WTO - Definition, GATT - Definition - Objectives - Structural format of WTO - Economic Impact of WTO
Bioethics - definition - Bioethics of IPR - ethical criteria in biotechnology

Unit-3

Definitions and scope of Biostatistics: Variable in biology, collection, classification and tabulation of data. Graphical and diagrammatic representation, histogram, frequency polygon, frequency curve; Importance and applications Tabulation and Classification of data, Frequency distribution and Graphical distribution of data Measure of Central tendencies Mean, Media, mode and their properties. Measures and Dispersion, Mean deviation, Variance, Standard deviation and Coefficient of Variation. Correlation and regression

Unit-4

Elements of probability theory; Probability distributions-binominal, Poisson and normal distribution; Correlation coefficient; Simple linear regression. Probit and logit analysis Hypothesis Testing Student T, r and Chi-square test; Probability and Distribution

Unit-5

Concepts and problems on probability, Binomial, Poisson, Normal Distribution and their Applications, Different Models of data presentation with special reference to biological samples.

Suggested Readings

1. Bernhard Palsson and Sangeeta N Bhatia, Tissue Engineering, 2nd Edition, Prentice Hall, 2004.
2. Pamela Greenwell, Michelle McCulley, Molecular Therapeutics: 21st century medicine, 1st Edition, Sringer, 2008.

MBI008A: GENETIC ENGINEERING **Credit(s) 4**

Unit-1

Concept and emergence of r-DNA technology, preparation and purification of total cell DNA, plasmid DNA and bacteriophage DNA; Basic techniques involved in rDNA technology; Enzymes involved in RDT (Klenow fragment, Taq DNA, Ribonucleases, Alkaline phosphatase, Nuclease, T4 DNA ligase) Restriction enzymes, Preparation of Desired Gene from genome, reverse transcription and gene machine. Generation of genomic and cDNA libraries; Methods of Ligation linkers, polylinker, adapter etc.

Unit-2

Vectors–Plasmids, cosmids, λ, phagemids, yeast artificial chromosomes. Introduction of DNA/RNA in bacteria, yeast, fungi and in other eukaryotic host systems; Selection and screening of recombinant clones: Direct and indirect methods. Probe preparation (radio labeling and non-radio labelling).

Unit-3

Methods based on Nucleic acid homology (Southern, northern, western, southern- western, subtractive, colony and plaque hybridization, in situ chromosomal hybridization, chromosomal walk, etc.)

Unit-4

Characterization of cloned DNA: Restriction mapping. DNA sequencing: Polymerase Chain Reaction and its variations. DNA fingerprinting, Molecular Markers (RAPD, SSR, VNR, RFLP, AFLP etc.)

Unit-5

Expression of cloned DNA: Expression vectors. Modification of cloned DNA (Site directed mutagenesis) Secretion of cloned product;
Applications of recombinant DNA technology: Transgenic animals. Transgenic plants;

Pharmaceutical products

Suggested Readings

1. Recombinant DNA: Watson
2. Genetic engineering: Sandya Mitra
3. Principles of gene manipulation: Old & Primrose
4. Gene cloning: T. A. Brown
5. Molecular Bio logy Lab fax I & II: T. A. Brown

MBI009A: **BIOPROCESSING ENGINEERING** **Credit(s): 4**

Unit-1

Historical background, Composition of food, Growth of microorganisms in food: Intrinsic and extrinsic factors. Characterization and Techniques of fermentation systems. Role of Fermentation; Biochemistry of Fermentation:
Fermentation of Carbohydrates, Protein. Lipid Metabolism, Formation of flavour. Advanced continuous fermentation for anaerobic microorganisms, Fermentation process development of carbohydrate based therapeutics,

Unit-2

Bioprocess development for detoxification and decolorization, Fermentation process validation. Genetic manipulation of industrially important microorganisms: Methods of reproduction, recombination, strain modification, stabilization of transformants, autonomous replication. Production of foreign protein, Commercial production of plant proteins in microorganisms. Economics of fermented products.

Unit-3

Microorganisms involved in natural fermentation, Microbial succession.
Composition and nutrition of fermented products Traditional fermented foods: Bread, cocoa, coffee, tea, sauerkraut, cheese, butter, yoghurt, meat, fish, etc. Alcoholic beverages: Beer, wine and whisky. Value addition products: High fructose syrup, invert sugars etc. Edible fungus: Mushrooms. Bioreactors in food fermentation; Packaging of fermented food products Biosensors; Bio logical monitoring of foods, waste management and food processing; HACCP and hurdle technology. Protein engineering in food technology: methods, targets and applications in foods.

Unit-4

Fermentation Technology- The component parts of a fermentation process range of fermentation processes, chronological development of fermentation industry. Isolation, Preservation and strain improvement of industrially-important microorganisms. Fermentation media for industrial fermentation Design of Fermentor- Basic functions of a Fermentor for microbial culture, aseptic operation and containment, Aeration and Agitation, valves and steam traps; Types of fermentation, Types of fermentation vessels

Unit-5

Fermentation Processes- Batch, fed-batch and continuous fermentations. Solid-state fermentations, Duel or multiple fermentations; Recovery and purification of fermentation products (down-stream processing) - Recovery of microbial cells, cell disruption. Chromatography, membrane processes, drying and crystallization ion. Fermentation Enzyme and cell immobilization and their industrial applications; Industrial Production of Antibiotics–Penicillin, Streptomycin, Tetracyclines Organic acids–Citric acid, Lactic acid, Acetic acid; Enzymes–Amylases, Proteases, lipases acids–Lysine, Glutamic acid. Beverages–Wine, Beer, alcohol Microbial leaching-Organisms involved in leaching, Chemistry of microbial leaching and commercial process. Mushroom cultivation

Suggested Readings

1. Microbial Biotechnology – Glazer and Nikaido 1995
2. Biotechnology–A Text Book of Industrial Microbiology–Crueger and Crueger, 2000.
3. Principles of Fermentation Technology– Stanbury, Whitaker and Hall 1997.
4. Microbial Technology. Vol. I and II - Peppler and Perlman (Eds).
5. Prescott and Dunn's Industrial Microbiology – Reed (Ed).
6. Concepts in Biotechnology– Balasubramanian, Bryce, Dharmalingam, Green and Jayaraman
7. Industrial Microbiology– A.H. Patel.
8. Industrial Microbiology– Casida.

MBI010A: Laboratory Exercises of Genetic engineering and Bioprocess Engineering — Credit(s): 6

1. Estimation of carbohydrate by Anthrone reagent
2. Estimation of Glycogen
3. Estimation of Protein by Lowry's, Barford and Biurette method
4. Saponification value of oil
5. Acid umber of oil and fats
6. Iodine number
7. Estimation of DNA by DPA Method
8. Estimation of RNA by Orcinol Method
9. Restriction digestion
10. Ligation
11. Isolation of Bacterial DNA
12. Quantification of bacterial DNA using spectrophotometer
13. Isolation of RNA and quantification by a spectrophotometric method
14. Separation of plant protein by SDS PAGE and visualization
15. Demonstration of PCR technique
16. Isolation of genomic DNA from plant and bacteria
17. Isolation of plasmid
18. Agarose gel electrophoresis
19. Restriction Digestion DNA/plasmid
20. Isolation of RNA
21. Southern Blotting
22. Ligation

23. Conjugation
24. Transformation
25. PCR
26. Microbial analysis of food samples, methylene blue reduction test for milk.
27. Microbial production of food and beverages by fermentation-wine and yogurt
28. Isolation of industrially important microbes from the environment
29. Microbial Production of citric acid and antibiotics
30. Comparative studies of Ethanol production using different substrates
31. Production and assay o f Alkaline Protease
32. Isolation of casein from milk
33. Microbial Production of antibiotics
34. Microbial Production of vitamin B12
35. Isolation of Ascorbic acid producing bacteria
36. Determination of TDP and TDT of microorganisms for design of a sterilizer
37. Microbial production of citric acid using *Aspergillus niger*.
38. Isolation and study of fungus responsible for food spoilage
39. Quality testing of milk by MBRT test
40. Determination of phosphatase activity in butter, whey, milk powder
41. Microbiological analysis of food production
42. Analysis of mycotoxin in fungal contaminated food materials.

SEMESTER – III		
MBI011A	ENVIRONMENTAL BIOTECHNOLOGY	4
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MBI014A	RESEARCH METHODOLOGY	4
MBI015A	Environmental, Plants, Animals and Immunological Techniques Practicals	6
	Total Credits	**22**

MBI011A-ENVIRONMENTAL BIOTECHNOLOGY **Credit(s): 4**

Unit-1

Air pollution: definition of air pollution, Sources of air pollution, acid rain, global warming, air pollution control through biotechnology.
Biofuels: plant derived fuels, biogas, landfill gas, bioethanol, biohydrogen; biogas

production, methogenic bacteria

Unit-2

Water pollution and its control: Water as a scarce natural resource, Need for water management, Measurement of water pollution, Sources of water pollution. Solid Waste management, Waste Water Treatment, Biomining and Bioleaching

Unit-3

Microbiology of waste water treatments: Aerobic process: Activated sludge, Oxidation ditches, Trickling filters, towers, rotating discs, rotating drums, oxidation ponds. Anaerobic processes: Anaerobic digestion, Anaerobic filters, Up flow anaerobic sludge blanket reactors. Sewage and waste water treatment and solid waste management, BOD, COD

Unit-4

Degradation of Xenobiotic Compounds in Environment: Microbiology of degradation of Xenobiotics in environment: Ecological considerations, decay behavior & derivative plasmids; Hydrocarbons, substituted hydrocarbons, oil pollution, surfactants, pesticides. Bioremediation ion: In-situ and ex-situ techniques, advantages and disadvantages of bioremediation ion, GEMs in environment, applications of genetically engineered microbes (GEM) in bioremediation.

Unit-5

Phytoremediation: Types and its applications, phytoremediation of soil metals; Environmental monitoring: Bioindicators Integrated pest management- An ecological approach

Suggested Readings

1. Carl, Branden and Tooze, John. Introduction to Protein Structure, Garland Publishing (Taylor and Francis Group). New York.
2. Yada, R.Y.; Jackman, R.L.; Smith, J.L. Protein Structure-Function Relationships Blakie Academic and Professional: London
3. Clark, R.J.H and Hester, R. E. Spectroscopy of Bio logical Systems, John Wiley and Sons, New York.
4. Nakai, S. and Modler, H.W. Food Proteins: Properties and Characterization, VCH Publishers, New York.
5. Waste water treatment for pollution control. 2nd Edition. Arceivala.
6. Environmental Microbiology. R. M. Maier, I. L. Pepper & G. P. Gerba
7. Comprehensive Biotechnology Vol.-4. Murray Moo Young.
8. Biotechnology. Rehm and Reid.
9. Wastewater Engineering-Treatment, Disposal and Reuse, Metcalf and Eddy. Inc.Tata McGraw Hill, New Delhi. 1991
10. Environmental Science (5th Edition) by WP Cunninghum & BW Saigo., Mc Graw Hill. 1999.
11. Introduction to Biodeterioration, D Allsopp and K.J Seal, ELBS/Edward Arnold.

Cambridge Univ Press. 2004.
12. Biotechnology for Wastewater Treatment. P Nicholas Cheremisinoff. Prentice Hall Of India. 2001
13. Biotechnological Methods of Pollution Control. S.A Abbasi and E.Ramaswami. Universities Press 1999.
14. Environmental Biotechnology, Concepts and Applications. Hans-Joachin Jordening and Josef Winter. Winter-VCH. 2005
15. Bio logy of wastewater Treatment. N F Gray. Mc Graw Hill . 2004.
16. Fundamentals of ecology (5th Edition) by EP Odum and GW Barrett, Thomson Books/Cole, 2005.
17. An Introduction to Environmental Biotechnology by Milton Wain Wright. Kluwar Acad Publ. Group, Springer, 1999.

MBI012A: PLANT BIOTECHNOLOGY **Credit(s):4**

Unit-1

Concepts & basic techniques in tissue culture; Conventional breeding v/s tissue culture. Tissue culture media (composition & preparation), sterilization techniques, tissue culture as a technique to produce novel plants & hybrids, Green home and Green house technology; Initiation and maintenance of callus and suspension cultures, single cell clones, nurse culture technique, differentiation, organogenesis & somatic embryogenesis, Production and application of artificial seeds.

Unit-2

Shoot tip culture for rapid lonal propagation & production of virus-free plants, stages of micropropagation, propagation by direct and indirect organogenesis, micro grafting, physiological nature/abnormalities of micro propagated plants. Transfer and establishment of whole plants in soil, in situ and ex situ rooting & difference; Changes during hardening of micropropagated plants

Unit-3

Protoplast isolation, fusion & culture, somatic hybridization, selection of hybrid cells and regeneration of hybrid plants, symmetric and asymmetric hybrids, cybrids and role o f protoplast culture and somatic hybridization in improvement of crop plants. Haploid production and its significance, anther, pollen culture, monoploid production through bulbosum method, Embryo culture/embryo rescue and ovary culture; Endosperm culture, production of triploids, Role of haploids, monoploids and triploids in agriculture

Unit-4

Basic concepts and genetic engineering for increasing crop productivity by manipulation of Photosynthesis, Nitrogen fixation, Nutrient uptake efficiency, biotic Insects, fungi, bacteria, viruses, weeds, Abiotic stress-drought, flooding, salt and temperature and for quality improvement- Protein, lipids, carbohydrates, vitamins& mineral nutrients.

Unit-5

Plants as bioreactor or Molecular farming- value added crops, edible vaccines, industrial enzymes, antibodies, medicines. Cell cultures for secondary metabolites production.

Suggested Readings

1. J Hammond, P Mc Garvey and V Yusibov (Eds): Plant Biotechnology. Springer Verlag, 2000

2. TJ Fu, G Singh and WR Curtis (Eds): Plant Cell and Tissue Culture for the Production of Food Ingredients. Kluwer Academic Press 1999

4. HS Chawla: Biotechnology in Crop Improvement. International Book Distributing Company 1998

5. RJ Henry: Practical Application of Plant Molecular Biology. Chapman and Hall 1997

6. PK Gupta: Elements of Biotechnology. Rastogi and Co.Meerut 1999.

MBI013A: IMMUNOTECHNOLOGY AND ANIMAL BIOTECHNOLOGY

Credit(s):4

Unit-1

History and development of animal tissue culture; Equipment and materials (culture vessels, CO_2 incubator, inverted microscope, cell counters). Principles of sterile techniques; Sources of tissues, types of tissues-epithelial, muscle, connective, nerve and blood; Introduction to balanced salt solutions.

Unit-2

Cell culture media-components of the medium, physical, chemical and metabolic functions of media; Role of serum and supplements, serum-free media, features and specifications of MEM, DMEM, RPMI and Ham's medium. Role of antibiotics in media; Primary culture-Mechanical and enzymatic mode of desegregation, establishment of primary culture; Subculture-passage number, split ratio, seeding efficiency, criteria for subculture; Cell lines- definite and continuous cell lines, characterization, authentication, maintenance and preservation of cell lines.

Unit-3

Measurement of cell number- hemocytometer, coulter counter;Measurement of cell viability and cytotoxicity; Dye exclusion and inclusion tests, colonigenic assay, macro molecular estimation, MTT based assay. Measuring parameters of growth-growth curves, PDT, Plating efficiency and factors influencing growth;

Unit-4

Gene therapy-ex vivo and in vivo gene therapy methods, applications; Application of animal cell culture - Vaccine production, specialized cell types.
Concepts of tissue engineering - skin, liver, kidney, bladder and heart

Unit-5

Transgenic animals-retroviral, micro inject ion, and engineered embryonic stem cell method of transgenesis; Application of transgenic animal's biopharming, disease models, functional knockouts.

Suggested Readings

1. Culture of Animal Cells, (3rd Edn) R Ian Fredhney. Wiley-Liss
2. Animal Cell Culture – Practical Approach, Ed. John RW. Masters, Oxford
3. Cell Growth and Division: A Practical Approach Ed. R. Basega, IRL Press
4. Cell Culture Lab Fax. Eds. M Butler & M Dawson, Bios Scientific
Publications, Ltd. Oxford
5. Animal Cell Culture Techniques Ed Martin Clynes, Springer
6. Methods in Cell Biology, Vol. 57, Animal Cell Culture Methods Ed. Jenni P Mather
7. David Bames. Academic Press
8. Animal Cell Technology, Principles and practices, 1987, Butter, M Oxford press
9. Animal Cell Biotechnology, 1990- Spier, RE and Griffith, JB Academic Press, London.

MBI014A: **RESEARCH METHODOLOGY** **Credit(s): 4**

Unit-1

Understanding Research: Introduction, definition and meaning of research, characteristics of research, objective of research, motivation in research, types of research, research approaches, significance of research, research methods versus methodology, research in decision making, role of research in various areas, limitations of research, what constitutes a good research.

Unit-2

Scientific Methods and Research: Scientific method, definitions of scientific method, characteristics of scientific method, basis of scientific method, scientific methods and scientific research, components of scientific approach, bias and prejudice in scientific research Formulating Research Problem and Hypothesis: Introduction, Research process/planning process, research problem-need for defining, pre-requisites for formulating research problem, select ion of the research problem, points to ponder on research problem, units of analysis, time and space co-ordination, characteristics of interest, environmental conditions, technique involved in defining a problem, formulation of a research problem and hypothesis testing

Unit-3

Hypothesis Testing: Introduction, Hypothesis: definition and meaning, role of hypothesis, source of hypothesis, kinds of hypothesis, characteristics of hypothesis, formulation of hypothesis, importance of hypothesis, difficulties in formulating hypothesis, means to overcome difficulties, testing of hypothesis, steps in testing hypothesis, flow diagram for

hypothesis testing, measuring the power of a hypothesis test, statistical hypothesis/tests of significance, limitations of tests of significance

Testing of Hypothesis-I (Parametric or Standard Tests of Hypothesis): Tests of hypothesis, important parametric tests, hypothesis testing of means, hypothesis testing for differences between means, hypothesis testing for comparing two related samples, hypothesis testing of proportions, hypothesis testing for difference between proportions, hypothesis testing for comparing a variance to some hypothesized population variance, testing the equality of variances of two normal populations, hypothesis testing of correlation coefficients.

Unit-5

Research Design: Introduction, Meaning and definition of research design, need for research design, relation between problem formulation and research design, factors affecting research design, advantages of research design, steps in research design, various types of research design, basic principles of experimental designs. Data Collection and Management: Introduction, Meaning and importance of data, Sources of data, choosing the method for data collection, methods of collection of primary data: definition and meaning, types, importance, advantages and disadvantages; methods of collection of secondary data, scrutiny of secondary data, merits and demerits of different methods of collection of primary data.

Suggested Readings

1. S. C. Gupta. Fundamentals of Statistics. Himalaya Pub. House.
2. J. Medhi. Statistical Methods: An introductory text. New Age International (P) Ltd. Publishers.
3. P.S.S. Sudar Rao & J. Richard. An introduction to biostatistics. Prentice Hall of India. N. Delhi.

MBI015A: Environmental, Plants, Animals and Immunological Techniques Practicals

Credit(s): 6

1. Water quality analysis - MPN method
2. Determination of dissolved oxygen concentration of water sample
3. Determination of bio logical oxygen demand (BOD) of sewage sample
4. Determination of Chemical oxygen demand (COD) of sewage sample
5. Isolation of xenobiotic degrading bacteria by selective enrichment technique
6. Test for the degradation of aromatic hydrocarbons by bacteria
7. Detection of coliforms for determination of the purity of potable water
8. Estimation of nitrate in drinking water
9. Isolation of VAM from soil by wet sieving and decanting method
10. Isolation and cultivation of mushroom
11. Introduction to tissue culture laboratory
12. Preparation of M.S. media
13. Growth regulator concentration maintenance
14. Anther culture
15. Apical meristem culture

16. Leaf culture
17. Artificial seed preparation
18. Preparation of Media
19. Window making
20. Blood Analysis (RBC, WBC, Differential Staining of WBC, Hemoglobin estimation, Blood Grouping, Clotting Time)
21. Production of Ginger wine
22. Production of Grape wine
23. Citric acid production by aspergillus and its estimation
24. Estimation of alcohol content
25. Saurkraut production
26. Production of antibiotic

SEMESTER –IV		
MBI016A	Dissertation	26
MBI017A	Seminar	2
	Total Credits	28
	Total Credits of All Four Semesters	**112**

MBI016A: **Dissertation** **Credit(s):26**

Project: The students of M.Sc. Biotechnology should carry out a dissertation work for at least
16 weeks in a National Lab/Private industry/reputed lab/institute. Dissertation will be based upon research and actual bench work. It will begin from the end o f III semester and will continue through the IV semester. Dissertation report will be submitted and evaluated at the end of IV semester and students should defend their work in front of a selected committee in their last semester.

MBI017A: Seminar **Credit(s):2**