ANNA UNIVERSITY, CHENNAI

UNIVERSITY DEPARTMENTS

REGULATIONS – 2015

CHOICE BASED CREDIT SYSTEM

M. Tech. BIOTECHNOLOGY

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs) :

I. To prepare students to excel in research and to succeed in Biotechnology research or industry through the latest state-of-art post graduate education.

II. To provide students with solid fundamentals and strong foundation in statistical, scientific and engineering subjects required to create and innovate in the field of biotechnology.

III. To train students with good scientific and technical knowledge so as to comprehend, analyze, design, and create novel products and solutions for developing novel therapeutics and enzymes.

IV. To sensitize students about scientific temper and the necessity of not only professional ethics but also bioethics.

V. This course also enables the student to develop good communication skills not only in scientific field but also for the work place. The students are trained to be team workers, develop organization skills.

VI. The course has a multidisciplinary approach, and therefore the student is able to choose various options in Biotechnology, Pharmaceutical technology and Food Technology.

VII. To provide student with an academic environment, social responsibility and awareness of the environment.

VIII. Finally to develop excellence in leadership skills, respect for authority, loyalty and the life-long learning needed for a successful scientific and professional career.

PROGRAMME OUTCOMES (POs):

On successful completion of the programme,

1. Graduates will demonstrate good knowledge of Statistics, Science and Technology.
2. They will be able to demonstrate an able to independently perform experiments in areas of Bioprocess, Enzyme Technology, Genetic Engineering, Animal Biotechnology and Immunotechnology.
3. They will be able to design and conduct experiments, analyze and interpret data.
4. The graduates will be capable of demonstrating an ability to design an experiment, component or process as per needs and specifications.
5. The would have acquired the skills necessary to complete with the best in the country or globally.
6. The graduate will be adept at performing experiments in cutting edge areas of modern Biotechnology
7. The student is trained in both verbal and written communication in English.
8. Graduate will develop confidence for self education and ability for life-long learning.
9. Having undergone a one year project the student is capable of designing, performing and interpreting the results of their experiment without much supervision.
10. They will demonstrate the ability and requirements to sense the needs of the nation and their role in nation building.

Attested

DIRECTOR
Centre For Academic Courses
Anna University, Chennai-600 025.

Programme Educational Objectives	Programme Outcomes									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
I	✓	✓	✓	✓						
II	✓	✓								
III		✓	✓	✓		✓				✓
IV								✓	✓	✓
V							✓	✓		✓
VI	✓	✓	✓	✓					✓	
VII								✓		✓
VIII					✓	✓	✓	✓		✓

			PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
YEAR 1	SEM 1	Applied statistics for Biologists	✓	✓	✓ ✓	✓						
		Bioprocess Technology		✓	✓	✓						
		Computational Biology	✓		✓						✓	
		Entrepreneurship, IPR and Biosafety		✓		✓				✓		
		Elective – 1										
		Elective – 2										
		Elective – 3										
		Preparative and Analytical Techniques in Biotechnology	✓	✓	✓	✓		✓				
	SEM 2	Bioseparation Technology		✓	✓	✓						
		Advanced Genetic Engineering		✓	✓	✓					✓	
		Immunotechnology		✓	✓	✓					✓	
		Animal Biotechnology		✓		✓						
		Elective – 4										
		Elective – 5										
		Elective – 6										
		Microbial and Immunotechnology Lab	✓	✓	✓	✓		✓				
YEAR 2	SEM 3	Advanced Molecular Biology and Genetic Engineering Lab	✓	✓	✓	✓		✓				
		Advanced Bioprocess and Downstream Processing Lab	✓	✓	✓	✓		✓				
		Project work (Phase – I)		✓	✓	✓		✓				
	SEM 4	Project Work (Phase – II)		✓	✓	✓		✓			✓	✓

Attested

DIRECTOR
Centre For Academic Courses
Anna University, Chennai-600 025.

ANNA UNIVERSITY : CHENNAI – 600 025.

UNIVERSITY DEPARTMENTS

REGULATIONS – 2015

CHOICE BASED CREDIT SYSTEM

I – IV SEMESTERS CURRICULUM AND SYLLABUS

M. TECH. BIOTECHNOLOGY

SEMESTER – I

Sl.No	Course Code	Course Title	Category	Contact Periods	L	T	P	C
Theory								
1.	BT7101	Bioprocess Technology	PC	3	3	0	0	3
2.	BT7102	Entrepreneurship, IPR and Biosafety	PC	3	3	0	0	3
3.	BT7152	Applied Statistics for Biologists	FC	4	3	1	0	4
4.	BT7153	Computational Biology	PC	4	2	0	2	3
5.		Elective I	PE	3	3	0	0	3
6.		Elective II	PE	3	3	0	0	3
7.		Elective III	PE	3	3	0	0	3
Practicals								
8.	BT7161	Preparative and Analytical Techniques in Biotechnology	PC	6	0	0	6	3
			TOTAL	**29**	**20**	**1**	**8**	**25**

SEMESTER – II

Sl.No	Course Code	Course Title	Category	Contact Periods	L	T	P	C
Theory								
1.	BT7201	Animal Biotechnology	PC	3	3	0	0	3
2.	BT7202	Bioseparation Technology	PC	3	3	0	0	3
3.	BT7203	Immunotechnology	PC	3	3	0	0	3
4.	BT7151	Advanced Genetic Engineering	PC	3	3	0	0	3
5.		Elective IV	PE	3	3	0	0	3
6.		Elective V	PE	3	3	0	0	3
7.		Elective VI	PE	3	3	0	0	3
Practicals								
8.	BT7211	Microbial and Immunotechnology Lab	PC	6	0	0	6	3
			TOTAL	**27**	**21**	**0**	**6**	**24**

Attested

DIRECTOR
Centre For Academic Courses
Anna University, Chennai-600 025.

SEMESTER – III

Sl.No	Course Code	Course Title	Category	Contact Periods	L	T	P	C
Practicals								
1.	BT7311	Advanced Bioprocess and Downstream Processing Lab	PC	6	0	0	6	3
2.	BT7312	Advanced Molecular Biology and Genetic Engineering Lab	PC	6	0	0	6	3
3.	BT7313	Project Work Phase –I	EEC	12	0	0	12	6
			TOTAL	**24**	**0**	**0**	**24**	**12**

SEMESTER – IV

Sl.No	Course Code	Course Title	Category	Contact Periods	L	T	P	C
Practicals								
1.	BT7411	Project Work Phase –II	EEC	24	0	0	24	12
			TOTAL	**24**	**0**	**0**	**24**	**12**

TOTAL NO OF CREDITS : 73

Foundation Courses (FC)

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.		Applied Statistics for Biotechnologists	FC	4	3	1	0	4

Professional Core (PC)

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.		Bioprocess Technology	PC	3	3	0	0	3
2.		Computational Biology	PC	4	2	0	2	3
3.		Entrepreneurship, IPR and Biosafety	PC	3	3	0	0	3

Attested

DIRECTOR
Centre For Academic Courses
Anna University, Chennai-600 025.

4.		Bioseparation Technology	PC	3	3	0	0	3
5.		Advanced Genetic Engineering	PC	3	3	0	0	3
6.		Immunotechnology	PC	3	3	0	0	3
7.		Animal Biotechnology	PC	3	3	0	0	3
8.		Advanced Molecular Biology and Genetic Engineering Lab	PC	6	0	0	6	3
9.		Advanced Bioprocess and Downstream Processing Lab	PC	6	0	0	6	3

Professional Electives (PE)

S.No	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	BT7072	Advanced Technologies in Omics Sciences	PE	3	3	0	0	3
2.	BT7073	Advances in Molecular Pathogenesis	PE	3	3	0	0	3
3.	BT7002	Applicable Mathematics for Biotechnology	PE	4	3	1	0	4
4.	BT7074	Biocatalysts and Enzyme Technology	PE	3	3	0	0	3
5.	BT7004	Biofuels and Platform Chemicals	PE	3	3	0	0	3
6.	BT7005	Bioprocess Modelling and Simulation	PE	4	2	0	2	3
7.	BT7006	Bioreactor Engineering	PE	3	3	0	0	3
8.	BT7003	Bioethics	PE	3	3	0	0	3
9.	BT7075	Communication Skill development	PE	3	2	0	2	3
10.	BT7007	Computational Fluid Dynamics	PE	3	3	0	0	3
11.	BT7008	Computational Techniques in Bioprocess	PE	3	2	0	2	3
12.	BT7009	Computer Aided Learning of Structure and Function of Proteins	PE	4	2	0	2	3
13.	BT7010	Environmental Biotechnology	PE	3	3	0	0	3
14.	BT7011	Food Processing and Biotechnology	PE	3	3	0	0	3
15.	BT7071	Advanced Genomics and Proteomics	PE	3	3	0	0	3

DIRECTOR
Centre For Academic Courses
Anna University, Chennai-600 025.

16.	BT7076	Metabolic Process and Engineering	PE	3	3	0	0	3
17.	BT7077	Nanobiotechnology	PE	4	2	0	2	3
18.	BT7013	Pharmaceutical Biotechnology	PE	3	3	0	0	3
19.	BT7015	Plant Genetic Engineering and Biotechnology	PE	3	3	0	0	3
20.	BT7014	Plant Design and Practice Human	PE	3	3	0	0	3
21.	BT7078	Research and Research Methodology in Biotechnology	PE	3	3	0	0	3
22.	BT7016	Sensors and Instrumentation for Bioapplications	PE	4	2	0	2	3
23.	BT7079	Tissue Engineering and Regenerative Medicine	PE	3	3	0	0	3
24.	BT7017	Unix Operating System and Programming Language C++	PE	4	2	0	2	3

Employability Enhancement Courses (EEC)

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.		Project Phase - I	EEC	12	0	0	12	6
2.		Project Phase - II	EEC	24	0	0	24	12

Attested

DIRECTOR
Centre For Academic Courses
Anna University, Chennai-600 025.

BT7101 BIOPROCESS TECHNOLOGY L T P C
3 0 0 3

OBJECTIVE:

- Design of Bioreactors
- To model & design various fermentation processes

UNIT I BLACK BOX MODEL 9

Yield coefficients, black box stoichiometries, elemental balances, heat balance, degrees of reduction balances, systematic analysis of black box stoichiometries, identification of gross measurement errors.

UNIT II MODELING OF VARIOUS FERMENTATION PROCESSES 9

Principles of model building for biotechnological processes, unstructured models on the population level, structured models on the cellular level, morphologically structured model, genetically structured models, cybernetic model, modeling of recombinant systems.

UNIT III DESIGN OF FERMENTATION PROCESSES 9

Kinetics of substrate utilization, biomass growth and product formation, inhibition on cell growth and product formation. Design and operation of continuous cultures, chemostat in series, batch and fed batch cultures, total cell retention cultivation.

UNIT IV BIOREACTOR DESIGN & CONSTRUCTION 9

Basic design and construction of CSTR, bioreactor design of agitator/agitator motor, power consumption in aerated bioreactor, design of sparger, mixing time estimation, oxygen mass transfer capability in bioreactor, Removal of Heat in bioreactor, Main parameters to be monitored and controlled in fermentation processes.

UNIT V CASE STUDIES IN FERMENTATION DERIVED PRODUCTS 9

Case studies on Production of green chemicals, algal biofuels, recombinant Insulin. Case studies should deal with medium design, reactor design & process optimization etc.

TOTAL : 45 PERIODS

OUTCOME:

The student will be capable of developing a process for the synthesis of biomolecules by fermentation.

TEXTS BOOKS

1. Shuler, M.L. and Kargi, F. Bioprocess Engineering : Basic concepts, 2nd ed., Prentice-Hall, 2002.
2. Doran Pauline M, Bioprocess Engineering Principles, Academic Press, 1995
3. Nielsen, J. and Villadsen, J. “Bioreaction Engineering Principles”. Springer, 2007.
4. Blanch, H.W and Clark D.S., “Biochemical Engineering”, Marcel Dekker,1997

REFERENCES

1. Bailey, J.E. and Ollis, D.F. Biochemical Engineering Fundamentals", 2nd ed.,McGraw Hill 1986.
2. Stanbury, P.F., Stephen J. Hall & A. Whitaker, Principles of Fermentation Technology, Science & Technology Books.

BT7102 ENTREPRENEURSHIP, IPR AND BIOSAFETY L T P C
3 0 0 3

OBJECTIVE:
To prepare the students to consider Entrepreneurship as a career option and also a tool for Nation building.

UNIT I ENTREPRENEURSHIP 10
Definition, functions and kinds of entrepreneurs, intrapreneur-entrepreneurship and economic development, entrepreneurial competencies-traits, developing competencies, project identification, selection and financing. Project report- content and significance, Planning Commission's guidelines for formulating project reports-methods of project appraisals.

UNIT II INTRODUCTION TO INTELLECTUAL PROPERTY 10
Types of Intellectual property (IP): Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of GMOs IP as a factor in R&D; IPs of relevance to Biotechnology Agreements and Treaties History of GATT & TRIPS Agreement; Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty; PCT; Indian Patent Act 1970 & recent amendments Case Studies.

UNIT III BASICS OF PATENTS AND CONCEPT OF PRIOR ART 8
Introduction to Patents; Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; Specifications: Provisional and complete; Forms and fees Invention in context of "prior art"; Patent databases; Searching International Databases; Country-wise patent searches (USPTO,esp@cenet(EPO), PATENTScope(WIPO), IPO, etc.).

UNIT IV PATENTING PROCEDURES 7
National and PCT filing procedure; Time frame and cost; Status of the patent applications filed; Precautions while patenting – disclosure/non-disclosure; Financial assistance for patenting - introduction to existing schemes Patent licensing and agreement Patent infringement-meaning, scope, litigation, case studies

UNIT V BIOSAFETY 10
Introduction; Historical Backround; Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals; Biosafety guidelines - Government of India; Definition of GMOs and LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of National Regulations and relevant International Agreements including Cartegana Protocol

TOTAL : 45 PERIODS

OUTCOME:
Once the student has been introduced to not only entrepreneurship he or
- she will understand the importance of intellectual property and Its protection in the global world and its procedures and also become aware of biosafety issues either in one's own industry, or any industry he or she is employed in .

TEXTS/REFERENCES

1. BAREACT, Indian Patent Act 1970 Acts & Rules, Universal Law Publishing
2. Co. Pvt. Ltd., 2007
3. Kankanala C., Genetic Patent Law & Strategy, 1st Edition, Manupatra Information Solution Pvt. Ltd., 2007
4. S.S.Kanka Entrepreneurship Development, S.Chand and Co, New Delhi 1997

BT7152 APPLIED STATISTICS FOR BIOLOGISTS L T P C
3 1 0 4

OBJECTIVES

Studying this subject will help the students to understand the fundamentals of statistics for biologists and biotechnologists.

UNIT I PROBABILITY 12

Random variable-sample spaces-Events-Axiomatic approach to probability, conditional probability, additional theorem, Multiplication theorem, Baye's theorem. Problems solving for continuous and discrete random variables, Distribution function, Expectation with properties, Moments, Mean, Variance. Problems solving for continuous and discrete distributions.

UNIT II DISTRIBUTION 12

Bivariate distribution, Conditional and Marginal distribution. Discrete distribution, Binomial, Poisson, Geometric distribution, Continuous distribution. Normal Exponential and Negative Exponential. Gamma distributions, Properties and Problem solving.

UNIT III METHODS OF CORRELATION 12

Correlation coefficient, Properties, Problems. Rank correlation, Regression equations

Problems. Curve fitting by the method of least squares, fitting curves of the form $ax+b, ax^2+bx+c, ab^x$ and ax^b. Bivariate correlation application to biological problems.

UNIT IV SAMPLING 12

Concept of sampling, Methods of sampling, sampling distributions and Standard Error. Small samples and large samples. Test of hypothesis: Type I, Type II Errors. Critical region, Large sample tests for proportion, Mean-Exact test based on normal, t, f and chi-square distribution. Problems, Test of goodness of fit.

UNIT V DESIGN OF EXPERIMENTS 12

Basic principles of experimentation. Analysis of variance, one-way, Two-way classifications. Randomised block design, Latin square design. Problems solving.

TOTAL: 60 PERIODS

OUTCOME

On the completion of this course the students will have learnt and Understanding of applying statistical methods of analysis for Biological applications in research and how justify the statistical significance of the results in testing hypothesis

TEXT BOOKS

1. Kapoor, V. C. "Elements of Mathematical statistics".

2. Vittal, P.R. and V.Malini."Statistical and Numerical Methods". Margham Publications.
3. Veerarajan,T. "Probability, Statistics and Random Processes".3rd Edition., Tata Mc Graw-Hill, 2008.

REFERENCES

1. Johnson, R. A."Miller & Freund's Probability and Statistics for Engineers". 6th ed. PHI, 2003.
2. Arora, P. N. Smeet Arora, and Arora, S. "Comprehensive Statistical Methods". S. Chand & Co,
3. Spiegel, Murray R., J.Schiller and R.Alu Srinivasan."Schaum's Outlines Probability and Statistics".2nd Edition. Tata Mc Graw-Hill 2000.
4. Kandasamy, P. K. Thilagavathi & K. Gunavathi."Probability Statistics and Queuing Theory". S. Chand & Co., 2004

BT7153 COMPUTATIONAL BIOLOGY L T P C
2 0 2 3

OBJECTIVE:

The course introduces students to biological data, tools and analysis. PERL programming language is introduced to provide skills in generating user defined scripts.

UNIT I INTRODUCTION TO COMPUTATIONAL BIOLOGY AND SEQUENCE ANALYSIS 9

Molecular sequences, Genome sequencing: pipeline and data, Next generation sequencing data, Biological databases: Protein and Nucleotide databases, Sequence Alignment, Dynamic Programming for computing edit distance and string similarity, Local and Global Alignment, Needleman Wunsch Algorithm, Smith Waterman Algorithm, BLAST family of programs, FASTA algorithm, Functional Annotation, Progressive and Iterative Methods for Multiple sequence alignment, Applications.

UNIT II PHYLOGENETICS 7

Introduction to Phylogenetics, Distance and Character based methods for phylogenetic tree construction: UPGMA, Neighbour joining, Ultrametric and Min ultrametric trees, Parsimonous trees, Additive trees, Bootstrapping.

UNIT III PROTEIN STRUCTURE, MODELLING AND SIMULATIONS 9

Protein Structure Basics, Visualization, Prediction of Secondary Structure and Tertiary Structure, Homology Modeling, Structural Genomics, Molecular Docking principles and applications, Molecular dynamics simulations.

UNIT IV MACHINE LEARNING, SYSTEMS BIOLOGY AND OTHER ADVANCED TOPICS 11

Machine learning techniques: Artificial Neural Networks and Hidden Markov Models: Applications in Protein Secondary Structure Prediction and Gene Finding, Introduction to Systems Biology and its applications in whole cell modelling, Microarrays and Clustering techniques for microarray data analysis, informatics in Genomics and Proteomics, DNA computing.

UNIT V PERL FOR BIOINFORMATICS 9

Variables, Data types, control flow constructs, Pattern Matching, String manipulation,

arrays, lists and hashes, File handling, Programs to handle biological data and parse output files for interpretation

Laboratory Demonstrations for

Biological Databases, Sequence alignment: BLAST family of programs, FASTA, ClustalW for multiple sequence alignment, Phylogenetics software, Homology Modeling and Model evaluation, AutoDock, GROMACS, Prokaryotic and Eukaryotic Gene finding software, Programs in PERL.

TOTAL : 60 PERIODS

OUTCOME:

At the end of the course, the student will acquire skills required for analysis of biological data and preparation of results. The skills acquired will help in interdisciplinary research.

TEXT BOOKS

1. Dan Gusfield. Algorithms on Strings Trees and Sequences, Cambridge University Press.
2. David W. Mount Bioinformatics: Sequence and Genome Analysis, Cold Spring Harbor Laboratory Press, Second Edition, 2004.
3. Arthur M. Lesk, Introduction to Bioinformatics by Oxford University Press, 2008.
4. Tisdall, James, Beginning PERL for Bioinformatics, O'Reilley Publications, 2001.
5. Andrew R. Leach, Molecular Modeling Principles And Applications, Second Edition, Prentice Hall.

REFERENCES

1. Baldi, P., Brunak, S. Bioinformatics: The Machine Learning Approach, 2nd ed., East West Press, 2003
2. Baxevanis A.D. and Oullette, B.F.F. A Practical Guide to the Analysis of Genes and Proteins, 2nd ed., John Wiley, 2002
3. Durbin, R. Eddy S., Krogh A., Mitchison G. Biological Sequence Analysis: Probabilistic
4. Models of Proteins and Nucleic Acids. Cambridge University Press, 1998.
5. Proteomics from protein sequence to function: Edited by S.R.Pennington and M.J.Dunn, Taylor and Francis Group, 2001.

BT7161 PREPARATIVE AND ANALYTICAL TECHNIQUES IN BIOTECHNOLOGY

L T P C
0 0 6 3

OBJECTIVE

To prepare the student in all the latest preparative and analytical techniques required in research or Industry.

EXPERIMENTS

1. Preparation of Acetate, Tris and Phosphate Buffer. Validation of Henderson-Hasselbach equation.
2. Reactions of amino acids – Ninhydrin, Pthalaldehyde, Dansyl chloride – measurement using colorimetric and fluorimetric methods.
3. Differential estimations of carbohydrates – reducing vs non-reducing, polymeric vs

oligomeric, hexose vs pentose.
4.Estimation of protein concentration using Lowrys' method, Dye-binding method.
5.DNA determination by UV-Vis Spectrophotometer – hyperchromic effect. Separation of lipids by TLC.
6.Enzyme Kinetics: Direct and indirect assays – determination of Km, Vmax and Kcat, Kcat/ Km.
7.Restriction enzyme – Enrichment and unit calculation.
8.Ion-exchange Chromatagraphy – Purification of IgG and Albumin
9.Gel filtration – Size based separation of proteins
10.Affinity chromatography – IMAC purification of His-tagged recombinant protein
11.Assessing purity by SDS-PAGE Gel Electrophoresis
12.Chemical modification of proteins – PITC modification of IgG and Protein Immobilization

TOTAL : 90 PERIODS

OUTCOME
Having learned all the techniques in this lab, the student will become capable in enzymology, techniques required in the quantitation of biomolecules, downstream processing and the chemical modification of proteins, which will prepare him for a career in research or employment in the biotech Industry.

REFERENCES

1. Biochemical Methods: A Concise Guide for Students and Researchers, Alfred Pingoud, Claus Urbanke, Jim Hoggett, Albert Jeltsch, 2002 John Wiley & Sons Publishers, Inc,
2. Biochemical Calculations: How to Solve Mathematical Problems in General Biochemistry, 2nd Edition, Irwin H. Segel, 1976 John Wiley & Sons Publishers, Inc,
3. Principles and Techniques of Practical Biochemistry- Wilson, K. and Walker, J. Cambridge Press.

BT7201 ANIMAL BIOTECHNOLOGY L T P C
3 0 0 3

OBJECTIVE:
The student will be able to appreciate how recombinant animals can be used for the production of importance of proteins.

UNIT I INTRODUCTION 4
Scope of Animal Biotechnology, Animal Biotechnology for production of regulatory proteins, blood products, vaccines, hormones and other therapeutic proteins.

UNIT II MOLECULAR BIOLOGY 9
Biology of animal viral vectors- SV40, adeno virus, retrovirus, vaccinia virus, herpes virus, adeno associated virus and baculo virus.

UNIT III CELL CULTURE TECHNOLOGY 11
Culturing of cells, primary and secondary cell lines, Cell culture-Scaling up of animal cell culture-monolayer culture, suspension culture; Various bio-reactors used for animal cell culture-Roller bottle culture; Bioreactor process control, stirred animal cell culture, Air-lift fermentor, Chemostat/Turbidostat; High technology vaccines: Hybridoma technology; Cell lines and their applications

UNIT IV GENETIC ENGINEERING 11

Gene therapy-prospects and problems; Knock out mice and mice model for human genetic disorder; Baculo virus in biocontrol; Enzymes technology, Somatic manipulation of DNA, Nucleic acid hybridization and probes in diagnosis- preparation of probes, evaluation and applications.

UNIT V APPLICATIONS 10

Rumen manipulation- probiotics embryo transfer technology, invitro fertilization, transgenesis- methods of transferring genes into animal oocytes, eggs, embryos and specific tissues by physical, chemical and biological methods; Biopharming - Transgenic animals (Mice, Cows, Pigs, Sheep, Goat, Birds and Insects); Artificial insemination and embryo transfer.

TOTAL : 45 PERIODS

OUTCOME:

The strong genetic engineering background this course will enable the student in bioforming, transgenics and cell culture technology.

REFERENCES

1. Watson, J.D., Gilman, M., Witowski J.and Zoller, M. Recombinant DNA, 2nd ed., Scientific American Books, 1983
2. Glick, B.R. and Pasternack, J.J. Molecular Biotechnology, 3rd ed., ASM Press, 2003
3. Lewin, B. Genes VIII , Pearson Prentice Hall, 2004
4. Davis J.M. Basic Cell Culture: A Practical Approach, IRL Press, 1998
5. Freshney R.I. Animal Cell Culture- a practical approach, 1987

BT7202 BIOSEPARATION TECHNOLOGY L T P C

3 0 0 3

OBJECTIVE

To equip the students with all techniques required in the purification of proteins downstream processing of large biomolecules and also important antibiotics and immunoacids.

UNIT I INTRODUCTION TO BIOSEPARATION 4

Characterization of biomolecules and fermentation broth. Guidelines to recombinant protein purification.

UNIT II SOLID-LIQUID SEPARATION AND CELL DISRUPTION 6

Solid liquid separation- microfiltration and centrifugation – theory and design for scaleup operation. Cell disruption – Homogeniser , Dynomill – Principle and factors affecting disruption. Batch and Continuous Operation. Cell disruption by chemical methods.

UNIT III CONCENTRATION AND PURIFICATION 7

Liquid- liquid extraction – theory and practice with emphasis on Aqueous two phase extraction. Solid liquid extraction. Precipitation techniques using salt and solvent. Separation by ultrafiltration, Dialysis, Electrophoresis.

UNIT IV CHROMATOGRAPHY 15

Theory, practice and selection of media for – Gel filtration chromatography, Ion-exchange chromatography, Hydrophobic interaction chromatography, reverse-phase chromatography, Affinity chromatography – Metal affinity chromatography, Dye affinity chromatography, Immunosorbent Affinity chromatography and Expanded bed chromatography. Scale-up criteria for chromatography. Calculation of number of theoretical plates and design.

UNIT V FINAL POLISHING AND CASE STUDIES 13

Freeze drying, spray drying and crystallization. Purification of cephalosporin, aspartic acid,Recombinant Streptokinase, Monoclonal antibodies, Tissue plasminogen activator, Taq Polymerase and Insulin.

TOTAL : 45 PERIODS

OUTCOME:

The knowledge derive from this course will give the skill sets to the students for the research, chemical, pharmaceutical, biotech and Food Industry.

REFERENCES

1. Belter,P.A. et al., Bioseparations: Downstream Processing For Biotechnology, John-Wiley , 1988
2. Janson J.C, & Ryden L. Protein Purification: Principles, High Resolution Methods And Applications, VCH Pub. 1989.
3. Scopes R.K. – Protein Purification – Principles And Practice, Narosa , 1994.

BT7203 IMMUNOTECHNOLOGY L T P C
3 0 0 3

OBJECTIVE:

The students who would have learnt the science of immunology will now be able to apply the science for the development of relevant immunotechnology.

UNIT I INTRODUCTION 12

Cells of the immune system and their development; primary and secondary lymphoid organs; humoral immune response; cell mediated immune responses; complement.

UNIT II ANTIBODIES 10

Monoclonal antibodies and their use in diagnostics; ELISA; Agglutination tests; Antigen detection assay; Plaque Forming Cell Assay.

UNIT III CELLULAR IMMUNOLOGY 12

PBMC seperation from the blood; identification of lymphocytes based on CD markers; FACS; Lymphoproliferation assay; Mixed lymphocyte reaction; Cr51 release assay; macrophage cultures; cytokine bioassays- IL2, gamma IFN, TNF alpha.; HLA typing.

UNIT IV VACCINE TECHNOLOGY 6

Basic principles of vaccine development; protein based vaccines; DNA vaccines; Plant based vaccines; recombinant antigens as vaccines; reverse vaccinology

UNIT V DEVELOPMENT OF IMMUNOTHERAPEUTICS 5

Engineered antibodies; catalytic antibodies; idiotypic antibodies; combinatorial libraries for antibody isolation.

Attested

DIRECTOR
Centre For Academic Courses
Anna University, Chennai-600 025.

TOTAL : 45 PERIODS

OUTCOME:
Having learnt the technology of applied immunology the students will be able to develop immunotherapeutic products and vaccines will be ready for the industry or become an entrepreneur.

REFERENCES

1. Roitt, Ivan. Essential Immunology, 9th ed., Blackwell Scientific, 1997
2. Roitt I., Brostoff J. and Male D. Immunology, 6th ed. Mosby, 2001
3. Goldsby , R.A., Kindt, T.J., Osbome, B.A. and Kerby J. Immunology, 5th ed., W.H. Freeman, 2003
4. Weir, D.M. and Stewart, J. Immunology, 8th ed., Cheerchill, Linvstone, 1997

BT7151 ADVANCED GENETIC ENGINEERING L T P C
3 0 0 3

OBJECTIVE
This course provides conceptual knowledge in the Cloning and Expression of genes, but alsofor knowledge for the construction of DNA libraries and Sequencing of DNA, PCR and mutagenesis Gene transfer and Gene therapy to students.

UNIT I CLONING AND EXPRESSION OF GENES 10
Overview of Restriction and Modification system. Cloning vehicles: Plasmids – Host range,
Copy number control, Compatibility. λ phage – Insertional and Replacement vectors, in vitro packaging. Single strand DNA vector – M13 Phage. Cosmids, Phasmids, PAC, BAC and YAC. Expression vector – Characteristics, RNA probe synthesis, High level expression of proteins, Protein solubilization, purification and export.

UNIT II CONSTRUCTION OF DNA LIBRARIES 10
DNA library – Types and importance. cDNA library: Conventional cloning strategies – Oligo dT priming, self priming and its limitations. Full length cDNA cloning – CAPture method and Oligo capping. Strategies for gDNA library construction – Chromosome walking. Differences between gDNA and cDNA library. Screening strategies – Hybridization, PCR, Immunoscreening, South-western and North-Western. Functional cloning – Functional complementation and gain of function. Difference cloning: Differential screening, Subtracted DNA library, differential display by PCR. Overview on microarray and its applications.

UNIT III DNA SEQUENCING 8
DNA sequencing – Importance, Chemical and Enzymatic methods, Pyrosequencing, Automated sequence, Genome sequencing methods – top down approach, bottom up approach.

UNIT IV PCR AND MUTAGENESIS 9
PCR – Principle and applications. Different types of PCR – Hot start PCR, Touchdown PCR, Multiplex PCR, Inverse PCR, Nested PCR, AFLP-PCR, Allele specific PCR, Assembly PCR, Asymmetric PCR, LATE-PCR, Colony PCR, in situ PCR, Long PCR. Real-time PCR – SYBR Green assay, Taqman Probes, Molecular beacons. Mutagenesis and chimeric protein engineering by PCR, RACE, Kuntels' method of mutagenesis.

UNIT V GENE TRANSFER AND GENE THERAPY 8

Introduction of foreign genes into animal cells and Importance, DNA Microinjection. Retroviral vectors, Trasnsfection of Embryonic stem cells and recombination. Transgenic plants and their Importance, Ti Plasmid, Cointegrate and Binary vectors. An overview of Gene therapy.

TOTAL : 45 PERIODS

OUTCOME

Having studied this course the students will gave the skills and state-of-art advanced molecular methods to help them design and execute complex molecular Biology experiments and design of transgenics and novel recombinant protein.

TEXTS/REFERENCES

1. Primrose S.B., Twyman R.H., and Old R.W. “Principles of Gene Manipulation”. 6th Edition., Blackwell Science, 2001
2. Winnacker E.L. “From Genes to clones : Introduction to Gene Technology”. Panima, 2003
3. Glick B.R. and Pasternak J.J. “Molecular Biotechnology: Principles and applications of recombinant DNA” 3rd Edition., ASM Press, 2003
4. Lemonie, N.R. and Cooper, D.N. Gene Therapy, BIOS, 1996.

BT7211 MICROBIAL AND IMMUNOTECHNOLOGY LAB L T P C
0 0 6 3

OBJECTIVE:

To teach students the latest techniques and skills required in Microbiology and Immunotechnology .

PART I MICROBIAL TECHNOLOGY

1. Disinfection, safety instructions; Preparation of media and Sterilization.
2. Identification and staining of microbes (gram staining, Giemsa etc).
3. Enumeration of microorganisms by serial dilution.
4. Growth curve, measure of bacterial population by turbidometry.

PART II IMMUNOTECHNOLOGY

1. Ethics, selection and handling of animals for immunological experiments (Eg. Mice, Rats, Rabbits).
2. Preparation of antigen and Routes of immunisation (Intra-peritonial, Sub-cutaneous, Intra-muscular, Intra-nasal, Oral).
3. Methods of bleeding (Eg. Tail bleeding, Intravenous, intraorbital) .

10

4. Collection of serum, storage and purification of total IgG (salt precipitation).
5. Evaluation of Antibody titre by direct ELISA.
6. Evaluation of Antigen by Sandwich ELISA.
7. Characterisation of antigens by native, SDS-PAGE.
8. Characterisation of antigens by Immunoblotting.
9. Conjugation of Immunoglobins (Streptavidin, colloidal gold).
10. Methods for prototype development of Immunodiagnostics (ICT card).
11. Blood smear identification of leucocytes by Giemsa stain.

12. Separation of mononuclear cells by Ficoll-Hypaque.
13. Separation of spleenocytes and proliferation against mitogens.

TOTAL : 90 PERIODS

OUTCOME:
With detailed knowledge and experience obtained after performing these experiments the industry ready.

REFERENCES

1. Antibodies: A Laboratory Manual, Ed Harlow, David P Lane, Cold Spring Harbor Laboratory Press, 2nd Edition, 1998
2. Molecular cloning : A laboratory manual / Joseph Sambrook, David W. Russell. 3rd ed. Cold Spring Harbor, N.Y. : Cold Spring Harbor Laboratory, 2001
3. Current protocols in immunology / editorial board John E. Coligan .et al,. 2003, New York : Wiley Interscience, 2003.

BT7311 ADVANCED BIOPROCESS AND DOWNSTREAM PROCESSING LAB

L	T	P	C
0	0	6	3

Enzyme kinetics, inhibition, factors affecting reaction ph, temp.

Enzyme immobilization studies – Gel entrapment, adsorption and ion exchange immobilisation.
Optimization techniques – Plackett burman, Response surface methodology.
Batch cultivation – recombinant E.coli – growth rate, substrate utilization kinetics, plasmid stability, product analysis after induction, Metabolite analysis by HPLC

Fed batch cultivation E.coli, Pichia pastoris
Continuous cultivation – x - d construction, kinetic parameter evaluation, gas analysis, carbon balancing, Pulse and shift techniques.

Bioreactor studies : Sterlisation kinetics, kLa determination, residence time distribution
Animal cell culture production: T-flask, spinner flask, bioreactor
Cell separation methods; Centrifugation and microfiltration Cell disruption methos: Chemical lysis and Physical methods Product concentration: Precipitation, ATPS, Ultrafiltration
High resolution purification; Ion exchange, affinity and Gel filtration Freeze drying

TOTAL : 90 PERIODS

BT 7312 ADVANCED MOLECULAR BIOLOGY AND GENETIC ENGINEERING LAB

L T P C
0 0 6 3

Preparation of Genomic DNA
PCR amplification of gene from the genomic DNA Preparation of plasmid DNA
Restriction Digestion of the vector and Insert Ligation and Transformation to E.coli
Lysate PCR confirmation.
Restriction & gel elution of DNA fragments Electroporation to Yeast
Induction experiments in E.coli using IPTG, salt etc SDS-PAGE analysis of expression
Western blot confirmation of expressed protein (anti his) ELISA (anti his) –
Quantification of expressed protein. RNA Isolation cDNA preparation from RNA Site directed mutagenesis
Southern hybridization experiment

TOTAL : 90 PERIODS

BT7074 BIOCATALYSTS AND ENZYME TECHNOLOGY L T P C
3 0 0 3

OBJECTIVES

The course intends to give advanced knowledge about Biocatalysts, Enzyme kinetics, immobilization and enzymatic biotransformation of drugs

UNIT I BASICS OF ENZYMES AS BIOCATALYSIS 9

Introduction to enzymes, Classification, Sources, Mechanism of enzyme action. Strategies of purification of enzymes, criteria of purity, molecular weight determination and characterization of enzymes , Enzymes of biological importance - Acetylcholinesterase, angiotensin converting enzyme (ACE), ACE Inhibitors, HMG Co A reductase inhibitors, pseudocholinesterase, 5 -nucleotidase (5NT), glucose-6-phosphate dehydrogenase (GPD), CKisoforms, immunoreactive trypsinogen (IRT) and chymotrypsin; amylase isoenzymes

UNIT II KINETICS OF ENZYME ACTION 9

Methods for investigating the kinetics of Enzyme catalysed reactions – Initial velocity Studies, Estimation of Michaelis Menten parameters, Effect of pH and temperature on enzyme activity, kinetics of inhibition. Modeling of rate equations for single and multiple substrate reactions.

UNIT III IMMOBILIZED ENZYMES 9

Techniques of enzyme immobilization; kinetics of immobilized enzymes, effect of solute,partition & diffusion on the kinetics of immobilized enzymes, design and configuration of immobilized enzyme reactors; applications of immobilized enzyme technology, Economic argument for immobilization

UNIT IV ENZYMES IN FUNCTIONAL GROUP TRANSFORMATION 9

Functional group interconversion using enzymes (hydrolysis reaction, oxidation/reduction reactions, C-C bond formations), Retrosynthetic biocatalysis, Chemoenzymatic synthesis of natural products. Industrial process using enzymes for production of drugs, fine chemicals and chiral intermediates.

UNIT V ENZYMATIC TRANSFORMATION 9

Reaction engineering for enzyme-catalyzed biotransformations. Catalytic antibodies. Biocatalysts from extreme Thermophilic and Hyperthermophilic microorganisms (extremozymes). The design and construction of novel enzymes, artificial enzymes, Biotransformation of drugs (hydroxylation of Steroids), Host Guest Complexation chemistry, enzyme design using steroid templates, enzymes for production of drugs, fine chemicals and chiral intermediates.

TOTAL: 45 PERIODS

OUTCOME

The students will acquire knowledge in all aspect of Biocatalysis, enzyme kinetics and immobilization. The enzymatic transformation will give theoretical idea about drug biotransformation.

TEXTS/REFERENCES

1. Blanch, H.W., Clark, D.S. Biochemical Engineering, Marcel Dekker, 1997
2. Lee, James M. Biochemical Engineering, PHI, USA, 1982.
3. Bailey J.E. & Ollis, D.F. Biochemical Engineering Fundamentals, 2nd Ed., McGraw Hill, 1986
4. Faber, Kurt “Biotransformations in organic chemistry : A Textbook” 5th Edition. Springer 2008.
5. Enzyme catalysis in organic synthesis (Vol I-III); Eds by K.Drauz and H. Waldmann. Willey-VCH (ISBN: 3-527-29949-1)
6. Hydrolases in organic synthesis (regio and stereoselective biotransformations). U. T. Bornscheuer and R. J. Kazlauskas. Willey-VCH. (ISBN: 3-527-30104-6).
7. Stereoselective biocatalysis. Ed. R.N. Patel. Marcel Dekker. (ISBN: 0-8247- 8282-8

BT7075 COMMUNICATION SKILL DEVELOPMENT L T P C
2 0 2 3

OBJECTIVES

To enhance the overall capability of students and to equip them with the necessary communication and soft skills to enable them to excel in their profession

UNIT I PROCESS OF COMMUNICATION 9

Concept of effective communication- Setting clear goals for communication; Determining outcomes and results; Initiating communication; Avoiding breakdowns while communicating; Creating value in conversation; Barriers to effective communication; Non verbal communication- Interpreting non verbal cues; Importance of body language, Power of effective listening; recognizing cultural differences

UNIT II PRESENTATION SKILLS 9

Formal presentation skills; Preparing and presenting using Over Head Projector, Power Point; Defending Interrogation; Scientific poster preparation & presentation; Participating in group discussions

UNIT III TECHNICAL WRITING SKILLS 9

Types of reports; Layout of a formal report; Scientific writing skills: Importance of communicating Science; Problems while writing a scientific document; Plagiarism; Scientific Publication Writing: Elements of a Scientific paper including Abstract, Introduction,Materials & Methods, Results, Discussion, References; Drafting titles and framing abstracts

UNIT IV COMPUTING SKILLS FOR SCIENTIFIC RESEARCH 9

Web browsing for information search; search engines and their mechanism of searching; Hidden Web and its importance in Scientific research; Internet as a medium of interaction between scientists; Effective email strategy using the right tone and conciseness

UNIT V RESUME / REPORT PREPARATION / LETTER WRITING 9

Students prepare their own resume and report, Presentation- Students make presentations on given topics, Group Discussion- Students participate in group discussions, and Interview Skills- Students participate in Mock Interviews

TOTAL: 45 PERIODS

OUTCOME

The course will enhance soft skills and interpersonal skills, which will make their transition from college to work place smoother and help them excel in their job.

REFERENCE

1. Mohan Krishna and N.P. Singh, Speaking English effectively,Macmillan, 2003.

BT7002 APPLICABLE MATHEMATICS FOR BIOTECHNOLOGY L T P C
3 1 0 4

UNIT I CALCULUS 12

Calculus (Quick review of concepts): Review of limits, continuity, differentiability; Mean value theorem, Taylor's Theorem, Maxima and Minima; Fundamental theorem of Calculus; Improper integrals; Applications to area, volume; Convergence of sequences and series; Power series; Partial Derivatives; Gradient andDirectional derivatives; Chain rule; Maxima and Minima.

UNIT II DIFFERENTIAL EQUATION AND PARTIAL DIFFERENTIAL EQUATIONS 12

Introduction- Differential Equation and solution-First order, linear differerential equation, partial differential equations solution-Various types of partial different equation of the form f(p,q)=0, f(x, p, q)=0, f(x, p)=g(y, q). Clairaut's form z=px+qy+f(p,q), Lagrange's equation Pp+Qq=R. Total differentiation Pdx+Qdy+Rdz=0. Simple Problem application to biology

UNIT III SECOND AND HIGHER ORDER DIFFERENTIAL EQUATIONS 12

Linear ODE's with constant coefficients: the characteristic equations; Cauchy-Euler equations; Linear dependence and Wronskians; Method of undetermined coefficients; Method of variation of parameters; Laplace transforms: Inverse theorem, shifting theorems, partial fractions.

UNIT IV LINEAR ALGEBRA 12

Basics: Vectors, matrices, determinants; Matrix addition and multiplication; Systems of equations: Gauss elimination, Matrix rank, Linear independence, Cramer's rule; Inverse of a matrix: Gauss-Jordan elimination; Eigenvalues and Eigenvectors: characteristic polynomials, eigenvalues of special matrices(orthogonal, unitary, hermitian, symmetric, skewsymmetric, normal)

Attested

DIRECTOR
Centre For Academic Courses
Anna University, Chennai-600 025.

UNIT V NUMERICAL METHODS 12

Solution of equations by iteration; Interpolation by polynomials; Piecewise linear and cubic splines; Numeric integration and differentiation; Linear systems: Gauss elimination, Gauss-Siedel, matrix inversion; LU factorization; Matrix eigenvalues; Numerical solution of ODEs: Euler and Runge-Kutta methods, Predictor-Corrector methods; Exposure to software packages like Matlab or Scilab.

TOTAL : 60 PERIODS

TEXTS/REFERENCES

1. G. B. Thomas and R. L. Finney, Calculus and Analytic Geometry, 9th Edition, ISE Reprint, Addison-Wesley, 1998.
2. E. Kreyszig, Advanced engineering mathematics, 8th Edition, John Wiley, 1999.
3. W. E. Boyce and R. DiPrima, Elementary Differential Equations, 8th Edition, John Wiley, 2005.
4. Higher Engineering Mathematics,37th Edition By Grewal.

BT7017 UNIX OPERATING SYSTEM AND PROGRAMMING LANGUAGE C++

L T P C
2 0 2 3

UNIT I UNIX OPERATING SYSTEM 8

Introduction to Operating Systems, Basic Commands in Unix, vi editor, filters, input/output redirection, piping, transfer of data between devices, shell scripts.

UNIT II INTRODUCTION TO C++ 10

Programming methodologies- Introduction to Object Oriented Programming - Comparison of Procedural and Object Oriented languages - Basics of C++ environment, Data types, Control Flow Constructs, Library functions, Arrays

UNIT III CLASSES 10

Definition-Data members-Function members-Access specifiers-Constructors-Default constructors-Copy constructors-Destructors-Static members- This pointer- Constant members- Free store operators- Control statements

UNIT IV INHERITANCE AND POLYMORPHISM 10

Overloading operators- Functions- Friends- Class derivation-Virtual functions-Abstract base classes-Multiple inheritance.

UNIT V TEMPLATES AND FILE HANDLING 7

Class templates-Function templates-Exception handling- File Handling Lab: Exercises for all the topics.

TOTAL : 45 PERIODS

REFERENCES

1. Kochen, S.J. & Wood, P.H. Exploring the Unix System, Techmedia, 1999
2. Bach M.J., The design of Unix operating systems, Prentice Hall of India, 1999.
3. Lippman S.B., The C++ Primer, Addison Wesley, 1998.
4. Deitel and Deitel, C++ How to Program, Prentice Hall, 1998.
5. Balagurasamy E. ,Object-Oriented Programming using C++, Tata McGraw- Hill, 2002.

BT7011 FOOD PROCESSING AND BIOTECHNOLOGY L T P C
3 0 0 3

UNIT I FOOD CHEMISTRY 9

Constituent of food – contribution to texture, flavour and organoleptic properties of food; food additives – intentional and non-intentional and their functions; enzymes in food processing.

UNIT II FOOD MICROBIOLOGY 9

Sources and activity of microorganisms associated with food; food fermentation; food chemicals; food borne diseases – infections and intoxications, food spoilage – causes.

UNIT III FOOD PROCESSING 9

Raw material characteristics; cleaning, sorting and grading of foods; physical conversion operations – mixing, emulsification, extraction, filtration, centrifugation, membrane separation, crystallization, heat processing.

UNIT IV FOOD PRESERVATION 9

Use of high temperatures – sterilization, pasteurization, blanching, asceptic canning; frozen storage – freezing curve characteristics. Factors affecting quality of frozen foods; irradiation preservation of foods

UNIT V MANUFACTURE OF FOOD PRODUCTS 9

Bread and baked goods, dairy products – milk processing, cheese, butter, ice-cream, vegetable and fruit products; edible oils and fats; meat, poultry and fish products; confectionery, beverages.

TOTAL : 45 PERIODS

REFERENCES

1. Coultate T.P. Food – The chemistry of its components, 2nd ed., Royal society, London, 1992
2. Sivasankar B. Food processing and preservation, Prentice Hall of India Pvt.Ltd., New Delhi, 2002
3. Fennema O.R. ed. Principles of food science : Part I, Food chemistry, Marcel Dekker, New York, 1976
4. Frazier W.C. and Westhoff D.C. Food Microbiology, 4th ed. McGram-Hill Book Co., New York, 1988.
5. Brenner, J.G., Butters, J.R., Cowell, N.D. and Lilly, A.E.V. Food engineering operations, 2nd ed., Applied Sciences Pub.ltd., London,1979
6. Pyke, M. Food Science and Technology , 4th ed., John Murray, London, 1981

BT7013 PHARMACEUTICAL BIOTECHNOLOGY L T P C
3 0 0 3

UNIT I INTRODUCTION 8

History of pharmaceutical industry, Drugs discovery and Development phases; Drugs and Cosmetics ACT and regulatory aspects; Definition: Generics and its advantages; Biogenerics and Biosimilars; The role of patents in the drug industry; Protein-based biopharmaceuticals; International Non-proprietary Names (INN) nomenclature system biosimilars regulation

UNIT II DOSAGE FORM: SCIENCE, PHARMACOKINETICS AND PHARMACODYNAMICS 10

Definition of Dosage forms, Classification of dosage forms (solid unit dosages – Tablets, capsules; liquids – solutions, lotions, suspension etc; semi-solid – ointments, creams, gel, suppositories, etc; Parenterals, Aerosols etc), Introduction to pharmacokinetics and pharmacodynamic principles (factors affecting the ADME process); bioavailability, bioequivalence.

UNIT III DRUG DELIVERY AND CHARACTERISATION OF BIOGENERIC RECOMBINANTS 9

Advanced drug delivery systems – controlled release, transdermals, liposomes and drug targeting. Approaches to the characterization of biosimilars; Problems in characterizing biologics (Types of biologic, Peptides, Non-glycosylated proteins, Glycosylated proteins, Monoclonal antibodies); Equivalence issues; Post-translational modifications; Effect of microheterogeneity.

UNIT IV PHARMACOLOGY PRINCIPLES, CLASSIFICATION OF DRUGS AND MECHANISM 10

Understanding principles of pharmacology, pharmacodynamics Study of a few classes of therapeutics like laxatives, antacids and drugs used in peptic ulcers, drugs used in coughs and colds, analgesics, contraceptives, antibiotics (folate inhibitors, protein synthesis inhibitors, DNA inhibitors), hormonal agonists and antagonists.

UNIT V CASE STUDIES ON BIOPHARMACEUTICAL PRODUCT DEVELOPMENT 8

Erythropoietin, Insulin, Somatotropin, Interleukin-2, Interferon Granulocyte-macrophage-CSF, Factor VIIa, Factor IX, Factor VIII, Tissue plasminogen activator, Monoclonal antibodies and engineered Mabs

TOTAL : 45 PERIODS

REFERENCES

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

BT7010 ENVIRONMENTAL BIOTECHNOLOGY L T P C
3 0 0 3

OBJECTIVE

The proposed course is designed to teach students the scientific and engineering principles of microbiological treatment technologies to clean up contaminated environments and to generate valuable resources for the human society. Conventional

treatment methodologies can be replaced with the advancements in biotechnological field such as molecular biology and genetic engineering strategies will be taught to the students. Also this study paves the way for the alternate sources of energy to avoid environmental issues.

UNIT I FUNDAMENTAL OF ENVIRONMENTAL BIOTECHNOLOGY 7

Microbial flora of soil, Ecological adaptations, Interactions among soil microorganisms, biogeochemical role of soil microorganisms.

Biodegradation, Microbiology of degradation and its mechanism, Bioaugmentation, Biosorption, Bioleaching, Bioremediation- Types of Bioremediation, Bioreactors for Bioremediation, Metabolic pathways for Biodegradation for specific organic pollutants.

UNIT II POLLUTION AND CONTROL 11

Pollution- Sources of pollutants for Air, Water (ground water, marine), Noise, Land and its characteristics- Pollution control and management- Environmental monitoring & sampling, Physical, chemical and biological methods and analysis- Air pollution- control and treatment strategies. Modes of Biological treatment methods for wastewater- aerobic digestion, anaerobic digestion, Anoxic digestion, the activated sludge process, Design and modeling of activated sludge processes, Aerobic digestion, Design of a trickling biological filter, Design of anaerobic digester.

UNIT III INDUSTRIAL WASTE MANAGEMENT 9

Industrial waste management- Dairy, Paper and Pulp, Textile, leather, hospital and pharmaceutical industrial waste management, e-waste- radioactive and nuclear power waste management- Solid waste management.

UNIT IV MODERN TOOLS OF BIOREMEDIATION 9

Molecular biology tools for Environmental management, rDNA technology in waste treatment, Genetically modified organisms in Waste management, Genetic Sensors, Metagenomics, Bioprospecting, Nanoscience in Environmental management, Phytoremediation for heavy metal pollution, Biosensors development to monitor pollution**.**

UNIT V RENEWABLE ENERGY SOURCES AND ENERGY MANAGEMENT 9

Alternate Source of Energy, Biomass as a source of energy, Biocomposting, Vermiculture, Biofertilizers, Organic farming, Biofuels, Biomineralization, Bioethanol and Biohydrogen, Bio-electricity through microbial fuel cell, energy management and safety.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Chakrabarty K.D., Omen G.S., Biotechnology And Biodegradation, Advances In Applied Biotechnology Series , Vol.1, Gulf Publications Co., London, 1989.
2. Waste water Engineering Treatment, Disposal and Reuse. Metcalf & Eddy (1991) Mc Graw Hill.
3. Environmental Biotechnology, Forster, C. F and Waste, D.A. J. (1987) Ellis Horwood Halsted Press.
4. Biochemical Engineering Fundamentals 2nd Ed. Bailey, J. E. and Ollis, D. F. (1986) Mac Graw Hill, New York.
5. Environmental Biotechnology by Alan Scragg (1999); Longman.
6. Bruce E. Rittmann, Eric Seagren, Brian A.Wrenn and Albert J. Valocchi, Chittaranjan Ray, Lutgarde Raskin, “In-situ Bioremediation” (2nd Edition) Nayes Publication, U.S.A, 1991.
7. Old R.W., and Primrose, S.B., Principles of Gene Manipulation (3rd Edition) Blackwell Science Publication, Cambridge, 1985.

REFERENCES

1. Stanier R.Y., Ingraham J.L., Wheelis M.L., Painter R.R., General Microbiology, Mcmillan Publications, 1989.
2. New Processes of Waste water treatment and recovery. G.Mattock E.D. (1978) Ellis Horwood.
3. Environmental Biotechnology, Jogdand, S.N. (1995) Himalaya Publishing House, New Delhi.
4. Comprehensive Biotechnology (Vol. 1-4) Young Murray Moo (Ed.) (1985) Elsever Sciences.
5. Standard Method for Examination of Water & Waste water 14th Ed.(1985) American Public Health Ass.
6. Lee, C.C. and Shun dar Lin, Handbook of Environmental Engineering Calculations, Mc Graw Hill, New York, 1999.
7. Hendricks, D. 'Water Treatment Unit Processes – Physical and Chemical' CRC Press, New York 2006
8. Martin, A.M., Biological Degradation of Wastes, Elsevier Appl. Science, New York, 1991.
9. Sayler, Gray S. Robert Fox and James W. Blackburn," Environmental Biotechnology for Waste Treatment, Plenum Press, New York, 1991.

BT7006 BIOREACTOR ENGINEERING L T P C
3 0 0 3

UNIT I TRANSPORT PROCESS IN BIOREACTOR 9

Gas-liquid mass transfer in cellular systems, determination of oxygen transfer rates, mass transfer for freely rising or falling bodies, forced convection mass transfer, Overall kla estimation and power requirements for sparged and agitated vessels, mass transfer across free surfaces, other factors affecting kla, non Newtonian fluids, Heat transfer correlations, thermal death kinetics of microorganisms, batch and continuous heat, sterilisation of liquid media, filter sterilisation of liquid media, Air. Design of sterilisation equipment batch and continuous.

UNIT II MONITORING OF BIOPROCESSES 6

On-line data analysis for measurement of important physico-chemical and biochemical parameters; Methods of on-line and off-line biomass estimation; microbial calorimetry; Flow injection analysis for measurement of substrates, product and other metabolites; State and parameter estimation techniques for biochemical processes. Case studies on applications of FIA and Microbial calorimetry.

UNIT III MODERN BIOTECHNOLOGICAL PROCESSES 14

Recombinant cell culture processes, guidelines for choosing host-vector systems, plasmid stability in recombinant cell culture, limits to over expression, Modelling of recombinant bacterial cultures; Bioreactor strategies for maxmising product formation; Case studies on high cell density cultivation and plasmid stabilization methods. Bioprocess design considerations for plant and animal cell cultures. Analysis of multiple interacting microbial populations – competition:survival of the fittest, predation and parasitism: Lotka Volterra model.

UNIT IV DESIGN AND ANALYSIS OF BIOLOGICAL REACTORS 11

Ideal bioreactors-batch, fed batch, continuous, cell recycle, plug flow reactor, two stage reactors, enzyme catalyzed reactions. Reactor dynamics and stability. Reactors with non ideal mixing. Other types of reactors- fluidized bed reactors, packed bed reactors, bubble column reactors, trickle bed reactors.

UNIT V SCALEUP OF REACTORS 5

Scaleup by geometry similitude, oxygen transfer, power correlations, mixing time

TOTAL : 45 PERIODS

REFERENCES

1. Moser, Anton, Bioprocess Technology: Kinetics and Reactors, Springer Verlag, 1988.
2. Bailey J.E. & Ollis, D.F. Biochemical Engineering Fundamentals, 2nd ed., McGraw Hill, 1986
3. Lee, James M. Biochemical Engineering, PHI, USA.
4. Atkinson, Handbook of Bioreactors, Blanch,H.W. Clark, D.S. Biochemical Engineering, Marcel Decker, 1999

BT 7009 COMPUTER AIDED LEARNING OF STRUCTURE AND FUNCTION OF PROTEINS

L	T	P	C
2	0	2	3

UNIT I COMPONENTS OF PROTEIN STRUCTURE 12

Introduction to Proteins, structure and properties of amino acids, the building blocks of Proteins, Molecular Interactions and their roles in protein structure and function, Primary Structure – methods to determine and synthesis

UNIT II PROTEIN BIOINFORMATICS 12

Protein sequence and structural databases, Multiple sequence alignment, Secondary, Tertiary and Quaternary Structure of Proteins; Sequence and Structural Motifs; Protein folding

UNIT III OVERVIEW OF STRUCTURAL AND FUNCTIONAL PROTEINS 12

Classes of Proteins and their Structure Function Relationships – alpha, beta, alpha/beta proteins, DNA-binding proteins, Enzymes, IgG, membrane proteins

UNIT IV PROTEIN STRUCTURAL CLASSIFICATION DATABASES 12

SCOP and CATH. Evolutionary relationships and Phylogenetic Studies

UNIT V PROTEIN MODIFICATIONS 12

Post translational modifications, Engineering of proteins, Site directed mutagenesis, Fusion Proteins, Chemical derivatization.

TOTAL : 60 PERIODS

REFERENCES

1. Biochemistry, 3rd Edition by Donald J. Voet, Judith G. Voet, 2004 John Wiley & Sons Publishers, Inc
2. Introduction to Protein Structure, 2nd Edition, Carl Branden and John Tooze, 1999, Garland Publications, New York
3. Proteins – Structures and Molecular Properties, 2nd Edition, Thomas E. Creighton, W. H. Freeman and Company, New York

BT7076 METABOLIC PROCESS AND ENGINEERING L T P C
3 0 0 3

OBJECTIVES

To familiarize the student with quantitative approaches for analyzing cellular metabolism and the use of theoretical and experimental tools that can give insights into the structure and regulation of metabolic networks. A central aspect of the course is to identify the optimal strategy for introducing directed genetic changes in the microorganisms with the aim of obtaining better production strains. Case studies will be taken up on metabolically-engineered products and processes in various expression systems.

UNIT I METABOLIC FLUX ANALYSIS 9

Introduction to metabolic engineering, comprehensive models of cellular reactions with stoichiometry and reaction rates; metabolic flux analysis of exactly/over/under determined systems. Shadow price, sensitivity analysis.

UNIT II TOOLS FOR EXPERIMENTALLY DETERMINING FLUX THROUGH PATHWAYS 9

Monitoring and measuring the metabolome, Methods for the experimental determination of metabolic fluxes by isotope labeling metabolic fluxes using various separation-analytical techniques. GC-MS for metabolic flux analysis, genome wide technologies: DNA /phenotypic microarrays and proteomics.

UNIT III CONSTRAINT BASED GENOMIC SCALE METABOLIC MODEL 9

Development of Genomic scale metabolic model, Insilico Cells:studying genotype-phenotype relationships using constraint-based models, case studies in E. coli, S.cerevisiae metabolic network reconstruction methods, optimization of metabolic network, Identification of targets for metabolic engineering; software and databases for genome scale modeling

UNIT IV METABOLIC CONTROL ANALYSIS AND KINETIC MODELING 9

Fundamental of Metabolic Control Analysis, control coefficients and the summation theorems, Determination of flux control coefficients. Multi-substrate enzyme kinetics, engineering multifunctional enzyme systems for optimal conversion, and a multi scale approach for the predictive modeling of metabolic regulation.

UNIT V CASE STUDIES IN METABOLIC ENGINEERING 9

Metabolic engineering examples for bio-fuel, bio-plastic and green chemical synthesis. Study of genome scale model in various systems for the production of green chemicals using software tools. Validation of the model with experimental parameters.

TOTAL : 45 PERIODS

OUTCOME

This course work will provide essential knowledge for the students to make their career in bioprocess Industries.

TEXT BOOKS

1. Stephanopoulos, G.N. “Metabolic Engineering: Principles and Methodologies”. Academic Press / Elsevier, 1998.
2. Lee, S.Y. and Papoutsakis, E.T. “Metabolic Engineering”. Marcel Dekker, 1998.
3. Nielsen, J. and Villadsen, J. “Bioreaction Engineering Principles”. Springer, 2007.
4. Smolke, Christiana D., “The Metabolic Pathway Engineering Handbook Fundamentals”, CRC Press Taylor & Francis, 2010.

REFERENCES

1. Voit, E.O. “Computational Analysis of Biochemical Systems : A Practical Guide for Biochemists and Molecular Biologists”. Cambridge University Press, 2000.
2. Scheper, T. “Metabolic Engineering” Vol 73 (Advances in Biochemical Engineering Biotechnology) Springer, 2001.
3. Cortassa, S. et al, “ An Introduction to Metabolic and Cellular Engineering”, World Scientific Publishing, 2002.
4. Kholodenko, Boris N and H. V. Westerhoff “Metabolic Engineering in the Post Genomic Era”, Horizon Bioscience, 2004.

BT7005 BIOPROCESS MODELING AND SIMULATION L T P C
2 0 2 3

OBJECTIVE

To introduce the fundamental aspects of modeling of various biological systems. To address the various modeling paradigms, based on the level of detail, the extent of data available as well as the question the model must address. To outline the applications of such modeling techniques

UNIT I MODELING OF BIOLOGICAL SYSTEMS 12

Modeling Principles, model development from first principles. Modeling approaches for Biological systems – structured and unstructured systems; Compartment models; Deterministic and stochastic approaches for modeling structured systems.

UNIT II MODELLING OF DIFFUSION SYSTEMS (BIOFILM AND IMMOBILIZED ENZYME SYSTEMS 12

External mass transfer, Internal diffusion and reaction within biocatalysts, derivation of finite model for diffusion-reaction systems, dimensionless parameters from diffusion-reaction models,the effectiveness factor concept, case studies; oxygen diffusion effects in a biofilm, biofilm nitrification

UNIT III MODELING BIOREACTOR 12

Bioreactor modelling: Ideal and non-ideal bioreactors; Stirred tank models; characterization of mass and energy transfer distributions in stirred tanks, Tower Reactor Model; Flow modeling, bubble column flow models, mass transfer modeling, structured models for mass transfer in tower reactors, process models in tower reactors, airlift models,

UNIT IV LINEAR SYSTEM ANALYSIS 12

Study of linear systems, linearization of non-linear systems; Simulation of linear models using MATLAB; Parameter estimation and sensitivity analysis; Steady state and unsteady state systems; stability analysis; Case study of recombinant protein production.

UNIT V HYBRID AND OTHER MODELING TECHNIQUES 12

Advanced modeling techniques such as fuzzy logic, neural network, hybrid systems and fuzzy logic systems; case studies.

TOTAL : 60 PERIODS

TEXTBOOKS

1. B. Wayne Bequette, Process Dynamics: Modeling, Analysis and Simulation, 1998, Prentice-Hall

2. Said S.E.H. Elnashaie, Parag Garhyan, Conservation Equations and Modeling of Chemical and Biochemical Processes, 2003, Marcel Dekker

REFERENCES

1. Process Dynamics, Modelling, Analysis and Simulation, B.W. Bequettre, Prentice Hall International series (1998). ISBN 0132107333.
2. Conservation Equations and Modelling of Chemical and Biochemical Processes. Said. E.H. Elnashaie and P. Garhyan, Marcel Dekker, Inc (2003). ISBN 0824709578.
3. Biological Reaction Engineering: Dynamic Modelling Fundamentals with Simulation Examples, I.J. Dunn, Wiley-VCH (2003). ISBN 3527307591.

BT7015 PLANT GENETIC ENGINEERING AND BIOTECHNOLOGY L T P C
3 0 0 3

UNIT I INTRODUCTION TO PLANT MOLECULAR BIOLOGY 9

Genetic material of plant cells, nucleosome structure and its biological significance; transposons,; outline of transcription and translation, alternative and trans splicing, constitutive and differentially expressed genes in plants

UNIT II CHLOROPLAST AND MITOCHONDRIA 9

Structure, function: Light and dark reaction and genetic material; rubisco synthesis and assembly, coordination, regulation and transport of proteins. Mitochondria: Genome, cytoplasmic male sterility and import of proteins, comparison and differences between mitochondrial and chloroplast genome, chloroplast transformation

UNIT III PLANT METABOLISM AND METABOLIC ENGINEERING 9

Nitrogen fixation, Nitrogenase activity, nod genes, nif genes, bacteroids, plant nodulins, production of secondary metabolites, flavanoid synthesis and metabolic engineering.

UNIT IV AGROBACTERIUM AND PLANT VIRUSES 9

Pathogenesis, crown gall disease, genes involved in the pathogenesis, Ti plasmid –T-DNA, importance in genetic engineering. Plant viruses and different types, Viral Vectors: Gemini virus, cauliflower mosaic virus, viral vectors and its benefits, vectors used for plant transformation ,Methods used for transgene identification.

UNIT V APPLICATIONS OF PLANT BIOTECHNOLOGY 10

Outline of plant tissue culture, transgenic plants, herbicide and pest resistant plants, molecular pharming , therapeutic products, RNA i, Transgene silencing ,ethical issues

TOTAL : 45 PERIODS

REFERENCES

1. Grierson D. and Covey, S.N. Plant Molecular Biology, 2nd ed., Blackie,1988
2. Slater A et al. Plant Biotechnology : The Genetic Manipulation of Plants, Oxford University Press, 2003 (1st and 2nd edition)
3. Gamburg O.L., Philips G.C. Plant Tissue & Organ Culture: Fundamental Methods.\ Narosa , 1995.
4. Heldt, Hans-Walter, Plant Biochemistry & Molecular Biology, Oxford University Press, 1997
5. Wilkins M.B .Advanced Plant Physiology , ELBS, Longman, 1987.

Attested

DIRECTOR
Centre For Academic Courses
Anna University, Chennai-600 025.

BT7014 PLANT DESIGN AND PRACTICE HUMAN LT P C
3 0 0 3

UNIT I PLANT DESIGN 12

Fermenter design, vessels for Biotechnology, piping and valves for biotechnology, Pressure relief system. Materials of construction and properties. Utilities for plant and their design introduction

UNIT II PROCESS ECONOMICS 8

General fermentation process economics, materials usage and cost, capital investment estimate, production cost estimate. Two case studies – one traditional product and one recombinant product.

UNIT III PHARMACEUTICAL WATER SYSTEM 7

Grades of water, sanitary design, water treatment system, Water distribution system, validation

UNIT IV VALIDATION OF BIOPHARMACEUTICAL FACILITIES 8

Introduction, why validation, when does validation occur, validation structure, resources for validation, validation of systems and processes including SIP and CIP

UNIT V GOOD MANUFACTURING PRACTICES 10

Structure – quality management, personnrl, premises and equipment, documentation, production, quality control, contract manufacturing and analysis, complaints and product recall, self inspection. GLP and its principles.

TOTAL : 45 PERIODS

REFERENCES

1. Peter, Max S. and Timmerhaus, Klaus D. Plant Design and Economics for Chemical Engineers, 4th ed., McGraw Hill, 1991.
2. A compendium of Good Practices in Biotechnology, BIOTOL Series, Butterworth-Heiemann, 1993
3. Seiler, Jiing P. Good Laboratory Practice: The why and How? Springer, 2001
4. Lydersen, B.K. et al., Bioprocess Engineering: Systems, equipment and facilities, John-Wiley, 1994

BT7007 COMPUTATIONAL FLUID DYNAMICS LT P C
3 0 0 3

UNIT I FLUID DYNAMICS 5

Introduction, Reasons for CFD. Typical examples of CFD codes and their use. Validation strategies. Derivation of Governing Equations of Fluid Dynamics: Mass conservation and divergence, Navier-Stokes and Euler equations. Energy equations. Conservation formulation and finite volume discretisation. Partial differential equations: classification, characteristic form. PDEs in science and engineering.

UNIT II BASIC NUMERICS 10

Mathematical behavior of hyperbolic, parabolic and elliptic equations. Well posedness. Discretization by finite differences. Analysis of discretized equations; order of accuracy, convergence. and stability (von Neumann analysis). Numerical methods for model equations related to different levels of approximation of Navier Stokes equation: linear

wave equation, Burgers equation, convection-diffusion equation. First and second order numerical methods such as upwind, Lax-Friedrichs, Lax-Wendroff, MacCormack, etc. Modified equation - dissipation and dispersion.

UNIT III COMPRESSIBLE FLOW 10

Euler equations, conservative/non-conservative form. ther-modynamics of compressible flow, scalar conservations laws: Conservation, weak solutions, non-uniqueness, entropy conditions. Shock formation, Rankine-Hugoniot relations. Numerical methods for scalar conservation laws. Properties of the numerical scheme such as CFL-condition, conservation and TVD. First order methods. System of conservations laws. Numerical methods for Euler equations: MacCormack and artificial viscosity for non-linear systems. Numerical/physical boundary conditions. Shock tube problem. High resolution schemes for conservations laws. Numerical methods for Euler equations. Boundary conditions, Riemann invariants. Compressible flow in 2D. Numerical methods for Euler equations, cont. Grids, algebraic mesh generation by transfinite inter-polation. Flow around an airfoil.

UNIT IV FINITE VOLUME AND FINITE DIFFERENCE METHODS 10

Laplace equation on arbitrary grids, equivalence with finite-differences, linear systems: Gauss-Seidel as smothers for multi-grid. Staggered grid/volume formulation + BC. Unsteady equations: projection and MAC method, discrete Poisson pressure equation. Time step restrictions. Steady equations: distributive iteration and SIMPLE methods.

UNIT V FINITE ELEMENTS 10

Diffusion problem. Variational form of the equation, weak solutions, essential and natural boundary condition. Finite-element approximations, stability and accuracy, the algebraic problem, matrix assembly. Navier–Stokes equations. Mixed variational form, Galerkin and FE approximations, the algebraic problem. Stability, the LBB condition, mass conservation.

TOTAL : 45 PERIODS

REFERENCES

1. Copies from Randall J LeVeque, Fininte Volume Method for Hyperbolic Problems, Cambridge University Press.
2. K.A. Hoffman and S. Chiang, Computational fluid dynamics for scientists and engineers, engineering education system.
3. J.C. Tannehill, D.A. Anderson, R.H. Pletcher, Computational Fluid Mechanics and Heat Transfer, Taylor and Francis.

BT7003 BIOETHICS L T P C
3 0 0 3

OBJECTIVES

The course will provide Fundamental ethical to Advanced clinical trial management including drug development and trial planning; Project management in clinical trials; Consent and data protection; Quality assurance and governance.

UNIT I INTRODUCTION TO CLINICAL TRIALS 9

Fundamentals of clinical trials; Basic statistics for clinical trials; Clinical trials in practice; Reporting and reviewing clinical trials; Legislation and good clinical practice - overview of the European directives and legislation governing clinical trials in the 21st century; International perspectives; Principles of the International Committee on Harmonisation (ICH)-GCP.

UNIT II REGULATIONS OF CLINICAL TRIALS 9

Drug development and trial planning - pre-study requirements for clinical trials; Regulatory approvals for clinical trials; Consort statement; Trial responsibilities and protocols - roles and responsibilities of investigators, sponsors and others; Requirements of clinical trials protocols; Legislative requirements for investigational medicinal products.

UNIT III MANAGEMENT AND ETHICS OF CLINICAL TRIALS 9

Project management in clinical trials - principles of project management; Application in clinical trial management; Risk assessment; Research ethics and Bioethics - Principles of research ethics; Ethical issues in clinical trials; Use of humans in Scientific Experiments; Ethical committee system including a historical overview; the informed consent; Introduction to ethical codes and conduct; Introduction to animal ethics; Animal rights and use of animals in the advancement of medical technology; Introduction to laws and regulation regarding use of animals in research.

UNIT IV INFORMED CONSENT 9

Consent and data protection- the principles of informed consent; Consent processes; Data protection; Legislation and its application; Data management – Introduction to trial master files and essential documents; Data management.

UNIT V QUALITY CONTROL AND GUIDELINES 9

Quality assurance and governance - quality control in clinical trials; Monitoring and audit; Inspections; Pharmacovigilance; Research governance; Trial closure and pitfalls-trial closure; Reporting and legal requirements; Common pitfalls in clinical trial management.

TOTAL : 45 PERIODS

OUTCOME

The students will acquire knowledge in all aspect of clinical trials, management and ethical standards required to conduct clinical trials.

REFERENCES

1. Lee, Chi-Jen; etal., “Clinical Trials or Drugs and Biopharmaceuticals.” CRC / Taylor & Francis, 2011.
2. Matoren, Gary M. “The Clinical Research Process in the Pharmaceutical Industry.” Marcel Dekker, 1984.

BT7073 ADVANCES IN MOLECULAR PATHOGENESIS L T P C
3 0 0 3

OBJECTIVES

The course will proved advanced information on molecular pathogenesis of infectious diseases

UNIT I INTRODUCTION 5

Discovery of microscope, Molecular Koch’s postulates, Concepts of disease, Virulence, Pathogenic cycle, Vaccines and its historical perspective, Biofilms, quorum sensing, multidrug resistance.

UNIT II HOST DEFENSE AGAINST PATHOGENS AND BACTERIAL DEFENSE STRATEGIES 10

Skin, mucosa, cilia secretions, physical movements, physical and chemical barriers to

Attested

DIRECTOR
Centre For Academic Courses
Anna University, Chennai-600 025.

bacterial colonisation, Mechanism of killing by humoral and cellular defenses, Complement, Inflammatory process, Phagocytosis, Colonization, Adherence, Iron acquisition mechanisms, Bacterial defense strategies.

UNIT III MOLECULAR MECHANISMS OF VIRULENCE 10

Virulence, Colonization factors, Microbial toxins, Secretion systems: General secretory pathway, Two-step secretion, Contact dependent secretion, Conjugal transfer system and Autotransporters.

UNIT IV MECHANISMS UNDERLYING MOLECULAR PATHOGENESIS (COMMON ENTERIC PATHOGENS) 10

Shigella: Entry, Induction of macropinocytosis, Invasion of epithelial cells, Intracellular motility and spread, Apoptotic killing of macrophages, Virulence factors involved. E.coli: Enterotoxigenic E.coli (ETEC), labile & stable toxins, Entero-pathogenic E.coli (EPEC), type III secretion, Cytoskeletal changes, intimate attachment; Enterohaemerrohogic E.coli (EHEC), Mechanism of bloody diarrhea and Hemolytic Uremic Syndrome, Enteroaggregative E.coli (EAEC). Vibrio Cholerae: Cholera toxin, Co-regulated pili, filamentous phage, survival.

UNIT V MECHANISMS UNDERLYING MOLECULAR PATHOGENESIS 10

(COMMON NON-ENTERIC PATHOGENS) 10 Mycobacterium tuberculosis: The Mycobacterial cell envelope, Route of entry, Uptake by macrophages, Latency and persistence, Entry into and survival in phagocytes, Immune response against MTB, MTB virulence factors, Emergence of resistance. Influenza virus: Intracellular stages, Neuraminidase and Haemagglutinin in entry, M1 & M2 proteins in assembly and disassembly, action of amantadine. Plasmodium: Lifecycle, erythrocyte stages, transport mechanism and processes to support the rapidly growing schizont, parastiparous vacuoles and knob protein transport, Antimalarials based on transport processes.

TOTAL: 45 PERIODS

OUTCOME

The subject will help the student towards understanding the virulence of the pathogen and Host-parasite interactions for advanced academic and industrial research in molecular pathogenesis.

TEXTS/REFERENCES

1. Salyers, Abigail A. “Bacterial Pathogenesis: A Molecular Approach”
2. Groisman, “Principles of Bacterial Pathogenesis”.
3. Waksman, Gabriel and Michael caparon “Structural Biology of Bacterial Pathogenesis”.
4. Clark, Virginia L. “Bacterial Pathogenesis”
5. Williams, Peter “Bacterial Pathogenesis” (Methods in Microbiology)
6. Mc Clane, Bruce A. “Microbial Pathogenesis”
7. Madigan, Michael T. “Biology of Microorganisms”
8. Stanley, “Genetic analysis of Pathogenic Bacteria”.
9. Hacker, Jorg “Molecular Infection Biology”

BT7077 NANOBIOTECHNOLOGY L T P C
2 0 2 3

OBJECTIVES

The course will provide advanced knowledge in field of Nanobiology and Nano medicine

UNIT I NANOSCALES 12

What is meant by Nanoscale – Nanoscale Processes – Physical and Chemical Properties of Materials in the Nanoscales - Nanoscale Measurements.

UNIT II PROPERTIES AND MEASUREMENTS OF NANOMATERIALS 12

Optical Prperties – Absorption and Fluroscence – Microscopy measurements – SEM – TEM - AFM and STM. Confocal and TIRF. Imaging

UNIT III NANOBIOLOGY 12

Properties of DNA and motor proteins – Measurements of Conductivity of DNA nanowires and angular properties of motor - Lessons from Nature on making nanodevices.

UNIT IV BIOCONJUGATION OF NANOMATERIALS TO BIOLOGICAL MOLECULES 12

Reactive Groups on biomolecules (DNA and Proteins) - Conjugation to nanoparticles (ZnS-Fe3O4) - Uses of Bioconjugated Nanoparticles

UNIT V NANO DRUG DELIVERY 12

Various Drug Delivery Systems – aerosol - Inhalants - Injectibles – Properties of Nanocarriers – Efficiency of the Systems.

PRACTICALS 15

1.Preparation of Silver Nanoparticles by Chemical Methods
2.Characterization of ZnS nanoparticles by Optical Methods.
3.Templated Synthesis of Fe3O4 Nanoparticles
4.AFM of ZnS nanoparticles.
5.SEM & HRTEM Analysis of silver and Fe3O4 Nanoparticles
6.Bacterial Synthesis of ZnS Nanoparticles.
7.Confocal & TIRF Microscopy of ZnS particles Interactiion with Cell lines

TOTAL : 60 PERIODS

OUTCOME

After the completion of course, the students would have learnt advanced theoretical knowledge in nano science and its application in new bioconjugation and nano delivery system to carry out cutting edge research in future.

TEXTS/REFERENCES

1. Niemeyer, Cristof M and Mirkiu, Chad A. “Nanobiotechnology: Concepts, Applications and Perspectives” Wiley-VCH, 2004.
2. Shoseyov, Oded and Ilan Levy ”NanoBioTechnology: BioInspired Devices and Materials of the Future”, Humana Press, 2007.
3. Rosenthal, Sandra J and D. W. Wright “NanoBiotechnology Protocols” Humana Press, 2005.

Attested

DIRECTOR
Centre For Academic Courses
Anna University, Chennai-600 025.

BT7078 RESEARCH AND RESEARCH METHODOLOGY IN BIOTECHNOLOGY

L	T	P	C
3	0	0	3

OBJECTIVES

The course will provide knowledge about the objectives to perform research and for interpretation of data from experimental results and presenting technical publications.

UNIT I RESEARCH AND ITS METHODOLOGIES (WITH EXAMPLES) 9

Objectives of research; research process – observation, analysis, inference, hypothesis, axiom, theory, experimentation; Types of research (basic, applied, qualitative, quantitative, analytical etc); Features of translational research, the concept of laboratory to market (bench to public) and Industrial R&D.

UNIT II RESEARCH IN BIOTECHNOLOGY – AN OVERVIEW 9

Biological systems and their characteristics that influence the type and outcome of research; Exploratory and product-oriented research in various fields of biotechnology (health, agri, food, industrial etc). Types of expertise and facilities required; Interdisciplinary nature of biotech research; Sources of literature for biotech research

UNIT III EXPERIMENTAL RESEARCH: BASIC CONCEPTS IN DESIGN AND METHODOLOGY 9

Precision, accuracy, sensitivity and specificity; major experimental variables, biochemical measurements, types of measurements, enzymes and enzymatic analysis, antibodies and immunoassays, instrumental methods, bioinformatics and computation, experimental planning – general guidelines

UNIT IV RESULTS AND ANALYSIS 9

Importance and scientific methodology in recording results, importance of negative results, different ways of recording, industrial requirement, artifacts versus true results, types of analysis (analytical, objective, subjective) and cross verification, correlation with published results, discussion, outcome as new idea, hypothesis, concept, theory, model etc.

UNIT V SCIENTIFIC AND TECHNICAL PUBLICATION 9

Different types of scientific and technical publications in the area of biotechnology, and their specifications, Ways to protect intellectual property – Patents, technical writing skills, definition and importance of impact factor and citation index; Assignment in technical writing

TOTAL : 45 PERIODS

OUTCOME

After the completion of course, students will able to design, conduct, and interpret research outcomes for academic and industrial research needs.

TEXT/REFERENCES

1. Essentials of Research Design and Methodology Geoffrey R. Marczyk, David DeMatteo, David Festinger, 2005 John Wiley & Sons Publishers, Inc
2. Biochemical Calculations: How to Solve Mathematical Problems in General Biochemistry, 2nd Edition, Irwin H. Segel, 1976 John Wiley & Sons Publishers, Inc
3. Guide to Publishing a Scientific paper, Ann M. Korner, 2004, Bioscript Press.

Attested

DIRECTOR
Centre For Academic Courses
Anna University, Chennai-600 025.

BT7016 SENSORS AND INSTRUMENTATION FOR BIOAPPLICATIONS L T P C
2 0 2 3

UNIT I **15**

Basic concepts in molecular interactions – types of forces involved (electrostatic, H-bonding, hydrophilic and hydrophobic), characterization of molecular recognition – affinity, avidity, binding and dissociation constants; basic design and characterization of sensor instrumentation - precision, sensitivity, resolution and specificity, errors and standard deviation, linear regression analysis.

UNIT II **15**

Basic concepts in instrumentation: Basic concepts of circuit elements (resistors, capacitors, conductors, diodes and transistors), Integrated Circuits; Measurement devices: AC, DC Voltmeter, Ammeter, LCR Bridge, Oscilloscope.

UNIT III **15**

Working principles of commonly used instrumentation in bioanalysis – gravimetric, optical - microscopic, spectrophotometric, spectrofluorimetric, luminometric; electrochemical; high-throughput devices: microplate readers, biochemical autoanalyzers, thermocyclers, microarray readers.

UNIT IV **15**

Various types of sensors and biosensors– mass, chemical, biochemical, optical, electrical, magnetic, electrochemical and thin film sensors; matrices, sensor arrays, protein immobilization techniques and biosensors.

Sensor applications in biotechnology: Agriculture, food, healthcare, environmental and industrial. Practical aspects of biosensor development: fabrication of an immune biosensor and an enzymatic biosensor.

TOTAL : 60 PERIODS

BT7004 BIOFUELS AND PLATFORM CHEMICALS L T P C
3 0 0 3

UNIT I INTRODUCTION **9**

Cellulosic Biomass availability and its contents. Lignocellulose as a chemical resource. Physical and chemical pretreatment of lignocellulosic biomass. Cellulases and lignin degrading enzymes.

UNIT II ETHANOL **9**

Ethanol as transportation fuel and additive; bioethanol production from carbohydrates; engineering strains for ethanol production from variety of carbon sources to improved productivity.

UNIT III BIODIESEL **9**

Chemistry and Production Processes; Vegetable oils and chemically processed biofuels; Biodiesel composition and production processes; Biodiesel economics; Energetics of biodiesel production and effects on greenhouse gas emissionsIssues of ecotoxicity and sustainability with ; expanding biodiesel production

UNIT IV OTHER BIOFUELS 9

Biodiesel from microalgae and microbes; biohydrogen production; biorefinery concepts

UNIT V PLATFORM CHEMICALS 9

Case studies on production of C3 to C6 chemicals such as Hydroxy propionic acid, 1,3 propanediol, propionic acid, succinic acid, glucaric acid, cis-cis muconic acid.

TOTAL: 45 PERIODS

REFERENCE

1. Lee, Sunggyu; Shah, Y.T. “Biofuels and Bioenergy”. CRC / Taylor & Francis, 2013.

BT7071 ADVANCED GENOMICS AND PROTEOMICS L T P C
3 0 0 3

OBJECTIVES

The course intends to provide advanced theoretical knowledge on the organization andfunction of genomes,functional genomic analyses, andadvanced methods and approaches in proteomics.

UNIT I STRUCTURE OF GENOMES, MAPPING AND SEQUENCING 9

Organization and structure of genomes in prokaryotes, eukaryotes, andorganelles (chloroplast, mitochondrion); Genome mapping methods (genetic and physical);RAPD, RFLP, SNP analyses; Fluorescence In-Situ Hybridization (FISH) techniques;Advances in gene finding and functional prediction; Chain termination and chemical degradation sequencing methods.

UNIT II LARGE SCALE GENOMICS/ FUNCTIONAL GENOMICS ANALYSES 9

Genome-wide association (GWA) analysis; Comparative Genomic Hybridization (CGH); Massively parallel Signature Sequencing(MPSS); Whole genome shot-gun sequencing and its applications. Introduction of Next Generation Sequencing (NGS).

UNIT III TRANSCRIPTOMICS ANALYSES 9

Gene expression analysis by cDNA and oligonucleotide arrays; Micro array experimental analysis and data analysis.Methylome analysis usingmicroarray;ChIP-on-Chip analysis.Bioinformatic analysis of large-scale microarray data for comparative transcriptomics.

UNIT IV SEPARATION AND PROCESSING OF PROTEINS FOR PROTEOMICS 9

Over-view of strategies used for the identification and analysis of proteins; Protein extraction from biological samples (Mammalian Tissues, Yeast, Bacteria, and PlantTissues); 2-DE of proteins for proteome analysis; Liquid chromatography separations in proteomics (Affinity, Ion Exchange, Reversed-phase, and size exclusion); Enzymatic cleavage of proteins. Analysis of complex protein mixtures using Nano-liquid chromatography (Nano-LC) coupled to Mass-spectrometry analysis.

UNIT V MASS SPECTROMETRY AND COMPARATIVE PROTEOMICS 9

Common ionization methods for peptide/protein analysis; Introduction to Mass spectrometers; MALDI-TOF and LC-MS analyses; Comparative proteomics based on

Attested

DIRECTOR
Centre For Academic Courses
Anna University, Chennai-600 025.

global in-vitro and in-vivo labeling of proteins/peptidesfollowed by Mass-spectrometry. Analysis of posttranslationalmodification (PTM) of proteins; Characterization of protein interactions using yeast two-hybrid system and Protein microarrays; Proteomics informatics and analysis of protein functions.

TOTAL: 45 PERIODS

OUTCOME

The students will acquire in-depthknowledge on the methods and approaches in genomics and proteomicsareas which help them to carry out cutting edge academic and industrial research.

TEXTS/REFERENCES

1. S.P. Hunt and F. J. Livesey, (2000) Functional Genomics
2. N. K. Spur, B. D. Young, and S. P. Bryant (1998) ICRF Handbook of Genome Analysis Volume 1 & 2.
3. G. Gibson and S. V. Muse (2002) A primer of Genome Science
4. R. J. Reece (2004) Analysis of Genes and Genomes
5. Rinaldis E. D. and Lahm A (2007)DNA Microarrays. Horizon bioscience.
6. Simpson R. J."Proteins and Proteomics - A Laboratory Manual".Cold Spring Harbour Laboratory Press, 2002.
7. Twyman R. M. "Principles of Proteomics". Taylor & Francis. 2004
8. O'Connor C. D. and Hames B. D. "Proteomics". Scion, 2008.
9. Schena M. "Protein Microarrays". Jones and Bartlett, 2005.
10. Smejkal G. B. and Lazarev A. V. "Separation methods in Proteomics". CRC Press, 2006.

BT7072 ADVANCED TECHNOLOGIES IN OMICS SCIENCES L T P C
3 0 0 3

UNIT I MICRO ARRAYS IN GENOMICS 9

Designing and producing microarrays; types of microarrays; cDNA microarray technology;Oligonucleatide arrays; Sample preparation, labeling, hybridization, generation of microarraydata. Transcriptomics using cDNA and oligonucleotide arrays.

UNIT II NEXT GENERATION SEQUENCING TECHNOLOGIES 9

Over-view of Next Generation Sequencing (NGS) technologies; Principles of NGS byRoche/454, Illumina, Life Technologies, Pacific Biosciences, Ion Torrent technologies;Applications of NGS to disease diagnosis and personalized medicine.

UNIT III PROTEIN MICRO ARRAYS AND YEAST TWO-HYBRID SYSTEM 9

Types of protein arrays; Protein microarray fabrication; Experimental analysis of proteinsarrays.Data acquisition and processing; Applications of protein microarray types.Principles and methods in yeast two-hybrid system, Advances in yeast two hybrid system and its applications.

UNIT IV TWO-DIMENSIONAL GELELECTRO PHORESIS OF PROTEINS 9

Sample preparation, First-dimension IEF with IPG; Second dimensional separation ofproteins; Image analysis of 2-DE gels; DIGE, Protein expression profiling and comparativeproteomics of complex proteomes using 2-DE.

Attested

DIRECTOR
Centre For Academic Courses
Anna University, Chennai-600 025.

UNIT V MASS-SPECTROMETRY 9

Basics of Mass-spectrometry (MS) and bimolecular analysis; Common ionization methodsfor peptide/protein analysis; Principles of Time of Flight (TOF), Ion Trap(IT), and Orbitrapmass analyzers; Mass spectrometry based proteomics: MALDI-TOF, Nano-LC-MS; Gas-chromatograpgy coupled to Massspectrometry;Mass-spectrometry analysis of Post-Translational Modifications of proteins.

TOTAL : 45 PERIODS

REFERENCES

1. Schena M. (2000) DNA Microarrays _ A Practical Approach. Oxford University Press.
2. Rinaldis E. D. and Lahm A (2007) DNA Microarrays. Horizon bioscience.Causton,H.C
3. Muller H. J. and Roder T. (2006) Microarrays. Elsevier Academic Press
4. Causton H. C., Quackenbush J., and Brazma A. (2004) A Beginner's Guide
5. Microarray. Gene Expression Data Analysis.Blackwell Publishing.
6. Schena M. (2005) Protein Microarrays. Jones and Bartlett Publishers
7. O'Connor C. D. and Hames B. D. (2008) Proteomics. Scion Publishing Ltd
8. Hoffman E. D. and Stroobant V. (2007) Mass Spectrometry – Principles and Applications, John Wiley & Sons Ltd.

BT7008 COMPUTATIONAL TECHNIQUES IN BIOPROCESS L T P C
2 0 2 3

UNIT I 9

Computation and Error Analysis. Linear Systems and Equations: Matrix representation; Cramer's rule; Gauss Elimination; Matrix Inversion; LU Decomposition; Iterative Methods; Relaxation Methods; Eigen Values.

UNIT II 9

Bracketing methods: Bisection, Reguli-Falsi; Open methods: Secant, Fixed point iteration, Newton-Raphson; Multivariate Newton's method.
Regression and Curve Fitting, Linear regression; Least squares; Total Least Squares; Interpolation; Newton's Difference Formulae; Cubic Splines.

UNIT III 9

Numerical differentiation, higher order formulae. Integration and Integral Equations, Trapezoidal rules; Simpson's rules; Quadrature.

UNIT IV 9

ODEs: Initial Value Problems - Euler's methods; Runge-Kutta methods; Predictor-corrector methods; Adaptive step size; Stiff ODEs.

UNIT V 9

ODEs: Boundary Value Problems- Shooting method; Finite differences; Over/Under Relaxation (SOR).PDEs: Introduction to Partial Differential Equations.
Note:
In practical MATLAB will be used and applications of these computational techniques in bioprocess starting from simple enzyme kinetics to parameter estimation in bioprocess modelling will be given as examples

TOTAL : 45 PERIODS

BT7079 TISSUE ENGINEERING AND REGENERATIVE MEDICINE

L T P C
3 0 0 3

OBJECTIVES

The course intends to give advanced theoretical knowledge on tissue engineering, Stem cells and its biological applications

UNIT I INTRODUCTION 9

Introduction to tissue engineering: Basic definition; current scope of development; use in therapeutics, cells as therapeutic agents, cell numbers and growth rates, measurement of cell characteristics morphology,number viability,motility and functions.Measurement of tissue characteristics ,appearance,cellular component,ECM component,mechanical measurements and physical properties.

UNIT II TISSUE ARCHITECTURE 9

Tissue types and Tissue components, Tissue repair, Basic wound healing events, Applications of growth factors: Role of VEGF. Angiogenesis,Basic properties,Cell-Matrix& Cell-Cell Interactions, Control of cell migration in tissue engineering.

UNIT III BIOMATERIALS 9

Biomaterials: Properties of Biomaterials ,Surface, bulk, mechanical and biological properties. Scaffolds & tissue engineering, Types of Biomaterials, biological and synthetic materials, Biopolymers, Applications of biomaterials,Modifications of Biomaterials, Role of Nanotechnology.

UNIT IV BASIC BIOLOGY OF STEM CELLS 9

Stem Cells : Introduction, Types & sources of stem cell with characteristics:hematopoietic differentiation pathway, Potency and plasticity of stem cells, sources,embryonic stem cells,hematopoietic and mesenchymal stem cells,Stem Cell markers, FACS analysis, Differentiation,Stem cell systems- Liver, neuronal stem cells, cancer stem cells, induced pleuripotent stem cells.

UNIT V CLINICAL APPLICATIONS 9

Stem cell therapy,Molecular therapy,In vitro organogenesis, Neurodegenrative diseases, spinal cord injury, heart disease,diabetes, burns and skin ulcers, muscular dystrophy, orthopedic applications, Stem cells and Gene therapy, Physiological models,tissue engineering therapies,product characterization,components,safety,efficacy.Preservation – freezing and drying. Patent protection and regulation of of tissue-engineered products,ethical issues.

TOTAL : 45 PERIODS

OUTCOME

The students will acquire knowledge in advanced methods to carry out cutting edge academic and industrial research.

TEXTS/REFERENCES

1. Bernhard O.Palsson,Sangeeta N.Bhatia,"Tissue Engineering" Pearson Publishers 2009.
2. Meyer, U.; Meyer, Th.; Handschel, J.; Wiesmann, H.P. .Fundamentals of Tissue Engineering and Regenerative Medicine.2009.
3. Bernard N. Kennedy (editor). New York : Nova Science Publishers, c2008.Stem cell transplantation, tissue engineering, and cancer applications

4. Raphael Gorodetsky, Richard Schäfer. Cambridge : RSC Publishing, c2011.Stem cell-based tissue repair.
5. R. Lanza, I. Weissman, J. Thomson, and R. Pedersen, Handbook of Stem Cells, Two-Volume, Volume 1-2: Volume 1-Embryonic Stem Cells; Volume 2-Adult & Fetal Stem Cells, 2004, Academic Press.
6. R. Lanza, J. Gearhart etal (Eds), Essential of Stem Cell Biology, 2006, Elsevier Academic press.
7. J. J. Mao, G. Vunjak-Novakovic et al (Eds), Translational Approaches In Tissue Engineering & Regenrative Medicine" 2008, Artech House, INC Publications. Naggy N. Habib, M.Y. Levicar, , L. G. Jiao,., , and N. Fisk, Stem Cell
8. Repair and Regeneration, volume-2, 2007, Imperial College Press.