B. E. SYLLABUS

BIOTECHNOLOGY

V &VI SEMESTER

With

Scheme of Teaching

& Examination

DEPARTMENT: BIOTECHNOLOGY ENGINEERING

1	Dr. C. Vaman Rao	M.Sc., Ph.D.	Prof. & Head
2	Dr. Ujwal P.	M.Sc., Ph.D.	Professor
3	Dr. Vidya S. M.	M.Sc., Ph.D.	Professor
4	Dr. Shyama Prasad S.	M.Sc., Ph.D.	Assoc. Prof.
5	Dr. D. M. Chetan	M.Sc., Ph.D.	Assoc. Prof.
6	Dr. Anil Kumar H. S.	M.Sc., Ph.D.	Assoc. Prof.
7	Dr. Bharath B. R.	M.Sc., Ph.D.	Asst. Prof. Gd III
8	Mr. Venkatesh Kamath H.	M.Tech., (Ph.D.)	Asst. Prof. Gd II
9	Mr. Vinayaka B. Shet	M.Tech., (Ph.D.)	Asst. Prof. Gd II
10	Mr. Sandesh K.	M.Tech., (Ph.D.)	Asst. Prof. Gd II
11	Ms. Sneha Nayak	M.Tech., (Ph.D.)	Asst. Prof. Gd I
12	Ms. Louella C. Goveas	M.Tech., (Ph.D.)	Asst. Prof. Gd I
13	Ms. Harshitha M. Jathanna	M.Tech., (Ph.D.)	Asst. Prof. Gd I

DEPARTMENT OF BIOTECHNOLOGY ENGINEERING

Vision :

To accomplish excellence in Biotechnology research and creating manpower for the benefit of society and human kind with an emphasis on present and future global needs.

Mission :

To empower the students of Department of Biotechnology Engineering in to

1. Competent professionals to undertake projects by providing academic training and technical achievements,
2. A successful professionals in research, academia and industry,
3. An engineer for effective utilization of natural resources in biotechnology related industries.

Program Educational Objectives (PEOs):

The program educational objectives are set in line with Institutional and Departmental mission statements. The program educational objectives of B.E. Biotechnology are to produce professionals who later take the role of engineering professionals and researchers with following qualities:

PEO1. Apply fundamental knowledge of mathematics, principles of physics and chemistry, and biological sciences for the engineering applications.

PEO2. Demonstrate the application of biotechnological processes and engineering principles through designing of industrial biochemical processes that are of societal and industrial importance.

PEO3. Exhibit skills of handling microbial processes, biochemical analysis by making use of state of the art instruments.

PEO4. Exhibit strong, independent learning, analytical and problem solving skills with special emphasis on design, communication, and an ability to work in teams.

PEO5. To have successful career as engineering professional or a researcher through life-long learning in the field of biotechnology.

Table : Mapping of Mission statements with Program Educational Objectives

Mission Statement	PEO1	PEO2	PEO3	PEO4	PEO5
Institution*: To develop NMAM Institute of Technology, Nitte as a Center of Excellence by imparting Quality Education to generate Competent, Skilled, and Humane Manpower to face emerging Scientific, Technological, Managerial and Social Challenges with Credibility, Integrity, Ethics and Social Concern.*	**M**	**H**	**M**	**H**	**H**

* L = Low, M= Moderate, H= High

Table : Mapping of Mission statements with Program Educational Objectives

Mission Statement	PEO1	PEO2	PEO3	PEO4	PEO5
Department*: To empower the students of Department of Biotechnology Engineering in to 1. Competent professionals to undertake projects by providing academic training and technical achievements.*	**M**	**H**	**H**	**H**	**M**
2. A successful professionals in research, academia and industry	**H**	**H**	**M**	**H**	**M**
3. An engineer for effective utilization of natural resources in biotechnology related industries.	**M**	**H**	**H**	**M**	**M**

* L = Low, M= Moderate, H= High

Program Outcomes (POs):

The B.E. Biotechnology program established a set of Program Outcomes (POs), expected to be met by every graduating student from the program at the time of graduation. Program outcomes listed below embrace the required outcomes as listed in National Board of Accreditation (NBA), India guidelines.

The graduates of B.E. Biotechnology will have ability to:

PO - 1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO - 2. Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO - 3. Design/Development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO - 4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO - 5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO - 6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO - 7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO - 8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO - 9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO - 10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO - 11. Project management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO - 12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSOs):

Program Specific Outcomes for B.E. programme in Biotechnology set by Faculty in Biotechnology Engineering are as follows:

PSO 1. Demonstrate proficiency in basic science and foundation engineering courses.

PSO 2. Demonstrate a working knowledge of advanced biological sciences.

PSO 3. Demonstrate competence in application of engineering principles to biological systems.

Table: Mapping of Program Outcomes with Program Educational Objectives

PO/PSO / PEO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
PEO1	**H**	**M**	**L**	**L**		**L**	**L**					**L**	**L**	**M**	**M**
PEO2		**M**	**H**	**H**	**L**	**H**	**H**		**L**	**M**	**L**	**M**	**H**	**H**	**H**
PEO3	**M**	**M**		**H**	**H**	**L**	**L**	**M**		**L**		**M**	**M**	**M**	**L**
PEO4		**H**	**H**	**H**		**H**	**H**	**L**	**M**	**M**	**H**	**L**	**H**	**L**	**M**
PEO5	**L**	**L**		**M**	**M**			**M**		**L**	**M**	**H**	**M**	**H**	**M**

CURRICULAR COMPONENTS (Degree Requirements for B. E. in Biotechnology)

Category of courses	Category code	Credits offered	Min. credits to earn
Basic Science Core	BSC	28	28
Engineering Science Core	ESC	27	27
Humanities & Social Sciences Core	HSC	5	5
Professional Core Courses	PCC	106	106
Professional Elective Courses	PEC	21	21
Open Elective Courses	OEC	3	3
Programme Major Project	PMP	12	12
Add on courses/Audit Courses	AOC	0	0 (Optional)
Mandatory Learning Courses	MLC	0	To secure PP grade to graduate
Total		200	200

DEPARTMENT OF BIOTECHNOLOGY ENGINEERING
SCHEME OF TEACHING AND EXAMINATION

V Semester **30 Hours/Week**

Sl. No.	Code	Course Title	Theory/Tuto. /Prac./ Self study	Total Hrs. /Week	CIE	SEE	Credits
1	15BT501	Reaction Engineering	2+2+0+0	4	50	50	3
2	15BT502	Enzyme Technology	4+0+0+S	4	50	50	4
3	15BT503	Bioinformatics & Applications	4+0+0+S	4	50	50	4
4	15BT504	Genetic Engineering & Applications	4+0+0+S	4	50	50	4
5	15BT505	Analytical Techniques	4+0+0+S	4	50	50	4
6	15BT51X	Elective - I	3+0+0+0	3	50	50	3
7	15BT506	Biokinetics Lab	0+0+3+0	3	50	50	2
8	15BT507	Bioinformatics Lab	0+0+3+0	3	50	50	2
9	15BT508	Immersive Group Workshop (IGW)*	0+0+3+0*	3*	-	-	0
10	15IL001	Employability Skill Development	1+0+0+0	1	50	-	0
TOTAL			**22+2+6+S**	**30**	**450**	**400**	**26**

* Conducted in the form of full day workshop for 5 working days

Elective - I 15BT51X			
15BT511	Basics of Computer Concepts	15BT513	Plant Physiology
15BT512	Human Physiology	15BT514	Food Biotechnology

DEPARTMENT OF BIOTECHNOLOGY ENGINEERING
SCHEME OF TEACHING AND EXAMINATION

VI Semester **28 Hours/week**

Sl. No.	Code	Course Title	Theory/Tuto./ Prac./ Self Study	Total Hrs. /Week	CIE	SEE	Credits
1	15BT601	Bioprocess Dynamics & Control	2+2+0+0	4	50	50	3
2	15BT602	Upstream Processing Technology	4+0+0+0	4	50	50	4
3	15BT603	Downstream Processing Technology	4+0+0+S	4	50	50	4
4	15BT61X	Elective -II	3+0+0+0	3	50	50	3
5	15BT62Y	Elective – III	3+0+0+0	3	50	50	3
6	15BT604	Bioprocess Control & Instrumentation Lab	0+0+3+0	3	50	50	2
7	15BT605	Upstream Processing Lab	0+0+3+0	3	50	50	2
8	15BT606	Downstream Processing Lab	0+0+3+0	3	50	50	2
9	15IL002	Employability Skill Development	1+0+0+0	1	50	-	0
TOTAL			**17+2+9+S**	**28**	**450**	**400**	**23**

Elective - II 15BT61X		**Elective - III 15BT62Y**	
15BT611	Genomics & Proteomics	15BT622	Food & Beverages Technology
15BT613	Basics of Pharmaceutical Science	15BT623	Industrial Biotechnology
15BT614	Process Equipment Design	15BT624	Clinical Studies & Data Management
15BT615	Biomedical Instrumentation	15BT625	Micro Array Technology

REACTION ENGINEERING

Sub Code : 15BT501 **Credits : 03**
Hrs/Week : 2+2+0+0 **Total Hours : 26+26***

**Hours/Week = Lecture hours + Tutorial hours*
***Prerequisites*:** Calculus, Numerical Methods, Bioprocess Calculations
***Corequisites*:** Enzyme Technology

Course Learning Objectives:

The objective of this course is
1. To learn the reaction mechanism, reaction kinetics.
2. To understand various types of reactors and their performance or design equations.
3. To characterize the non ideal behavior of reactors.
4. To learn heterogeneous reaction systems.
5. To understand working of various bioreactors.

UNIT – I

REACTION KINETIC PRINCIPLES
Scope of bioreaction engineering.Classification of reactions.Rate equation and rate of reaction. Factors affecting rate of reaction. Rate vs equilibrium consideration. Chemical kinetics and thermodynamics equilibrium.elementary and non-elementary reactions. Kinetic models and mechanisms for non-elementary reactions.Molecularity and order of reaction. Temperature dependency of rate constant from Arrhenius, Collision and Transition state theories. **4+4 Hours***

UNIT – II

ANALYSIS OF BATCH REACTOR DATA
Rate equation – Interpretation of batch reactor data for constant volume batch: integral, differential, half life and dilution methods, I order, II order, zero order, Shifting order reactions (Michaelis-Menten, Monod kinetics), Series and parallel reactions, Reversible reactions. Variable volume systems. **4+6 Hours**

UNIT – III

IDEAL REACTORS
Isothermal batch, mixed and plug flow, semi-batch reactors; design equation for batch, fed-batch and plug flow bioreactor with I order, II order, Michaelis-Menten and Monod growth kinetics. CSTR/MFR: Ideal chemostat for microbial growth and product formation, dilution factor, washout rate for single reactor. Recycle bioreactors. Multiple reactor systems: series, parallel and combinations, size comparison. **5+7 Hours**

UNIT - IV

NON IDEALITY IN REACTOR
Causes of non-ideality of reactors, RTD analysis: tracer input signals, tracer materials, analysis of C-E-F curves, material balance for step and pulse input signals, RTD for ideal

reactors. Models of non-ideality: zero parameter model (Earliness & Lateness of mixing, segregation), 1 parameter model (Dispersion model, Tanks in series model), 2-parameter model (Cholette-Cloutier model). Reactor performance with non ideal flow: calculation of conversions for I and II order reactions with zero parameter, 1 parameter and 2 parameter models. **6+5 Hours**

UNIT – V

HETEROGENEOUS REACTIONS

Introduction: Role of heterogeneous reaction in bioprocess, rate of reaction for heterogeneous reaction, rate controlling step. Mechanism of solid catalyzed reaction. Immobilized biocatalyst beads, reactors for heterogeneous reaction: calculation of amount of biocatalysts in reactor.

Concentration gradient and reaction rates in solid biocatalyst: first order, zero order. Substrate concentration profile in flat biofilm: first order, zero order. Effectiveness factor. Significance of Thiele modulus and Weisz's criteria. **6+5 Hours**

Course Outcomes:

At the end of this course, the student will be able to

1. Explain reaction mechanism for homogeneous reaction and determine the temperature dependent term of rate equation.
2. Develop and analyze the kinetics of homogeneous process.
3. Determine the size of ideal reactors for a given rate of reaction.
4. List and analyze the degree of non-ideality in reactor.
5. Construct and analyze the rate equation for heterogeneous reaction process.

Mapping of POs & COs:

	PO												PSO		
CO	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		H	L	L		L	L						L		M
CO2		H	M	L		M	L						L		H
CO3		M	H			M	L								H
CO4		M	M	L		M	L								H
CO5		M	M			M	L								H

PO = Programme Outcome; CO = Course Outcome; PSO = Programme Specific Outcome
Mapping codes: L = Low, M= Mid, H= High

TEXT BOOKS:

1. Fogler H.S., *Elements of Chemical Reaction Engineering*, 3rd Ed., PHI, 2004.
2. Levenspiel, O. *Chemical Reaction Engineering*, 3rd Ed., John Wiley, 1999.
3. Doran, P. M. *Bioprocess Engineering Principles*, Elsevier, Academic Press,1995.

REFERENCE BOOKS:

1. Blanch, H. W. and Clark, D. S. Biochemical Engineering, 2nd Ed., Marcel Dekker Inc. 2012.
2. Smith J.M., *Chemical Engineering Kinetics*, 2nd Ed., MGH, 1970.
3. Lee, J. M. *Biochemical Engineering*, Prentice Hall Inc., 1992.
4. Shuler, M. L. and Kargi, F. *Bioprocess Engineering*, 2nd Ed., PHI, 2002.
5. Stanbury, P. F. and Whitaker, A., Hall, S. J. *Fermentation Technology*, 2nd Ed., Butterworth Heinemann, 1995.

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ENZYME TECHNOLOGY

Sub Code : 15BT502 **Credits : 04**
Hrs/Week : 4+0+0+S* **Total Hours : 52**

*** Self Study to be exercised under the supervision of course instructor and to be restricted to not more than 10% of the total teaching hours.**

***Prerequisites*:** Biochemistry
***Corequisites*:** Reaction Engineering

Course Learning Objectives:

The objective of this course is
1. To understand the mechanisms of enzymatic reactions.
2. To learn kinetic models of enzyme reaction.
3. To know the use of enzymes in native or immobilized form in various fields.

UNIT - I

INTRODUCTION TO ENZYMES AND ENZYME MODELS

History of enzymes. Nomenclature and classification of enzymes. Chemical nature and properties of enzymes. Energy of activation, Enzyme activity, types of enzyme specificities, enzyme substrate reactions. Active site, allosteric site, coenzymes and co factors. Lock and key hypothesis, induced fit hypothesis, substrate strain model with lysozyme as typical example. Multi-substrate reactions like ping pong mechanism, sequential mechanism – orderly and random sequential mechanisms. Allosteric enzymes. **8 Hours**

UNIT - II

ENZYME KINETICS

Covalent catalysis, acid base catalysis, metal ion catalysis with mechanism. Enzyme kinetic-pseudo order, fist order, second order reactions, Sigmoidal Kinetics-MWC model, KNF model, Determination of Michaelis Menten kinetic parameters: Lineweaver- Burk plot, EadieHofstee plot, Hanes - Woolf plot. Enzyme inhibition- competitive, uncompetitive and non competitive inhibition. Enzyme deactivation kinetics, factors affecting enzyme kinetics (Temperature, pH), numericals. **12 Hours**

UNIT – III

SCREENING FOR ENZYMES AND EXTRACTION

Screening for novel biocatalysts, general procedures for isolation and selection of microorganisms involved in enzyme production, high-throughput screening, strategies of extraction and purification of enzymes, criteria of purity, molecular weight determination and characterization of enzymes. Creation of tailor made biocatalyst. **10 Hours**

UNIT –IV

IMMOBILIZATION OF ENZYMES

Techniques of enzyme immobilization-covalent attachment, Adsorption, Entrapment, cross linking and encapsulation. Enzyme stabilization, Properties of immobilized enzymes, Industrial applications of immobilized enzymes and whole cells. Bioreactors using Immobilized enzyme. **10 Hours**

UNIT – V

CLINICAL AND INDUSTRIAL APPLICATIONS OF ENZYMES

Isoenzymes, Importance of enzymes in diagnostics-use of enzymes to determine the concentration of metabolites of clinical importance, Determination of enzyme activities for clinical diagnosis. Lactate dehydrogenase, creatinine kinase, aspartate transaminase, alanine transaminase, acid phosphatase, alkaline phosphatase, γ-glutamyltranspeptidase, α-hydroxybutyrate dehydrogenase, α-amylase, Detection of inborn errors by the assay of enzymes, use of microorganisms in the production of organic chemicals, use of enzymes in industrial processes-alcoholic beverages, bread making, cheese making, meat tenderizing, sweeteners, clarification of beers, wines and fruit juices, detergents. Carbohydrate and protein metabolizing enzymes used in industry. **12 Hours**

Course Outcomes:

At the end of this course, the student will be able to

1. Outline the classification of enzyme and their mechanism of action.
2. Understand and explain the specificity, kinetics of enzyme.
3. Develop screening & extraction method for enzyme.
4. Choose and apply various types of enzyme immobilization techniques.
5. List and explain the uses of enzymes in clinical diagnostics and bioprocess industries.

Mapping of POs & COs:

	PO												PSO		
CO	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1			L											L	M
CO2		L	M	L										L	M
CO3		M	M									L			H
CO4		L	M	L								L		L	M
CO5		M				H	M					L		M	L

TEXT BOOKS:

1. Price, N. C and Stevens, L. *Fundamentals of Enzymology*, Oxford Press, 1999.
2. Pandey, A., Webb, C., Soccol, C. R., Larroche, C. *Enzyme Technology*, Asiatech Publishers, Inc., New Delhi, 2005.
3. Shuler, M. L. andKargi, F. *Bioprocess Engineering*, 2nd Ed., PHI, 2002.

REFERENCE BOOKS:

1. Gerhartz, W. Ed. *Enzymes in Industry: Production and Applications*, VCH Publishers, NY, 1990.
2. Chaplin, M. F. and Bucke, C. *Enzyme Technology*, CUP, Cambridge, 1990. (http://www.pdftitles.com/author/Martin+F.+Chaplin)
3. Messing, *Enzyme Technology*: *Principles of Enzymology for technological Applications*, Butterworth Heinemann Ltd. Oxford, 1993.
4. Dordick, J. S. *Biocatalyst for Industry*, Plenum press, New York, 1991.
5. Aiba, S., Humphrey.A. E., Millis, N. F. *Biochemical Engineering*, University of Tokyo Press, 1973.
6. Inamdar, S. T. A, *Biochemical Engineering*: *Principles and Concepts*, 2nd Ed., PHI, 2012.

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BIOINFORMATICS & APPLICATIONS

Sub Code : 15BT503 **Credits : 04**
Hrs/Week : 4+0+0+S* **Total Hours : 52**

*** Self Study to be exercised under the supervision of course instructor and to be restricted to not more than 10% of the total teaching hours.**

***Prerequisites*:** Structural Biology, Basics of computer knowledge
***Corequisites*:** Nil

Course Learning Objectives:

The objective of this course is
1. To learn fundamentals of informatics and biological science.
2. To learn application of computer science to problems in biological sciences.
3. To appreciate the commercial and academic perspectives on bioinformatics.
4. To understand the impact of bioinformatics on the methodologies used in biological science and the influence of biological science on computing science.

UNIT – I

INTRODUCTION TO SEQUENCING, OMICS &GENOME PROJECTS

Introduction, Different approaches to bioinformatics applications. Genomics: Introduction to Genome sequencing, genome projects, Human genome project. Proteomics: Methods for protein expression analysis. Metabolomics: Scope and application. **10 Hours**

UNIT – II

BIOLOGICAL DATABASES

Database, Types of database (Flat file, Relational (E-R diagram and Object Oriented). Sequence Database: Nucleotide and protein sequence database. Primary (Genbank, EMBL, DDBJ) and Secondary (SWISS PROT, TREMBL) database. Sequence Flat File Formats. Structure Database: Protein structure databases (PDB) and Pubchem. PDB format A dissection. Protein Structure viewers (RASMOL, SWISS PDB viewer, and Pymol). Specialized Database-HPRD, SGD. Metabolic Pathway DB (KEGG). Medical database. Information Retrieval from biological database (Entrez, SRS). **10 Hours**

UNIT – III

SEQUENCE ALIGNMENT AND DATABASE SEARCHING

Introduction, Evolutionary basis of sequence alignment, Local alignment, Global alignment, Modular Nature of proteins, Methods of sequence alignment (Pairwise and multiple), Dot plot, optimal alignment, scoring matrices (BLOSUM & PAM) Gap penalties. Internet based analysis tools-Clustal, T-coffee.

Database similarity searching-BLAST, FASTA. Low complexity regions. Practical issue of alignment, Profiles & Hidden Markov Model, Motif and Patterns, Neural Networks.

11 Hours

UNIT – IV

PHYLOGENETIC ANALYSIS

Molecular evolution, Types of tree. Phylogenetic analysis-Alignment, substitution model, Tree building (Distance based, Character based), Tree evaluation (Boot strapping), PHYLIP.

9 Hours

UNIT – V

STRUCTURE PREDICTIONS AND APPLICATION

Packages: Software tools, the SeqLab environment. Analysing sequences with operation, viewing output. Vector NTI, gene construction kit.

Applications: Predictive methods using Nucleotide sequences, RNA structure prediction. Prediction of protein secondary structure and tertiary structure. Systems biology and its scope, Drug discovery: Methods and tools for target identification and validation, Insilico modeling & drug design. **12 Hours**

Course Outcomes:

At the end of this course, the student will be able to:

1. Infer the biological problems using appropriate *in silico* approaches.
2. Select the suitable tools or servers to solve the specific biological issue and curate experimental data.
3. Perform and analyze database similarity search and sequence alignment.
4. Construct and analyze phylogenetic trees.
5. Use appropriate tools and packages to analyze varied range of biological problems.

Mapping of POs & COs:

	PO												PSO		
CO	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		M		L										M	
CO2		M		L	H							L		L	
CO3		L			H				L					L	
CO4					M									M	
CO5					H				L			L		L	

TEXT BOOKS :

1. Xiong, J. *Essential Bioinformatics*, 1st Ed., Cambridge University Press, 2006.
2. Baldi, P. and Brunk, S. *Bioinformatics-The machine learning approach*, 2nd Ed., A Bradford Book, 2003.

REFERENCE BOOKS:

1. Bergeron, B. *Bioinformatics computing*, Pearson Education 2003.
2. Mount, D. *Bioinformatics-Sequence and genome analysis*, Cold Spring Harbor, 2005.
3. Bauxevanis, A. D. *Bioinformatics*, Wiley Inter-Science, 1998.
4. Krane, D. E. and Raymer, M. L. *Fundamental concepts of Bioinformatics*, Pearson Education 2003.

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GENETIC ENGINEERING & APPLICATIONS

Sub Code : 15BT504 **Credits : 04**

Hrs/Week : 4+0+0+S* **Total Hours : 52**

*** Self Study to be exercised under the supervision of course instructor and to be restricted to not more than 10% of the total teaching hours.**

***Prerequisites*:** Genetics & Molecular Biology, Biochemistry

***Corequisites*:** Nil

Course Learning Objectives:

The objective of this course is

1. To provide in depth knowledge about the fundamental concepts of gene manipulation, mechanisms, identification, storing the very chemical blueprints (DNA) of living organism.
2. To learn about how transgenes are developed for industrial and research applications.
3. To understand rDNA technology and its contribution in understanding gene function.
4. To learn about the advantages and disadvantages of this technology for human welfare.

UNIT – I

BASICS OF RECOMBINANT DNA TECHNOLOGY

Role of genes within cells, genetic code, genetic elements that control gene expression, method of creating recombinant DNA molecules; vectors in recombinant DNA technology, types, their biology and salient features – plasmids, cosmids, phages and viruses. **8 Hours**

UNIT – II

ENZYMES IN GENETIC ENGINEERING

Types and classification, Restriction Enzymes, Nucleases, Ligases, Polymerases, Topoisomerases, Modifying enzymes, RNase, RNase inhibitors, Polynucleotide phosphorylase, DNase, RNA modification, Role of kinases, Phosphatases, Eukaryotic DNA & RNA kinases in genetic engineering techniques. **10 Hours**

UNIT – III

CONSTRUCTION OF DNA LIBRARIES, NUCLEIC ACID HYBRIDIZATION AND AMPLIFICATION

Isolation and purification of nucleic acids, Isolation of plasmids, Construction of genomic and cDNA libraries. Methods of nucleic acid detection; polymerase chain reaction (PCR): types, Principle, instrumentation and applications, RT-PCR-principle, instrumentation and applications; Methods of nucleic acid hybridization; Mutagenesis in vivo and vitro.

14 Hours

UNIT – IV

APPLICATIONS OF RECOMBINANT DNA TECHNOLOGY

Gene transfer techniques, Agrobacterium (Ti and Ri plasmids), Ti plasmids structure and function of T-DNA in the expression of genes, advantages of Ti plasmids in crop improvements, Electroporation, Microprojectile system, Liposome mediated transfer and other techniques, Structure, Transgenic animals and plants. **14 Hours**

UNIT – V

GENE THERAPY

Gene editing technology, Gene therapy in somatic and germ line, gene therapy in immunodeficiency diseases and cancer; Severe Combined Immunodeficiency (SCID) in human beings and its cure, genome editing. **6 Hours**

Course Outcomes:

At the end of this course, the student will be able to

1. Recall and relate the role of genes, genetic code, recombinant methods in rDNA technology.
2. Describe the role of various enzymes in genetic manipulation.
3. Make use of the techniques involved in isolation, purification and separation of nucleic acids.
4. Apply rDNA technology in various fields using suitable methodology.
5. Appraise the use of genetic engineering principles for gene therapies.

Mapping of POs & COs:

	PO												PSO		
CO	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		L								M				M	
CO2		M								M				M	
CO3		M		L								L		M	
CO4		L										L		M	
CO5												L		M	

TEXT BOOKS:

1. Nicholl, D. *Introduction to Genetic Engineering*, Cambridge Low Price Edition, 2002.
2. Old R.W. and Primrose, S.B. *Principles of gene manipulation - An introduction to genetic engineering*, Blackwell Scientific Publications, 2004.

REFERENCE BOOKS:

1. Latchman, D. S. *From Genetics to Gene Therapy – the molecular pathology of human disease*, BIOS scientific publishers, 1994.
2. Lewin, B. *Genes VIII*, Oxford University Press, 1999.

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ANALYTICAL TECHNIQUES

Sub Code : 15BT505 **Credits : 04**
Hrs/Week : 4+0+0+S* **Total Hours : 52**

*** Self Study to be exercised under the supervision of course instructor and to be restricted to not more than 10% of the total teaching hours.**

***Prerequisites*:** Fundamentals of Physics, Biochemistry
***Corequisites* :** Nil

Course Learning Objectives:

The objective of this course is

1. To understand the fundamental concepts of analyzing biomolecules qualitatively as well as quantitatively.
2. To understand the fundamental principles underlying spectroscopic techniques.
3. To learn the basic concepts and application of chromatographic and electrophoretic techniques.

UNIT – I

BASIC PRINCIPLES OF ANALYSIS

Units of measurements: SI units, Solutions-expression of concentrations, calculation of molarity, dilutions, ionization and ionic strength, calculation of ionic strength, activities and activity coefficients, ionization of weak acids and bases. Buffer solutions-their nature and

preparation, Henderson-Haseelbalch equation, buffer capacity, preparation of buffer solutions, selection of buffers (*as dealt in Wilson and Walker*), Numericals.

pH and oxygen electrodes: Reference electrodes-half cell and galvanic cells, saturated calomel electrode, silver/silver chloride electrode, pH electrode, ion selective electrodes, gas sensing electrodes, biosensors and optical sensors, oxygen electrode (as dealt in Wilson and Walker), Numericals.

Analytical consideration and experimental error: The test sample, selecting an analytical method, the nature of experimental errors, systematic errors (determinate errors), identification of systematic errors, random errors, standard operating procedures (as dealt in Wilson and Walker), Numericals.

Assessment of the performance of an analytical method: Precision, accuracy, detection limits, analytical range, analytical specificity, analytical sensitivity.

Calibration methods: reagent blank, one point calibration, linear calibration, standard addition method, internal and external standard. **10 Hours**

UNIT – II

SPECTROSCOPIC TECHNIQUES-I (ATOMIC AND MOLECULAR ELECTRONIC SPECTROSCOPY)

UV-Visible spectroscopy: Beer – Lambert's law (derivation), chromophores and their characteristic absorption, instrumentation (single and double beam), qualitative and quantitative analysis.

Turbidimetry, nephelometry, application.

Optical spectroscopy (colorimeters): Source, optical components, wavelength selector, sample holders, detectors, applications.

Fluorescence and Phosphorescence spectroscopy: Theory (Jablonski diagram, Stokes law), instrumentation.

Atomic absorption spectroscopy: Theory, instrumentation. **11 Hours**

UNIT – III

SPECTROSCOPIC TECHNIQUES-II (RESONANCE & SCATTERING SPECTROSCOPY)

Nuclear magnetic resonance spectrometry: Theory (Larmor Equation), environmental effects on pNMR, pNMR spectrum and chemical shift, spin-spin splitting (Pascal's triangle), solvents for pNMR, applications.

Mass spectrometry: Theory, methods of ionization (ESI, and MALDI), mass analyzers (Quadrupole, and TOF), applications.

Introduction to ICP-MS, ICP-OES, LC-MS and GC-MS. Infrared spectroscopy: Theory, instrumentation, FT-IR, application. **10 Hours**

UNIT – IV

CHROMATOGRAPHIC TECHNIQUES

Introduction to chromatographic separations, classification. Basic principles and theory of chromatography (plate theory, rate theory – van Deemter equation).

Planar chromatography: Concept, selection of solvent system, visualization methods (color development and UV illuminator).

Gas chromatography- principle, instrumentation, working and applications.
HPLC (High performance liquid chromatography)-principle, instrumentation, working and applications.
Ion exchange chromatography- principle, instrumentation, column, detector, mobile phase, sample preparation, applications.
Molecular exclusion (Gel filtration) chromatography-principle, instrumentation, column, detector, mobile phase, sample preparation, applications.
Affinity chromatography- principle, instrumentation, column, detector, mobile phase, sample preparation, applications. **13 Hours**

UNIT – V

ELECTROPHORETIC TECHNIQUES
General principles, support media-agarose gels, polyacrylamide gels, Electrophoresis of proteins: SDS-polyacrylamide gel, native gel, gradient gels, isoelectric focusing gels, two dimensional polyacrylamide gel electrophoresis, detection, estimation and recovery of proteins in gels.
Electrophoresis of nucleic acids: Agarose gel electrophoresis of DNA, DNA sequencing gels, pulsed field gel electrophoresis, electrophoresis of RNA. Detection of DNA and RNA in the gel, Gel doc system. **8 Hours**

Course Outcomes:
At the end of this course, the student will be able to:
1. Adapt the fundamental analytical procedures like selection of suitable pH probe, solution preparation, suitable sample processing, and calibration method.
2. Describe the principle, instrumentation system and applications of absorption and emission spectroscopy.
3. Illustrate the principle, instrumentation system and applications of resonance and scattering spectroscopy.
4. Outline the instrumentation system and applications of chromatography.
5. Select and apply suitable electrophoretic technique to analyze biomolecules.

Mapping of POs & COs:

	PO												PSO		
CO	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		M			M							M		M	L
CO2		M		H	M							M		H	
CO3		M		H	M							L		M	
CO4		M		H	M							L		M	L
CO5		M		H	M							L		H	

TEXT BOOKS:
1. *Willard*, H. H., Merritt, L. L., Dean, J. A., Settle, F. A. *Instrumental Methods of Analysis*, CSS Publishers, 1986.
2. Anand, C. *Instrumental Methods of Chemical Analysis*, Himalaya Publishing House, 2009.

3. Skoog, D. A., Holler, J. F. andNieman, T. A. *Principles of Instrumental analysis*, Harcourt Brace College Publishers, 5th Ed., 1998.

REFERENCE BOOKS:

1. Wilson, K. and Walker, J. *Principles and techniques of Practical biochemistry*, Cambridge University Press, Cambridge, 5th Ed., 2002.
2. Campbell, I. D. and Dwek, R. A. *Biological Spectroscopy*, Benjamin-Cummings Pub Co., 1984.
3. Silverstein. R. M. and Webster, W. P. *Spectrometric Identification of organic compounds*, Wiley & Sons, 1999.
4. Ahuja S. & Jespersen, N. *Modern Instrumental Analysis*, Elsevier, 2006.
5. Harvey, D. *Modern Analytical Chemistry*, MGH, 2000.

ONLINE RESOURCES:

1. Spectral Database for Organic Compounds SDBS [http://sdbs.db.aist.go.jp/sdbs/cgi-bin/cre_index.cgi]
2. The Chemistry LibreTexts library [https://chem.libretexts.org/]

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BASICS OF COMPUTER CONCEPTS

Sub Code : 15BT511 **Credits : 03**
Hrs/Week : 3+0+0+0 **Total Hours : 39**

***Prerequisites*:** Nil
***Corequisites*:** Nil

Course Learning Objectives:

The objective of this course is
1. To learn the basic concepts of operating system, internet, database and its management.
2. To understand soft computing tools.

UNIT – I

OPERATING SYSTEM

Definition and classification of operating systems (Mainframe, Desktop, Multiprocessor, Distributor, Clustered, Real time, Hand held, Future migration). Hardware components. Process concept, process scheduling, Co-operating processes and interprocess communication, Threading, Semaphores, deadlocks, Memory management, Paging, segmentation, Virtual memory, demand paging. **7 Hours**

UNIT - II

LINUX

Introduction to Linux, Architecture of Linux, Basic commands. Working with files, file attributes, installing programs using rpm, Basic editors and their features. Introduction to Shell scripts, types, uses of pipes, aliases, and wildcards. Killing processes Decision making statements: If-then, else-if, test, while-do-done, until-do- done, for-in-do-done, case-in-esac, select-in-do. Basic regular expressions, grep command, applications towards string search

7 Hours

UNIT – III

INTERNET AND XML

Internet address, protocol, Transport layer, Upper layer protocols, Internet access and applications. Overview of HTML and HTTP, Web servers, Security, WWW proxies, HTML technology and applications, Search engines of biological relevance (MEDMINER, SCIRUS), Legal and ethical issues.

Structured and Unstructured data, XML fundamentals, XML documents and XML files, elements and character tags, attributes, XML names, CDATA sections, XML declarations, DTD element declarations, attribute declarations, namespaces, parsing, Programming applications of XML, General features of NCBI'S molecular biology data model, General features of BioXML, NeuroML, Chemical Markup Languages (CML), General features of Microarray ML (MAML), RiboML and SBML **9 Hours**

UNIT – IV

DATABASES AND ONTOLOGIES

Introduction to Databases, flat files, Concepts of DBMS and RDBMS, E-R Model, E-R Mapping, Introduction to MS-ACCESS, Introduction to SQL, using basic SQL commands in MS-ACCESS, Tables in MS-ACCESS-creation, Modification, and joining two tables, Simple queries using SQL, Concept of joins, inner and outer joins with examples, Data sorting and filters.

Overview of Ontologies, gene ontologies, Open biological Ontologies (OBO), cell cycle ontology, Gene X ontology, Building ontology, feature of Ontology development tools.Ontology Integration (TAMBIS ontology), applications of bio ontologies. CSV Data formats. **8 Hours**

UNIT -V

MATLAB

Introduction to MATLAB, features of MATLAB toolbox, Introduction to MS-EXCEL, EXCEL spreadsheets utilities, and operations. Usage of MATLAB toolboxes towards Biochemical applications: MATLAB programming basics - solving algebraic linear and non linear equations, ODE, PDE. Simulink tool kits for Bioinformatics, regression analysis tools. Systems biology tools. **8 Hours**

Course Outcomes:

At the end of this course, the student will be able to

1. Relate the principles of operating system, needs, and hardware requirements.
2. Explain the functioning and protocols of Linux operating system.
3. Understand and describe fundamental concepts of Internet and XML.
4. Appraise the database management, ontologies and their applications.
5. Use MATLAB for soft computing and Apply to solve bioprocess system.

Mapping of POs & COs:

	PO												PSO		
CO	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1									L				L		

CO2					M				L				L		
CO3					M				L				L		
CO4					M				L				M		
CO5		L			M				L				M		

REFERENCE BOOKS:

1. Silberschatz, A., Galvin, P. B., and Gagne, G., *Operating System concept*, 6th Ed., John Wiley, 2003.
2. Das, S. *Unix Concepts & Application*, 4th Ed., MGH, 2006.
3. Morrison, M. *HTML and XML for beginners*, Microsoft Press, 2001
4. Ferouzan, B. A. *Data communications and Networking*, 5th Ed., MGH, 2013.
5. Date, C. J. *An Introduction to Database Systems*, 8th Ed., Pearson, 2003.
6. Simons, P. *A study in Ontology*, Oxford Press, 2007.
7. Finlayson, B. A. *Introduction to Chemical Engineering Computing*, 2nd Ed., Wiley, 2012.

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HUMAN PHYSIOLOGY

Sub Code : 15BT512 **Credits : 03**
Hours/Week : 3+0+0+0 **Total Hours : 39**

***Prerequisites* :** Nil
***Corequisites* :** Nil

Course Learning Objectives:

The objective of this course is
1. To gain the knowledge of human physiology- basic structure and function of human body.
2. To understand various functional systems of human body for use of biotechnological products in health care sectors as well as clinical studies.

UNIT – I

SKELETAL AND MUSCULAR SYSTEM

Cartilage and bone; Comparison between cartilage and bone; Functions of skeletal system; Joints; Muscles of limb movement.Introduction to Muscular system; Principal types of muscles; General properties of muscles; Mechanism of muscle contraction and relaxation, Red and white muscle fibers, disorders of muscle system. **8 Hours**

UNIT – II

DIGESTIVE AND RESPIRATORY SYSTEM

Overview of digestive system, functional anatomy of digestive system: mouth, pharynx, esophagus, stomach, small and large intestine. Digestive glands, Digestive enzymes; physiology of digestion and absorption. Structure of respiratory organs; Mechanism of

breathing; Pulmonary air volumes, Gas exchange in the lungs; respiratory adjustments in exercise, Artificial respiration; Transport of respiratory gases in the blood, Respiratory quotient, Control of respiration. Disorders of digestive & respiratory system. **9 Hours**

UNIT – III

EXCRETORY AND CARDIOVASCULAR SYSTEM

Methods of excretion; Physiological processes involved in excretion; Kidneys; Anatomy and physiology, Nephron and its structure. Functions of nephron; Nephron physiology and mechanism of urine formation; Regulation of urine formation; urine; Micturition; Osmoregulation by kidney.Anatomy of Heart, cardiac cycle, regulation of heart pumping, Rhythmical excitation of heart.Disorders of excretory & cardiovascular system. **8 Hours**

UNIT – IV

NERVOUS SYSTEM

Introduction; Role of nervous system; Generalized neuron; Morphological types of neurons; Physiological or functional types of neurons; Main properties of nervous tissue; Stimulus; Mode of action of nerves; Conduction of nerve impulses; Reflex action; Central nervous system; The brain; The spinal cord; Peripheral nervous system and reflux activity. Special senses: tongue, smell, eye, hearing and balance. Disorders of the nervous system. **7 Hours**

UNIT – V

ENDOCRINE AND REPRODUCTIVE SYSTEM

Introduction; Endocrine systems of vertebrates; Pituitary gland; Thyroid gland; Parathyroid gland; Pancreas; Adrenal or suprarenal glands; Sex glands; Gastrointestinal mucosa; Thymus gland; Pineal gland; Summary of different endocrine glands; their hormones and influence; Summary of the effect of hyper secretion and hyposecretion of some important endocrine glands; Physiology of male and female reproduction systems, in vitro fertilization, test tube baby. Disorders of endocrine & reproductive system. **7 Hours**

Course Outcomes:

At the end of this course, the student will be able to

1. Relate the structure of human skeletal and muscular organs to biomedical engineering needs.
2. Describe human digestive and respiratory system.
3. Explain the physiology and function of human excretory and cardiovascular system.
4. Illustrate the human nervous system and its functioning.
5. Compare and analyze interrelationship of endocrine organs with other organs.

Mapping of POs & COs:

	PO												PSO		
CO	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	M					L								L	
CO2	M					L								L	
CO3	M					L								L	

CO4	M					L								L	
CO5	M					L								L	

TEXT BOOKS:

1. Guyton, A. C., Hall, J. E. *Text Book of Medical Physiology*, 11th Ed. Elsevier – Saunders Publication, 2012.
2. Sembulingam, K. and Sembulingam, P. *Essentials of Medical Physiology*, 3rd Edition, Jaypee Publications, 2004.

REFERENCE BOOKS:

1. Waugh, A. and Grant, A. *Ross & Wilson's Anatomy and Physiology in Health and Illness*, 11th Ed., Churchill Livingstone Publications, 2011.
2. Chaudhuri, S. K. *Concise Medical Physiology*, 5th Edition, New Central Book Agency Pvt. Ltd., 1997.
3. Chakrabarti, B. K., Ghosh, H. N., Sahana, S. N. *Text book of Human Physiology*, The New Book Stall, Calcutta,1984.

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PLANT PHYSIOLOGY

Sub Code : 15BT513 **Credits : 03**
Hrs/Week : 3+0+0+0 **Total Hours : 39**

***Prerequisites*:** Nil
***Corequisites*:** Nil

Course Learning Objectives:

The objective of this course is

1. To learn basic structure and function of plants.
2. To learn photosynthetic processes.
3. To gain knowledge about signal transduction and metabolite production in plants which in future would help to study advanced studies on plant based products in biotechnology.

UNIT – I

Plant life, overview of plant structure. Water uptake: imbibition, diffusion, osmosis, water potential and its components – Translocation of water Ascent of sap – Transpiration – Stomatal physiology – Guttation – Water stress and its significance – Translocation in Phloem. Mechanism of water transport through xylem; Essential nutrients, deficiencies and plant disorders; Solute transport by passive and active mechanisms and membrane transport.

8 Hours

UNIT – II

Growth – measurement of growth, growth curve – PGR, Auxins, Gibberellins, Cytokinins, Ethylene Growth regulation, senescence and programmed cell death. Application of hormones in agriculture - Nitrogen fixation in plants.Photomorphogenesis - Photoperiodism,

Vernalisation, Phytochrome, Biological clock. Physiology of germination - Types and methods to overcome dormancy. **9 Hours**

UNIT – III

Photosynthesis: Photosynthetic pigment systems - radiant energy - cyclic and noncyclic electron transport - C3 and C4 pathways - factors affecting photosynthesis - photorespiration Respiration: Aerobic - anaerobic, Glycolysis, Krerb's cycle, oxidation - reduction potential, ATP synthesis, Factors affecting respiration. **8 Hours**

UNIT – IV

Signal transduction: Over view, receptors and G. proteins, second messengers, Stress Physiology: Water deficit and its physiological consequences, drought tolerance mechanisms, salinity stress and plant responses, heat stress and heat shock proteins, metal toxicity, biotic stress. **7 Hours**

UNIT – V

Secondary metabolites and plant defense: Terpenes, Phenolic compounds, nitrogen containing compounds, Cutin, waxes and suberin. Importance of secondary metabolites.Induced plant defense against insect herbivores, Plant defense against pathogens, host pathogen interaction. **7 Hours**

Course Outcomes:

At the end of this course, the student will be able to

1. Understand nutrient and water translocation in plant system.
2. Appraise the plant growth and plant morphogenesis.
3. Elaborate the principles and mechanisms involved in photosynthesis.
4. Illustrate the signal transduction mechanisms in plant system.
5. Outline the production and importance of secondary metabolites.

Mapping of POs & COs:

	PO												PSO		
CO	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	M					L								L	
CO2	M					L								L	
CO3	M					L								L	
CO4	M					L								L	
CO5	M					L	L							L	

TEXT BOOKS:

1. Salisbury, F. B and Ross, C. W, *Plant Physiology*, Wadsworth Publishing Co, Belmont, 1991.
2. Bidwell, R. G. S, *Plant Physiology*. Macmillan Publication Co, New York, 1974.

REFERENCE BOOKS:

1. Rao, K.N Rao, S. G and Bharathan S., *The Functioning of Plant.* S.ViswanathanPvt Ltd., 1987.

2. Ting I. P, *Plant Physiology*, Addison Wesley Publication Co. Philippines, 1982.
3. Michealis, I. and Torrey, J. C., *Plant in Action*, W.H. Freeman, 1956.
4. Withem, F.H., Blaydes, D. F and Devlin, R. N, *Experiments in Plant Physiology*, Van Nostrand Reinhold Co., 1972.
5. Devline, R. M. and Witham, F. H. *Plant Physiology*. CBS Publishers & Distributors, New Delhi, 1986.
6. Hopkins, W.G. *Introduction to Plant Physiology*, John Wiley & Sons. Inc., New York, USA, 1995.

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FOOD BIOTECHNOLOGY

Sub Code : 15BT514 **Credits : 03**
Hrs/Week : 3+0+0+0 **Total Hours : 39**

***Prerequisites*:** Microbiology
***Corequisites*:** Nil

Course Learning Objectives:

The objective of this course is

1. To learn the interaction between microorganism and food.
2. To understand the role of major groups of food borne microorganisms in food spoilage.
3. To learn the role of biotechnological processes for processing and preservation of food.

UNIT - I

INTRODUCTION

Food: Types, Constituents and nutritional aspects of food, Food Quality and Health.

Food Biotechnology: Evolution, History, Impact and Benefits. Importance of rDNA technology in food. Microbes in Food: Role and significance, types and primary sources of microbes in food. Synopsis of common food borne microbes: Bacteria, molds and yeasts.

8 Hours

UNIT – II

FOOD SPOILAGE AND PRESERVATION

Food Spoilage: Microbial spoilage of vegetables, fruits, fresh and processed meat, sea food. Spoilage of miscellaneous food: milk and milk products, eggs, heated canned foods.

Food borne Diseases: Bacterial (*S. aureus, Salmonella, E.coli, Listeria monocytogenes, Clostridium botulinum*), Non bacterial: Mycotic (*Candida* spp., *Wangiella* spp., Mycotoxins and Alfatoxins) and viral (Norovirus and Rotavirus induced gastroenteritis).

Food preservation: Irradiation, Low temperature, High temperature, drying, Chemical food preservatives: benzoic acid and parabens, propionates, sulphites and sulphur dioxide, nitrites and nitrates. Natural food preservatives: antimicrobials, salt, sugar and vinegar. **8 Hours**

UNIT – III

BIOTECHNOLOGY IN FOOD INDUSTRY

Food Industry: Characteristics and Types, Food Processing: Objectives and effect of processing on food constituents. Applications of biotechnology to food industry: Enzymes in

food manufacture, processing and preservation (hydrolases, proteases, lipases), probiotics & prebiotics, functional foods, neutraceuticals.
Genetically modified Foods: Introduction, Risks and benefits, Regulatory affairs, Case studies: Golden rice, BT Brinjal, Soyabean (Monsanto). **9 Hours**

UNIT – IV

MICROBIOLOGICAL ANALYSIS OF FOOD PRODUCTS

Parameters of food that affect growth of microorganisms; Sampling procedure of foods for microbial analysis: raw meat and poultry, eggs, milk products (cheese), raw and frozen fish, raw fruits and vegetables and fruit juices.
Detection of microbes and their products in food: Conventional methods (Direct microscopic count, Standard plate count, most probable number, agar droplets, dye-reduction) and Rapid methods: DNA-RNA methodology, Electrical method, Immunological methods: Fluorescent antibody and ELISA.
Detection and confirmation of common microbes in food: *Clostridium perfringens, Salmonella and Vibrio species, Listeria monocytogenes, Staphylococcus aureus, E coli.*
Microbial Food Safety: Indicators of product quality and food safety, HACCP. **7 Hours**

UNIT – V

FERMENTED AND MICROBIAL FOODS

Microbial Foods: Single cell proteins i.e*Spirulina*, *Rhodopseudomonas capsulate*, *and Saccharomyces cerevisiae*, Edible Macro Fungi (Mushrooms). Flavor enhancers: Monosodium glutamate, Sweeteners: dextrose, corn and high fructose corn syrup.
Fermented Foods: Organic acids: Lactic acid, citric acid and acetic acid (vinegar), Alcoholic Beverages: Beer and wine, Dairy products: Cheese and Yogurt, Cereal products: Bread, cakes and pastries,
Novel foods: Tempeh, Miso, Kimchi, Sauerkraut. **7 Hours**

Course Outcomes:

At the end of this course, the student will be able to

1. Outline the role and significance of microorganisms in food spoilage and its detection.
2. Apply various food preservation techniques and its application in food processing industries.
3. Appraise the role of essential microbes in fermentation and production of various fermented foods.
4. Explain the role of microbes as probiotics and their importance in nutrition
5. Discuss the role of important enzymes of microbial origin in food processing.

Mapping of POs & COs:

	PO												PSO		
CO	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	L											L		L	
CO2		M				L	L							M	L
CO3		L				L	L					M		L	

CO4	L											L		M	
CO5	L	L										L		M	

TEXT BOOKS:

1. Jay, J. M., *Modern food Microbiology*, 4th Ed., CBS Publishing company Ltd., New Delhi India, 2005.
2. Shivasankar, B., *Food Processing and Preservation*, 6th Ed., Prentice Hall of India Pvt., Ltd. New Delhi, India 2009.

REFERENCE BOOKS:

1. Frazier, W.C., Westhroff, D.C., *Food Microbiology*, 4th Ed., Tata McGraw-Hill publishing company Ltd, New Delhi, India, 2008.
2. Bohra, A. &Parihar, P. *Food Microbiology*, Agrobios India, 2008.
3. Adams, M. R. and Moss, M. O., *Food Microbiology*, 2nd Ed., Panima publishing cooperation, New Delhi, India, 2000.

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BIOKINETICS LAB

Sub Code : 15BT506 **Credits : 02**
Hrs/Week : 0+0+3+0 **Total Hours : 39**

***Prerequisites*:** Nil
***Corequisites*:** Reaction Engineering, Enzyme Technology

Course Learning Objectives:

The objective of this course is

1. To learn the techniques associated with the study of kinetics of enzymes and cells.
2. To gain experimental knowledge of enzymatic reactions and analysis of reactors.

EXPERIMENTS

1. Extraction of Enzyme and Determination of specific activity.
2. Effect of temperature on enzyme activity.
3. Effect of pH on enzyme activity.
4. Effect of metal ions on enzyme activity.
5. Enzyme kinetics (Determination of Km and Vm).
6. Enzyme inhibition kinetics.
7. Analysis of Batch reactor data (Integral and Differential method).
8. Mixed Flow reactor analysis (RTD).
9. Plug flow reactor analysis (RTD).
10. Batch growth kinetics of microbial cells –Monod Kinetics.
11. Immobilization and enzyme loading calculation (Lowry's Method).
12. Mass transfer limitation for immobilized enzyme (Effect of pore size on observed activity and calculation of Thiele modulus).

Enzyme used: Alpha amylase (Starch as substrate) or Phosphatase (PNPP as substrate).

Course Outcomes:

At the end of this course, the student will be able to

1. Perform enzymatic experiments and understand principles of enzyme kinetics and various parameters affecting enzyme activity and kinetics.
2. Analyse and interpret the batch and continuous reactors data.
3. Perform experiments on heterogeneous batch kinetics.

Mapping of POs & COs:

	PO												PSO		
CO	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		M		H						L		L		M	L
CO2		L	M	H						L		L			H
CO3		L		M						L		L		M	L

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BIOINFORMATICS LAB

Sub Code : 15BT507 **Credits : 02**

Hrs/Week : 0+0+3+0 **Total Hours : 39**

***Prerequisites*:** Basics of Computer Applications

***Corequisites*:** Bioinformatics, Genetic Engineering & Applications

Course Learning Objectives:

The objective of this course is

1. To learn the application of computer, internet and database technology to biological data and their analysis using softwares.

EXPERIMENTS

1. Sequence retrieval from primary nucleotide and protein databases (GenBank)
2. Sequence retrieval from secondary nucleotide and protein databases (SWISSPROT, TREMBL)
3. Study of PDB format file.
4. Study of specialized databases (SGD, KEGG)
5. Bibliographic retrieval (PubMed, PubMed Central)
6. Database similarity (FASTA and BLAST) searches – Analysis of parameters affecting alignment.
7. Pair wise comparison of sequences – Analysis of parameters affecting alignment.
8. Multiple alignments of sequences – Analysis of parameters affecting alignment.
9. Evolutionary studies / Phylogenetic analysis – Analysis of parameters affecting trees.
10. Identification of functional sites in Genes / Genomes.
11. Restriction mapping.
12. Primer Design.
13. Secondary structure prediction of proteins.
14. Protein structure visualization (RASMOL)

15. Pattern elucidation in Proteins (PROSITE).
16. Superposition of structures – Calculation of RMSD for main chain atoms.
17. Molecular Docking studies.

Course Outcomes:

At the end of this course, the student will be able to

1. Use various primary, secondary and specialized databases for data retrieval for nucleotides and protein sequences.
2. Perform similarity searches, pair wise and multiple alignments and identification of functional sites using tools and servers.
3. Design primers for genetic analysis.
4. Visualize protein structures and elucidate protein patterns using relevant software.

Mapping of POs & COs:

	PO												PSO		
CO	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		L		M	M					L		L		M	
CO2		L		M	M					L		L		M	
CO3				H	M					L		L		M	
CO4		L		M	M					L		L		M	

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IMMERSIVE GROUP WORKSHOP (IGW)

Sub Code : 15BT508 **Credits : 00**
Hrs/Week : 0+0+3+0 **Total Hours : 39***
***Prerequisites*:** IEL
***Corequisites*:** Nil

Course Learning Objectives:

The objective of this course is

1. To develop behavioral etiquettes and skills to perform as an individual and in groups.
2. To develop interpersonal relationship skills and builds confidence in overcoming conflicts.

**This course is conducted as one week (5 days) workshop in August 2016. Course conducted and evaluated by I-Point Consultancy. Students obtain PP (pass) and NP (fail) grade during evaluation. The student needs to get PP grade to be eligible for gradation.*

Module 1: Minds-on and hands-on simulation project

- Understanding Task environment – Goals, responsibilities, Task focus
- Working in Teams towards common goals
- Organizational performance expectations–technical and behavioural competencies.

Module 2: Re- enforcement of critical individual skills and behaviour

- Application of individual effectiveness skills in team and organizational context – improving self awareness, goal setting, time management, communication and presentation skills.

Module 3: Etiquettes and Ethics

- Professional etiquettes at workplace – dressing, telephone, e-mail, meeting and general behaviour
- Basic honesty & respect for law / rules
- Conflict of interest
- Use of organizational resources
- Misrepresentation and misappropriation
- Intellectual property
- Whistle blowing

Module 4: Interpersonal Behaviour& relationship skills

- Establishing trust based relationships in team & organizational environment
- Trust equation – credibility, responsiveness, integrity, self-interest

Module 5: Dealing with Conflicts

- Orientation towards conflicts in team and organizational environment
- Understanding sources of conflicts
- Conflict resolution styles and techniques

Pedagogical tools & techniques used in the workshop

- Organizational templates for simulating a organizational context- structures, units, roles and activities
- Metaphoric scenarios for simulating real –life tasks and dynamics in a team/project context
- LEGO ^{TM} building blocks for simulating last-mile technical activity in teams
- Case studies, Role play scenarios group learning activities, observation and feedback.

Course Outcomes:

At the end of this course, student will be able to

1. Relate the tasks and work in team.
2. Reinforce the individual effectiveness skills to work in group efficiently.
3. Apply professional etiquettes and behavior and appreciate interpersonal relationship.
4. Formulate to deal with situations of conflict.

Mapping of POs & COs:

	PO												PSO		
CO	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1									M	M		L			
CO2									H	M		L			
CO3								M		M		L			
CO4										M		L			

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BIOPROCESS DYNAMICS & CONTROL

Sub Code : 15BT601 **Credits : 03**
Hrs/Week : 2+2+0+0 **Total Hours: 26+26***
**Hours/Week = Lecture hours + Tutorial hours*
***Prerequisites* :** Laplace Transforms, Calculus, Bioprocess Calculations.
***Corequisites* :** Nil

Course Learning Objectives:

The objective of this course is
1. To learn the dynamics of a bioprocess system and control strategies.
2. To study the open loop & closed loop response of the control system.
3. To learn process regulation using various controller mechanisms.
4. To understand the mechanism of various sensors used in fermenter and its control.

UNIT – I

FUNDAMENTALS OF PROCESS CONTROL

Objectives of control system and significance of control system in bioprocess industry, examples of bioprocess control, needs and incentives for controlling a biochemical process, classification of variables in process control as input and output, design elements of control system, need of mathematical modeling in controlling of biochemical process.

Definition of process control terminologies: Process, Process variable, measured variable, manipulated variable, set point, error, offset, load disturbance, final control element. Signals (Pneumatic, Electric and electronic), SISO and MIMO systems.

Control strategies: manual and automatic control, open loop and closed loop control, discrete and continuous control, feed forward, cascade. ratio, adaptive control and control of nonlinear process (only descriptive and block diagrams).

Laplace Transform: Transform of functions, transform of derivatives, Laplace inversion by partial fractions, qualitative nature of solutions (complex roots), final value and initial value theorem. **7+3 Hours**

UNIT – II

BIOPROCESS DYNAMICS

Forcing functions, response, Transfer function. First order system: Mercury in glass thermometer, Level process, Composition, Mixing. First order system in series: Non-Interacting and Interacting systems. Second order system: Manometer and damped oscillator. Transient response to Step, Ramp changes for under damped, critically damped and over damped systems. Nonlinear systems: Transportation lag; Linearization of nonlinear system and development of transfer function (Taylors series, Pade's I approximation).

4+8 Hours

UNIT – III

CLOSED LOOP CONTROL SYSTEM AND DYNAMICS

Controllers – Proportional, Integral and Differential control actions and their combination. Block diagram for servo and regulator mechanism and block diagram reduction (using

reduction rules). Transient response of I order process for set point and load changes with P, PI, and PD controllers. **6+5 Hours**

UNIT – IV

STABILITY ANALYSIS IN LAPLACE & FREQUENCY DOMAIN

Concept of stability, roots in complex plane and stability, criterion of stability for linear systems. Routh – Herwitz criterion of stability; Root locus diagram: concept, stability analysis. Introduction to frequency response, Laplace domain vs frequency domain analysis. Bode stability criterion.

Control system design: Ziegler Nichols controller settings, Cohen-Coon rules (reaction curve method, conceptual only). **4+6 Hours**

UNIT – V

CONTROL OF BIOREACTOR

Methods of measuring and control of process variable: Online and offline analysis; modern sensors/transducers used in analysis of pressure, temperature, pH, dissolved oxygen (DO), agitator speed, CO_2, biomass and biosensors.

Pneumatic Controllers: actuators, positioners, valve characteristics.

Computers in process control: hardware components of microprocessor based control systems, implementation of control algorithms, special features.

Fermentation process control: Fermentation process dynamics. Supervisory control: SCADA– Architecture, generations of evolution. **5+4 Hours**

Course Outcomes:

At the end of this course, student will be able to

1. Define process control terminologies and identify suitable mode of controlling a given process.
2. Develop suitable control equations for bioprocess dynamics.
3. Examine the closed loop control system and select suitable control action.
4. Analyze the stability of control system in Laplace and frequency domain.
5. Utilize suitable type of sensors necessary in fermenter control and illustrate the computerized control of fermenter.

Mapping of POs & COs:

	PO												PSO		
CO	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		L			L										L
CO2		M	H												M
CO3		M	M												H
CO4		M	L												M
CO5		L			L							L			H

TEXT BOOKS:

1. Stephanopouls, G. *Chemical process control*, PHI, 2005.
2. Seborg, D. W., Edger, T. F. Millichamp, D. A. *Process Dynamics and Control*, John Wiley & Sons, 1989.

REFERENCE BOOKS:

1. Coughanowr, D. R. *Process Systems Analysis and Control*, MGH, 2009.
2. Moo-Young, M (Ed.). *Comprehensive Biotechnology*, Vol 2, Pergamon Press, 2004.
3. Demain, A. L. and Davis, J. E. (Ed). *Manual of Industrial Microbiology and Biotechnology*, 2nd Ed., ASM Press, Washington, 2004.
4. Luyben, W. L. and Luyben, M. L. *Essentials of Process Control*, MGH, 1996.

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UPSTREAM PROCESSING TECHNOLOGY

Sub Code : 15BT602 **Credits : 04**
Hrs/Week : 4+0+0+0 **Total Hours : 52**

***Prerequisites*:** Microbiology, Biostatistics
***Corequisites*:** Nil

Course Learning Objectives:

The objective of this course is

1. To learn various aspects of microbial, plant and animal cell culture, maintenance, scale up and biotechnological principles for the production of valuable products.

UNIT – I

ISOLATION, PRESERVATION AND IMPROVEMENT OF INDUSTRIALLY IMPORTANT CULTURES

Isolation and screening methods, Preservation: Desiccation, lyophilisation, storage by sub culture. Culture management. Improvements of industrial cultures: Isolation & selection of induced mutants, Isolation of auxotrophic, resistant, revertant mutants, use of rDNA technology. The improvement of industrial strains by modifying properties other than the yield of products. **10 Hours**

UNIT – II

STERILIZATION

Introduction, Sterilization of media: Methods, design of batch sterilization, Del factor calculation, continuous sterilization processes, Filter sterilization. Sterilization of gases: Selection criteria for filters. Sterilization of fermenters and vessels, numericals.

10 Hours

UNIT – III

MEDIA PREPARATION

Media formulation: Microbial, Plant and Animal cell culture, Energy sources, precursors and metabolic regulators, oxygen requirement, antifoaming agents, Media optimization, numericals. **8 Hours**

UNIT – IV

INOCULUM DEVELOPMENT & GROWTH KINETICS

Criteria for the transfer of inoculum, development of inocula for yeast, bacteria,mycelialplant, animal cell culture processes, Aseptic inoculation to pilot plant fermentor, Scale up of the inoculum. Models of growthkinetics: substrate, biomass and product, numericals.

12 Hours

UNIT – V

FERMENTATION & SCALE UP

Types of fermentation: submerged, SSF, modes of fermentation: batch, fed batch, continuous. Types of fermenter: Shake flasks& bottles, Stirred tank fermenter, Air lift fermenter, tower fermenter, packed bed & fluidized bed bioreactors; Scale up criteria for fermenter. Numericals. **12 Hours**

Course Outcomes:

At the end of this course, student will be able to

1. Identify and apply strain isolation and preservation techniques.
2. Translate and apply the concepts of sterilization.
3. Formulate suitable medium composition and make use of statistical approach for its optimization.
4. Explain the inoculum development techniques for various industrial applications.
5. Appraise the requirements of fermentation process.

Mapping of POs & COs:

	PO												PSO		
CO	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		M	L		L							M		M	
CO2		L	M		L							M		M	L
CO3		H	M	M	L						L	L		M	M
CO4		L										L		L	H
CO5		L									L	L		L	L

TEXT BOOKS:

1. Stanbury, P. F. and Whitaker, A. *Principles of fermentation Technology,* Pergamon Press, 2008.
2. Shuler, M. L. and Kargi, F. *Bioprocess engineering,* Pearson Education Ltd., 2014.
3. Dutta, R. *Fundamentals of Biochemical engineering,* Springer, 2008.

REFERENCE BOOKS:

1. McNeil, B. and Harvey, L. M. *Fermentation: A practical approach*, Oxford press, 1990.
2. Doran, P. M.*Bioprocess Engineering Principles,* Academic Press, 2013.
3. Dixon, R. A. and Gonzales,R. A. *Plant Cell Culture: A Practical Approach*, 2nd Ed., IRL Press, 1995.
4. Dodds, J. H. and Robert, L. W. *Experiments in Plant Tissue Culture*, 3rd Ed., Cambridge University Press, 1995.
5. Bhojwani, S. S. and Razdan,M. K. *Plant tissue Culture: Theory and Practice*, Elsevier, Amsterdam, 1996.
6. Moo-Young, M. *Animal Biotechnology*, Pergamon Press, Oxford, 1989.
7. Glazer, A. N. and Hiroshi Nikaido, H. *Microbial Biotechnology: Fundamentals of Applied Microbiology*, W.H. Freeman & Company, New York, 1995.
8. Moo-Young, M. (Ed.). *Comprehensive Biotechnology*, Vol 2, Pergamon Press, 2004.

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DOWNSTREAM PROCESSING TECHNOLOGY

Sub Code : 15BT603 **Credits : 04**
Hrs/Week : 4+0+0+S* **Total Hours : 52**

*** Self Study to be exercised under the supervision of course instructor and to be restricted to not more than 10% of the total teaching hours.**

***Prerequisites*:** Unit Operations, Analytical Techniques
***Corequisites*:** Upstream Processing Technology

Course Learning Objectives:

The objective of this course is

1. To describe key industrial downstream processing methods from the traditional to the recently evolved.
2. To learn the major steps involved in separation, concentration and purification of a bio-product from the fermenter stage to the commodity stage.
3. To integrate biological and engineering principles involved in the production and recovery of commercial products.

UNIT – I

INTRODUCTION

Role and importance of downstream processing in biotechnological processes.Problems and requirements of bioproduct purification.Economics & Cost cutting strategies.Introduction to high volume, low value products and low volume, high value products. General account of downstream processing steps: removal of insolubles, cell disruption, isolation, product purification and product formulation. Analysis of product purity: Chromatography, Electrophoresis and spectroscopy. Numericals. **8 Hours**

UNIT – II

PRIMARY SEPARATION TECHNIQUES

Cell disruption techniques: fungal mycelia, bacterial cells, plant cell and animal cell, mechanical and non-mechanical disruption, Ultrasonic cell disruption.

Filtration techniques: bed filters, pretreatment, continuous rotary drum filters, filter media and filter aids, microfiltration.

Centrifugation: settling of solids, centrifuges (tubular bowl, disc type, continuous-industrial scale as dealt in Belter), scale up, centrifugal filtration.Numericals. **11 Hours**

UNIT – III

ENRICHMENT & PURIFICATION TECHNIQUES

Precipitation methods with salts, organic solvents and polymers, liquid-liquid extraction, aqueous two-phase extraction, supercritical fluid extraction; adsorption. Distillation and Evaporation: principle, types. Chromatographic purification: Adsorption, Ion exchange, affinity, reversed phase with suitable examples. Numericals. **12 Hours**

UNIT – IV

MEMBRANE BASED SEPARATIONS

Types of membranes, membrane based separation theory. Types of membrane processing and application: reverse osmosis, microfiltration, ultrafiltration, dialysis and electrodialysis. Design and configuration of membrane separation equipment.Numericals. **11 Hours**

UNIT – V

PRODUCT RESOLUTION AND CASE STUDIES

Crystallization: Theory – nucleation, crystal growth; mixed product removal crystallizer with mixed suspension. Crystallization processes.

Drying: drying curve, tray dryer, flash dryer, freeze drying, vacuum filter drying.

Process design criteria for various classes of bioproducts (high volume, low value products and low volume, high value products: Antibiotics, Organic acids, Vitamins, Insulin. Numericals. **10 Hours**

Course Outcomes:

At the end of this course, student will be able to

1. Explain the significance of downstream processing in bioprocess industry.
2. Evaluate primary separation techniques for product recovery.
3. Choose the techniques for product enrichment and purification.
4. Utilize membrane based operations for product purification.
5. Apply downstream processing concepts for commercial bio-products.

Mapping of POs & COs:

	PO												PSO		
CO	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		L									L	L			M
CO2			M									M			H
CO3			M									M			H
CO4			M				M					L			H
CO5		L	M		L		L					L			M

TEXT BOOKS:

1. Belter, P. A. and Cussler, E., *Bioseparations*, Wiley Publication, 1985.
2. Sivasankar, B. *Bioseperations principles and techniques*, PHI Eastern economy edition, 2005.

REFERENCE BOOKS:

1. Krishna Prasad, N. *Downstream Process Technology – A New Horizon in Biotechnology*, 1st Ed., PHI, 2010.
2. Najafpour, G. D. *Biochemical Engineering and Biotechnology*, 1st Ed, Elsevier, 2007.
3. Geankoplis, C. J. *Transport Processes and Separation Process Principles*, 4th Ed, Prentice hall professional technical reference, 2003.
4. Boyer, R. *Modern Experimental Biochemistry*, 3rd Ed., Pearson Education Ltd., 2009.
5. Sawhney, S. K. and Randhir Singh, *Introduction to Practical Biochemistry*, Narosa Publishing House, 2000.
6. *Product Recovery in Bioprocess Technology* - BIOTOL Series, VCH, 1990.
7. Harrison, R. G., Todd, P. W., Rudge, S. R., Petrides, D. P. *Bioseparation Science and Engineering*, Oxford University Press, 2015.
8. Wang D.I.C., Cooney C.L., Demain A.L. *et al* , *Fermentation & Enzyme Technology* , Wiley Eastern, 1979.
9. Hardy, J. E., Hylton, J. O., McKnight, T. E., Remenyik, C. J. Ruppel, F. R.Bioseparations engineering-Principle, Practice and Economics, John Wiley, 2012.

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GENOMICS & PROTEOMICS

Sub Code : 15BT611 **Credits : 03**
Hrs/Week : 3+0+0+0 **Total Hours : 39**

***Prerequisites*:** Genetic Engineering
***Corequisites*:** Nil

Course Learning Objectives:

The objective of this course is

1. To gain overview of the current fields of genomics and proteomics and relates them to biopharmaceutical and biotechnology industries.
2. To learn the techniques used in genomics and proteomics research.

UNIT – I

GENOME MAPPING, SEQUENCING & GENOME PROJECTS

Methods of genetic mapping and physical mapping, features of mapping microbial genomes, Methods of preparing genomic DNA for sequencing, DNA sequencing methods - Sanger Di-deoxy method, Fluorescence method, Genome sequencing methods-Hierarchical & Shotgun method, Next Generation Sequencing, Exome Sequencing, RNA sequencing, Genome projects on *E. coli, Arabidopsis,* rice,yeast, *Drosophila, C. elegans.* Human Genome Project. **8 Hours**

UNIT – II

GENOME ANALYSIS

Genome anatomy- nomenclature, Prokaryotic genome, eukaryotic genome, Sequence assembly and gene identification, Comparative Genomics- Ancient conserved region, Horizontal gene transfer, Functional Classification of genes- Gene order, Gene regulation, Functional genomics- genome databases, Raw genome sequence data. **7 Hours**

UNIT – III

MOLECULAR MARKERS IN GENOME ANALYSIS

Principle classes of markers: DNA hybridization markers- RFLP's & AFLP's; DNA amplification markers- RAPD's, SCAR, microsatellites- simple sequences repeats (SSR) & Inter simple sequences repeats (ISSR); EST's & Gene variation, SNP's- disease associations, diagnostic genes and drug targets. Methods in animal & plant genomes- applications in animal & plant breeding, YAC libraries- its applications in genome mapping. **9 Hours**

UNIT – IV

PROTEOMIC TECHNIQUES

Principles of separation, purification & quantification of protein (2D-Gel Electrophoresis, MALDI-TOF, High resolution Mass spectrometry), Large-scale synthesis of proteins, use of peptides, High Protein Network Mapping, Applications of Proteomics and Protein arrays, Protein Interaction Maps, Protein Biochips, Protein Expression profiling, Shotgun Proteomics and its application to yeast proteome, Forward and Reverse Proteomics. **8 Hours**

UNIT – V

PROTEIN-PROTEIN INTERACTIONS

Yeast two hybrid, Co-Precipitation, Phage Display, Phylogenetic Profile, Gene Neighborhood, Gene Cluster, Analysis of genome wide Protein-Protein Interactions in yeast, Genome wide yeast two hybrid analysis of other organisms, Protein fragment complementation assays. **7 Hours**

Course Outcomes:

At the end of this course, student will be able to

1. Recall the methods of gene mapping, DNA sequencing.
2. Analyze the importance of genome project and genetic maps.

3. Illustrate the concepts and methods involved in genome analysis.
4. Explain molecular markers and their use in genome analysis.
5. Appraise the techniques involved in proteomic research.

Mapping of POS & COs:

	PO												PSO		
CO	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		M												M	
CO2		M		L		L								M	
CO3		M												M	
CO4		M				L								M	
CO5		M				L								M	

TEXT BOOKS:

1. Pevsner, J. *Bioinformatics and Functional Genomics*, John Wiley & Sons, Inc., 2003.
2. Mount, D. *Bioinformatics: Sequence and Genome Analysis*, 2nd Ed., Cold Spring Harbor Lab Press, 2004.
3. Pennington, S. R. and Dunn, M. J. *Proteomics: From protein sequence to function*, Garland Science, 2000.
4. Primrose, S. B, Twyman, R. M. *Principles of Gene Manipulation & Genomics*, 7th Ed., Oxford, 2006.
5. Sensen.C. W. *Essentials of genomics and Bioinformatics*, Wiley VCH, 2002.
6. Rastogi, S. C,, Mendiritta, N., Rastogi, P. *Bioinformatics: Methods & Applications*, 2nd Ed., PHI, 2006.

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BASICS OF PHARMACEUTICAL SCIENCE

Sub Code : 15BT613 **Credits : 03**
Hrs/Week : 3+0+0+0 **Total Hours : 39**

***Prerequisites*:** Chemistry
***Corequisites*:** Nil

Course Learning Objectives:

The objective of this course is

1. To equip students with multidisciplinary skills and knowledge base required in the field of biotechnology, particularly with reference to its pharmaceutical applications.
2. To enable the student to pursue careers within the field or to continue further studies in the field of Pharmaceutical Technology.

UNIT – I

INTRODUCTION

Introduction to pharmaceutical biotechnology.Pharmaceutical Industry. Biotechnology and drug Design. Drug development and its economics Preclinical studies and principles/practices of process development.Orphan drugs.Provisions and use of unlicensed medicines.Drug abuse and dependence.Prescription and non-Prescription drugs.Concepts of pharmacovigilance, biotherapeutics, nutraceuticals, sulphadrugs and generic drugs. Pharmacotherapy: Classification of drugs based on therapeutic actions with special emphasis on laxatives, analgesics, non steroidal contraceptives, antacids and external antiseptics. Hormone replacement therapy. **7 Hours**

UNIT – II

PHARMACOKINETICS PRINCIPLES

Pharmacokinetics: ADME definitions, Plasma drug concentration –Time profile; Drug absorption: Gastrointerstinal absorption of drugs, Mechanism of drug absorption:passive diffusion, pore transport, facilitated diffusion, active transport, ionic and electrochemical diffusion, ion pair transport and endocytosis; Physicochemical factors affecting drug absorption: drug solubility and dissolution rate, Factors affecting drug dissolution and dissolution rate, dosage form factors affecting drug absorption, patient related factors affecting drug absorption.

Distribution of drugs: physicochemical properties of drug, physiological barriers to distribution of drugs, organ tissue size and perfusion rate, binding of drugs and perfusion rate, Miscellaneous factors affecting drug distribution.

Phase I Metabolism of drug: Oxidative reactions, reductive reactions and hydrolytic reactions.

Phase II Metabolism of drug: Conjugation with glucuronic acid, sulfate moieties, alpha amino acids, glutathione; Acetylation and methylation. Bioactivation and tissue toxicity.

Drug elimination-Renal and non renal, Rate, rate constants and orders of reactions; Zero order, First order and mixed order kinetics; Pharmacokinetic models: compartment model, non-compartment model and physiologic model. **12 Hours**

UNIT – III

DOSAGE FORMS AND ITS MANUFACTURE

Routes of administration, solid dosage forms vs liquid dosage forms,tablets, compressed tablets, tablet granulation, capsule hard and soft pills. Classification of ointment bases and its manufacture, herbal extracts, oral liquids, injectables, implants, Ointments.

Coating process and types, (conceptual only).

Capsule: types, formulation and capsule production. Difference between hard gelatin and soft gelatin capsules. **8 Hours**

UNIT – IV

BIOAVAILABILITY AND BIOEQUIVALENCE

Considerations *in vivo* bioavailability study design, measurement of bioavailability, *invitro*drug dissolution testing models, dissolution acceptance criteria and *invitro-invivo* correlation (IV-IVC).Bioavailability-absolute versus relative, single dose versus multiple dose studies.

Bioequivalence studies: Types of bioequivalence studies, bioequivalence study protocol.
Methods for enhancement of bioavailability: Drug permeability across biomembrane, enhancement through drug stability, gastrointestinal retention. Bioefficacy and Polymorphic drugs. **6 Hours**

UNIT – V

DRUG DELIVERY SYSTEM

Tissue permeability of drugs, Blood-Brain Barrier, factors in the design of controlled release drug delivery systems, Pharmacokinetic principles in the design of controlled-release drug delivery systems.
Design of controlled drug delivery systems: oral controlled release systems, ocular controlled release systems parenteral controlled release systems, intranasal controlled release systems, transdermal drug delivery systems, ophthalmic drug delivery systems, pulmonary controlled release systems, Intravaginal and intrauterine controlled release systems, nanoformulations. Bioavailabilty testing of controlled-release formulations. **6 Hours**

Course Outcomes:

At the end of this course, student will be able to
1. Relate to the basic organization of the work units in a pharmaceutical company.
2. Explain the significance of pharmaco-kinetic models and pharmaco-dynamic principles.
3. Describe various dosage forms and manufacturing process
4. Appraise the concept of bioavailability, bioequivalence and its significance.
5. Assess the significance and make use of drug delivery system as one of the dosage form.

Mapping of POs & COs:

	PO												PSO		
CO	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1									L		L	L			L
CO2		L				L								M	L
CO3		M				L			L						L
CO4		L				L								L	L
CO5		M				L									L

TEXT BOOKS:

1. Walsh, G. *Biopharmaceuticals Biochemistry and Biotechnology*, Wiley Pub. 2003.
2. Katzung, B. G. *Basic & Clinical Pharmacology*, 9th Ed. MGH, 2004.

REFERENCE BOOKS:

1. Brahmankar, D. M. and Jaiswal, S. B. *Biopharmaceutics and Pharmacokinetics*, VallabhPrakashan, 2012.
2. Lachman, L., Lieberman, H. A. and Kanig, J. L. *The Theory & Practice of Industrial Pharmacy*, 3rd Ed., Vergese Publishing House Bombay, 1987.
3. Singh, P. P. &Rangnekar, D. W. *Introduction to Synthetic Drugs*, Himalaya publishing House, 1980.

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PROCESS EQUIPMENT DESIGN

Sub Code	**: 15BT614**	**Credits**	**: 03**
Hrs/Week	**: 3+0+0+0**	**Total Hours**	**: 39**

***Prerequisites*:** Unit Operations, Heat & Mass Transfer, Reaction Engineering
***Corequisites*:** Nil

Course Learning Objectives:

The objective of this course is

1. To know the requirements, general process and thumb rules of process design.
2. To design various bioprocess equipments with process design as major aspect and mechanical design as minor aspect.

UNIT – I

BASIC CONCEPTS

Material of construction: Classification, properties, corrosion, design considerations. Joints: welding, threading, flanges – basic concepts. Various types of piping, their usage and P&I diagram. Codes and standards for process equipment design, general guidelines, factor of safety. Design information and data: source and accuracy of data, use of data handbook, physical properties of pure fluids and mixtures: density, viscosity, specific heat, thermal conductivity, allowable stresses. **7 Hours**

UNIT – II

DESIGN OF PROCESS EQUIPMENTS

Detailed Process design of the following:

a) **Fermenter** – L/D and volume calculation, sparger design (calculation of aeration rate), thickness for internal and external pressures, heads design, jacket design, agitator design, flange design. **9 Hours**

b) **Shell and Tube heat exchanger**: Heat transfer rate calculations, LMTD, no. of tubes, tube layout, heat transfer coefficient, pressure drop calculation. [Fixed tube as per TEMA standards] **8 Hours**

c) **Rotary dryer**: mass balance, shell diameter, enthalpy balance, NTU, air flow rate, length and thickness of dryer, thickness of insulation (*Ref: NPTL*). **7 Hours**

d) **Batch Extractor** (Packed bed): Counter current operation, calculation of number of stages (graphical), height of packing, flooding calculation. **8 Hours**

All designs shall be in conformity with IS codes. Use of following books is permitted in the examination.

a) Code for Unfired Pressure Vessel - IS2825
b) Code for Shell & Tube heat exchangers - IS4503
c) Chemical Engineer's Handbook by Perry, 6^{th}& 7^{th} Edition.

Question paper pattern:
Since the design problems are long and time consuming only two questions are to be framed
Unit 1: 2 questions of 20 marks each shall be asked of which 1 has to be answered.
Unit 2: 2 design problems of 80 marks each shall be asked of which 1 has to be answered.

Course Outcomes:
At the end of this course, student will be able to

1. Know the design requirements of a process vessel and piping for the flow of process fluids.
2. Design bioprocess equipment: fermenter
3. Design bioprocess equipment: heat exchanger
4. Design bioprocess equipment: dryer.
5. Design bioprocess equipment: extractor.

Mapping of POs & COs:

	PO												PSO		
CO	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		L						L			L	M			M
CO2		M	H			L	M					L			H
CO3		M	H			L	M					L			H
CO4		M	H			L	M					L			H
CO5		M	H			L	M					L			H

TEXT BOOK:

1. Sinnott, R. K. *Coulson, R. Chemical Engineering: Chemical Engineering Design*, Vol. 6, 3rd Ed., Butterworth Heinemann, 1999.

REFERENCE BOOKS:

1. Dawande, S.D., *Process equipment Design*, Vol 1 & 2., 5th Ed., Denett& Company, 2007.
2. Joshi, M. V., Mahajani, V. V. *Process Equipment Design*, 3rd Ed., Macmillan India, 1994.
3. Perry R. H. and Green, D. *Chemical Engineers Hand Book*, 7th& 8th Ed., MGH, 2007.
4. *Code for Unfired Pressure Vessel* - BIS 2825, Indian Standards Institution, New Delhi, 1969.
5. *Code for Shell & Tube heat exchangers* - BIS 4503, Indian Standards Institution, New Delhi, 1969.
6. NPTEL Lecture series/Chemical Engineering/Process Equipment Design II (http://nptel.ac.in).
7. Stanbury, P. F. and Whitaker, A. Principles of Fermentation Technology, 3rd Ed. Elsevier, 2016.

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BIOMEDICAL INSTRUMENTATION

Sub Code : 15BT615 **Credits : 03**
Hrs/Week : 3+0+0+0 **Total Hours : 39**

***Prerequisites*:** Nil
***Corequisites*:** Nil

Course Learning Objectives:

The objective of this course is

1. To learn the functions of instrumentation system, its static and dynamic characteristics.
2. To understand different types of transducers.
3. To learn the analytical instruments used for measurement of different parameters of cardiovascular system and respiratory system.
4. To understand principles and constructional aspects of biosensors, its commercialization and applications.

UNIT – I

INTRODUCTION

Electrical quantities and units; functional elements of an instrumentation system; static and dynamic characteristics; principles of analog and digital meters; CRO, energy meters, multimeters. Transducers: Classification, resistive strain gauges, RTD, LVDT, Piezoelectric transducers, electromagnetic transducers, optical transducers, transducers for biomedical applications. **7 Hours**

UNIT – II

BIOMEDICAL INSTRUMENTS

The terminology of medical instrumentation, a review of medical and physiological signals, principles of EEG, ECG and EMG, PC based Instrumentation, microcontroller based instrumentation. pH meters, radiometric devices, fluorescence spectrophotometer; lab on a chip - instrumentation, validation, commissioning and maintenance. **8 Hours**

UNIT – III

CARDIOVASCULAR SYSTEM

Overview of cardiovascular system, types of blood pressure sensors, lumped parameter modeling of a catheter-sensor system, heart sounds, cardiac catheterization, indirect measurement of blood pressure, measuring blood flow rate, measuring blood volume, pacemakers, defibrillators, cardiac-assist devices, replacement heart valves – related instrumentation of equipments involved and sensors. **8 Hours**

UNIT – IV

RESPIRATORY SYSTEM

Modeling the respiratory system, measuring gas flow rate, measuring lung volume, tests of respiratory mechanics, measuring gas concentration, tests of gas transport, ventilators, anesthesia machines, heart-lung machine – instrumentation of equipments involved and sensors. **8 Hours**

UNIT – V

BIOSENSORS

Introduction to biosensors: concepts and applications. Biosensors for personal diabetes management. Microfabricated sensors and the commercial development of biosensors. Electrochemical sensors, chemical fibrosensors, Ion-selective FETs, noninvasive blood-gas monitoring, blood-glucose sensors. Noninvasive biosensors in clinical analysis. Applications of biosensor-based instruments to the biomedical sector. BIAcore- an optical biosensor.

8 Hours

Course Outcomes:

At the end of this course, student will be able to

1. Relate fundamental electronic components and their functioning.
2. Explain transducers and their applications.
3. Elaborate the fundamental biomedical devices used in routine medical analysis.
4. Appraise various devices used for measurement of cardiovascular system and respiratory system parameters.
5. Know the working of different types of biosensors and make use in biomedical analysis.

Mapping of POs &COs:

	PO												PSO		
CO	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	M								L				L		
CO2	L	L							L				L		L
CO3					L				L			L	L		
CO4	L				L				L			L	L		
CO5		M			L				L			L	L		L

TEXT BOOKS:

1. Eggins, B. R. *Biosensors – An introduction*, Wiley –Blackwell, 1997.
2. Khandpur, R. S. *Hand book of Biomedical Instrumentation*, 3rd Ed., MGH, 2014.

REFERENCE BOOKS:

1. Strimaitis, J. R. and Little, J. N. (Ed.), *Advances in Laboratory Automation-Robotics*, Zymark Corporation, Hopkinton, MA 1991.
2. Yang Victor, C. Y. and Ngo That, T. N. *Biosensors and their applications - Automation technologies for genome characterization*, John Wiley & Sons, Inc., 2000.
3. Murthy D.V.S., *Transducers and Instrumentation*,2nd Ed., PHI Learning, 2008.
4. Devlin, J. P. (Ed.), *High Throughput Screening: The Discovery of Bioactive Substances*, CRC Press, 1997.
5. Ramsay, G. *Commercial Biosensors*, John Wiley & Son Inc. 1998.
6. Cunningham, A. J. *Introduction to Bioanalytical sensors*, John Wiley, 1998.

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FOOD & BEVERAGES TECHNOLOGY

Sub Code : 15BT622 **Credits : 03**
Hrs/Week : 3+0+0+0 **Total Hours : 39**

Prerequisites: Unit operations, Microbiology, Heat & Mass Transfer
Corequisites: Nil

Course Learning Objectives:

The objective of this course is

1. To understand the science underpinning food fermentations, food preservation, technology of fermented beverages and fermented food products and food sanitation.

UNIT – I

FOOD INDUSTRY & REGULATORY BODIES

Food and beverages production & processing in India and abroad, challenges faced by food industries, initiatives by Govt. of India. Food: food properties, nutritional aspects, loss of nutrients and properties during processing. Food additives: types and necessity, E numbers. Food regulations: Codex Alimentarius, The Food Safety and Standards Act-2006, FSSAI Regulations, FDA - regulations. 7 **Hours**

UNIT – II

FOOD PRESERVATION

Preservation by moist Heat: Heat resistance of microorganisms and spores, decimal reduction time (D values), 12D concept, thermal death time curves, unit of lethality, determination of process lethality requirements, effective F values, sterilization methods (blanching & pasteurization), effect on food quality, numericals.

Preservation by low temperature: the behavior of microorganisms under freezing and refrigeration environment, growth and lethal effects of low temperature treatments on microorganisms in raw and processed foods, equipments (cold air, cryogenic), effect on food quality. Preservation by drying, chemicals (preservatives) and ionizing irradiation, pulsed electric field (PEF) method. **9 Hours**

UNIT – III

TECHNOLOGY OF FERMENTED FOOD PRODUCTS

Vinegar making processes and chemical synthesis of vinegar, production of cheese, processed cheese, yoghurt, shrikhand, rabadi, bread making, dhokla; Meat fermentation, Soy sauce, Miso, Natto processes; Vegetable fermented products, Cocoa. **8 Hours**

UNIT - IV

TECHNOLOGY OF FERMENTED BEVERAGES

Production fermented products: Beer- overview of malting and brewing; Mashing- the production of sweet wort–milling, mashing, wort boiling & clarification-wort separation, brewery fermentations, stabilization of beer-hops.

Production of wine: Grape processing, fermentation processes, unit operation in the production of wine-ageing, milling, pressing, fermentation and post-fermentation processes of cider.

Distilled alcoholic beverages –whiskey, cognac and rum;

Flavoured spirits -vodka, gin, liqueurs.Sake brewing-polishing, steeping and steaming.

9 Hours

UNIT – V

FOOD SANITATION

Principles of food sanitation, methods of food sanitation, sanitizers in the food industry, indicator organism: coli form. Hazard Analysis and Critical Control Point (HACCP) – Principles and steps, Pre-Requisite Program (PRP), Good manufacturing Practices (GMP's) and criteria for purity, microbiological standards. Case studies on HACCP, PRP & GMP from food industry perspective (FDA e-resource). **6 Hours**

Course Outcomes:

At the end of this course, student will be able to

1. Outline the challenges faced by food & beverages industry and criteria followed by regulatory bodies.
2. Apply suitable preservation technique for food & beverages.
3. Summarize the process for production of fermented foods.
4. Outline and explain the detailed process for production of fermented beverages.
5. Recall the sanitation procedures and good manufacturing processes required in food process operations and adapt suitable protocols.

Mapping of POs & COs:

	PO												PSO		
CO	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		L		L		L						L		M	L
CO2		L		L			L							M	L
CO3		L		L	L	L	L							M	L
CO4		L		L	M		L							M	M
CO5		L		L	L	L	L					L		M	L

TEXT BOOKS:

1. Bamforth, C. W. *Food, fermentation and microorganisms*, Blackwell Publishing, 2005.
2. Frazier, W. C. and Westhoff, D. C. *Food Microbiology*, 4th Ed., Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1995.

REFERENCE BOOKS:

1. Paul Singh. R. P, *Introduction to Food Engineering*, Academic Press, 3rd Ed., 2004.
2. Fellows, P. *Food Processing Technology: Principles and practice*, Woodhead Publishing Ltd., Cambridge, 2nd Ed., 2005.
3. Sivasankar, B. *Food processing and Preservation*, Prentice Hall of India, New Delhi, 2002.
4. FDA, HACCP Principles & Application Guidelines (http://www.fda.gov/Food/GuidanceRegulation /HACCP/ucm2006801.htm).

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INDUSTRIAL BIOTECHNOLOGY

Sub Code : 15BT623 **Credits : 03**
Hrs/Week : 3+0+0+0 **Total Hours : 39**

***Prerequisites*:** Microbiology
***Corequisites*:** Upstream Processing Technology, Downstream Processing Technology

Course Learning Objectives:

The objective of this course is
1. To learn the industrial aspects such as product development from lab scale level, treatment of industrial wastes.
2. To learn various production strategies and bioprocess industries through case studies.

UNIT – I

INDRODUCTION
Traditional and modern biotechnology, Types and stages of fermentation process. Design of media and media requirements, Isolation, preservation and improvement of industrially important microorganisms, Metabolic basis for product formation. Economics of fermentation processes. **6 Hours**

UNIT – II

PRODUCTION OF PRIMARY METABOLITES
A brief outline of processes for the production of some commercially important organic acids (e.g. citric acid, lactic acid and acetic acid), amino acids (Glutamic acid and Lysine),Case study on bioprocesses for the manufacture of amino acids. Production of Ethanol and beverages. **8 Hours**

UNIT – III

PRODUCTION OF SECONDARY METABOLITES
Study of production processes for various classes of secondary metabolites: antibiotics: beta-lactams (penicillin), aminoglycosides (streptomycin etc.) macrolides (erythromycin), Steroids. Case study on biotechnological production of the antibiotic Cephalexin.
9 Hours

UNIT – IV

PRODUCTION OF ENZYMES AND OTHER BIOPRODUCTS Production of industrial enzymes such as protease, amylase, and lipase. Production of biopesticides, biofertilisers, biopreservatives (Nisin), cheese, biopolymers (Xanthan gum, PHB), single cell protein.
8 Hours

UNIT – V

PRODUCTION OF MODERN BIOTECHNOLOGY PRODUCTS Production of recombinant proteins having therapeutic and diagnostic applications-Human Growth

hormone, Erythropoietin, and peroxidase. Production of vaccines.Production of Interferon-α.Biotechnological inputs in producing good quality natural fibers (cotton, wool and silk).

8 Hours

Course Outcomes:

At the end of this course, student will be able to

1. Understand the basic needs of Industrial Biotechnology
2. Choose suitable cultivation techniques and cell systems for the production of primary metabolites.
3. Adapt suitable cultivation techniques and cell systems for the production of secondary metabolites.
4. Design metabolism based control strategies for the production of commercial bioproducts.
5. Appraise on production of modern biotechnology products.

Mapping of POs & COs:

	PO												PSO		
CO	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		M					L				L				L
CO2		M					L					L			M
CO3		M					L					L			M
CO4		M					L								M
CO5		H					L				L	L			H

TEXT BOOKS:

1. Brock, T. D. *Biotechnology: A Text Book of Industrial Microbiology*, Smaeur Associates, 1990.
2. Casida, L. E. *Industrial Microbiology*, Willey Eastern Ltd., 1989.

REFERENCE BOOKS:

1. Prescott, S. C. & Dunn, C. G. *Industrial Microbiology*, CBS Publishers, 1987.
2. Young, M. Y. *Comprehensive Biotechnology*, Vol. 1- 4, (Eds.), Pergamon Press, 2006.
3. Crueger, W. and Crueger, A. *Biotechnology - A hand book of industrial microbiology*, Sinauer publications, 1990.
4. Glazer, N. and Nikaido, H. *Microbial Biotechnology*, 2nd Ed., Cambridge University Press, 2007.
5. Peppler, H. J. and Perlman, D. *Microbial Technology-Microbial processes*, Vol 1, 2nd Ed., Academic press, 2001.

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CLINICAL STUDIES AND DATA MANAGEMENT

Sub Code : 15BT624 **Credits :03**
Hrs/Week : 3+0+0+0 **Total Hours :39**

***Prerequisites*:** Biostatistics
***Corequisites* :** Nil

Course Learning Objectives:
The objective of this course is
1. To provide information regarding coordinating and managing day to day activities of a clinical research study.
2. To understand drug design, development and its evaluation.
3. To identify, describe, evaluate and use of sources of data commonly used in the field of clinical research.

UNIT – I

DRUG DISCOVERY

History of drug discovery process, source of drugs, Disease target identification and selection. Receptor based approaches, agonists, antagonists, enzyme inhibitors, personalized medicine. Lead optimization. New drug registration process. **8 Hours**

UNIT- II

CLINICAL PHARMACOLOGY

Pharmacological background for drug evaluation.Safety testing – acute and chronic toxicology, genotoxicology, reproductive toxicology, Immunotoxicology, Carcinogenicity. Alternate methods of assessing toxicity – in-vitro models, cell lines, their use and limitations.Pharmacokinetics, Pharmacodynamics, Bioavailability and Bioequivalence. Dose ranging studies, Pharmacovigilance- current methods in pharmacovigilance- medication errors, Risk assessments. Adverse drug reactions. **9 Hours**

UNIT – III

CLINICAL TRIALS

History of clinical trials, Essential documents in a clinical trial, Design decisions, Randomization and Blinding, Clinical trial study design – epidemiological study design, Prevalence surveys or cross-sectional studies. Phases of clinical trials (I, II, III, IV and V), Design for cancer clinical trials, selection of human volunteers (healthy & patients), Case reports. Managements of clinical trials. Clinical Research Organization (CRO)

12 Hours

UNIT – IV

CLINICAL DATA MANAGEMENT

Principles of clinical data management, Data preparation and analysis, Data entry, Queries and Data clarification, Secondary data sources, Survey data collection methods, Software in clinical data management. **5 Hours**

UNIT – V

GUIDELINES FOR GOOD CLINICAL PRACTICE (GCP) AND REGULATORY AFFAIRS

Introduction to GCP, Role of Investigator, Sponsor for clinical trials, Clinical trial protocols, and Protocol amendments, Investigation Brochure. History of clinical regulations, Regulatory environment in India – CDCSO, DCGE, ICM. Regulatory Environment in US – FDA, Regulatory environment in Europe – EMEA. **5 Hours**

Course Outcomes:

At the end of this course, student will be able to

1. Recall the history and process in drug discovery with respect to specific drug types.
2. Understand drug design, development and its evaluation through various stages of pre-clinical steps.
3. Demonstrate the process of drug design, development and its evaluation through various stages of clinical trials
4. Describe the processes involved in clinical data management and practices referring to the regulatory mechanisms involved.
5. Appraise the guidelines for GCP and Drug regulatory affairs.

Mapping of POs & COs:

	PO												PSO		
CO	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		L									L			L	
CO2		L							L					L	
CO3		M	L						L						M
CO4		L						L				L		M	
CO5		L						L				L		L	

REFERENCE BOOKS:

1. Walsh, G. *Biochemistry and Biotechnology*, John Wiley & Sons Ltd., 2002.
2. Gallin, J. I. and Ognibene, F. P. *Principles and Practice of Clinical Research*, 2nd Edition, Elsevier Publication, 2007
3. Marshak, D. R. *Stem Cell Biology*, Cold Spring Harbor Symposium Publication, 2001.
4. Kayser, O. and Warzecha, H. *Pharmaceutical Biotechnology: Drug Discovery and Clinical Applications*. Wiley publications. 2012.

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MICRO ARRAY TECHNOLOGY

Sub Code : 15BT625 **Credits : 03**
Hrs/Week : 3+0+0+0 **Total Hours : 39**

***Prerequisites*:** Biochemistry, Genetic Engineering
***Corequisites* :** Nil

Course Learning Objectives:

The objective of this course is
1. To introduce the students to the fundamental concepts of measuring expression levels of genes blended with computer chips.
2. To appreciate the parallel system analysis of hundreds or thousands of molecules at a time.
3. To gain knowledge on identification of molecular signatures of diseases/ abnormalities/ infectious agents and developing clinical diagnostic tools, vaccines and novel therapeutic agents.

UNIT – I

INTRODUCTION

Basics of Biochips and Microarray Technology, Historical Development. DNA Microarrays, Oligonucleotide, cDNA and genomic microarrays, Chromosome on a chip, Tissue chip, RNA chip, Protein chip technology, Glycochips, **8 Hours**

UNIT – II

BIOCHIP AND MICROARRAY CONSTRUCTION

DNA Microarrays, Oligonucleotide, cDNA and genomic microarrays, Microchip production technologies, Megaclone technology for fluid microarrays, Microarray labels, Microarray scanners/headers, Microarray robotics, Microfluidics systems, Chromosome on a chip, Tissue chip, RNA chip, Protein chip technology, Glycochips, immunoarray, Microarray and Biosensor technology, Biochip versus gel-based methods, Standardization of microarray analysis, Electrical detection methods for microarrays, Importance of SERS (Surface enhanced Raman Spectroscopy) based microarrays. **9 Hours**

UNIT – III

APPLICATIONS OF BIOCHIP TECHNOLOGY I

Molecular diagnosis, Pharmacogenomics, Microarray technology in drug discovery & development, Gene expression studies, Drug delivery. Biochips in healthcare, population genetics & epidemiology. **7 Hours**

UNIT – IV

APPLICATIONS OF BIOCHIP TECHNOLOGY II

Microarrays in forensics, DNA chip technology for water quality management, Bioagent chip. Microarrays in agroindustry, genetic disease monitoring, Limitations of biochip technology.
8 Hours

UNIT – V

COMMERCIAL ASPECTS OF BIOCHIP TECHNOLOGY AND DNA COMPUTING
Markets for Biochip technologies, Commercial support for the development of Biochips, Government support and Business strategies, Patent issues. DNA computing and Future trends. **7 Hours**

Course Outcomes:

At the end of this course, student will be able to
1. Know the fundamental aspects of biochips and microarray.
2. Illustrate the constructional aspects of biochips and microarray.
3. Apply the knowledge of microarray technology in the fields of health and pharmaceutical sector.
4. Apply the knowledge of microarray technology in the fields of agriculture and forensics.
5. Evaluate the markets and supports for biochips and microarray industry

Mapping of POs & COs:

	PO												PSO		
CO	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		L												L	
CO2		L												L	
CO3		L	M			M	L				L	L		M	
CO4		L	M			M	L				L	L		M	
CO5		L					M				L	L			L

REFERENCE BOOKS:
1. *Biochips and Microarrays - Technology and Commercial Potential*,Informa Global Pharmaceuticals and Health Care, 2000.
2. Grigorenko, E.V (Ed.), *DNA Arrays: Technology and Experimental Strategies*, CRC Press, 2002.
3. Schena, M. *Microarray Analysis*, J. Wiley & Sons, 2002.

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BIOPROCESS CONTROL AND INSTRUMENTATION LAB

Sub Code	**: 15BT604**	**Credits**	**: 02**
Hrs/Week	**: 0+0+3+0**	**Total Hours**	**: 39**

***Prerequisites*:** Analytical Techniques
***Corequisites* :** Bioprocess Dynamics and Control

Course Learning Objectives:

The objective of this course is

1. To learn various sensors, and their control using computer that are industrially important.
2. To learn the use of instrumentation system like UV Vis, AAS, HPLC and GC for specific analysis.

EXPERIMENTS

1. Separation, identification and analysis of components from beverages and pharmaceutical drugs using HPLC.
2. Separation, identification and analysis of volatile components using Gas Chromatography (GC).
3. Analysis of sewage samples containing metal ions by using atomic absorption spectrophotometer (AAS).
4. Determinations of molar extinction coefficient and analysis of complex systems using UV-VIS Spectrometer.
5. Characteristics of Transducers
    a. Temperature: RTD, Thermocouple
    b. Pressure
    c. Flow: Wheel flow meter
6. Dynamics of First order system for step/pulse input.
7. Dynamics of Non-interacting tank system.
8. Dynamics of Interacting tank System.
9. Automated Process Controllers
    a. Pressure process controller
    b. Level process controller
    c. Flow process controller
    d. Temperature process controller
10. Determination of dissolved oxygen

Course Outcomes:

At the end of this course, student will be able to

1. Apply the knowledge of appropriate analytical techniques to process and analyze samples using UV –Visible spectrometer, HPLC, GC and AAS.
2. Perform experiments to characterize the transducers.
3. Determine the dynamic behavior of processes and operate the automated control systems.

Mapping of POs & COs:

	PO												PSO		
CO	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		M	M	M	H					L		M		H	L
CO2		L	M	M						L		L			H
CO3		L	M	M						L		L			H

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UPSTREAM PROCESSING LAB

Sub Code : 15BT605 **Credits : 02**
Hrs/Week : 0+0+3+0 **Total Hours : 39**

***Prerequisites*:** Microbiology Lab
***Corequisites* :** Upstream Processing Technology

Course Learning Objectives:
The objective of this course is

1. To have practical knowledge on various techniques and tools of tissue culture, cell culture, inoculum preparations and fermentation preparation.

EXPERIMENTS

Part A: Microbial culture

1. Preparation of media
2. Inoculum preparation
3. Screening of variables for the production of commercial product
4. Effect of Temperature, pH & carbon sources on growth kinetics
5. Thermal death kinetics
6. Production of amylase from microbial source
7. Demonstration of fermenter operation (aerobic)
8. Induction of invertase enzyme in packed bed reactor using immobilized yeasts.

Part B: Plant cell culture

9. Preparation of plant cell culture media
10. Callus induction techniques
11. Development of suspension culture from callus
12. Production and estimation of secondary metabolite
13. Estimation of radical scavenging activity of biomolecules.
14. Artificial seed production

Course Outcomes:
At the end of this course, student will be able to

1. Acquire experimental skills in culturing plant, microbial and animal cells.
2. Apply the knowledge of inoculum development, thermal death kinetics and optimization of media and bioprocess.

Mapping of POs & COs:

	PO												PSO		
CO	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		M		M	L	L	L					M		H	L
CO2		M	M	M		L	L					M		M	M

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DOWNSTREAM PROCESSING LAB

Sub Code : 15BT606 **Credits : 02**
Hrs/Week : 0+0+3+0 **Total Hours : 39**

***Prerequisites*:** Unit Operations
***Corequisites* :** Downstream Processing Technology, Upstream Processing Lab

Course Learning Objectives:

The objective of this course is

1. To have a practical know how on product recovery aspects from fermentation broth.
2. To learn various unit operations involved in processing and recovery of product.

EXPERIMENTS

1. Cell disruption techniques (homogenization, chemical).
2. Solid-liquid separation methods: Filtration.
3. Solid-liquid separation methods: Centrifugation.
4. Product enrichment operations: Precipitation – $(NH_4)_2SO_4$ fractionation of a protein.
5. Product enrichment operations: Aqueous two – phase extraction.
6. Product drying techniques: Hot air, freeze drying.
7. Separation of Amino acids, Carbohydrates and Lipids by TLC.
8. Characterization of protein by dot blot.
9. Recovery and Estimation of ethanol from fermentation broth.
10. Recovery and Estimation of Citric acid from fermentation broth.

Course Outcomes:

At the end of this course, student will be able to

1. Relate various Unit operations involved in product recovery and apply downstream processing strategy for the recovery and purification of product from fermentation broth.
2. Design and apply downstream process procedure for a given product.
3. Estimate quantitatively the recovered product.

Mapping of POs & COs:

	PO												PSO		
CO	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		L	M	M						L		M			H
CO2		M	H	M						L		M			H
CO3		L		M						L		M			H

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EMPLOYABILITY SKILL DEVELOPMENT

Sub Code : 15IL001/002 **Credits : Nil (MLC)**
Hrs/Week : 1+0+0+0 **Total Hours : 12**

UNIT - I

Analytical Aptitude Skill: concept of analytical skill, definition-logical thinking and testing of Analytical Aptitude

UNIT - II

Quantitative Aptitude skill-Concept-definition-Preliminary requirement for development of quantitative skill- testing of quantitative skill.

UNIT - III

Verbal and ability skill – Knowledge and Vocabulary and grammer-comprehension-Verbal Reasoning skill

REFERENCE BOOKS:

1. Aggarwal R.S "Modern Approach to Logical Reasoning" S. Chand Publication, 2008.
2. Aggarwal R.S "Quantitative Aptitude" S. Chand Publication, 2014.
3. Aggarwal R.S "Modern Approach to verbal and non verbal reasoning" S. Chand Publication, 2013.
4. Arun Sharma "Verbal ability and reading comprehension CAT" TMH Publications, 2014.
5. Ethnus Consultancy Pvt. Ltd " APTIMTRA: Your friend for cracking aptitude test", MGH Publications, 2014.
6. Aggarwal R.S "Advanced objective general knowledge" S. Chand Publication, 2014.

Examination pattern:

This course is a mandatory learning course without credit. Continuous internal examination (CIE) consists of 2 internal exams (20 marks each) and tasks (10 marks). There is no semester end examination (SEE). The student will be awarded PP or NP grade as per autonomous regulations.

Course Outcomes:

At the end of this course, student will be able to

1. Develop analytical and aptitude skills to prepare herself for placements.
2. Solve quantitative problems for placements and appreciate the techniques involved.
3. Inculcate grammatic and verbal skills to prepare herself for placements.

Mapping of POs & COs:

	PO												PSO		
CO	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	L											L		L	
CO2	L											L		L	
CO3										H		L		L	

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