CURRICULUM

IV SEMESTER

S. No.	Subject Name	L	P	M
Theory				
1.	Bio-organic Chemistry	**4**	**0**	**100**
2.	Analytical Techniques in Biotechnology	**4**	**0**	**100**
3.	Molecular Biology	**4**	**0**	**100**
4.	Principles of Chemical Thermodynamics and Biothermodynamics	**4**	**0**	**100**
5.	Plant and Animal Biotechnology	**4**	**0**	**100**
6.	Enzyme Engineering and Technology	**4**	**0**	**100**
Practicals				
1.	Bio-organic Chemistry	**0**	**3**	**100**
2.	Cell and Molecular Biology	**0**	**3**	**100**

BIO-ORGANIC CHEMISTRY

AIM

To deal with the Basic considerations of Bio-organic Chemistry and the chemistry involved in the Biological systems.

OBJECTIVES

- To know the Basic consideration and Proximity effect in Bio-Organic Chemistry
- To discuss the Chemistry of Amino acids and Peptides
- To study the Chemistry involved in Enzymes
- To enlighten the roles of Metal ions which are essential for Biological systems
- To impart knowledge on the Enzyme Models

UNIT I

INTRODUCTION TO BIO-ORGANIC CHEMISTRY

Basic Considerations – Proximity effects in Organic chemistry – Molecular recognition and the supramolecular level.

UNIT II

BIO-ORGANIC CHEMISTRY OF AMINO ACIDS AND PEPTIDES

Chemistry of living cells, Analogy between organic reactions and Biochemical Transformations, Chemistry of the peptide bond, Asymmetric, Synthesis of Amino acids, Transition state, Analogues Chemical mutations, Molecular Recognition and Drug Design.

UNIT III

ENZYME CHEMISTRY

Introduction to catalysis, Introduction to enzymes, Multifunctional catalysis and Simple models, Alpha Chymotrypsin, Hydrolytic enzymes, Stereo Electronic Control, Immobilised enzymes, Enzymes in Synthetic organic chemistry, Design of molecular clefts.

UNIT IV

METAL IONS IN BIOLOGICAL SYSTEMS

Metal ions in Proteins and Biological molecules, Carboxy peptidase and role of Zinc, Hydrolysis of Amides and Peptides, Iron and Oxygen transport – Copper ion – Biomodels for Photosynthesis and Energy transfer, Cobalt and Vitamin B_{12} actions, Oxidation and Reduction reactions.

UNIT V

ENZYME MODELS

Host guest Complexation chemistry, Development in Brown ether chemistry, Membrane chemistry and Micelles – Cyclodextrin – Enzyme design using Steroid templates, Remote functionalisation reaction, Biomimetic polyene cyclisations.

TEXT BOOKS

1. Zubay, G., 1987. Biochemistry. *Maxwell Macmillan International Editions*, 2nd Edition.
2. Dugan, H., 1989. Bio-organic Chemistry – A Chemical Approach to Enzyme Action. *Springer Verlag*.

ANALYTICAL TECHNIQUES IN BIOTECHNOLOGY

AIM

To have a broad knowledge about the different types of Chromatographic techniques used for the purification and assay of Biomolecules and their intermediates, microscopic techniques, DNA analysis and sequencing and the immunotechniques.

OBJECTIVES

- To introduce the general Chromatographic techniques and their classification.
- To impart knowledge on the principles, operations and applications of Classical chromatography and to familiarize with the design of HPLC and selection of columns.
- To study in detail the principles, operations and applications of Gas chromatography and to discuss the scopes, types, application of Chiral chromatography.
- To know the qualitative analysis of protein by various electrophoretic techniques and to have a wide knowledge about the DNA analysis.
- To study the various immunotechniques and analysis of Bioprocess.

UNIT I

INTRODUCTION

Classification of techniques, Paper and column chromatography, Distribution coefficients, Retention chromatography, Sorption mechanisms, Retention parameters, Factors affecting retention, Qualitative and quantitative aspects of chromatography, Peak shape sorption isotherms, Column efficiency, Band broadening process, Selectivity and resolution.

UNIT II

CLASSICAL CHROMATOGRAPHY AND HIGH PERFORMANCE LIQUID CHROMATOGRAPHY

Stationary phases, Application of ion exchange, Size exclusion, Thin layer chromatography (TLC). Introduction, Design of a typical HPLC machine, Types of columns, Applications, HTPLC.

UNIT III

GAS CHROMATOGRAPHY AND CHIRAL CHROMATOGRAPHY

Introduction, Instrumentation, Columns, Qualitative and quantitative aspects of gas chromatography, Quantitative analysis of gas chromatography, GC-MS. Principles, Types of chiral chromatography, Scopes and limitations, Applications, Capillary electrophoresis.

UNIT IV

ELECTROPHORETIC TECHNIQUES AND DNA ANALYSIS

Electrophoresis of Proteins and Nucleic acids, 1D and 2D Gels, Pulsed – Field electrophoresis, Western Blotting, Gel Documentation, DNA Purification, PCR – Based analysis, DNA Finger Printing.

UNIT V

IMMUNO – TECHNIQUES AND ANALYSIS OF BIOPROCESS

Antiserum Production, Immuno histocompatibility, Location of cells in tissues, Immuno blotting, Analysis of Biomass, Measurement of Dry weight and Biomass composting, Analysis of substrate uptake and product formation rates, Measurement of BOD and COD in Waste waters, Gas analysis for O_2 and CO_2, Flow injection analysis, Computerized data acquisition of Bioprocesses.

TEXT BOOKS

1. Sewell, P.A. and Clarke, B., 1991. Chromatographic Separations. John Wiley and Sons.
2. Lindsay, B., 1991. High Performance Liquid Chromatography. John Wiley and Sons.
3. Willard, H.H., Merrit, J.A., Dean, L.L. and Setlle, F.A., 1986. Instrumental Methods of Analysis. *CBS Publishers and Distributors*.
4. Srivastava, V.K. and Kishore, K., 1991. Introduction to Chromatography – Theory and Practice. S. Chand and Company Ltd., India.
5. Chatwal and Anand, 2000. Instrumental Methods of Analysis.

REFERENCES

1. Lecture Notes on Short Course on Enantiomeric Separations. April 28 – 29, 1995.
2. Henner Schmidt-Traub, 2005. Preparative Chromatography. *John Wiley and Sons*.
3. Freeman, W.H. 1985 – 1993. Reading in Scientific American.

MOLECULAR BIOLOGY

AIM

The course offers the fundamental concepts and basic principles of structure of DNA, RNA, Transcription, Translation, Gene regulation and Recombinant DNA technology.

OBJECTIVES

- To gain knowledge on Nucleic acids, their characteristics and organization.
- To learn the process of Transcription and translation.
- To study the mechanism of Gene Regulation and mutations.
- To familiarize with the fundamentals of Recombinant DNA technology.

UNIT I

NUCLEIC ACIDS

Nucleic acids, Primary, Secondary and Tertiary structures, Prokaryotic nucleoid structure, Extra chromosomal DNA – Plasmids, Chloroplast, Mitochondrial genomes, Replication in prokaryotes and eukaryotes – Different modes of replication, Complex replication apparatus, Inhibitors of replication, DNA polymorphism, Single Nucleotide Polymorphism (SNPs).

UNIT II

TRANSCRIPTION

Transcription in prokaryotes and eukaryotes, Exons, Intron concept, Transcription initiation factor, Promoters, Enhancers, Inhibitors, Transcription factors, Post transcriptional modification, Processing of mRNA, rRNA and tRNA, RNA splicing, Reverse transcription, RNA editing, Termination concepts.

UNIT III

TRANSLATION

Genetic code and its features – Deciphering of the genetic code, Structure and functions of ribosomes, Translation mechanism, Post translational modifications, Inhibitors, Colinearity of gene and polypeptide, Protein foldings.

UNIT IV

MUTATION AND GENE REGULATION

Mutation – Point mutation (Sense, Missense, Non-sense, Silent and Frame-shift), Physical and chemical agents, Mechanism of action of mutagens, UV repair mechanism, Gene regulation – Operon concept, gal, lac, trp, Mitogens and Oncogenes.

UNIT V

CONCEPTS OF RECOMBINANT DNA TECHNOLOGY

Elementary concepts of recombinant DNA technology, General principles of cloning, Uses of restriction endonucleases, Plasmids and phage vector, Genomic and cDNA libraries, Vectors, Plant cloning vectors, Retro viral vectors.

TEXT BOOKS

1. Benjamin Lewin, 2000. Gene VII. *Oxford University Press*, UK.
2. De Robertis, E.D.P. and De Robertis, E.M.F., 2001. Cell and Molecular Biology. 8th Edn., *B. I. Publications Pvt. Ltd*.
3. Verma, P.S. and Agarwal, V.K., 2006. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology. *S. Chand and Company Ltd.,* India.
4. Gupta, P.K., 2005. Cell and Molecular Biology, *Rastogi Publications*, India.

REFERENCES

1. James Watson *et al.,* 1992. Recombinant DNA. 2nd Edn.
2. James Watson *et al.,* 1987. Molecular Biology of Gene. *The Benjamin / Cummings Publication Co. Inc.,* California.
3. Turner, P.C., McLennan, A.G., Bates, A.D. and White, M.R.H., 2003. Instant Notes in Molecular Biology. *Viva Books Private Limited*.
4. Jeremy M. Berg, John L. Tymoczko and Lubert Stryer, 2002. Biochemistry. 5th Edn., *W.H. Freeman and Company*.
5. Freifelder, D., 1987. Molecular Biology. *Jones and Bartlett Publishers Inc*.
6. Brown, T.A. Gentics – A Molecular Approach.
7. Lodish, Berk, Zipursky, Matsudaira, Baltimore Darnell, 2000. Molecular Cell Biology. 4th Edn., *W.H. Freeman and Company*.

PRINCIPLES OF CHEMICAL THERMODYNAMICS AND BIOTHERMODYNAMICS

AIM

To introduce the basic energy concepts associated with Chemical and Biological process.

OBJECTIVES

- To introduce the fundamentals of chemical and biochemical thermodynamics.
- To learn the concepts of the thermodynamic properties of fluids and solution.
- To study the thermodynamic parameters of different types of phase equlibria.
- To analyze the thermodynamic functions at reaction equilibrium.
- To gain knowledge in the energetics of metabolic pathways.

UNIT I

THERMODYNAMIC PROPERTIES OF FLUIDS

Volumetric properties of fluids exhibiting non ideal behaviour, Residual properties, Estimation of thermodynamic properties using equations of state, Calculations involving actual property exchanges, Maxwell's relations and applications.

UNIT II

SOLUTION THERMODYNAMICS

Partial molar properties, Concepts of chemical potential and fugacity; Ideal and non-ideal solutions, Concepts and applications of excess properties of mixtures, Activity coefficient, Composition models, Gibbs Duhem equation.

UNIT III

PHASE EQUILIBRIA

Criteria for phase equilibria, v-l-e calculations for binary and multi component systems, Liquid-liquid equilibria and solid-solid equilibria.

UNIT IV

CHEMICAL REACTION EQUILIBRIA

Equilibrium criteria for homogeneous chemical reactions, Evaluation of equilibrium constant, Effect of temperature and pressure on equilibrium constant, Calculation of equilibrium conversion and yields for single and multiple reactions.

UNIT V

THERMODYNAMMIC ANALYSIS OF PROCESS

Concept of lost work, Entropy generation, Calculation of real irreversible processes, Power cycle, Liquefaction.

TEXT BOOKS

1. Narayanan, K.V., 2001. A Text Book of Chemical Engineering Thermodynamics. *Prentice Hall India.*
2. Rao, Y.V.C. Chemical Engineering Thermodynamics.

REFERENCES

1. Smith, J.M., Van Ness, H.C. and Abbot, M.M., 2001. Chemical Engineeting Thermodynamics. 6th Edn., *McGraw- Hill.*
2. Sandler, S.I., 1989. Chemical and Engineering Thermodynamics. *John Wiley and Sons.*
3. Roels, J.A., 1983. Kinetics and Energetics in Biotechnology. *Elsevier.*
4. Donald T. Haynie. Biological Thermodynamics. *Cambridge.*
5. Volker Hessel, 2005. Chemical Microprocess Engineering. *John Wiley and Sons.*
6. Irving J. Dunn and Eth Zurich, 2003. Biological Reaction Engineering. *John Wiley and Sons.*

PLANT AND ANIMAL BIOTECHNOLOGY

AIM

To course offers a focussed study on the important aspects of Biotechnology in plant and animal sciences.

OBJECTIVES

To expose the students to the concepts of

- Cell culture technologies
- Transgenic plants and animals
- Embryo transfer method
- Gene therapy and disease diagnosis in animals
- Xenotransplantation and stem cell technology

UNIT I

PLANT CELL AND TISSUE CULTURE

Tissue culture as a technique to produce novel plants and hybrids, Tissue culture media – Composition and preparation, Organogenesis, Somatic embryogenesis, Shoot-tip culture, Rapid clonal propagation and production of virus free plants, Embryo culture and embryo rescue, Protoplast isolation, Culture and fusion, Selection of somatic hybrids, Cybrids, Cryopreservation, DNA banking for germplasm conservation.

UNIT II

PLANT VECTORS AND BIOLOGICAL NITROGEN FIXATION

Agrobacterium mediated gene transfer and cloning, Types of plant vectors and their use in gene manipulation, Plant viruses – Classification, Applications, Legume symbiosis. Nitrogen fixation, Regulation of nif and nod gene.

UNIT III

PLANT GENETIC ENGINEERING

Genetic engineering – Techniques for insertion of foreign genes into plant cells, Ti and Ri plasmid and vectors, Production of transgenic plants, Molecular marker-aided breeding, RFLP maps, STS, Micro satellites, SCAR (Sequence Characterized Amplified Regions), SSCP (Single Strand Conformational Polymorphism), AFLP, QTL map based cloning, Molecular markers assisted selection.

UNIT IV

TRANSGENIC ANIMALS AND DISEASE DIAGNOSIS

Basic techniques of animal cell culture and their application, Gene cloning techniques for mammalian cells, Transgenic animals, *In-vitro* fertilization and embryo transfer, Molecular biological technique for rapid diagnosis of genetic disease and gene therapy.

UNIT V

TRANSFECTION METHODS AND STEM CELL TECHNOLOGY

Gene transfer methods in animals, Xenotransplantation, Regulation of transgenic animals, Patenting genetically engineered animals, Stem cell technology.

TEXT BOOKS

1. Gupta, P.K., 1996. Elements of Biotechnology. *Rastogi* and Co., Meerut.
2. Ranga, M.M., 2002. Animal Biotechnology. *Agrobios India Limited.*
3. Ignacimuthu, S., 1996. Applied Plant Biotechnology. *Tata McGraw Hill*.
4. Gamburg, O.L. and Philips, G.C., 1995. Plant Tissue and Organ Culture Fundamental Methods. *Narosa Publications.*
5. Singh, B.D., 1998. Text Book of Biotechnology. *Kalyani Publishers.*
6. Ramadas, P. and Meera Rani, S., 1997. Text Book of Animal Biotechnology. *Akshara Printers.*

REFERENCES

1. Hamond, J.,McGarvey, P. and Yusibov, V., 2000. Plant Biotechnology. *Springer Verlag.*
2. Mantal, S.H., Mathews, J.A. and Mickee, R.A., 1985. Principles of Plant Biotechnology. An Introduction of Genetic Engineering in Plants. *Blackwell Scientific Publication.*
3. Dodds, J.H., 1985. Plant Genetic Engineering. *Cambridge University Press*.
4. Spier, R.E. and Griffiths, J.B., 1998. Animal Cell Biotechnology. *Academic Press.*
5. Masters, J.R.W., 2000. Animal Cell Culture. Practical Approach. *Oxford University.*
6. Heldt, H.W., 1997. Plant Biochemistry and Molecular Biology. *Oxford University*
7. Rainer Fischer, 2004. Molecular Farming. *John Wiley and Sons.*
8. Glyn Stacey, Nibsc, Ulk and John Davis, 2005. Medicines from Cell Culture. *John Wiley and Sons.*
9. Potten, C.S., 2006. Stem Cells. *Academic Press.*

ENZYME ENGINEERING AND TECHNOLOGY

AIM

The course provides an opportunity to understand the theoretical concepts of Enzyme technology principles in an explicit and concentrated manner.

OBJECTIVES

To impart knowledge on

- Enzyme purification.
- Mechanism of enzyme action.
- Enzyme immobilization techniques.
- Design of enzyme reactors.

UNIT I

CLASSIFICATION, PURIFICATION AND CHARACTERIZATION OF ENZYMES FROM NATURAL SOURCES

Classification of enzymes, Production and purification of crude enzyme extracts from plants, Animals and Microbial sources – Some case studies, Methods of characterization of enzymes, Development of enzymatic assay.

UNIT II

MECHANISMS AND KINETICS OF ENZYME ACTION

Mechanisms of enzyme action, Concept of active site and energetics of enzyme substrate complex formation, Specificity of enzyme action, Kinetics of single substrate reactions, Turn over number, Estimation of Michaelis-Menton parameters, Lineweaver – Burk plot, Eadie - Hofster plot, Hans - Woolf equations, Multi substrate reactions – Mechanism and kinetics. Types of inhibition – Kinetic models, Substrate and product inhibition, Allosteric regulation of enzymes, Deactivation kinases.

UNIT III

ENZYME IMMOBILIZATION AND MASS TRANSFER EFFECTS IN IMMOBILIZED ENZYME SYSTEMS

Physical and chemical techniques for enzyme immobilization – Adsorption, Matrix entrapment, Encapsulation, Cross-linking, Covalent binding etc., Examples, Advantages and disadvantages of different immobilization techniques, Overview of application of immobilized enzyme systems, Analysis of film and pore diffusion effects on kinetics of

immobilized enzyme reactions, Formation of dimensionless groups and calculation of effectiveness factors.

UNIT IV

DESIGN OF ENZYME REACTORS FOR BIOCONVERSION PROCESS

Design of immobilized enzyme reactors, Packed bed, Fluidized bed and Membrane reactors, Bioconversion calculations in free enzymes CSTRs and Immobilized enzyme reactors, Applications.

UNIT V

ENZYME BIOSENSORS AND COMMERCIAL APPLICATIONS

Applications of enzyme in analysis, Design of enzyme electrodes and their applications as biosensors in industry, Health care and Environment, Commercial applications of enzymes in food, Pharmaceutical and other cosmetological industries, Enzymes for analytical and diagnostic applications.

TEXT BOOKS

1. Zuaby, G. Biochemistry.
2. Bailey and Ollis, D.F. Biochemical Engineering Fundamentals. *McGraw Hill*. New York.

REFERENCES

1. Butterworth, 1995. Technological Applications of Biocatalysts. *BIOTOL Series.*
2. Cornish-Bowden, A., 1996. Analysis of Enzyme Kinetic Data. *Oxford University Press*.
3. Wiseman, A., Blakeborough, N. and Dunnill, P., 1981. Enzymatic and Nonenzymatic catalysis. Vol. 5, *Ellis and Harwood*, UK
4. Wiseman, A., Topics in Enzyme and Fermentation Biotechnology. Vol.5 *Ellis and Harwood*, UK.
5. Kolot, F.B. Immobilized Microbial Systems, Principles, Techniques and Industrial applications. *R.R Krieger Publications*.
6. Rehm, H. and Reed, G. Biotechnology. Vol. I – XII, *Verlag Chemie*.
7. Samuel C. Prescott, Cecil G. Dunn, 2002. Industrial Microbiology. *Agrobios* (India).
8. Tailor, R.F. Protein Immobilisation – Fundamentals and Applications.
9. Gerharts, W. Enzyme Industry – Production and Applications.
10. Klaus Buchholz, 2005. Biocatalyst and Enzyme Technology. *John Wiley and Sons.*
11. Hans Bisswanger, 2004. Practical Enzymology. *John Wiley and Sons.*

BIO-ORGANIC CHEMISTRY LAB

AIM

To verify the Theoretical concepts practically in a more Explicit and Concentrated manner.

OBJECTIVES

The Students should be able to develop their skills in the interconversions of Carbohydrates and Preparation of Amino acids.

EXPERIMENTS

1. Synthesis of Aspirin
2. Hydrolysis of Sucrose
3. Preparation of Pyruvic acid from Tartaric acid.
4. Preparation of Oleic acid
5. Carbohydrate Interconversions
    a. Preparation of alpha-D-glucopyranose penta acetate
    b. Preparation of 1,2,5,6 di- O-Cyclohexylidine-alpha-D-glucofuranose.
6. Preparation of Lycopene from Tomato paste
7. Preparation of l-Proline.
8. Preparation of l-Cystine from hair.
9. Preparation of s-ethyl hydroxybutonate from ethylacetoacetate using Yeast.
10. Preparation of s-ethyl hydroxybutonate using 3, 5 dinitrobenzoate.

CELL AND MOLECULAR BIOLOGY LAB

AIM

The course aim is to offer hands on training in the area of Cell culture and cell identification. This will serve as a prerequisite for Post graduate and specialized studies and Research.

OBJECTIVES

- At the end of the course from various sources, the students would have learnt the methodology to isolate cells and to identify them by specialized Microscopy. This will be extremely beneficial to take up project work in Cellular biology.
- The student would have learnt basic techniques used in Molecular biology and its application. This will be strength for student to undertake research projects in the area of Molecular biology.

1. Introduction to principles of sterile techniques and cell propagation.
2. Principles of microscopy, phase contrast and fluorescent microscopy.
3. Identification of given plant, animal and bacterial cells and their components by microscopy.
4. Gram's staining.
5. Leishman Staining.
6. Thin layer chromatography.
7. Giemsa Staining.
8. Separation of peripheral blood mononuclear cells from blood.
9. Osmosis and Tonicity.
10. Tryphan blue assay.
11. Staining for different stages of mitosis in *Allium cepa* (Onion).
12. Isolation of bacterial DNA.
13. Isolation of plant cell and animal cell genomic DNA.
14. Agarose gel electrophoresis.
15. Restriction enzyme digestion.
16. Competent cells preparation.
17. Transformation and Screening for recombinants.
18. Blue and White selection for recombinants.
19. Plating of O phage.
20. O phage lysis of liquid cultures.

REFERENCES

1. Kalaichelvan, P.T., 2006. Microbiology and Biotechnology. A Laboratory Manual. *Lab Man Series, MJP Publishers.*
2. Ralph Rapley and John M. Walker, 1998. Molecular Biomethods Handbook. *Humana Press.*