DHANALAKSHMI SRINIVASANCOLLEGE OF ARTS & SCIENCE FOR WOMEN (AUTONOMOUS)
(Nationally Re-Accredited with 'A' Grade by NAAC)
PERAMBALUR 621212
(For the candidates admitted from the academic year 2018-2019 onwards)
M.SC BIOTECHNOLOGY -COURSE STRUCTURE UNDER CBCS

Year/Semester	Course	Course title	Subject Code	Ins.Prd /week	credit	Exam hrs	Marks		Total
							Int	Ext	
I Year/I Semester	Core Course-I	Cell biology	18PBT1C1	6	5	3	25	75	100
	Core Course-II	Molecular Biology	18PBT1C2	5	4	3	25	75	100
	Core Course-III	Genetic Engineering	18PBT1C3	5	4	3	25	75	100
	Core Course-IV	Practical covering core course I,II & III	18PBT1C4P	6	3	6	40	60	100
	Elective Course-I	A) Agricultural Biotechnology	18PBT1E1A	5	4	3	25	75	100
		B) Genomics and Proteomics	18PBT1E1B						
	Application oriented course I	Biotechnology for Entrepreneurship	18PBT1A1	3	3	3	25	75	100
		Total		**30**	**23**				**600**
I Year/II Semester	Core Course-V	Recombinant DNA technology	18PBT2C5	6	5	3	25	75	100
	Core Course-VI	Environmental Biotechnology	18PBT2C6	5	4	3	25	75	100
	Core Course-VII	Plant Biotechnology	18PBT2C7	5	4	3	25	75	100
	Core Course-VIII	Practical covering core course V,VI & VII	18PBT2C8P	6	3	6	40	60	100
	Elective Course-II	A) IPR, Biosafety, Bioethics	18PBT2E2A	5	4	3	25	75	100
		B) Marine Biotechnology	18PBT2E2B						
	Application oriented course –II	Microbial product development	18PBT2A2	3	3	3	40	75	100
		Total		**30**	**23**				**600**

II Year/III Semester	Core Course-IX	Animal Biotechnology	18PBT3C9	6	6	3	25	75	100
	Core Course-X	Bioprocess Technology	18PBT3C10	6	5	3	25	75	100
	Core Course-XI	Immunotechnology	18PBT3C11	5	5	3	25	75	100
	Core Course-XII	Practical covering core course IX , X & XI	18PBT3C12P	8	4	6	40	60	100
	Elective Course-III	A) Advanced Biochemistry	18PBT3E3A	5	4	3	25	75	100
		B) Application of Bioinformatics for Biotechnology	18PBT3E3B						
		Total		**30**	**24**				**500**
II Year / IV Semester	Core course XIII	Advanced Instrumentation for biotechnology	18PBT4C13	6	5	3	25	75	100
	Project	Project work	18PBTPW	24	15	3	50	150	200
		Total		**30**	**20**				**300**
		Grand Total		**120**	**90**				**2000**

ELECTIVE PAPERS

SEMESTER	SUBJECT NAME	SUBJECT CODE
I	A. Agricultural Biotechnology	18PBT1E1A
	B. Genomics and Proteomics	18PBT1E1B
II	A. IPR, Bioethics and Biosafety	18PBT2E2A
	B. Marine Biotechnology	18PBT2E2B
III	A. Advanced Biochemistry	18PBT3E3A
	B. Application of Bioinformatics for Biotechnology	18PBT3E3B

CORE COURSE - I

CELL BIOLOGY

Semester: I | Max mark: 100(Int:25,Ext:75)
Course code: 18PBT1C1 | Credit: 5
Total Hours: 90 | Exam hrs: 3

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

UNIT I **16**

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: 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 **20**

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 **16**

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 **19**

Specialized chromosomes, chromosomal abnormalities and qualitative inheritance. Population genetics and developmental genetics using Drosophila melanogaster as model system. Somatic cell genetics. Cell 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 **19**

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

MOLECULAR BIOLOGY

Semester: I
Course code: 18PBT1C2
Total Hours: 75

Max mark: 100(Int:25,Ext:75)
Credit: 4
Exam hrs: 3

OBJECTIVES

To develop skills of the students in area of molecular biology specifically central dogma of life in detail and to study various molecular techniques, to know the basic process of DNA replication, transcription & translation and to know isolation, restriction of DNA etc.

UNIT-I

NUCLEIC ACIDS – AN INTRODUCTION **15**

Evolution of genetic material, Endo-symbiotic theory– Identification of genetic material – Chemistry of nucleic acids – Structure – types of DNA and RNA, Organization –prokaryotic and eukaryotic DNA, Mitochondrial and Chloroplast DNA Griffith, Avery and Hershey and Chase experiments.

UNIT-II

DNA REPLICATION AND MUTATION **15**

DNA replication: Meselson –Stahl experiment, Molecular mechanisms of DNA Replication – bidirectional and rolling circle replication – Differences in prokaryotic and eukaryotic replication, Enzymes of DNA replication, DNA repair – mechanism of excision repair, SOS repair and mismatch repair. Mutation – Occurrence, kinds of Mutation, spontaneous & induced Mutation, Mutagens, detection of Mutation, Lethal Mutations, Biochemical Mutations, Phenotypic effects of Mutation, Molecular basis of Mutation, Significance & Practical applications of Mutation

UNIT-III

TRANSCRIPTION **15**

Enzymatic Synthesis of RNA Basic features of RNA synthesis, *E.coli* RNA polymerase, Classes of RNA molecules, processing of tRNA and rRNA in *E.coli*, Transcription in Eukaryotes, Eukaryotic rRNA genes, formation of eukaryotic tRNA molecules, RNA Polymerases of eukaryotes, RNA polymerase II Promoters, Eukaryotic Promoters for RNA polymerase III, Hypersensitive sites, Upstream activation sites and enhancers, Splicing mechanisms, Splicing of SStRNA precursors, Splicing of rRNA precursors, Splicing without a protein enzyme.

UNIT-IV

TRANSLATION **15**

Outline of Translation, The Genetic Code, The Decoding System, Codon Anticodon interaction, The special properties of the prokaryotic Initiator tRNAfMet, Transfer RNA genes, suppressors, Ribosomes, Protein Synthesis, Complex Translation units, Some numerical parameters ofProtein synthesis, Inhibitors and Modifiers of protein synthesis, Protein Synthesis in Eukaryotes.

UNIT-V
GENE REGULATION **15**

General aspects of Regulation, The lactose system and the operon model, The Galactose operon, The Arabinose operon, The Tryptophan operon, Relative positions of Promoters and Operators, Regulons, Regulation of Translation, Regulation of the synthesis of Ribosomes, Unregulated changes in gene expression, Feedback Inhibition. Regulatory strategies in Eukaryotes, Gene alteration. Transcriptional Control by hormones, Regulation mediate through Transcription factors, Regulation of enhancer activity, Methylation, Regulation of processing, Translational control, Regulation of gene expression in plant cells by light.

REFERENCE BOOKS:

1. Freifelder. D., Essentials of Molecular Biology, 3rd Edition, Jones and Bartlett Publications Inc., London, 1998.
2. Lewin Benjamin, Gene VIII, Pearson Education, New Jersey, 2004.
3. Watson. J.D., Molecular Biology of the Gene, 5th Edition, Pearson Education, New Jersey, 2004.
4. Peter J. Russell, Reed College, 5th Edition, Pearson Education,1998

WEB RESOURCE LINKS

http://www.cellbiol.com/education.php ¬
http://www.cellbiol.com/sequence_tools.php/#basic-tools ¬
http://www.cellbiol.com/sequence_tools.php/#basic-tools

CORE COURSE - III

GENETIC ENGINEERING

Semester: I | Max mark: 100(Int:25,Ext:75)
Course code: 18PBT1C3 | Credit: 4
Total Hours: 75 | Exam hrs: 3

OBJECTIVES:

To impart the learners with the advanced knowledge and growing significance of genetic and protein engineering/ DNA cloning. To educate the students with the advanced tools, techniques and methods employed in DNA/ gene cloning and expression as well as in protein engineering strategies.

UNIT I

INTRODUCTION TO GENE CLONING STRATEGIES **15**

Gene cloning: Steps - Isolation and purification of nucleic acids (genomic DNA, RNA and Plasmids) – Methods of handling and quantification of DNA and RNA. Analyses of DNA/ RNA and proteins: Agarose Gel and SDS – PAGE - Blotting – types of blotting – Southern, Northern and Western Blotting. Chromosome walking.

UNIT II

TOOLS AND METHODS IN GENE CLONING **15**

Restriction endonucleases – nomenclature, classification and characteristics - DNA methylases – DNA polymerases - Ligases – Adapters, Linkers and Homopolymer tailing – Gene transfer techniques: electroporation, microinjection, protoplast fusion and microparticle bombardment – Screening for recombinants: Direct: Insertional inactivation, plaque phenotype and indirect methods: Immunochemical detection, nucleic acid hybridization, Dot and Colony Blotting. Methods of DNA cloning. Construction and applications of Genomic DNA and cDNA libraries.

UNIT III

GENE CLONING VECTORS FOR PROKARYOTES AND EUKARYOTES **15**

Cloning Vectors – properties - types of vectors – plasmids – host range and incompatibility – plasmids vectors for cloning in E. coli (pBR322 and derivatives, pUC vectors and pGEM3Z) - Vectors constructed based on bacteriophages (M13 and Lambda), cosmids, phasmids, phagemids and BACs - Eukaryotic vectors - Yeast vectors – animal and plant vectors – expression vectors: E. coli lac and T7 phage promoter based vectors - shuttle vectors - Expression of foreign genes in bacteria, animal, plant, algae and fungi – merits and demerits.

UNIT IV

TECHNIQUES IN GENETIC ENGINEERING **15**

Characterization of cloned DNA: Restriction mapping - restriction fragment length polymorphism (RFLP) - Polymerase chain reaction (PCR) – Principles, 43 types and their applications. DNA sequencing: Primer walking, Chemical method: Maxam and Gilbert method, Sanger's method: traditional (dideoxy) and automated sequencing methods. Pyrosequencing – DNA chips and micro array.

UNIT V

PROTEIN ENGINEERING AND TECHNIQUES **15**

Site directed mutagenesis – methods - Design and construction of novel proteins and enzymes, Basic concepts in enzyme engineering, engineering for kinetic properties of enzymes. protein folding, protein sequencing, protein crystallization. Data analysis - Mass spectrometry based methods for protein identification, MALDI-TOF, 2D gel electrophoresis – Applications of protein engineering: Examples of engineered proteins.

REFERENCES

1. Old RW and Primrose SB. Principles of gene manipulations – An introduction to genetic engineering, 5 ed. University of California Press, 1995.
2. Winnacker EL. From Genes to Clones. – Introduction to gene technology. Wiley-Blackwell. 1987.
3. Nicholl DST. An introduction to genetic engineering. Cambridge University Press.1994.
4. Brown TA. Gene Cloning. London; New York: Chapman and Hall.1995.
5. Pinler A. Genetic engineering of microorganisms. Protein Structure, Stability and Folding by Kenneth P. Murphy. Published by Humana Press Inc. 2001.
6. Jeffrey L, Cleland and Charles S Craik. Protein Engineering Principles and Practice Published by Wiley-Liss Inc. 1996.
7. Paul R Carey. Protein Engineering and Design, Published by Academic Press Inc. 1996.
8. Glick BR. Molecular Biotechnology – Principles and applications of recombinant DNA. 3rd edition, ASM Press, Washington, DC. 2003.
9. Old RW and Primrose SB. Principles of Gene Manipulation - An Introduction to Genetic Engineering. 5th edition. Blackwell Scientific Publications, London. 2003.
10. Winnacker EL. From Genes to Clones – Introduction to Gene Cloning, 1st edition. Indian reprint, Panima publishing Corporation, New Delhi. 2003.
11. Nicholl D. An introduction to genetic engineering. 3rd Cambridge University Press, Cambridge. 2008. 12. Brown TA. Genomes. 2nd Ed, John Wiley and sons. 2012.
13. Brown TA. Gene Cloning and DNA analysis introduction. 4th Ed. Blackwell Science Ltd., London. 2001.

CORE COURSE - IV

LAB IN CELL BIOLOGY, MOLECULAR BIOLOGY AND GENETIC ENGINEERING

Semester: I
Course code: 18PBT1C4P
Total Hours: 90

Max mark: 100(Int:40,Ext:60)
Credit: 3
Exam hrs: 3

OBJECTIVE

This course presents the study about cells , extraction of molecules inside the cell and tools used in Genetic Engineering.

CELL BIOLOGY

1. Introduction to principles of sterile techniques and cell propagation
2. Identification of given plant, animal and bacterial cells and their components by microscopy.
3. Leishman Staining and Giemsa Staining.
4. Osmosis and Tonicity.
5. Tryphan Blue Assay.
6. Staining for different stages of mitosis and meiosis.

MOLECULAR BIOLOGY

1. Extraction of DNA and RNA
2. Estimation of DNA and RNA.
3. Isolation of Plasmid DNA.
4. Mutagenesis in Bacteria: The Ames test
5. Transformation in *E. coli.*
6. Mutant isolation by gradient plate technique.

GENETIC ENGNEERING

1. Elution of DNA from agarose gels.
2. Restriction digestion of DNA
3. Ligation of DNA into expression vectors.
4. SDS-PAGE, 2DGel, ISO–electricFocussing.
5. Western blotting.
6. PCR.

CORE COURSE – V

RECOMBINANT DNA TECHNOLOGY

Semester: II | Max mark: 100(Int:25,Ext:75)
Course code: 18PBT2C5 | Credit: 5
Total Hours: 90 | Exam hrs: 3

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

INTRODUCTION **18**

Isolation of DNA and RNA. Quantification of nucleic acids. Radiolabelling of nucleic acids: End labelling, nick translation, labelling by primer extension, DNA sequencing: Maxam-Gilbert (Chemical) and Sanger- Nicolson (dideoxy/ enzymatic) sequencing method, Pyrosequencing.

UNIT II

RESTRICTION ENDONUCLEASES **18**

Restriction endonucleases: Types of restriction endonucleases, classification and uses. Restriction mapping. DNA modifying enzymes: Nucleases, Polymerases, Phosphatases and DNA ligases.

UNIT III

HOST AND VECTORS **18**

Prokaryotic host. Plasmid vectors, Bacteriophage, other vectors, expression vectors, Construction of genomic and c-DNA libraries, Joining of DNA Fragments to vectors, Homo polymer tailing, cohesive and blunt end ligation, adaptors, linkers.

UNIT IV

ANALYTICAL TECHNIQUES **18**

Selection, screening and analysis of recombinants. Principle of hybridization. Northern blotting, Southern blotting, Western blotting. Polymerase chain reaction, Restriction fragments length polymorphism, RAPD, AFLP, MAP.

UNIT V

VECTOR **18**

Biology of bacteriophage lambda. Lambda phage as natural in vivo vector, in vitro construction of a lambda vector, classes of lambda vectors. Cosmid vectors, M13 vectors and their use, Specialized vectors, Animal viruses and gene cloning. Agrobacterial plasmid biology, Vectors for yeast.

REFERENCES

1. Principles of gene manipulation by RN old & S.B. Primrose (1996) Blackwell Scientific Publications

2. DNA cloning I & II by DM Glover & BD. Hames (1995) IRL, Press

3. PCR strategies by MA. Innis, DH, Gelfand & JJ Sninskey (((%), Academic press

4. Diagnostic Molecular Microbiology by D.H. Persing, K T.F. Smith, F.c. Teower and T.J. While. ASM Press 1993

5. Recombinant DNA by Watson JD, Gilman M. Witkowski, Zoller M. (1992), Scientific American Books

6. Recombinant gene expression protocols by Tvan RS (1997) Humana Press.

7. The Bacteriophages Vol. II by R. Calendar (1988) Plenum Press.

CORE COURSE - VI

ENVIRONMENTAL BIOTECHNOLOGY

Semester: II | Max mark: 100(Int:25,Ext:75)
Course code: 18PBT2C6 | Credit: 4
Total Hours: 75 | Exam hrs: 3

OBJECTIVES: This course will give an knowledge about the environmental issues of water pollution, solid waste management and their treatment.

UNIT – I
ENVIRONMENTAL POLLUTION **15**

An Introduction - Types of pollution, Methods for the measurement of pollution; Global environmental problems: ozone depletion, green house effect and acid rain - Methodology of environmental management – the problem solving approach, its limitations. Air Pollution and its Control through Biotechnology; Bioremediation of contaminated soils and wastelands. Biological remediation - Reclamation and fertility improvement -agriculture farm land.

UNIT – II
WATER POLLUTION AND CONTROL **15**

Need for water management, Measurement and sources water pollution.- Biological treatment of industrial effluents -Utilization of aquatic macrophytes, terrestrial plants, fungi, bacteria and cyanobacteria. -Biodegradation of inorganic and organic wastes, lignin, tannin. Bioremediation of oil spills. Microbial remediation of phenolics. metals, sewage nutrients (phosphate and nitrate)- Bio Bioremediation and bioaugmentation. Biosorption and bioleaching. Biotechnological approaches for heavy metal elimination from sewage water and effluents.

UNIT - III
WASTE TREATMENT **15**

Physico-Chemical properties of water - Waste water treatment: physical, chemical and biological treatment processes. Biotechnological approaches for industrial waste water treatment - treatment schemes for waste waters of dairy, distillery, tannery, sugar, and pharmaceutical industries. Bioreactors for waste water treatment. Biomonitoring: Principle of biomonitoring. Biomonitoring and management for (BOD,COD) effluent toxicity, heavy metal pollution, thermal and radioactive pollution. - Biomonitoring of water pollutation using algae, bacteria, plankton, macrophytes, invertebrates, fishes (Bioindicators).

UNIT – IV
SOLID WASTE MANAGEMENT **15**

Types of solid wastes - Solid waste characteristics. Its impact on environment. Solid waste disposal; land filling, incineration. composting, mushroom farming, vermiculture and biogas production - Processing of sugar factory wastes, coir wastes, residential and municipal wastes, and mycostraw wastes. Bioplastics. Xenobiotics: Biodegradation of xenobiotics compounds, Organisms involved in degradation of xenobiotics: hydrocarbons, substituted hydrocarbons,

degradative plasmids, surfactants, pesticides. Biotechnological methods for hazardous waste management.

UNIT – V

CONSERVATION BIOTECHNOLOGY **15**

Biodiversity. Definition and types . Uses and values of Biodiversity- Loss of Biodiversity-Conservation and sustainable management of Biodiversity-. In situ (afforestation, social forestry, agro forestry, botanical Gardens, 24 Zoos, biosphere reserves, national parks sanctuaries, scared groves and Sthalavrikshas) and Ex situ (Cryopreservation, gene banks, seed banks, pollen banks, sperms banks, DNA banks, Tissue culture and Biotechnological strategies), ecorestoration, environmental and biodiversity laws, environmental education. Environmental Management: Environmental Impact Assessment. National environmental policies - pollution control Boards-mass movements on environmentenvironmental ethics- environmental awareness- mass communication.

REFERENCES

1. Alan Scragg. 1999. Environmental Biotechnology. Pearson Education Limited, England.
2 Jogdand, S.N. 1995. Environmental Biotechnology. Himalaya Publishing House, Bombay.
3. Technoglous, G., Burton,F.L. and Stensel, H.D. 2004. Wastewater Engineering – Treatment, Disposal and Reuse. Metcalf and Eddy, Inc.,Tata Mc Graw Hill, NewDelhi.
4. De, A.K. 2004. Environmental Chemistry. Wiley Eastern Ltd. NewDelhi.
5. Allsopp, D. and K.J. Seal. 1986. Introduction to Biodeterioration. ELBS/Edward Arnold, London.
6. Athie, D. and C.C. Cerri. 1990. The Use of Macrophytes in Water Pollution Control, Pergamon Press, Oxford.
7. Chin, K.K. and K. Kumarasivam. 1986. Industrial Water Technology Treatment, Resuse and Recycling . Pergamon Press, Oxford.
8. Henze, M. and W. Gujer 1992. Interactions of Wastewater: Biomat and Reactor Configurations in Biological Treatment Plan - Pergamon Press, Oxford.
9. Jenkins, D. and B.H. Olson(Eds). 1989. Water and Wastewater Microbiology. Pergamon Press, Oxford.
10.Fry, F.C., Gadd, G.M. Herbert, R.A. , Jones, C.W., and Watson-Craik,J.A.(Eds.) 1982. Microbial Control of Pollution . Cambridge University Press, New York.
11. McEldowney, Sharon, Hardman, David, J.,and Waite, Stephen. (Eds). 1993 . Pollution, Ecology Biotreatment . Longman Scientific & Technical, Harlow, England.
12. Kaul,T. Nady and Trivedy, R.K.1993. Pollution Control in Distilleries. Enviromedia, Karad, India.
13. Sastry, C.A., Hashim, M.A.,and Agamuthu, P.(Eds.)1995. Waste Treatment Plants . Narosa Publishing House, New Delhi, India.
14. Dart, R.K. and R.J. Stretton, 1994. Microbiological Aspects Pollution Control.Elsevier Pub.Co., Amsterdam:New York.
15. John Cairns and Todd V. Crawford 1990. Integrated Environmental Management . Lewis Publishers Inc., Chelsea, Michigan.
16. Dekruiif, H.A.M. deZwart, P.K. Ray and P.N. Viswanathan. 1988. Manual on Aquatic Ecotoxicology, Allied Publishers Pvt. Ltd., Lucknow, India.

17.Cairns, John., B.R. Niedalehner and David R. Orves. (Eds.). 1992. Predicting Ecosystem Risk, Preinceton Scietific Publishing Co.Princeton, NJ, USA.
18. Matsui, S. 1983. Hazard Assessment and Control of Environmental Contaminants in Water. Pergamon Press, Oxford.
19. Robert Lauwerys and Perrine Hoet. 2001. Industrial Chemical Exposure : Guidelines for Biological Monitoring . CRC Press, Lewi Publishers, Boca Raton, Florida, USA. 25
20. Holmes, G., Singh, B.R. and Thedore. L. 1993. Handbook of Environmental Management and Technology. John Wiley and Sons, New York.
21. Krishna Iyer, V.R. 1992. Environmental Protection and Legal Diffence. Sterling Publishers, New Delhi.
22. Shukla, S.K. and Srivastava, P. 1997. Pollution Control . Common Wealth Publishers, New Delhi.
23. Howard, S., Peavy,D.R. and Rowe and G.Tchnoglous. 1985. Environmental Engineering. McGraw Hill, New York.
24. Raul Gagliardi and Torkel Alfthan. 1984. Environmental Training. Oxford & IBM Publishing Co., Pvt. Ltd., New Delhi

CORE COURSE – VII

PLANT BIOTECHNOLOGY

Semester: II | Max mark: 100(Int:25,Ext:75)
Course code: 18PBT2C7 | Credit: 4
Total Hours: 75 | Exam hrs: 3

OBJECTIVES:

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

UNIT I

PLANT GENOME ORGANIZATION **15**

Plant genome organization – organization of chloroplast genome, nuclear encoded and chloroplast encoded genes for chloroplast proteins. Organization of mitochondrial genome – encoded genes for mitochondrial proteins.

UNIT II

PLANT TISSUE CULTURE **15**

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 – Micro propagation, Callus culture, somatic embryogenesis, suspension culture, embryo culture, haploid culture, protoplast culture, protoplast fusion; Somaclonal variation; Artificial seeds; hardening.

UNIT III

PLANT TRANSFORMATION TECHNOLOGY **15**

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 IV

GENETIC TRANSFORMATION **15**

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 V

PHYTOCHEMICAL PRODUCTS **15**

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. Extraction & purification of phyto-chemicals

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,(2nd 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.

CORE COURSE – VIII

LAB IN rDNA TECHNOLOGY, ENVIRONMENTAL BIOTECHNOLOGY AND PLANT BIOTECHNOLOGY

Semester: II | Max mark: 100(Int:40,Ext:60)
Course code: 18PBT2C8P | Credit: 3
Total Periods: 90 | Exam hrs: 3

LAB IN rDNA TECHNOLOGY

1. Restriction analysis of plasmid (pBR322,pUC18)
2. Selection methods (Blue white selection,insertional inactivation)
3. primer design and PCR amplification of β(beta)- galactosidase
4. Cloning of PCR product into pBR322
5. Introduction of cloned genes and analysis by SDS – PAGE
6. Southern blotting
7. RFLP Analysis of 18s rRNA of the genome
8. Genetic diversity of Pseudomonas by RAPD
9. Reporter gene assay (GUS/ β(beta)- galactosidase)

ENVIRONMENTAL BIOTECHNOLOGY

1. Water Analysis: Measurement of Total Solids, Total-dissolved solids, Total-suspended solids, dissolved oxygen, total hardness, chloride, turbidity, nitrite, nitrate, COD, BOD, fluoride and total nitrogen.
2. Air Analysis: Suspended particles, Sio2, oxides of nitrogen, H2S
3. Treatment studies of effluent using aeration techniques.
4. Removal of solids using coagulation technique
5. Microbial assessment of air quality (open plate and air sample)
6. Potability test of water (MPN technique).
7. Degradation of phenols. Colorimetric assay
8. Phosphate, nitrogen and metal removal by microbes
9. Generation of biogas (methane) from wastes- estimation by gas chromatography.
10. Field trip to dairy, food industries, sewage treatment plants.

PLANT BIOTECHNOLOGY

1. Tissue Culture Techniques: Media composition and preparation-sterilization Techniques.
2. Micropropagation through node and shoot tip explants
3. Organ development from cultured tissue
4. Induction of Somatic Embryos
5. Culture of matured embryos and endosperm
6. Initiation and maintenance of callus
7. Measurement of plant cell growth, (PCV, cell number, Wet and Dry Weights)

8. Determination of vascular element formation
9. Seed culture technique; Production of Synthetic seeds
10. Phytochemical analysis of total protein, sugar in cultured tissue
11. Detecting antibacterial secondary metabolite production by cultured tissue
12. Qualitative analysis of secondary metabolites in cultured cells
13. Protoplast isolation and fushion
14. Culture of Agrobacterium, plasmid isolation and identification by agarose gel Electrophoresis.
15. Agrobacterium mediated transformation studies, confirmation of trans gene Expression by GUS expression, PCR analysis and blotting techniques
16. Demonstration of RFLP and RAPD in plants.

APPLICATION ORIENTED COURSE I

BIOTECHNOLOGY FOR ENTREPRENEURS

Semester: I | Max mark: 100(Int:25,Ext:75)
Course code: 18PBT1A1 | Credit: 3
Total Hours: 45 | Exam hrs: 3

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

Unit I

Introduction to Entrepreneurship **9**

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 **9**

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 **9**

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,

Unit IV

Generation of Fund **9**

Funding of biotech business ,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 .

Unit V **9**

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

APPLICATION ORIENTED COURSE II

MICROBIAL PRODUCT DEVELOPMENT

Semester: II
Course code: 18PBT2A2
Total Hours: 45

Max mark: 100(Int:25,Ext:75)
Credit: 3
Exam hrs: 3

OBJECTIVE: This course will give an idea about the Pollutants in the environment and their treatments using biological techniques and the products produced using microbes.

UNIT I - WASTE & POLLUTANTS 9

Source of Waste and Pollutants; Hazardous from Waste and Pollutants; Waste Treatment-Biofilters, Treatment of Liquid wastes, Treatment of Solid wastes, Contributions of Biotechnology to waste treatment and Environmental Managements.

UNIT II - WASTE WATER BIOTREATMENT 9

Characteristics of Waste Waters; Aerobic and Anaerobic waste water treatment: Activated Sludge Process and Natural Treatment Systems; Stoichiometry and Bioenergetics ;Anaerobic Digestion; Nitrogen Removal and Anammox; Phosphorus Removal and EBPR.

UNIT III - SOLID WASTE MANAGEMENT 9

Definition of solid wastes — types of domestic solid wastes – collection – transportation – characteristics of solid waste–segregation – types of disposal methods – sanitary land fill – incineration – composting – Vermicompost – recovery of energy from solid wastes. Biocontrol agents- Bioherbicides & Biopesticides, Biofertilizers.

UNIT IV - SPECIFIC BIOREMEDIATION TECHNOLOGIES 9

Application, specific advantages and disadvantages of specific bioremediation technologies-land farming, prepared beds, biopiles, composting, bioventing, biosparging, pump and treat method, constructed wet lands, use of bioreactors for bioremediation. Phytoremediation, restoration of water bodies a case study. . Heavy metal pollution & sources; ;Microbial transformation; – Biosurfactants.

UNIT V MICROBIAL PRODUCTS AND ITS MARKETING 9

Microbial products developed in agriculture, Marketing principles of microbial and agricultural product, Ethics of marketing.

TEXT BOOK

1. Bruce E. Rittmann, Perry L. McCarty, "Environmental Biotechnology: Principles and Applications" McGraw-Hill, 2001.
2. Phillip L. Buckingham, Jeffrey C. Evans," Hazardous Waste Management" Waveland Pr Inc; Reissue edition 1, 2010.
3. Agarwal S. K., "Environmental Biotechnology", APH Publishing, 2000. 4. Rajendran P., P. Guansekaran, "Microbial Bioremediation", Mjp Publishers, 2011.
4. Chatterjee.A.K, "Introducton to Environmental Biotechnology," Prentice-Hall of India, 2004.
5. Jogdand.S.N, "Environmental biotechnology: industrial pollution management," Himalaya Publishing, 2005.

REFERENCE BOOK

1. Leslie Grady Jr C. P., Glen T. Daigger, Nancy G. Love, Carlos D. M. Filipe, "Biological Wastewater Treatment," Third Edition, CRC Press, 2011.
2. Agarwal S. K., "Environmental Biotechnology", APH Publishing, 2000.
3. Martin Alexander, "Biodegradation & Bioremediation", Academic press, 1999.

ELECTIVE COURSES

ELECTIVE COURSE-I

A. AGRICULTURAL BIOTECHNOLOGY

Semester: I | Max mark: 100(Int:25,Ext:75)
Course code: 18PBT1E1A | Credit: 4
Total Hours: 75 | Exam hrs: 3

OBJECTIVES: This course will give an idea about the basic principles and techniques involved in plant tissue culture and to understand the concepts of crop improvement and achievements of biotechnology in Agricultural.

UNIT I

PLANT TISSUE CULTURE **15**

Basic techniques and tools in Plant Tissue Culture.Establishment of plant tissue culture lab: equipment, culture vessels,surface sterilization of various explants, pretreatment of explant, subculture and repeated transfer of explants and cultures.Composition of various tissue culture mediaand their preparation. Establishment of callus, suspension cultures, organogenesis and embryogenesis, Meristem tip culture, Hardening of plants, Techniques of anther, embryo and ovule culture.Protoplast isolation, culture and fusion. Artificial seed (synthetic seed).

UNIT II

CROP IMPROVEMENT **15**

Crop improvement – Advantages of biotechnological methods over conventional methods of crop improvement. a) Homozygous plant production through anther & pollen culture b) Embryo rescue & embryo culture in rearing viable hybrid embryos c) Endosperm culture & production of triploids d) Apomixis e) Induced Polyembryony f) Somaclonal and gametoclonal variations and their applications in crop improvement

UNIT III

BIOREACTORS IN PLANT PRODUCTION **15**

Designing, Fabrication, Assembly, Accessories of reactors – Working principles – Media selection – Microbes multiplication. Use of bioreactors in plant production & Scale-up Marker assisted selection – introduction to markers (RFLP, AFLP, microsatellites, RAPD, QTL), generation of maps using markers, case studies of MAS, virus indexing. Green fluorescent & red fluorescent protein – Plantibody production – plants as tool for recombinant protein production – vaccine product in plants,

UNIT IV

TRANSGENICS IN CROP IMPROVEMENT **15**

Gene transfer methods in plants: direct and indirect DNA transfer. Chloroplast transformation and its advantages. Transgene stability and gene silencing.

Application of Plant Transformation: Herbicide resistance - Disease resistance - Virus resistance-Nematode resistance. Abiotic stress tolerance: drought and salt. Postharvest losses: long shelf life of fruits and flowers.

UNIT V

AGRO-BIOTECHNOLOGY **15**

Case studies in agro-biotechnology – one each from following crops a) cereal, b) pulse, c) oil seed d) ornamental e) vegetable. Agricultural biotechnology and agribusiness. Economic value of herbals and herbal drugs. Identification,cultivation and micropropagation of herbals, biotechnological exploitation.

REFERENCES

1. Hou CT, Shaw JF (2009) – Biocatalysis and agricultural biotechnology, CRC Press, USA
2. Agricultural biotechnology, 1st edition, (2008) Raw at H, Oxford Book Co, India.
3. Agrobiotechnology and plant tissue culture, Bhojwa ni SS, Soh WY, Oxford & IBH Publ, India
4. Agricultural biotechnology, (2005), Kumar HD, Daya Publ House, India
5. Plant molecular breeding, (2009), Newbury HJ, John Wiley and Sons., USA.
6. Embryology of Angiosperms, (2009), S.S. Bhojwani and S.P. Bhatnagar, Vikas Publ House, India.
7. Ashwani Kumar, Shekhawat NS (2009) – Plant tissue culture and molecular markers: theor role in improving crop productivity (IK International)
8. Biotechnology, 4th edition, (2010), H K Das, Wiley India Pvt. Limited, India.

B. GENOMICS AND PROTEOMICS

Semester: II | Max mark: 100(Int:25,Ext:75)
Course code: 18PBT1E1B | Credit: 4
Total Hours: 75 | Exam hrs: 3

OBJECTIVES: To impart in depth knowledge on genomics and proteomics. This paper is also designed to provide knowledge on genomics and proteomics function and also their applications

UNIT I

GENOME MAPPING, ASSEMBLY AND COMPARISON **15**

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 **15**

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 **15**

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 **15**

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 **15**

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. Necia Grant Cooper; (Ed.) 1994.The Human Genome Project; Deciphering the blueprint of heredity University Science books, CA, USA.
2. Gary zweiger, 2003. Transducing the Genome; Information, Anarchy and Revolution in Biomedical Sciences. Tata McGraw-Hill Publishers, New Delhi.
3. Howard L McLeod1 and William E Evans. 2001. PHARMACOGENOMICS: Unlocking the Human Genome for Better Drug Therapy. *Annu. Rev. Pharmacol. Toxicol.* 41:101–121.
4. Evans W.E. and Relling, M.V. 1999. Pharmacogenomics: translating functional genomics into rational therapeutics. *Science* 286:487
5. Satoskar, R.S., Bhandarkar, S.D and Annapure, S.S. 1999. Pharmacology and Pharmacotherapeutics, Popular Prakashan, Mumbai.
6. Branden, C and J.Troze, 1999. Introduction to Protein Structure. Second Edition.Garland Publishing, New Delhi.
7. Baxevanis, A.D and Ouellette, B.F.F. Eds. 2001. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. Wiley Interscience. New York.
8. Higgins, D and Taylor, W (Eds). 2000. Bioinformatics: Sequence, Structure and Databnks.Oxford University Press, Oxford.

ELECTIVE COURSE-II

A. IPR, BIOETHICS AND BIOSAFTY

Semester: II
Course code: 18PBT2E2A
Total Hours: 75

Max mark: 100(Int:25,Ext:75)
Credit: 4
Exam hrs: 3

OBJECTIVES:

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

UNIT I

INTRODUCTION TO INTELLECTUAL PROPERTY **15**

Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of New GMOs; International framework for the protection of IP IP as a factor in R&D; IPs of relevance to Biotechnology and few Case Studies; Introduction to History of GATT, WTO, WIPO and TRIPS

UNIT II

CONCEPT OF 'PRIOR ART' AND BASICS OF PATENTS **15**

Invention in context of "prior art"; Patent databases; Searching International Databases; Country wise patent searches (USPTO, EPO, India etc.); Analysis and report formation, Types of patents; Indian Patent Act 1970; Recent Amendments; Filing of a patent application; Precautions before patenting-disclosure/non-disclosure; WIPO Treaties; Budapest Treaty; PCT and Implications; Role of a Country Patent Office; Procedure for filing a PCT application.

UNIT III

PATENT FILING AND INFRINGEMENT **15**

Patent application- forms and guidelines, fee structure, 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-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, financial incentives Patent infringement- meaning, scope, litigation, case studies and examples

UNIT IV

BIOETHICS **15**

Benefits and risks of genetic engineering – ethical aspects of genetic testing – ethical aspects relating to use of genetic information – genetic engineering and biowarfare; Ethical implications

of cloning: Reproductive cloning , therapeutic cloning ; Ethical, legal and socioeconomic aspects of gene therapy, germ line, somatic, embryonic and adult stem cell research-GM crops and GMO's – biotechnology and biopiracy – Ethical implications of human genome project

UNIT V

BIOSAFETY **15**

Introduction; Historical Backround; 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 - Government of India; Definition of GMOs & LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of National Regulations and relevant International Agreements including Cartagena Protocol.

REFERENCES:

1. Ethics in engineering, Martin. M.W. and Schinzinger.R. III Edition, Tata McGraw-Hill, New Delhi. 2003.
2. BAREACT, Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., 2007
3. Kankanala, K . C. 2007. Genetic Patent Law & Strategy, 1st Edition. Manupatra Information Solution Pvt. Ltd.,.Noida, India.
4. Jose B. Cibelli, Robert P. Lanza, Keith H. S . Campbell, Michael D.West. 2002. Principles of Cloning, Academic Press, SanDiego, Gurdon.
5. Hoosetti, B.B.2002. Glimpses of Biodiversity. Daya, New delhi.
6. Senthil Kumar Sadhasivam and Mohammed, Jaabir. 2008. IPR, Biosafety and Biotechnology Management. Jasen Publications, Tiruchirapalli, India.
7. http://www.cbd.int/biosafety/background.shtml
8. http://web.princeton.edu/sites/ehs/biosafety/biosafetypage/section 3.html.

B. MARINE BIOTECHNOLOGY

Semester: II | Max mark: 100(Int:25,Ext:75)
Course code: 18PBT2E2B | Credit: 4
Total Hours: 75 | Exam hrs: 3

OBJECTIVES: To impart knowledge on marine microbes. This paper is also designed to provide knowledge on active compound in marine microbes and their applications in various aspects.

UNIT I

BASICS OF MARINE BIOTECHNOLOGY **15**

Biotechnology in marine science- history of marine biotechnology application in aquaculture, pharmaceutical, environment remediation, biofouling and biocorroison.

UNIT II

DEVELOPMENTAL BIOTECHNOLOGY **15**

Developmental biotechnology induced breeding in-vitro fertilization cryopreservation biotechnological tools - ELISA, FISH, PCR Gene probes, dot immuno binding activity, monoclonal antibodies biosafety ethics.

UNIT III

BIOACTIVE COMPOUNDS **15**

Bioactive marine natural products membrane receptors, anti tumor compounds, anti inflammatory / analgesic compounds, anti viral agents, isolation and identification of marine bioactive compounds such as labile proteins, toxins, carotenoids bioterminator Commercial development of marine natural products-chitosan, chitin.

UNIT IV

ALGAL BIOTECHNOLOGY **15**

Algal biotechnology - single cell protein, hydrocolloids, agarose, carrageen alginates and other by products. Marine Enzyme sources and their applications, Marine Lipid sources and their applications.

UNIT V

APPLICATIONS **15**

Pharmaceutical compounds: antibiotics, antiviral compounds, antitumour compounds, enzymes, surfactants, other potentially useful microbial products such as marine cements, biominerals, antifouling compounds and other applications.

REFERENCES

1. Italy, E (Eds). 1998, New Developments in Marine Biotechnology, Plenum Pub. Corp.
2. Milton Fingerman and Rachakonda Nagabhushanam, 1996, Molecular Genetics of Marine Organisms,Science Pub Inc.
3. Y. Le Gal and H.O.Halvorson 1998, New Developments in Marine Biotechnology. Springer.
4. David H. Attaway, 2001. Marine Biotechnology, Volume 1, Pharmaceutical and BioactiveNatural Products.
5. Rita R. Colwell 1984. Biotechnology in the Marine Sciences (Advances in Marine Science & Biotechnology) Wiley Interscience.
6. Scheupr, P.J. (Ed.), 1984. Chemistry of Marine Natural Products, ,Chemical and Biological Perspectives. Vol. I III, Academic Press, New York.

CORE COURSE IX

ANIMAL BIOTECHNOLOGY

Semester: III | Max mark: 100(Int:25,Ext:75)
Course code: 18PBT3C9 | Credit: 6
Total Hours: 90 | Exam hrs: 3

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

INTRODUCTION **18**

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, invitro 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 **18**

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 **18**

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 **18**

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

GENE THERAPY AND PATENDING **18**

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.

REFERENCE

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) 1st 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.

CORE COURSE X

BIOPROCESS TECHNOLOGY

Semester: III | Max mark: 100(Int:25,Ext:75)
Course code: 18PBT3C10 | Credit: 5
Total Hours: 90 | Exam hrs: 3

OBJECTIVES

This course is designed to have an understanding about the basics of Bioreactor and the

Fermentation techniques, Upstream and Downstream Processing and their application

UNIT I:
INTRODUCTION
Principles of Microbial growth – introduction, the ways of growing microorganisms, ways to increase yield of microbes, Batch, fed-batch and continuous cultures (definition and kinetics).

UNIT II:
BIOREACTOR **18**
Bioreactor / Fermenter – types, working & operation of Bioreactors, Fermenters (Stirred tank, bubble columns, airlift. Bioreactors, Static, Submerged and agitated fermentation), advantages & disadvantages of solid substrate & liquid fermentations, Quality control.

UNIT III:
UPSTREAM AND DOWNSTREAM PROCESS **18**
Upstream processing (Strain selection, Sterilization, pH maintainance and antifoaming), Downstream processing – extraction, separation, concentration, recovery & purification, operations (Insulin, Vitamins, Metabolites), Quality Control.

UNIT IV:
ENZYME TECHNOLOGY **18**
Enzyme technology – nature of enzymes, application of enzymes, limitations of microbial cells used as catalysts in fermentation, multi-enzyme reactors, protein engineering of enzymes, cloning strategy for enzymes, technology of enzyme production, industrial applications of immobilized enzymes.

UNIT V:
INDUSTRIAL APPLICATIONS OF BIOTECHNOLOGY **18**
Biotechnology in specific medical & industrial applications - Microbial process for immunization (Production of monoclonal antibodies), Deterioration of paper, textiles, painted surfaces and their prevention, Biofilms, microbial biopolymers, biosurfactants, Microbial culture selection with high yield potential and quality control.

REFERENCES

1. Sullia S. B& Shantharam S: (1998) General Microbiology, Oxford & IBH Publishing Co. Pvt. Ltd.
2. Bisen P.S (1994) Frontiers in Microbial Technology, 1st Edition, CBS Publishers.
3. Glaser A.N & Nilaido.H (1995) Microbial Biotechnology,W.H Freeman & Co.
4. Prescott & Dunn (1987) Industrial Microbiology 4th Edition, CBS Publishers & Distributors.
5. Prescott & Dunn (2002) Industrial Microbiology, Agrobios (India) Publishers.

CORE COURSE XI

IMMUNOTECHNOLOGY

Semester: III | Max mark: 100(Int:25,Ext:75)
Course code: 18PBT3C11 | Credit: 5
Total Hours: 75 | Exam hrs: 3

OBJECTIVES: This course is designed to make the learner understand about the basic concepts of Immunotechnology, generation antibodies and vaccines using recent technology.

UNIT I - INTRODUCTION TO IMMUNOTECHNOLOGY **15**

Kinetics of immune response, memory; Principles of Immunization; Techniques for analysis of Immune response, Hybridoma Technology-Production of Monoclonal Antibodies, Isolation and Purification of Monoclonal Antibodies (Affinity Chromatography)

UNIT II - ANTIBODY RELATED TECHNIQUES **15**

Immuno-chemistry of Antigens - immunogenecity, Antigenecity, haptens, Toxins-Toxiods, Hapten-carrier system; Genetic bases of immune response – Heterogenecity; Role and properties of adjuvants, Immune modulators; B cell epitopes; human; Antigen – Antibody interaction, affinity, cross reactivity, specificity, epitope mapping; Immuno assays RIA, ELISA, Western blotting, ELISPOT assay, immunofluorescence, Surface plasmon resonance, Biosensor assays for assessing ligand –receptor interaction

UNIT III - NEW GENERATION ANTIBODIES **15**

Multigene organization of immunoglobulin genes, Antibody diversity; Antibody engineering; Phage display libraries; Antibodies as in vitro and in vivo probes, Immuno antology, Immunoglobulin Database and Abzymes.

UNIT IV - CMI AND IMAGING TECHNIQUES **15**

CD nomenclature, Identification of immune Cells; Principle of Immunofluorescence Microscopy, Flurochromes; Staining techniques for live cell imaging and fixed cells; Flow cytometry, Immuno-electron microscopy or Confocal Microscopy. In vivo cell tracking techniques; Microarrays, Applications; Cell Functional Assays – lymphoproliferation, Cell Cytotoxicity, mixed lymphocyte reaction, Apoptosis, Cytokine expression; Cell cloning, Reporter Assays, In–situ gene expression techniques; Cell imaging Techniques – In vitro and In vivo.

UNIT V - VACCINE TECHNOLOGY **15**

Rationale vaccine design based on clinical requirements: Hypersensitivity, Immunity to Infection, Autoimmunity, Transplantation, Tumor immunology, immunodeficiency; Active immunization, live, killed, attenuated, Sub unit vaccines; Recombinant DNA and protein based vaccines, plant-based vaccines and reverse vaccinology; Peptide vaccines, conjugate vaccines; Passive Immunization; Antibody, Transfusion of immuno-competent cells, Stem cell therapy; Cell based vaccines

REFERENCES

1. Benjamin E. Coico and G. Ssunskine (2000) Immunology a short course, IV edn. (Chapters 1-13) Wiley – Liss Publication, NY

2. Kuby. J (1997) Immunology, 3Ed. WH Freeman & Co. NY

3. Goldsby R.A. Kindt T.I. and Osborne B.A. (2000) Kuby Immunology IV edn. WH Freeman & Co. NY.

4. Janeway C.A. Travers P. Wolport M and Capra J.D (1999) Immunology IV edn. Current Biology, NY

5. Roitt, I (2000), Essential Immunology, IV edn. Blackwell Sci. NY

6. Brown, F, Chanock, R.M., Lerner R.A. (Editiors) (1986) Vaccines 86; New approaches to Immunization

7. Fathman, C.G. Fitch F.W. (1982) Isolation, Characterization and utilization of TIymphocytes clones, Academic Press, London

8. Goding, J.W. (1998) Monoclonal antibodies: Principles and practice, Academic Press, London

9. Roitt, Male and Brostoff (1998) Immunology 4th edn. Pub. Mochy, New York pp 28.14

CORE COURSE XII

PRACTICAL COVERING CORE COURSE IX, X & XI

Semester: III
Course code: 18PBT3C12P
Total Hours: 120

Max mark: 100(Int:40,Ext:60)
Credit: 4
Exam hrs: 3

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 gel electrophoresis
6. Isolation & identification of stem cells

BIOPROCESS TECHNOLOGY

1. Ethanol production by yeast.
2. Wine production by yeast.
3. Estimation of alcohol content by colorimetric method and GLC.
4. Enzyme production of amylase.
5. Production of citric acid by solid state fermentation.
6. Down stream processes of enzymes – dialysis.
7. Ion exchange chromatography – drying – cellulose column chromatography.
8. Immobilization of yeast cell by alginate beads
9. Bioassay techniques for antibiotics.
10. Visit to Distillery unit and pharmacological industries.

IMMUNOTECHNOLOGY

1. Immunodiffusion (Single, Radial and Double)
2. Western blot
3. Isolation of Monocyte from blood.
4. Preparation of Serum and Plasma
5. WIDAL

ELECTIVE COURSE-III

A. ADVANCED BIOCHEMISTRY

Semester: III | Max mark: 100(Int:25,Ext:75)
Course code: 18PBT3E3A | Credit: 4
Total Hours: 75 | Exam hrs: 3

OBJECTIVES:

The objective o this course is to orient towards the application of knowledge acquired in solving clinical problems and to provide a base for molecular modelling and drug designing.

UNIT I :

METABOLISM OF POLYSACCHARIDES LIPIDS AND NUCLEIC ACIDS 15

Biosynthesis of nucleotide, Denova and Salvage Pathways or Purines and Pyrimidines. Regulatory mechanisms: degradation of nucleic acid by exo and endo nucleases. biosynthesis and degradation of starch and glycogen. triacylglycerol and phospholipid biosynthesis and degradation; cholesterol biosynthesis and regulation and targets and action of cholesterol lowering drugs.

UNIT II :

METABOLISM OF AMINO ACIDS 15

Basic structure and classification of amino acid, biosynthesis of amino acid – essential and non essential amino acid. metabolic disorders associated with branched chain and aromatic amino acid degradation. important molecules derived from amino acids -auxins, dopa, serotonin, porphyrins, t3, t4, adrenaline, noradrenaline, histamine, GABA, polyamines.

UNIT III :

PROTEIN TRANSPORT AND DEGRADATION 15

Protein targeting, signal sequence, secretion; folding, chaperons and targeting of organelle proteins, protein degradation, receptor-mediated endocytosis, turnover.

UNIT IV :

VITAMINS AND COENZYMES 15

Fat soluble vitamins, provitamins (a, d, e and k). Structure,physiological significance and deficiency symptoms. Water soluble vitamins, structure, coenzyme role and deficiency symptoms. Thiamine,riboflavin, pyridoxine, niacin, folic acid, biotin and vitamin b12. Recommended dietary intake. Coenzymes: their role in metabolic pathways.nad, fad,tpp, plp, carboxy biotin

UNIT V :

HORMONES **15**

Introduction. effects of hormones. chemical classification of hormones. peptide hormone vasopressin, protein hormone- insulin. lipid and phospholipid derived hormones prostaglandin and phospholipids. steroid hormones-testosterone, estrogen, cortisol. monoamines: thyroxine, adrenaline. mechanism of action of the different classes of hormones.production of insulin by rdna technology and it's biological properties.

REFERENCES

1. Voet, D.J And J.G. Voet And C.W. Pratt (2008) Principles Of Biochemistry 3rd Stryer, Lubert (2000) Biochemistry". 4th Edition, W.H Freeman & Co.,.
2. Edition,
   John Wiley & Sons Inc.,.
3. Murray, R.K., Et Al (2006) Harper's Illustrated Biochemistry". 27th Edition. McGraw-Hill,.
4. Creighton. T.E (1993) Proteins: Structure And Molecular Properties" 2nd Edition, W.H.Freeman And Co.
5. Salway, J.G (2000) Metabolism At A Glance -2nd Ed. Blackwell Science Ltd.

B. APPLICATION OF BIOINFORMATICS FOR BIOTECHNOLOGY

Semester: III
Course code: 18PBT3E3A
Total Hours: 75

Max mark: 100(Int:25,Ext:75)
Credit: 4
Exam hrs: 3

OBJECTIVES

The structure of the course is designed so as to provide an in-depth knowledge of all the necessary concepts related to bioinformatics, biology, tools, sequences, algorithms and the analysis of phylogenetic tree

UNIT I

BASIC BIOINFORMATICS **15**

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 **15**

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 **15**

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 **15**

Pairwise alignment methods such as Smith-Waterman and NeedlemanWunsch. 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. Phylogenetic tree, Neighbour joining, UPGMA. Use of Hidden Markov model (HMM) in assigning homology. Advantages and disadvantages of various sequence analysis methods.

UNIT V

DOCKING AND DYNOMIC STUDIES **15**

Ramachandren plot, Homology modeling, compound search DB-Pubchem, biocyc, principle of docking-classifiction of docking studies- docking software-auto dock, schrodinger, discovery studio. Visualization and interpretion of resource. Visualization tools- PyMOL, LIGPLOT, QSIR, pharmacophere modeling.

REFERENCE

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.

CORE COURSE XII

ADVANCED INSTRUMENTATION FOR BIOTECHNOLOGY

Semester: IV | Max mark: 100(Int:25,Ext:75)
Course code: 18PBT4C13 | Credit: 3
Total Hours: 45 | Exam hrs: 3

OBJECTIVES: This course is designed to give the knowledge about advanced techniques in biotechnology and their working principle.

UNIT I
BASIC TECHNIQUES **9**
Measurement of pH: pH Indicators, pH Meter, titration of acids, preparation of buffers. Estimation of macromolecules – carbohydrates, proteins, lipids

UNIT II
COLORIMETRY AND SPECTROSCOPY **9**
Properties of electromagnetic radiation - interaction with matter; Beer-Lambert‟s Law - differences between spectrophotometer and colorimeter - Visible light spectroscopy: Principle, instrumentation and applications. Ultraviolet spectroscopy - Atomic absorption spectroscopy, Thermogravimetric analysis, Spectrofluorimetry, FTIR, NMR and mass spectrometry.

UNIT III
CENTRIFUGATION **9**
Basic principles; Types of centrifuge - microfuge, and high-speed and ultracentrifuge; Preparative centrifugation; Differential and density gradient centrifugation; applications (Isolation of cell components); analytical centrifugation; determination of molecular weight by sedimentation velocity and sedimentation equilibrium methods

UNIT IV
ELECTROPHORESIS **9**
Theory and applications of electrophoresis; agarose and polyacrylamide Disc- and slab-gel electrophoresis; Gradient electrophoresis - Capillary electrophoresis; 2D Electrophoresis - Isoelectric focusing, pulse-field gel electrophoresis

UNIT V
CHROMATOGRAPHIC METHODS OF SEPARATION **9**
Introduction to chromatography - models, ideal separation, retention parameters Van - Deemter equation – TLC, HP-TLC and Column chromatography – chromatographic separation of proteins – ion-exchange, affinity, hydrophobic interaction and size-exclusion chromatography; gas chromatography (GLC) and high-performance Liquid Chromatography (HPLC)

REFERENCES
1. Friefelder. D (1982) Physical Biochemistry, Application to Biochemistry and Molecular Biology, W.H. Freemen and Company, San Francisco.
2. William, B.L. and Wilson, K (1986) A Biologist‟s Guide to Principles and Techniques