# Syllabus for M.Sc., Biotechnology

## 2011-12


## P.G and Research Department of Biotechnology

## Jamal Mohamed College

(Autonomous)

## Tiruchirappalli – 620 020.

JAMAL MOHAMED COLLEGE (AUTONOMOUS)
TIRUCHIRAPPALLI – 620 020.

## M.Sc.- Biotechnology Degree Course Structure From 2011-12

## P.G Department of Biotechnology

| SEM | Subject Code | Course | Title of the Paper | Hrs / Week | Credit | Int. Mark | Ext. Mark | Max. Mark |
|---|---|---|---|---|---|---|---|---|
| I | 11 PBT 1401 | Core I | Biochemistry and Biophysics | 6 | 4 | 25 | 75 | 100 |
| | 11 PBT 1402 | Core II | Cell and Molecular Biology | 6 | 4 | 25 | 75 | 100 |
| | 11 PBT 1403 | Core III | Microbiology | 6 | 4 | 25 | 75 | 100 |
| | 11 PBT 1404 | Core IV | Immunology and Immunotechnology | 6 | 4 | 25 | 75 | 100 |
| | 11 PBT 1405:P | Core V | Biochemistry, Microbiology, Molecular Biology and Immunotechnology - Practical | 6 | 4 | 40 | 60 | 100 |
| TOTAL | | | | 30 | 20 | 140 | 360 | 500 |
| II | 11 PBT 2406 | Core VI | Molecular Genetics | 6 | 5 | 25 | 75 | 100 |
| | 11 PBT 2407 | Core VII | Recombinant DNA Technology | 6 | 5 | 25 | 75 | 100 |
| | 11 PBT 2408 | Core VIII | Enzymology and Bioinstrumentation | 6 | 5 | 25 | 75 | 100 |
| | 11 PBT 2409 | Core IX | Bioinformatics and Biostatistics | 6 | 5 | 25 | 75 | 100 |
| | 11 PBT 2410:P | Core X | Molecular Genetics- rDNA Technology, Enzymology and Bioinformatics - Practical | 6 | 4 | 40 | 60 | 100 |
| TOTAL | | | | 30 | 24 | 140 | 360 | 500 |
| III | 11 PBT 3411 | Core XI | Bioprocess Technology | 6 | 5 | 25 | 75 | 100 |
| | 11 PBT 3412 | Core XII | Animal Biotechnology | 6 | 5 | 25 | 75 | 100 |
| | 11 PBT 3413:P | Core XIII | Bioprocess Technology- Animal and Plant Biotechnology - Practical | 6 | 5 | 40 | 60 | 100 |
| | 11 PBT 3501 | Core based Elective I | Plant Biotechnology | 6 | 4 | 25 | 75 | 100 |
| | 11 PBT 3502 | Core based Elective II | IPR, Biosafety and Bioethics | 6 | 4 | 25 | 75 | 100 |
| TOTAL | | | | 30 | 23 | 140 | 360 | 500 |
| IV | 11 PBT 4503 | Core based Elective III | Research Methodology and Biotechnology Management | 6 | 5 | 25 | 75 | 100 |
| | 11 PBT 48 | Project Work | --- | 24 | 18 | 100 | 300 | 400 |
| TOTAL | | | | 30 | 23 | 125 | 375 | 500 |
| GRAND TOTAL | | | | 120 | 90 | 545 | 1455 | 2000 |

Semester I Course Code - 11PBT1401

## CORE I – BIOCHEMISTRY AND BIOPHYSICS

Hours: 6 Credits: 4

Unit: 1 Bioenergetics: Thermodynamics and Molecular basis for evolution - Principles of bioenergetics -free energy functions - ATP as main career of free energy. Energy molecules. Biological oxidation - reduction reaction. Biomolecular Interactions - Structure and properties of $H_20$. Solute – Solvent Interactions - Bonding; strong and weak interactions – hydrogen bonding – hydrophobic - hydrophilic interactions and ionic interactions.

Unit: 2 Carbohydrate Metabolism: Glycolysis - citric acid cycle. Oxidative phorphorylation. Photophosphorylation Glyoxalate cycle - Carbohydrate biosynthesis - $C_2$ - $C_3$-- $C_4$ cycles. Biochemistry of monosaccharide – disaccharides - polysaccharides.

Unit: 3 Overview of Metabolic pathways: Lipid metabolism - chemical nature of fatty acids and acylglycerols - sources and storage of fatty acids - utilization fatty acids for energy production. Triacyglycerols - cholesterol - Phospholipids - sphingolipids. Amino acid metabolism – an over view: incorporation of nitrogen to amino acids - transport of nitrogen to liver and kidney - urea cycle - synthesis and oxidation of amino acids - de novo synthesis and salvage pathways in nucleotide metabolism.

Unit: 4 Understanding structure of nucleic acids: primary – secondary - tertiary and quaternary - structural components of nucleic acids- DNA supercoiling. RNA structures. DNA-protein interactions. Understanding structure of proteins at different levels – primary – secondary - tertiary and quaternary. Globular and fibrous proteins. Protein stability - protein folding. Ramachandran plot.

Unit: 5 Structure of biological membranes: Membrane proteins and transport - Ion – Channels - model membranes - liposomes. An overview of the Biochemistry of hormones: classification - mechanism of action - signal transduction. Hormonal integration of mammalian metabolism. Vitamins.

REFERENCE BOOKS:


1. A.L. Lehninger- D.L. Nelson and M.M Cox (2003) - Principles of Biochemisty - Worth publishers- New York.
2. L. Stryer- (2002) - Biochemistry- W.H. Freeman and Co.- New York.
3. C. Branden J.Tooze. (1999)- Introduction to protein structure - Publishing Inc.
4. Thomas Devlin (2002) - Textbook of Biochemistry by John publishers.
5. Voet and Voet - Principles of Biochemistry
6. Van Holde and Mathew- Principles of Biochemistry.

Semester I Course Code - 11PBT1402

## CORE II – CELL AND MOLECULAR BIOLOGY

Hours: 6 Credits: 4

Unit – 1 Cell Biology: Cell Theory- Prokaryotic and Eukaryotic cell structure and Intracellular organelles. DNA and RNA as genetic material - structure and function Prokaryotic and eukaryotic genome organization. Cytoskeleton - Mitosis and Meiosis.

Unit – 2 Replication: Enzymes in DNA replication - modes of replication. Prokaryotic and eukaryotic replication - Events- Plasmids – Types and Replication.

Unit – 3 Transcription: Prokaryotic and Eukaryotic transcription - RNA polymerase - transcription factors - mechanism of transcription - Post Transcriptional modifications - Export of mRNA - Si RNA- SnRNA.

Unit – 4 Translation: Genetic code - Elucidation of Codons - mRNA- ribosomes - aminoacyl tRNA synthetase. Prokaryotic and eukaryotic translation. Regulatory elements in translation - post-translational modification. Regulation of gene expression - Operon concepts – Lac- Trp- Ara.

Unit – 5 DNA Repair and Protein Localization: DNA repair and recombination- Chaperons and protein folding - nuclear localization signals for nucleus – mitochondria – chloroplast – Golgi - endoplasmic reticulum- membrane and secretory proteins and targeting.

REFERENCE BOOKS:


1. S.R. Maloy- J.E. Cronan and D.Friefelder (1994) Microbial Genetics Jones and Bartlett publishers.
2. N. Trun and J. Trempy. (2004) Fundamental Bacterial Genetics Blackwell Science Ltd.
3. Watson JD- Hopokins NH- Roberts JW- Steitz JA- Weiner AM. (2004Molecular Biology of Gene) Benjamin / Cummings Publishing company.
4. B. Levin. (2004) Genes VII Oxford University press.
5. D. P. Snustand M. J. Simmons and J. B. Jenkins. (1997) Principles of Genetics John Wiley and sons.
6. A. J. Griffiths- J. H. Miller- D. T. Suzuki- R. C. Lewontin and W. M. Gelbart. (2000) An Introduction to Genetic Analysis by W. H. Freeman and company.

Semester I Course Code - 11PBT1403

## CORE III – MICROBIOLOGY

Hours: 6 Credits: 4

Unit – 1 Introduction to microbiology: Integrative approach - Scope and History. Properties of Light - Light microscopy - Phase contrast - Interference - Fluorescence and Electron microscopy: SEM - TEM and Scanning Tunneling Microscopy - principles - applications and limitations. Specimen preparation for Light and Electron Microscopy. Structural organization (Internal and External) - function and reproduction of bacteria - actinomycetes - cyanobacteria - fungi (yeast and moulds) - virus - Bacteriophage.

Unit – 2 Isolation- cultivation and identification of bacteria: Microbial growth - culture media - isolation of pure culture. Growth curve: Diauxy - continuous culture - chemostat - turbidostat - synchronized growth - induction and selection techniques - Helmstetter - Cummings technique - Measurement of microbial growth - Total cell count method - viable cell count method and biomass determination. Effect of environment on microbial growth: temperature - pH - osmotic pressure - hydrostatic pressure - surface tension - electromagnetic radiation - electricity and magnetism - sound and microwaves - super - sonic vibrations.

Unit – 3 Microbial Nutrition: Nutritional requirements - carbon - hydrogen - oxygen - nitrogen - phosphorus and sulphur - growth factors and nutritional types of microorganisms. Uptake of nutrients: passive and facilitated diffusion - active transport - group translocation and membrane function. Bacterial taxonomy and Nomenclature. Cultivation of moulds and yeast.

Unit – 4 Principles of sterilization and disinfection. Physical and chemical methods of microbial control. Maintenance and preservation of microorganism - Antimicrobial chemotherapy - determination of levels of antimicrobial activity - mechanisms of action of antimicrobial agents - factors influencing. Principles of antimicrobial resistance. Bacterial spores.

Unit – 5 Soil microbiology: cycles of the elements - plant - microbe interaction - nitrogen fixation. Microbiology of air - water and food. Elementary account of most common diseases caused by Bacteria- virus and fungi in humans - respiratory tract and skin infections - diseases of nervous system - digestive system and sexually transmitted diseases.

REFERENCE BOOKS

1. Prescott LM- Harley JP- Klein DA. – 1996 Microbiology- Wm.C. Brown Publishers.
2. Davis BD- Dulbecco R- Eisen HN- Ginsberg HS. 1980 Microbiology- Harper Intl. Edition..
3. Pelczar MJ Jr.- Chan ECS- Krieg NR. 2001 Microbiology- TataMcGraw Hill Publishing Co.-.
4. Tortora- Funke- Case- 1995 Microbiology – An Introduction- Benjamin-Cummings Publications-.

Semester I Course Code - 11PBT1404

CORE IV – IMMUNOLOGY AND IMMUNOTECHNOLOGY

Hours: 6 Credits: 4

Unit – 1 The Immune System: Introduction - Cells of the Immune system - Innate and Acquired immunity - Primary and secondary lymphoid organs – Nature of antigens - Chemical and molecular basis of antigenecity – Immunogenecity - Haptens - Adjuvants - Primary and Secondary Immune Responses - Theory of Clonal selection.

Unit – 2 Humoral Immunity: B-lymphocytes and their activation - Structure and function of Immunoglobulin - Isotypes of immunoglobulins - Antigen-Antibody interactions - Antibody affinity- avidity; Agglutination – Precipitation - Idiotypic antibodies - monoclonal antibodies - antibody engineering – Generation of antibody diversity - Major Histocompatibility Complex.

Unit – 3 Cell Mediated Immunity: Biology of T lymphocyte - Classification of T lymphocytes - Structure of T Cell Receptor (TCR) - TCR diversity and genetics - Antigen presenting cells (APC) – macrophages - dendritic cells - Origin and functions of APC - Antigen processing and presentation – Cytokines - Cell mediated cytotoxicity - mechanism of Tcell and NK cell mediated lysis - Complement- Hypersensitivity.

Unit - 4 Immunity And Infection Mechanism: Tissue injury and Inflammation – Immunosuppression - Immunological Tolerance - Immunity to infectious agents – Transplantation – Autoimmunity - Tumor Immunology - Vaccines: Conventional- Molecular vaccines -Types of vaccines - Recent trends in Immunology of Infectious diseases.

Unit – 5 Experimental Immunology: Immunodiffusion and Immunoelectrophoresis – Hemagglutination - production of polyclonal and monoclonal antibodies - Western Blotting – ELISA - Radio Immunoassay - FACS.

REFERENCES


1. Kuby J- Cameron J- Todd C- Mitchell J-2000 Immunology- W.H. Freeman and Co.-.
2. Elgert KD- 1996 Immunology: Understanding Immune system- John Wiley and sons-
3. Roitt I- Brostoff- Male- 2001 Immunology- Mosby Publications-.

Semester I Course Code - 11PBT1405:P

CORE V – BIOCHEMISTRY- MICROBIOLOGY- MOLECULAR BIOLOGY AND IMMUNOLOGY - **Practical**

Hours: 6 Credit: 4

1. Theory and application of colorimeter - spectrophotometer - pH meter and buffers.
   Preparation of a few regularly used buffers in molecular biology.
2. Estimation of proteins - aminoacids - sugars.
3. Polyacrylamide gel electrophoresis.
4. Thin layer chromatography - Paper chromatography - ion-exchange chromatography.
5. Theory and demonstration of HPLC - GLC
6. Media preparation - Sterilization.
7. Culture transfer techniques - Isolation of pure cultures.
8. Bacterial staining (Simple - Negative- Gram's- Acid fast - spore)
9. Bacterial growth curve.
10. Isolation of Antibiotic producing organism and determination of antimicrobial spectrum of isolates
12. Extracellular activities of micro organisms
13. Preparation of Ag - Protocols of immunization - methods of bleeding- Routes of administration of antigen.
14. Blood group - typing. Peripheral mono nuclear cell separation- lymphocyte subset identification and enumeration.
15. Immunoelectrophoresis - immunodiffusion and rocket electrophoresis. ELISA Western blotting

REFERENCE BOOKS:


1. Rodney Boyer (2003), An Introduction to Practical Biochemistry, Pearson Education.
2. J. G. Cappuccino and N. Sherman (2004), Microbiology. A laboratory manual, Pearson Education.
3. J. Sambrook and D. W. Russell (2001), Molecular Cloning, Cold Spring Harbour Lab. Press.
4. J.Jayaraman (1988), Laboratory Manual of Biochemistry, Wiley Eastern
5. Wilson and Walker (1994), Practical Biochemsitry by Cambridge University Press
6. J.H. Miller (1992), A short course in Bacterial Genetics Cold Spring Harbor Laboratory.
7. Ed. RGF Murray- WA. Wood and NB krieg (1994), Methods for Genetics and molecular Bacteriology American society for Microbiology.
8. N. Kannan (2003), Handbook of Laboratory culture media- Reagents- Stains and Buffers - Panima Publishers- New Delhi.

Semester II Course Code - 11PBT2406

CORE VI – MOLECULAR GENETICS

Hours: 6 Credits: 5

Unit: 1 Cross over and Recombination: Linkage mapping techniques in eukaryotes – Ordered and un-ordered Tetrad analysis in Neurospora crassa - Genetics of Bacteria and virus: Overview of genetic exchange in bacteria. Conjugation – discovery- $F^+$ x $F^-$ matings- Hfr conjugation- sexduction- Determining linkage from interrupted mating experiments. Determining gene order from the gradient of transfer. Transduction – Discovery- generalized transduction- specialized transduction- Transformation – the process- competency. Bacterial viruses- discovery- genetic fine structure. Phage cross- rII System- Selection in genetic crosses of bacteriophages.Elucidation of fine Structure of genes by Benzer's experiment- Cis-Trans complementation.

Unit: 2 Mutation and DNA Repair and DNA Recombination: Mutation – Genetic variability required for evolution. Mutation – basic features of the process – somatic- Germinal- spontaneous- induced random- non – adaptive- reversible nature of mutations. Molecular basis of mutation – chemical- Radiation- transposable genetic elements- organ of spontaneous mutations. Mutations – phenotypic effects – effect of mutation in human hemoglobin genes- blocks in metabolic pathways. Conditional lethal mutations and their uses. Ames Test suppression of mutation – inter and intra gene suppression- nonsense- missense suppression.

Unit: 3 Regulation of gene expression in prokaryotes: Constitutive- inducible and repressible gene expression. Operon systems – lactose operon – induction- catabilite repression. Tryptophan operon – Repression - attenuation. Arabinose operon - positive and negative controls. Translational control and gene expression- post – translational regulatory mechanisms. Viral gene regulation: Molecular biology of lambda phage life cycle- HIV – structure and genome.

Unit : 4 Gene regulation in eukaryotes: spatial and temporal regulation of eukaryotic genes – tubulin genes in plants- globins genes in animals. Induction and transcriptional activity by environmental and biological factors – temperature- molecular control and Transcription in eukaryotes- enhancers- silencers. Eukaryotes transcription factors. Cytoplasmic control of mRNA stability. Chloroplast and Apicoplast DNA. Mitochondrial control DNA - gene expression- inter play between mitochondrial and nuclear gene products. Epigenetic regulation- RNA mediated regulation. DNA methylation.

Unit: 5 Transposable genetic elements and Cancer biology : IS Elements- composite transposons- Tn3- Tn5- Tn 9- Tn10 elements- medical significance. Eukaryotes – Ac and Ds elements in maize- P elements in drosophila. Retro transposons. Genetic and evolutionary significance of transposable elements.Cell cycle – genetic control of cell division – hematopoiesis as model system role of transcription factors and Growth factors. Genetic basis of cancer - benign- malignant- metastatic cancer. Oncogenes and tumour suppressor genes- Ras protein signaling and cancer. Apoptosis.

REFERENCE BOOKS:


1. Watson JD- Hopokins NH- Roberts JW- Stettz JA- Weiner AM. (2004), Melecular Biology of Gene, The Benjamin/ Cummings Publishing company.
2. Levin B (2003), Genes VII- Oxford university press.
3. Sinustad, (1997), Principles of Genetics John Wiley publications.
4. A. J. Griffiths- J. H. Miller- D. T. Suzuki- R. C. Lewontin and W. M. Gelbart. (2000), An Introduction to Genetic Analysis, W. H. Freeman and company.
5. R. A. Goldsby- T. J. Kindt- B. A. Osborne and J. Kuby. (2003), Immunology, W. H. Freeman and Company.
6. A. G. Atherly- J. R. Girton and J. F. McDonald (1999), The Science of Genetics by Harcourt College Publishers.
7. N. Trun and J. Trempy (2004), Fundamental bacterial Genetics, Blackwell publishers.

Semester II Course Code - 11PBT2407

CORE VII - RECOMBINANT DNA TECHNOLOGY

Hours: 6 Credits: 5

Unit: 1 Introduction to rDNA technology: DNA modifying enzymes and their uses. Restriction enzymes - Discovery – types - use of type II restriction enzymes- Elucidation of restriction site - Restriction mapping. DNA polymerases – Klenow - DNA polymerase I - thermostable DNA polymerases used in PCR - T4 / T7 DNA Polynucleotide kinases and alkaline phosphatases. RNA polymerases – ligases - nucleases - DNAse I - SI Nuclease - Mung Bean Nuclease – RNAases - Exo III.

Unit: 2 Cloning Vectors and their applications: Vectors for gram positive and gram negative bacteria. Bacteriophage vectors - Lambda and Ml3 virus - based vectors- cosmids- phagmids. Yeast vectors. Expression vectors - vectors facilitating protein purification Shuttle vectors. Artificial chromosomes – BAC – YAC - HAC. Inteins (protein introns)- Exteins

Unit : 3 DNA Cloning: sticky ends - blunt ends- homopolymeric tailing- use of adaptors and linkers. PCR based cloning. Preparation of radiolabelled / fluorescent labeled DNA and RNA probes. Chemical synthesis of oligo-nucleotides. Blotting & hybridization techniques. Screening of recombinants - alpha complementation- Blue – white selection.

Unit : 4 DNA sequencing: - Maxxam – Gilbert - Sanger methods. Automated DNA sequencing. PCR technology – concept - types - primer design - analysis of products and applications. DNA - finger printing. Chromosome jumping-chromosome walking. Site - directed mutagenesis.

Unit : 5 cDNA arrays and Micro array technology: Strategies for the production of recombinant proteins – insulin - human growth hormone - industrially important proteins. Construction of genomic library - cDNA library.

REFERENCE BOOKS:


1. Ernst-L. Winnacker (2003), Genes to Clones- Panima Publishing House- New Delhi.
2. T. A. Brown (2001), Gene Cloning Blackwell Science.
3. Bernard R. Glick and Jack J. Pasternak (2002), Molecular Biotechnology Panima Publishing House New Delhi.
4. S. B. Primrose (2001), Molecular Biotechnology, Panima Publishing House- New Delhi.
5. DM. Glover & BD. Hames (1995), DNA cloning I & II by IRL Pres.
6. MA. Innis- DH- Gelfand & D JJ Sninskey (1995), PCR strategies by Acadmic Press.
7. Watson JD- Gilman M- Witkowski- Zoller M (1992), Recombinant DNA by Scientific American books.

Semester II Course Code - 11PBT2408

CORE- VIII ENZYMOLOGY AND BIOINSTRUMENTATION

Hours: 6 Credits: 5

Unit - 1 Enzyme Classification and nomenclature: General properties of enzymes like effect of pH- Temperature - Ions etc. Extraction - assay and purification of enzymes. Steady state kinetics. Michaelis – Menten- Lineweaver Burke- Eadie-Hofstee and Hanes – Woolf equation and y value. Different types of inhibitors. Pre-steady state kinetics. Fast kinetics to elucidate the intermediates and rate limiting steps (flow and relaxation techniques) Km and Kcat values.

Unit - 2 Enzyme Kinetics and Mechanism: Enzyme specificity. Evidences for enzyme substrate complex Nucleophilic and electrophilic attack. Role of metal ions and Co-Enzymes in enzyme catalysis. Mechanism of enzyme action eg.- Lysozyme - Chymotrypsin DNA Polymerase - RNase etc. Zymogens and enzyme activation. Allosteric interactions and product inhibition. Complex kinetics and analysis. Membrane bound enzymes – extraction-assay. Clinical and Industrial applications of Enzymes. Immobilizations of Enzymes and their applications. Enzyme engineering. Biosensors and their industrial applications.

Unit – 3 Tracer Techniques: Radioactive isotope and half life and isotope; Assessing the metabolic pathways- Meselson and Stahl experiment- autoradiography. Counting techniques: Liquid scintillation counting- Photomultiplier tubes- Chemiluminescence and bioluminescence. Green fluorescent protein. Fluorescence activated cell sorting.

Unit: 4 Separation Techniques: Principles and application of gel exclusion chromatography- ion exchange chromatography- affinity chromatography- Gas and high performance liquid chromatography. Electrophoretic techniques (single dimension and Two - Dimension)- Centrifugation (Velocity and buoyant density) and Precipitation techniques for the separation of proteins and nucleic acids.

Unit: 5 Spectroscopic techniques: Principles of UV-Vis- IR- NMR- spectroscopy. CD – ORD and X – Ray Diffraction (XRD). Principles of Microscopy - phase contrast- fluorescence- confocal- scanning and Electron microscopy. ID and 2D gel electrophoresis of proteins. Mass spectrometry- MALD1-TOF.

Reference Books


1. Canter and Canter (1996), Biophysical Chemistry
2. Dixon and Webb, Enzymes
3. Glick and Pasternack (1994), Molecular Biotechnology by. ASM Press.
4. Alan Fersht (1995), Enzyme structure and Mechanisms. W.H. Freeman and Company New York.
5. Trevor Palmer - Enzymology
6. P.L. Soni, Physical chemistry, S. Chand publications
7. Puri and Sharma, Physical chemistry.
8. David Freifelder, Biophysical chemistry.

Semester II Course Code – 11PBT2409

## CORE IX - BIOINFORMATICS and BIOSTATISTICS

Hours: 6 Credits: 5

Unit – 1 Structural Biology: Factors determining primary – secondary - tertiary and quaternary structures of Proteins and Nucleic acids. Algorithms to identify the patterns in the primary – secondary - tertiary and quaternary structures.

Unit – 2 Databases: Introduction to databases - Types of databases. Flat file database - Relational databases - Object oriented databases - Database software: Overview of Sequence Retrieval System – Oracle - MySQL. Database design: visualization of databases - data mining. Structural Bioinformatics: Models of protein structure – Structure function – relationship - Structural alignment – Classification of 3D structure. CATH and SCOP – Concepts in protein prediction. Micro array data and analysis: Tools and resources - Proteomic data analysis - Bioinformatics in drug discovery.

Unit – 3 Phylogenetic analysis: Internet sequences on the net - Sequencing DNA-RNA Proteins – Determination of Protein Structure – Gene and Protein expression data – Protein interaction data-File formats – Sequences databases – Genome and organism specific databases – Retrieval - Entrez – SRS - Similarity searches – Amino acid substitution matrices - FASTA - BLAST – various types of BLAST. Multiple sequence alignment: Protein families - Protein domain families. Building trees – Evolution of macromolecular sequences – Genome annotation.

Unit – 4 Programming In C and Perl: C-language-Introduction-Operators-expressions- variables- input output statements- control statements-function- arrays- pointers- structures- unions- file handling and case studies. Introduction to PERL- variables- strings and numbers- lists analysis- hashes-conditional loops- strings- pattern matching- applying PERL to bioinformatics.

Unit – 5 Biostatistics: measures of central Tendency - mean arithmetic's- harmonic and geometric median and mode - measures of dispersion -standard deviation and standard error; correlation coefficient- simple linear regress- Basic idea of significance test- hypothesis test. Level of significance - T test - 'Chi' square and goodness of fit - Graphics.

REFERENCES


1. E. Balaguruswamy-1992 Programming in ANSI C- TataMcGraw Hill.
2. Attwood TK- Parry Smith DJ-2001 Introduction to bioinformatics- Pearson Education Asia.
3. Kutti- 1995 C and Unix programming: a conceptual perspective- Tata McGraw Hill-.
4. Gibas C- Jambeck P. 2001 Developing bioinformatics in computer skills. Oreilly and Associates Inc. Shroff Publishers.
5. David W. Mount- 2001-Bioinformatics- Cold Spring Harbor Laboratory Press.

Semester II Course Code - 08PBT2408:P

CORE X –MOLECULAR GENETICS- rDNA TECHNOLOGY ENZYMOLOGY AND BIOINFORMATICS - Practical

Hours: 6 Credits: 4

1. Experiments with lac operon- induction and assay of beta-galactosidase.
2. Preparation of competent cells and transformation- Transduction- Conjugation
3. Isolation and quantification of Nucleic acids – Bacterial- fungal- animal- plant
4. Restriction digestion of DNA
5. Ligation of DNA fragments.
6. Demonstration of gene transfer techniques- Cloning a gene
7. Enzyme kinetics – salivary amylase- acid / alkaline phosphatase-
8. Enzyme Immobilization
9. Enzyme preparation and purification – acid phosphatase –Ammonium Sulphate precipitation
10. Agarose gel electrophoresis- resolution and purification of DNA fragments.
11. PCR amplifications- RFLP- RAPD
12. Computer basic knowledge; hardware, connection cables, typing, Windows 98/XP, Internet browsers, search engines.
13. LAN connections, setting up the IP address, network security.
14. Internet surfing and searching information, downloading and installing software (Acrobat Reader, etc).
15. Program to store a DNA sequence
16. Program to concatenate DNA fragments
17. Program to convert DNA to RNA
18. Program to read protein sequence data from a file
19. Program to find motif in a protein sequence
20. Program to count nucleotide in a sequence
21. Program to find the percentage of G and C in a DNA sequence
22. Program to find the percentage of type of amino acid in a sequence
23. Program to find is a DNA is stable or not.

REFERENCE BOOKS:


1. J.H. Miller (1992), A short course in Bacterial Genetics by Cold Spring Harbor Laboratory.
2. DM. Glover & BD. Hames (1995), DNA cloning I & II by IRL Pres.
3. MA. Innis- DH- Gelfand &D JJ Sninskey (1995), PCR strategies by AcadmiPress.
4. Molecular cloning Volume I- Volume II and Volume III- Academic Press.
5. Grierson and S.N. Covey (1988), Plant Molecular Biology by Blackie
6. S.Ignacimuthu S.J. (1996), Applied Plant Biotechnology- Me Graw Hill publications Co. Ltd.- New Delhi.

Semester III Course Code - 11PBT3411

CORE - XI BIOPROCESS TECHNOLOGY

Hours: 6 Credits: 5

UNIT I INTRODUCTION TO WHITE BIOTECHNOLOGY: Isolation and screening of industrially important microbes. Strain improvement - mutation and recombination. Media/substrates for industrial fermentation/process - typical media, media formulation, water, energy and carbon sources, nitrogen sources, minerals, growth factors, buffers, precursors, inhibitors, inducers and antifoams. Media formulation / optimization. Preservation of industrially important microorganisms.

UNIT II FERMENTATION AND FERMENTOR/BIOREACTOR: Concepts of basic modes of fermentation – Batch, Fed batch and Continuous fermentation. Fermentor/Bioreactor design and operations - basic function, design, components and body construction. Sterilization of Fermentor/Bioreactor - air and media sterilization. Bioprocess control and monitoring - control and monitoring of variables such as temperature - pH – aeration - agitation - pressure - online measurement - on / off control - PID control - computers in bioprocess control system.

UNIT III TYPES OF FERMENTORS / BIOREACTORS: Mechanical - Stirred tank bioreactors, pneumatic - Airlift fermentors, Hydrodynamic - jet fermentors, enzymatic membrane reactors, photo bioreactors, solid state fermentors, anaerobic solid stage silage fermentors, bed fermentors, tower fermentors, rotating disc fermentor, bubble cap fermentor, animal cell culture reactors and plant cell culture reactors, and cylindro conical vessel.

UNIT IV DOWNSTREAM PROCESSING: Objectives and criteria - foam separation - precipitation methods. Filtration - filtration devices and filter aids. Centrifugation - industrial scale centrifugation and cell disruption. Liquid - liquid extraction, solvent recovery. Chromatography - two-phase aqueous extraction, super - critical fluid extraction, ultra filtration, membrane process, drying devices, crystallization and whole broth processing. Effluent treatment - disposal, treatment process and by - products.

UNIT V BIOPROCESS ECONOMICS AND INDUSTRIAL PRODUCTION: Bioprocess economics. Production of enzymes-amylases and proteases. Acetone – Butanol - Ethanol (ABE) fermentation. Antibiotic production - penicillin, streptomycin and tetracycline. Amino acid - Lysine, proline and glutamic acid. Vitamin production - vitamin B12. Organic acid production - citric acid. SCP production. Cell and enzyme immobilization. Biotransformations.

REFERENCE BOOKS:


1. Glazer, A N. and Nikaldo, H.1995 Microbial Biotechnology -W H Freeman and company network.
2. Prescott, L M., Harley, J P and Klein, D A.1999. Microbiology 4th edition Mc Graw Hill.
3. Stainer, R Y, Ingrtham, J L., Wheels, M.L and Painter P.R.1987 - General Microbiology. Maomillan.
4. Stanbury P.F., Whitaker A., Hall S.J. (1995) Principles of Fermentation Technology, Butterwoth Heinemann.
5. Casida L.E. (1968) Industrial Microbiology, John Wiley & Sons.
6. Flickinger M.C., Drew S.W. (1999) Encyclopedia of Bioprocess Technology – 5 Volumes, John Wiley & Sons.
7. Arnold L. demain & Julian E. Davis. (2004) Industrial Microbiology & Biotechnology ASM Press.
8. Emt.el - Mansi & CFA. Bryce (2004). Fermentation Microbiology & Biotechnology Taylor & Francis Ltd.
9. P.F. Stanbury - A. Whitaker & S.J. Hall (1997) - Principles of fermentation technology Oxford.
10. Gungalus- I.C. and Stainer. RY. (Eds.) The Bacterial Vol. III Academic press. New York.
11. Sala Teh JR -Bacterial physiology and metabolism Academic press- New York.
12. J.M. Coulson and J.F. Richardson (1984) Chemical Engineering Pergamon Press.

Semester III Course Code – 11PBT3412

## CORE – XII ANIMAL BIOTECHNOLOGY

Hours: 6 Credits: 5

Unit : 1 Gametogenesis and Embryodevelopment: Molecular biology of animal development - Oogenesis and fertilization- Blastula- gastrulation and morphogenesis. Genetic analysis of development in drosophila- a model system- sex determination in drosophila- maternal gene activity- zygotic gene activity- vertebrate homologues of invertebrate genes.

Unit: 2 Animal cell and tissue culture: – primary cell culture- transformed cell lines- cell culture media – components and their function- serum- and serum free media. Flask culture and passage of cells $CO_2$ incubator. Organ culture methods of introducing of DNA into cell lines – microinjection- calcium phosphate transfection- lipofection- electroporation. Reporter gene systems – luciferase and green fluorescent protein- CAT assay. Preservation of animal cells. American type culture collection.

Unit : 3 *In vitro* fertilization and embryo transfer: Embryo technology. development and use of transgenic animals – retroviral method- embryonic stem cell method- micro –injection method. Generation of gene knockouts and insertional mutants in mice. Stem Cells – types- Gene therapy. Cloning of animals. Stem cell therapy – reproductive cloning. Biotechnology of silkworms and aquaculture.

Unit : 4 Hybridoma technology: monoclonal antibody production. Fusion methods. Selection and screening methods for positive hybrids. Purification of monoclonal antibodies. Application of monoclonal antibodies. T cell cloning and applications – cytokine technology.

Unit: 5 Vaccine Production: – active / passive immunization- whole organism vaccines- purified macromolecules as vaccines- recombinant vector vaccines- DNA vaccines- multivalent subunit vaccines strategies for Hepatitis B- Malaria- HIV and Cancer. Dendritic cells as therapeutic agents. Multi – valent vaccines. Immunodiagnostics.

Reference Books:


1. A. J. Griffiths- J.H. Miller- D.T. Suzuki- R.C. Lewontin and W.M. Gelbart (2000), An introduction to Genetic analysis, W. H.Freeman and Company.
2. J.R.W. Masters (2000), Animal Cell culture, Oxford University Press.
3. M.M. Ranga (2003), Animal Biotechnology, Student Edition- Jodhpur.
4. Bernard R. Glick and Jack J. Pasternak (2002), Molecular Biotechnology, Panima Publishing House- New Delhi.
5. R. A. Goldsby- T.J. Kindt- B. A. Osborne and J. Kuby. (2003), Immunology, W.H. Freeman and company.
6. T. A. Springer (1985), Hybridoma Technology in Biosciences and Medicine by Plenum Press- New York.
7. C. Garrison Fathman- F. W. Fitch (1982), Isolation- Characterization and utilization of T – Lymphocyte clones by Academic Press
8. J.D. Watson- N.H. Hopkins- J.W. Roberts- JA. Steitz and A.M. Weiner (2002), Molecular Biology of gene by Benjamin / cummings 4th Ed. Vol. 1 &2-
9. J.D. Watson- M. Gilman- J. Witknowski and M. Zoller (1992), Recombinant DNA 2nd, Scientific American Books- New York.
10. A. Puher (1993), Genetic Engineering of animals by (Ed.) VCH Publishers- Weinheim- FRG.

Semester III Course Code – 11PBT3413:P

## CORE XIII - BIOPROCESS TECHNOLOGY, ANIMAL AND PLANT BIOTECHNOLOGY- Practical

Hours: 6 Credits: 5

1 Introduction to bioprocess technology parts and designs of bioreators; production of biomass; batch and continuous fed batch fermentation- recovery of products.
2 Laboratory scale fermentation of antibiotics- immobilization of cells and enzymes.
3 Preparation of Ag - Protocols of immunization- methods of bleeding- Routes of administration of antigen.
4 Blood group - typing. Peripheral mono nuclear cell separation- lymphocyte subset identification and enumeration.
5 Immunoelectrophoresis- immunodiffusion and rocket electrophoresis. ELISA
6 Western blotting
7 Demonstration. Primary cell culture - fibroblasts from mouse and Chick embryo - Cell viability- MTT Assay.
8. Plant tissue culture- sterilization- media preparation- hormones.
9. Micropropagation- shoot induction- multiplication- root induction and hardening.
10. Callus induction- cell suspension cultures- regeneration- haploid culture- anther culture. Protoplast isolation
11. Agrobacterium-mediated transformation- GUS expression- extraction of DNA from transformed plants.

REFERENCE BOOKS:


1. Sambrook, (2001), Molecular Cloning : A laboratory manual Vol. I - III Cold Spring Harbor Laboratory.
2. F.M. Abubel (1987), Current Protocols in Molecular Biology Vol. & II, John Wiley Publishers- New York.
3. Weir- D.M. (1986), Hand Book of Experimental Immunology Vol. I & II by Blackwell Scientific Publications.
4. Hudson- L and Hay. H.C. (1980), Practical Immunology by Blackwell Scientific Publications.
5. Muthukkaruppan V.R. Baskar- S. and F. Sinigaglia (1986)Hybridoma Techniques : A Laboratory Course Macmillan India Limited.

Semester III Course Code – 11PBT3501

## CORE BASED ELECTIVE I – PLANT BIOTECHNOLOGY

Hours: 6 Credits: 4

UNIT I INTRODUCTION TO TISSUE CULTURE: Objectives, roles and landmarks in plant breeding; special breeding techniques: Mutational breeding and distant hybridization. History of plant cell, tissue and organ culture – laboratory organization – aseptic techniques – nutritional requirements and culture media. Micro propagation – Mass production of plantlets – hardening and mist chambers – transplantation to field – techniques for maintaining plantlets in the field. Types of cultures – Solid – Liquid – Stationary – agitated – batch cultures – Organogenesis – callus induction – Caulogenesis – Rhizogenesis – technique of hairy root production. – Somatic embryogenesis – induction of multiple shoots.

UNIT II *IN-VITRO* PROPAGATION: Production of virus free plants – production and exploitation of haploids and triploids – techniques of overcoming incompatibility barriers – embryo rescue – protoplast culture and parasexual hybridization – exploitation of Somaclonal and Gametoclonal variations. Mass Culture of Cells – Manipulation of cell line selection – immobilization of cells and its application – cryopreservation – germplasm conservation and establishment of gene banks – Synseed technology.

UNIT III GENE TRANSFER TECHNIQUES: Genetic Engineering in Plants - Molecular biology of Agrobacterium mediated DNA transfer- Ti plasmid Vectors- Binary and co-integrated vectors- Transformation strategies in plants – *Agrobacterium tumefaciens* & *Agrobacterium rhizogenes*. Plant viruses as vectors. Physical method of transfer-Biolistics –Electroporation. Transposons in transgenic plants – their uses – Terminator gene technology, RNAi, Metabolic Engineering.

UNIT IV MOLECULAR MARKERS: Selectable Markers, reporter genes- Promoters used in Plant vectors genetic engineering for - heat, drought and saline tolerance (Osmogenes) - Virus resistance - Pest resistance – Bt genes, Non-Bt like protease inhibitors, alpha amylase inhibitors - Herbicide resistance - Herbicide tolerance - Delayed fruit ripening - Fungal and bacterial resistance - Secondary metabolite production . Production of therapeutic proteins - antibodies, vaccines - edible vaccines- hormones- Golden Rice. Marker free transgenic plants. Co-transformation-Transgenic silencing.

UNIT V PLANT GENOME MAPPING: Physical and molecular maps, gene tagging – Seed production techniques, release of new varieties and plant breeders right: UPOV 369, 370, 372. Plant DNA finger printing: Hybridization and PCR based markers (RFLP, SSR's, RAPD, QTLs, SCARS, AFLP etc.,). Green House Technology - Molecular aspects of nitrogen fixation. Management aspect of plant Genetic Engineering. Transgene escape – Tagging - mapping and cloning of plant genes. Molecular biology of plant pathogen interactions.

REFERENCE:


1. R.A Dixon And R.A. Gonzales (2004).Plant cell culture, IRL press.
2. G.W. Lycett and D. grierson (1990) Genetic Engineering of crop plants- (Eds)
3. M.J. Chrispeels and D.F. Sadava (1994) Plants- Genes and Agriculture Jones and Bartlett.
4. Glick and Paster mark (2002) Molecular Biotechnology by Panima.
5. S.S. Bhojwani and M.K. Razdan (2004) Plant Tissue culture: theory and practice a revised edition Elsevier science.
6. F.H.Erbisch and K.M.Maredia (2000). Intellectual property in agricultural Biotechnology, Edited by, University Press.
7. Bernard R.Glick and Jack J.Pasternak (2001). Molecular Biotechnology, Principles and applications of recombinant DNA technology. ASM Press Washington DC.
8. J.Hammond, P.McGarvey and V.Yusibov (eds) (1999). Plant Biotechnology – New products and Applications. By Springer Publication.
9. Kalyankumar De. (2007). An Introduction to Plant Tissue Culture Techniques. New Central Book Agency, Kolkata.

Semester III Course Code – 11PBT3502

CORE BASED ELECTIVE II – IPR, BIOSAFTEY AND BIOETHICS

Hours: 6 Credits: 4

UNIT I BIOSAFETY: Introduction – biosafety issues in biotechnology - historical background. Biological Safety Cabinets, Primary Containment for Biohazards. Biosafety Levels - Levels of Specific Microorganisms, Infectious Agents and Infected Animals.

UNIT II BIOSAFETY GUIDELINES: Guidelines and regulations (National and International including Cartegana Protocol) – operation of biosafety guidelines and regulations of Government of India; Definition of GMOs & LMOs. Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture. Environmental release of =GMOs - Risk - Analysis, Assessment, management and communication.

UNIT III INTELLECTUAL PROPERTY RIGHTS: Introduction to IPR, Types of IP - Patents, Trademarks, Copyright and Related Rights, Industrial Design, Traditional Knowledge and Geographical Indications. Importance of IPR – patentable and non patentables, patenting life, legal protection of Biotechnological inventions. Agreements and Treaties - History of GATT and TRIPS Agreement; Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty; PCT; Indian Patent Act 1970 and recent amendments. IPR and WTO regime - Consumer protection and plant genetic resources.

UNIT IV PATENTS AND PATENT LAWS: Objectives of the patent system - Basic, principles and general requirements of patent law. Biotechnological inventions and patent law - Legal development - Patentable subjects and protection in Biotechnology. Patent Filing Procedures - National & PCT filing procedure, Time frame and cost, Status of the patent applications, Precautions while patenting, disclosure/ nondisclosure, financial assistance for patenting, introduction to existing schemes. Patent licensing and agreement. Patent infringement - meaning, scope, litigation, case studies.

UNIT V BIOETHICS: Introduction to ethics and bioethics, framework for ethical decision making. Ethical, legal and socioeconomic aspects of gene therapy, germ line, somatic, embryonic and adult stem cell research. Ethical implications of GM crops, GMO's, human genome project, human cloning, designer babies, biopiracy and biowarfare. Eugenics and its possible approaches. Animal right activities - Blue cross in India- society for prevention of cruelty against animals. Ethical limits of Animal use. Green peace - Human Rights and Responsibilities.

REFERENCES:


1. Beier- F.K.- Crespi- R.S. and Straus- T. Biotechnology and Patent protection- Oxford and IBH Publishing Co. New Delhi.
2. Sasson A- Biotechnologies and Development- UNESCO Publications.
3. Jeffrey M. Gimble- Academia to Biotechnology- Elsevier- Academic Press.
4. Biosafety and Bioethics related book. Rajmohan Joshi (Ed.) 2006. Biosafety and Bioethics. Isha Books, Delhi.

Semester IV Course Code – 11PBT4503

CORE BASED ELECTIVE III

RESEARCH METHODOLOGY AND BIOTECHNOLOGY MANAGEMENT

Hours: 6 Credits: 5

UNIT I RESEARCH CONCEPTS AND DATA COLLECTION: Definition of Research, Qualities of Researcher, Components of Research Problem, Various Steps in Scientific Research, Types of Research; Hypotheses Research Purposes - Research Design - Survey Research - Case Study Research. Sources of Data: Primary Data, Secondary Data; Procedure Questionnaire - Sampling Merits and Demerits - Experiments - Kinds - Procedure; Control Observation - Merits - Demerits - Kinds - Procedure - Sampling Errors - Type-I Error - Type-II Error.

UNIT II RESEARCH REPORTS: Structure and Components of Research Report, Types of Reports, Styles of reporting, Steps in drafting reports, editing and evaluation of final draft, evaluating the final draft; Good Research Report, observation and research report. Pictures and Graphs; Research proposal/ Grant- definition, structure, budget allocation, specific aims, background and significance. Hierarchy of funding agencies in India and their operations.

UNIT III MODEL ORGANISMS IN BIOLOGY: definition of model organism and research resources – classification of model organisms. Non-human mammalian models – mouse *(Mus musculus)*; Guinea pigs *(Cavia porcellus)*. Non-mammalian models – Bacteria (Escherichia *coli*), Viruses (T4 and Lambda Bacteriophage), Yeast (*Saccharomyces cerevisae*), Amoeba (*Dictyostelium discoideum*), Round worm (*Caenorhabditis elegans)*, Fruit fly *(Drosophila melanogaster)*, Zebra fish *(Danio rerio)*, Mouse Ear cress (*Arabiddopsis thaliana)*, Maize (*Zea mays*) – rationale of model organism, comparative physiology, life cycle, scope and research preferences.
Repositories- ATCC, NCCS, Pune. Culture collection and submission.

Unit - 4 Biotechnology Management: Introduction - Designing a manuscript- grant experimental protocols & experimental methods. Selection of a Biotechnology company. Setting up of a Laboratory: laboratory administration – collaborations - inventories and inspections – personnel – Recruitment hiring – mentoring - promoting and terminating

Unit – 5 Good Manufacturing Practices Ensuring Biosafety: Biosafety regulations - Good laboratory practices - Good manufacturing practices in industry. Storage and disposal of hazardous wastes: radioactive materials - pathogenic strains. GMO's and their release in environment. Experimental protocol approvals -Levels of containment - Environmental aspects of biotech applications.

REFERENCE BOOK


1. Beier- F.K.- Crespi- R.S. and Straus- T. Biotechnology and Patent protection- Oxford and IBH Publishing Co. New Delhi.
2. Sasson A- Biotechnologies and Development- UNESCO Publications.
3. Jeffrey M. Gimble- Academia to Biotechnology- Elsevier- Academic Press.

Semester IV Course Code – 11PBT48

PROJECT WORK
REPORT AND VIVA VOCE

Hours: 24 Credits: 18