BHARATHIDASAN UNIVERSITY TIRUCHIRAPPALLI – 620 024

M.Sc. Biotechnology Course Structure under CBCS

(For the candidates admitted from the academic year 2016-2017 onwards)

Sem	Course	Course Title	Ins. Hrs / Week	Credit	Exam Hrs	Marks		Total
						Int.	Ext.	
I	Core Course - I (CC)	Cell Biology	6	4	3	25	75	100
	Core Course - II (CC)	Microbiology	6	4	3	25	75	100
	Core Course - III (CC)	Biochemistry	5	4	3	25	75	100
	Core Course - IV (CC)	Molecular Biology	5	4	3	25	75	100
	Core Practical - I (CP)	Cell Biology, Microbiology, Biochemistry & Molecular Biology (P)	8	4	3	40	60	100
	TOTAL		**30**	**20**				**500**
II	Core Course - V (CC)	rDNA Technology	6	5	3	25	75	100
	Core Course - VI (CC)	Immunology	6	5	3	25	75	100
	Core Practical - II (CP)	rDNA Technology & Immunology (P)	8	4	3	40	60	100
	Elective Course - I (EC)	Bio Instrumentation	5	5	3	25	75	100
	Elective Course - II (EC)	Bio Informatics	5	5	3	25	75	100
	TOTAL		**30**	**24**				**500**
III	Core Course – VII(CC)	Plant Biotechnology	6	5	3	25	75	100
	Core Course – VIII (CC)	Animal Biotechnology	6	5	3	25	75	100
	Core Practical - III (CP)	Plant and Animal Biotechnology (P)	8	4	3	40	60	100
	Elective Course – III (EC)	Biostatistics, Bioethics and IPR	5	5	3	25	75	100
	Elective Course - IV (EC)	Biotechnology for Entrepreneurs	5	5	3	25	75	100
	TOTAL		**30**	**24**				**500**
IV	Core Course - IX (CC)	Bioprocess Technology	5	5	3	25	75	100
	Core Course - X (CC)	Food Technology	5	5	3	25	75	100
	Core Practical - IV (CP)	Bioprocess and Food Technology (P)	8	4	3	40	60	100
	Elective Course - V (EC)	Environment Biotechnology and Nanotechnology	5	4	3	25	75	100
	Project		7	4	-	-	-	100
	TOTAL		**30**	**22**				**500**
GRAND TOTAL			**120**	**90**				**2000**

Note:

Project : 100 Marks
Dissertation : 80 Marks
Viva Voice : 20 Marks

Core Papers	- 10
Core Practical	- 4
Elective Papers	- 5
Project	- 1

Note:

1. Theory	Internal	25 marks	External	75 marks
2. Practical	”	40 marks	”	60 marks

3. Separate passing minimum is prescribed for Internal and External

a) The passing minimum for CIA shall be 40% out of 25 marks (i.e. 10 marks)
b) The passing minimum for University Examinations shall be 40% out of 75 marks (i.e. 30 marks)
c) The passing minimum not less than 50% in the aggregate.

*****

CORE COURSE I

CELL BIOLOGY

PREAMBLE

Scope: This paper provides a thorough knowledge about structure and function of cells, cellular signaling, protein trafficking, bio molecules and cellular development.

Objective: Understanding the structural and functional aspects of the cell provides the student with a strong foundation in the molecular mechanisms underlying cellular function.

Goal: Students after completion of this paper will be exceptionally well prepared to pursue careers in cellular and sub cellular biological research, biomedical research, or medicine or allied health fields.

Unit I Cell structure

Introduction to cell: Prokaryotic, akaryotic and eukaryotic cell. Biosis, viroid, mycoplasmas and cyanobacteria (gene organization only). Difference between plant and animal cell at different level.

Plasma Membrane: The lipid layer, membrane proteins, membrane carbohydrate, membrane transport of small molecules, cell adhesion, cell junction and extra cellular matrix.

Cell Wall: Chemical composition, cross linkage, porosity, tensile strength, turgor modifications in special types of cells. Plasmadesmeta and fluid transport between cells.

Unit II Cell Organelles

Endoplasmic Reticulum: Types – rough & smooth. Ultra structure. Role in compartmentalization, intracellular transport & lipid biosynthesis.

Ribosomes: Ultra structure, general chemistry, assembly and function.
Golgi Apparatus: Structure and functions.

Mitochondria: Ultra structure and membrane organization. Role of mitochondria in cellular energies & biogenesis.

Chloroplast: Structure and function. Photosynthesis. Photosynthetic units and reaction centers. Photophosphorylation. CO_2 fixation and synthesis of carbohydrates. Importing proteins in chloroplast and biogenesis.

Lysosomes: General organization, polymorphism, enzyme systems and their functions. Vacuoles and ergastic substances.

Peroxisomes: Formation, enzyme content and role.

Unit III Nuclear Material

Cytoskeleton: Microtubules, microfilaments & associated proteins – actin, myosin and intermediate filaments. 3 dimensional organization of cytoskeleton.

Nucleus: Nucleus, nuclear envelops, nucleoplasam, chromatin and chromosomes. Nuclear division.

Unit IV Organization of Chromosomes, Cell Division & Cell Cycle

Specialized chromosomes, chromosomal abnormalities and qualitative inheritance. Population genetics and developmental genetics using *Drosophila melanogaster* as model system. Somatic cell genetics.

C**ell Division**: Mitosis, meiosis and binary fission. Cell cycle, cell cycle clock & check points.

Cell Cycle and Cell Growth Control: Overview of cell cycle; molecular mechanisms for regulating mitotic events; check points in cell cycle regulation; meiosis; cell birth, lineage and death; Cancer – genetic basis of cancer; Oncogenes and tumour suppressor genes.

Unit V Microbial Cell Biology

Structural organization of prokaryotic cell. Cell appendages – cilia, pili, fimbriae & flagella. Cell wall structure and bacterial surface layers. Cytoplasm. Bacteria as example for prokaryote. Eukaryotic cell organization – filamentous fungus and yeast as example.

Text Books

1. Freifelder D. 1985. Molecular Biology, Narosa Publishing House. New Delhi.
2. Lewin B. 2007. Genes IX. Oxford University Press, London.
3. Ajoy Paul. 2011. Textbook of Cell and Molecular Biology. Books and Allied Ltd.
4. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter. 2008. Molecular Biology of Cell. 6th Edition. Garland Science, Taylor & Francis group Publishers.
5. Harvey Lodish, Arnold Berk, S Lawrence Zipursky, Paul Matsudaira, David Baltimore, and James Darnell. 1995. Molecular Cell Biology. 3rd Edition. W.H. Freeman Publishers.

Reference Books

1. Watson JD, Gilman M, Witkowski J and Zoller M. 1992. Recombinant DNA. Scientific American Books. 2nd Edition. New York.
2. Blackburn GM and Gait MJ. 1996. Nucleic Acids in Chemistry and Biology. Oxford University Press.
3. Lodish H, Baltimore D, Beck A, Zipursky SL, Matsudaria P and Darnell J. 1995. Molecular Cell Biology. Scientific American Books.
4. Cooper M 1995. The Cell Molecular Approach. 2nd Edition. ASM Press.
5. Lewis J Kleinsmith and Valerie M Kish. 1980. Principle of Cell and Molecular Biology 2nd Edition. Benjamin-Cummings Publishing Company.
6. De Robertis, EDP and E.M.F Robertis. 1980. Cell and Molecular Biology. 7th Edition. Saunders Company.
7. T.A. Brown. 2011. Introduction to genetics: A molecular approach. 1st Edition. Garland Science.
8. J.D.Watson, Tania A. Baker, Stephen P. Bell, Michael Levine and Richard Losick. 2013. Molecular Biology of the Gene. 7th Edition. Benjamin/Cummings Publ. Co., Inc., California.
9. Benjamin Lewin. 2008. Genes XI. 9th Edition. Jones & Bartlett Learning.
10. R.A. Meyers. 1995. Molecular Biology and Biotechnology. A comprehensive desk reference. (Ed) Wiley-Blackwell Publishers.

*****

CORE COURSE II

MICROBIOLOGY

Scope: This paper deals with various types of classification of microbes. The paper also throws light on multifarious habitats of microbes and provides information about all the microbial cellular functions and various metabolic pathways in microbes.

Objective: To impart knowledge on classification of microbes. This paper is also designed to provide knowledge on metabolic function and biochemical reaction going on inside the microbial cell

Goal: This paper enables the students to identify any microorganisms. The students will be able to understand and predict the intermediate metabolism of any microbe used in industrial production processes

Unit I Introduction to Microbiology

Discovery of microbial world, the experiment of Pasteur, the era of discovery of antibiotics and anaerobic life. Types and classification of microbes. Isolation, identification, characteristics and ultra structure of microbes – Viruses, Bacteria, Fungi and Algae. Various associations of microbes.

Unit I1 Microbial Biodiversity, Growth and Molecular Systematic

Origin and evolution of microorganisms. Concepts of species and hierarchical taxa. Bergy's system of classification – Viruses, Bacteria, Fungi. Biological nomenclature - Measurement of species richness and evenness. Simpson's diversity index – Multivariate analysis.

Microbial Nutrition and Growth: Principles of microbial nutrition – carbon, nitrogen, sulphur, growth factors, nutritional requirements of Bacteria. Nutritional uptake and transport. Nutritional classification of Bacteria. Culture media preparation. Types of media - Selective media, Enrichment media and Differential media.

Molecular Systematic: Polyphasic approach –16S rRNA gene sequencing, Phylogenetic grouping. Mol % G+C analysis, DNA-DNA hybridization, Fatty Acid Methyl Ester (FAME) analysis, peptidoglycan, Isoprenoid and quinines. Microbial Community analysis: DGGE, TGGE, SSCP, T-RFLP, FISH.

Unit III Microbial Metabolism

Influence of environment on microbial physiology. Physical factors – radiations, temperature, pH and pressure. Chemical factors – nutrients, water, C, H, O, N, P, S. Growth factors - amino acids, purines, pyrimidines, nucleosides, nucleotides, vitamins, lipids, inorganic nutrients. Antimicrobial compounds, metabolic inhibitors. Response to environment – growth and reproduction; growth inhibition and death, movement, differentiation. Modification to the environment – changes in chemical composition, changes in physical properties. Quantitative measurement of bacterial growth by cell mass, cell number and cell activity. Maintenance and preservation of cultures.

Unit - IV Methods in Microbiology

Isolation of microbes from various sources - serial dilution, pure culture and culture préservation techniques. Microbial culture collection centers. **Staining techniques** – Simple & differential - Gram, endospore, negative, flagellar staining. **Sterilization**

techniques: 1. Concept of sterilization, disinfection, asepsis and sanitation. Moist heat; dry heat, pasteurization, Richards' rapid method - HTST (high temperature/short time) treatments; filter sterilization. 2. Sterilization methods - batch sterilization, continuous sterilization of medium and air. Physical methods of control - temperature, radiation, desiccation, osmotic pressure and filtration. Chemical methods of control - phenol, alcohol, halogens, heavy metals, dyes, detergents, quaternary ammonium compounds, aldehydes and gaseous chemosterilizers. Evaluation of antimicrobial potency of disinfectants and antiseptics - tube dilution, agar diffusion. phenol coefficient.

Unit V Microbial Genetics

Genetic system of bacteria – transformation, transduction, recombination. Extra cellular genetic material - plasmids and transposons. Genetic systems of viruses – Phage I, RNA viruses and retroviruses. Genetic system of fungi – Yeast and Neurospora. Genetic system of protozoa and mycoplasma. Gene regulation - prokaryotic gene regulation. Operon concept -lac operon and tryptophan operon.

Metagenomics - Culture Independent Studies: Exploring and exploiting the microbial gene pool. Methods to detect and quantify bacteria in various ecological niches. Analysis of microbial communities in microhabitats using FISH. Functional characterization of microbial communities by mRNA analysis. Detection of active bacterial populations in soil.

Text Books

1. Prescott, Harley, Klein. 2003. Microbiology. 5th Edition. McGraw Hill Publ.
2. Bernard R. Glick & Jack J. Pasternak. 2002. Molecular Biotechnology. Indian edition. Panima Publishing Corporation.
3. Pelzer, Chan and Kreig. 1986. Microbiology. 5th Edition. McGraw-Hill.

Reference Books.

1. Tortora, G.J., Funke, B.R. and Case, C.L. 2012. Microbiology - An Introduction. 11th *Edition.* Pearson Education.
2. Stainer, Ingharam, Wheelis and Painter. 1987. General Microbiology. 5th Edition. Macmillan Education, London.
3. A.J. Salle. 1974. Fundamental Principles of Bacteriology. Tata McGraw – Hill Edition.
4. AH Rose. 1977. Chemical Microbiology – An introduction to microbial physiology. Butterworth, London.
5. S. Meenakumari. 2006. Microbial Physiology. MJP Publishers.
6. MT Madigan, JM Martinko and Jack Parker. Brock Biology of Microorganisms. 10th Edition. Pearson and Education Inc., New Jersey.
7. David Freifelder, David M. Freifelder and John E. Cronan. 1994. Microbial genetics. 2nd Edition. Jones & Bartlett Publishers.
8. R.W. Old and S.B. Primrose. 1985. Principles of gene manipulation. Blackwell Scientific Publications.
9. Benjamin Lewin. 2006. Genes IX. 9th Edition. Jones and Bartlett publishers.
10. R.A. Atlas. 1998. Microbiology, Fundamental and Applications. 2nd Edition. McMillan Publishers.
11. Powar and Daginawala. 2010. General Microbiology. Volume – I. Himalaya Publishing House.

*****

CORE COURSE III

BIOCHEMISTRY

Objectives

This paper aims to study the structure, properties and metabolism of different biomolecules and to know the interrelationships between different metabolisms.

Unit I Introduction

Chemical basis of life and composition of living matter. Biomolecules - chemical composition and bonding. Properties of water, acids, gases and buffer. pH, ionization and hydrophobicity. Emergent properties of biomolecules in water and bimolecular hierarchy. Macromolecules and molecular assemblies – relationship between structure and function. Structure and biochemical organization of amino acids, proteins, carbohydrate, fatty acids nucleic acids and vitamins.

Unit II Amino Acids, Proteins and Enzymes

Amino acids - Structure and functional group, properties. Biosynthesis, types, properties and metabolism of amino acids.

Proteins - Peptides and covalent structure of proteins. Elucidation of primary and higher order structures. Ramachandran plot, structural characteristics of protein. Structure - function relationship in model proteins like ribonuclease A, myoglobin, hemoglobin and chymotrypsin. Tools to characterize the expressed proteins.

Enzymes - Nomenclature, classification, properties, structure and functional relationship. Enzyme catalysis and general principles of catalysis. Quantification of enzyme activity and efficiency. Enzyme characterization and Michaelis-Menten kinetics. Relevance of enzymes in metabolic regulation, activation, inhibition and covalent modification. Single substrate and multi-substrate enzymes. Mechanism of action.

Unit III Carbohydrates and Lipids

Carbohydrates - Structure and classification. Sugars - mono, di, and polysaccharides, chemical composition and bonding. Cellular structure, energy storage and signaling. Glycosylation of biomolecules – glycoproteins and glycolipids. Glycolysis, Kreb's cycle, Gluconeogenesis and HMP pathway.

Lipids - Structure, classification and properties. Lipid metabolism. Oxidation - Fatty acids and cholesterol. Biosynthesis of lipids. Lipid storage and membrane lipids. Lipoproteins. Biomembrane organization - sidedness and

function. Membrane bound proteins - structure, properties and function. Transport phenomena of nucleosides and nucleotides.

Unit IV Nucleic Acids and vitamins

Nucleic acids - Structure, diversity and function. Sequencing of nucleic acids. Brief overview of central dogma.

Vitamins - Classification and derivatives. Secondary metabolites from plants.

Unit V Law of Thermodynamics

Bioenergetics - basic principles, equilibrium and concept of free energy, redox potential and their applications. Coupled processes - process of photosynthesis. Logic and integration of central metabolism – entry and exit of various biomolecules from central pathways. Principles of metabolic regulation. Regulatory steps, signals and secondary messengers.

Texts Books

1. L. Lehninger. 2004. Principles of Biochemistry, 4th Edition. W.H Freeman and Company.
2. Stryer. 2002. Biochemistry. 5th Edition. W.H. Freeman and Company.
3. M.N. Chattergea Rana Shinde. 2011. Text book of Medical Biochemistry. 8th Edition.J.P. Medical Ltd.

References Books

1. Donald Voet and Judith G.Voet. 2004. Biochemistry. 3rd Edition. John Wiley, New York.
2. Allan Fershi. 1984. Enzyme structure and mechanism. 2nd Edition. W.H.Freeman & Co. Ltd., USA.
3. Trevor Palmer. 1985. Understanding Enzymes. 2nd Edition. Ellis, Horwood Limited.
4. Victor W. Rodwell, David A Bender, Kathleen M. Botham, Peter J. Kennelly and Anthony P. Weli. 2015. Harper's Illustrated Biochemistry. 30th Edition. Mc Graw Hill Lange Medical Books.

*****

CORE COURSE IV

MOLECULAR BIOLOGY

Objectives

This paper is aimed to understand the basic structure and functioning of the genetic materials – DNA, RNA and to understand the changes in the genetic material and the consequences.

Unit I Introduction

Nucleic Acid, Bases, Nucleoside, Nucleotide Types: Overview of Molecular biology, discovery of DNA as genetic material and structure of DNA - Watson and Crick model. DNA & its types. RNA & its types, structure and function. Chromosomes, chromatin and their function. Prokaryotic replication of DNA/RNA and enzymes involved. DNA repair mechanisms and recombination.

DNA Replication: Prokaryotic and Eukaryotic DNA replication. Mechanism of DNA replication. Enzymes & proteins involved in DNA replication. Models of replication - Semi-conservative, unidirectional, bidirectional, rolling circle mechanism. Inhibitors of DNA replication.

Unit II Central Dogma - Transcription & Translation.

Transcription: Prokaryotic transcription, transcription unit, promoters - constitutive and inducible, operators and regulatory elements. Initiation, elagation, termination, Rho-dependent and independent and anti - termination. Post transcriptional modifications. Processing of hnRNA, tRNA, rRNA, 5' cap formation, 3' end processing and polyadenylation. Splicing, RNA editing, nuclear export of mRNA, mRNA stability and catalytic RNA.

Translation : Translation machinery, ribosomes, composition and assembly. Universal genetic code, degeneracy of codons and termination codons, isoaccepting tRNA and Wobble hypothesis. Mechanism of initiation, elongation and termination. Co and post translational modifications. Transport of proteins and molecular chaperones. Protein stability, protein turnover and degradation.

Unit III Mutation

Mutation. Types - Non sense mutation, missense mutation and point mutations, intragenic and intergenic suppression and frame shift mutations. Physical, chemical and biological mutagens. Transposition, mechanisms of transposition and role of transposons in mutation. Gene as unit of mutation and recombination. Molecular nature of mutation, mutagen and origin of spontaneous mutations. Gene transfer mechanisms - transformation, transduction, conjugation, transfection and their applications. **Regulation in eukaryotes:** gene loss, gene amplification, gene rearrangement. Regulation of synthesis of primary transcripts, transcriptional control by hormones.

Unit IV Extra-chromosomal hereditary materials & transposable genetic elements

Extra-chromosomal hereditary material

Plasmids: Biology of plasmids, discovery, types and structure of R, Rif, Col factors & Ti plasmids. Replication, incompatibility and copy number. Natural & artificial plasmids. Plasmid curing, plasmid transfer and their applications.

Transposable genetic elements: Discovery, early experiments of McClintock in maize. Insertion sequence in prokaryotes. Complex transposons (Tn10, Tn3 & Tn9 as examples). Mechanisms, control, consequences and applications of transposition by simple & complex elements. transposable genetic elements in prokaryotes and eukaryotes and their uses in genetic analysis.

Unit - V Genetic analysis of microbes

Genetic analysis of microbes - bacteria and yeast. Bacteriophages, Lyticphages - T 7and T4. Lysogeneic phages - I and P1, M13 and f X174. Life cycle and their uses of microbial genetics. Microbial genetics and design of vaccines for BCG, TB and leprosy. DNA vaccine, designing and advantages.

Text Books

1. Ajoy Paul. 2011. Textbook of Cell and Molecular Biology. Books and Allied Ltd.
2. Benjamin Lewin. 2007. Gene IX. 9th Edition, Jones and Barlett Publishers.
3. J.D.Watson, N.H. Hopkins, J.W Roberts, J. A. Seitz & A.M. Weiner. 2007. Molecular Biology of the Gene. 6th Edition. Benjamin Cummings Publishing Company Inc.
4. Watson JD, Gilman M, Witkowski J, Zoller M. 1992. Recombinant DNA. Scientific American Books.

References

1. Bruce Alberts, Alexander Johnson. Julian Lewis, David Morgan, Martin Raff, Keith Roberts, Peter Walter. 2014. Molecular Biology of Cell. Garland Science publication.
2. Burton E. Tropp. 2012. Molecular Biology – Genes to Proteins. Jones and Bartlett Publishers.
3. George M. Malacinski. 2013. Freifeder's Essentials of Molecular Biology. Norosa Publishing House.
4. Stanely R. Maloy, Jhon E Cornan Jr, David Freifelder. 1994.Microbial genetics. 2nd Edition. Jones and Bartlett publisher.
5. Uldis N. Streips and Ronalad E. Yasbin. 2002. Modern Microbial Genetics. 2nd Edition. Wiley-Blackwell.
6. Sandy B. Primrose, Richard M. Twyman and Robert W. Old. 2008. Principles of Gene Manipulation. 6th Edition. Blackwell Science.

*****

CORE PRACTICAL I

CELL BIOLOGY, MICROBIOLOGY, BIOCHEMISTRY & MOLECULAR BIOLOGY (P)

Objectives

In this course the students will get hands on experience in Cell Biology, Microbiology, Biochemistry & Molecular Biology Techniques.

Cell Biology

1. Microtomy – (Demo).
2. Prokaryotic & eukaryotic cell - structure observation.
3. Cell count - prokaryotic & eukaryotic.
4. Types of cells - parenchyma, collenchyma, sclerenchyma, columnar epithelium, squamous epithelium.
5. Leishman staining
6. Giemsa staining
7. Total (WBC, RBC) & differential count of human blood cells.
8. Separation of Peripheral Blood Mononuclear Cells from blood.
9. Osmosis and Tonicity.
10. Cell Division - Cytological preparations of tissues (onion) for mitosis.
11. Cell Division - Cytological preparations of tissues (Tradescantia) for meiosis.
12. Cell Division - Binary fission of yeast
13. Polytene and diplotene chromosomes.
14. Temporary and permanent slide preparation.
15. Sub-cellular fractionation.

Microbiology

1. Microscopy - Observation of different microbes.
2. Sterilization techniques – physical, chemical, filtration and irradiation techniques.
3. Preparation of media - simple media and complex media.
4. Isolation of microorganisms from air, soil & water - spread plate, pour plate, streak plate techniques
5. Staining methods – simple, differential, acid - fast & negative
6. Identification - Macroscopic, microscopic, biochemical, serological & generic level.
7. Bacterial growth curve - colony counting, cell counting, spectrophotometric method.
8. Preservation & maintenance.
9. Antibiotic sensitivity test – Kirby - Bauer method.

Biochemistry

1. Preparation of solutions – Molar, Normal, Percentage, Stock, Working etc.
2. Preparation of buffers – PBS, Tris and Acetate buffer.
3. Identification of sugars - reducing & non-reducing sugars.

4. Estimation of mono saccharine (glucose) by Nelson, Somogi method & polysaccharide (starch) by iodine method.
5. Estimation of amino acid by Ninhydrin method.
6. Estimation of protein by Lowry's method and Barford Method
7. Estimation of nucleic acids by absorbance at 260 nm and hyperchromic effect.
8. Enzyme assay: Estimation of salivary amylase from saliva & phosphatase from potato
9. Estimation of DNA by diphenylamine and RNA by orcinol method.
10. Estimation of lipids - cholesterol, PUFA & steroid.
11. Estimation of vitamins – ascorbic acid, α-tocopherol & β – carotenoids.

Molecular Biology

1. Isolation and purification of genomic DNA from prokaryotes.
2. Isolation and purification of genomic DNA from eukaryotes.
3. Isolation and purification of plasmid DNA.
4. Observation of DNA - Agarose gel electrophoresis.
5. Quantification of nucleic acids – DNA & RNA – Chemical and UV method.
6. Separation of protein by SDS PAGE
7. Protein staining techniques. Amido black, coomosic brilliant blue & $AgNO_3$.
8. Transfer of protein - Western blot.
9. Observation of transferred protein – staining (Indian ink), immunoblot.
10. Bacterial mutagenesis – physical & chemical.
11. Preparation of *E. coli* competent cells.
12. Transformation of bacteria – $CaCl_2$ method.
13. Bacterial conjugation.
14. Transduction.

Reference Books

1. S.Sadasivam., A. Manickam. 1996. Biochemical Methods. 2nd Edition. New Age International (p) Ltd, Publishers.
2. Dr. G.Rajagobal., Dr. B.D.Toora. 2001. Practical Biochemistry. 1st Edition. Ahuja Book Company Pvt.Ltd.
3. J.Jayaraman. 2000. Laboratory Manual in Biochemistry. New Age International Publishers.
4. Plummer Mu, David T. Plummer. 1988. Introduction to Practical Biochemistry. Tata McGraw-Hill Education.
5. Gunasekaran, P. 2009. Laboratory Manual in Microbiology. 1st Edition. New Age International Publishers. Reprint 2009.
6. Dr. T. Sundararaj. Microbiology Laboratory Manual. Dr.A.L. MPGIBMS, University of Madras, Taramani, Chennai – 600 113.
7. Arnold L. Demain & Julian E. Davies. 1999. Manual of Industrial Microbiology and Biotechnology. 2nd Edition. ASM press.
8. M. Mooyoung. 1985. Comprehensive Biotechnology. Vol. 2, 3 & 4. Pergamon press.
9. Dr. David A Thompson. 2011. Cell and Molecular Biology Lab Manual.

*****

CORE COURSE V

rDNA TECHNOLOGY

Objectives

This paper is aimed to study the various principles underlying genetic engineering that forms the basis of rDNA technology and to study the methodologies, and in brief the applications and related issues of rDNA technology.

Unit I Basics Concepts

DNA structure and properties. Restriction enzymes, DNA ligase, klenow enzyme, T4 DNA polymerase, polynucleotide kinase, alkaline phosphatase, cohesive and blunt end ligation, linkers, adaptors and homopolymeric tailing. Labeling of DNA - nick translation, random priming, radioactive and non radioactive probes, hybridization techniques - northern, southern and colony hybridization, fluorescence *in- situ* hybridization, chromatin immuno-precipitation, DNA - protein interactions, electromobility shift assay, DNeI foot printing and methyl interference assay.

Unit II Cloning Vectors

Plasmids, bacteriophages, M13 mp vectors, PUC19 and blue script vectors. Phagemids, lambda phage vectors, insertion and replacement vectors, EMBL, cosmids, artificial chromosome vectors (YAC, BAC), animal virus derived vectors - SV40, vaccinia/bacculo & retroviral vectors. Expression vectors – pMal, GST and pET based vectors. Protein purification. his-tag, GST-tag, MBP-tag etc., intein-based vectors, inclusion bodies, methodologies to reduce formation of inclusion bodies, baculovirus and pichia vectors system, plant based vectors, Ti and Ri as vectors, yeast vectors and shuttle vectors.

Unit III Cloning Methodologies

Insertion of foreign DNA into host cells, transformation, construction of libraries, isolation of mRNA and total RNA. cDNA and genomic libraries, cDNA and genomic cloning, expression cloning and protein-protein interactive cloning. Yeast two hybrid system, phage display and principles in maximizing gene expression.

Unit IV PCR and its Applications

Primer design, fidelity of thermostable enzymes, DNA polymerases, types of PCR - multiplex, nested, reverse transcriptase, real time, touchdown, hot start, and colony. Cloning of PCR products, T-vectors, proof reading enzymes, PCR in gene recombination, deletion, addition, overlap extension, and site specific mutagenesis. PCR in molecular diagnostics, viral and bacterial detection, PCR

based mutagenesis, mutation detection - SSCP, DGGE, RFLP, oligo ligation assay (OLA), Mismatch Chemical Cleavage (MCC), Allele-Specific Amplification (ASA) and Protein Truncation Test (PTT).

Unit V Sequencing Methods

DNA sequencing - Enzymatic, chemical & automated DNA sequencing and RNA sequencing. Chemical synthesis of oligonucleotides, introduction of DNA into mammalian cells, and transfection techniques. Gene silencing techniques, introduction to siRNA, siRNA technology, micro RNA, construction of siRNA vectors, principle and application of gene silencing. Gene knockouts and gene therapy, creation of knockout mice, disease model, somatic and germ line therapy – *in-vivo* and *ex-vivo*, suicide gene therapy, gene replacement and gene targeting. Transgenics, cDNA and intragenic arrays, differential gene expression and protein array.

Text Books

1. S.B. Primrose, R.M. Twyman and R.W.Old. 2001. Principles of Gene Manipulation. 6th Edition. S.B.University Press.
2. J.D. Watson, N.H. Hopkins, J.W Roberts, J. A. Seitz & A.M. Weiner. 2007. Molecular Biology of the Gene. 6th Edition. Benjamin Cummings Publishing Company Inc.
3. Watson JD, Gilman M, Witkowski J, Zoller M. 1992. Recombinant DNA. Scientific American Books.

Reference Books

1. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter. 2002. Molecular Biology of the Cell, 4th Edition. Garland Sciences.
2. Stanley Maloy 1994. Microbial genetics. 2nd Edition. Jones and Bartlett publisher.
3. Uldis N. Streips and Ronalad E. Yasbin. 2002. Modern Microbial Genetics. 2nd Edition. Wiley-Blackwell.
4. Sandy B. Primrose, Richard M. Twyman, Robert W. Old. 2008. Principles of Gene Manipulation. 6th Edition. Blackwell Science.
5. *Brown TA. 2008. Genomes. 3rd Edition.* New York: Garland Publishing Co. New York: *Garland Science.*

*****

CORE COURSE VI

IMMUNOLOGY

Objectives

This paper is aimed to understand the basic concepts of immune system, elucidate the immune response of humans to foreign substances and to study the modern techniques of immunology that help determine human protection.

Unit I Fundamental Concepts and Anatomy of the Immune System

Terminology – Antigen, immunogen, hapten, allergen, tolarogen, super antigens, antibody, immunoglobulin, antigenigity, immunogenicity. Self & nonself, innate & acquired immunity. Haematopoesis. Organs, tissues, cells and mediators of immune system - primary lymphoid organs, secondary lymphoid tissues, lymphocytes, cytokines and lymphokines. Lymphatic system, lymphocyte circulation and lymphocyte homing. Mucosal and Gut associated lymphoid tissue (MALT&GALT) and mucosal immunity. Principles of cell signaling.

Unit - II Immune Responses Generated by B and T lymphocytes

B cell: B cell development, maturation, activation and differentiation. B cell receptor and determinants. B cell subsets. Immunoglobulins - basic structure, classes & subclasses of immunoglobulins, antigenic determinants, multigene organization of immunoglobulin genes and immunoglobulin super gene family. Generation of antibody diversity.

T cell: T cell development, maturation, activation and differentiation. T cell receptor and determinant. T cell subsets. TCR complex. Antigen processing and presentation - endogenous antigens, exogenous antigens, non-peptide bacterial antigens Cell to cell co-operation and hapten-carrier system.

Unit - III Immune Response

Recognition & response: Non specific and Specific. **Nonspecific**: Natural built-in barrier, phagocytosis. Complements, natural killing, inflammatory response. **Specific:** HI & CMI. Antigen recognition and response. Major Histocompatibility Complex - MHC genes, MHC in immune responsiveness and disease susceptibility. HLA typing. Kinetics of immune response and memory. **Unresponsiveness:** tolerance, suppression and potentiation.

Unit - IV Vaccinology

Active, passive and combined immunization. Live, killed, attenuated, plasma derived, sub unit, recombinant DNA, protein based, plant-based, peptide, anti-idiotypic and conjugate vaccines – production & applications. Role and

properties of adjuvants & ISCOMS. Antibody genes and antibody engineering - chimeric and hybrid monoclonal antibodies, catalytic antibodies and generation of immunoglobulin gene libraries.

Unit - V Clinical Immunology

Immunity to infection, bacteria, viral, fungal and parasitic infections (with examples from each group). Hypersensitivity – Type I, II, III and IV. Autoimmunity and types of autoimmune diseases. Mechanism and role of $CD4^+$ T cells, MHC and TCR in autoimmunity. Treatment of autoimmune diseases. Transplantation – immunological basis of graft rejection, clinical transplantation and immunosuppressive therapy. Tumor immunology, tumor antigens, immune response to tumors and tumor evasion of the immune system. Cancer immunology and immunotherapy. Immunodeficiency - primary immuno - deficiencies, acquired or secondary immuno - deficiencies.

Text Books

1. Peter J. Delves, Seamus J. Martin, Dennis R. Burton and Ivan M. Roitt. 2011. Essential Immunology 12th Edition. Wiley - Blackwell. 2. Charles A Janeway, Jr. Paul Travers, Mark Walport, and Mark J Shlomchik. 1999. Immunobiology. 4th Edition. Journal of Current Biology publications.
2. D. M. Weir and John Stewart. 1997. Immunology. 8th Edition. Churchill Livingstone.
3. P.J.Delves, I S.J.Artin, I D.R.Burton and I.M.Roitt. 2006. Essential Immunology. 11th Edition. Wiley - Blackwell.
4. Richard M. Hyde. 2012. Microbiology and Immunology. 3rd Edition. Springer Science & Business Media.

Reference Books

1. Brostoff J, Seaddin JK, Male D and Roitt IM., 2002. Clinical Immunology. 6th Edition. Gower Medical Publishing.
2. Paul William E. 1999. Fundamental of Immunology. 4th Edition. Lippencott Raven.
3. E Roitt. 2011. Essential Immunology. 12th Edition. Blackwell Publication.

*****

CORE PRACTICAL II

rDNA TECHNOLOGY & IMMUNOLOGY (P)

Objectives

By studying this paper the students will get trained in immological techniques and basic molecular biology techniques which are essential for them to know about rDNA technology.

rDNA Technology

Unit V Molecular Biology Techniques

1. Isolation of plasmids – small & large scale.
2. Size analysis of plasmids by agarose gel electrophoresis.
3. Restriction digestion, ligation.
4. Preparation of competent *E.coli* cells & transformation of *E.coli* with recombinant DNA.
5. Selection methods (Blue white selection, insertional inactivation).
6. Primer design and PCR amplification of β(beta)- galactosidase.
7. Cloning of PCR product into pBR322.
8. Introduction of cloned genes and analysis by SDS – PAGE.
9. Southern blotting.
10. RFLP Analysis of 18s rRNA of the genome.
11. Genetic diversity of Pseudomonas by RAPD.
12. Reporter gene assay (GUS/ β(beta)- galactosidase).
13. Northen blotting.

Immunology

Basics - Bleeding, separation of serum, plasma. (Hands on).

Precipitation techniques – Agar gel diffusion, counter immuno-eletrophoresis, single radial immuno-diffusion, rocket immuno-electrophoresis (Hands on).

Agglutination techniques
Blood grouping and Rh factor; Latex agglutination – RF, ASLO, HBsAg and CRP (Hands on); Heme agglutination - RPHA / IHA (Hands on)

Labeled Assays

1. Enzyme Linked Immunosorbent Assay (ELISA) (Hands on).
2. Immunoflouresence (IF) (Hands on).
3. Immunohistochemistry (IH) (Demonstration).
4. Immunoperoxidase (PAP) staining.
5. Radioimmunoassays (RIA) (Theory).

Animal Tissue Culture (Demonstration).

1. Preparation of tissue culture media.
2. Separation of Human PBMC & analysis.
3. Types of culture.
4. Maintenance of culture

***In-vivo* Testing (Theory)**

1. Breeding and maintenance of experimental animals.
2. Surgical and experimental techniques – thymectomy, spleenectomy and harvesting of lymphnodes.
3. Isolation and enumeration of immune reactive cells.
4. Immunization techniques and use of adjuvants.
5. Choice of animals, form and dose of antigen, route of immunization, immunization schedule, bleeding schedule.
6. Collection of blood, separation and preservation of serum / plasma.

Text Books

1. Richard A. Goldsby, Thomas J. Kindt. Barbara, A. Osborne, Janis Kuby. 2003. Immunology. 5th Edition, W. H. Freeman & Company.
2. J. Sambrook and D.W. Russel, CSHL. 2001. Molecular Cloning: A Laboratory Manual, Vols 1-3.Cold spring Harbor Laboratory press.

Reference Books

1. J. W. Goding, Academic Press, 1983. Monoclonal Antibodies: Principles and Practice
2. T.A. Springer. 1985. Hybridoma Technology in the Biosciences and Medicine. Plenum Press New York.
3. F.Brown, R.M.Chanock, KA Lerner. 1986. Vaccines, New Approaches to immunization, Cold Spring Harbor Lab.
4. Topley and Wilson. G. Wilson, A.Miles, M.T.Paker. Arnold, Heineman, 1984. Principles of Bacteriology, Virology and immunology. Willy – Blackwell.
5. J.H.Miller. 1999. A short core courses in bacterial genetics. Cold spring Harbor Laboratory.
6. Brenda D. Spangler. 2002. Methods in Molecular Biology and protein chemistry. John Wiley & sons, Ltd.
7. Bruce Rirren/Eric. D. Green. 1997. Genome Analysis – A laboratory manual – vol I Analyzing DNA. Cold spring Harbor Laboratory press.
8. Sambrook et al., 1989. Molecular cloning: A Laboratory manual vol.I – III Cold Spring Harbor Laboratory.
9. Stanley R.Maloy, Valley.J.Stewart. 1996. Genetic analysis of Bacteria. Cold spring Harbor Laboratory press.
10. John M.S.Barlett, David Stirling. 2003. PCR protocols. Humana press Inc.
11. Robert E.Farrel Jr. 1996. RNA Methodologies. 2nd Edition. Academic press Inc.
12. Frederick M. Ausbel, Roger Breut. 2002. Short protocols in Molecular Biology. Vol I & II, 5th Edition. John Wiley & Sons Inc
13. Micheal,A. Immis, David.H.Gelfand. 1995. PCR Strategies. Academic Press, Inc.

*****

ELECTIVE COURSE I

BIO INSTRUMENTATION

Objectives

This course will give an understanding about the working principles, construction and applications of the instruments often used in the studies related to various disciplines of Biological Sciences.

Unit I Basic Instrumentation (Theory & Demo)

Principles, operation protocol & applications of the following instruments: Weighing balance, pH meter, Polarography, Radioactivity, ECG, FTIR.

Unit II Microscopy (Hands on)

Observation of different microbes. Light – Bright & Dark field; Phase contrast, Inverted Phase contrast; Fluorescent, Electron – TEM & SEM; Confocal

Unit III Spectroscopy (Theory & Demo)

Colorimeter, Spectrometer, UV visible spectrometer, X – ray spectrometer, ELISA reader, Atomic absorption spectrometer, Flame photometer, Flourimeter & Spectro flourimeter.

Unit IV Separation Techniques (Theory & Demo)

Centrifugation - Principle, operation, types & applications.

Chromatography - Principle, operation & applications - Paper – ascending, descending & Circular, TLC, HPTLC, GC, HPLC, Column Chromatography, Ion Exchange & Affinity Chromatography, LC – MS.

Unit V Electrophoresis (Theory & Demo)

Native & denatured - zone, iso-electrofocusing & isotachophoresis, 1D & 2D. PCR, MoldiTof

Reference Books

1. S.SadasivamA. Manickam. 2004. Biochemical Methods. 2nd Edition. New Age International (p) Ltd, Publishers.
2. Dr. G.Rajagopal, Dr. B.D.Toora. 2005. Practical Biochemistry. 2nd Edition. Ahuja Book Company Pvt.Ltd.
3. J.Jayaraman. 2000. Laboratory Manual in Biochemistry. New Age International Publishers.
4. Plummer Mu, David T. Plummer. 1988. Introduction to Practical Biochemistry. Tata McGraw-Hill Education.
5. M. Mooyoung. 1985. Comprehensive Biotechnology. Vol. 2, 3 & 4. 2nd Edition. Pergamon press.

*****

ELECTIVE COURSE II

BIO INFORMATICS

Objectives

By studying this course the students will get an idea about the basic understanding about Bioinformatics, tools, sequences, algorithms and the analysis of phylogenetic tree.

Unit I Basic Bioinformatics

Aim and branches of Bioinformatics. Application of Bioinformatics. Role of internet and www in bioinformatics. Basic biomolecular concepts: Protein and amino acids. DNA & RNA - Sequence, structure and function. NCBI, EBI, ExPASy, RCSB, DDBJ: The knowledge of databases and bioinformatics tools available at these resources. Organization of databases: data contents, purpose and utility. Algorithms; asymptotic analysis of algorithms; NP complete problems; Algorithm types; Brute force; divide and conquer; sorting algorithms.

Unit II Methods of Sequences

Basic concepts of sequence similarity, identity and homology, definitions of homologues, orthologues, paralogues. Introduction to PAM and BLOSUM matrices; basic concept of a scoring matrix, matrices for nucleic acid and proteins sequences, PAM and BLOSUM series; principles based on which these matrices are derived; differences between distance & similarity matrices.

Unit III Tools

Collecting and storing sequences. Various file formats for bio-molecular sequences: GenBank, FASTA, GCG, MSF, NBRF-PIR etc. Database searching: Using BLAST, FASTA and other sequence analysis tools to assign homology; BLAST algorithms, various versions of basic BLAST, application of methods for sequence analysis including the on-line use of the tools and interpretation of results.

Unit IV Dynamic Programming Algorithm

Pairwise alignment methods such as Smith-Waterman and Needleman-Wunsch. Concepts behind multiple sequence alignment; ClustalW, TCoffee. Sequence patterns and profiles: Basic concept and definition of sequence patterns, motifs and profiles, various types of pattern representations viz. consensus, regular expression (prosite-type) and profiles.

Unit V Phylogenetic Analysis

Phylogenetic tree, Neighbour joining, UPGMA. Use of Hidden Markov model (HMM) in assigning homology. Advantages and disadvantages of various sequence analysis methods.

Text Books

1. J. M.Keith. 2008. Bioinformatics. Vol. 1: Data, sequence analysis & evolution. Humana Press.
2. R. Durbin. 1998. Biological sequence analysis. Cambridge University Press.
3. M. Holmes. 2007. A Cell Biologists' guide to modeling and Bioinformatics. Wiley Interscience.
4. R.C. Elston, W.D. Johnson. 2008. Basic biostatistics for geneticists & epidemiologists – A practical approach. Jhon Wiley & Sons Pvt. Ltd.
5. P. R. Bevington. 1969. Data reduction and error analysis for the physical sciences. McGraw Hill.

Reference Books

1. Teresa K. Attwood, David J. Parry –Smith. 1999. Introduction to bioinformatics. 4th Edition. Pearson Education.

*****

CORE COURSE VII

PLANT BIOTECHNOLOGY

Objectives

This course will give an idea about the basic principles and techniques involved in plant cell culture and to understand the concepts of transformation and achievements of biotechnology in Plant systems.

Unit I Basics of Plant Tissue culture

Plant tissue culture techniques. *In-vitro* pollination and fertilization. Embryo culture and its applications. Embryogenesis and organogenesis. Micropropagation, haploids and their applications. Somaclonal variations and applications. Endosperm culture and production of triploids.

Unit II Protoplast – Culture & Genetic Manipulation

Introduction to protoplast isolation, culture and regeneration, methods of fusing protoplasts, somatic hybridization. Protoplast and tissue culture manipulation for genetic manipulation of plants.

Unit III Plant Transgenesis

Agrobacterium mediated gene transfer, *Agrobacterium* based vectors (Ti plasmids and Ri plasmids), viral vectors and their applications. Direct gene transfer methods - electroporation, microinjection and particle bombardment. Characterization of transgenics, screenable and selectable markers. Marker free methodologies and gene targeting.

Unit IV Transgenic plants

Transgenic rice with Vitamin A, transgenic plants with stress tolerance for drought and salinity, crop improvement, herbicide resistance, insect resistance, virus resistance, plants as bioreactors. Genetically modified foods - application, future applications, ecological impact of transgenic plants. Organic food, types of organic food, identifying organic food, organic food & preservatives. Genetic modification in food industry – background, history, controversies over risks, application, future applications.

Unit V Plant Molecular Biology Techniques

Quantitative Real time PCR, Southern blotting, Northern blotting, Western blotting, DNA sequencing methods and their applications. DNA finger printing in plants. Marker assisted selection (MAS) for crop improvement.

Text Books

1. Gamborg O.L and Philips, G.C. 1995. Plant Cell, Tissue and organ culture - Fundamental methods. Narosa Publishing House, New Delhi.
2. Slater A., Scott N.W. and Fowler, M.R. 2008. Plant Biotechnology - the genetic manipulation of plants. 2nd Edition. Oxford University press, USA.
3. H.S. Chawla, 2002. Introduction to Plant Biotechnology. Oxford and IBH P Publishing Co. Pvt. Ltd. New Delhi.
4. Monica. A. Hughes. 1999. Plant Molecular Genetics. Pearson Education limited, England.

Reference Books

1. Phundan Singh. 2013. Principles of Plant Biotechnology. Kalyani Publishers, India.
2. V. Kumaresan. 2015. Applied Plant Biotechnology. Saras Publication, India.
3. Singh. 2014. Plant Biotechnology, 2nd Revised Edition, Kalyani Publishers, India.
4. Harvey Lodish, Arnold Berk, S Lawrence Zipursky, Paul Matsudaira, David Baltimore, and James Darnell. 2000. Molecular cell Biology. 4th Edition, W.H. Freeman & Company.

*****

CORE COURSE VIII

ANIMAL BIOTECHNOLOGY

Objectives

This course is designed to have an understanding about the basics of Animal cell culture, transgenic animals, pest & animal management, Molecular markers and regulations about the use of Biotechnology.

Unit - I Animal Cell, Tissue and Organ Culture

History – Definitions – steps for preparation of cell culture room, culture Environment (Substrate and Media) – Techniques for establishing of cell lines – insect cell culture – organ and embryo culture – cryo
preservation – valuable products. Artificial insemination (IUI, ICSI) – Embryo transfer – cloning (DOLLY, MOLLY and POLLY). Nuclear transplantation, *in-vitro* fertilization technology. Genetic Engineering in animals: Transformation of animal cells – Cloning vectors – Restriction Endonucleases, expression vectors – RTPCR - animal viral vectors and yeast vectors.

Unit – II Transgenic Animals

Development and uses - mice, cattle, goat, fish and sheep and transgenic pets. Tendered meat production. Transgenic breeding strategies – Molecular farming (products with strategic importance). Insulin production using GMO. Embryonic stem cell preservation and its uses in endangered animals.

Unit - III Pest and Animal Management

Juvenile hormone analogues – pheromones and genetic manipulation. Biotechnology of silkworms. Transgenic silk production – Baculo viruses vector and foreign gene expression. Biotechnological approach to the production of live feed. Animal management: cat, dog, pig, horse using appeasing pheromones and their products.

Unit – IV Molecular Markers

Use of nucleic acid probes and antibodies in clinical diagnosis and tissue typing. Mapping of human genome – HGP (Human genome project), RFLP, RAPD and its applications. Genetic engineering approaches for the correction of genetic disorders. Human cloning, Gene silencing. Animal right activities Blue cross in India – Society for prevention of cruelty against animals. Ethical limits of Animal use –Human Rights and Responsibilities. Proteomics in disease biomarkers indentification.

Unit – V Regulating the use of Biotechnology

Regulating DNA technology – DNA barcoding. Regulating food and food ingredients. Human gene therapy. Initial public concerns – accumulation of defective genes in future generation. Future of gene therapy. Patenting Biotechnology inventions – patenting multi-cellular organisms – patenting of fundamental research. Indian and USA patents.

Text Books

1. B Singh, SK Gautam and MS Chauhan. 2015. Textbook of Animal biotechnology. Teri Publication.
2. M.K. Sateesh. 2010. Biotechnology: V: (Including Animal Cell Biotechnology, Immunology and Plant Biotechnology). 2nd Edition. New Age International Pvt. Ltd. Publishers.

Reference Books

1. Harrison, M.S. and Bal, I.R. 1997. General techniques of all culture Cambridge University press.
2. Prasash M. and Arora. C.K.. 1998. Plant tissue culture, Ammol publication Pvt. Ltd.
3. Darling D.C. and Morgan S.J. 1994. Animal cells, culture Media. Wiley, New York.
4. *In-vitro* cultivation of animal cells. 1994. I. ed., Butter worth – Heinemann Ltd.
5. R. Ian Freshney. 2010. Culture of Animal cells & Manual of basic technique. 6th Edition. Wiley – Blakwell publication.
6. Bernard B. Glick, Jack J. Pastunak. 2009. Molecular Biotechnology principles and application of Recombinant – DNA
7. R. Sasidhara. 2006. Animal Biotechnology. MJP publishers
8. Duhcy R.C. 2007. Text book of biotechnology. S.Chand & Company Ltd.
9. Bobert C. Tait. 1997. An Introduction to Molecular Biology. 1st Edition. Horizon Scientific Press.
10. Bobert Matheson. 1994. Entomology- an introductory course. 2nd Edition. Comstock Publishing Company.

*****

CORE PRACTICAL III

PLANT AND ANIMAL BIOTECHNOLOGY (P)

Objectives

This course is planned to give hands on training on plant & animal tissue culture and biotechnology

Plant Biotechnology

1. Introduction to the laboratory and general Safety Practices for plant cell, Plant growth and development. Laboratory Report Guidelines (Theory & Demo).
2. Aseptic culture techniques for establishment and maintenance of cultures (Hands on).
3. Tissue culture media preparation: Preparation of stock solutions of Murashige Skoog basal medium and plant growth regulator stocks (Hands on).
4. Mechanical isolation of protoplast. Enzymatic isolation of protoplast and culture (Hands on).
5. Isolation of plant genomic DNA by modified CTAB method (Hands on).
6. Size analysis of DNA by Agarose Electrophoresis (Hands on).
7. The cell cycle, plant vascular system & Photoperiodism.
8. Transformation of leaf discs with Agrobacterium (Hands on).
9. Expression of foreign genes into plant cells: use of *Agrobacterium tumefaciens* (Theory).
10. Morphogenesis in tobacco leaf tissue (Hands on).
11. Regeneration abilities of the Shoot Apical Meristem (SAM).
12. Preparation of chloroplast from pea (Hands on).
13. Effect of different light wavelengths on germinating corn embryos (Hands on)..
14. Measurement of photosynthesis (Hands on).
15. Stomata conductance & transpiration (Hands on).
16. Separation of thylakoid and stromal proteins by SDS-Gel electrophoresis.
17. Isolation of DNA & RNA from light and dark –grown seedlings.

Animal Biotechnology

1. Isolation of DNA from Animal liver
2. Isolation of DNA from human cheek cells
3. Isolation of DNA from blood
4. Quantification of DNA by spectrophotometeric method
5. Size analysis of DNA by Agarose gell electrophoresis
6. Isolation & identification of stem cells

Reference Books

1. M. S. Clark. 1997. *Plant Molecular Biology:* A *Laboratory Manual.* Springer-Verlag.
2. Slater A., Scott N.W. and Fowler, M.R. 2008. Plant Biotechnology - the genetic manipulation of plants. 2nd Edition. Oxford University press, USA.
3. H.S. Chawla, 2002. Introduction to Plant Biotechnology. Oxford and IBH P Publishing Co. Pvt. Ltd. New Delhi.
4. Monica. A. Hughes. 1999. Plant Molecular Genetics. Pearson Education limited, England.
5. Harrison, M.S. and Bal, I.R. 1997. General techniques of all culture Cambridge University press.
6. Prasash M. and Arora. C.K.. 1998. Plant tissue culture, Ammol publication Pvt. Ltd.
7. Darling D.C. and Morgan S.J. 1994. Animal cells, culture Media. Wiley, New York.

*****

ELECTIVE COURSE III

BIOSTATISTICS, BIOETHICS AND IPR

Objectives

This course is planned to give an understanding about Biostatistics, Bioethics, IPR & Legal Protection, Patent Filing and Infringement and Biosafety.

Unit I Biostatistics

Introduction to Biostatistics – sample, population and statistical inference.
Interval data: construction of histogram; interpretation of histogram, the normal distribution, mean, median, mode and standard deviation. Representing normal curve, uncertainties in estimation of mean, comparison of mean and variance.

Proportion data: examples of proportion data (MPN, sterility testing of medicines, animal toxicity, therapeutic trial of drugs and vaccines, infection and immunization studies) statistical treatment to proportion data. Chi – square data and goodness of fit.

Count data: examples of count data (bacterial cell count, radio activity count, colony and plaque counts) statistical treatment to count data, Poisson distribution, standard error, confidence limits of count.

Unit II Bioethics

Concept, philosophical considerations, epistemology of science, ethical terms, principles and theories and relevance to biotechnology. Ethics and the law issues - genetic engineering, stem cells, cloning, medical techniques, transhumanism and bioweapons. Research concerns - animal rights, ethics of human cloning, reproduction and stem cell research. Emerging issues - biotechnology's impact on society, DNA on the witness stand and use of genetic evidence in civil and criminal court cases. Challenges to public policy, regulations, improving public understanding of biotechnology products to correct misconceptions.

Unit III Introduction to IPR & Legal Protection

Basics of patents, types of patents, Indian Patent Act 1970, recent amendments, filing patent application, precautions before patenting – disclosure and non-disclosure. WIPO treaties, Budapest treaty, PCT and implications, role of a country patent office and procedure for filing a PCT application. Types of IP - patents, trademarks, copyright & related rights, industrial design, traditional knowledge, geographical indications and international framework for the protection of IP. Introduction to history of GATT, WTO, WIPO and TRIPS. Global scenario of patents and Indian position,

patenting of biological materials. IP as a factor in R&D and IP relevance to Biotechnology.

Unit IV Patent Filing and Infringement

Patent application - forms and guidelines, fee structure and time frames. Types of patent applications, provisional and complete specifications, PCT and convention patent applications. International patenting - requirement, procedures and costs. Financial assistance for patenting and introduction to existing schemes. Publication of patents -gazette of India, status in Europe and US. Patenting by research students, lecturers and scientists. University/organizational rules in India and abroad, credit sharing by workers and financial incentives. Patent infringement - meaning, scope, litigation, case studies and examples.

Unit V Biosafety

Introduction and historical background. Introduction to biological safety cabinets, primary containment for biohazards, biosafety levels, biosafety levels of specific microorganisms, recommended biosafety levels for infectious agents and infected animals. Biosafety guidelines by Government of India. Definition of GMOs and LMOs. Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO's applications in food and agriculture. Environmental release of GMOs, risk assessment; risk management and communication. Overview of national regulations and relevant international agreements including Cartagena protocol.

Important Links

1. Bioethics - by Ellen Frankel Paul, Fred D. Miller, Jeffrey Paul, Fred Dycus Miller Cambridge University Press, 2002.
2. Bioethics & Science, John A. Bryant, Linda Baggott la Velle, John F. Searle – 2002.
3. http://www.w3.org/IPR/
4. http://www.wipo.int/portal/index.html.en
5. http://www.ipr.co.uk/IP_conventions/patent_cooperation_treaty.html
6. www.patentoffice.nic.in
7. www.iprlawindia.org/ - 31k - Cached - Similar page
8. http://www.cbd.int/biosafety/background.shtml
9. http://www.cdc.gov/OD/ohs/symp5/jyrtext.htm
10. http://web.princeton.edu/sites/ehs/biosafety/biosafetypage/section3.html
11. http://www.accessexcellence.org/RC/AB/IE/#Anchor-Bioethics-6296 ww.bioethics.net
12. http://www.americanprogress.org/issues/domestic/science?_kk=bioethics
13. http://www.billmuehlenberg.com/2005/09/02/the-stem-cell-debate/

*****

ELECTIVE COURSE IV

BIOTECHNOLOGY FOR ENTREPRENEURS

Objectives

This purpose of this course is to give an understanding about biotechnology based entrepreneurship among students.

Unit I Introduction to Entrepreneurship

Entrepreneurship definition, factors necessary for entrepreneurship, desirables in a startup, mistakes to be avoided, pillars of bio-entrepreneurship, promoting bio-entrepreneurship, biotech company roadmap, legal, regulatory and other business factors.

Unit II Identification of a Project

Project management: Search for a business idea, concept of project and classification, project identification, project formulation, project design and network analysis, project report, project appraisal.

Unit III Assessment of a Project

Financial analysis: Ratio analysis, Investment process, Break even analysis, Profitability analysis, Budget and planning process. Sources of finance: Source of development finance, Project financing, Institutional financing to Entrepreneurs, Financial institutions, Role of consultancy organizations. Marketing channels: Methods of marketing, marketing channels, Marketing institutions and assistance.

Unit IV Generation of Fund

Funding of biotech business (Financing alternatives, VC funding, funding for biotech in India, Exit strategy, licensing strategies, valuation), support mechanisms for entrepreneurship (Bio-entrepreneurship efforts in India, difficulties in India experienced, organizations supporting biotech growth, areas of scope, funding agencies in India, biotech policy initiatives), Role of knowledge centers and R&D (knowledge centers like universities and research institutions, role of technology and upgradation).

Unit V Biotech enterprises

Setting up Small, Medium & Large scale industry, Quality control in Biotech industries, Location of an enterprise, steps for starting a small industry, incentives and subsidies, exploring export possibilities.

Text Books

1. D. Hyne & John Kapeleris. 2006. Innovation and entrepreneurship in biotechnology: Concepts, theories & cases.
2. Richard Dana Ono. 1991. The Buisiness of Biotechnology: From the Bench of the Street. Butterworth- Heinemann.
3. Martin Grossmann. 2003. Entrepreneurship in Biotechnology: Managing for growth from start-up to Initial Public Offering

Reference Books

1. Yali Friedman. 2008. Best Practices in Biotechnology Education. Logos Press.
2. Robert Nicholas Trigiano and Dennis John Gray. 2004. Plant Development and Biotechnology CRC Press. 358 pages.
3. Vasant Desai. 2005. Dynamics of Entrepreneurial Development and Management. 6th Edition. Himalaya Publishing House, 2005.
4. Prasannan. Projects: Planning Analysis, Selection, Implemantation & Review. 7th Edition.

*****

CORE COURSE IX

BIOPROCESS TECHNOLOGY

Objectives

This course is designed to give an idea about the avenues of exploiting microbes and to study the downstream processes for product recovery in fermentation.

Unit I Basic principle of Biochemical engineering

Isolation, screening and maintenance of industrially important microbes. Microbial growth and death kinetics (an example from each group, particularly with reference to industrially useful microorganisms). Strain improvement for increased yield and other desirable characteristics.

Microbial Growth and Preservation

Mathematical expression of bacterial growth, generation time and growth rate. Different phases of growth & growth curve and. Batch, continuous and synchronous cultures. Diauxic growth and factors affecting microbial growth. Stress response. Microbial death curve under adverse conditions.

Unit II Concepts of basic mode of fermentation processes

Bioreactor designs and types of fermentation and fermentors. Concepts & basic modes of fermentation - Batch, fed batch and continuous fermentation. Conventional fermentation versus biotransformation. Solid substrate, surface and submerged fermentation. Fermentation economics and fermentation media. Fermenter design - mechanically agitated, pneumatic and hydrodynamic fermenters. Large scale animal and plant cell cultivation and air sterilization. Upstream processing - media formulation, sterilization, aeration and agitation. Measurement and control of bioprocess parameters, scale up and scale down process.

Unit III Downstream processing

Bioseparation - filtration, centrifugation, sedimentation, flocculation, microfiltration, sonication. Cell disruption – enzymatic lysis and liquid-liquid extraction. Purification by precipitation (ammonium sulfate, solvent), electrophoresis and crystallization. Extraction (solvent, aqueous two phase, super critical) and chromatographic techniques. Reverse osmosis and ultra filtration. Drying, crystallization, storage and packaging. Treatment of effluent and its disposal.

Unit IV Applications of enzymes in food processing

Mechanism of enzyme function and reactions in food processing. Enzymic bioconversions e.g. starch and sugar conversion processes. High fructose corn syrup, hydrolyzed protein and their downstream processing. Baking by amylases, deoxygenation and de-sugaring by glucose oxidase, beer mashing and chill proofing; cheese making by proteases and various other enzyme catalytic actions in food processing.

Unit V Applications of Microbes in food processing and production

Fermented foods and beverages, food ingredients and additives used in fermentation and their purification. Fermentation as a method of preparing and preserving foods. Microbes and their use in pickling, producing colours and flavours, alcoholic beverages and other products. Process wastes - whey, molasses, starch substrates and other food wastes for bioconversion to useful products. Bacteriocins from lactic acid bacteria – production and applications in food preservation.

Text Books

1. Jackson AT. 1991. Bioprocess Engineering in Biotechnology. Prentice Hall, Engelwood Cliffs.
2. Shuler ML and Kargi F. 2002. Bioprocess Engineering: Basic concepts, 2nd Edition, Prentice Hall, Engelwood Cliffs.

Reference Books

1. Young M.M. and Reed. 2004. Comprehensive Biotechnology: The Principles, Applications and Regulations of Biotechnology in Industry, Agriculture and Medicine. Vol 1, 2, 3 and 4. Elsevier India Private Ltd, India.
2. Mansi EMTEL and Bryle CFA. 2007. Fermentation Microbiology and Biotechnology. 2nd Edition, Taylor & Francis Ltd, UK.

*****

CORE COURSE X

FOOD TECHNOLOGY

Objectives

This course is designed to understand the chemical nature and associated microbes of food and to understand the principles of food processing, preservation and manufacture.

Unit I Basics of Food Technology

Food chemistry: constituents of food - contribution to texture, flavour and organoleptic properties of food. Food additives - intentional and nonintentional and their functions. Enzymes in food processing.

Unit II Microbiology of Food

Sources and activity of microorganisms associated with food. Food fermentation & food chemicals. Food borne diseases - infections and intoxications. Food spoilage - causes.

Unit III Food Processing

Raw material characteristics; cleaning, sorting and grading of foods; physical conversion operations - mixing, emulsification, extraction, filtration, centrifugation, membrane separation, crystallization, heat processing.

Unit IV Food Preservation

Use of high temperatures - sterilization, pasteurization, blanching, canning - concept, procedure & application; Low temperature storage - freezing curve characteristics. Factors affecting quality of frozen foods. Irradiation preservation of foods.

Unit V Manufacture of Food Products

Bread and baked foods. Dairy products - milk processing, cheese, butter, ice-cream. Vegetable and fruit products. Edible oils and fats. Meat, poultry and fish products. Confectionery, beverages.

Text Books

1. Crosby, N.T. 1981. Food packaging Materials Applied Science Publishers, London.
2. David, S. Robinson. 1997. Food Chemistry and nutritive value. Longman group, UK.
3. Frazier, W.C. and Westhoff, D.C. 1988. Food Microbiology, 4th Edition. McGram-Hill, New York.
4. Pyke, M. 1981. Food Science and Technology, 4th Edition. John Murray, London.
5. Sivasankar, B. 2002. Food processing and preservation. Prentice Hall, New Delhi.

Reference Books

1. Brenner, J.G., Butters, J.R., Cowell, N.D. and Lilly, A.E.V. 1979. Food engineering operations, 2nd Edition. Applied Sciences Pub. Ltd., London.
2. Desrosier, N.W. and Desrosier, J.N. 1987. The Technology of Food Preservation, CBS Publishers and Distributors, New Delhi.
3. Fennema, O.R. 1976. Principles of food science: Part I, Food chemistry, Marcel Dekker, New York.
4. Lindsay, W. 1988. Biotechnology, Challenges for the flavor and food Industries, Elsevier Applied Science.
5. Shakuntala, N. and Shadaksharaswamy, M. 1997. Foods; Facts and principles. 2nd Edition. New Age International Publishers, New Delhi.

CORE PRACTICAL IV

BIOPROCESS AND FOOD TECHNOLOGY (P)

Objectives

By doing this course the students will get hand on exposure & understand the chemical nature and associated microbes of food and the principles of food processing, preservation and manufacture.

1. Isolation of industrially important microorganisms.
2. Selective isolation of actinomycetes – study their growth characteristics.
3. Isolation and enumeration of lactic acid bacteria.
4. Ethanol production by yeast.
5. Wine production by yeast – setting up a lab experiment.
6. Estimation of alcohol content by colorimetric method and GLC.
7. Enzyme production – amylase production.
8. Production of organic acids – citric acid production by solid state fermentation.
9. Antibiotic production by different strains of microbes (Theory).
10. Test for sensitivity of microorganisms.
11. Down stream processes of enzymes – dialysis.
12. Ion exchange chromatography – drying – cellulose column chromatography.
13. Immobilization of yeast cell by alginate beads
14. Bioassay techniques for antibiotics.
16. Large scale production of organic acids, large scale production of solvents using fermentor (Demo).
17. Visit to Distillery unit; alcohol production and pharmacological industries. Pasteur Institute (Field visit).
18. Isolation & identification microbes from spoiled food.
19. Production of yogurt, butter.

Reference Books

1. E Mans, E.M.T. and C.F.A. Bryce, Taylor and Francis, UK. 2002. Fermentation technology and Biotechnology.
2. Ghose, T.K and P.Ghose. 2003. Biotechnology in India. Springer Publishers, India.
3. Glazer, A.N and H. Nikaido. 1995. Microbial Biotechnology. W.H. Freeman and Co., New York.
4. Stanbury, P.F., A. Whitaker ans S.J. Hall. 1995. Principles of fermentation Technology, Pergamon, UK.
5. Wolf. Cruzer and Annalise Cruzer. 2000. Biotechnology Text Book of Industrial Microbiology. Panima Publishing House, New Delhi.
6. Patel, A.H. 2001. Industrial Microbiology, Mac-Millan India Ltd.

*****

ELECTIVE COURSE V

ENVIRONMENT BIOTECHNOLOGY AND NANOTECHNOLOGY

Objectives

This course to planned to give an idea about Pollution, types of pollution, management to waste. Synthesis of nanomaterials, charecterisation and their application is also planned.

UNIT I Introduction to Pollution

Introduction - Types of pollution – Air, water, sound pollution. Measurement of pollution. Global environmental problems - ozone depletion, green house effect and acid rain. Control of pollution through Biotechnology.

UNIT II Water Pollution

Water management, measurement and sources of water pollution. Waste water treatment - physical, chemical and biological treatment processes. Biotechnological approaches for industrial waste water treatment - dairy, distillery, tannery, sugar, and pharmaceutical industries. Biodegradation of inorganic and organic wastes, lignin, tannin. Bioremediation of oil spills. Biomonitoring of water pollution using algae, bacteria, plankton, macrophytes, invertebrates, fishes (Bioindicators). Management for effluent toxicity, heavy metal pollution, thermal and radioactive pollution.

UNIT III Solid waste management

Types of solid wastes. Solid waste characteristics and its impact on environment. Solid waste disposal - land filling, incineration, composting, mushroom farming, vermiculture and biogas production. Processing of sugar factory wastes, residential and municipal wastes, coir wastes and mycostraw wastes. Biodegradation of xenobiotics compounds. Biotechnological methods for hazardous waste management.

Conservation Biotechnology: Biodiversity - types, uses and values. Loss of Biodiversity. Conservation and sustainable management of Biodiversity - In *situ* and *Ex-situ* ecorestoration. Environmental and biodiversity laws, environmental education.

UNIT IV Synthesis of Nano Materials & Characterisation

Definition of a nano system - dimensionality and size dependent phenomena, Quantum dots, Nanowires and Nanotubes, 2D films. Methods for synthesis of Nanoscale Materials. Aspects of Nanofluidics. Basic concepts and properties of nanostructured materials. Gold Nanoparticles. Nanopores.

Characterisation of Nanomaterials: Scanning electron microscopes, transmission electron microscopes, scanning probe microscopy, atomic force microscopy, scanning tunneling microscope, Scanning Non-linear Dielectric microscopy, Nuclear Magnetic Resonance Spectroscopy, Nuclear Quadrupole Resonance Spectroscopy Mossbauer & Microwave Spectroscopy and Electron Spin Resonance Spectroscopy, IR & Raman Spectroscopy.

UNIT V Applications of nanotechnology

Nanosensors - types and its applications. Nanocarriers for Drug Delivery - Polymeric Nanoparticles as Drug Carriers. Micelles for Drug Delivery. Micro-array and Genome Chips. Polymer Micelles as Drug Carriers. Microemulsions as Drug Delivery Vehicles. Lipoproteins as Pharmaceutical Carriers. Solid Lipid Nanoparticles as Drug Carriers. Nanocapsules – preparation, characterization and therapeutic Applications. Nanomedicine - Bio-Pharmaceuticals, Implantable Materials, Implantable Devices, Surgical Aids, Diagnostic Tools, Genetic Testing, Imaging, Nanoparticles Probe. Nanotechnology for Cancer Research and Therapy. Nanotechnology for Imaging and Detection. Environmental Nano Remediation Technology - Thermal, Physico-Chemical, and Biological Methods. Nano Filtration for the Treatment of Wastes, Removal of Organics, Inorganics and Pathogens. Nanotechnology for Water Purification.

Text Books

1. Jogdand, S.N. 1995. Environmental Biotechnology. 1st Edition. Himalaya Publishing House, Bombay.
2. Technoglous, G., Burton, F.L. and Stensel, H.D. 1995. Wastewater Engineering – Treatment, Disposal and Reuse. 3rd Edition. Metcalf and Eddy, Inc., Tata Mc Graw Hill, New Delhi.
3. Jain, K.K. 2006. Nanobio-Technology in Molecular Diagnostics: Current Techniques and Applications. Horizon Biosciences, India.
4. Parag Diwan and Ashish Bharadwaj. 2006. Nano Medicines Pentagon Press. ISBN 81-8274-139-4.

Référence Books

1. Alan Scragg. 1999. Environmental Biotechnology. Pearson Education Limited, England.
2. De, A.K. 2004. Environmental Chemistry. Wiley Eastern Ltd. New Delhi.
3. Allsopp, D. and K.J. Seal. 1986. Introduction to Biodeterioration. ELBS/Edward Arnold, London.
4. Ratner, M. and Ratner, D. 2005. Nanotechnology: A Gentle Introduction to the Next Big idea. Pearson Education, Inc. NJ, USA.
5. Christef M. Niemeyer, C. A. Mirkin. 2004. Nanobiotechnology: Concepts, Application and Properties. Wiley – VCH Publishers, New York.
6. Tuan Vo-Dinh. 2007. Nanotechnology in Biology and Medicine: Methods, Devices and Applications. Taylor and Francis Inc., London.
7. Pradeep, T. 2006. NANO. Tata McGraw Publishers, New Delhi, India
8. Challa S.S.R. Kumar (Ed). 2006. Biological pharmaceutical Nanomaterial, Wiley-VCH Verlag Gmbh & Co, KgaA. Weinham, Germany.
9. Vladimir P.Torchilin (Ed.). 2006. Nanoparticulates as Drug Carriers. Imperial College Press, North Eastern University, USA. ISBN 1-86094.

*****