Faculty of Science
M. Sc. Biotechnology - Course Structure (CBCS Scheme)
I Semester

Sl. No.	Paper	Title of the paper	Instruction Hours per Week	No. of Credits	Duration of Exam	Marks		
						Internal Assessment	Semester End Exam	Total Marks
1	CPT-1.1	Cell Biology and Developmental Biology	4	4	3 Hrs	20	80	100
2	CPT-1.2	Biochemistry and Enzymology	4	4	3 Hrs	20	80	100
3	CPT-1.3	Molecular Genetics	4	4	3 Hrs	20	80	100
4	SPT-1.4 A	Microbiology	4	4	3 Hrs	20	80	100
	SPT-1.4 B	Medicinal Chemistry	4	4	3 Hrs	20	80	100
5	CPP-1.5 (1.1)	Practical - Cell Biology and Developmental Biology	4	2	5 Hrs	10	40	50
6	CPP-1.6 (1.2)	Practical - Biochemistry and Enzymology	4	2	5 Hrs	10	40	50
7	CPP-1.7 (1.3)	Practical - Molecular genetics	4	2	5 Hrs	10	40	50
8	SPP-1.8 (1.4) A	Practical - Microbiology	4	2	5 Hrs	10	40	50
	SPP-1.8 (1.4) B	Practical - Medicinal Chemistry	4	2	5 Hrs	10	40	50
		Total	32	24				600

CPT: Core paper theory, SPT: Special paper theory, CPP: Core paper practical; SPP: Open Elective practical

Chairman BOS in Biotechnology

Faculty of Science
M. Sc. Biotechnology - Course Structure (CBCS Scheme)
II Semester

S. No.	Paper	Title of the paper	Instruction Hours per Week	No. of Credits	Duration of Exam	Marks		
						Internal Assessment	Semester End Exam	Total Marks
1	CPT-2.1	Enzyme Technology	4	4	3 Hrs	20	80	100
2	CPT-2.2	Immunology	4	4	3 Hrs	20	80	100
3	SPT-2.3 A	Biostatistics and Bioinformatics	4	4	3 Hrs	20	80	100
	SPT-2.3 B	Pharmaceutical Biotechnology	4	4	3 Hrs	20	80	100
4	OET-2.4	Recombinant DNA Technology	4	4	3 Hrs	20	80	100
5	CPP-2.5 (2.1)	Practical -Enzyme Technology	4	2	5 Hrs	10	40	50
6	CPP-2.6 (2.2)	Practical -Immunology	4	2	5 Hrs	10	40	50
7	SPP-2.7 (2.3) A	Practical-Biostatistics and Bioinformatics	4	2	5 Hrs	10	40	50
	SPP-2.7 (2.3) B	Practical - Pharmaceutical Biotechnology	4	2	5 Hrs	10	40	50
8	OEP-2.8 (2.4)	Practical - Recombinant DNA Technology	4	2	5 Hrs	10	40	50
		Total	32	24				600

CPT: Core paper theory; SPT: Special paper theory; OET: Open Elective Theory; CPP: Core Paper Practical; SPP: Special Paper Practical
OEP: Open Elective practical

Chairman BOS in Biotechnology

Faculty of Science
M. Sc. Biotechnology - Course Structure (CBCS Scheme)
III Semester

Sl. No.	Paper	Title of the paper	Instruction Hours per Week	No. of Credits	Duration of Exam	Marks		
						Internal Assessment	Semester End Exam	Total Marks
1	CPT-3.1	Animal Biotechnology	4	4	3 Hrs	20	80	100
2	CPT-3.2	Environmental Biotechnology and IPR	4	4	3 Hrs	20	80	100
3	SPT-3.3 A	Genetic Engineering	4	4	3 Hrs	20	80	100
	SPT-3.3 B	Genomics and Proteomics	4	4	3 Hrs	20	80	100
4	OET-3.4	Industrial Biotechnology	4	4	3 Hrs	20	80	100
5	CPP-3.5 (3.1)	Practical -Animal cell Technology	4	2	5 Hrs	10	40	50
6	CPP-3.6 (3.2)	Practical - Environmental Biotechnology and IPR	4	2	5 Hrs	10	40	50
7	SPP-3.7 (3.3) A	Practical - Genetic Engineering	4	2	5 Hrs	10	40	50
	SPP-3.7 (3.3) B	Practical - Genomics and Proteomics	4	2	5 Hrs	10	40	50
8	OEP-3.8 (3.4)	Practical -Industrial Biotechnology	4	2	5 Hrs	10	40	50
		Total	32	24				600

CPT: Core paper theory; SPT: Special paper theory; OET: Open Elective Theory; CPP: Core Paper Practical; SPP: Special Paper Practical
OEP: Open Elective practical

Chairman BOS in Biotechnology

Faculty of Science
M. Sc. Biotechnology - Course Structure (CBCS Scheme)
IV Semester

Sl. No.	Paper	Title of the paper	Instruction Hours per Week	No. of Credits	Duration of Exam	Marks		
						Internal Assessment	Semester End Exam	Total Marks
1	CPT-4.1	Plant Biotechnology	4	4	3 Hrs	20	80	100
2	CPT-4.2	Medical and Nano-Biotechnology	4	4	3 Hrs	20	80	100
3	SPT-4.3 A	Bioprocess Technology	4	4	3 Hrs	20	80	100
	SPT-4.3 B	Agricultural Biotechnology	4	4	3 Hrs	20	80	100
4	CPD-4.4	Project / Dissertation Work	4	2	5 Hrs	20	80	100
5	CPP-4.5 (4.1)	Practical -Plant Biotechnology	4	2	5 Hrs	10	40	50
6	CPP-4.6 (4.2)	Practical - Medical and Nano Biotechnology	4	2	5 Hrs	10	40	50
7	SPP-4.7 (4.3) A	Practical – Bioprocess Technology	4	2	5 Hrs	10	40	50
	SPP-4.7 (4.3) B	Practical –Agricultural Biotechnology	4	2	5 Hrs	10	40	50
8	CPPP-4.8	Core paper project practicals	4	2	5 Hrs	10	40	50
		Total	32	24				600

CPT: Core paper theory, SPT: Special paper theory, CPD: Core Paper Dissertation, CPP: Core Paper Practical SPP: Special Paper Practical CPPP: Core Paper Project Practicals,

Basis for Internal Assessment Marks Allotment

1st Test for 10 marks
2nd Test for 10 marks: Average of two tests : 10
Seminar (Biotechnological perspective/journal club) : 05
Extra activities (Awareness programes for public / Extn activities) : 05
Total : **20Marks**

Chairman BOS in Biotechnology

THEORY QUESTION PAPER PATTERN

M.Sc. Biotechnology (CBCS Scheme)

Duration: 03 Hours **Max. Marks = 80**

Note: 1. Answer all questions.
2. Illustrate wherever necessary

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1. Define/Explain very briefly on the following: 8 X 2 = 16
(a)
(b)
(c)
(d)
(e)
(f)
(g)
(h)

2. Write short notes on any **FOUR** of the following 4 X 4 =16
(a)
(b)
(c)
(d)
(e)

3. Answer any **THREE** of the following questions: 3 X 16 =48
(a)
(b)
(c)
(d)
(e)

***Note: Equal weightage to be given to each unit while preparing question paper.**

PRACTICAL QUESTION PAPER PATTERN

Duration: 03 Hours **Max. Marks = 40**

1.	Experiment and Spotting (Major and Minor Experiments)	30
2.	Practical Record	05
3.	Viva-voce	05
	Total Marks	**40**

Chairman BOS in Biotechnology

CPT-1.1 CELLBIOLOGY & DEVELOPMENTAL BIOLOGY (4 Credits; 60 Hours)

UNIT I

General Aspects of Cell Biology

Study of Structure, composition and functions of Prokaryotic and Eukaryotic cells.Cell theory, levels of organization. Cell organelles-organization and functions: Nucleus, Mitochondria, Plastids; Endoplasmic Reticulum, Golgi complex, Lysosomes, Microtubules, Centriole, Vacuole, Cytoskeleton**:** microtubules and microfilaments; muscle organization and function, Cilia and Flagella. **10 Hrs.**

UNIT II

Membrane system, transport and signaling

Ultra structure and functions of cell membrane, composition and dynamics transport of nutrients, ions and macromolecules (Pumps, carriers, channels, endo and exocytosis) cellular recognition, junctions and adhesions, structure and functional significance of plasmodesmata. Ligands classification and functions. Receptors classifications and functions. Role of secondary messengers. Neuron structure and functions:Nerve transmission, resting and action potential, electrical and chemical transmission. Neurotransmitters and receptors. **12 Hrs.**

UNIT III

Cell cycle

Cell growth and cell division- apoptosis and cancer. Differentiation, Cellular senescence. Mitosis, Meiosis, Molecular control involving checkpoints in cell cycle. **08 Hrs.**

UNIT IV

Development of Multicellular organisms

Yeast, *Caenorhabditis elegans* and *Arabidopsis thaliana*, *Drosophila melanogaster,* Stem cells, types, use of stem cells to repair damaged tissues. **08 Hrs.**

UNIT V

Embryonic development

Structure of gametes, cellular and biochemical processes during early fertilization. Cascade of events (acrosome reaction and egg activation cleavage blastulation, gastrulation) embryonic development in frog and fish, morphogenetic movements origin of embryonic endoblasts (ecto, meso and endoderm) regeneration in animals. **12 Hrs.**

UNIT VI

Morphogenesis in Plants

Organization of shoot and root apical meristem. Differentiation, Polority in uni and multicellular organisms. Self-incompatibility and its genetic control; Embryo and endosperm development.Heterosis and apomixes. **10 Hrs.**

CPP-1.5 (1.1) PRACTICALS

1. Principles of Microscopy and Optics.
2. Determination of size of Prokaryotic and Eukaryotic cell by Micrometry.
3. Study of Plant and Animal Organs Histology.
4. Isolation and Separation of Sub cellular organelles.
5. Determination of cell constant of 0.1mM KCl Vs 0.1mM Nacl by conductometry method.
6. Study of cell counting and viability test.
7. Determination of Osmotic fragility of RBC membrane.
8. Preparation of metaphase chromosomes form blood.
9. Analysis of polytene chromosomes.
10. Image analysis and karyotyping.
11. Study of mitosis and meiosis stages of cell division.
12. Study of gametes in plant and animals.
13. Study of Drosophila life cycle.
14. Preparation of salivary gland chromosome.
15. Blood smear-differential staining and identification of different types of cell.
16. Study of apoptosis by TUNEL method.
17. Estimation of Acetylcholinesterase in animal model (Rat).
18. Developing stages of fish embryo-characteristics and documentation.
19. Preparation of different stages of chick embryo from blastoderm to subsequent changes.
20. Cryopreservation techniques.

TEXT/REFERENCES:

1. Lodish et al., Molecular cell biology, 4th Edition, W.H. Freeman & Company, 2000.
2. Smith & Wood, Cell Biology,2nd edition, Chapman & Hall,London,1996.
3. Watson et al., Molecular biology of the gene,5th edition ,Pearson Prentice Hall.USA,2003.
4. B.M. Turner, Chromatin &Gene regulation,1st edition,Wiley-Blackwell,2002.
5. Benjamin Lewin, Gene IX,9thEdition,Jones and barlett Publishers,2007.
6. Alberts, B.,Bray Dennis, Lewis Julian, Raff Martin, Roberts. K and
7. Watson, J.D. Molecular Biology of the Cell. Garl and Publishing Inc. New York,1994.
8. Cellis, J.E Cell Biology: a Laboratory Handbook Vol.I and II. Academic press, 1998.
9. Malacininski, G.M &Freifelder,D.Essentials of Molecular Biology III Ed.Jones & Bartlett Publishers,1998.
10. Knudson A.G.1998,Anti-oncigenes and Human cancer. Proceedings of the national academy of sciences USA 90:10,0114-10921
11. Bishop J.A.1982,Retroviruses and cancer genes. Advances in Cancer Research.
12. Brachet J.1985 Molecular Cytology. Academic Press New york.
13. Gilbert S.F. Developmental Biology IV Edition. Sinauer Associates Inc. Publishers, Massachusetts,2000.
14. Kalthoff.K Analysis of biological development. McGraw Hill Inc. New York,1996.
15. Rao, K.V Developmental Biology: A modern Synthesis. Oxford & IBH Publishing Co.Pvt.Ltd,1993.
16. Subramanian, T. Developmental Biology Narosa Publishing House,2002.
17. Twyman, R.M Instant Notes. Developmental Biology. Bioss Scientific Publishers Ltd, 2001.

CPT – 1.2 Biochemistry and Enzymology (4 Credits; 60 Hours)

UNIT I

Bioenergetics

Principles of thermodynamics (First and second law). Free energy, important energy rich molecules, Standard free energy change, concepts of redox reactions. **04 hrs.**

Chemical foundations of Biology – Introduction to biomolecules, weak bonds, covalent bonds, weak interactions in aqueous system, ionization of water, Acids and Bases,pH, pKa and pKb, Henderson-Hassel Balch equation, titration curves, buffers, buffer systems. Biological buffers and their action. Diffusion and osmosis. **04 Hrs.**

Unit II

Carbohydrates

Sugars-Classification and reactions, mono, di and polysaccharides-types, structural features, methods for compositional analysis. Glycogen metabolism, lactic acid and alcoholic fermentation. **04 Hrs.**

UNIT III

Amino acids, Proteins, Lipids and Vitamins

Amino acids: Classification, chemical reactions. Proteins: Classification, hierarchy in structure, physics of proteins-three dimensional structure and confirmation using physical methods (Haemoglobin and myoglobin) Glycoproteins and Lipoproteins: Structure and function. Lipids: Classification, structure and functions. Cholesterol biosynthesis.Vitamins-Biosynthesis of fat soluble and water soluble vitamins and their role. Role of minerals in human health**.** Biosynthesis of eicosanoids (Prostaglandin, leucotrines and thromboxanes) and their functions. **12 Hrs.**

UNIT IV

Hormones and Metabolites

Definition, Classification of hormones. Biological functions and disorders of pancreatic hormone (Insulin), thyroid hormone (Thyroxin), Hypothalamus and pituitary hormone (GH,TSH,GTH,ADH) and Adrenal gland (Adrenaline, Nor adrenaline). Hormones in pharmaceuticals: Auxins, cytokinins, gibberellins and abscissic acid. Secondary metabolites in living systems: Alkaloids, Steroids and Flavonoids**.** **08 Hrs.**

UNIT V

Metabolism

Metabolism of Carbohydrates, Proteins, Amino acids, Lipids and Nucleic acids: Biosynthesis, degradation and their regulations; Over all in born errors of metabolisms. Mechanism of oxidative phosphorylation and its inhibitors, and photophosphorylation, hormonal regulation of mammalian metabolism. **10 Hrs**.

UNIT VI

Bioanalytical Techniques

UV-Visible spectroscopy, Flame emission spectroscopy and atomic absorption Spectroscopy, Fluorimetry, Infrared spectrophotometry, Nuclear magnetic resonance spectroscopy, Electron

spin resonance spectroscopy, Massspectroscopy,Chromatographictechniques.Electrophoresis, Radio immuno assay, X-ray diffraction methods. **05 Hrs**.

UNIT VII

Enzymes and Enzyme catalysis

Classification-IUB and rationale. Characteristics of enzymes, enzyme substrate complex. Concept of active centre, binding sites, Stereospecificity of enzyme and ES complex formation. Role of metal ions and coenzymes. Mechanism of enzyme reaction of single & double substrates: Nucleophilic, electrophilic, substitution and elimination ractions (with one or two example). Activation energy & Transition state theory. Factors affecting catalytic efficiency: proximity, orientation effects, distortion or strain. Isoenzymes, Ribozymes & Abzymes. **07 Hrs.**

UNIT VIII

Enzyme kinetics

Rate of reactions, steady state enzyme kinetics, Michaelis-Menten Equation - form and derivation. Significance of Vmax and Km, K/cat. Bisubstrate reactions. Graphical procedures in enzymology, advantages and disadvantages of alternate plotting. Inhibitors-competitive, non-competitive and uncompetitive, mode of action and experimental determination. Enzyme activity, international units, specific activity, molecular activity, turns over number, end point kinetic assay**.** **07 Hrs.**

CPP-1.6 (1.2) PRACTICALS

1. Safety guidelines in Biochemistry laboratory practices.
2. Preparation of solutions and buffers (Tris-HCl, Phosphate, Citrate) and pH measurements (Including pH meter Calibration).
3. To determine pKa of a weak acid using pH - metric titration.
4. Titration of amino acids (Glycine)-Determination of pKa and pKb and pI values.
5. Determination of redox potential of Fe^{++} and Fe^{+++} by potentiometry method.
6. To determine the molecular weight of protein (BSA) and DNA by viscometry.
7. To measure the angle of rotation of Sugars, and amino acid solutions.
8. Determination of Chlorophyll-a, Chlorophyll-b & total Chlorophyll by Arnon method.
9. Qualitative tests for carbohydrates, aminoacids, lipid/fatty acids, (Including analysis of unknown).
10. Fractionation of total lipid by column chromatography.
11. Fractionation of phospholipids by TLC.
12. Extraction and Estimation of Glycogen/Starch
13. Extraction and Estimation of total soluble sugars (Glucose/Fructose/Maltose/ Sucrose).
14. Extraction and Estimation of total proteins from plant/animal source.
15. Separation and identification of Sugars and Amino acids by chromatography techniques.
16. Acid hydrolysis of methyl acetate/Ethyl acetate.
17. Determination of activity of Amylase / Invertase / and Protease.
18. Determination of Km and Vmax of Amylase / Invertase / Protease.
19. Effect of pH and Temperature on enzyme activity.
20. ELISA of selected hormone (demonstration only).

REFERENCES:

1. V. Voet and J.G.Voet, Biochemistry, 3rd edition, John Wiley, New York, 2004.
2. A.L. Lehninger, Principles of Biochemistry, 4th edition, W.H Freeman and Company, 2004
3. L. Stryer, Biochemistry, 5th edition, W.H. Freeman and Company, 2002
4. Geoffrey Zubey, Biochemistry, Wm C Brown Publishers, 1995
5. Garet and Grasham, Biochemistry, Sunders College Publishers, 1999.
6. Devlin, Biochemistry, John Wily & Sons, Inx Publications, 1997
7. Robert Scopes, Protein Purification.
8. J. Jayaraman, Laboratory Manual in Biochemistry, Wiley eastern ltd., New Delhi, 1988
9. S Sadasivan and A Manikam, Biochemical Methods, wiley eastern A ltd., New Delhi, 1992
10. S. K. Thimmaiah, Standard Methods of Biochemical Analysis, Kalyani Publishers, New Delhi, 1999
11. Isoenzymes By D. W. Moss
12. Immobilized Biocatalysts- W. Hartneir
13. Selected papers Allosteric Regulation -M. Tokushige
14. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry, Trevor Palmer, (2004)

CPT-1.3 MOLECULAR GENETICS (4 Credits; 60 Hours)

UNIT I

Concept of Mendelism and Extension of Mendelian Principles

Concept of Gene: Allele, Multiple Alleles, Pseudoallele, Complementation tests. Mendelian Principles: Dominance, Segregation, Independent Assortment, Deviation from Mendelian Inheritance. Extensions of Mendelian Principles: Codominance, Incomplete Dominance, (Partial Dominance), Gene Interactions, Pleiotrophy, Genomic Imprinting, Penetrance and Expressivity, Phenocopy, Linkage and Crossing over, Sex, determination, Sex Differentiation, Sex Linkage, and Sex influenced characters**.** **10 Hrs.**

UNIT II

Genetic material

Nucleic Acids Structure, types of DNA and RNA and their properties. Prokaryotic and eukaryotic DNA replication. Organization of Gene in Prokaryotes and Eukaryotes. Structure of eukaryotic chromosomes; super coiled loops, domains and scaffolds. Heterochromatin, euchromatin and telomers. Human chromosomal aberrations; normal and abnormal karyotypes. **06 Hrs.**

UNIT III

Genetics of Recombination

Enzymes in homologous and site specific Recombination. Transduction – generalized and specialized. Conjugation–Hfr; F-transfer; Transformation–natural and artificial transformation. Replicative and non-replicative transposition (Insertinal elements/transposons) . Eukaryotic recombination. **05 Hrs.**

UNIT IV

Mutations and Gene Mapping Methods:

Nonsense, missense and point mutations; Intragenic and Intergenic suppression; Frameshift mutations; Physical, chemical and biological mutagens; adaptive mutations in bacteria. Site directed mutagenesis. Mutations in Drosophila and Human disorders by mitochondrial genomes. DNA Repair mechanisms. Linkage maps, Tetrad analysis, mapping with molecular markers, Mapping by using somatic cell hybrids, development of mapping population in plants. **12 Hrs.**

UNIT V

Transcription and Translation

Prokaryotic and Eukaryotic transcription, RNA polymerase, General and specific transcription factors, Regulatory elements and mechanisms of transcription regulation, Transcriptional and post-transcriptional gene silencing. Modifications in RNA: 5'-cap formation, 3'-end processing and Polyadenylation, Splicing, Editing, Nuclear export of mRNA and mRNA stability. Processing of other RNAs, Ribosome formation. Genetic Code-Properties of genetic code, Deciphering of Genetic code. Prokaryotic and eukaryotic translation, the translation machinery, Mechanisms of initiation, elongation and termination, Regulation of translation, co-and post-translational modifications of proteins. Protein Localization: Synthesis of Secretory and membrane proteins, import into nucleus, mitochondria and chloroplast and peroxisomes**.** **12 Hrs.**

UNIT VI: Regulation of Gene Expression

Regulation of gene expression in prokaryotes: Transcriptional control; enzyme induction and repression, constitutive synthesis of enzymes. The operon concept: The fine structure of '*lac*' operon-genes involved in regulation-regulatory gene, promoter gene, operator gene, and structural gene, role of cAMP cAMP receptor protein (CRP). The dual promoters – '*gal*' operon model. Dual functions of the repressor – '*Ara*' operon. Transcriptional control by attenuation and mechanism of attenuation; '*Trp*' (Biosynthesis), 'His' Operon. Catabolite repression. Account of Eukaryotic gene regulation. **06 Hrs.**

UNIT VII: Oncogenes and Tumor Suppressor Genes

Viral and cellular oncogenes, tumor suppressor genes from humans, Structure,function and mechanisms of action of pRB and p53 tumor suppressor proteins. **04 Hrs.**

UNIT VIII: Antisense and Ribozyme technology

Introduction to RNAi : Molecular mechanism of antisense molecules, inhibition of splicing , Polyadenylation and translation, Disruption of RNA structure and capping, Biochemistry of ribozyme, hammerhead, hairpin and other ribozymes. Strategies for designing ribozymes. Current applications of antisense and ribozyme technologies. **05 Hrs.**

CPP-1.7 (1.3) PRACTICALS

1. Study of Drosophila and its mutants.
2. Isolation of genomic DNA from Bacteria/plant cells / animal cells.
3. Isolation of plasmid DNA from different type of bacteria by adopting different methods , purification and calculation of molecular weight of plasmid DNA. , plasmid curing (acridine orange, heat shock).
4. Determination of Tm of Nucleic acid.

5. Estimation of DNA by Di-Phenylamine/C-TAB method.
6. Estimation of RNA by Orcinol method.
7. Study of conjugation in E. coli
8. Study of transduction in E. coli
9. Study of transformation in E. coli
10. Study of mutation in E.Coli (antibiotic resistance).
11. Restriction mapping of genomic/plasmid DNA (E.coli).
12. Study of human genetic Disorders and Karyotypic studies and Imaging.
13. Studies on mutagenic treatment to seeds, pollen grains and its mitotic and meiotic analysis.
14. Tns-5 induced mutagenesis in E. coli.
15. Isolation of auxotrophic mutants of E. coli by chemical mutagenesis.
16. UV mutagenesis and screening of pigment deficient mutants of *Serratia* sp.
17. Determination of UV survival of *Serratia* sp.
18. Study of Mutation by Ames test.
19. Study of thermal death kinetics.

REFERENCES:

1. S.R. Maloy, J.E. Cronan, D. Friefelder, Microbial Genetics, 2nd Edition, Jones and Bartlett Publishers, 1994.
2. N. Trun and J. Trempy, Fundamental Bacterial Genetics, Blackwell publishing, 2004.
3. Strachan T and Read A P, Human molecular genetics, 3rd Edition Wiley Bios, 2006.
4. Mange E J and Mange A. P., Human genetics, 2nd Edition, Sinauer Associates publications, 1999.
5. Hartl L D and Jones B, Analysis of genes and genomes, 3rd Edition, Jones and Bartlett Publishers, 1994.
6. Molecular Biology of the Cell:-Alberts et al., 1983.
7. Molecular Biology of the Gene:J.D. Watson.
8. Molecular Cell Biology :Darnell et al.,
9. The Gene:-Benjamin Levine
10. Recombinant DNA:- Watson et al.,1983.
11. Principle of Genetics:-Snusted, Simmons and Jenkins, Hohn Wiley and Sons Inc. 1997.
12. Modern Genetics By Francis Co.J. Ayala, 1980. The Benjamin/Cummings
13. Publishing Company Inc, California.
14. Essentials of Molecular Biology, Fourth Edition (2002) by G. M. Malacinski, Jones & Bartlett Publishers.
15. Microbial Genetics (2006) by S.R. Maloy, J. E. Cronan Jr., and D. Freifelder, Jones and Bartlett Publishers, Sudbury, Massachusetts.
16. Genetics – A Molecular Approach, 2nd Edition (2006) by Peter J. Russel.

SPT-1.4 A MICROBIOLOGY (4 Credits; 60 Hours)

UNIT I

History and Development of Microbiology

Definition and scope of Microbiology. Evolution of microbes controversy over spontaneous generation. Contribution of Scientists: Antony von Leeuenhoeck, Robert Koch, Edward Jenner, Joseph Lister, Louis Pasteur, Robert Hook, Alexander Fleming and Iwanowsky. Branches of microbiology. **06 Hrs.**

UNIT II

Microscopy Techniques

Light, Dark field, Phase contrast, Fluorescence, Electron microscopes and Laser optic system and micrometry. **04 Hrs.**

UNIT III

Microbiological Techniques

Theory and practice of sterilization; Physical methods, chemical methods and Radiation methods. Cultivation of microorganisms; culture media and types of culture media. Nutritional requirements of microorganisms, Definition of growth; Growth curve, Mathematical expression of growth; Measurment of growth and growth yields; Counting of bacteria, Synchronous growth, and continuous culture, growth as affected by environmental factors. Isolation of microorganisms- serial dilutions, streak plate, pour plate & spread plate and enrichment methods for isolation of chemoautotrophs and chemoheterotrophs and photosynthetic microorganisms, merits and demerits of each technique. Staining Techniques: Simple and differential, fluorescent, negative; Structural staining: capsule, spore, cell wall and reserve food material. Preservation of cultures. **14 Hrs.**

UNIT III

Microbial diversity

Methods to assess microbial diversity, Merits and demerits of culture dependent and culture independent methods. Molecular analysis of bacterial community: Denaturing Gradient Gel Electrophoresis (DGGE), Terminal Restriction Fragment Length Polymorphism (T-RFLP), Amplified Ribosomal DNA and Restriction Analysis (ARDRA). Bacterial systematics:
Characterization & identification of colonies / Biochemical methods, and molecular techniques, Numerical taxonomy, Chemotaxonomy, Bergeys manual of systematic Bacteriology. **12 Hrs.**

UNIT IV

Biology of Microorganisms

Ultra structure of cyanobacteria (Spirulina), Archaea (Methanococcus); Eubacteria (E. coli); Viruses, Bacterial, Plant (TMV), Animal (Hepatitis B and Tumour viruses) DNA viruses, RNA viruses and Retroviruses), Plant viruses: TMV, Potato virus-X and Y, CMV, CaMV, TYMV, Plant rhabdoviruses. Bacterial viruses: Lytic and lysogenic cycles (T4 and lambda), Transduction (Restricted as in lambda) Phage Mu and M3. viroids and prions. Eukaryotic microorganisms: structure,classification and reproduction of Protozoa, yeast and filamentous fungi, Algae **16 Hrs.**

UNIT V

Domain Archea, salient features in structure; unique enzymes, Environmental and Phylogenetic significance. **02 Hrs.**

UNIT VI

Microbes in natural habitats, commercial applications

Air, water & soil. Bio-fertilizers and Bio-pesticides; leaching of ores by microorganisms; microorganisms and pollution control. Bioremediation & biosensors. Industrial application of microbes - Wine, Beer, Cheese, Yogurt. Primary and secondary metabolites and their applications; preservation of food. **06 Hrs.**

SPP 1.8 (1.4)A. PRACTICALS

1. Safety guidelines in Microbiology laboratory practices.
2. Study of aseptic techniques-Disinfection and chromic acid preparation for glassware's
3. Study of apparatus used in microbiological experiments.
4. Preparation of culture media for growth of various microorganisms.
5. Isolation and Identification of various microorganisms (Bacteria, Fungi and Yeasts) from soil, water and air sample.
6. Study of colony characteristics of bacteria.
7. Staining of Microorganisms-Gram's stain, Acid-fast stain and structural stain.
8. Biochemical tests used for the identification of microorganisms.
    i. Fermentation of carbohydrates.
    ii. Starch hydrolysis.
    iii. Gelatin liquefaction.
    iv. Urase test.
    v. Catalase test.
    vi. Oxidase test.
    vii. Triple sugar Iron agar test (TSIA).
    viii. Nitrate reduction Test.
    ix. IMViC Tests.
9. Growth curve and measurement of bacterial population by turbidometry.
10. The study of synchronous growth of a bacterial population (E. coli).
11. Counting of microorganisms by using Haemocytometer (Smuts and yeast sample)/ SPC and DMC.
12. Study of bacterial motility by Hanging Drop Method.
13. Isolation of Phages by Plaque Count Method.
14. Isolation of *Candida* species and study its morphological characters (Budding, Mycelia, Spores).
15. Assay of antibiotics by agar disc method and dilution method.
16. Testing for quality of water (coliform test), H_2S strip method.
17. Isolation of rhizosphere/phylloplane microflora microflora
18. Isolation of actinomycetes from soil.
19. Isolation of Rhizobium from legume root nodules
20. Identification of Rhizobium and Agrobacterium
21. Vesicular Arbuscular Mycorrhiza (VAM)

REFERENCES:

1. Alexander M (1977) Introductio to soil microbiology, John Wiley and sons inc. N.Y.
2. Atlas R.M. (1998) Microbiology, Fundamentals and applications (2nd Edition) McMillan Publishing company.
3. Brock, T.D. and Madigan, M.T.(1992) Biology of Microorganisms, 6th Edition, Prentice Hall, Englewood cliffs N.J.
4. Frazier, W.C and Westhaff, D.C. 91998) Food microbiology, Tata McGraw Hill Pub. Delhi.
5. Grabiel Balton (1994) Waste water Microbiology,Wiley Liss Inc.N.Y.
6. Holt, J.S.kreig N.R. Sneath P.H.A. and Williams S.T. (1994) Bergey's Manual of systematic Bacteriology (9th Edition) William and Wilkins, Blatimore.
7. Pelezar Jr. M.J. Chan ECS and Kreig N.R. 91993) Microbiology, MCGraw Hill Inc. NY.
8. Prescott, L.M. , Harley , T.P and Klein D.A. (1996) Microbiology, Wm.C. Brown Publishers.
9. Stacey R.H. and Evans H.J (1992) Biological Nitrogen Fixation, Chapman Hall Ld. London.
10. Sullia S.B. and Shantharam .S (1998) General Microbiology, Oxford and IBH Publishing Co. Pvt. New Delhi.

SPT-1.4 B. MEDICINAL CHEMISTRY (4 Credits; 60 Hours)

UNIT I

Introduction to Drugs

Historical background: Sources of Drugs, Classification of drugs-important terminologies used in medicinal Chemistry. Drug Action: role of intermolecular forces - drug targets: lipids, carbohydrates, proteins (enzymes, receptor) and nucleic acids as drug targets. Pharmacokinetics and pharmacodynamics: Routs of drug administration, dosage forms. Fate of drugs in the body- absorption, distribution, metabolism, and elimination of drugs (ADME). Bioavailability of drugs, drug addiction and drug toxicity. **10 Hrs.**

UNIT II

Drugs and Their Mechanism of Action

Antibacterial agents-mechanism of action-antibacterial agents that act against cell metabolism (sulfonamides), inhibit cell wall synthesis (penicillins, cephalosporins), interact with plasma membrane (valinomycin and gramicidin A), drugs impair protein synthesis (tetracyclines, chloramphenicol) and drugs act on nucleic acids (quinolones and fluoroquinolones, rifamycins). Antiviral agents-general principles-nucleic acid synthesis inhibitors (HIV, HBV), host cell penetration inhibitors, inhibitors of viral protein synthesis. Antifungal agents-azoles, allyamines and phenols. Anti-protozoal drugs (antiamoebic, Giardia, Trichomoniasis, Leishmaniasis, Anthelimintics) Anticancer drugs and their mechanism of action- role of antimetabolites, antisense drugs, alkylating agents and interchelating agents in cancer chemotherapy. Cardiovascular drugs: antiarrhythemic and antihypertension drugs. Gastro intestinal drugs; Peptic ulcer, gastroesophagal reflux disorders, laxatives, antidiarrhoeal. **15 Hrs.**

UNIT III

Drug discovery, Design and Development

Identification of diseases and corresponding targets, bioassays and leads. Stereochemistry and solubility issues in drug design. Structure activity relationships (SARs): changing size and shape-introduction of new substituent's. Quantitative structure activity relationships (QSARs): lipophilicity-electronic and steric effects- Hansch Analysis-Topliss decision tree. Chemical and process development of drugs. Preclinical trials: pharmacology, toxicology, metabolism and stability studies-formulation. Clinical trials: phase I-IV studies ethical issues. Patent protection and regulation. **10 Hrs.**

UNIT IV

Lead and Analogue Synthesis

Designing organic synthesis-disconnection approach-synthons and synthetic equivalents-one group disconnections: alcohol, olefin, ketone, acids-two group disconnections:1,2-, 1,3-, 1,4- and 1,5-difunctional compounds-convergent synthesis-functional group inter conversions-functional group additions-carbon heteroatom bonds-methods for 3- to 6-membered rings. **10 Hrs.**

UNIT V

Combinotorial chemistry

Introduction and scope of combinatorial synthesis in medicinal chemistry: Solid phase techniques-methods of parallel synthesis-mix and split techniques-dynamic combinatorial chemistry-screening and deconvolution-limitations of combinatorial synthesis Assymmetric synthesis: basic principles-stereoselective and stereospecific reactions- methods for determining enantiomeric excess-chiral auxiliary, reagents and catalysts and their applications (wherever applicable) in alkylation, hydrogenation, hydroxylation, epoxidation and hydroboration of alkenes, reduction of ketones-Cram and Felkin-ahn models. Noyori's BINAP – Jacobson catalyst – Evans catalyst. **15 Hrs**.

SPP-1.8 (1.4) B. PRACTICALS

1. Safety measures in Medicinal chemistry Laboratory
2. Qualitative analysis of Steroids, Terpenoids, Alkaloids, Saponins, Flavonoids
3. Extraction and estimation of vitamin C from citrus fruits / squashes.
4. Estimation of Ascorbic acid from commercially available tablets.
5. Extraction and estimation of Piperin from black pepper.
6. Extraction and estimation of Lycopene from tomato.
7. Extraction, purification of beta-carotene from carrot.
8. Spectrophotometric / Colorimetric assay of medicinally useful compounds.
9. Extraction and evaluation of Arecolin from arecanut.
10. Preparation of 4-hydroxy coumarins from resorcinol.
11. Synthesis of Chloramine-T and Dichloramine-T by Sulphonation method.
12. Synthesis of (Acetanilide, Aspirin, Acetylcysteine, Paracetamol) by Acetylation method.
13. Synthesis of (Bezoylglycine, Benzoylperoide, Flavone) by Benzoylation method.
14. Synthesis of (p-Bromoacetanilide, p-Bromophenol) by Bromination method.
15. Solid phase synthesis of medically important chemicals and peptides.
16. Determination of partition Coefficients and Ionisation constant of Drug molecules.

17. Techniques: Crystallization, fractional crystallizsation, fractional distillation, vacuum distillation, sublimation.
18. Isolation of Natural products from Clove, Cinnamom by steam distillation. Also use Soxhlet apparatus for one natural product.

REFERENCES:

1. Fundamentals of Medicinal Chemistry by Gareth Thomas, John Wiley & Sons: Chichester, 2003.
2. Medicinal Chemistry: An Introduction by Gareth Thomas, Wiley-Interscience, 2nd edition, 2008.
3. An introduction to Medicinal Chemistry by Graham L. Patric, Oxford University Press, USA, 3rd edition, 2005.
4. Wilson and Giswald's Textbook of Organic Medicinal and Pharmaceutical Chemistry by John Block and John M Beale (Eds), Lippincott Williams & Wilkins, 11th edition, 2003.
5. The Organic Chemistry of Drug Design and Drug Action by Richard B. Silverman, Academic press, 2nd edition, 2004.
6. Designing Organic Synthesis: The Disconnection Approach by Stuart Warren, Wiley, 2nd edition, 1984.
7. Asymmetric Synthesis by H. B. Kagan, Thieme Medical Publishers, 2003.
8. Advanced Organic Chemistry: Part-A and Part-B by Francis A. Carey and Richard B. Sundberg, Springer, 5th edition, 2007.
9. Pharmacological classification of drugs with doses and preparations by KD. Tripathi, 3rd Edition, Jaypee brothers Medical Publishers (P) Ltd.New Delhi.2006.
10. Combinotorial chemistry: Principles and Techniques by Arpad Furka 2007.
11. B.D. Furniss, A.J. Hannaford, V.Regers, P.W.G.Smith and A.R.Tachell, Vogels Text Book of Practical organic chemistry, including Quantitative analysis ELBS Longman London.
12. Organic drug synthesis LediserMitzsher Vol. 1 and 2.
13. Burgers medicinal chemistry M.E. Welly Medicinal chemistry M.E. Walffed John willey and sons, Vol 1, 2, 3.
14. Wilson and Giswold's, Text Book of Organic and Medicinal chemistry.

CPT-2.1 ENZYME TECHNOLOGY (4 Credits; 60 Hours)

UNIT I

Introduction, Structure and functional relations of Enzymes: Role of enzymes in living systems. Nature and characteristic features of enzymes. Nomenclature and classification of enzymes with examples. Intracellular localization of enzymes. Lysozyme, ribonuclease, trypsin, carboxypeptidase, phosphorylase, aspartate transcarbamylase and Na-K ATPase.

06 Hrs.

UNIT II

Allosteric interactions

Allosteric sites, Modulators, Protein ligand binding including measurements, analysis of binding isotherms, cooperativity, Hill and Scatchard plots and kinetics of allosteric enzymes. Enzyme regulation: Product inhibition, feedback control, enzyme induction and repression and covalent modification. Allosteric regulation. **06 Hrs.**

UNIT III

The investigation of active site structure and Coenzymes : The identification of binding sites and catalytic sites- trapping the E-S complex, the use of substrate analogs, chemical modification of amino acid side chains, photo-oxidation, enzyme modification by treatment with proteolytic enzymes. The 3-D structural features of active sites as revealed by X-ray, NMR and chemical studies. Mechanisms of reactions catalyzed by the following enzymes – chymotrypsin, trypsin, lysozyme and ribonuclease. Metal-activated and metallo-enzymes- pyruvate kinase & carboxypeptidase-A. The Structure and mechanistic role of coenzymes in enzyme catalyzed reactions – nicotinamide nucleotides, flavin nucleotides, pyridoxal phosphate, coenzyme A, thiamine pyrophosphate and biotin. **12 Hrs.**

UNIT IV

Engineering techniques

Metabolic engineering, enzyme engineering. Immobilized enzymes: Relative practical and economic advantage for industrial use, effect of partition on kinetics and performance with particular emphasis on charge and hydrophobicity (pH, temperature and Km). Methods of immobilization – ionic bonding, adsorption, covalent bonding (based on R groups of amino acids), microencapsulation and gel entrapment, design and configuration of immobilized enzyme reactors, Immobilized multienzyme systems, Applications of immobilized enzyme technology. Biosensors: glucoseoxidase, cholesterol oxidase, urease, catalase and antibodies as biosensors.

12 Hrs.

UNIT V

Biotransformation and Enzyme assay:

Reaction engineering for enzyme-catalyzed biotransformations. Catalytic antibodies. Biocatalysts from extreme Themophilic and Hyperthermophilic microorganisms (extremozymes). Peptide synthesis. The design and construction of novel enzymes , artificial enzymes, Biotransformation of drugs (steroids, amino acid derivatives) and Hydrophilic, hydrophobictoxins, Host Guest complexation chemistry. Fundamentals of enzyme assay: Enzyme units, coupled kinetic assay. Enzyme purification: criteria of purity of enzymes and its importance. **14 Hrs.**

UNIT VI

Enzymes of Clinical and Diagnostic importance:

Importance of enzymes in diagnostics, Enzyme pattern in diseases like Myocardial infarction (SGOT, SGPT & LDH), Isoenzymes (CK, LD, ALP). Use of isoenzymes as markers in cancer and other diseases. Clinical significance of choline esterases. Enzyme immunoassay techniques. Therapeutic enzymes. **06 Hrs.**

UNIT VII

Industrial Applications

Enzymes used in detergents, use of proteases in food, leather and wool industries; methods involved in production of glucose syrup from starch (using starch hydrolyzing enzymes), production of maltose and sucrose, glucose from cellulose, use of lactase in dairy industry, Restriction enzymes and DNA ligases. **04 Hrs.**

CPP 2.5 (2.1) PRACTICALS

1. Isolation and quantification of activity of – Amylase / Invertase / Alkaline phosphatase (salivary / yeast/ plant source).
2. Determining the Molecular Weight of Amylase by Gel Filtration/Size Exclusion Chromatography.
3. Determination of specific activity of enzyme (Amylase/Protease/Invertase).
4. Determination of temperature coefficient & energy of activation.
5. Determination of activity of enzyme in presence of activator and inhibitor.
6. Induction and assay of beta-galactosidase in E.Coli.
7. Enzyme production, purification and assay (Protease/Invertase).
8. Enzyme purification by crystallization-Urase
9. Kinetics of Immobilized enzyme (Amylase / Invertase).
10. Starch hydrolysis by a co-immobilized alpha-amylase and glucoamylase
11. Production of α-Amylase by using Aspergillus species.
12. Determination of adsorption isotherm of α-Amylase.
13. Estimation of proteins by Lowry's method.
14. Determination of SGOT in serum.
15. Determination of SGPT in serum.
16. Hydrolysis of egg protein by pepsin.
17. Determination of marker Enzymes: LDH, Serum glutamate
18. Isoenzyme profile study.
19. Hydrolytic Enzyme profiling of the fresh water isolates.

TEXTS/REFERENCES

1. Fundamentals of Enzymology- Price and Stevens
2. Enzymes -Dixon and Webb
3. Isoenzymes By D. W. Moss
4. Immobilized Biocatalysts- W. Hartneir
5. Selected papers Allosteric Regulation -M. Tokushige
6. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry, Trevor Palmer, (2004)
7. Principles and Applications in Engineering Series: Biotechnology for Biomedical
8. Engineers - Martin L.Yarmush, CRC Press, Boca Raton London New York Washington,D.C.

CPT-2.2 IMMUNOLOGY (4 Credits; 60 Hours)

UNIT I

Immunity

Innate immunity- 1st and 2nd line of Defense, Humoral immunity- Clonal selection theory, Primary and Secondary immune response, Mechanism of antibody production against TI and TD antigens, Structures of Antibodies, Gene expression and Ig Diversity, Cell-Mediated immunity- lysis of Self-altered cells, Lytic pathways of CMI. Components of Humoral immunity and CMI. **12 Hrs.**

UNIT II

Antigen, MHC, Complement and Cytokines

Antigen- Types, Factors affecting antigenecity, Epitopes, Haptens, Adjuvants, Mitogens, MHC- Genetic organization and inheritance, Antigen processing and presentation (Cytosolic and Endocytic pathway), Presentation of non-peptide antigens, Complements- Complement activation pathways, Cytokines- Cytokines secreted by TH1 and TH2 cells and its regulation. **12 Hrs.**

UNIT III

Vaccinology

Active and passive immunization; live, killed, attenuated vaccine (Cholera, Salmonella, Leishmania) sub unit vaccines; designing vaccines, whole organism vaccines, purified macromolecules, recombinant vector vaccines (Herpes simplex, SARS, S. aureus), DNA vaccines (Dental caries), peptide vaccines (Foot and Mouth disease, Malaria), synthetic peptide vaccines, sub-unit vaccines. **14 Hrs**.

UNIT IV

Clinical Immunology

Hypersensitivity: types and general mechanism of hypersensitivity) Autoimmunity: general mechanism, (organ specific, non-organ specific; with 2 examples each). Transplantation immunology- Immunologic Basics of Graft rejection, Immunosuppressive Therapy, Tumor immunology- Tumor antigens, Immune response to tumor antigens, Tumor evasion of the immune system, Cancer immunotherapy. **12 Hrs.**

UNIT V

Antigen-Antibody Interactions

In vitro methods: Priciples of Agglutination, precipitation, complement fixation test, immuno-fluorescence, immunoelectrophoresis, immunodiffusion ELISA, Radio-immunoassays and Flow cytometry. In vivo Methods: skin tests and immune complex tissue demonstrations. Applications of these methods in diagnosis of microbial infections. **10 Hours**

CPP 2.6 (2.2) PRACTICALS

1. Blood grouping.
2. Blood cell analysis.
3. Lymphocyte subset identification and enumeration.
4. Preparation of antigen - protocol of immunisation.
5. Methods of bleeding.
6. Preparation of serum and serum components.
7. Precipiation of IgG's from serum sample.
8. Dialysis of ammonium sulphate precipitated immunoglobulins. Dialysis against phosphate buffered saline.
9. Electrophoresis of the immunoglobulin prepararion (SDS-PAGE)
10. Ochturlouny double diffusion test.
11. Radial Immunodiffussion
12. Roket Immuno electrophoresis
13. Immuno precipitation test.
14. Diagnosis of *Salmonella typhi* by Widal test (Qualitative and Quantitative test)
15. To study the Dot-blot ELISA.
16. Westron blotting.
17. Demonstration of ELISA for HIV diagnosis.

18. Isolation and staining of murine peritoneal macrophages.
19. Determination of Phagocytic Index of macrophages exposed to selected environmental particulate in vivo / invitro.
20. Study of haemeagglutination.

REFERENCES:

1. Essentials of immunology, Ian&Roit Blackwell scientific publications,2001
2. Fundamentals of immunology-williamc.boyed (wileytoppan), 1998
3. Introduction to immunology-john w.kinball,2000
4. Fundamentals of immunology-ottos.view and others., 2004
5. Immunology: Janis Kuby (2001) second edition W.H.freeman&com
6. Cellular & molecular immunology 3rd edn.abulk.Abbas,Andrewk.Lichtman, Jordan s.pober, 1989
7. Immunology and Immunotechnology. RajasekaraPandian M and Senthilkumar B (2007). Panima Publishing Corporation , New Delhi.
8. Immunology and Immunotechnology. RajasekaraPandian M and Senthilkumar B (2007). Panima Publishing Corporation , New Delhi.
9. Immunology 6th Edn. Goldsby RA, KindtTJ.Osborne BA, Kuby J (2003WH Freeman &Co. New York.
10. Immunology .4th Edn. Benjamini E, Coico R and Sunshine G (2000) . A John Wiley & sons, Inc. Publication.
11. Handbook of Experimental Immunology. Weir DM (1979). Black Well Scientific Publications. Oxford.
12. Microbiology (2006) 5th Edn. Pelczar MJ, Chan ECS and Krieg NR. Microbiology (2006) 5th Edn. Tata, McGraw-Hill Publishing Company Ltd.New Delhi.
13. Tizard IR (1995).Immunology 4th Edn. Saunders College Publishing Harcourt Brace College Publishers.
14. Immunology 4th Edn. Talwar GP and Guptha (2004). Vol II .CBS Publications.

SPT-2.3 A BIOSTATISTICS & BIOINFORMATICS (4 Credits; 60 Hours)

UNIT I

Principles of Biostatistics

Scope of Statistical methods in scientific studies: Population, Sample, variable, parameter, primary and secondary data, screening and representation of data. Frequency distribution, tabulation, bar diagram, histograms, per diagram, and cumulative frequency curves. Measures of central tendency-Mean, median, mode, quartiles and percentiles. Measures of Variability-Range, mean deviation, Analysis of variance, standard deviation and coefficient of variation. Hypothesis testing-Normal T & F-Test, and Chi-square. Probability, Correlation and regression, Standard errors and confidence intervals. Design of experiments in biological research. Computer Programs for Statistical analysis (MS Word, Excel, SPSS, Sigma Plot etc). **18 Hrs.**

UNIT II

Databases & Tools

Introduction and scope of Bioinformatics, Need for informatics tools and exercises, Bioinformaticsresources: NCBI, EBI, ExPASy, RCSB. Significance of databases towards informatics projects.Primary and Secondary Databases. GenBank, DDBJ, EMBL, PIR, Uniprot-KB, SWISS-PROT, TrEMBL, UniParc. Format of databases, Gene bank flat file.

Protein Data Bank (PDB) flat file; FASTA Format, PIR Format; Structure file formats, PDBSUM, PDBLite, MMDB, SCOP, Pfam, ProDOM; Database of structure viewers. Specialized databases: NCBI, Pubmed, OMIM,Medical databases, KEGG, EST databases; Genome databases at NCBI, EBI, TIGR, SANGER. Overview of other popular tools for various bioinformatics exercises. **08 Hrs.**

UNIT III

Sequence alignment & Database searches

Introduction, The evolutionary basis of sequence alignment, the Modular Nature of proteins, Optional Alignment Methods, Substitution scores, substitution matrices, PAM, BLOSUM, Gap penalties, Statistical significance of Alignments, Database similarity searching, FASTA, BLAST, Low-Complexity Regions, Repetitive Elements. Practical Aspect of Multiple Sequence Alignment, Progressive Alignment Methods, CLUSTALW, Motifs and Patterns, PROSITE, 3DPSSM. MeMe, PSI-BLAST, PHI-BLAST, PRATT, Hidden Markov Models (HMMs), and Threading methods. Conceptual numericals. Tools for comparative genomics: BLAST2, AVID, Vista, MUMmer, COG, VOG. Qualitative discussions on Machine Learning Tools (Artificial Intelligence, Genetic algorithm and neural networks). **08 Hrs.**

UNIT IV

Phylogenetic Analysis

Introduction to Phylogenetic analysis, rooted and unrooted trees, Elements of phylogenetic Models, Phylogenetic Data Analysis: Alignment, Substitution Model Building, Tree Building, and Tree Evaluation, Tree - Building Methods-Distance based and character based methods, Evaluating Trees and Data- Boot strapping (parametric and non parametric), Phylogenetic softwares (CLUSTALW, PHYLIP etc), Conceptual numericals. **06 Hrs.**

UNIT V

Predictive Methods

Predictive Methods using Nucleotide sequences: Framework, Masking repetitive DNA, Database searches, Codon Bias Detection, Detecting Functional Sites in the DNA (promoters, transcription factor binding sites, translation initiation sites), Integrated Gene Parsing, finding RNA Genes, Web based tools (GENSCAN, GRAIL, GENEFINDER). Predictive Methods using Protein sequences: Protein Identity based on composition, Physical properties Based on sequence, secondary structure and folding classes, specialized structures or features, tertiary structure. Related web based software (JPRED, PROSEC, NNPREDICT, SOPMA, DSSP, STRIDE) **06 Hrs.**

UNIT VI

Molecular Modeling & Visualization

Scope and applications of insilico modeling in modern biology. Comparative modeling,constructing an initial model, refining the model, manipulating the model; molecularsuperposition and structural alignment, concept of energy minimization, different types of interactions and formulation of force fields. Basic MD algorithm, its limitations, treatment of long range forces. Structure visualization and Graphical representation of molecular structures: small molecules (low molecular weight – peptides, nucleotides, disaccharides, simple drugs molecules) and macromolecules (high molecular weight molecules - proteins, DNA, RNA, membranes). Usages of visualization software available in public domain like VMD, Rasmol, Pymol, SpdbViewer, Chime, Cn3D and GRASP. Rotameric Structures of Proteins (Conformational Flexibility), Canonical DNA Forms (DNA Sequence Effects). **08 Hrs.**

UNIT VII

Insilico Drug Design

Molecular modeling in drug discovery, deriving bioactive conformations, molecular docking, quantitative structure-activity relationship (QSAR), deriving the Pharmacophoric pattern, Receptor Mapping, Estimating Biological Activities, Ligand - Receptor Interactions: Dockingsoftwares (AUTODOCK, HEX) Calculation of Molecular Properties, Energy Calculations (noderivation). Conceptual numericals. **06 Hrs.**

SPP-2.7 (2.3) A. PRACTICALS

1. Measures of Central Tendency and Dispersion on Excel.
2. Statistical Analysis using EXCEL (Diagrammatic and graphical presentation).
3. Bibliographic search from PUBMED, SCIRUS, MEDMINER and Sequence retrieval from Nucleic acid and Protein databases.
4. Sequence (FASTA and BLAST) searches – Retrieval of homologs, paralogs, orthologs, and xenologs.
5. Pair wise comparison of sequences – Analysis of parameters affecting alignment.
6. Multiple alignments of sequences and pattern determination using PROSITE
7. Multiple sequence alignment by CLUSTALx/w (offline tool).
8. Retrieval of E.Coli glycolytic pathway from KEGG.
9. Evolutionary studies / Phylogenetic analysis – Analysis of parameters affecting trees.
10. Identification of functional sites in Genes / Genomes.
11. Secondary structure prediction of proteins and nucleic acid (DNA/RNA)
12. Study of posttranslational modifications using relevant tools.
13. PDB structure retrieval and visualization: Analysis of homologous structures.
14. Comparative Modeling of homologous sequences and validation of modeled (3D) structures.
15. Determination of ligand-protein interactions using SPDBV/ LIGPLOT
16. Superposition of structures – Calculation of RMSD.
17. Structure analysis: secondary, tertiary and Quaternary structure, bond angle, bond Length, different interactions by RasMol.
18. Docking studies – Analysis of substrate / ligand binding using homologous structures
19. Derivation of pharmacophore patterns for selective ligands.

References:

1. BIOINFORMATICS by Andreas D Boxevanis. Wiley Interscience.
2. BIOINFORMATICS by David W Mount, cold spring harbor.
3. BIOINFORMATICS: A biologists guide to biocomputing and the internet. Stuart M Brown, NYU Medical Center, NY USA.
4. ESSENTIALS OF BIOINFORMATICS, Jin Xinog, Texas A & M University, Cambridge University press.
5. Analytical Tools for DNA, Genes & Genomes: by Arseni Markoff, New Age.
6. DISCOVERING GENOMICS, PROTEOMICS & BIOINFORMATICS BY A M CAMPBELL & L J HEYER, PEARSON EDUCATION.
7. Fundamental Concepts of Bioinformatics by D E Krane & M L Raymer, Pearson.
8. Computational methods in Molecular Biology. S.L.Salzberg, D B Searls, S Kasif, Elsevier.
9. BIOINFORMATICS – METHODS AND APPLICATIONS: GENOMICS, PROTEOMICS AND DRUG DISCOVERY BY S C RASTOGI, NMENDIRATTA &P RASTOGI, PHI.

10. Introduction to Bioinformatics by Arthur Lesk, Oxford Publications.
11. Structural Bioinformatics by Philip E Bourne, John Wiley & Sons
12. Computational methods for macromolecular sequence analysis: R F Doolittle. Acad. Press.
13. Computational methods in Molecular Biology. S.L.Salzberg, D B Searls, S Kasif, Elsevier.
14. The molecular modeling perspective in drug design by N Claude Cohen, Academic Press.
15. Analytical Tools for DNA, Genes & Genomes: by Arseni Markoff, New Age.
16. Introduction to Bioinformatics by ANNA TRAMONTANO, TAYLOR
17. Applied Bioinformatics – an introduction – (springer) Selzer P.M and others
18. Bioinformatics Basics – (CRC) – Rashidi, HoomanH , Lukas K Buchler
19. Bioinformation a practical guide to the analysis of genes and proteins
20. BexevanisAndress D - ed
21. Practical Bioinformatics (springer) - Bujnicki, Janusz M.-ed
22. Biostatistics refoundation for analysis in health sciences (John wiley) Wayne, W Daniel
23. Fundamentals of Biostatistics a practical approach (Kanishka) – Narenkumar Dutta
24. Statistical methods in Biology (Cambridge University Press) – Bailey,Norman T. J
25. Principles of Biostatistics (Wadsworth,USA) – Pagano Marcello.
26. Biostatistics for the biological and health sciences (Pearnon) Triola

SPT-2.3 B. PHARMACEUTICAL BIOTECHNOLOGY (4 Credits; 60 Hours)

UNIT I
Pharmaeutics

Introduction and Scope of Pharma industry and biopharmaceuticals, Biotechnology and drug design: Development and economics, Preclinical studies and principles of process development, early prof -of- concept of chemical and biological entities, Orphan drugs. Provisions for and use of unlicenced medicines. Drug abuse and dependence, Prescription and non-prescription drugs. **06 Hrs.**

UNIT II
Metabolism of Drugs and Xenobiotics

Evolution of drug metabolism Phase I metabolism (microsomal oxidation, hydroxylation, dealkylation) Phase II metabolism (drug conjugation path way) CYP families. Pharmacodynamic and Pharmacokinetics of protein based drugs. Physiologic pharmacokinetic mode, mean residence, time and statistical movement theory. Molecular mechanism of drug action. **06Hrs.**

UNIT III
Toxicology

Introduction, Scope and importance: Basic concepts, Dose response-Fundamental issues in toxicology, LD_{50}, ED_{50}, PD_{50}, Graphs and calculations. Dose respose relationships for cumulative effects. Factors influencing dose response. Fate of toxicants and mechanism of action of toxins, biotransformation of toxins and their clearance from the body; Toxic

intermediates; Toxicokinetics and Toxicity testing-Invitro methods and invivo methods. **12 Hrs.**

UNIT IV

Drug Manufacture and Formulation

Basic concepts and applications, composition, preparation, physicochemical considerations in manufacture of current biotech products and herbal medicines. Qualitiy controle (QC), storage and stability of biotech products. Concept and testing of preformulations and their parameters. Tablets: compressed, granulation, coatings, pills, capsules. Parental preparations, Herbal extracts, Oral liquids, Ointments**.** **08 Hrs.**

UNIT V

Drug delivery systems

Advanced sustained release, advanced drug delivery systems: Liposomes and nanoparticles, biodegradable delivery system (Hydrogel based). **04 Hrs**.

UNIT VI

Analysis of Pharamceuticals

Validation techniques for pharmaceutical industries, pilot plant, scale-up techniques. Analytical methods and tests for various drugs-Alkalimetry, Acidimetry, Iodimetry, Aqueous and non-aqueous titration, Diazotization, Complexometry, Gravimetry, Potentiometry methods. Packaging techniques-Glass containers, plastic containers, film wrapper, bottle seals; Quality Assurance (QA) and Quality Controle (QC). **10 Hrs.**

UNIT VII

Advanced pharmacology and Pharmacotherapy

Introduction and scope: Psychotherapeutic agents, Immuno-modulators, heavy metals and heavy metal antagonists, therapeutic gases. Free radical biology, antioxidants and antitoxicants. Pharmacotherapy; Special emphasis on vitamins, growth regulators, Growth factors, cold remedies, laxatives, analgesics, non-steroidal contraceptives, external antiseptics, antacids, biological, herbal products. Pharmacotherapy of migrane, Alzheimers, TB, Diabetes and male sexual dysfunction. Hormone replacement therapy (HRT). Advances and promises of gene therapy in combating diseases wherein cure presently unknown.**14 Hrs.**

SPP-2.7 (2.3) B. PRACRICALS

1. Method of injecting drugs by various roots.
2. Assay of Ibuprofen/Aspirin by alkalimetry.
3. Assay of Adrenalin by acidimetry.
4. Assay of Ethambutol hydrochloride by acidimetry.
5. Assay of Analgin by Iodimetry.
6. Assay of Ephedrin hydrochloride/Phenobarbitone sodium by non-aqueous titrations.
7. Assay of Procaine/Benzocaine by Diazotization.
8. Assay of vitamin B_{12} in commertially available capsules/tablets.
9. Assay of Piperazine phosphate/ Benzylpenicillin Na^+or K^+ Salt by Gravimetry.
10. Assay of Nitrazepam /Allopurinol/ Chloridine hydrochloride by potentiometry.
11. Assessment of cytotoxicity of drug by mitotic index.
12. Sterility testing methods for pharmaceutical products.
13. Tests for disinfectants (Phenol coefficient/RWC)
14. Determination of antibacterial spectrum of drugs/antibiotics
15. Chemical assays for antimicrobial drugs.

16. Testing for antibiotic/drug sensitivity/resistance.
17. Determination of MIC value for antimicrobial chemicals.
18. Microbiological assays for antibiotics (Liquid tube assay, agar tube, agar plate assays)
19. Toxicity tests in lab animals; Pyrogenicity tests in lab animals.
20. Analysis of Pharmaceutical products by TLC, HPLC and GC

REFERENCES:

1. An Introduction to synthetic drugs- Singh & Rangnekar, Himalya Publishing House, 1980.
2. Priciples of Medicinal chemistry-Foye, L W Publishers 2008.
3. Biopharmaceuticals, Biochemistry and Biotechnology- Gary Walsh, Wiley Pub, 2nd Edn. 2003.
4. Industrial Pharmaceutical Biotechnology- Heinrich Klefenz- Wiley-VCH Edn, 2002
5. Biopharmaceutical Drug Design and Development-S Wu Pong, Y Rojanasakul, and J Robinson, Humana Press 1999.
6. Pharmaceutical Biotechnology- K Sambamurthy and Ashutosh Kar, New age International Publishers-New Delhi 2006.
7. Pharmaceutical Biotechnology-S P Vyas and V K Dixit, CBS Publishers, 2007
8. Drug Delivery and Targeting for Pharmacists and Pharmaceutical Scientists by Anya M.Hillery et.,al. 2005.
9. Experimental Design and Analysis by Howard J. Seltman 2014.
10. Hand book of Modren Pharmaceutical Analysis by Satinder Ahuja et.,al. Acadimic Press 2001.
11. A Text Book of Modern Toxicology by Ernest Hodgson 3rd Edn. John Wiley & Sons, Inc. 2004.

OET-2.4 RECOMBINANT DNA TECHNOLOGY (4 Credits; 60 Lectures)

UNIT I

Gene cloning

Introduction and Scope of rDNA technology, General concept, restriction endonuleases, enzymatic tools for gene cloning, linkers and adaptors. **04 Hrs.**

UNIT II

Vectors Used in Gene cloning.

Plasmids (pBR 322, pACYC 1854, PUC Vectors, pBin19,121), Yeast plasmid vectors (Integrative plasmid, episomal plasmid,replicative plasmid).Ti plasmid, binary vector, Co-integrate vector. Cosmids, phagemids. Bacteriophage vector – λ phage cloning vectors M13 phage. YAC, BAC, HAC, PAC Shuttle vectors. Expression vectors. **08 Hrs.**

UNIT III

cDNA and genomic cloning

Genomic libraries, c-DNA libraries, identification and analysis of cloned DNA. Approaches for identification of genes (colony and plaque hybridization, Immunological detection, Southern blot analysis) Radioactive labelling, Non-radioactive labelling. **08 Hrs.**

UNIT IV

Methods in rDNA Technology

In vitro mutagenesis-Site directed mutagenesis, deletion mutagenesis, PCR based mutagenesis. Gene transfer methods- Marker genes (reporter genes, selectable markers) Gene transfer in plants (Agrobacterium mediated gene transfer, physical gene transfer methods, chemical gene transfer methods) Gene transfer in animals (transfection methods, ES cell transfer, Targeted gene transfer). **14 Hrs.**

UNIT V

Antisense & ribozyme technology

Introduction and scope, Molecular mechanism of antisense molecules, Si-RNA. Biochemistry of ribozymes-hammerhead, hairpin and other ribozymes, Strategies for designing ribozymes. Application of antisense and ribozyme technologies. **08 Hrs.**

UNIT VI

PCR Technology

Primer design; Fidelity of thermostable enzymes; DNA polymerases; Types of PCR – multiplex, nested, Reverse transcriptase, real time PCR, touchdown PCR, hot start PCR, colony PCR, cloning of PCR products; Tvectors; Proof reading enzymes; PCR in gene recombination; Deletion; addition; Overlap extension; and SOEing; Site specific mutagenesis; PCR in molecular diagnostics; Viral and bacterial detection; PCR based mutagenesis, Mutation detection: SSCP, DGGE, RFLP, Oligo Ligation Assay (OLA), MCC (Mismatch Chemical Cleavage, ASA (Allele-Specific Amplification), PTT (Protein Truncation Test) **10 Hrs.**

UNIT VII

Sequencing and Applications of rDNA Technology

Enzymatic DNA sequencing; Chemical sequencing of DNA; Automated DNA sequencing; RNA sequencing; Chemical Synthesis of oligonucleotides; Transfection techniques; Gene silencing techniques; Gene knockouts and Gene Therapy; Creation of knock out mice; Disease model; Somatic and germ-line therapy- in vivo and ex-vivo; Suicide gene therapy; Gene replacement; Gene targeting; Transgenics; cDNA and intragenic arrays; Differential gene expression and protein array. **08 Hrs.**

OEP 2.8 (2.4) PRATICALS

1. Isolation of genomic DNA from bacteria.
2. Isolation of plasmid DNA from bacteria.
3. Determination of molecular weight of DNA
4. Restriction digestion analysis.
5. Ligation of restricted fragments.
6. Southern Hybridization study.
7. Western Blotting.
8. Transformation.
9. Conjugation.
10. PCR amplification study using thermal cycler.

REFERENCES:

1. S.B. Primrose, R.M. Twyman and R.W.Old; Principles of Gene Manipulation. 6th Edition, S.B.University Press, 2001.
2. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.
3. Brown TA, Genomes, 3rd ed. Garland Science 2006
4. Selected papers from scientific journals.
5. Technical Literature from Stratagene, Promega, Novagen, NewEnglandBiolab etc.
6. Principles of gene manipulations, R.N. Old and S.B. Primrose, 1994. Blackwell Scientific Publications.
7. DNA Cloning I & II, D.M. Glover & B.D. Hames, 1995. IRL Press.
8. PCR Strategies, M.A.Innis, D.H. Gelfant&J.J.Sninskey, 1995. IRL Press.
9. Recombinant DNA (2nd Ed), J.D.Watson, M.Gillman, J.Witknow Ski and M.Zoller, 1992. Scientific Americans books, N.Y.
10. Genetic Engineering of Animals, A.Puhler, 1993. VCH Publishes, Weninheim FRG.
11. Gene Transfer and expression protocols - methods is molecular biology volume 7, E.T. Murray, 1991. Humana Press.

CPT-3.1 ANIMAL BIOTECHNOLOGY (4 Credits; 60 Hours)

UNIT I

Animal reproductive system

Rreproductive system with reference to insects and mammals-Organization, function. Hormonal regulation of growth and reproduction in insects and mammals. **04 Hrs.**

UNIT II

Animal Cell Culture

Historical background, Development and scope, Requirements for cell culture-Animal cell culture infrastructure, equipment, Laboratory design, culture vessels, aseptic handling, biohazards and safety, safety regulations.Advantages and limitations of tissue culture. Culture Medium: Physico-chemical factors and metabolic functions of different constituents of culture medium: CO_2, Hormones and Growth factors (EGF, PDGF, NGF, GAP43 etc). Natural media, Synthetic media: Composition of Minimal Essential Medium, growth media, Commercial types: Development, merits and demetits of Serum and protein free media.

10 Hrs.

UNIT II

Cell culture Techniques and Cell lines

Primary culture- Introduction,isolation of tissue, Tissue Disaggregation; Trypsinisation, disaggregation by collagenase. Primary explanation techniques- slide/cover slip cultures, Flask cultures, test tube cultures; Cell quantitation. Organ cultures- characteristics, methods and limitations, Histotypic culture techniques. Suspension culture-Culturing hemopoitic cells. Cell Lines: Biology of cultured cells, Sub culturing and designation of cell lines,Types of cell lines - Routine maintenance of cell lines. Cell selection- Finite/continuous cell line, species, normal or transformed; growth characteristics and growth phases..Selection and Cloning of Cells**:** Introduction, Cell Cloning, Selection and isolation of clones. Isolation techniques- irradiation, broken cover slip, and capillary technique. Cell synchronization- Physical and chemical methods. **16 Hrs**.

UNIT III

Processing of Cultured cells and Characterization

Separation of viable cells: Physical methods- Density gradient centrifugation and Centrifugal elutriation. Biological Methods Panning, Magnetic cell sorting and Fluorescence-activated cell sorter (FACS). Applications of separation methods. Cryopreservation of Animal Cells and Tissues - Principles of freezing and thawing of cells. Generation of Cell Banks. Cell Viability and Cytotoxicity assays: Introduction and background, Drug exposure and recovery period. Toxicity and Viability Assays - Membrane integrity: ^{51}Chromium release, Enzyme release, Dye exclusion, MTT and Fluorescent dyes. Colorimetric assays- of Proteins and DNA; Lysosome and Golgi body activities, Tetrazolium dye reduction and apoptosis. **12 Hrs.**

UNIT IV

Scale up of animal cell culture: General methods and parameters, practical consideration of growth kinetics, medium and nutrients, pH, oxygen. Monolayer cultures- Roller bottle modifications, large capacity stationary cultures, unit process system microcarrier cultures. Suspension cultures-Stirred bioreactors, airlift fomenters. Immobilized cultures- immurement cultures, entrapment cultures and porous carriers. **08 Hrs.**

UNIT VI

Applications of Animal Biotechnology

Organ culture: whole embryo culture - specialized culture techniques - measurement of cell death. Design and engineering of tissues - tissue modeling. Embryonic stem cell engineering ES cell culture to produce differential cells. Human embryonic stem cell research. Transgenic animals in xenotransplantation. IVF-Embryo transfer technology in live stock and man. **08 Hrs.**

UNIT VII

Molecular Pharming

Introduction. Creating Transgenic, Biopharmaceuticals: Generation of Vaccines. Transgenic Animals; Methods for production of Transgenic Animals. Applications of Transgenic Mice, fish, Sheep, Chickens, Pigs, Cow and Transgenic silk worm. **06 Hrs.**

CPP-3.5 (3.1) PRACTICALS

1. Safety measures in Animal cell culture laboratory.
2. Designing of animal cell culture laboratory.
3. Cleaning and sterilization of glassware and plastic tissue culture flasks.
4. Preparation of tissue culture media.
5. Preparation of sera for animal cell culture.
6. Preparation of single cell suspension from chicken liver (Primary cell culture).
7. Trypsinization of monolayer and subculturing; Cryopreservation and thawing;
8. Macrophage monolayer from PEC and measurement of phagocytic activity.
9. Isolation and staining of liver parenchyma cells.
10. Initiation of Primary cell culture.
11. Continuous cell culture.
12. Drug/Toxicity testing
13. MTT assay
14. Morphological characterization of cell death.
15. Acridine orange/Ethidium bromide staining.
16. Biochemical characterization of cell death.
17. Isolation of Genomic DNA and RNA.

18. DNA laddering assay.
19. Cell counting and viability testing:
    Staining of cells - A. Vital Staining (Trypan blue, Erythrosin B) b) Giemsa staining.
20. Role of serum in cell culture;
21. MTT assay for cell viability and growth; Cell fusion with PEG.
22. Embryonic development and stem cells (Fish/ chick/ frog)

REFERENCES:

1. Animal Cells Culture and Media, D.C.Darling and S.J.Morgan, 1994. BIOS Scientific Publishers Limited.
2. Methods in Cell Biology, Volume 57, Jennie P.Mathur and David Barnes, 1998. 3.
3. Animal Cell Culture Methods Academic Press.
4. Epithelial Cell Culture, Ann Harris, 1996. Cambridge University Press
5. Animal Biotechnology, M.M. Ranga, 2000. Agrobios, India.
6. Biotechnology, Satyanarayana, U., 2006. Books and Allied (P) Ltd.
7. Culture of Animal cells, 3rd Edition, R. Ian Freshney. A John Wiley & Sons, Inc., publications.
8. Animal Cell Culture- Practical Approach, R.W. Masters, Oxford.
9. Animal Cell Culture Techniques. Ed. Martin Clynes, Springer.
10. Animal Cell Biotechnology, Methods and protocols, Nigel Jenkins, Humana Press.
11. Biotechnology of Animal Tissue. P.R.Yadav& Rajiv Tyagi. 2006. Discovery Publishing House. New Delhi.
12. Animal Cell Culture- Practical Approach. John, R.W.Masters. 2000. 3rd Edition. Oxford University Press.

CPT-3.2 ENVIRONMENTAL BIOTECHNOLOGY & IPR (4 Credits; 60 Hours)

UNIT I

Environment and Pollution

Introdution to environment, Ecosystem structure and functions, abiotic and biotic component, Energy flow, food chain, food web, Ecological Pyramids-types, biogeochemical cycles, ecological succession, Ecads and ecotypes. Enivronmental pollution, Types; Air pollution: sources and measurement, water pollution: sources and measurements, Soil pollution: sources and measurements. Noise pollution, Thermal pollution, Marine pollution.

12 Hrs.

UNIT II

Microbiology of waste water treatment

Water as a scarece natural resources, Need for water management-waste water collection. Physical, chemical and biological waste water treatment methods. Aerobic waste water treatment: Activated sludge process, Oxidation Ponds, Oxidation ditches, trickling filters, towers, rotating discs. Anaerobic processes: Anaerobic digestion, anaerobic filters, anaerobic sludge, membrane bioreactors, Reverse osmosis and ultrafiltration.Treatment of industrial effluents (Dairy, distillery, tannery, antibiotic industries, Textile, paper and Sugar indutries).

08 Hrs.

UNIT III

Solid waste Management and Bioremediation

Sources and types of solid wastes, Strategies for Management (Composting, vormiculture, and methane production), treatment of hazardous wastes, and Biomedical wastes. Solid and wasteland-Bioremediation using microbes, in situ & ex-situ Bioremediation, Biosorption, & Bioaccumulation of heavy metals, Phytoremediation. Xenobiotics in environment: Bioaccumulation, Biomagnification, Biodegradation, Role of degradative plasmids, degradation of hydrocarbons: substituted hydrocarbons, fate of polychlorinated biphenyls, and fate of surfactants, detergents, and fate of oil spillage, and Biofilms. Reduction of organochlorine compounds in bleach plant effluents. **10 Hrs.**

UNIT IV

Global Environmental Problems

Acid rain, Ozone depletion, UV-B Radiation Flux increase, effect of UV-light on biological system, Green house effect, Implications of global warming, Effects and measures to control environmental problems. **04 Hrs.**

UNIT-V

Bioleaching

Introduction and Principles of Bioleaching, Types of Bioleaching, Bioleaching of Copper, Iron, Gold, Uranium, Nickle and microorgamisms involved in bioleaching. Insitue bioleaching and ex-situe bioleaching. Merits and demerits of bioleaching. **04 Hrs.**

UNIT VI

Energy resources, Biofuels and Bioplastics

Renewable and non renewable energy resources. Waste as a source of energy, Production of oil and fuels from wood waste, composting , Biofuels : Biogas production, methanol production from organic wastes, Bioethanol production, Biological Hydrogen production and applications. Biochemistry and microbiology of biofuel production. Byproducts of sugar industries. Bioplastics: PHA, PHB, BIOPOL-A. Microorganisms involved in the degradation of plant fiber, cell wall, lignin, fungal de-lignification and pulping of wood, solving pitch problems in pulp and paper processes using enzymes or fungi hemicellulases in pulp bleaching. Biotechnology for solving slime problem in the pulp and paper industry. **12 Hrs.**

UNIT-VII

Intellectual property rights & Patenting system

TRIP International conventions patents and methods of application of patents - legal implications biodiversity and farmer rights - beneficial applications and development of research focus of the need of the poor - Identification of directions for yield effect in agriculture - aquaculture and bioremediation. Objectives of the patent system - basic principles and general requirements of patent law-biotechnological inventions and patent law. Legal development - patentable subjects and protection in biotechnology. Consumer protection and plant genetic resources-GATT and TRIPS. **08 Hrs.**

UNIT VIII

Biodiversity and Conservation

Current status of Biodiversity, Role of Biotechnology in conservation of biodiversity, influence of transgenic plants and animals on the environment. **04 Hrs.**

CPP 3.6 (3.2) PRACTICALS

1. Detection of coli forms for determination of the purity of potable water.
2. Methods of Water and Soil sampling and assessment of pH.
3. Determination of dissolved oxygen (DO) concentration of different water samples.
4. Estimation of CO_2 and total hardness (calcium and magnesium) of different water samples.
5. Determination of Biological oxygen demand (BOD) and Chemical oxygen demand (COD) of a sewage sample.
6. Isolation of Bacteriophages from sweage sample.
7. Determination of Total dissolved solids (TDS) of water sample.
8. Isolation of xenobiontics degrading bacteria by selective enrichment technique.
9. Survey of degradative plasmids in microbes growing in polluted environment.
10. Isolation and characterization of Iron and Manganese reducing bacteria.
11. Study of microflora of Industrial wastes and effluents.
12. Acquisition of "Google Earth" images for the known and unknown area for land use - land cover mapping.
13. Determination of atmospheric pollutants (NOx, SOx, and particulate matters).
14. Effect of sulphur dioxide on crop plants.
15. Estimation of Nitrate, Chloride, Phosphates and sulphates in drinking water.
16. Study on biogenic methane production.

REFERENCES:

1. Wastewater Engineering – Treatment, Disposal and Reuse. Metcalf and Eddy.
2. Comprehensive Biotechnology Vol.4, M.Moo-Young.
3. Environmental Chemistry, A.K.De,
4. Introduction to Biodeterioration, D.Allsopp and K.J.Seal
5. Biotechnology and Patent protection, Beier, F.K., Crespi, R.S. and Straus, T., 1985. Oxford and IBH Publishing Co, New Delhi.
6. Intellectual Property rights on Biotechnology, Singh K, BCIL, New Delhi
7. www.ipr-helpdesk.org/
8. www.patentoffice.nic.in/ipr/patent/patents.htm
9. www.bangalorebio.com/GovtInfo/ipr.htm
10. Allsopp D. and K.J. Seal (1999) Introduction to Biodeterioration –ELBS/Edward Arnold.
11. Christson, J.Harst (1997) Manual of Environmental Microbiology, ASM Press, Washington. DC.
12. De, A.K. (1987) Environmental Chemistry –Wiley Eastern Limited, New Delhi Foster C.F. John Ware D.A. Environmental Biotechnology, Ellis Horwood Limited.
13. Ericksson Ed. (1998) Biotechnology in the pulp and paper industry, Springer.
14. Geetha Bali et al eds (2001) Environmental Biotechnology, ApS Pub.
15. Jitendraprakash and LM Pierik, (1993) Plant Biotechnology : Commercial aspect and problems Oxford and IBH.
16. Hurst C.J. et al eds (1997) Environmental microbiology , ASM Press, Washington, D.C.
17. Larry Anderson and David A. Tilman (1977) Fuels from waste, Academic press.
18. Moo –Young M (Ed-in-Chief), Comprehensive Biotechnology, Vol. 4- Pergamon Press, Oxford.

19. Ramamurthy et al. Ed (2001) , Biodiversity, APS publishers New Delhi.
20. Sinha R.K. (1997) Global Biodiversity, INA , Shree publishers, Jaipur
21. Whitaker, Joh Reed and S.Philip (1989) Biocatalysis in agricultural biotechnology, Washington ACS.

SPT-3.3 A. GENETIC ENGINEERING (4 Credits; 60 Hours)

UNIT I

Molecular tools in Genetic engineering

Introduction and scope. DNA Structure and properties; Restriction Enzymes-Types, proterties and assay. DNA ligases-types, properties and assay. T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase; Cohesive and blunt end ligation; Linkers; Adaptors; Homopolymeric tailing, etc. **04 Hrs.**

UNIT II

Vectors:

General characteristics of vectors, desirable characters such as size orisite, selection / marker gene, restriction sites and unique multiple cloning sites for cDNA cloning. Types: Cloning and expression vectors –Plasmids –PBR 322 pUC vectors, pichia vectors system, Plant based vectors-Ti and Ri as vectors, Phage vectors – lambda based vectors, M13, M13 derived pUC vectors, Cosmids, Phagemids, ARS, Mini Chromosome, yeast artificial chromosomal vectors (YAC). Design of Shuttle vectors for replication in bacteria and yeast cells, specific promoters for expression in yeast cells, transcriptional terminators, selection of marker genes for bacteria and yeast cells. Vectors for plants: expression vectors need for promoters such as Lac-Z, T7 and TaC, MCS. Vectors for animals: SV40, vaccinia virus, Bovine papilloma virus (BPV), Retrovirus. Isolation and purification of vector DNA, digestion and end modification. Introduction of recombinant vectors into suitable hosts, selection of recombinant clones, and purification of recombinant DNA. **14 Hrs.**

UNIT III

Cloning and Transformation

Cloning and selection of individual gene, gene libraries, preparation of cDNA libraries ; isolation and purification of mRNA ; importance of poly-A tailing in the preparation of cDNA library; Genomic library isolation and purification of total genomic DNA, partial digestion with suitable enzyme size fractionation and end modification. Transformation Techniques: Preparation of competent cells of bacteria, yeast, insect, mammalian and plant cells. Methods of rDNA transfer-exogenously supplied chemical methods, calcium phosphate precipitation method, liposome mediated method and electroporation, Agrobacterium Ti-DNA mediated method, gene gun method ; Determination of transformation / transfection efficiency. Lambda DNA based DNA recombinants : In vitro packaging of DNA using packaging extracts infection of bacteria using packaged lambda viruses containing recombinant DNA. **14 Hrs**.

UNIT IV

Analysis of recombinants

Plating, screening and selection-preparation of nutrient media with selection, marker antibiotics and additives for visual screening of recombinant clones, selection of clones, amplification and preservation. Labeling of DNA, RNA and proteins. Use of radioactive isotopes,Non–radio active labeling relative advantages and disadvantages, in-vivo labeling,

Nick translation, random primer labeling, Fluorescence in situ hybridization (FISH), Chromatin Immunoprecipitation; DNA-Protein Interactions-Electromobility shift assay; DNase-Ifootprinting; Methyl-interference assay, auto radiography, autofluorography.

08 Hrs.

UNIT V

In vitro translation

Purification of mRNAs and translation using cell free systems from wheat germ extract or rabbit reticulocytes and characterization of protein products on gel electrophoresis. Blotting experiments – southern , Northern western and western / southern blotting methods, agarose gel, polyacrylamide gel and 2D gel electrophoresis ; DNA microarrays (DNA chips) to study gene expression etc. **08 Hrs.**

UNIT VI

PCR Technology

Primer design; Fidelity of thermostable enzymes; DNA polymerases; Types of PCR – multiplex, nested, Reverse transcriptase, real time PCR, touchdown PCR, hot start PCR, colony PCR, cloning of PCR products; T-vectors; Proof reading enzymes; PCR in gene recombination; Deletion; addition; Overlap extension; and SOEing; Site specific mutagenesis; PCR in molecular diagnostics; Viral and bacterial detection; PCR based mutagenesis, Mutation detection: SSCP, DGGE, RFLP, Oligo Ligation Assay (OLA), MCC (Mismatch Chemical Cleavage, ASA (Allele-Specific Amplification), PTT (Protein Truncation Test). **08 Hrs.**

UNIT VII

Applications of Genetic engineering

Productions of proteins for pharmaceutical use, Medical applications, Industrial applications, transgenic technology in research and development with case studies. **04 Hrs.**

SPP-3.7 (3.3) A. PRACTICALS

1. Isolation of genomic DNA from bacteria/plant/Animal.
2. Isolation of plasmid DNA from bacteria.
3. Restriction digestion analysis.
4. Ligation of restricted fragments.
5. Primer Design: Factors affecting primer design.
6. Restriction mapping: Analysis of maps for suitable molecular biology experiment by using bioinformatics tools.
7. Cloning and sub cloning using plasmid and E.Coli expression vectors.
8. Selection of cloned microorganisms by blue /while colony, X-Gal method.
9. Transformation through $CaCl_2$ and PEG method.
10. Transformation of rDNA in E. coli by electroporation method.
11. PCR amplification study using thermal cycler and analysis of the products.
12. Competent cell preparation.
13. Preparation of competent cells in E.coli and yeast.
14. Western and southern blotting.

REFERENCES:

1. S.B. Primrose, R.M. Twyman and R.W.Old; Principles of Gene Manipulation. 6th Edition, S.B.University Press, 2001.
2. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.
3. Brown TA, Genomes, 3rd ed. Garland Science 2006
4. Selected papers from scientific journals.
5. Technical Literature from Stratagene, Promega, Novagen, NewEnglandBiolab etc.
6. Principles of gene manipulations, R.N. Old and S.B. Primrose, 1994. Blackwell Scientific Publications.
7. DNA Cloning I & II, D.M. Glover & B.D. Hames, 1995. IRL Press.
8. PCR Strategies, M.A.Innis, D.H. Gelfant&J.J.Sninskey, 1995. IRL Press.
9. Recombinant DNA (2nd Ed), J.D.Watson, M.Gillman, J.Witknow Ski and M.Zoller, 1992. Scientific Americans books, N.Y.
10. Genetic Engineering of Animals, A.Puhler, 1993. VCH Publishes, Weninheim FRG.
11. Gene Transfer and expression protocols - methods is molecular biology volume 7, E.T. Murray, 1991. Humana Press.

SPT-3.3 B. GENOMICS & PROTEIOMICS (4 Credicts; 60 Hours)

UNIT I

Sequencing Technology

Introduction, scope of sequencing technology: Strategies for genome sequencing: Chain termination method, automated sequencing, pyrosequencing. Sequence assembly: Clone contig and shotgun approaches. Organization of genomes: main features of prokaryotic and eukaryotic genome organization. Plant genome project, human genome project and its applications. Locating the genes: ORF scanning, homology searches. **12 Hrs.**

UNIT II

Genomics

Introduction and scope, Determination of the functions of genes: gene inactivation (knock-out, anti-sense and RNA interference) and gene over expression. Approaches to analyze global gene expression: transcriptome, Serial Analysis of Gene Expression (SAGE), Expressed Sequence Tags (ESTs), SNPs and their relevance, Massively Parallel Signature Sequencing (MPSS), microarray and its applications, gene tagging. Metagenomics: Prospecting for novel genes from metagenomes and their biotechnological applications.

12 Hrs.

UNIT III

Proteomics

Introduction and scope, Human genome - Genomes to Proteomes – Human proteome organization (HUPO). Branches of proteomics - Protein extraction Methods: Subcellular fractionation, Density gradients, Ultrafiltration, - Protein fractionation - Affinity purification –Combined Fractional Diagonal Chromatography (COFRADIC) - Removal of interfering compounds, salts, DNA, lipids, Protein solubilization methods, chaotropes, detergents, etc., Preparation of Sample - Sample handling and storage - Protein detection and quantification methods – Stable Isotope Labeling with Aminoacids in Culture (SILAC) - Chemical tagging, fluorescence, negative staining, radio labeling–Chemical modifications. **12 Hrs.**

UNIT IV

Analysis of Proteome

Introduction, Proteomic Techniques for Analysis: 2-D gel electrophoresis – Mass Spectrometry –Principles of MALDI-TOF - RP chromatography /Tandem mass spectrometry - Protein sequence analysis; N-terminal determination methods, C-terminal determination methods. Protein modification – Protein microarrays – Tissue microarray – Infra red Protein array with Quantitative Readout (IPAQ) - X-ray crystallography-Nuclear Magnetic Resonance (NMR) - X-ray Tomography -Data Analysis algorithms – Sequence Analysis algorithms. **12 Hrs.**

UNIT V

Applications of proteomics

Proteomic approach for Clinical studies: Protein Biomarker Discovery and Validation – Body fluid profiles, blood disease profiles, diabetes profiles, infectious diseases, stroke and myocardial infarction, nervous system, Alzheimer, low abundance and hydrophobic proteins. High through put techniques to identify protein molecules in sample - Emerging technologies: Proteomics in Biotechnology - Microfluidics. **12 Hrs.**

SPP - 3.7 (3.3) B PRACTICALS

1. Extraction and estimation of total proteins from plants/animal/microorganisms.
2. Estimation of protein by Micro-Kjeldahl's method.
3. Estimation of total amino acid composition.
4. Estimation of amino acid by ninhydrin method.
5. Protein profile studies (Case study).
6. Separation of proteins by electrophoretic method SDS-PAGE.
7. 2D-Gel Electrophoresis of protein and imaging.
8. Physical mapping of the alpha amylase gene.
9. Cloning and sub cloning of alpha-amylase gene in yeast.
10. Purification and analysis of alpha amylase by chromatographic techniques.
11. Determination of molecular weight of alpha amylase.
12. Determination of N'-terminal and C'-terminal amino acid sequence.
13. Gene structure and function prediction (Using Genscan,GenMark)
14. Molecular visualization of protein (Amylase) using RASMOL
15. Prediction of tertiary structure of protein using SWISS-MODEL server.

REFERENCES:

1. Twyman, R.M. Principles of Proteomics. BIOS Scientific Publisher, New York. 2004.
2. Liebler, D.C. Introduction to Proteomics: Tools for the New Biology. Human Press, Totowa NJ. 2002.
3. Buchanan B, Gruissem G, and Jones R (2000) Biochemistry and Molecular Biology of Plants, American Society of Plant Physiologists, USA.
4. Hammes GD (2005) Spectroscopy for the Biological Sciences; Wiley Interscience, USA.
5. Harlow and Lane D (Eds.) (1988) Antibodies – A Laboratory Manual; Cold Spring Harbor Laboratory, USA.
6. Lieber DC (2006) Introduction to Proteomics: Tools for New Biology; Humana Press, NJ.

7. 7. Pennington SR, Dunn MJ (Eds.) (2002) Proteomics: From Protein Sequence to Function,
8. BIOS Scientific Publishers, United Kingdom.
   Sambrook J and Russell DW (2001). Molecular Cloning. A Laboratory Manual,Vol I, Vol II, Vol III. Cold Spring Harbor Laboratory, USA.
9. Singer M and Berg P (1991). Genes and Genomes: A Changing Perspective; University Science Books, CA, USA.
10. Westermeier, R and T. Naven. Proteomics in Practice: A Laboratory Manual of Proteome Analysis. Weinheim: Wiley-VCH, 2002.

OET-3.4 INDUSTRIAL BIOTECHNOLOGY (4 Credits; 60 Hours)

UNIT I

Introduction: Industrial Technology, Principles of fermentation and Historical Back ground.Microbial Strain Improvement**:** Isolation, selection and improvement of microbial cultures; Screening of microorganisms for primary and secondary metabolites, enrichment, specific screening for the desired product. Strain improvement for the selected organism -random and strategic screening methods; Media for Industrial Fermentation**:** Natural and synthetic media; Media formulations- Carbon sources, Nitrogen sources, minerals, vitamin sources, nutrient recycle; Buffers; Precursors and metabolic regulators and Oxygen requirement. **12 Hrs.**

UNIT II

Design of Fermenter

Basic functions of a fermenter, Bioreactor configurations: Design features, culture vessel, cooling and heating devices. Mass transfer in reactors : Transport phenomena in fermentation- Gas- liquid exchange and mass transfer, oxygen transfer, critical oxygen concentration, determination of Kla; Heat transfer, aeration/agitation. Sterilization of Bioreactors, nutrients, air supply, products and effluents, process variables; Measurement and control of Bio-process - probes for online monitoring and computer control of fermentation process.Reactors for specialized applications: Stirred tank reactors, Cyclone reactors, Packed bed reactors, Fluidized bed reactors and Trickle flow reactors. **12 Hrs.**

UNIT III

Fermentation Process

Batch, fed batch and continuous cultivation; Solid state cultivation; Growth of cultures in the fermenter; Kinetics of growth in batch culture, continuous culture with respect to substrate utilization. Specific growth rate, doubling time, growth yield, metabolic quotient; Chemostat Culture- Balance equations critical dilution rate, Biomass productivity, comparison with batch cultures, residence time distribution, Test of validity; Product formation in microbial cultures; Effect of inhibition and activation of growth. **10 Hrs.**

UNIT IV

Down Stream Processing: Cell disintegration- Physical, chemical and enzymatic methods. Biomass separation by centrifugation, filtration and flocculation.Extraction- solvent, two phase, liquid extraction, whole broth and aqueous multiphase extraction. Purification – Chromatograghy, concentration , ultra-filtration, reverse osmosis, drying and crystallization. **06 Hrs.**

UNIT V

Microbial Products: Metabolic pathways and metabolic control mechanisms; Microbiological fermentation Products:- Alcohol- Ethanol, Alcoholic beverage – Wine , Beer & Whisky, Organic acids – Citric acid, Amino acids – Glutamic acid and Vitamin – $B_{12.}$ Microbial Production of Therapeutic Compounds:**A**ntibiotics- production of Penicillin, Streptomycin, Tetracycline, Rifamycin and Quinolinones. **08 Hrs.**

UNITVI

Enzymes in Industrial Processing: Structure**,** characteristics**,** metabolic pathways, control mechanisms.Role of cellulases, hemicellulases, Lipases – pancreatic lipases and microbial lipases, proteases – Serine proteases, metalloproteases, acid proteinases, laccases. Food Technology: Extraction, Brewing, Grain Processing, Protein Processing & Flavours, Dairy Processing, Extraction and clarification of fruit and vegetable juices, Infusion of pectinases and b-glucosidases to alter the sensory properties of fruits and vegetables Production of fruit nectars and purees, Improving the quality of bakery products, enzymes used in meat industry. Fermented Foods - Industrial production of Yoghurt, Cheese, Tempeh. Textile Processing, Leather Processing, Paper & Pulp Processing, Immobilization techniques: Industrial techniques for whole cell and enzyme immobilization. **12Hrs.**

OEP-3.8 (3.4) PRACTICALS

1. Fermentation of wheat bran/ cellulose/ birchwood xylan by Trichoderma
2. Analysis of spent broth
3. Purification and precipitation secreted proteins from spent broth
4. 2-D gel electrophoresis of precipitated protein
5. Estimation of cellulase activity of cellulose degraders
6. Estimation of cellulose/xylanase activity in broth and precipitated protein fraction
7. Production of algal biomass.
8. Microbial production of Vitmain B_{12} and assay
9. Fermentation of lignocellulolytic biomass
10. Detection of GMO food
11. Microbial load of canned foods
12. Analysis of preserved food stuff for presence of pathogens
13. Detection of viable, non-viable and viable but nonculturable cells by fluorescence microscopy in GMO products

TEXTS/REFERENCES

1. Gautam, N. C., Food Biotechnology in Comprehensive Biotechnology, Vol. 6., Shree
2. Publishers, New Delhi, 2007
3. Gutierrez – Lopez, G. F. et. al., Food Science and Food Biotechnology. CRC Publishers, Washington, 2003
4. Maheshwari, D. K. et. al., Biotechnological applications of microorganisms, IK . International, New Delhi, 2006
5. Stanbury, P. F. et. al., Principles of Fermentation Technology, 2nd Edition, Elsevier, UK, 1995.
6. Waites, M. J. et. al., Industrial Biotechnology: An Introduction, Blackwell publishing, UK, 2007.

7. Bisen P.S (1994) Frontiers in Microbial Technology, 1st Edition, CBS Publishers.
8. Glaser A.N and Nilaido.H (1995) Microbial Biotechnology, W.H Freeman and Co.
9. Prescott and Dunn (1987) Industrial Microbiology 4th Edition, CBS Publishers & Distributors.
10. Prescott and Dunn (2002) Industrial Microbiology, Agrobios (India) Publishers.
11. Crueger W. and Crueger A. (2000) A Text of Industrial Microbiology, 2nd Edition, Panima Publishing Corp.
12. Stanbury P.F, Ehitaker H, Hall S.J (1997) Priciples of Fermentation Technology, Aditya Books (P) Ltd.
13. Food Fermentation – Microbiology, Biochemistry & Technology, Vol. I & II , Joshi and Pandey.

CPT-4.1 PLANT BIOTECHNOLOGY (4 Credits; 60 Hours)

UNIT I
Plant tissue culture

History, contributions of GottleibHaberlandt, GoutheretLaibach, Guha and Maheshwari. Laboratory organization, organization, aseptic manipulation, Inoculation techniques, green house maintainance.Culture environment- Physical and chemical factors influencing morphogenesis.types of culture, role of growth regulators in growth and differentiation in tissue, hormone habituation. Micropropagation in commercial perspectives, advantages, economics, robotics and automation. **12 Hrs.**

UNIT II
Somatic embryogenesis, Hybridization and Somaclonal variation

Induction, development and maturation.somatic, zygotic and parthenogenetic embryo, synthetic seed production and applications. Protoplast isolation- mechanical and enzymatic methods, purification, viability test, culture techniques, fusion methods, microcalli formation, screening and regeneration, hybrids and Cybrids.Molecular basis of variation, variants Selection.Application in plant breeding.Mutation breeding in tissue culture-Spontaneous, induced, chimeras. Germplasm conservation- Modes of conservation, *in vitro* methods of conservation,viability testing, applications. **14 Hrs.**

UNIT III
Ovary and Embryo culture

Aanther and microspore culture, pathways of androgenesis, media, factors controlling androgenesis, applications in plant breeding. Triploid production-endosperm culture, media, factors affecting organogenesis, appllications in plant breeding, Types of embryo, media, role of suspensor, precocious germination, morphogenesis of undifferentiated embryo, embryo rescue, applications in plant breeding. Culture of ovule and ovary, factors affecting seed-set after *in vitro* pollination, applications. **12 Hrs.**

UNIT IV
Genetic engineering

Selectable markers, reporter genes and promoters used in plant vectors - direct transformation of plants by physical methods. Application of DNA technology - transgenic plants with reference to virus and pest resistances - herbicidal resistance - stress tolerance (heat & salt) - cytoplasmic male sterility - resistance to fungi and bacteria - delay of fruit ripening.Basis of tumor formation, hairy roots, features of Ti and Ri plasmids, mechanisms of DNA transfer,

role of virulence genes, use of Ti and Ri as vectors, binary vectors, use of 35S and other promoters, genetic markers, use of reporter genes, methods of nuclear transfer, particle bombardment, electroporation, microinjection, transformation of monocots. Transgene stability and gene silencing. Herbicide and insect resistance. Transgenic plants, Genetically modified (GM) plants (Bt cotton, Bt Brinjal). **16 Hrs.**

UNIT-V

Plant metabolic engineering

plant secondary metabolites, control mechanisms and manipulation of phenylpropanoid pathway, shikimate pathway, alkaloids, industrial enzymes, biodegradable plastics, polyhydroxybutyrate, therapeutic proteins, lysosomal enzymes, antibodies, edible vaccines, purification strategies, oleosin partitioning technology. **06 Hrs.**

CPP-4.5 (4.1) PRACTICALS

1. Preparation and sterilization of glass wares, instruments and explant.
2. Preparation stock solution for MS, WPM, Whites, Nitsch & Nitsch 1967) media.
3. Initiation and maintenance of callus.
4. Organogenesis from callus
5. Somatic embryogenesis from root cultures.
6. Induction of haploids from anther and pollen cultures
7. Isolation and culture of protoplasts from leaf/callus by
8. Embryo culture and embryo rescue of different plant species.
9. Assessment of genetic variation related to plant taxa using allozyme method.
10. Production of secondary metabolites.
11. Protoplast isolation and fusion.
12. Isolation, culture and fusion of protoplasts.
13. In vitro morphogenetic studies using selected plant species.
14. Preparation of artificial seeds.
15. Isolation of plant genomic DNA (Pea shoot tip –CTAB, Cauliflower –SDS)
16. Isolation of plant chloroplasts.
17. Agrobacterium culture, selection of transformants.
18. Developing RFLP and RAPD maps.
19. Suspension culture and production of secondary metabolites.

REFERENCES:

1. Bhojwani,S.S and Razdan.M.K. Palnt tissue culture,Elsevier,Amsterdam.
2. Razdan.M.K. Introduction to Palnt tissue culture, Beltsville.USA
3. Debergh,P.C. and Zimmerman,R.H.(Eds.) 1991.Micropropagation technology and application,Kluwer,Dordrecht.
4. Dixon.R.A. &Gonzales,R.A.(Eds.) Plant cell culture-A practical approach,IRI,Press,Oxford.
5. Gamborg O.L and Phillips,G.C.,Plantcell,tissue and organ culture.Narosa publishing house,New Delhi.
6. Plant tissue culture I & II E.F.George,Exegetics.

7. Radenbaugh K. (ed.).Synseeds: application of synthetic seeds to crop improvement,CRC Press, Boca Raton,FL.

CPT-4.2 MEDICAL & NANOBIOTECHNOLOGY (4 Credits; 60 Hours)

UNIT I

Microbial Diseases

Normal microbial flora of human body, host-microbe interactions. Infection and infectious process, routes of transmission of microbes in the body. Epidemiology, description and pathology of human diseases caused by bacteria; Staphylococcus, Streptococcus, Gonococcus, Enterobacteiaceae, E.coli, Salmonella, Pseudomonas, Klebsiella, Vibrio cholera; pathogenic anaerobes, Tetanus, Mycobacteria, syphilis, Chlamydae. Fungi: Description and pathology of diseases Caused by Aspergillus Candida. Blastomycosis, Micrococcosis, Rhinosporidiian, Epidermophycosis. Protozoa: Malaria and Ameobiosis. Laboratory diagnosis of common infective syndromes and parasitic manifestations, Methods of transmission and role of vectors - biology of vectors. House fly, Mosquitoes, Sandfly. Need and significance of epidemiological studies. **18 Hrs.**

UNIT II

Molecular Virology - General Properties of viruses, Classification, medicinally important viruses, pathogenesis (HSV, HIV, and IMV), Host defenses, viral immunology, lab diagnosis and antiviral drugs. Structure, cultivation and replication of viruses and M.O.I. **06 Hrs.**

UNIT III

Chemotherapy:

Principles of chemotherapy, Mode of action of antibiotics: Penicillin, Streptomycin, Sulfonamides, and Polymyxins Antifungal drugs (Nystatin), Antiviral agents. Problems of drug resistance and drug sensitivity, Drug resistance in bacteria. Interferon - Nomenclature, types and classification. Induction of interferon, types of inducers. Inactivation of viruses - Photodynamic inactivation. Application of phages in therapeutic uses. **10 Hrs.**

UNIT IV

Biosensors: Concept and development of biosensors- Historical perceptive. Market potential and limitations, new generations of biosensors, Biosensors in medical diagnostics. Industrial applications of biosensors **06 Hrs.**

UNIT V

Introduction to Nanoworld

The nanoscale dimension and paradigm,Definitions and historical evolution (colloids etc.) and current practice. Nanoscience and Nanotechnology - Types of nanomaterials and their classifications (1D, 2D and 3D etc.) Nanoparticles, Nanowires, thin films and multilayer. Physical and Chemical Fundamentals of Nanomaterials, Applications in nanotechnology viz. Biosensors, separation of cells and cell organelles, drug delivery, gene therapy etc. **10 Hrs.**

UNIT VI

Synthesis of nanostructures: Natural in inorganic, Natural in organism, chemical and physical methods –Sol Process, Micelle, Chemical Precipitation, Hydrothermal Method,

Pyrolysis, Bio-based Protocol, Chemical Vapor Deposition, Sputtering etc. Applications in various fields viz. Physical and Chemical, Materials, Life Sciences. **08 Hrs.**

UNIT VII

Functionalization of nanoparticles for biological applications, Recent trends in Nanobiotechnology. **02 Hrs.**

CPP-4.6 (4.2) PRACTICALS

1. Preparation of selective and differential media used in diagnostic microbiology.
2. Laboratory examination of sputum: Collection of sputum. Microbiological examination of sputum by differential staining
3. Normal micro flora of throat and skin on Blood agar /Nutrient agar/Chocolate Agar.
4. Microbiological examination of pus, urine and blood.
5. Mycology - Laboratory diagnosis of fungal diseases. Direct microscopy - cultures using Sabouraud's Dextrose Agar medium - Filamentous fungi, yeasts, yeast-like fungi, and dimorphic fungi. *Aspergillusniger, Nocardia, Candida albicans*. (Slides).
6. Medical Parasitology - *E. histolytica, G. laniblia, Trypanaosinas, Leishmania and Plasmodium* (Slides).
7. Laboratory diagnosis of diseases-Widal, VDRL.
8. Detection of virus by ELISA technique.
9. PCR method detection of infectious agents.
10. Synthesis of Al_2O_3 nanoparticles using sol gel method.
11. Synthesis of Fe_2O_3, $AuCl_2$and AgO_2 nanoparticles by chemical method.
12. Synthesis of semiconductor (ZnS, CdS etc.) nanoparticles by chemical method.
13. Synthesis of nanoparticles using biological process – (2-3 methods).
14. Detection of nanoparticles in colloidal solutions using UV-Vis absorption Technique.
15. Size determination of nanoparticles using laser beam.
16. Biological sample preparation for SEM

REFERENCES:

1. Medical Microbiology by David Green wood Richard slack & John Peuthrer Churchill Livingston Company.
2. Medical Microbiology by Jawelz, Melnick, Geo R. Brokes Me Graw-Hill Company.
3. Medical Microbiology by Anantanarayan&Panekar Orient Longman Limited.
4. Practical Medical Microbiology by Mackic&McCarteney.
5. Bacterial Diseases by Wilson & Topley.
6. General Virology by Luria &Parnel.
7. Handbook of Nanostructured Biomaterials and Their Applications in Nanobiotechnology- Hari Singh Nalwa
8. Nanobiotechnology; ed. C.M.Niemeyer, C.A. Mirkin.
9. Nanocomposite Science & Technology Ajayan, Schadler& Braun

10. BioMEMS (Microsystems)- Gerald A. Urban.
11. Introduction to Nanoscale Science and Technology (Nanostructure Science and Technology**)** -Massimiliano Di Ventra.
12. Nanosystems: Molecular Machinery, Manufacturing, and Computation- K. Eric Drexler.
13. Springer Handbook of Nanotechnology- Bharat Bhushan.
14. Nanobiotechnology; ed. C.M.Niemeyer, C.A. Mirkin.
15. Nanofabrication towards biomedical application: Techniques, tools, Application and impact – Ed. Challa S., S. R. Kumar, J. H. Carola.

SPT-4.3 A BIOPROCESS TECHNOLOGY (4 Credits; 60 Hours)

UNIT I

Bioprocess engineering

The chronological development of the fermentation industry, Microbial biomass, Microbial metabolites, Recombinant products, Transformation process. **04 Hrs.**

UNIT II

Bioreactors, Isolation and Inoculation

A typical bioreactor-Configuration of a bioreactor. Body construction. Aeration and agitation. Achievement and maintenance of aseptic conditions. Sterilization of fermenter, air supply exhaust gas from fermenter. Ports and Probes. Valves and steam traps. Isolation, preservation and maintenance of microorganisms Selection of natural variants important characteristics. Strain improvement -Random mutagenesis and Site directed mutagenesis Isolation of induced mutants synthesizing improved levels of primary metabolites and secondary metabolites. **14 Hrs.**

UNIT III

Media and Fermentation

Typical media composition.Medium formulation.Carbon, Nitrogen, Minerals and Energy sources.The addition of precursors and metabolic regulators to media Medium optimization.Oxygen requirements.Antifoams.Air and media sterilization- Media and Air sterilization.Batch, continuous and Filter sterilization.Types of fermentation processes, types of reactors.Stability of microbial reactors.Analysis of mixed microbial populations. Bioreactors like pulsed, fluidized, photobioreactors, Plugflow. **12 Hrs.**

UNIT IV

Kinetic of microbial growth,Measurement and control

Methods of measuring. Control systems. Computer applications in fermentation technology. Mass /Oxygen transfer resistance. Aeration and agitation.Yield and energy consideration.Reynolds number and power number. **04 Hrs.**

UNIT V

Downstream processing

Biomass removal and disruption: Removal of microbial cells and solid matter; entrifugation; Sedimentation; Flocculation; Microfiltration; Sonication; Bead mills; Homogenizers; hemicallysis; Enzymatic lysis; Membrane based purification: Ultrafiltration ; Reverse osmosis; Dialysis ; Diafiltration ; Ervaporation; Extraction; Adsorption and chromatography:

size, charge, shape, hydrophobic interactions, Biological affinity; Process configurations (packed bed, expanded bed, simulated moving beds); Precipitation (Ammonium Sulfate, solvent) Electrophoresis (capillary); Extraction (solvent, aqueous two phase, super critical), Drying and Crystallization. **16 Hrs.**

UNIT VI

Industrial production of Biochemicals and Bioseparations

Alcohol (ethanol) Acids(citric, acetic and gluconic) Solvents(glycerol, acetone and butanol) Antibiotics(penicillin, streptomycin and tetracycline) Amino acids(lysine, glutamic acid) Single cell protein Whole cell immobilization and their industrial applications. Biomass removal; Biomass disruption; Membrane-based techniques;Extraction; Adsorption and Chromatography. Industrial Processes and Process economics. **10 Hrs.**

SPP-4.7 (4.3) A PRACTICALS

1. Media formulation - Sterilization of bioreactors.
2. Study of fermenters-Demonstration only.
3. Media standardization (C: N ratio) for maximum biomass production of an industrially important microorganism.
4. Detection and quantification of sideorophores produced by *Psuedomonas spp*
5. Isolation of industrially important microorganisms (amylase, pectinase, cellulase) for Microbial process & maintenance of bacterial & fungal cultures.
6. Determination of thermal death point and thermal death time of microorganisms.
7. Study of alcohol fermerntation-alcohol from different substrates-estimation of percentage of alcohol, total acidity and volatile acidity.
8. Production and analysis of SCP and SCO.
9. Microbial production of citric acid using *Aspergillusniger*.
10. Microbial production of pectinase by Aspergillus niger by agrowastes.
11. Microbial production and assay of vitamins and amino acids.
12. Cell disruption by sonication and product recovery.
13. Microbial production of Penicillin and product recovery.
14. Citric acid production by *Aspergillus niger* and *Penicillium citrianum*
15. Production of amylase, cellulose, pectinase in a bioreactor.
16. Aqueous two phase extraction of enzymes.
17. Production and Estimation of Alkaline Phosphatase.
18. Downstream process – purification of any one protein / enzyme from fermented broth.
19. Cell and enzyme immobilization.
20. Conservation of bacteria by lyophilisation.

TEXTS/REFERENCES

1. Biochemical engineering, Alba.S, Humphrey,A.Eand Millis
2. Biochemical reactors,Atkinson,B,
3. Principles of fermentation technology, Stanbury,P.F and Whitaker

4.Process engineering in biotechnology, Jackson, A.T., Prentice Hall,Engelwood

5. Bioreaction engineering principles, Nelson,J and Villdsen, J. Plen

13. Comprehensive Biotechnology Vol. 1- 4: M.Y. Young (Eds.), Pergamon Press.
14. Biotechnology: A Text Book of Industrial Microbiology: T.D. Brock, Smaeur Associates, 1990.
15. Industrial Microbiology: L.E. Casida, Willey Eastern Ltd., 1989.

16. Industrial Microbiology: Prescott & Dunn, CBS Publishers, 1987.
17. Bioprocess Technology- fundamentals and applications, S O Enfors& L Hagstrom (1992), RIT, Stockholm.
18. Biotechnology, Economic & Social Aspects: E.J. Dasilva, C Rutledge & A Sasson, Cambridge Univ. Press, Cambridge.
19. Biotechnology - a handbook of industrial microbiology: W. Crueger and A. Crueger.
20. Microbial Biotechnology: Channarayaappa, University press, Hyderabd, 2003
21. Basic Biotechnology by Colin Ratledge and Bjorn Kristiansen : 2nd Edition, Cambridge, University Press.

SPT-4.3 B AGRICULTURAL BIOTECHNOLOGY (4 Credits; 60 Hours)

UNIT I

Transgenic plants

Introduction and importance of transgenic technology. Application of plant transformation technology (transgenic plants) for improvement of productivity and performance. Disease resistance: Genes and gene constructs used for viral resistance by coat protein mediated protection and RNA mediated protection. Bacterial resistance by lysozyme gene, Fungal resistance by chitinase and 1,3-beta glucanase genes. Herbicide resistance in commercially important plants. Insect resistance through BT genes (cry genes) and protease inhibitor genes, BT crops, current status in the world. Other biopesticides and their importance. Terminator gene technology. Male sterile plants, methods of inducing male sterility, its importance in breeding, Barstar and barnase system. **14 Hrs.**

UNIT II

Plant breeding and crop improvents

Introduction, Conventional breeding methods and their merits and demerits. Crop improvement to resist adverse soil conditions; Salinity tolerance, Drought resistance in plants. Protection breeding and quality breeding. Applications of plant breeding for crop improvement through mutations. Plant genetic resources: Plant introduction agencies in India-merits and demerits, Organizations involved in plant breeding in india. NBPGR, PBRs. **10 Hrs.**

UNIT III

Post harvest technology

Introduction and importance of post harvest technology. Post harvest protection: Antisense RNA technology (ACC synthase gene and polygalacturonase) Delay of softening and ripening of fleshy fruits by antisense RNA for ACC synthase gene in tomato banana watermelons etc. Use of antisense RNA technology for extending shelf life of fruits and flowers. Protection of cereals, millets and pulses. Post harvesting using biotechnology. Biotechnology for fortification of agricultural products –golden rice, transgenic sweet potatoes. **12 Hrs.**

UNIT IV

Bioinoculants

Introduction and Importance of biofertilizers in agriculture,Mass culturing and quality control of microbial inoculants-mother culture, shake culture and large scale production of biofertilizers (Rhizobium, Azotobacter, Mycorrhiza, Actinorhiza) types of carrier materials,

packing storage, shelflife and transportation of biofertilizers. Methods of application to seed, soil and nursery. vermiculture, composting , current practices and production**.** **08 Hrs.**

UNIT V

Integrated pest management.

Breif introduction to entomology: Importance of JH and JH analogues in insect pest control. Insect pheromones and their applications. Biological control of insect pests and weeds using natural enemies, mass multiplication of predators and parasites. Biological control of plant pathogens using antagonistic fungi and antagonistic bacteria. **06 Hrs.**

UNIT VI

Applications of Biotechnology in Animal husbandry

Indroduction and importance of animal husbandry. Applications of biotechnology in poultry, aquaculture, sericulture, Improvement of poultry, disease resistance, recombinant vaccines for poultry, growth hormones for increasing biomass, fish breeding techniques, silkworm as bioreactor for the production of commercially important proteins ; improvement of livestock, molecular pharming of products - (Pharmaceuticals through milk or genetically engineered cows). **10 Hrs.**

SPP-4.7 (4.3) B. PRACTICALS

1. Bioinoculants : Isolation and mass production of: Rhizobium, Azospirillum, Azatobacter, Anabena, and Azolla
2. Isolation of phosphate solubilizing microorganisms from soil sample.
3. Estimation of phosphate by Fiskay-Subbarao method.
4. Detection and quantification of mycorrhizae by root clearing technique from different crop plants.
5. Study of root /stem nodules and study of VAM.
6. Assay of Biofertilizers (at least three types).
7. Testing of antagonism by dual culture plate technique.
8. Testing of antimicrobial property of antagonists culture filtrate.
9. Bio-insecticidal effect of biopesticides from microbial and plant sources.
10. Protoplast fusion in Rhizobium for enhanced nodule formation.
11. Baculovirus stocks –Preparation and titration using plaque colony.
12. Co-transfection of insect cells using linearized baculovirus stocks.
13. Induced breeding of commertially important fishes.

REFERENCES:

1. Handbook of Agriculture (1987), ICAR Publication New Delhi.
2. Disease of crop plants in India –G.Rangaswamy and D.H. Bagayraj 3rd Edition (1994), Prentice Hall of India Private Limited, New Delhi.
3. Plant Pathology –R.S. Mehrotra (1993) Tata McGraw Hill Publications Limited, New Delhi.
4. Agricultural Microbiology: G.Rangaswamy and D.J. Bagyaraj 1993, 2nd Edition, Prentice Hall of India Private Limited, New Delhi.
5. Microbial Biotechnology – Fundamentals of applied Microbiology. Glazer and Nikaido (1995) W.H. Freeman Publication company.

6. Biotechnology theory and techniques –Chirikjian. Veena, D.P.S. and Hons T (1984) Plant gene research, Springer Verlag, Heidelberg and New York.
7. Trevan, M.D. Boffey, S. Goulding, K.H. and Starberry P (1990) Biotechnology – the basic principles Tata McGraw Hill Edition.
8. Plant Pathology by Agrios. Powel C.L. and Bagyaraj, D.J. (1984) V. Mycorrhiza, CRD Press Florida.
9. Vincent J.M. (1982) Nitrogen fixation in legumes Cambridge University Press, London.
10. Stacey R.H. Evans H.J (1992) Biological Nitrogen fixation, Chapman and Hall Limited, London.
11. Biosafety for sustainable Agriculture –Krathiger and Rosemarin – International service for the agribiotech applications.
12. K.R. Aneja (1992) Experiments in microbiology, plant pathology, Tissue culture and Mushroom cultivation –Vishwa Prakashana.

CPP-4.4 PROJECT /DISSERTATION WORK:

1. Dissertation work should be carried out as an individual Dissertation and actual bench work.

2. The students will carry independent project work under the supervision of the staff of Biotechnology Department on an advanced topic assigned to him/her.

3. The projects will be carried in the Departmental laboratories /Research institutes /Industries as per the availability of Infrastructure.

4. The Dissertation work will begin from 3rd Semester, and will continue through the 4th Semester.

5. The Dissertation report (also work book shall be presented at the time of presentation and viva voce) will be submitted at the end of the 4th Semester and evaluated.

6. Three copies of the project report shall be submitted to the Chairman, Department of Biotechnology before one week of the theory examination of fourth semester.

7. For the conduct of the End Semester Examination and evaluation of dissertation work the University will appoint External Examiners. Since the dissertation is by research, dissertation work carries a total of 100 marks and evaluation will be carried out by both internal and external evaluators.

8. The average marks awarded by them will be considered. 6. The viva-voce examination is part of dissertation which carries marks.

9. The assignment of marks for Project is as follows:
   a. Continuous Internal Assessment Marks Best 2 out of 3 presentations (Literature survey, Methodology and Results of the project work): 60 Marks
   b. Project work book: 20 Marks
   c. Viva-voce : 20 Marks

Chairman BOS in Biotechnology