

**BHARATHIAR UNIVERSITY, COIMBATORE.**  
**M. Sc. BIOTECHNOLOGY DEGREE COURSE (AFFILIATED COLLEGES)**  
**(Effective from the academic Year 2014 - 2015 onwards)**  
**SCHEME OF EXAMINATIONS**

Sem.	Study Components Course title		Ins. Hrs/ week	Exam				Credit
				Dur.	CIA	Un. exam	Total	
I	Paper I	Molecular Biology and Genetics	4	3	25	75	100	4
I	Paper II	Applied Biochemistry	5	3	25	75	100	4
I	Paper III	Applied Microbiology	4	3	25	75	100	4
I	Paper IV	Bioinstrumentation & Biostatistics	4	3	25	75	100	4
I	Practical I		5	-	-	-	-	-
I	Practical II		4	-	-	-	-	-
I	Elective	Elective paper I	4	3	25	75	100	4
II	Paper V	Immunology & Immunotechnology	5	3	25	75	100	4
II	Paper VI	Genetic Engineering	4	3	25	75	100	4
II	Paper VII	Plant Biotechnology	4	3	25	75	100	4
II	Paper VIII	Animal Biotechnology	4	3	25	75	100	4
II	Practical I		5	6	40	60	100	4
II	Practical II		4	6	40	60	100	4
II	Elective	Elective paper II	4	3	25	75	100	4
II	Industrial Training		-	-	-	-	-	-
III	Paper IX	Bioprocess Technology	4	3	25	75	100	4
III	Paper X	Pharmaceutical Biotechnology	4	3	25	75	100	4
III	Paper XI	Genomics & Proteomics	4	3	25	75	100	4
III	Paper XII	Bio-entrepreneurship	4	3	25	75	100	4
III	Practical III		5	-	-	-	-	-
III	Practical IV		5	-	-	-	-	-
III	Elective	Elective Paper III	4	3	25	75	100	4
III	Industrial Training		-	-	50*	-	50*	2
IV	Project		16	-	-	-	200**	8
IV	Practical III		5	6	40	60	100	4
IV	Practical IV		5	6	40	60	100	4
IV	Elective	Elective Paper IV	4	3	25	75	100	4
Total							2250	90

**\* Industrial Training has to be undergone during II semester vacation period.**

**Mark shall be given based on training report and presentation**

**\*\* For Project report – 160 marks, Viva-voce – 40 marks.**

**List of Group Elective papers (Colleges can choose any one of the Group papers as electives)**

<b>Paper/ Sem</b>	<b>GROUP A</b>	<b>Group B</b>
I	Occupational health and industrial safety	Plant system Physiology
II	Bioethics, biosafety and IPR	Animal System Physiology
III	Biotechniques	Developmental Biology
IV	Conservation biology	Evolution and behavior

**PROJECT GUIDELINS**

- 1) Project is pertain to the field of Biotechnology
- 2) Three review meetings should be conducted at regular intervals in the presence OF HOD and respective guide. The review should evaluate for a maximum of 30 marks.

<b>Review</b>	<b>Maximum Marks</b>
<b>I Review</b>	<b>30</b>
<b>II Review</b>	<b>30</b>
<b>III Review</b>	<b>30</b>

<b>Dissertation evaluation by External Examiner</b>	<b>70</b>
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<b>Viva-voce</b>	<b>40</b>
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**Note : The syllabus for the Elective papers be the same as prescribed for the academic year 2012-13.**

## PAPER I

### MOLECULAR BIOLOGY AND GENETICS

**Objective of the subject:** This paper provides insight on replication, transcription and translation processes in prokaryotes and eukaryotes, various mutations, their repair mechanisms. The major objective of the paper is to provide knowledge of molecular biology and genetics of prokaryotic and eukaryotic organisms to the students. Helps the student understand and apply this knowledge in research to study the molecular mechanism of mutation, repair in eukaryotes and prokaryotes.

#### UNIT I:

Gene Structure: Fine structure of gene, split genes, pseudogenes, overlapping genes and multigene families. DNA and RNA as genetic material; Chemistry and structure of DNA. Chromosome- structure, organization, banding, karyotyping, and labeling. Special types of chromosome - sex chromosomes, B-chromosome, polytene and lambrush chromosomes; Numerical and structural changes in the chromosome, Techniques in the study of chromosomes and applications.

#### UNIT II:

DNA replication in prokaryotes and eukaryotes: mechanism of replication, Transcription: initiation, elongation and termination (rho-dependent and independent) of RNA synthesis; eukaryotic promoters, enhancers, transcription factors, RNA polymerases; various protein motifs involved in DNA-protein interactions during transcription. Translation: Prokaryotes and eukaryotes translation and their regulation, processing of mRNA for translation (e.g. 5' capping and splicing) and involvement of different translational factors at different stages of the process. Regulation of gene expression in prokaryotes and eukaryotes.

#### UNIT III:

Gene Mutation and its mechanism ; Types of mutation: Forward; Reverse; Intragenic suppressor; Extragenic suppressor; point mutations; Missense; Nonsense; Somatic versus germinal mutation. Mutagenesis- spontaneous and induced. DNA repair mechanisms- direct reversal; Excision repair (base excision, nucleotide excision and mismatch); recombinational repair; SOS response and SOS bypass. Recombination - Models; Rec A, RecBCD, Ruv ABC, and molecular mechanism of recombination. Conjugation; transformation and transduction. Transposons - simple and complex in prokaryotic and eukaryotic systems.

#### UNIT IV:

Prenatal diagnosis of genetic diseases- amniocentesis, DNA probes in the diagnosis of infectious diseases; Tuberculosis, Malaria and AIDS. DNA probes in diagnosis of genetic diseases: Cystic fibrosis, Sickle cell anemia, Cancer, Diabetes, Obesity. Pedigree studies: Symbols used in pedigree analysis. Pedigree analysis of important genetic diseases like Haemophilia, Color blindness, Duchennemuscardystrophy (DMD). Human genome project.

#### UNIT V:

Introduction to Epigenetics: Gene expression without a change in DNA sequence changes in gene expression arising from chemical modification of DNA or histone proteins. Genes for

development in Drosophila, Genes for development in Arabidopsis, Fertilization and development; genetic control of X inactivation; in vitro fertilization and embryo transfer.

### REFERENCES:

1. Genes VI - Benjamin Lewin. Published by Oxford University Press, U.K., 1997. Edition: 6.
2. Molecular Cell Biology- Darnell, Lodish, Baltimore. Published by Scientific American Books, Inc., 1994.
3. Genomes 2 -T A Brown. Published by Garland Science Publishing, New York. 2002.
4. Genetics: A Conceptual Approach by Benjamin A Pierce. Published by Freeman and Company, New York. 2005. Edition: 2.
5. Cell and Molecular Biology - Gerald Karp. Published by John Wiley, 2009 Edition: 6.
6. Molecular Biology of the Cell - Alberts, Bruce et al. Published by Garland Science, Taylor & Francis, 2002, Edition: 4.
7. William S. Klug & Michael R. Cummings 1996. Essentials of Genetics, 2<sup>nd</sup> Ed, Prentice Hall Internationals.
8. Daniel L. Hartl & Elizabeth W. Jones, 1999. Essential Genetics, 2<sup>nd</sup> Ed., Jones & Bartlett Publishers.
9. Robert H. Tamarin, 2002. Principles of Genetics, 7<sup>th</sup> Ed, TaTa McGraw-Hill Edition, New Delhi, India.

## PAPER II - APPLIED BIOCHEMISTRY

**Scope:** This paper presents the study of identification and quantitative determination of the substances, studies of their structure, determining how they are synthesized metabolized and degraded in organisms, and elucidating their role in the operation of the organism.

**Objective:** On the successful completion of the course the students will get an overall understanding of structure of atoms, molecules and chemical bonds, enzyme kinetics, bio polymers and metabolic reactions in a living system.

**Goal:** This paper in biochemistry has been designed to provide the student with a firm foundation in the biochemical aspects of cellular functions which forms a base for their future research.

### UNIT I

Structure of atoms, molecules and chemical bonds; Classes of organic compounds and functional groups. Covalent and Noncovalent interactions - Van der Waals, Electrostatic, Hydrogen bonding and hydrophobic interactions; Respiration and photosynthesis.

Energy metabolism (concept of free energy); Principles of thermodynamics; Kinetics, dissociation and association constants; bioenergetics.

### UNIT II

Enzyme kinetics (negative and positive cooperativity); Regulation of enzymatic activity; Enzyme catalysis in solution, kinetics and thermodynamic analysis, effects of organic solvents on enzyme

catalysis and structural consequences. Active sites; Enzymes and coenzymes: Coenzymes interactions: activators and inhibitors, kinetics of enzyme inhibitors, isoenzymes, allosteric enzymes; Ribozyme, hammer head, hair pin and other ribozymes, strategies for designing ribozymes. Abzyme: structure and drug targets (enzymes and receptors).

### **UNIT III**

Carbohydrates, Polysaccharides - classification and reactions.: occurrence, isolation, purification, properties and biological reactions. Structural features of homoglycans, heteroglycans and complex carbohydrates Glycolysis and TCA cycle; Glycogen breakdown and synthesis; Gluconeogenesis; interconversion of hexoses and pentoses: Co-ordinated control of metabolism; Biosynthesis of purines and pyrimidines; Oxidation of fatty acids; Biosynthesis of fatty acids; Triglycerides; Phospholipids; Sterols.

### **UNIT IV**

Primary structure of proteins, structural comparison at secondary and tertiary levels (Ramchandran map), conformation of proteins and polypeptides (secondary, tertiary, quaternary and domain structure), Purification and criteria of homogeneity: protein folding-biophysical and cellular aspects.

Nucleic acids: Structure of double stranded DNA (B, A, C, D, T and Z DNA). The biological significance of double strandedness, sequence dependent variation in the shape of DNA. Physical properties of double stranded DNA, types of RNAs and their biological significance. DNA bending, DNA supercoiling. Conformational properties of polynucleotides, secondary and tertiary structural features and their analysis.

Biochemistry and molecular basis of different disorders related to carbohydrate, protein fat and nucleic acids, Inborn errors of metabolism, Clinical manifestations and their precautions by nutritional management.

### **UNIT V**

Drug, toxin and venoms- types and chemistry. Allergens, Carcinogens. Plant products as a toxicant or medications. Drug metabolism, excretion. Environmental sources of toxicity, Clinical manifestations and precautions. Toxicity studies, LD50, ED50, EC50. Possible sites for drug targets, Drug resistance. Drug development; Prodrug delivery using enzymes; Bioluminescence

Oncology - Cancer markers for oral cancer. Prostate cancer, Colorectal cancer, breast cancer and gastrointestinal tract cancer. Alpha fetoproteins, carcino embryonic antigens, leukemia. Radioisotopes & their clinical applications.

### **REFERENCES:**

1. Biochemistry- Donald Voet, Judith G. Voet, Published by J. Wiley & Sons, 2010, Edition: 4.

2. Harper's Illustrated Biochemistry- Robert K. Murray, Darryl K. Granner, Peter A. Mayes, Victor W. Rodwell, Published by McGraw-Hill Professional, 2012, Edition: 29.
3. Biochemistry- Geoffrey L. Zubay, Published by Wm.C. Brown Publishers, 1993, Edition: 3.
4. Lehninger principles of biochemistry- Albert L. Lehninger, David Lee Nelson, Michael M. Cox, Published by W.H. Freeman, 2008, Edition: 5.
5. Biochemistry- Jeremy Mark Berg, John L. Tymoczko, Lubert Stryer, Published by W. H. Freeman, 2006, Edition: 6.
6. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry-Trevor Palmer, Published by Horwood Publishing Limited, 2001, Edition: 5.
7. Fundamentals of clinical chemistry – Teitz, W.B.Saunders company, 1994
8. Practical clinical biochemistry, volume I and II, 5th edition – Varley et.al., CBS Publishers, 1980.
9. Clinical chemistry in diagnosis and treatment 6th edition – Mayne, ELBS Publications, 1994
10. Teitz text book of clinical biochemistry 3rd edition – Burtis et al., William Heinmann medical books, Ltd., 1999
11. Clinical biochemistry – Metabolic and clinical aspects, Pearson Professional Ltd.1995
12. Clinical chemistry 5th edition – Mosby, Marshall, 2004
13. Clinical chemistry – principles, procedures and correlations, Bishop, Lippincott, 2000

## PAPER III

### APPLIED MICROBIOLOGY

**Subject description:** This course presents the morphology, biochemical, physiological characteristics of microorganisms, and presents the principles and the applications of microorganisms.

**Goals:** To make the student understand the concept of the biology of microorganisms and its applications.

#### **Objectives:**

On successful completion of the subject, the students will be aware of basic microbiology, and production of useful biomaterials from microorganisms.

#### **Contents:**

#### **UNIT I: Introduction to Microbiology**

History of Microbiology - Ultra structure of Bacterial cell - Growth phases - Generation time. Kinetics of growth, Batch culture, Continuous culture, Synchronous culture (definition and brief description). Physical factors influencing growth - Temperature, pH, osmotic pressure, salt concentration. Classification of algae, protozoa and fungi. General properties and outline classification of viruses - structure and properties of T4 phage, Tobacco mosaic virus and HIV. Pure culture techniques. Control of growth of microorganisms. Working principle and construction of bright field, dark field, phase contrast and Electron microscopy.

#### **UNIT II: Food Microbiology**

Normal microflora in milk, meat, poultry, eggs, fruits and vegetable; Fresh food, canned food and stored grains; Milk quality tests; Preservation of food: High temperature (Boiling, Pasteurization, Appertization), Low temperature (Freezing), Dehydration, Osmotic Pressure. Chemical Preservations, Radiation. Microbiologically Fermented food: Curd, Cheese, Idli, Yogurt, Acidophilic Milk. Microorganisms as food - SCP: *Spirulina* and Edible mushrooms; Food borne diseases: Salmonellosis - Shigellosis.

#### **UNIT III: Industrial Microbiology**

Primary screening & secondary screening of industrially important strains; Strain improvement through random mutation (random & rational selection), genetic recombination and genetic engineering; Preservation. Microbial production of organic acids - citric acid; antibiotics - Penicillin & Streptomycin; enzymes- amylase and Lipase; vitamins - B12; Alcoholic beverage - Beer; Production of native and recombinant proteins in bacteria and yeast - vaccine production in microbes

#### **UNIT IV: Environmental Microbiology**

Brief account of microbial interactions (symbiosis, neutralism, commensalism, competition, ammensalism, synergism, parasitism, and predation); Biological nitrogen fixation - symbiotic

and asymbiotic; Biofertilizers, Biological Pest control. Plant disease (brown spot of rice, black stem rust of wheat) dissemination and control. Carbon, Nitrogen, Phosphorus, and Sulphur cycles. Different types of microorganisms in the air, aerosols, sampling techniques. Coliform test - detection of faecal and non-faecal coliform.

#### **UNIT V: Waste water treatment**

Waste water collection, Physico-chemical properties of water, physical, chemical and biological treatment processes. Activated sludge, oxidation ditches, trickling filter, towers, rotating discs, rotating drums, oxidation ponds. Anaerobic digestion, anaerobic filters, up flow anaerobic sludge blanket reactors.

**Xenobiotics:** Ecological considerations, decay behaviour and degradative plasmids; hydrocarbons, substituted hydrocarbons, oil pollution, surfactants, pesticides. Bioremediation of contaminated soils and wastelands.

Mineral leaching by microorganisms.

#### **REFERENCES:**

1. Principles of Microbiology - Atlas R M, WCB McGraw Hill Publications, New Delhi, 1997, Edition: 2.
2. Microbiology: Principles and Explorations - Black J G, Prentice Hall International, Inc. 1999, Edition: 4.
3. Microbiology - Prescott L M, Harley J P and Klein D A, Tata Mc Graw Hill, New Delhi. 2005, Edition: 6.
4. Fundamentals of Microbiology - Alcamo E, Jones and Bartlett Publishers, New Delhi, 2001, Edition: 6.
5. Environmental Microbiology - Mitchell R., John Wiley and Sons, New York. 1992.
6. Microbial Ecology - Fundamentals and Applications - Atlas R N and Bartha R, Redwood City C A Benjamin / Cumming. 1998, Edition: 4.
7. Microbial Ecology - Campbell R., Blackwell Scientific Publication, London. 1983, Edition: 2.
8. Modern Food Microbiology - Jay J M, Chapman and Hall Inc, New York, 1992. Edition:
9. Food Microbiology – Frazier W C and West Hoff D C, Tata McGraw Hill Ltd, New Delhi, 1989, Edition: 8.
10. Principles of fermentation Technology – Stanbury P F, Whittaker A and Hall S J, Aditya Books (P) Ltd., New Delhi. 1997.
11. Biotechnology - A Textbook of Industrial Microbiology, Cruegar and Cruegar, Panima publishing Corporation, New Delhi. 2002, Edition: 2.
12. Wastewater Engineering - Treatment, Disposal and Reuse. Metcalf and Eddy, Inc., Tata Mc Graw Hill, New Delhi, 1995, Edition: 3.
13. Waste water treatment: Concepts and design approach – G L Karia and R A Christian, Prentice – Hall of India private Limited, New Delhi, 2006.
14. Environmental chemistry - A.K. De, Wiley Eastern Ltd. New Delhi, 1989.
15. Introduction to Biodeterioration - D. Allsopp and K.J. Seal, ELBS/Edward Arnold, London, 1986.

## **PAPER IV - BIOINSTRUMENTATION & BIOSTATISTICS**

### **UNIT I**

Electrochemical techniques: Principles, redox reactions, the pH electrode, ion-sensitive and gas-sensitive electrodes, oxygen electrode, Biosensors, turbidometry .Chemical foundations of Biology- pH, pK, acids, bases and buffers, Henderson - Hasselbach equation, biological buffer solutions. Ionic equilibrium, acid-base balance and their disorders. Blood as a buffer, Definition of solvation and hydration, role of lung and kidney and their disorder

Colorimetry & Spectrophotometry: Principles, types and applications, UV-VIS double beam spectrophotometry, Spectroflurometry, Mass spectroscopy, IR spectroscopy, Flame photometry. NMR Spectroscopy, Circular Dichroism and X- ray diffraction studies.

### **UNIT II**

Principles, types and applications of chromatography, size exclusion, Ionexchange chromatography, affinity chromatography. High performance liquid chromatography (HPLC), Gas chromatography (GC), Thin layer chromatography (TLC), Paper chromatography, Mass spectrometry, MALDI TOF .

### **UNIT III**

Centrifugation: Principles, types and applications of centrifuges; Principles, types and applications of Electrophoresis. Agarose gel electrophoresis PAGE (SDS/Native), Gradient gel, Isoelectric focusing, 2-D gel electrophoresis (2-D PAGE), cellulose, Capillary electrophoresis. Flowcytometry

Nature & detection of radio isotopes; Applications of Radio isotope techniques; Detection based on gas ionization - Geiger Muller counter; Detection based on excitation - Liquid Scintillation counter; Supply, storage, purity, specific activity and safety aspects of radiolabelled compounds;

### **Unit – IV**

Biostatistics – Scope of Biostatistics, Measures of Central tendency – Arithmetic mean, Median and Mode. Calculation of mean, median, mode in series of individual observation discrete series, continuous open end classes.

### **Unit – V**

Classification and tabulation of data – Graphical and diagrammatic representations – scale diagrams – Histograms – frequency polygon - Frequency curves. Measures of Dispersion – standard deviation and Range. Chi – square test, student t test, regression, correlation, one way and two way ANOVA. Application of statistical software for biological research.

### **References books:**

1. Introductory Practical Biochemistry – S. K. Sawhney and Randhir Singh. Narosa Publishing House

2. Principles of Applied Biomedical Instrumentation- Gedder A and L. E. Balsar, John Wiley and Sons.
3. Modern Experimental Biochemistry 2nd Edition- Boyer, Rodney F. Benjamin and Cummins.
4. Introductory Biostatistics by chap. T. Lee (Wiley – Interscience)
5. Statistical methods edited by Stephen W. Looney (Humana publications)
6. Biostatistics: A Methodology for the Health Sciences, Second Edition, by Gerald Van Belle (Wiley – Interscience publication)
7. <http://www.itl.nist.gov/div898/handbook/prisection3/pri3.htm>(online e book)
8. [http://www.statease.com/de7\\_man.html](http://www.statease.com/de7_man.html)(software tutorial website)

## PAPER V - IMMUNOLOGY AND IMMUNOTECHNOLOGY

### Subject description:

this course presents the defense system of the higher vertebrates against invading pathogen.

### Goals:

to make the student to understand the defense mechanism and their regulations

### Objectives:

on successful completion the subject student should have understand:

What is immunity, how it discriminate self and non-self, how it is regulated and what are the applications

## Contents

### Unit – I

History and scope of immunology. Types of Immunity: Passive, Active and Acquired immunity. Humoral, Cell Mediated immunity. Cells and organs of immune response and their functions. Antigens Types, haptens, epitopes and Factors influencing antigenicity. Antibodies Structure types, properties and functions of immunoglobulins.

### Unit – II

Cells of immune system. T-Cells, B-Cells, antigen presenting cells, cell mediated subset of T-Cells helper and suppressor cells, natural killer cells. Lymphoid organs (primary and secondary) MHC molecules, Antigen presentation, B cell and T cell activation, cytokines Complement system. Structure, components, properties and functions.

### Unit –III

Antigen antibody reactions: in vitro tests- precipitation, immune-electrophoresis, Hemagglutination, Labeled antibody (RIA ELISA and immuno – fluorescent techniques) Hypersensitivity and Allergic reactions Blood cell components, ABO blood grouping RH typing. Application of immunological techniques: hybridoma technology:- Fusion of myeloma cells with lymphocytes, production of monoclonal antibodies and their applications. Human monoclonal catalytic antibodies and plant bodies.

#### **Unit IV**

Hyper sensitivity reactions, auto immuno disorders, deficiencies (Primary and secondary) and immuno tolerance. Tumor immunology: tumor antigens, immune responses and therapy \, tissue and organ transplant.

#### **Unit V**

Immunity to bacteria, viruses and parasites vaccines and immunization: passive and Active immunization Types of vaccines – Inactivated, attenuated and Recombinant Vaccines – Peptide and DNA vaccines, Synthetic vaccines, epitope mapping.

#### **Reference books**

1. Essentials of Immunology (6<sup>th</sup> Edition): Ivan Riot – Blackwell Scientific Publications, Oxford, 1988
2. Fundamentals of Immunology: Paul W.E (Eds) Ravan prss, New York, 1988
3. Antibodies A laboratory Manual: Harlow and David Lane (1988), cold spring harbor laboratory.
4. Janis Kuby (1997) Immunology, WH Freeman & Company, New york.
5. Tizard (1995) Immunology IV Ed Saunders college publishers, New York.

### **PAPER VI - GENETIC ENGINEERING**

#### **SUBJECT DESCRIPTION:**

This paper provides the student a thorough knowledge in principles and methods in genetic engineering, vectors in gene cloning, transformation in higher organisms.

#### **GOALS:**

To enable the students to grasp of the latest advances in genetic engineering, which is a powerful tool in modern Biotechnology.

#### **OBJECTIVES:**

On successful completion of the course the students will be aware of the techniques and the applications of genetic engineering in various fields of biotechnology, medicine and research areas.

#### **UNIT I:**

##### **Gene Manipulation**

Enzymes used in manipulation: Polymerases and types; nucleases: endonucleases, exonucleases and restriction enzymes; ligases; topoisomerases, methylases; other modifying enzymes. Electrophoresis. Blotting techniques- Southern, Northern, Western, Dot and Slot blot.

#### **UNIT II:**

##### **Biology of Cloning Vectors**

Biology and construction of plasmid vectors: pBR 322; pUC 18. Phages as vectors: Lambda phage; cosmids; phagemids. Expression vectors; shuttle vectors; artificial chromosomes: YAC, PAC, BAC, HAC.

### **UNIT III:**

#### **Basic Recombinant DNA Techniques**

Construction of a recombinant molecule. Bacterial transformation: principle and methods; Physical methods of transformation. Analysis of cloned genes: direct and indirect methods. Molecular Marker techniques: RFLP, RAPD, STS, SSR, ISSR, SCAR, SSCP and AFLP. Importance of molecular markers, molecular marker assisted selection, aided plant breeding. Selectable marker and reporter genes.

### **UNIT IV:**

**Advanced Recombinant Techniques:** Genomic and cDNA libraries; PCR: principle and types; Site directed mutagenesis; DNA sequencing. Microarrays - cDNA and protein chips. DNA fingerprinting; SNPs; VNTRs and microsatellites.

### **UNIT V:**

**Applications:** Gene therapy: Ex vivo, In vivo, germ line and somatic gene therapy, Vectors in gene therapy. Viral gene delivery system- Adeno associated virus vector- Retro virus vector - HSV vector system ; DNA forensics. Recombinant Products: blood products; vaccines; interferons; interleukins and therapeutic proteins. Molecular Pharming - Hirudin (Plant), Antibodies (Animal) and tissue plasminogen activator (Bacteria).

### **REFERENCE:**

1. Principles of Gene Manipulation by Primrose by S.B., Twyman R.M., Old. R.W. Published by Blackwell Science Limited. 2001. Edition: 6.
2. DNA Science, A First Course in Recombinant Technology by D.A. Mickliss and G A Freyar, Published by Cold Spring Harbor Laboratory Press, New York, 1990.
3. Molecular Biotechnology by S. B. Primrose. Published by Blackwell Scientific Publishers, Oxford, 1994. Edition: 2.
4. Route Maps in Gene Technology by M.R. Walker and R. Rapley. Published by Blackwell Science Ltd., Oxford, 1997.
5. Genetic Engineering. An Introduction to Gene Analysis and Exploitation In Eukaryotes by S.M. Kingsman and A.J. Kingsman. Published by Blackwell Scientific Publications, Oxford, 1998.
6. Human Molecular Genetics by Tom Strachan and Andrew P. Read. Published by Bios Scientific Publishers, 1996.
7. Gene Cloning and DNA Analysis by Brown TA. Published by Garland Science. 2006. Edition: 5.
8. [www.blackwellpublishing.com/genecloning/pdfs/chapter7.pdf](http://www.blackwellpublishing.com/genecloning/pdfs/chapter7.pdf).

9. From Genes to Clones: Introduction to Gene Technology by Ernst L. Winnacker. Published by VCH, 1987.
10. Recombinant DNA by James D. Watson, Michael Gilman, Jan Witkowski, Mark Zoller. Contributor James D. Watson, Mark Zoller. Published by Scientific American Books, 1992, Edition: 2.
11. Genetic Engineering: Concepts and Applications by R. Suganthi and C.S. Shobana, Published by Kalaikathir Achchagam, Coimbatore - 37, 2013, Edition: 1

## **PAPER VII - PLANT BIOTECHNOLOGY**

### **Unit – I**

Tissues culture media - Composition and preparation; Plant Propagation - Conventional & *In vitro* techniques; Conventional plant breeding methods - Selection, hybridization, mutation and polyploidy; Cell and tissue culture techniques for plants - Micropropagation, Callus culture, somatic embryogenesis, suspension culture, embryo culture, haploid culture, protoplast culture, protoplast fusion; Somaclonal variation; Artificial seeds; hardening.

### **Unit –II**

Plant transformation technology: Ti and Ri plasmids, binary & co-integrated vector systems; viral vectors and their applications; 35S and other promoters; genetic markers; reporter genes; virulence genes; Cloning Strategies; Gene transfer methods in plants – Direct DNA transfer methods, Agrobacterium mediated nuclear transformation, Chloroplast transformation.

### **Unit –III**

Application of genetic transformation techniques for improving productivity and performance of plants: herbicide resistance, insect resistance, virus resistance, disease resistance, PR Proteins, antifungal proteins, nematode resistance, abiotic stress tolerance, Heat Shock Proteins, Male Sterile Lines, Nitrogen Fixation, long shelf life of fruits & flowers.

### **Unit – IV**

Secondary metabolic pathways in plants. Industrial phytochemical products from plants: Alkaloids, Biodegradable Plastics, Therapeutic proteins, biodegradable plastics, antibodies, plant vaccines, herbal drugs, bioethanol and biodiesel.

### **Unit –V**

Extraction & purification of phyto-chemicals. phytoremediation; Green house and green home technology. Arid and semiarid technology.

### **Reference:**

1. An Introduction to genetic engineering in plants, Mantel. S.H, Mathews. J.A, Mickee, R.A, 1985 Black well Scientific Publishers, London.

2. In Vitro culture of plants by R.L.M. pierik, 1987. Martinus Nijhoff publishers , Dordrecht
3. Palnt cell culture, A practical approach,(2<sup>nd</sup> ed). Edited by R.A. Dixon and R.A. Gonzales. 1994. Oxford University Press, Oxford.
4. Plant Molecular Biology by Grierson and son Ltd, New york
5. Palnt Molecular Genetics by Monica. A.Hughes,1999, Pearson Education Ltd, England
6. Plant Biotechnology by Mantell and Smith, 1983, Cambridge University Press
7. Plants, Genes and agriculture by M.J. Chrispeels and D.F.Sadava .2000. the American scientific publishers.
8. practical Application of plant molecular biology by R.J.Henry, 1997, Chepmans and Hall
9. Elements of Biotechnological by P.K.Gupta, 1996. Rastogi and Co.Meerut
10. Plant Biotechnology by J.Hammond, P.Mcgarey and V.Yusibov (Eds) 2000 Springer verag
11. Plant cell and tissue culture in the production of food ingredients by T.J. Fu. G.Sings and W.R. Curtis kluwer Academic/plenum press
12. Biotechnology in crop improvement by H.S Chawla. 1998 International Book Distributor Company.

### PAPER VIII - ANIMAL BIOTECHNOLOGY

**Scope:** The study of animal cells has helped us gain an insight not only in the structure and function of cells and tissues but also in different physiological, biochemical and immunological processes. Biotechnologists explore and develop new technologies using molecular biology, embryo manipulation and cell and tissue culture. Research on gene regulation and early embryo development has resulted in novel techniques to manipulate and explore the genomes of domestic animals for ways to increase healthier food production as well as to develop biomedical applications.

**Objective:** The major objective is to provide a world-class training experience for these students in an interdisciplinary research program connecting animal genomics with animal reproduction and biotechnology.

**Goal:** This paper will help students interested in careers as laboratory, research or animal care technicians in the fields of veterinary and human health or biotechnology.

#### UNIT I

Introduction to Animal Tissue Culture: Background, Advantages, Limitations, and applications. Culture Environment, Cell Adhesion, Cell Proliferation and Cell differentiation. Essential Equipments required for animal tissue culture, Aseptic Technique, Objectives, Elements, Sterile Handling, Risk Assessment and General Safety. Media: Physicochemical Properties, Balanced Salt Solutions, Complete Media, Serum, Disadvantages of Serum supplemented media, Serum-Free Media, Advantages of Serum-Free media.

#### UNIT II

Primary Culture: Isolation of Tissue, Steps involved in primary cell culture, Cell Lines, Nomenclature, Subculture and Propagation, Immortalization of cell lines, Cell line designations, Routine maintenance. Characterization of Cell Line: Need for characterization, Morphology, Chromosome Analysis, DNA, RNA and Protein Content, Enzyme Activity and Antigenic

Markers. Transformation of animal cell, Immortalization, Aberrant Growth Control, Tumorigenicity, Cell counting, Cell Proliferation, Plating Efficiency, Labeling Index, Generation Time of established cell line.

### **UNIT III**

Contamination: Source of contamination, Type of microbial contamination, Monitoring, Eradication of Contamination, Cross-Contamination. Cryopreservation: Need of Cryopreservation, Preservation, Cell banks, Transporting Cells. Cytotoxicity: measurement of cell death; Apoptosis and its determination; Cytotoxicity assays. Application of animal cell culture ; Vaccine production; Tissue engineering; Engineered cell culture as source of valuable products and therapeutic protein production.

### **UNIT IV**

Transgenic Animals: Production Methodology-Embryonic Stem Cell method, Microinjection method; Applications of transgenic animals-in therapeutic protein production; live stock improvement; Transgenic animals as disease models. Nucleic acid therapeutic agents. Gene targeting, silencing and knockout technologies. Animal cloning

### **UNIT V**

*In Vitro* Fertilization and Embryo Transfer: Composition of IVF media, Steps involved in IVF, Fertilization by means of micro insemination, PZD, ICSI, SUZI, MESA. Stem cell culture, embryonic stem cell and their applications. Ethical issues in animal biotechnology.

### **References:**

1. Animal cell culture; A practical approach, 4th Edition, by Freshney. R.I. John Wiley publication.
2. Methods in cell biology; Volume 57, Animal cell culture methods, Ed. Jennie P.Mather, David Barnes, Academic press.
3. Mammalian cell biotechnology; A practical approach, Ed. M. Butler, Oxford university press.
4. Exploring genetic mechanism; Ed. Maxine Singer and Paul Berg.
5. Principles of genetic manipulation; Ed. Old and Primrose, 6th Edition. Blackwell science publication.

## **PAPER IX - BIOPROCESS TECHNOLOGY**

**Subject description:** This paper presents the basics of fermentation technology, media components as applied to lab scale, pilot scale and industrial scale upstream and down stream processing.

**Goals:** This paper is introduced to acquire requisite skills for the design and development of bioreactors, production optimization, and preparation of sterile base materials for downstream processing.

**Objectives:** On successful completion of the course the students should have understood the basics of fermentation technology and learnt the concept of screening, optimization and maintenance of cultures.

### **UNIT I: Introduction to Bioprocess Engineering**

Fermentation a Historical perspective. Biotechnology and bioprocess engineering, Bioprocess regulatory constraints, Basic of Biology - an engineering perspectives - cell construction, cell nutrients. Stoichiometry of microbial growth and product formation. Alteration in cellular information.

### **UNIT II: Bioreactor - Designs**

Introduction to fermentation process. Sterilization. Thermal death kinetics. Design of continuous sterilization process, Fibrous filters. Bioreactor design, parts and their functions, Alternative vessel designs - CSTR, Tower, Airlift, Loop jet, Bubble Column, Packed bed. Immobilized cells.

### **UNIT III: Kinetic Studies**

Microbiology of Industrial fermentation, Fermentation kinetics, Rheological properties of the medium Theory of mixing. Oxygen transfer rate, Oxygen transfer coefficient and correlation. Biological heat transfer and heat transfer coefficient.

### **UNIT IV: Instrumentation Controls**

Different types of instrumentation, common measurement and control systems, Additional sensors, Feedback control, PID control, Computers in Bioprocess control systems, Biosensors in bioprocess monitoring and control.

### **UNIT V: Upstream and Downstream Processing**

Upstream processing, Removal of microbial cells, cell disruption – enzymatic, chemical and physical methods; purification of fermentation products - precipitation methods, membrane process, centrifugation – Ultracentrifugation; Chromatography -Ion exchange and gel permeation chromatography, HPLC; crystallization, drying, lyophilisation, packaging and quality assurance.

## REFERENCE:

1. Bioprocess Engineering Basic concepts by Michael L. Shuler Fikret Karg. Published by Prentice Hall International services, 2001. Edition: 2.
2. Fermentation Microbiology and Biotechnology by E.M.T El-Mansi and C. F. A.Bryce. Published by Taylor & Francis. Reprinted 2002.
3. Biotechnology-A Textbook of Industrial Microbiology by Wulf Crueger and Anneliese Crueger. Published by Panima Publishing Corporation New Delhi. 2000. Reprinted 2005. Edition: 2.
4. Principles of Fermentation Technology by Peter. F. Stanbury, Allan Whitaker, Stephen. J. Hall. Published by Elsevier Science Ltd., reprinted 2007, Edition: 2.
5. Bioprocess Engineering Principles by Pauline M. Doran, Published by Elsevier, Reprinted 2006.

## PAPER X - PHARMACEUTICAL BIOTECHNOLOGY

### UNIT I

History of pharmaceutical industry, Drugs discovery , Development phases and Drug-Manufacturing Process. Drugs and Cosmetics ACT and regulatory aspects. Definition: Generics and its advantages . Biogenerics and Biosimilars... Protein-based biopharmaceuticals.

### Unit II

Introduction to pharmaceuticals of animal, plant and microbial origin. Pharmacological, Microbial, Recombinant, Biochemical and Molecular level screening systems and their construction strategies. Hemotopoietic growth factors and coagulation factors. Interferons and cytokines for anti-infective and cancer therapy. Insulin and growth hormones. Vaccine: genetically improved vaccines, synthetic peptide based vaccines, nucleic acid vaccines.

### Unit III

Recombinant thrombolytic agents: tissue type plasminogen activator, first and second generation of thrombolytic agents. Xenotransplantation in pharmaceutical biotechnology. The role of biotechnology in forensic sciences . Estimation of toxicity: LD50 and ED50. Pre-clinical and clinical trails

### Unit IV

Introduction to pharmacopoeia, good microbiological techniques and good laboratory practice (GLP). Basic principles of quality control (QA) and quality assurance (QC) Guidelines for QA and QC: raw materials, sterilization, media, stock cultures and products Validation study and toxicity testing . Role of culture collection centre, public health laboratories and regulatory agencies Concept of biotech process validation, Cell lines culture process validation and characterization.Purification process for viral clearance, validation of recovery , Purification, Cleaning and Filtration.

### Unit V

Issues of DNA vaccines and plasmid DNA vaccines.Analytical methods in protein formulation: concentration, size, purity, surface charge, identity,structure/sepence, shape, activity.

Introduction to drug designing and Search of database. Biosafety guidelines; Risk and risk assessment- Biosafety levels, laboratory biosecurity concepts Introduction to drug design- Pre-clinical and clinical trials. Basics of bioethics principles, international codes and guidelines in India. Ethics in post-genomic era.

**Reference:**

1. Gareth Thomas. Medicinal Chemistry. An introduction. John Wiley. 2000.
2. Katzung B.G. Basic and Clinical Pharmacology, Prentice Hall of Intl. 1995.
3. T.V.Ramabhadran. Pharmaceutical Design And Development : A Molecular Biology Approach, Ellis Horwood Publishers, New York, 2005
4. Goodman & Gilman's The Pharmacological Basis of Therapeutics, 11th edition, Mc Graw-Hill Medical Publishing Division New York, 2006.
5. Sarfaraz K. Niazi, Handbook of Biogeneric Therapeutic Proteins: Regulatory, Manufacturing, Testing, and Patent Issues, CRC Press, 2006.
6. Rodney J Y Ho, MILO Gibaldi, Biotechnology & Biopharmaceuticals Transforming proteins and genes into drugs, 1st Edition, Wiley Liss, 2003.
7. Brahmkar D M, Jaiswal S B, Biopharmaceutics and Pharmacokinetics A Treatise, Vallabh Publisher, (1995, reprint 2008)

## **PAPER XI - GENOMICS & PROTEOMICS**

### **Unit I. Genome mapping, assembly and comparison.**

Genome mapping, Genome sequencing, Genome sequence assembly: Base calling and assembly programs, Genome annotation: Gene ontology, Automated genome annotation, Annotation of hypothetical proteins and Genome economy. Comparative genomics: Whole genome alignment, Finding a minimal genome, Lateral gene transfer, Within-genome approach and Gene order comparison.

### **Unit II. Functional Genomics.**

Sequence based approaches: EST, EST index construction and SAGE. Microarray based approaches: Oligonucleotide design, Data collection, Image processing, Data transformation and normalization, Statistical analysis to identify differentially expressed genes and Microarray data classification. Comparison of SAGE and DNA Microarrays.

### **Unit III. Proteomics**

Technology of protein expression analysis: 2D-PAGE, Mass spectrometry protein identification, protein identification through database searching, Differential in-gel electrophoresis and Protein Microarrays. Post translational modification: Prediction of disulphide bridges and Identification of posttranslational modifications in proteomics analysis. Protein sorting.

#### **Unit IV. Protein-protein interactions.**

Experimental determination of protein-protein interaction, Prediction of protein-protein interactions: prediction interactions based on domain fusion, predicting interactions based on gene neighbors, predicting interactions based on sequence homology, predicting interactions based on phylogenetic information and prediction interactions using hybrid methods.

#### **Unit V. Applications of proteomics.**

Medical proteomics-disease diagnosis: Biomarkers, Biomarker discovery using 2DGE and mass spectrometry and Biomarker discovery and pattern profiling using protein chips. Pharmaceutical proteomics-drug development: The role of proteomics in target identification, Proteomics and target validation, Proteomics in the development of lead compounds and Proteomics and clinical development. Proteomics and Plant biotechnology: Proteomics in plant breeding and genetics, Proteomics for the analysis of genetically modified plants and Proteomics and the analysis of secondary metabolism.

#### **References**

1. Xiong J. (2006). Essential bioinformatics. Cambridge, UK: Cambridge University Press.
2. Goodman N. (2002). Biological data becomes computer literature: New Advances in Bioinformatics. *Curr. Opin. Biotechnol.* 13: 68-71.
3. Hagen J.B. (2000). The origin of bioinformatics. *Nat. Rev. Genetics.* 1: 231-236.
4. Apweiler R. (2000). Protein sequence databases. *Adv. Protein Chem.* 54: 31-71.
5. Hughes A.E. (2001). Sequence databases and the internet. *Methods Mol. Biol.* 167: 215-223.
6. Stein L.D. (2003). Integrating biological databases. *Nat. Rev. Genet.* 4: 337-45.
7. Batzoglou S. (2005). The many faces of sequence alignment. *Brief. Bioinformatics.* 6: 6-22.
8. Xuang X. (1994). On global sequence alignment. *Comput. Appl. Biosci.* 10: 227-235.
9. Pearson, W.R. (1996). Effective protein sequence comparison. *Methods Enzymol.* 266: 227-258.
10. Spang R. and Vingron M. (1998). Statistics of large scale sequence searching. *Bioinformatics.* 14: 279-284.
11. Mullan L.J. (2002). Multiple sequence alignment- The gateway to further analysis. *Brief. Bioinform.* 3: 303- 305.
12. Brenden C, and Tooze J. (1999). Introduction to protein structure, 2nd ed. New York: Garland publishing.
13. Baker D. and Sali A. (2001). Protein structure prediction and structural genomics. *Science* 294: 93-96.
14. Stekel D. (2003). Microarray bioinformatics. Cambridge, UK: Cambridge university press.
15. Huynen M.A., Snel B., Mering C. and Bork P. (2003). Function prediction and protein networks. *Curr. Opin. Cell Biol.* 15: 191-198.
16. Attwood T.K. and Parry-Smith D.J. (2003). Introduction to bioinformatics, Singapore, Pearson education.
17. Twyman R.M. (2004). Principles of proteomics, York: Garland Science/Bios Scientific publishers.

## PAPER XII - BIO-ENTREPRENEURSHIP

### UNIT-I

**Principles of management:** Introduction, definition – Management principles of Henry Foyal - setting and managing biotechnology industry: principles and decisions on starting a venture; sources of financial assistance – making a business proposal, approaching loan from bank and other financial institutions, budget planning and cash flow management, basics in accounting practices - balance sheet, P&L account, and double entry bookkeeping; estimation of income, expenditure, profit, income tax etc.

### UNIT -2

**Human Resource Development (HRD):** Recruitment and selection process; leadership skills; managerial skills; organization structure; training; team building; teamwork; **Marketing:** Assessment of market demand for potential product(s) of interest; Market conditions, segments; prediction of market changes; identifying needs of customers including gaps in the market.

### UNIT -3

**Entrepreneur:** Meaning of entrepreneur, evaluation of the concept, function of an entrepreneur types of entrepreneur, evolution of entrepreneurship, development of entrepreneurship, stages in entrepreneurial process, role of entrepreneurs in economic development entrepreneurship in India, entrepreneurship - its barriers

### UNIT -4

**Small Scale Industry:** Definition, characteristics, need and rationale, objectives, scope, role of SSI in economic development, advantages of SSI, steps to start an SSI – Govt policy towards SSI, different policies of SSI, Govt support for SSI during 5 year plans. Impact of liberalization, privatization, globalization on SSI, effect of WTO/ GATT, supporting agencies of Govt for SSI, meaning; nature of support, objectives, and functions, types of help, ancillary industry and tiny industry (Definition only)

### UNIT -5

**Institutional Support:** Different Schemes, TECKSOK, KIADB, KSSIDC, KSIMC, DIC single window Agency SISI, NSIC, SIDBI, KSFC. Preparation of Project-Meaning of Project; Project Identification Project Selection. Project Report, Need and significance of Report, Contents, Formulation Guidelines by Planning Commission for Project report; Network Analysis; Errors of Project Report, Project Appraisal, Identification of Business Opportunities. Market Feasibility Study, Technical Feasibility study, Financial Feasibility Study & Social Feasibility study.

### TEXT BOOKS:

1. "Principles of Management", PC Tripathi, PN Reddy, –Tata Mc Graw Hill, (Chapter 1,2,3,4,5,15,16,17)
2. "Dynamics of Entrepreneurial Development & Management" Vasant Desai Himalaya Publishing House (Chapter 1,2,4,8,9,10,13,15,16,17,18,19,20,21,22,42,46,47)

3. "Entrepreneurship Development – small Business Enterprises" Poornima M Charanthmath  
Pearson Education – 2005 (2 & 4)

#### REFERENCE

1. "Management Fundamentals ", Robert Lusier,– Concepts, Application, Skill Development"  
Thomson (Chap 1,4,12)
2. "Entrepreneurship Development" S S Khanka S Chand & Co  
(Chapter1,2,5,11,12,13,16,18,20)
3. "Management" Stephon Robbins Pearson Education/PHI 17th Edition 2003.

#### BOOKS:

### PRACTICAL I - LAB IN BIOCHEMISTRY AND ENVIRONMENTAL BIOTECHNOLOGY

#### BIOCHEMISTRY

1. Estimation of reducing sugars by Nelson - Somogyi method
2. Estimation of total carbohydrates by Anthrone method
3. Estimation of acid value, saponification value, Iodine number of fat
4. Estimation of total free amino acids
5. Protein estimation by Absorbance at 280nm, Lowry's method and Bradford method.
6. Separation of LDH isozymes from serum by SDS-PAGE.
7. Paper Chromatography - separation of pigments
8. Thin Layer Chromatography - separation of amino acids
9. Ion Exchange Chromatography
10. Gel permeation Chromatography
11. Extraction and purification of peroxidase from soy bean seeds
12. Assay of amylase activity and determination of enzyme kinetic parameters - Km, Vmax and Kcat
13. Estimation of ascorbic acid and riboflavin
14. Estimation of calcium and iron

#### ENVIRONMENTAL BIOTECHNOLOGY

15. Sampling techniques: Waste water analysis for physio - chemical characteristics such as pH, conductivity, TDS, DO, BOD, COD, CO<sub>2</sub>, alkalinity, nutrients, chlorides, hardness, settleability of solids
16. Isolation of microorganisms (Bacteria and Fungi) from polluted environment
17. Microbial degradation of hydrocarbons
18. Removal of Heavy metals from industrial effluent

#### REFERENCE

1. Principles of Instrumental Analysis by D. A. Skoog, F. J. Holler and T.A. Nieman, Published by Saunders. 1998. Edition: 5.

2. Laboratory Manual of Biochemistry by J. Jayaraman, Published by Willy Eastern. 1981. Edition: 2.
3. Protein Methods by Daniel M. Bollag *et al.* Published by Wiley-Liss, Inc. 1996. Edition: 2.
4. Biochemical Methods by S. Sadasivam and A. Manickam, Published by Reprint New age international (P) Ltd. 1996. Edition: 2.
5. An Introduction to practical Biochemistry by David T Plummer, Published by Tata Mcgraw hill Publication. 1971. Reprinted 2004. Edition: 3.
6. Environmental Biotechnology by C. F. Forster and D.A., John Wase, Published by Ellis Horwood Ltd. 1987.
7. Advances in Waste Water Treatment Technologies (Volumes I and II) by K. Trivedy, Published by Global Science publications.1998.
8. Biocatalysis and Biodegradation: Microbial transformation of organic compounds by Lawrence P. Wacekett, C. Douglas Hershberger Published by ASM Publications. 2000.
9. A Manual of Environmental Microbiology by Christon J. Hurst Published by ASM Publications. 2001. Edition: 2.

## **PRACTICAL II - MICROBIOLOGY AND MICROBIAL BIOTECHNOLOGY**

### **MICROBIOLOGY**

1. Microscopy- care and use of microscope
2. Sterilization
3. Sample collection - clinical and Environmental samples
4. Culture media preparation
5. Pure culture techniques
6. Staining of Bacteria: simple, negative, differential, microchemical staining
7. Staining of fungi - Lacto phenol cotton blue
8. Isolation, purification and biochemical identification of bacteria
9. Antibiotic sensitivity test
10. Maintenance and storage of bacterial strains

### **MICROBIAL BIOTECHNOLOGY**

11. Screening and Isolation of Industrially important microorganisms and strain improvement by mutation.
12. Growth curve - measure of bacterial population by turbidimetry and studying the effect of temperature, pH, carbon and nitrogen source in the media.
13. Determination of thermal death point and thermal death time of microorganisms
14. Lab scale fermentation of antibiotics
15. Production of alcohol
16. Production of citric acid from *Aspergillus niger*
17. Production of extracellular lipase from *Bacillus* spp.
18. Immobilization of bacteria
19. Immobilization of enzymes
20. Lab scale production of Biofertilizer and Biopesticide

## REFERENCE

1. Manual of Microbiology Tools and Techniques by Kanika Sharma, Published by Ane Books, 2007. Edition: 4.
2. Laboratory Manual on Biotechnology- Prof. P.M. Swamy, Published by Rastogi Publications.
3. Microbial Technology: Fermentation technology - Henry J. Peppler, D. Perlman, Published by Academic Press, 1979. Edition: 2.
4. Microbiology: A laboratory Manual by James G. Cappuccino, & Natalie Sherman, Published by Benjamin/Cummings, 1996. Edition: 7.
5. Experiments in Microbiology, Plant pathology and Biotechnology by K.R. Aneja, Published by New age International Publishers, 2003. Edition: 4.
6. Manual of industrial Microbiology and Biotechnology by Davis J.E. and Demain A.L. Published by ASM publications, 1999. Edition: 2.

## PRACTICAL III - IMMUNOLOGY, ANIMAL BIOTECHNOLOGY AND PHARMACEUTICAL BIOTECHNOLOGY

### IMMUNOLOGY

1. Demonstration of animal handling for experimental purposes, cervical dislocation, dissection of mice, cardiac puncture, blood sample preparation and its handling
2. Immunization and generation of antiserum in animals against antigen
3. Separation of IgG using affinity chromatography
4. Blood grouping and counting of blood cells
5. Antigen-Antibody Interactions: Radial Immunodiffusion, Ouchterlony double diffusion Precipitin ring test
6. Immunoelectrophoresis and rocket immunoelectrophoresis.
7. Antibody titre by ELISA
8. SDS-PAGE and Immunoblotting
9. Separation of mononuclear cells from Human peripheral blood

### ANIMAL BIOTECHNOLOGY

10. Sterilization techniques
11. Preparation of culture media and sera
12. Preparation of primary cell culture
13. Trypsinizing and subculturing cells from a monolayer
14. Passaging cells in suspension culture
15. Determining cell number and viability with a hemocytometer and Trypan blue staining
16. Preservation of cells

### PHARMACEUTICAL BIOTECHNOLOGY

17. Various modes of administration of drugs: Intravenous, Intramuscular, Intraperitoneal, Intradermal

18. Acute toxicity testing of drugs
19. Determination of analgesic and anti-inflammatory activity of a compound
20. Spectrophotometric determination of Allantoin and Griseofulvin
21. Microbial analysis of pharmaceuticals (syrups)

## REFERENCE

1. Animal Cell Culture: A Practical Approach- R. Ian Freshney, Published by IRL Press, 1986.
2. Practical Immunology - Leslie Hudson, F.C. Hay, Published by Blackwell Scientific Publications, 1981, Edition: 2.
3. Animal Cell Culture: A Practical Approach- John R. W. Masters Contributor John R. W. Master, Published by Oxford University Press, 2000, Edition: 3.
4. Practical Immunology- Leslie Hudson, Frank C. Hay, Published by Blackwell (Oxford), 1976.
5. Pharmaceutical Microbiology by W. B. Hugo & A. D. Russell Published by Blackwell scientific Publications.2009, Edition: 6.
6. Analytical Microbiology by Frederick Kavanagh Volume I & II. Published by Academic Press New York.
7. Quality control in the Pharmaceutical Industry by Murray S. Cooper Volume.II. Published by Academic Press New York.
8. Manual of Clinical Laboratory and Immunology by Noel R. Rose, Published by ASM Publications, 2002, Edition: 6.

## PRACTICAL IV - PLANT BIOTECHNOLOGY AND RECOMBINANT DNA TECHNOLOGY

### PLANT BIOTECHNOLOGY

1. Composition and preparation of media and sterilization
2. *In vitro* Seed Germination
3. Micropropagation - Nodal and apical meristems.
4. Callus induction , regeneration and Acclimatization
5. Somatic Embryogenesis and Synthetic Seeds
6. Suspension cultures and somatic embryogenesis
7. Anther culture
8. Embryo culture
9. Protoplast Isolation and Viability Testing
10. Isolation of plant genomic DNA
11. Qualitative and quantitative analysis of plant genomic DNA
12. Isolation of plasmid DNA from *Agrobacterium* spp.
13. *Agrobacterium* mediated transformation
14. RNA Isolation from plants and separation in denaturing gel

## **RECOMBINANT DNA TECHNOLOGY**

15. Isolation of genomic DNA from bacteria and animal tissue. Purification and Quantification.
16. Agarose gel electrophoresis
17. Isolation of plasmid DNA from bacteria
18. Restriction digestion and ligation of Lambda phage DNA and gel analysis
19. Transformation of plasmid DNA in *E.coli*, expression and selection
20. Polymerase chain reaction
21. Southern Hybridization using non-radioactive detection
22. Northern Blotting
23. RAPD

## **REFERENCE**

1. Plant Tissue Culture Concepts and Laboratory Exercise - Robert Nicholas Trigiano, Dennis John Gray, Published by CRC Press, 1999 Edition: 2.
2. Introduction to Plant Tissue Culture - M. K. Razdan, Published by Science Publishers, 2003, Edition: 2.
3. An Introduction to Practical Biotechnology - S. Harisha, Published by Firewall Media, 2006.
4. Novo's Handbook of Practical Biotechnology - C. O. L. Boyce, Boyce, Published by Novo Industri A/S, 1986.
5. Genetic Engineering Principles and Practice, Sandhya Mitra, Published by Macmillan India, 1996.
6. Molecular Cloning: A Laboratory Manual - Joseph Sambrook, E. F. Fritsch, Tom Maniatis, Chris Nolan Published by Cold Spring Harbor Laboratory, 1989 Edition: 2.
7. Molecular Cloning: A Laboratory Manual - Joseph Sambrook, David William Russell, Published by CSHL Press, 2001, Edition: 3.