RAJALAKSHMI ENGINEERING COLLEGE

(An Autonomous Institution Affiliated to Anna University Chennai)

DEPARTMENT OF BIOTECHNOLOGY

CURRICULUM AND SYLLABUS REGULATIONS – 2019

M.TECH –BIOTECHNOLOGY

VISION

To be a department of academic excellence focused on education, research and development and to conquer the frontiers of biotechnology, benefitting the society.

MISSION

- To impart quality technical education
- To continuously enhance and enrich the teaching / learning process
- To provide an ambience for overall development of the students to be more creative, innovative and globally competent ethical professionals
- To promote research and develop technologies and products for the sustenance and wellbeing of the society

PROGRAMME EDUCATIONAL OBJECTIVES

I. This program will strengthen the graduates' foundation in different facets of biotechnology, enhance their knowledge, hone their research skills and prepare them for higher studies and become ideal teachers in reputed academic institutes.

II. This program will inspire, motivate, guide and train graduates to become globally competent and find employment in pharma, food and other biotech industries in R&D, quality control, process control and product development sectors.

III. This program will help graduates with their creative thinking, analytical and managerial skills imbibed with ethical values to develop products, become successful entrepreneurs and serve the society.

PROGRAMME OUTCOMES

1. An ability to research, investigate, critically analyse and solve problems in the different areas of Biotechnology

2. An ability to write and present precise and accurate data, publish papers and communicate the findings to scientific community and society

3. An ability to impart knowledge to enthusiastic young minds and become ideal teachers in reputed academic institutions

4. An ability to find employment in pharma, food and other biotech industries in R&D, quality control, process control and product development sectors or become entrepreneurs imbibed with ethical and humane values

CURRICULUM

SEMESTER I

Sl. No	COURSE CODE	COURSE TITLE	CONTACT PERIODS	L	T	P	C	Category
THEORY								
1	MA19103	Statistical Techniques for Biotechnologist	4	3	1	0	4	BS
2	BY19101	Advanced Genetic Engineering	4	3	1	0	3	PC
3	BY19102	Enzyme Technology and Fermentation Technology	3	3	0	0	3	PC
4	BY19103	Bioinformatics and Applications	4	3	1	0	3	PC
5	PG19101	Research Methodology and IPR	3	3	0	0	3	HS
6		Professional Elective I	3	3	0	0	3	PE
7		Professional Elective II	3	3	0	0	3	PE
8	AC19101	English for Research Paper Writing (Non credit course)	3	3	0	0	0	MC
PRACTICAL								
9	BY19111	Preparative and Analytical Techniques in Biotechnology	4	0	0	4	2	PC
		TOTAL	**31**	**24**	**3**	**4**	**24**	

SEMESTER II

Sl. No	COURSE CODE	COURSE TITLE	CONTACT PERIODS	L	T	P	C	Category
THEORY								
1	BY19201	Bio separation Technology	3	3	0	0	3	PC
2	BY19202	Bioreaction Engineering	4	3	1	0	3	PC
3	BY19203	Biopharmaceuticals and Biosimilars	3	3	0	0	3	PC
4	BY19204	Immunotechnology	3	3	0	0	3	PC
5	BY19205	Advanced Genomics and Proteomics	3	3	0	0	3	PC
6		Professional Elective III	3	3	0	0	3	PE
7		Professional Elective IV	3	3	0	0	3	PE
8	AC 19201	Constitution of India (Non credit course)	3	3	0	0	0	MC
PRACTICAL								
8	BY19211	Immunotechnology Laboratory	4	0	0	4	2	PC
		TOTAL	**29**	**24**	**1**	**4**	**23**	

SEMESTER III

Sl. No	COURSE CODE	COURSE TITLE	CONTACT PERIODS	L	T	P	C	Category
PRACTICAL								
1	BY19311	Advanced Molecular Biology and Genetic Engineering Laboratory	6	0	0	6	3	PE
2	BY19312	Bioprocess and Downstream processing Laboratory	6	0	0	6	3	PE
3		Open elective I	3	3	0	0	3	OE
PROJECT								
4	BY19313	Project Phase – I	12	0	0	12	6	EEC
		TOTAL	**27**	**3**	**0**	**24**	**15**	

SEMESTER IV

Sl. No	COURSE CODE	COURSE TITLE	CONTACT PERIODS	L	T	P	C	Category
PROJECT								
1	BY19411	Project Phase – II	24	0	0	24	12	EEC
TOTAL			**24**	**0**	**0**	**24**	**12**	

TOTAL NO. OF CREDITS: 74

PROFESSIONAL ELECTIVES - I (SEMESTER I)

Sl. No	COURSE CODE	COURSETITLE	CONTACT PERIODS	L	T	P	C
1	BY19P11	Molecular concepts in Biotechnology (For Engineering Stream)	3	3	0	0	3
2	BY19P12	Analytical Techniques in Biotechnology	3	3	0	0	3
3	BY19P13	Metabolic Process and Engineering (For Biotechnology Stream)	3	3	0	0	3
4	BY19P14	Oncogenetics	3	3	0	0	3

PROFESSIONAL ELECTIVES - II (SEMESTER I)

Sl. No	COURSE CODE	COURSETITLE	CONTACT PERIODS	L	T	P	C
1	BY19P15	Advances in Animal Biotechnology	3	3	0	0	3
2	BY19P16	Basics of Chemical Engineering (For Science Stream)	3	3	0	0	3
3	BY19P17	Plant Tissue Culture and Gene Manipulation	3	3	0	0	3
4	BY19P18	Food Science and Technology	3	3	0	0	3

PROFESSIONAL ELECTIVES - III (SEMESTER II)

Sl. No	COURSE CODE	COURSETITLE	CONTACT PERIODS	L	T	P	C
1	BY19P21	Bionanotechnology	3	3	0	0	3
2	BY19P22	Medicinal Chemistry	3	3	0	0	3
3	BY19P23	Advances in Molecular Pathogenesis	3	3	0	0	3

PROFESSIONAL ELECTIVES -IV (SEMESTER II)

Sl. No	COURSE CODE	COURSETITLE	CONTACT PERIODS	L	T	P	C
1	BY19P24	Bioreactor Design and Analysis	3	3	0	0	3
2	BY19P25	Bioprocess Modeling and Simulation	3	3	0	0	3
3	BY19P26	Tissue Engineering	3	3	0	0	3
4	BY19P27	Biofuels and Platform Chemicals	3	3	0	0	3

SUMMARY OF CREDIT DISTRIBUTION

S.NO	SUBJECT AREA	CREDITS PER SEMESTER				CREDITS TOTAL
		I	II	III	IV	
1	BS	4				4
2	HS	3				3
3	PC	11	17			28
4	PE	6	6	6		18
5	OE			3		3
6	EEC			6	12	18
7	MC	*	*			
TOTAL		24	23	15	12	74

MA19103	STATISTICAL TECHNIQUES FOR BIOTECHNOLOGISTS	Category	L	T	P	C
		BS	3	1	0	4

Course objectives:
This course will enable the students

- To introduce the basic concepts of probability, one dimensional and two dimensional Random Variables.
- To provide information about Correlation, Regression and applications.
- To enable the students to use the concepts of Testing of Hypothesis and Design of Experiments.

UNIT I	RANDOM VARIABLE AND PROBABILITY DISTRIBUTION	15

Discrete random variable – Probability mass function – Properties – Continuous random variable – Probability density function – Properties – Moments : Mean and variance with properties –Special distributions : Binomial, Poisson, Geometric, Uniform, Exponential, Gamma, Weibull and Normal – Properties - Simple Problems.

UNIT-II	SAMPLING DISTRIBUTIONAND ESTIMATION THEORY	15

Random sampling – Sample mean and variance – Standard error – Simple problems –Estimator: Unbiasedness – Maximum likelihood estimation – Method of moments – Curve fitting by the method of least squares: Fitting curves of the form $y = ax + b,\ y = ax^2 + bx + c,\ y = ab^x$ and $y = ax^b$ - Multiple regression lines.

UNIT-III	TESTING OF HYPOTHESIS	15

Sampling distributions – Type I and Type II errors – Tests based on Normal, t, χ^2 and F distributions for testing of mean, difference between two means, proportion, difference between two proportions, variance, ratio of two variances – Independence of attributes (r x c contingency table) - Goodness of fit.

UNIT-IV	NON PARAMETRIC STATISTICS	15

One sample sign test – Sign test for paired samples – Signed rank test – Rank-sum test: The U-test – Rank-sum test: The H-test – Test based on runs.

UNIT-V	DESIGN OF EXPERIMENTS	15

Completely random design – Randomized complete block design – Analysis of variance: One-way and two - way classifications – Latin square design - 2^2 factorial design.

Total Contact Hours	:	75

Course outcomes:
Upon completion of the course, the students will be able to

- Apply the basic concepts of probability, one dimensional and two dimensional Random Variables.
- Apply the concept of sampling distribution for estimation theory and curve fitting.
- Enable the students to use the concepts of Testing of Hypothesis for industrial problems
- Test the hypothesis for population parameter not obeying normal distribution
- Apply the concept of ANOVA in decision making in the industrial problems

Reference books:

- Veerarajan T, Probability, statistics and random process with queueing theory and queueing networks, 4th edition, McGraw - Hill Publishing Company Limited
- Spiegel Libschutz, "Probability and Statistics ", 4th Edition, McGraw Hill, New Delhi, 2010.
- FreundJ.E., " Mathematical Statistics ", 5th Edition, Prentice Hall of India.
- Miller I and Miller M., "Mathematical Statistics ", 7th Edition, Pearson Education Inc. (10th impression), 2012.
- Jay L. Devore," Probability and Statistics for Engineering and Sciences", 8th Edition, Cengage Learning Pvt. Ltd., New Delhi, 2014.
- Johnson, R.A and Gupta C. B., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education Int., Asia, 8th Edition, 2011.
- Gupta, S.C. and Kapoor, V. K, "Fundamentals of Mathematical Statistics", Sultan Chand and Sons, 14th Edition, 2016.

PO / CO	PO1	PO2	PO3	PO4
MA19103.1	2	1	2	3
MA19103.2	2	1	2	3
MA19103.3	2	1	2	3
MA19103.4	2	1	2	3
MA19103.5	2	1	2	3
Average	2	1	2	3

BY19101	**ADVANCED GENETIC ENGINEERING**	**Category**	**L**	**T**	**P**	**C**
		PC	**3**	**0**	**0**	**3**

Course objectives:
This course will enable the students

- To develop an understanding towards the cloning vectors.
- To provide knowledge on the gene isolation and screening strategies.
- To develop an understanding towards the DNA sequencing techniques
- To explain the importance of mutation.
- To explain the fundamentals of gene therapy.

UNIT I	**CLONING AND EXPRESSION OF GENES**	**9**
DNA Manipulative enzymes, cloning vectors: plasmids – Host range, copy number. λ phage – Insertional and Replacement vectors, in vitro packaging. Single strand DNA vector – M13 Phage. Cosmids, BAC.Yeast vectors-YRp,YEp,Yip and YAC.Mammalian vector-SV40.Insect vector-transposon.		
UNIT-II	**CONSTRUCTION OF DNA LIBRARIES**	**9**
cDNA library construction : Full length cDNA cloning – CAPture method and Oligo capping. Strategies for Genomic DNA library construction and screening strategies. overview on microarray and its applications.		
UNIT-III	**DNA SEQUENCING**	**9**
DNA sequencing –Chemical & Enzymatic methods, Pyrosequencing, Automated sequence, Genome sequencing methods – top down and bottom up approach. Metagenomics.		
UNIT-IV	**PCR AND MUTAGENESIS**	**9**
PCR – Principle and applications. Different types of PCR – Hot start PCR, Touchdown PCR, Multiplex PCR, Nested PCR, AFLP-PCR, Assembly PCR, Colony PCR, Real-time PCR, RACE PCR – Primer design strategies , SYBR Green assay, Taqman probes. Site directed mutagenesis by PCR,Kunkels'method.		
UNIT-V	**GENE TRANSFER& GENE THERAPY**	**9**
Introduction of foreign genes into animal cells – DNA Microinjection, Retroviral vectors, Trasnsfection of Embryonic stem cells. Transgenic plants -Ti Plasmid, Co integrate and Binary vectors.Gene therapy.		
	Total Contact Hours :	**45**

Course outcomes:
Upon completion of the course, the students will be able to

- Understand the cloning of vectors
- Gain knowledge about the gene isolation and screening strategies.
- Learn DNA sequencing techniques
- Analyse the importance of mutation.
- Apply the fundamentals of gene therapy.

Text books:	
•	T A Brown "Gene cloning and DNA analysis"2006.
•	Mullis kary B ,FerreFrancois,Gibbs "The polymerase chain reaction"1994

Reference books:	
•	Primrose SB and R. Twyman "Principles Of Gene Manipulation &Geneomic Blackwell Science Publications, 2006.
•	Genomes 3 by T.A.Brown, Third Edition (Garland Science Publishing)

PO / CO	PO1	PO2	PO3	PO4
BY19101.1	2	3	3	3
BY19101.2	3	3	3	3
BY19101.3	2	3	3	3
BY19101.4	3	3	3	3
BY19101.5	3	3	3	3
Average	2.6	3	3	3

BY19102	**ENZYME TECHNOLOGY AND FERMENTATION TECHNOLOGY**	**Category**	**L**	**T**	**P**	**C**
		PC	**3**	**0**	**0**	**3**

Course objectives:
This course will enable the students

- To give advanced knowledge about use of fermentation processes in enzyme production
- To help understand utility of enzymes in producing metabolites and other industrial applications

UNIT I	**FUNDAMENTALS OF FERMENTATION**	**9**
Overview of fermentation – Microbial biomass – Microbial Enzymes – Microbial Metabolite – Recombinant products – Media for industrial fermentations – Medium optimization – Medium sterilization – Types of culture medium – Oxygen requirements of industrial fermentation – Mass transfer in fermentation – Determination of K_La values – Factors affecting K_La values in fermentation		
UNIT-II	**INDUSTRIAL FERMENTATION PROCESSES**	**9**
Aerobic and anaerobic fermentations – Development of inocula for industrial fermentation – Batch culture, continuous culture, fed batch culture – Comparison of batch and continuous culture – Submerged and solid state fermentation for the production of enzymes – Immobilization of enzymes – Biocatalysis in organic media using enzymes – Biotransformation		
UNIT-III	**PRODUCTION OF ENZYMES AND METABOLITES**	**9**
Production of Proteases, Cellulases, Lipase, Amylase, Glucose isomerase, Pectinase, Peroxidase – Production of organic acids (Citric acid, Lactic acid) – Production of antibiotics (Penicillin, streptomycin) – Production of vitamins (Vitamin B12, Riboflavin) – production of amino acids (Glutamic acid, Lysine).		
UNIT-IV	**ENZYME KINETICS**	**9**
Overview of enzyme and its action – Time course of enzymatic reactions – Effects of substrate concentration on velocity – Steady state model of enzyme kinetics – Significance of *kcat* and *Km* –Experimental Measurement of *kcat*and*Km* – Linear transformations of enzyme kinetic data – Bi Bi reaction mechanisms – Modes of reversible inhibition.		
UNIT-V	**APPLICATIONS OF ENZYMES**	**9**
Enzymes in organic synthesis – Enzymes as biosensors – Enzymes for food, pharmaceutical, tannery, textile, paper and pulp industries applications – Enzyme for environmental applications – Enzymes for analytical and diagnostic		

applications – Enzymes for molecular biology research.			
	Total Contact Hours	**:**	**45**

Course outcomes: Upon completion of the course, the students will be able to	
•	Fundamentals and important parameters in fermentation processes
•	Industrial fermentation process for enzyme production
•	Industrially important enzymes and their use in producing biological metabolites
•	Enzyme kinetics
•	Applications of enzymes as biosensors and in other varied industrial applications

Text books:	
•	Buchholz, K., Kasche, V. and Bornscheuer, U., "Biocatalysts and Enzyme Technology", WILEY– VCH, 2005.
•	Mansi, E.M.T.EL., Bryce, C.F.A., Demain, A.L. and Allman, A.R., "Fermentation Microbiology and Biotechnology", Taylor and Francis,2006.

Reference books:	
•	Copeland, R. A., "Enzymes", 2 nd Edition, WILEY–VCH, 2008.
•	Najafpour, G.D., "Biochemical Engineering & Biotechnology", Elsevier, 2007.
•	McNeil, B., Harvey, L., "Practical Fermentation Technology", John Wiley & Sons, 2008.

PO / CO	PO1	PO2	PO3	PO4
BY19102.1	1	1	2	2
BY19102.2	2	1	2	2
BY19102.3	2	2	2	2
BY19102.4	3	3	2	3
BY19102.5	3	3	2	3
Average	2.2	2	2	2.4

BY19103	**BIOINFORMATICS AND APPLICATIONS**	**Category**	**L**	**T**	**P**	**C**
		PC	**3**	**1**	**0**	**3**

Course objectives: This course will enable the students	
•	To develop skill in Perl Programming and Linux commands.
•	To provide knowledge on DBMS and different Biological Databases.
•	To develop data analysis/visualisation skill with basic knowledge of data analysis
•	To understand different algorithms of Sequence Alignment/Structural Bioinformatics
•	To understand different statistical methods and application in Biology.

UNIT I	**LINUX OS AND PERL**	**9**

File system – Listing Directories – Working with files – Text processing – Shell programmes – Programming in PERL: Name conventions – Variables – Operators – Functions – Control structures – File input and output.		
UNIT-II	**BIOLOGICAL DATA BANKS**	**9**
Design of Relational database – FTP – Integration of databases – Strategies for integration – Methods of data mining – Management of work flow – Analysis of biological database – Biological databases – Primary databases – Secondary databases – Composite databases.		
UNIT-III	**ANALYZING AND VISUALIZING DATA**	**9**
Sequence analysis – Analysis of gene expression – Analysis of protein expression-Gene Network Analysis– Different packages of R for gene expression data analysis. Analysis of mutations in cancer – High-throughput image analysis – High volume scatter plots – Heat maps-visualizing distances – Plotting along genomic coordinates.		
UNIT-IV	**SEQUENCING ALIGNMENT/STRUCTURAL BIOINFORMATICS**	**9**
Models for sequence analysis – Methods of alignment – Scoring matrices: PAM – BLOSUM - Global alignment – Local alignment – FASTA – BLAST – Multiple sequence alignment–SP method – Star alignment. Applications of multiple alignment. Phylogenetic Tree analysis. UPGMA, Neighbor Joining Methods, Tree assessment Bootstrapping. Homology Modeling, ab-initio Modeling, Structural Genomics, Bioinformatics in Drug Design.		
UNIT-V	**STATISTICAL ANALYSIS**	**9**
Probability theory – Methods to describe data – Basic probability distribution – Populations and samples – Hypothesis testing – Scoring a pair wise alignment – Probabilistic model of alignments – HMM approach.		
	Total Contact Hours : 45	

Course outcomes: Upon completion of the course, the students will be able to	
•	Write Perl Program and apply Linux commands.
•	Learn DBMS and come to know about different Biological Databases in detail.
•	Understand data analysis methods and develop skill of data analysis.
•	Apply different algorithm of Sequence Alignment/Structural Bioinformatics
•	Be proficient in application of statistical methods in biology.

Text books:	
•	Rastogi, S.C., "Bioinformatics Concepts, Skills & Applications", 2nd Edition, CBS Publishers, 2009.
•	Wunschiers, R., "Computational Biology", Springer Verlag Publications, 2004.

Reference books:	
•	Gentleman, R., "Bioinformatics and Computational Biology Solutions using R and Bioconductor", Springer Science and Business media Inc.,2005.
•	Jiang, T. and Xu, Y., "Current Topics in Computational Molecular Biology", MIT Press,2002.
•	Pevzner, P., "Computational Molecular Biology: An algorithmic approach", 2nd Edition, MIT Press, 2000.

PO / CO	PO1	PO2	PO3	PO4
BY19103.1	1	2	2	2
BY19103.2	1	2	2	2
BY19103.3	1	2	2	2
BY19103.4	1	2	2	2
BY19103.5	1	2	2	2
Average	1	2	2	2

PG19101	RESEARCH METHODOLOGY AND IPR	Category	L	T	P	C
		HS	3	0	0	3

Course objectives:
This course will enable the students

- To inculcate the importance of research methodology and Intellectual Property Rights. The main objective of the IPR is to make the students aware of their rights for the protection of their invention done in their project work .To get registration of patents in our country and foreign countries of invention, designs and thesis or theory written. To get knowledge of patents, copy right, trademarks and designs.

UNIT I	RESEARCH METHODOLOGY	9

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations.

UNIT-II	REVIEW OF LITERATURE AND TECHNICAL WRITING	9

Effective literature studies approaches, analysis Plagiarism, Research ethics, Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.

UNIT-III	INTELLECTUAL PROPERTY RIGHTS	9

Nature of Intellectual Property: Patents, Designs, Trade and Copyright, copyright registration in India Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under Patent Cooperation Treaty.

UNIT-IV	PATENT RIGHTS AND RECENT DEVELOPMENTS IN IPR	9

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

UNIT-V	INDUSTRIAL DESIGNS AND GEOGRAPHICAL INDICATIONS	9

Industrial designs and IC Layout design, Registrations of designs, conditions and procedures of industrial designs-Cancellation of Registration, International convention of design- types and functions. Semiconductor Integrated circuits and layout design Act- Geographical indications-potential benefits of Geographical Indications.

	Total Contact Hours	:	45

Course outcomes:
Upon completion of the course, the students will be able to

- understand the research problem formulation and analyze research related information
- Understanding that when IPR would take such important place in growth of individuals & nation.
- Understand the importance of copyright and industrial designs
- Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits
- Be aware of acquiring the patent and copyright for their innovative works.

Text books:

- Neeraj Pandey and Khushdeep Dharni, Intellectual Property Rights, First edition, PHI learning Pvt. Ltd., Delhi, 2014
- Uma Sekaran and Roger Bougie, Research methods for Business, 5th Edition, Wiley India, New Delhi, 2012.
- Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students',2nd edition, Juta Academic, 2001.
- Ramakrishna B & Anilkumar H S, Fundamentals of Intellectual Property Rights, Ist edition, Notion Press, 2017.

Reference books:	
•	William G Zikmund, Barry J Babin, Jon C.Carr, Atanu Adhikari,Mitch Griffin, Business Research methods, A South Asian Perspective, 8th Edition, Cengage Learning, New Delhi, 2012.

PO / CO	PO1	PO2	PO3	PO4
PG19101.1	1	3	3	2
PG19101.2	1	3	3	2
PG19101.3	1	3	3	2
PG19101.4	1	3	3	2
PG19101.5	1	3	3	2
Average	1	3	3	2

AC19101	**ENGLISH FOR RESEARCH PAPER WRITING**	**Category**	**L**	**T**	**P**	**C**
		MC	**3**	**0**	**0**	**0**

Course objectives:
This course will enable the students

- To express technical ideas in writing
- To plan and organize the research paper
- To understand the structure and familiarise the mechanics of organised writing
- To improvise academic English and acquire research writing skills

UNIT I	**INTRODUCTION TO RESEARCH WRITING**	**9**
Research – Types of Research - Selecting the Primary resources - Categorizing secondary sources - Discovering a researchable area and topic – Need Analysis - Research Question- Focussing on the Research Problem- Developing Research Design – Framing the Hypothesis – Identifying the Scope of the Research - Writing – General and Academic Writing.		
UNIT-II	**LANGUAGE OF WRITING**	**9**
Active reading – text mining – use of academic words – jargons – ambiguities – use of expression – use of tense - proper voices – third person narration – phraseology – use of foreign words – use of quotes – interpreting quotes.		
UNIT-III	**THE FORMAT OF WRITING**	**9**
Types of Journals - different formats and styles - IEEE format - Structure – Margins - Text Formatting - Heading and Title - Running Head with Page Numbers - Tables and illustrations - Paper and Printing - Paragraphs - Highlighting – Quotation – Footnotes.		
UNIT-IV	**ORGANISING A RESEARCH PAPER**	**9**
Title- Abstract – Introduction – Literature review - Methodology - Results –Discussion –Conclusion - Appendices - Summarising - Citation and Bibliography		
UNIT-V	**PUBLISHING PAPER**	**9**
Finding the Prospective publication or Journal - analysing the credits - Reviewing - Revising – Plagiarism Check - Proof reading - Preparing the Manuscript- Submitting - Resubmitting - Follow up - Publishing		
	Total Contact Hours : 45	

Course outcomes:
Upon completion of the course, the students will be able to

- Understand the basic structure of research work
- Apply proper use of language in writing paper
- Comprehend different formats of journal paper
- Learn the process of writing a research paper

•	Know the process of publishing journal paper

Text books:	
•	Adrian Wallwork: "English for Writing Research Papers", Springer Science Business Media, Second Edition, LLC 2011
•	Stephen Howe and Kristina Henrikssion: "Phrasebook for Writing Papers and Research in English", The Whole World Company Press, Cambridge, Fourth edition 2007
•	The Modern Language Association of America: "MLA Handbook for Writers of Research Papers" 8th Edition, The Modern Language Association of America, 2016
•	Rowena Murray: The Handbook of Academic Writing: A Fresh Approach, Sarah Moore Open University Press, 2006 Open University Press, 2006
•	Stephen Bailey: Academic Writing: A Practical Guide for Students Routledge Falmer: 2003
•	Joseph M. Moxley: Publish, Don't Perish: The Scholar's Guide to Academic Writing and Publishing, Praeger Publishers, 1992.

PO / CO	PO1	PO2	PO3	PO4
AC19101.1	1	1	1	1
AC19101.2	2	2	2	2
AC19101.3	3	3	3	3
AC19101.4	3	3	3	3
AC19101.5	3	3	3	3
Average	2.4	2.4	2.4	2.4

BY19111	**PREPARATIVE AND ANALYTICAL TECHNIQUES INBIOTECHNOLOGY**	**Category**	**L**	**T**	**P**	**C**
		PC	**0**	**0**	**4**	**2**
Course objectives: This course will enable the students						
•	To prepare the student in all the latest preparative and analytical techniques required in research or Industry.					

LIST OF EXPERIMENTS	
1	Preparation of Acetate, Tris and Phosphate Buffer. Validation of Henderson Hasselbach equation.
2	Reactions of amino acids – Ninhydrin, Pthalaldehyde, Dansyl chloride – measurement sing colorimetric and fluorimetric methods.
3	Differential estimations of carbohydrates – reducing vs non-reducing, polymeric vs 13 oligomeric, hexose vs pentose.
4	Estimation of protein concentration using Lowrys' method and Dye-bindingmethod.
5	DNA determination by UV-Vis Spectrophotometer – hyperchromic effect.
6	Separation of lipids by TLC.
7	Enzyme Kinetics: Direct and indirect assays – determination of Km, Vmax and Kcat, Kcat/Km
8	Enzyme Immobilisation studies.
9	Ion-exchange Chromatagraphy – Purification of IgG andAlbumin
10	Gel filtration – Size based separation of protein.
11	Affinity chromatography – IMAC purification of His-tagged recombinantprotein
12	Assessing purity by SDS-PAGE GelElectrophoresis

TOTAL PERIODS:90

COURSE 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.

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

PO / CO	PO1	PO2	PO3	PO4
BY19111.1	3	3	3	2
BY19111.2	3	3	2	3
BY19111.3	3	2	2	3
BY19111.4	3	3	2	3
BY19111.5	3	3	2	3
Average	3	2.8	2.2	2.8

BY19201	**BIOSEPARATION TECHNOLOGY**	**Category**	**L**	**T**	**P**	**C**
		PC	**3**	**0**	**0**	**3**

Course objectives:
This course will enable the students

•	Understand the methods to obtain pure proteins, enzymes and in general about product development R &D
•	Have depth knowledge and hands on experience with on Downstream processes

UNIT I	**DOWNSTREAM PROCESSING**	**8**
Introduction to downstream processing principles characteristics of biomolecules and bioprocesses. Cell disruption for product release – mechanical, enzymatic and chemical methods. Separation characteristics of proteins and enzymes – size, stability, properties – Flocculation and conditioning of broth – Process design criteria for various classes of bio products (high volume, low value products and low volume, high value products).		
UNIT-II	**PHYSICAL METHODS OF SEPERATION**	**9**
Unit operations for solid-liquid separation - Filtration at constant pressure and at constant rate – cake filtration– Types of filtration equipment's – Centrifugation – Basic principles, design characteristics – Types of centrifuges and applications and centrifugation.		
UNIT-III	**ISOLATION OF PRODUCTS**	**10**
Theory, Design consideration and configuration of membrane separation processes – Reverse osmosis, microfiltration, ultra filtration, dialysis and pervaporation – Structure and characteristics of membranes – Membrane modules – Enrichment Operations – Extraction– Aqueous two-phase extraction process – Adsorption isotherms and techniques – Protein precipitation – Methods of precipitation.		
UNIT-IV	**PRODUCT PURIFICATION**	**10**
Chromatography – Classification of chromatographic techniques – General description of column chromatography –		

Chromatographic terms and parameters – Practice of chromatography – Partition, normal-phase, displacement, reversed-phase, size exclusion, ion exchange, hydrophobic, affinity chromatography – Scale-up of chromatography – Process considerations in Preparative liquid chromatography and HPLC .			
UNIT-V	**FINAL PRODUCT FORMULATION AND FINISHING OPERATIONS**		**8**
Drying – Mechanism, methods and applications, Types of dryers – Tray, spray, rotary, belt, disc – Crystallization – Nucleation , growth – Types of crystallizers – Freeze drying – Principle, process, applications – Case studies- Citric acid, Penicillin , cephalosporin.			
	Total Contact Hours	**:**	**45**

Course outcomes: Upon completion of the course, the students will be able to	
•	Define the importance and fundamentals of downstream processing for product recovery.
•	Understand the requirements for successful operations of downstream processing in solid liquid separation.
•	Describe the components of downstream equipment in liquid- liquid separation.
•	Apply the principles of various chromatographic techniques used in downstream processing.
•	Learn the mechanism and applications in finishing operations and formulations.

Text books:	
•	Belter, P.A. E.L. Cussler And Wei-Houhu – "Bioseparations – Downstream Processing For Biotechnology, Wiley Interscience Pun.(1988).
•	Sivasankar, B. "Bioseparations : Principles and Techniques". PHI,2005.
•	Ghosh, R., "Principles of Bioseparations Engineering", World Scientific Publishers,2006.

Reference books:	
•	R.O. Jenkins, (Ed.) – Product Recovery In Bioprocess Technology – Biotechnology By Open Learning Series, Butterworth-Heinemann(1992).
•	J.C. Janson And L. Ryden, (Ed.) – Protein Purification – Principles, High Resolution Methods And Applications, VCH Pub.1989.
•	R.K. Scopes – Protein Purification – Principles And Practice, Narosa Pub.(1994).

PO / CO	PO1	PO2	PO3	PO4
BY19201.1	3	3	2	3
BY19201.2	3	3	2	3
BY19201.3	3	3	2	3
BY19201.4	3	3	2	3
BY19201.5	3	3	2	3
Average	3	3	2	3

BY19202	**BIOREACTION ENGINEERING**	**Category**	**L**	**T**	**P**	**C**
		PC	**3**	**0**	**0**	**3**

Course objectives: This course will enable the students	
•	To learn the stoichiometry and balances of substrate and biomass.
•	To learn and find the different modes of cultivation parameters and its kinetics.

•	To study about the various structured kinetic models and its application techniques.
•	To solve the practical problems arising on the performance of bioreactors.
•	Towork on immobilized bed bioreactors.

UNIT I	**METABOLIC STOICHIOMETRY AND ENERGETICS**	**9**
Mass and energy balance in biological system – Stoichiometry of cell growth and product formation – Elemental balances, degrees of reduction of substrate and biomass, available electron balances, yield coefficients of biomass and product formation – Maintenance coefficients – Oxygen consumption and heat evolution in aerobic cultures – Thermodynamic efficiency of growth.		
UNIT-II	**MICROBIAL GROWTH, KINETICS, MAINTENANCE AND PRODUCT FORMATION**	**9**
Phases of cell growth in batch cultures – Simple unstructured kinetic models for microbial growth – Substrate utilization and product formation – Growth associated and non-growth associated product formation kinetics – Monod and Leudeking-Piret models – Effects of inhibition – Determination of kinetic parameters by batch, fed batch and continuous culture and analysis of chemo state performance – Role of maintenance and endogenous metabolism in substrate utilization andgrowth.		
UNIT-III	**STRUCTURED MODELS**	**9**
Structured models for growth and product formation – Compartmental and metabolic models , Chemically and genetically structured models – Kinetics of growth and product formation by filamentous organisms – Considerations for the production of r-DNAproducts.		
UNIT-IV	**MASS TRANSFER IN BIOLOGICAL SYSTEMS**	**9**
Interphase Gas-Liquid mass transfer – General oxygen balances for Gas-Liquid transfer – Volumetric mass transfer co-efficient – Models for oxygen transfer in large scale bioreactors – Case studies for large scale bioreactors – Model for oxygen gradients in air lift bioreactor		
UNIT-V	**DIFFUSION AND BIOLOGICAL REACTION IN IMMOBILIZED BIOCATALYST SYSTEMS**	**9**
External mass transfer – Internal diffusion and reaction within biocatalysts – Derivation of finite difference model for diffusion – Reaction systems – Dimensionless parameters from diffusion – Reaction models – Effectiveness factor concept – Case study for diffusion with biological reaction		
	Total Contact Hours : 45	

Course outcomes: Upon completion of the course, the students will be able to	
•	Learn about the stoichiometry and balances of substrate and biomass.
•	Gain knowledge to find the different modes of cultivation parameters and its kinetics.
•	Gain knowledge about the various structured kinetic models and its application techniques.
•	Solve the practical problems arising on the performance of bioreactors.
•	Work on immobilized bed bioreactors.

Text books:	
•	Dunn, I.J., Heinzle, E., Ingham, J. and Prenosil, J.E., "Biological Reaction Engineering", 2nd Edition, WILEY-VCH publications,2003.
•	Dutta, R., "Fundamentals of Biochemical Engineering", Springer,2008.
•	Shuler, M.L. and Kargi, F., Bioprocess Engineering: Basic concepts, 2nd Ed., Prentice-Hall,2002.
•	Doran Pauline M, Bioprocess Engineering Principles, 2nd Ed., Academic Press,1995.
•	Nielsen,J.andVilladsen,J.,BioreactionEngineeringPrinciples,2ndEd.,Springer,2007.
•	Blanch,H.WandClarkD.S.,BiochemicalEngineering,2nd Ed., MarcelDekker,1997.

Reference books:	
•	Najafpour, G.D., "Biochemical Engineering & Biotechnology", Elsevier,2007.
•	Truskey, G.A., Yuan, F. and Katz, D.F., "Transport Phenomena in Biological Systems", Pearson Prentice Hall,2004.
•	Katoh, S. and Yoshida, F., "Biochemical Engineering – A Text Book for Engineers, Chemists and Biologists", Wiley publications,2009.

PO / CO	PO1	PO2	PO3	PO4
BY19202.1	2	3	2	3
BY19202.2	2	3	2	3
BY19202.3	2	3	2	3
BY19202.4	2	3	2	3
BY19202.5	2	3	2	3
Average	2	3	2	3

BY19203	**BIOPHARMACEUTICALS AND BIOSIMILARS**	**Category**	**L**	**T**	**P**	**C**
		PC	**3**	**0**	**0**	**3**

Course objectives:
This course will enable the students

•	To provide knowledge on drug development approval process.
•	To impart knowledge in advanced molecular concepts in Biosimilar production
•	To provide knowledge on the lyophilized products

UNIT I	**DRUG DEVELOPMENT**	**9**
Drug development, Pharmacokinetics – Absorrption, Distribution, Metabolism and Excretion. Pharmacodynamics.		
UNIT-II	**RECOMBINANT BIOPHARMACEUTICALS & DOSAGE FORMS**	**9**
Medically important recombinant proteins – Factor VIII – Human insulin – Human somatotropin. Formulation of tablet –coated tablets, gelatin capsules, suspension and emulsion.		
UNIT-III	**BIOSIMILARS**	**9**
Biosimilar medicine-INN nomenclature system – key trends in biosimilar product development – Production of biosimilar products –Non clinical and clinical study – Regulation and approval process		
UNIT-IV	**LYOPHILIZATION AND PRODUCT ANALYSIS**	**9**
Lyophilization equipment – Protein based contaminants – Detection of protein based impurities – Immunological approach – Endotoxin and other pyrogenic contaminants.		
UNIT-V	**ADJUVANT TECHNOLOGY AND CONTROLLED RELEASE MEDICATION**	**9**
Safe and potent adjuvant for human use – Development – Mineral adjuvant – Mucosal and non-parenteral – Adjuvants in non-infectious disease vaccine – T cell adjuvants – Clinical evaluation of adjuvants. Controlled release medication –oral osmotic pump and osmotic pressure activated drug delivery systems.		
	Total Contact Hours : 45	

Course outcomes: Upon completion of the course, the students will be able to	
•	Understand the basic principles of preclinical trials and clinical trials
•	Obtain knowledge in concept of genetic engineering in the production of recombinant products.
•	Understand the approval process involved in Biosimilar production

•	Learn various techniques to produce lyophilized products.
•	Obtain knowledge on the formulation of advanced drug delivery system

Text books:	
•	Walsh, G., "Pharmaceutical Biotechnology-Concepts and Application", John Wiley and Sons Publishers, 2007.
•	Crommelin, D.J.A., Sindelar, R.D. and Meibohm, B., "Pharmaceutical Biotechnology: Fundamentals and application", 3rd Edition, Informa Health care, 2007.

Reference books:	
•	Carter, S.J., "Cooper and Gunn's Dispensing for Pharmaceutical Students", CBS Publishers & Distributors,2008.
•	Schijns, V.E.J.C. and Ohagan, D.T., "Immuno potentiators in Modern Vaccines", Elsevier academic press, 2006.
•	Gad, S.C., "Handbook of Pharmaceutical Biotechnology" John Wiley & sons,2007.
•	Reminton"pharmacy practice"

PO / CO	PO1	PO2	PO3	PO4
BY19203.1	2	3	3	3
BY19203.2	2	3	3	3
BY19203.3	2	3	3	3
BY19203.4	3	3	3	3
BY19203.5	2	3	3	3
Average	2	3	3	3

BY19204	**IMMUNOTECHNOLOGY**	**Category**	**L**	**T**	**P**	**C**
		PC	**3**	**0**	**0**	**3**

Course objectives:
This course will enable the students

•	To impart knowledge about the development of immune cells and their function
•	To provide knowledge on immune defense mechanism, through which pathogen elimination occurs
•	To explain the principle of various types of immunological techniques
•	To provide basic knowledge on various types of vaccines and their development
•	To enable the student to lay a strong foundation on immunological oriented research.

UNIT I	**IMMUNE SYSTEM AND ITS RESPONSE**	**9**
Cells of the immune system and their development – Primary and secondary lymphoid organs – Immunity and their types - Humoral immune response – Cell mediated immune responses – Hypersensitivity and their types – T lymphocyte and B lymphocyte Tolerance – Homeostasis in immune system – Cytokines nad Complement role in immuneresponse.		
UNIT-II	**ANTIGEN AND ANTIBODY**	**9**

Antigen – Classification of antigen based in chemical, properties and functions – immunogen – preparation of cellular, bacterial and protein antigen – Antibody- Properties and classification of antibody – Preparation and characterization of polyclonal and monoclonal antibodies – Purification of antibody – Analysis of antigen and antibody reactions (Agglutination and precipitation tests ELISA – RIA – Western Blot – Hybridization – Immunofluorescence nad immunohistochemistry).		
UNIT-III	**CELLULAR IMMUNOLOGICAL TECHNIQUES**	**9**
PBMC separation from the blood – Ficoll-hypaque method – Identification of lymphocytes based on CD markers – FACS – Lymphoproliferation assay – Cr5I release assay – Macrophage cultures detection assays – Rosette assay – Cytokine bioassays: IL2, IFNγ, TNFα – Mixed lymphocyte reaction – HLA typing – Transplantation techniques – T cell cloning.		
UNIT-IV	**VACCINE TECHNOLOGY**	**9**
Principles in vaccine development – Adjuvant, Immunization (Active and Passive immunization) – Vaccine validation – Protein based vaccines – DNA vaccines – Plant based vaccines – Edible vaccine – Recombinant antigens as vaccines – Multivalent subunit vaccine – Reverse vaccinology – New Types of Replicating vaccines.		
UNIT-V	**IMMUNOTHERAPEUTICS**	**9**
Engineered antibodies – Catalytic antibodies, idiotypic antibodies, plantibodies – Combinatorial libraries for antibody isolation. Cancer immunotheraphy and Immunosuprressive therapy – Cytokine therapy – Immunoglobulin therapy: Replacement and immunomodulators – Gene transfer techniques for immunological diseases.		
	Total Contact Hours : 45	

Course outcomes: Upon completion of the course, the students will be able to	
•	Able to understand the role of the immune system on elimination of pathogens
•	Understand the principle of various immunological techniques
•	Able to separate the immune cells based on CD markers and also acquired the ability to perform cytokine bioassay.
•	Basic knowledge about the vaccine principle and their advancement.
•	Articulate applications of immunology in the modern world.

Text books:	
•	Goldsby, R.A., Kindt, T. J., Kuby, J. and Osborne, B. A., "Immunology", Fifth Edition, W H Freeman, 2006.
•	Abbas, A.K., Lichtman, A.H. and Pillai, S., "Cellular and Molecular Immunology", 6th Edition, Elsevier, 2007.
•	Roitt,Ivan.Essential Immunology,9th Ed.,BlackwellScientific,1997.
•	Roitt, I.,Brostoff ,J & Male,D.Immunology,6th Ed.Mosby,2001.
•	Goldsby, R.A., Kindt, T.J., Osbome, B.A&Kerby, J. Immunology, 5th Ed., W.HFreeman,2003.
•	Weir, D.M&Stewart,J.Immunology, 8th Ed.,ChurchillLivingstone,1997.

Reference books:	
•	Fleisher, Dr., "Clinical Immunology Principle", 3rd Edition, Elsevier,2008.
•	Rabson, A., Roitt, I.M. and Delves, P.J. "Really Essential Medical Immunology". 2nd Edition, Blackwell Publishing, 2005.
•	Domitzer, P.R., Mandl, C.W. and Rappuoli, R., "Replicating Vaccine – A New Generation", Springer, 2011.
•	Kenneth Murphy: Janeway'sImmunobiology, 8th Ed. Garland Science, 2011, ISBN:9780815342434.
•	Ajoy Paul: Immunology, Books & Allied (P) Ltd, Kolkata, 2016. ISBN:978-93-84294-72-4.

PO / CO	PO1	PO2	PO3	PO4
BY19204.1	2	2	3	3
BY19204.2	3	3	3	3
BY19204.3	3	3	3	3
BY19204.4	3	3	3	3
BY19204.5	3	2	3	3
Average	2.8	2.8	3	3

BY19205	**ADVANCED GENOMICSAND PROTEOMICS**	**Category**	**L**	**T**	**P**	**C**
		PC	**3**	**0**	**0**	**3**

Course objectives:

This course will enable the students

- Be familiar to the basic biology of modern genomics and the experimental tools that can be used to measure it.
- Be able to discuss the key technological developments that enabled modern genomic and proteomic studies.
- Understand principles and technologies for generating genomic information for biotechnological applications.

UNIT I	**INTRODUCTION TO GENOME AND GENE STRUCTURE**	**9**

Introduction: Genome, Genomics, Omics and importance, History of genome projects, Organization and structure of genomes in prokaryotes, eukaryotes, and organelles (chloroplast, mitochondrion); Genome mapping methods (Genetic Mapping –i)Cross breeding and pedigree analysis, ii)DNA markers – RFLPs, SSLPs, SNPs and Physical Mapping – Restriction mapping, Fluorescent in situ hybridization, Radiation hybrid mapping and Sequence tagged site mapping); Advances in gene finding and functional prediction.

UNIT-II	**LARGE SCALE GENOMICS/ FUNCTIONAL GENOMICS ANALYSES**	**9**

Genome projects: The Human genome project, HapMap Project, The 1000 genome project, and The ENCODE Project. Structural genomics: Assembly of a contiguous DNA sequence- shotgun method, clone contig method, and whole –genome shotgun sequencing ,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). Pharmacogenetics – High throughput screening in genome for drug discovery-identification of gene targets, Pharmacogenetics and drugdevelopment

UNIT-III	**TRANSCRIPTOMICS**	**9**

Gene expression analysis by cDNA and oligonucleotide arrays; DNA microarray: understanding of microarray (experimental analysis and data analysis), normalizing microarray data, detecting differential gene expression, correlation of gene expression data to biological process and computational analysis tools (especially clustering approaches).Methylome analysis using microarray; ChIP-on Chip analysis. Bioinformatic analysis of large-scale microarray data for comparativetranscriptomics.

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 Plant Tissues); 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 global in-vitro and in-vivo abelling of proteins/peptides followed by Mass-spectrometry. Analysis of post translational modification (PTM) of proteins; Characterization of protein interactions using yeast two-hybrid system and Protein microarrays; Proteomics informatics and analysis of protein functions.

	Total Contact Hours	**:**	**45**

Course outcomes: Upon completion of the course, the students will be able to	
•	Have basic knowledge about the methods used for genomics and proteomics.
•	Apply functional genomics techniques in the laboratory
•	Familiar with how the methods are applied in real-life scientific research.
•	Know where to access the immense volumes of –omics data
•	In-depth knowledge on the methods and approaches in genomics and proteomics areas which help them to carry out cutting edge academic and industrial research.

Text books:	
•	P. Hunt and F. J. Livesey, (2000) FunctionalGenomics
•	N. K. Spur, B. D. Young, and S. P. Bryant (1998) ICRF Handbook of Genome Analysis Volume 1 & 2.
•	G. Gibson and S. V. Muse (2002) A primer of GenomeScience
•	R. J. Reece (2004) Analysis of Genes andGenomes
•	Rinaldis E. D. And Lahm A (2007) DNA Microarrays. Horizonbioscience.
•	Simpson R. J.“Proteins and Proteomics – A Laboratory Manual”.Cold Spring Harbour Laboratory Press, 2002.
•	Twyman R. M. “Principles of Proteomics”. Taylor & Francis.2004
•	O’Connor C. D. And Hames B. D. “Proteomics”. Scion, 2008.

Reference books:	
•	Schena M. “Protein Microarrays”. Jones and Bartlett, 2005.
•	Smejkal G. B. And Lazarev A. V. “Separation methods in Proteomics”. CRC Press,2006.

PO / CO	PO1	PO2	PO3	PO4
BY19205.1	2	3	2	3
BY19205.2	2	3	2	3
BY19205.3	2	3	2	3
BY19205.4	3	3	3	3
BY19205.5	3	3	3	3
Average	2.4	3	2.4	3

AC 19201	**CONSTITUTION OF INDIA (NON CREDIT COURSE)**	**Category**	**L**	**T**	**P**	**C**
		MC	**3**	**0**	**0**	**0**
Course objectives: To inculcate the values enshrined in the Indian constitution						
•	To create a sense of responsible and active citizenship					
•	To know about Constitutional and Non- Constitutional bodies					
•	To understand sacrifices made by the freedom fighters..					

UNIT I	**INTRODUCTION**	**6**
Historical Background – Constituent Assembly of India – Philosophical foundations of the Indian Constitution – Preamble – Fundamental Rights – Directive Principles of State Policy – Fundamental Duties – Citizenship – Constitutional Remedies for citizens.Constitution' meaning of the term, Indian Constitution: Sources and constitutional history, Features: Citizenship, Preamble, Fundamental Rights and Duties, Directive Principles of State Policy.		
UNIT-II	**STRUCTURE AND FUNCTION OF CENTRAL GOVERNMENT**	**6**
Union Government – Structures of the Union Government and Functions – President – Vice President – Prime Minister – Cabinet – Parliament – Supreme Court of India – Judicial Review.		
UNIT-III	**STRUCTURE AND FUNCTION OF STATE GOVERNMENT AND LOCAL BODY**	**6**
State Government – Structure and Functions – Governor – Chief Minister – Cabinet – State Legislature – Judicial System in States – High Courts and other Subordinate Courts- Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation, Pachayati Raj: Introduction, Elected officials and their roles, ,Village level: Role of Elected and Appointed officials.		
UNIT-IV	**CONSTITUTIONAL FUNCTIONS AND BODIES**	**6**
Indian Federal System – Center – State Relations – President's Rule – Constitutional Functionaries – Assessment of working of the Parliamentary System in India- CAG, Election Commission, UPSC, GST Council and other Constitutional bodies-. NITI Aayog, Lokpal, National Development Council and other Non –Constitutional bodies		
UNIT-V	**MASS SPECTROMETRY AND COMPARATIVE PROTEOMICS**	**6**
British Colonialism in India-Colonial administration till 1857- Revolt of 1857- Early Resistance to British Rule-Rise of Nationalism in India-I**ndian Freedom Struggle under Mahatma Gandhi-**Non- Cooperation Movement-Civil Disobedience Movement- Quit India Movement-British Official response to National movement- Independence of India Act 1947-Freedom and Partition.		
	Total Contact Hours : 30	

Course outcomes: Upon completion of the course, the students will be able to	
•	Understand the functions of the Indian government
•	Understand and abide the rules of the Indian constitution.
•	Gain knowledge on functions of state Government and Local bodies
•	Gain Knowledge on constitution functions and role of constitutional bodies and non constitutional bodies
•	Understand the sacrifices made by freedom fighters during freedom movement

Text books:	
•	Durga Das Basu, "Introduction to the Constitution of India ", Lexis Nexis, New Delhi., 21st ed 2013
•	Bipan Chandra, History of Modern India, Orient Black Swan, 2009
•	Bipan Chandra, India's Struggle for Independence, Penguin Books, 2016
•	P K Agarwal and K N Chaturvedi , Prabhat Prakashan, New Delhi, 1st ed , 2017.
•	Maciver and Page, " Society: An Introduction Analysis ", Mac Milan India Ltd., New Delhi.2nd ed, 2014

Reference books:	
•	Sharma, Brij Kishore, " Introduction to the Constitution of India:, Prentice Hall of India, New Delhi.
•	U.R.Gahai, "Indian Political System ", New Academic Publishing House, Jalaendhar.

PO / CO	PO1	PO2	PO3	PO4
AC19201.1	-	-	3	-
AC19201.2	-	-	3	-
AC19201.3	-	-	3	-
AC19201.4	-	-	3	-
AC19201.5	-	-	3	-
Average	-	-	3	-

BY19211	**IMMUNOTECHNOLOGY LABORATORY**	**Category**	**L**	**T**	**P**	**C**
		PC	**0**	**0**	**4**	**2**

Course objectives:
This course will enable the students

- To teach advanced techniques and skills required in diagnosis, treatment and research in Immunotechnology.
- To acquire knowledge concerning the principles and applications of immunoassay procedure.

LIST OF EXPERIMENTS	
1	Selection and handling of animals for immunological experiments
2	Collection of Blood, Serum and Plasma
3	Blood smear identification of leucocytes by Giemsa stain.
4	Isolation and identification of lymphocytes.
5	Preparation microbial antigen from pathogens
6	Administration of antigen and rising of antiserum in test animal
7	Purification of IgG by Precipitation technique.
8	Slide and Tube agglutination reaction
9	Qualitative analysis of antigen or antibody by ELISA
10	Characterisation of antigens by Immunoblotting.
11	Chromatographic immunoassay(CEA)
12	Immunofluorescence Technique
	TOTAL PERIODS: 90

COURSE OUTCOME
Upon completion of the course, the students will be able to

- Isolate, Identify and characterization of various immune cells.
- Have knowledge on antigen preparation and immunization techniques.
- Learn techniques like developing diagnostic tests, purification of antibody, Antigen –Antibody engineering etc for industrial applications.
- Access health problems with an immunological background.
- Develop approaches for immune intervention.

Reference books:

- Antibodies: A Laboratory Manual, Ed Harlow, David P Lane, Cold Spring Harbor Laboratory Press, 2nd Edition, 1998
- Current protocols in immunology / editorial board John E. Coligan .et al,. 2003, New York : Wiley Interscience,2003

•	Ashim K. Chakravarthy, Immunology, TataMcGraw-Hill, 1998.

PO / CO	PO1	PO2	PO3	PO4
BY19211.1	3	3	3	3
BY19211.2	3	3	3	3
BY19211.3	3	3	3	3
BY19211.4	3	3	3	3
BY19211.5	3	2	3	3
Average	3	2.8	3	3

BY19311	**ADVANCED MOLECULAR BIOLOGY AND GENETIC ENGINEERING LABORATORY**	**Category**	**L**	**T**	**P**	**C**
		PC	**0**	**0**	**6**	**3**

Course objectives:
This course will enable the students

•	To learn and understand the principles behind the cloning and expression of agene
•	To perform nucleic acid assays
•	To study the recombinant protein expression

LIST OF EXPERIMENTS	
1	Isolation of Genomic DNA and Plasmid DNA from bacteria
2	Restriction Digestion and ligation of the plasmid vector
3	Transformation to *E.coli*
4	Polymerase chain reaction.
5	Colony PCR
6	Gel elution of DNA fragments.
7	Optimisation of inducer time and concentration for recombinant protein expression.
8	Western blotting analysis
9	Extraction of RNA
10	cDNA preparation from RNA
11	Site directed mutagenesis
12	Southern blotting – Non radioactive
	TOTAL PERIODS: 90

COURSE OUTCOME
Upon completion of the course, the students will be able to

•	Understand the basic principles of molecular biotechnology and assays
•	Obtain practical knowledge in analysing nucleic acid molecules both quantitatively and qualitatively
•	Gain knowledge in concept of genetic engineering
•	Acquire ability to use PCR techniques, to create site directed mutagenesis and detect disease- causing microbes.
•	Learn various techniques to make transgenic plants and transgenic animals.

Reference books:	
•	Green M.R and Sambrook J Molecular cloning -A laboratory manual 4th Edition, Cold spring habor laboratory press, USA, 2012.
•	Zyskind J.W and Bernestin S.I Recombinant DNA laboratory manual Revised edition, Academic press, USA 1992.

PO / CO	PO1	PO2	PO3	PO4
BY19311.1	3	2	1	3
BY19311.2	2	3	3	1
BY19311.3	3	3	3	2
BY19311.4	2	1	3	3
BY19311.5	3	2	3	3
Average	2.6	2.2	2.6	2.4

BY19312	**BIOPROCESS AND DOWNSTREAM PROCESSINGLABORATORY**	**Category**	**L**	**T**	**P**	**C**
		PC	**0**	**0**	**6**	**3**

Course objectives:
This course will enable the students

•	This course aims to provide hands on training in Bioprocess and Downstream Processing Lab by performing enzyme kinetics, immobilization techniques and medium optimization methods.
•	To make the students understand the different methods involved in isolation, extraction of components, purification and preservation of products.

LIST OF EXPERIMENTS	
1	Enzyme kinetics, inhibition, factors affecting reaction pH, temperature.
2	Enzyme immobilization studies – Gel entrapment and adsorption immobilisation.
3	Optimization techniques – Plackett Burman, Response surface methodology.
4	Batch cultivation – recombinant *E.coli* – growth rate, substrate utilization kinetics.
5	Fed batch cultivation -*E.coli*, *Pichiapastoris*
6	Continuous cultivation-*E.coli.*
7	Plasmid isolation and stability.
8	Metabolite analysis by HPLC
9	Batch sterilization design
10	Bioreactor studies: Sterilisation kinetics.
11	kLa determination-sodium sulphite method, power correlation method, residence time distribution
12	Cell separation methods; Centrifugation and microfiltration
13	Cell disruption methods: Chemical lysis and Physical
14	Product concentration: Precipitation, ATPS, Ultrafiltration
15	High resolution purification; Ion exchange, affinity and Gel filtration chromatography, Freeze drying
16	Animal cell culture production: T-flask, spinner flask, bioreactor
17	Plant cell culture-Photo-bioreactor.
	TOTAL PERIODS: 90

COURSE OUTCOME	
•	The students will be able to explain about enzyme kinetics and characterization and how to use them for

	practical applications.
•	The students will learn about immobilization techniques and optimization methods.
•	The students will be able to evaluate the growth kinetics of microorganisms.
•	The students will get a better knowledge about isolation, extraction and purification techniques.
•	The students will have a good handling experience on plant cell culture and the various media used for its growth.

Reference books:	
•	Shuler, M.L. and Kargi, F., Bioprocess Engineering: Basic concepts, 2nd Ed., Prentice-Hall, 2002.
•	Doran Pauline M, Bioprocess Engineering Principles, 2nd Ed., Academic Press, 1995.

PO / CO	PO1	PO2	PO3	PO4
BY19312.1	3	2	1	3
BY19312.2	2	3	3	1
BY19312.3	3	3	3	2
BY19312.4	2	1	3	3
BY19312.5	3	2	3	3
Average	2.6	2.2	2.6	2.4

PROFESSIONAL ELECTIVES

BY19P11	MOLECULAR CONCEPTS IN BIOTECHNOLOGY (FOR ENGINEERING STREAM)	Category	L	T	P	C
		PE	3	0	0	3

Course objectives:
This course will enable the students

- To provide knowledge for understanding the molecular machinery of living cells
- To impart knowledge of advanced molecular concepts in genetic engineering in the modern era
- To provide knowledge on the importance of human genome project with related to research

UNIT I	**DNA, RNA AND PROTEIN SYNTHESIS**	**9**
Concept and organization of genetic materials – Types of DNA & RNA – DNA replication, Decoding genetic information – Regulation of gene expression – Protein synthesis, Transcription and translation. Regulation of transcription in bacteria and eukaryotes – Non-coding RNAs – DNA repair mechanism.		
UNIT-II	**MANIPULATION OF GENE EXPRESSION IN PROKARYOTE**	**9**
Prokaryotic genome organization - Regulatable promoters, fusion proteins – Construction, cleavage and use of fusion proteins – Unidirectional tandem gene arrays and translation expression vectors – Protein stability – Oxygen limitation, protease deficient host strains, bacterial hemoglobin *Vitreoscill*sp. – Increased protein secretion – Factor Xa and bacteriocin		
UNIT-III	**DIRECTED MUTAGENESIS AND PROTEIN ENGINEERING**	**9**
Directed mutagenesis – Oligonucleotide-directed mutagenesis with M13 virus and plasmid DNA – PCR amplified oligonucleotide directed mutagenesis – Protein thermo stability – Addition of disulfide bonds, reduction in free sulfhydryl residues – Increasing enzyme activity – Modifying the substrate binding specificity, modifying metal cofactor requirements – Restriction modification enzymes – Zinc finger proteins.		
UNIT-IV	**TRANSGENIC ANIMALS**	**9**
Concept of genetic engineering – Techniques in genetic engineering - Transgenic animals – Gene transfer methods – Retroviral vector method, DNA microinjection, engineered embryonic stem cell, nuclear transfer, YAC – Applications of transgenic animals – Transgenic livestock – Production of donor organs, pharmaceuticals, disease resistant livestock – Improving milk quality and animal production traits.		
UNIT-V	**HUMAN MOLECULAR GENETICS**	**9**
Genetic linkage and gene mapping – Genetic polymorphism, RFLP, SNP, STRP – Physical mapping of the human genome – Sequence tagged site (STS) for constructing physical maps from YAC, BAC or PAC – Genomic libraries – Transcriptional mapping – Cloning human disease genes and methods – Human Genome Project.		
	Total Contact Hours :	**45**

Course outcomes:
Upon completion of the course, the students will be able to

- Acquire knowledge of basic concepts in genomics
- Acquire knowledge about the importance of cloning vehicle on recombinant gene expression
- Understand the need of site directed mutagenesis on recombinant protein development
- Acquire knowledge on various advanced techniques in gene transfer with, related to transgenic area.
- Articulate the need the human genome mapping on address to various diseases

Text books:

- Glick, B.R., Pasternak, J.J. and Cheryl L. Patten., "Molecular Biotechnology – Principles and Applications of Recombinant DNA", 4th Edition, ASM Press, 2009.
- Wink, M., "An Introduction to Molecular Biotechnology – Molecular Fundamentals, Methods and Applications in Modern Biotechnology", Wiley-VCH Verlag, 2006.
- Clark, D.P. and Pazdernik, N.J., "Biotechnology – Applying the Genetic Revolution", Elsevier Inc., 2009.

•	Kun, L.U.,"Microbial Biotechnology–Principles and Applications", 2nd Edition,
•	Walker, J.M. and Rapley, R., "Molecular Biology and Biotechnology", 5th Edition, RSC publishing, 2009.

Reference books:	
•	Ajoy Paul: Cell and Molecular Biology, 4th Ed., Books and Allied (P) Ltd., Kolkata, 2015.

PO / CO	PO1	PO2	PO3	PO4
BY19P11.1	2	2	3	2
BY19P11.2	3	2	3	3
BY19P11.3	3	2	3	3
BY19P11.4	3	2	3	3
BY19P11.5	3	2	3	3
Average	2.8	2	3	2.8

BY19P12	**ANALYTICAL TECHNIQUES IN BIOTECHNOLOGY**	**Category**	**L**	**T**	**P**	**C**
		PE	**3**	**0**	**0**	**3**

Course objectives:
This course will enable the students

•	To get basic knowledge about the principle and methods of protein crystallization and use of micro fluidics enables crystallization of protein that is available in very small amount.
•	To acquire knowledge on the different chromatographic methods, immune precipitation and for separation of biological compounds which can be used for high-end research?
•	To understand the principle behind 2D gel electrophoresis, the different staining methods and their use in estimating the molecular weight of proteins.
•	To understand the construction and application of various types of microscopy.
•	To familiarize with different spectroscopic techniques, NMR, FTIR which can be used for characterization of the purified proteins.

UNIT I	**PROTEIN CRYSTALLOGRAPHY**	**9**
Biological macro-molecules – Principle of protein crystallization – Method – Testing – Cryotechniques – Influence of heterogeneity on crystallization – Progress in structural genomics – Micro crystallization – Utility of microfluidics for crystallization		
UNIT-II	**PROTEIN AND PEPTIDE PURIFICATION**	**9**
Chromatographic methods for protein and peptide purification – Multidimensional chromatography – High throughput screening of soluble recombinant proteins – Immunoprecipitation – Affinity chromatography for antibody purification – Role of reverse phase HPLC in proteomic research.		
UNIT-III	**ELECTROPHORETIC TECHNIQUES**	**9**
Strategies – Separation of proteins using 2D gel electrophoresis – Electrophoresis method for purifying proteins – *in situ* enzyme detection – Staining method – Separation of peptide mixture – Pulse field gel electrophoresis – Denaturing gradient gel electrophoresis		
UNIT-IV	**MICROSCOPY**	**9**
Microscopy with light and electrons – Electrons and their interaction with the specimen – Electron diffraction – Instrument, specimen preparation and application of TEM and SEM – Fluorescence microscopy – Laser confocal microscopy – Phase contrast – Video microscopy – Scanning probe microscopy.		
UNIT-V	**SPECTROSCOPY**	**9**

Methods for characterizing purified proteins – IR absorption process, IR spectrometer and sample preparation – Instrumentation and applications of UV – Over view of mass spectrometry, ionization methods, mass analysis, detection and quantitation – Circular dichroism (CD) spectroscopy – NMR – Fourier transform infrared spectroscopy (FTIR).

	Total Contact Hours	**:**	**45**

Course outcomes: Upon completion of the course, the students will be able to	
•	Understand the principle and methods of protein crystallization and use of microfluidics enables crystallization of protein that are available in very small amount.
•	Acquire knowledge and perform various chromatographic experiments to evaluate the characteristics of a biological component and can also interpret the chromatograms thereby they can have a better understanding about the component to be analyzed using the different chromatographic methods and immunoprecipitation technique for separation of biological compounds which can be used for high-end research.
•	Able to understand the principle behind 2D gel electrophoresis, the different staining methods and their use in estimating the molecular weight of proteins.
•	Able to understand the construction and application of various types of microscopy to understand the components that makeup the sample for analysis.
•	Knowledge on different spectroscopic techniques, NMR, FTIR which can be used for characterization of the purified proteins.

Text books:	
•	Bhowmik, G. and Bose, S., "Analytical Techniques in Biotechnology", Tata McGraw-Hill Publishers, 2011.
•	Simpson, R.J., "Purifying Proteins for Proteomics", Cold Spring Harbor Lab Press, 2004.

Reference books:	
•	Chandler, D. and Roberso, R.W., "Bioimaging: Current Techniques in Light & Electron Microscopy", Jones and Bartlett publishers, 2008.
•	Babine, R.E. and Abdel-Meguid, S.S., "Protein Crystallography in Drug Discovery", Willy-VCH Verlag GmbH& Co., 2004.
•	Pavia, D.L., Lampman, G.M., Kriz, G.S. and Vyvyan, J.R., "Introduction to Spectroscopy", 4th Edition, Brooks/Cole Cengage Learning, 2008.

PO / CO	PO1	PO2	PO3	PO4
BY19P12.1	3	3	1	3
BY19P12.2	3	3	1	3
BY19P12.3	3	3	1	3
BY19P12.4	3	3	1	3
BY19P12.5	3	3	1	3
Average	3	3	1	3

BY19P13	**METABOLIC PROCESS ANDENGINEERING**	**Category**	**L**	**T**	**P**	**C**
	(FOR BIOTECHNOLOGY STREAM)	**PE**	**3**	**0**	**0**	**3**

Course objectives:	
•	This course work will provide essential knowledge to make career in bioprocess industries and in field of computational systems biology.

UNIT I	**CELLULAR METABOLISM**	**9**
Transport Processes – Fueling reactions – Glycolysis, fermentative pathways – TCA cycle and oxidative phosphorylation, anaplerotic pathways – Catabolism of fats, organic acids, and aminoacids - Biosynthesis of aminoacids, nucleic acids, and fatty acids – Polymerization – Growth energetics.		
UNIT-II	**REGULATION, MANIPULATION AND SYNTHESIS OF METABOLIC PATHWAYS**	**9**
Regulation of enzyme activity – Regulation of enzyme concentration – Regulation of metabolic networks – Regulation at the whole cell level – Metabolic pathway manipulations – Enhancement of Product yield and productivity – Extension of substrate range, product spectrum and novel products (Antibiotics, Polyketides, Vitamins) – Improvement of cellular properties – Metabolic pathway synthesis algorithm – Lysine biosynthesis		
UNIT-III	**ANALYSIS AND METHODS FOR THE METABOLIC FLUX**	**9**
Metabolic flux map – Fluxes through the catabolic pathways in microbes – Metabolic flux analysis for determined, overdetermined and underdetermined systems – Sensitivity analysis – Direct flux determination from fractional label enrichment – Applications involving complete enumeration of metabolite isotopomers – Carbon metabolite balances.		
UNIT-IV	**APPLICATION OF METABOLIC FLUX ANALYSIS**	**9**
Amino acid production – Biochemistry and regulation – Metabolic flux analysis of lysine biosynthetic network and specific deletion mutants – Metabolic fluxes in mammalian cell cultures – Intracellular fluxes, validation of flux estimates by ^{13}C labeling studies – Design of cell culture media.		
UNIT-V	**ANALYSIS OF METABOLIC CONTROL AND STRUCTURE OF METABOLIC NETWORKS**	**9**
Fundamentals of metabolic control analysis (MCA) – Determination of flux control coefficients – MCA of linear and branched pathways – Theory of large deviations – Branched and unbranched networks – Control of flux distribution at a single branch point – Grouping reactions.		
	Total Contact Hours :	**45**

Course outcomes: Upon completion of the course, the students will be able to	
•	Understand the current advances in systems biology
•	Gain insights into the field of metabolic engineering
•	Biosynthesis of primary & secondary metabolites, bioconversions.
•	Gain knowledge about the metabolic flux
•	Understand and apply metabolic networks

Text books:	
•	Stephanopoulos, G.N., Aristidou, A.A. and Nielsen. J., "Metabolic Engineering - Principles and Methodologies", Elsevier Science,2001.
•	Cortossa, S., Aon, M.A., Iglesias, A.A. and Lloyd.D., "An Introduction to Metabolic and Cellular Engineering", World Scientific Publishing Co,2002.
•	Stephanopoulos, G.N., Aristidou, A.A. and Nielsen.J., "Metabolic Engineering - Principles and Methodologies", Elsevier Science,2001.

Reference books:	
•	Scheper, T., "Metabolic Engineering – Advances in Biochemical Engineering
•	Curran, C.P., "Metabolic Processes and Energy Transfers - An Anthology of Current Thought", The Rosen Publishing group, Inc., 2006.
•	Nielsen, J., Villadsen, J. and Liden, G., "Bioreaction Engineering Principles", 2nd Edition, Kluwer Academic / Plenum publishers,2003.

PO / CO	PO1	PO2	PO3	PO4
BY19P13.1	3	2	3	3
BY19P13.2	3	3	3	3
BY19P13.3	3	2	3	3
BY19P13.4	3	3	3	3
BY19P13.5	3	2	2	3
Average	3	2.4	2.8	3

BY19P14	**ONCOGENETICS**	**Category**	**L**	**T**	**P**	**C**
		PE	**3**	**0**	**0**	**3**

Course objectives:

- To enable the students to know cell cycle dys regulation in cancer and various stages of carcinogenesis.
- To understand the molecular basis of cancer and propose new treatment options for cancer patients

UNIT I	**PRINCIPLES OF CANCER BIOLOGY**	**9**
Cancer: Definition, causes, properties, classification, clonal nature – Cell Cycle: Regulation of cell cycle, cell proliferation and apoptosis – Signal transduction pathways – Apoptosis: apoptotic pathways, signal molecules, effects on receptor, signal switches – Modulation of cell cycle in cancer – Mechanism of spread.		
UNIT-II	**PRINCIPLES OF CARCINOGENESIS**	**9**
Cancer risk factors – Theory of carcinogenesis – Chemical carcinogenesis – Physical carcinogenesis: x-ray radiation – mechanisms of radiation carcinogenesis – Stages of cancer: initiation, promotion, progression.		
UNIT-III	**MOLECULAR BIOLOGY OF CANCER**	**9**
Signal targets and cancer – Growth factors – Transformation – Activation of kinases – Oncogenes: c-Myc, Ras, Bcl-2 family – Mechanism of oncogene activation – Retroviruses and oncogenes – Detection of oncogenes – Oncogenes/proto oncogene activity – Tumor suppressor genes: Rb, p53, APC, BRCA paradigms. Telomerases.		
UNIT-IV	**CANCER METASTASIS**	**9**
Clinical significances of invasion – Heterogeneity of metastatic phenotype – Metastatic cascade: basement membrane disruption, invasion – Recent approach to identify key factors controlling metastasis – Angiogenesis.		
UNIT-V	**CANCER THERAPY**	**9**
Therapy forms – Surgery, chemotherapy, radiation therapy - Detection of cancers – Prediction of aggressiveness of cancer – Advances in cancer detection – Tumor markers; New approaches of cancer therapy - mAbs, vaccines, gene therapy, stem cell therapy.		
	Total Contact Hours :	**45**

Course outcomes:
Upon completion of the course, the students will be able to

- To know signal transduction pathways and cell cycle in cancer
- To understand the risk factors and stages of cancer
- To learn oncogenes and tumour suppressor genes
- To evaluate cancer metastasis and angiogenesis
- To analyse chemo, radiation and advanced therapy for cancer

Text books:

- Ruddon, R.W., "Cancer Biology", 2nd Edition, Oxford University Press, 2007
- Weinberg, R.A., "The Biology of Cancer", Taylor & Francis, Garland Science, 2007

Reference books:	
•	Schulz, W.S., "Molecular Biology of Human Cancers – An Advanced Students Text Book", Springer, 2005.
•	Pelengaris, S. and Khan, M., "The Molecular Biology of Cancer", Blackwell Publishing, 2006.
•	Fialho, A. and Chakrabarty, A., "Emerging Cancer Therapy: Microbial Approaches and Biotechnological Tools" 1st Edition, Wiley, 2010.

PO / CO	PO1	PO2	PO3	PO4
BY19P14.1	3	2	3	2
BY19P14.2	3	2	3	3
BY19P14.3	3	2	3	3
BY19P14.4	3	2	3	2
BY19P14.5	3	2	3	3
Average	3	2	3	2.6

BY19P15	**ADVANCES IN ANIMAL BIOTECHNOLOGY**	**Category**	**L**	**T**	**P**	**C**
		PE	**3**	**0**	**0**	**3**

Course objectives:
This course will enable the students

•	To understand the fundamentals of animal cell culture, details of the diseases and therapy
•	To provide the knowledge about the micromanipulation and transgenic animals

UNIT I	**CELL CULTURE TECHNOLOGY**	**12**
History and Scope of Animal Biotechnology, primary and secondary cell culture, cell lines, Scaling up of animal cell culture-monolayer culture: Multiarray disks, spirals and tubes; Roller culture; Microcarriers; Perfused monolayer cultures; Membrane perfusion; Hollow fibre perfusion; Matrix perfusion; Microencapsulation, Suspension culture: Fluidized bed reactors for suspension, Air-lift fermentor, Chemostat/Turbidostat, Bioreactor process control. Chicken embryo fibroblast culture, Chicken liver and kidney culture.		
UNIT-II	**THERAPEUTIC PRODUCTS FROM ANIMAL CELL CULTURE**	**5**
Animal Biotechnology for production of regulatory proteins, blood products, viral vaccines, hormones and other therapeutic proteins, Hybridoma technology.		
UNIT-III	**MOLECULAR BIOLOGY AND GENETIC ENGINEERING**	**9**
Types of animal viral vectors- SV40, adeno virus, retrovirus, vaccinia virus, herpes virus, adeno associated virus and baculo virus. Molecular diagnostics for detection of animal diseases –PCR, Nucleic acid hybridization, DNA based methods for identification of animal species, DNA biosensor chips for GMO detection. Metagenomics in animal gastro intestinal ecosystems.		
UNIT-IV	**REPRODUCTIVE BIOTECHNOLOGY**	**12**
Biotechnological approaches to reproduction, methodology of super ovulation, Oestrus Synchronization and Timed Artificial Insemination, preparation of sperm for IVF; In vitro maturation; Fertilization and culture of embryos; embryo splitting, embryo sexing by different methods and their limitations; Genetics and Epigenetic alterations involved in Assisted Reproductive Technologies (ARTs), Multiple Ovulation and Embryo Transfer; Rate of Genetic Improvement using AI, MOET, ONBS; Embryo transfer in large and small ruminants. Laparoscopic and Laparoscope guided ET. Cryopreservation of sperm and embryos.		
UNIT-V	**APPLICATIONS**	**7**

Knockout mice and mice model transgenesis- methods of transferring genes into animal oocytes, eggs, embryos and specific tissues by physical, chemical and biological methods; Transgenic animals (Mice, Cows, Pigs, Sheep, Goat, Birds and Insects); Biopharming, application of stem cells in animal biotechnology.			
	Total Contact Hours	**:**	**45**

Course outcomes: Upon completion of the course, the students will be able to	
•	Learn the scope of animal biotechnology and develop cell culture based products
•	Design animal cell culture based bioreactors
•	Create molecular tools like probes and diagnose animal diseases
•	Analyze the efficiency of different gene transfer methods and gain knowledge on micromanipulation technology.
•	Understand the use of different transgenic animals in various research areas.

Text books:	
•	Watson, J.D., Gilman, M., WitowskiJ.andZoller, M. Recombinant DNA, 2nd ed., Scientific American Books, 1983
•	Lewin, B. Genes VIII , Pearson Prentice Hall, 2004
•	Davis J.M. Basic Cell Culture: A Practical Approach, IRL Press, 1998 5. Freshney R.I. Animal Cell Culture- a practical approach,1987
•	Freshney R.I. Animal Cell Culture- a practical approach,1987

Reference books:	
•	Portner R Animal cell biotechnology: Methods and Protocols, Humana Press, 2014.
•	Glick, B.R. and Pasternack, J.J. Molecular Biotechnology, 3rd ed., ASM Press, 2003

PO / CO	PO1	PO2	PO3	PO4
BY19P15.1	3	1	3	2
BY19P15.2	-	2	2	3
BY19P15.3	1	3	2	1
BY19P15.4	3	2	3	1
BY19P15.5	2	3	3	1
Average	2	2	3	2

BY19P16	**BASICS OF CHEMICAL ENGINEERING**	**Category**	**L**	**T**	**P**	**C**
	(FOR SCIENCE STREAM)	**PE**	**3**	**0**	**0**	**3**
Course objectives:						
•	To develop skills of the students in the area of chemical Engineering with emphasis in thermodynamics fluid mechanics. This will be necessary for certain other course offered in the subsequent semesters and will serve as a prerequisite.					

UNIT I	**FUNDAMENTALS OF CHEMICAL ENGINEERING**	**9**
Concepts of unit operation and unit process with examples – Units and dimensions, conversion factors, dimensional analysis – Presentation and analysis of data – Mole, density, Specific gravity – Mass fraction, Mole fraction – Analysis of multicomponent system – Concentration.		

UNIT-II	MATERIAL AND ENERGY BALANCES	9
Overall and component material balances – Material balances without chemical reactions – Chemical reactions, stoichiometry, conversion and yield – Material balance calculations with chemical reactions – Combustion calculations – Recycle operations – Energy balances – Entropy, latent heat – Concepts of chemical thermodynamics – Relation to VLE, solution thermodynamics and reaction thermodynamics.		
UNIT-III	**FLUID MECHANICS**	**9**
Laminar and turbulent flow – Basic equations of fluid flow, continuity equations and Bernoulli's equation – Shear – Stress relationships – Non-Newtonian fluids, friction factor and its calculation in laminar and turbulent flow – Operational principles of different types of pumps, compressors and valves – Measurement of fluid flow using venturimeters, orifice meters – Rotameters, pivot tube.		
UNIT-IV	**HEAT TRANSFER**	**9**
Conduction – Concept of heat conduction, Fourier's law of heat conduction: one dimensional steady state heat conduction, equation for flat plate, hollow cylinder – Individual and overall heat transfer coefficients and relationship between them – Convection – Concept of heat transfer by convection, natural and forced convection, equations for forced convection – Operational principles of heat exchangers – Double pipe heat exchangers, shell and tube heat exchangers.		
UNIT-V	**MASS TRANSFER**	**9**
Fick's law of diffusion – Analogy with momentum and heat transfer, diffusivities of gases and liquids, diffusion in binary mixtures, Interphase mass transfer – Film theory of mass transfer, determination of volumetric mass transfer coefficient – Overview of separation operations with examples, ideal stage concept – Mass transfer equipment – Distillation, liquid extraction, gas absorption, drying.		
	Total Contact Hours : 45	

Course outcomes: Upon completion of the course, the students will be able to	
•	Understand the conversion factors and physical properties of gases.
•	Learn the material balances for overall and component balances in any process.
•	Apply the knowledge in energy balance for steady and unsteady state.
•	Define the fluid statics and applications in chemical engineering.
•	Describe the types of pump and its applications.

Text books:	
•	Himmelblau, D.M. and Riggs, J.B., "Basic Principles and Calculations in Chemical Engineering", International Edition, Prentice Hall, 2003.
•	Ghasem, N. and Henda, R., "Principles of Chemical Engineering Processes", CRC Press, 2008.

Reference books:	
•	Coulson, J.M. and Richardson, J.F., "Chemical Engineering", Vol. I, 6th Edition, Butterworth- Heinemann Ltd., 2007.
•	Geankoplis, C.J., "Transport Processes and Unit Operations", Prentice Hall India, 2002.
•	McCabe, W.L., Smith, J.C., and Harriott, P.,"Unit Operations of Chemical Engineering" 7th Edition, McGraw-Hill Higher Education, 2005.

PO / CO	PO1	PO2	PO3	PO4
BY19P16.1	2	2	3	2
BY19P16.2	2	2	3	2
BY19P16.3	2	2	3	2
BY19P16.4	2	2	3	2
BY19P16.5	2	2	3	2
Average	2	2	3	2

BY19P17	PLANT TISSUE CULTURE AND GENE MANIPULATION	Category	L	T	P	C
		PE	3	0	0	3

Course objectives:

- To enable the students to understand details of plant cells, genome and its functions
- To provide the basics of agrobacterium and applications of plant biotechnology.

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**	**9**
Outline of plant tissue culture, transgenic plants, herbicide and pest resistant plants, molecular pharming , therapeutic products, RNA i, Transgene silencing ,ethical issues.		
	Total Contact Hours :	**45**

Course outcomes:
Upon completion of the course, the students will be able to

- Understand the fundamentals of plant cells, structure and functions
- Learn the nitrogen fixation mechanism and significance of viral vectors
- Learn viral vectors and agrobacterium based vectors in creating transgenic plants
- Gain knowledge about the plant tissue culture and transgenic plants
- Gain knowledge for the development of therapeutic products

Text books:

- Grierson D. and Covey, S.N. Plant Molecular Biology, 2nd ed.,Blackie,1988
- Slater A et al. Plant Biotechnology : The Genetic Manipulation of Plants, Oxford University Press, 2003 (1st and 2ndedition)
- Gamburg O.L., Philips G.C. Plant Tissue & Organ Culture: Fundamental Methods. Narosa, 1995.
- Heldt, Hans-Walter, Plant Biochemistry & Molecular Biology, Oxford University Press, 1997.

Reference books:

- Wilkins M.B .Advanced Plant Physiology, ELBS, Longman, 1987.

PO / CO	PO1	PO2	PO3	PO4
BY19P17.1	2	2	3	3
BY19P17.2	2	2	3	3
BY19P17.3	2	2	3	3
BY19P17.4	2	2	3	3
BY19P17.5	2	2	3	3
Average	2	2	3	3

BY19P18	**FOOD SCIENCE AND TECHNOLOGY**	**Category**	**L**	**T**	**P**	**C**
		PE	**3**	**0**	**0**	**3**

Course objectives:
This course will enable the students

- To know about the constituents and additives present in the food.
- To gain knowledge about the microorganisms, which spoil food and food borne diseases.
- To know different techniques used for the preservation of foods.

UNIT I	**FOOD CHEMISTRY**	**12**
Constituent of food – water , carbohydrates, lipids, proteins, vitamins and minerals, dietary sources, role and functional properties in food, contribution to texture, flavor and organoleptic properties of food; food additives – intentional and non-intentional and their functions.		
UNIT-II	**FOOD MICROBIOLOGY**	**8**
Food fermentation; food chemicals and enzymes; food borne diseases – infections and intoxications, Microbiology and spoilage of milk & milk products, meat, fish, poultry & egg, fruits & vegetable, confectionary.		
UNIT-III	**FOOD PROCESSING OPERATIONS**	**8**
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**	**8**
Use of high temperatures – sterilization, pasteurization, blanching, canning; evaporation and drying; frozen storage – freezing curve characteristics. Factors affecting quality of frozen foods; irradiation preservation of foods and preservation using chemicals.		
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; beverages.		
	Total Contact Hours : 45	

Course outcomes:
Upon completion of the course, the students will be able to

- Gain knowledge about the techniques followed in food processing
- Understand about the food fermentation & the role of enzymes in food processing
- Learn about different fermented foods produced
- Understand about food spoilage & different preservation techniques
- Know about the process of quality control in foods

Text books:

- Fellows, P.J., "Food Processing Technology: Principles and Practice", 3rd Edition, CRC Press, 2009.
- Pometto A, Shetty K, Paliyath G and Levin R. E., "Food Biotechnology", 2nd Edition, CRC press, 2005.

Reference books:	
•	Hutkins R. W., "Microbiology and Technology of Fermented Foods", IFT Press series, Volume 32 of Institute of Food Technologists Series, Wiley-Blackwell, 2006.
•	ZeuthenP. and Bogh-Sorensen, L., "Food Preservation Techniques", 1stEdition, CRC Press, 2003.
•	Adams M., Adams M. R. and Robert Nout M. J., "Fermentation and food safety", Springer, 2001.
•	Da-Wen S., "Emerging Technologies for Food Processing", Academic Press, 2005.
•	Coultate, T.P. Food – The chemistry of its components, 2nd Ed., Royal society, 1992.
•	Sivasankar, B. Food processing and preservation, Prentice Hall of India Pvt. Ltd., 2002.
•	Fennema, O.R. Principles of food science: Part I, Food chemistry, Marcel Dekker, 1976.
•	Frazier, W.C. &Westhoff, D.C. Food Microbiology, 4th Ed. McGram-Hill Book Co., 1988.
•	Brenner, J.G., Butters, J.R., Cowell, N.D. & Lilly, A.E.V. Food Engineering Operations, 2nd Ed., Applied Sciences Pub. Ltd., 1979.
•	Pyke, M. Food Science and Technology, 4th Ed., John Murray, 1981.

PO / CO	PO1	PO2	PO3	PO4
BY19P18.1	2	2	3	3
BY19P18.2	2	2	3	3
BY19P18.3	2	1	1	3
BY19P18.4	3	2	2	3
BY19P18.5	2	1	-	3
Average	2.2	1.6	1.8	3

BY19P21	**BIONANOTECHNOLOGY**	**Category**	**L**	**T**	**P**	**C**
		PE	**3**	**0**	**0**	**3**

Course objectives:
This course will enable the students

•	To understand Biological Assembly/Structures in nanoscale
•	To know principles of structural and functional bionanotechnology
•	To gain knowledge on artificial bio assemblies.
•	To understand Biomimetic fabrication
•	To understand the concept of nanomedicine, nanopharmaceuticals and bionanosensor.

UNIT I	**BIOLOGICAL ASSEMBLY AND STRUCTURES ATTHENANO-SCALE**	**9**

Concepts in nanotechnology – Interface between Nanotechnology and Biotechnology – Theoretical basis for Self-Assembly – Combination of Bionanotechnology and Nanobiotechnology – Self-Assembly and Self- Organization of bacterial S-Layers, Viruses, Phospholipids membrane, Fibrillar Cytoskeleton, Nucleic Acids, Oligosaccharides and Polysaccharides, Amyloid Fibrils, Silk, Ribosome – Biological Activity through Self- Assembly – Affinity and Specificity of Biological Interactions – Antibodies as the Molecular Sensors of Recognition.

UNIT-II	**STRUCTURAL AND FUNCTIONAL PRINCIPLES OF BIONANOTECHNOLOGY**	**9**

Biomolecular structure and stability – Protein folding – Self-assembly – Self-organization – Molecular recognition – Flexibility – Information – Driven nanoassembly – Energetics – Chemical transformation – Regulation – Biomaterials – Biomolecular motors – Traffic across membranes – Biomolecular sensing – Self- replication –

Machine-phase bionanotechnology.		
UNIT-III	**BIOTEMPLATING AND ARTIFICIAL BIOASSEMBLIES**	**9**
Experimental strategies of porinMspA as a Nanotemplate – Nanostructuring by deposition of the MspAporin – MspA-Nanochannels generated by the porin/polymer-template Method – Porin-Transport Assay – Scaffolds as Quantum dots, Organic Chains, polymers, DNA structures, Immobile DNA Junctions, Order in DNA and Proteins – Genetically Engineered S-Layer Proteins and S-Layer-Specific Hetero polysaccharides –Versatile molecular construction kit for applications in Nanobiotechnology.		
UNIT-IV	**DNA-BASED NANOSTRUCTURES**	**9**
DNA-Protein nanostructures – Effective Models for Charge Transport in DNA Nanowires - DNA-Based Nanoelectronics - Biomimetic fabrication of DNA based metallic nanowires and networks – DNA-Gold nanoparticle conjugates – Nanoparticles as non-viral transfection agents - Nanocomputing.		
UNIT-V	**NANOMEDICINE,NANOPHARMACEUTICALS AND NANOSENSING**	**9**
Relationships of biotechnology, nanotechnology, and medicine – Promising nanobiotechnologies for applications in medicine – Role of nanotechnology in methods of treatment – Nanomedicine according to therapeutic areas – Nano-Sized Carriers for Drug Delivery and drug carrier systems – Gene and Drug delivery system with soluble inorganic carriers – Cellular behaviors during drug delivery – Nanosensors design using Molecules, Cells, Materials – Bionanosensors in Bioanalytical Technology.		
	Total Contact Hours : 45	

Course outcomes: Upon completion of the course, the students will be able to	
•	Understand the concept of bionanotechnology.
•	Learn the principle of bionanotechnology.
•	Apply the knowledge of bio assemblies to design new device.
•	Understand the concept of biomimetic fabrication
•	Gain knowledge about application of nanotechnology in medicine, pharmaceuticals and biosensors.

Text books:	
•	Niemeyer, C.M. and Mirkin, C.A., "Nanobiotechnology: Concepts, Applications and Perspectives", Wiley-VCH, 2004.
•	Goodsell, D.S., "Bionanotechnology", John Wiley and Sons, 2004.

Reference books:	
•	Shoseyov, O. and Levy I., "Nanobiotechnology: Bioinspired Devices and Materials of the Future", Humana Press,2007.
•	Bhushan, B., "Springer Handbook of Nanotechnology", Springer-Verlag Berlin Heidelberg, 2004.
•	Freitas Jr, R.A., "Nanomedicine", Vol. II, 1st Edition, Landes Biosciences, 2004.
•	Kohler, M. and Fritzsche, W., "Nanotechnology – An Introduction to Nanostructuring Techniques", Wiley-VCH, 2004.
•	Rosenthal, S.J. & Wright, D. W. NanoBiotechnology Protocols (Methods in Molecular Biology), 1st Ed, Humana Press, 2005.
•	Madhuri, S., Maheshwar, S., Pandey, S. &Oza, G. Bio-Nanotechnology Concepts and applications, 1st Ed, Ane Books Pvt Ltd, 2012.
•	Clarke, A.R. &Eberhardt, C.N. Microscopy Techniques for Material Science, 1st Ed, CRC Press, 2002.

PO / CO	PO1	PO2	PO3	PO4
BY19P21.1	1	1	2	1
BY19P21.2	1	3	1	2
BY19P21.3	3	2	3	3
BY19P21.4	2	3	2	2
BY19P21.5	1	2	2	3
Average	2	2	2	2

BY19P22	**MEDICINAL CHEMISTRY**	**Category**	**L**	**T**	**P**	**C**
		PE	**3**	**0**	**0**	**3**

Course objectives:

- To enable the students to know, screen and characterize phytochemicals
- To apply the knowledge and use phytochemicals for therapeutic purpose and produce in large scale

UNIT I	**INTRODUCTION OF PHYTOCHEMICALS**	**9**

Categories of phytochemicals and their classification (carbohydrates, tannins, alkaloids, glycosides, steroids, saponins, terpenoids, flavonoids, coumarins, mucilage's xanthine) – Phytochemical screening: Physiochemical tests – Moisture content, total ash, water-soluble ash, acid-insoluble ash, sulphate ash, alcohol and water-soluble extractive values –Heavy metal detection by atomic spectroscopy.Macroscopic studies – Shape, apex, base, margin, taste and odour Microscopic-stomatal number, stomatal index, vein islet number and vein termination number.

UNIT-II	**THERAPEUTIC EFFECT OF PLANT PRODUCTS**	**9**

Anti-tumor activity – Anti-coagulation – Anti-bacterial – Anti-inflammatory– Anti-MRSA and Anti-VRE activities of Phytoalexins and Phytoncides. Screening of Plant extracts for antiparasitic activity.

UNIT-III	**BIOACTIVITY STUDIES**	**9**

Screening of drugs for biological activity – Antidiabetic, antinflammatory, antihepatotoxic, antifertility, diuretic, anticancer, antihepatotoxic, antimalarial, antihypertensive and hypolipedemic and adoplogenic agents.

UNIT-IV	**SEPARATION TECHNIQUES AND STRUCTURE ELUCIDATION**	**9**

Thin layer chromatography – HPTLC – Column chromatography – GC-MS – LC-MS – HPLC – Partition chromatography – Gas chromatography – FT-IR – UV- NMR (1D&2D) – X-ray diffraction.

UNIT-V	**LARGE SCALE PRODUCTION OF BIOACTIVE PRODUCTS**	**9**

Secondary metabolite production through cell culture system – Hairy root induction –Methods of gene transfer – Chemical methods – PEG – dextran – Physical method – Electroporation – Microinjection – Lipofection agrobacterium based vector mediated gene transfer – Particle bombardment.

Total Contact Hours	**:**	**45**

Course outcomes:
Upon completion of the course, the students will be able to

- Know the therapeutic effects like anti tumour, anti inflammatory, antibacterialetc
- Learn screening of drugs for biological activity
- Analyse separation and characterisation of phytochemicals
- Understand large scale production of bioactive products by chemical, physical and cell culture methods
- Learn the therapeutic effects like anti tumour, anti inflammatory, antibacterialetc

Text books:

- Ahamed, I., Aqil, F. and Owais, M., "Modern Phytomedicine", WILEY VCH, Verlag GmbH & Co, KGaA, Weinheim. 2006.
- Chawla, H.S., "Introduction to Plant Biotechnology", Science Publishers, 2004.

Reference books:	
•	Meskin, M.S., Bidlack, W.R., Davies, A.J. and Omaye, S.T., "Phytochemicals in Nutrition and Health", CRC Press,2002.
•	Arnason, J.T., Arnason, J.E. and Arnason, J.T., "Phytochemistry of Medicinal Plants", Kluwer Academic Publishers,1995.
•	Bidlack, W.R., Omaye, S.T., Meskin, M.S. and Topham, D.K.W.," Phytochemicals as Bioactive Agents", 1St Edition, CRC Press, 2000.

PO / CO	PO1	PO2	PO3	PO4
BY19P22.1	3	3	3	3
BY19P22.2	3	3	3	3
BY19P22.3	3	3	3	3
BY19P22.4	3	3	3	3
BY19P22.5	3	3	3	3
Average	3	3	3	3

BY19P23	**ADVANCES IN MOLECULAR PATHOGENESIS**	**Category**	**L**	**T**	**P**	**C**
		PE	**3**	**0**	**0**	**3**

Course objectives:

- To understand the key concepts of host defense against pathogens and microbial defense strategies
- To learn the techniques of molecular approach to control the microbial pathogens

UNIT I	**VIRAL PATHOGENESIS**	**9**
Various pathogen types and modes of entry – Viral dissemination in the host – Viral virulence – Injury induced by virus – Host susceptibility of viral disease – Pattern of infection - Acute infection – Persistant infection – Latent infection – Slow infection – Methods for the study of pathogenesis – Foot and mouth disease virus, Pestiviruses, Arteriviruses, Blue tongue virus and Animal herpes viruses		
UNIT-II	**FUNGAL PATHOGENESIS**	**9**
Innate humoral immunity to fungi – Acquired cellular immunity – Mucosal immunity – Intracellular pathogenesis of *Histoplasma capsulatum*– Facultative intracellular pathogen of *Cryptococcus neoformans*– Fungal interaction with leukocytes – Fungal vaccine development – Host defence against chronic disseminated *Candidiasis*– Study fungal virulence by using Genomics – Functional genomic approaches to fungal pathogenesis.		
UNIT-III	**BACTERIAL PATHOGENESIS**	**9**
Epidemology and Clinicaldisease–Clinicalcourseandbasicimmunology–*Invitro*modelsof*Salmonella* virulence – Antibiotic resistant *Salmonella–Salmonella* based vaccines – *Shigella*cellular models of infection – Influenza virus – Pathogenic *Escherichia coli – Vibrio cholerae*– Streptococcal disease – *Haemophilus influenza* infection.		
UNIT-IV	**MANIPULATION OF HOST CELLS AND IMMUNE FUNCTION BY VIRAL PROTEINS**	**9**
Clinical importance of understanding host defence – Interference with cytokine and Chemokine function – impairment of host mediated killing of infected cells – inhibition of apoptosis – Immunological structure of proteins – Class I and II MHC mediated antigen – Evasion from natural killer cells.		
UNIT-V	**MOLECULAR APPROACHES TO CONTROL**	**9**
Classical approaches based on serotyping – Modern diagnosis based on highly conserved virulence factors, immune and DNA based techniques – New therapeutic strategies based on recent findings on molecular pathogenesis – Viral Vaccines – Immune modulators – New vaccine technology.		

	Total Contact Hours	**:**	**45**

Course outcomes: Upon completion of the course, the students will be able to	
•	Describe the basic feature of pathogenesis and how virus involved in disease progress.
•	Learn the knowledge about the host defense strategy against pathogens and fungi defense strategies.
•	Understand the molecular mechanism of virulence and the ability to perform the cause of bacterial infections.
•	Study the basic knowledge about the molecular mechanism of pathogen (virus) invasion to the host.
•	Learn different molecular techniques to control the mechanism of microbial pathogens.

Text books:	
•	Groismen, E.A., "Principles of Bacterial Pathogenesis", Academic Press,2001.
•	Norkin, L.C., "Virology: Molecular Biology and Pathogenesis", ASM Press,2009.

Reference books:	
•	Gyles, C.L., Prescott, J.F., Songer, J.G. and Thoen C.O., "Pathogenesis of Bacterial Infections in Animals", 3rd Edition, Wiley-Blackwell, 2004.
•	Flint, J., Enquist, L.W., Krug, R.M., Racaniello, V.R. and Skalka, A.M., "Principles of Virology: Molecular Biology, Pathogenesis and Control", American Society of Microbiology, 2003.
•	Mettenleitter, T.C. and Sobrino, F,"Animal Viruses: Molecular Biology", Caister Academic Press, 2008.

PO / CO	PO1	PO2	PO3	PO4
BY19P23.1	3	3	3	2
BY19P23.2	3	3	3	3
BY19P23.3	3	3	2	3
BY19P23.4	3	3	3	2
BY19P23.5	3	3	3	3
Average	3	3	2.8	2.6

BY19P24	**BIOREACTOR DESIGN AND ANALYSIS**	**Category**	**L**	**T**	**P**	**C**
		PE	**3**	**0**	**0**	**3**

Course objectives: This course will enable the students	
•	To understand and develop mathematical models for batch and CSTR bioreactors by application of substrate, biomass, and product mass balances.
•	To know and apply the transport phenomena principles to bioreactors.
•	To frame the requirements needed for the design of reactor.
•	To analyse the sterilization and other techniques to bioreactors in scale up process.
•	To measure and control the process variables involves in the process.

UNIT I	**BASIC BIOREACTOR CONCEPTS**	**9**
Bioreactor Operation – Batch operation, semi-continuous and fed-batch operation, Continuous Operation –		

Chemostat, turbidostat – General balances – Tank-type biological reactors, biomass productivity – Case studies – Continuous Fermentation with Biomass Recycle, Enzymatic Tanks-in-series, Tubular plug flow bioreactors.		
UNIT-II	**AERATION AND AGITATION IN BIOPROCESS SYSTEMS**	**9**
Mass transfer in agitated tanks – Balance between oxygen supply and demand, Correlations with k_La in Newtonian and non Newtonian liquid – Power number, Power requirement for mixing in aerated and non aerated tanks for Newtonian and non Newtonian liquids – Mixing time in agitated reactor, residence time distribution – Shear damage, bubble damage, Methods of minimizing cell damage – Laminar and Turbulent flow in stirred tank bioreactors.		
UNIT-III	**SELECTION AND DESIGN OF BIOPROCESS EQUIPMENT**	**9**
Materials of construction for bioprocess plants – Design considerations for maintaining sterility of process streams processing equipments, selection, specification – Design of heat and mass transfer equipment used in bioprocess industries – Requirements, design and operation of Bioreactor for microbial, plant cell and animal cell.		
UNIT-IV	**SCALE UP AND SCALE DOWN ISSUES**	**9**
Effect of scale on oxygenation, mixing, sterilization, pH, temperature, inoculum development, nutrient availability and supply – Bioreactor scale-up based on constant power consumption per volume, mixing time, impeller tip speed (shear), mass transfer co-efficients – Scale up of downstream processes – Adsorption (LUB method), Chromatography (constant resolution etc.), Filtration (constant resistance etc.), Centrifugation (equivalent times etc.), Extractors (geometry based rules) – Scale–down related aspects.		
UNIT-V	**BIOREACTOR INSTRUMENTATION AND CONTROL**	**9**
Methods of measuring process variables –Temperature – Flow measurement and control – Pressure measurement and control – Agitation – shaft power, rate of stirring – Foam sensing and control – Microbial biomass – Measurement and control of Dissolved oxygen – Inlet and outlet gas analysis – pH measurement and control.		
	Total Contact Hours : 45	

Course outcomes: Upon completion of the course, the students will be able to	
•	Select appropriate bioreactor configurations and operation modes based upon the nature of bioproducts and cell lines and other process criteria.
•	Apply their knowledge of transport phenomena in designing field.
•	Plan a research career or to work in the biotechnology industry with strong foundation.
•	Design bioreactor, scale up and troubleshooting the problems in bioreactors.
•	Integrate research lab and Industry; identify problems and seek practical solutions for large scale implementation of Biotechnology with process control expertise.

Text books:	
•	Mansi,E.M.T.EL., Bryce,C.F.A., Demain, A.L. andAllman,A.R.,"Fermentation
•	Mann, U., "Principles of Chemical Reactors Analysis & Design: New tools for Industrial Chemical Reactor Operations ", Willey–VCH, 2009.

Reference books:	
•	Impre, J.F.M.V., Vanrolleghem, P.A. and Iserentant, D.M., "Advanced Instrumentation, Data Interpretation and Control of Biotechnological Processes", Kluwer Academic Publishers, 2010.
•	Shuler, M.L. and Kargi, F., "Bioprocess Engineering: Basic Concepts", 2nd Edition, Prentice Hall, 2001.
•	Towler, G. and Sinnott, R., "Chemical Engineering Design: Principles, Practice, Economics of Plant and Process Design", Butterworth – Heinemann ltd., Elsevier, 2008.

PO / CO	PO1	PO2	PO3	PO4
BY19P24.1	3	2	3	2
BY19P24.2	3	2	3	2
BY19P24.3	3	2	3	2
BY19P24.4	3	2	3	2
BY19P24.5	3	2	3	2
Average	3	2	3	2

BY19P25	**BIOPROCESS MODELING AND SIMULATION**	**Category**	**L**	**T**	**P**	**C**
		PE	**3**	**0**	**0**	**3**

Course objectives:

- This course aims at imparting knowledge about the different types of bioreactors and its models for non-ideal behaviour.

UNIT I	**CONCEPTS AND PRINCIPLES**	**9**

Introduction to modelling – Systematic approach to model building – Material and energy balance – Classification of models – General form of dynamic models dimensionless models – General form of linear systems of equations nonlinear function – Conservation principles thermodynamic principles of process systems.

UNIT-II	**MODELS**	**9**

Structured kinetic models – Compartmental models (two and three) – Product formation Unstructured models – Genetically structured models–Stochastic model for thermal sterilization of the medium – Modelling for activated sludge process – Model for anaerobic digestion – Models for lactic fermentation and antibiotic production

UNIT-III	**MODELLING OF BIOREACTORS**	**9**

Modelling of non-ideal behaviour in Bioreactors – Tanks-in-series and Dispersion models – Modelling of PFR and other first order processes – Analysis of packed bed and membrane bioreactors Recombinant Cell Culture Processes – Plasmid stability in recombinant Cell Culture limits toover-expression.

UNIT-IV	**MONITORING OF BIOPROCESSES**	**9**

On-line data analysis for measurement of important physico-chemical and biochemical parameters – State and parameter estimation techniques for biochemical processes – Biochemical reactors-model equations – Steady-state function – Dynamic behaviour – Linearization – Phase plane analysis – Multiple steady state – Bifurcation behavior.

UNIT-V	**SOLUTION STRATEGIES**	**9**

Solution strategies for lumped parameter models – Stiff differential equations – Solution methods for initial value and boundary value problems – Euler's method – R-K method – shooting method – Finite difference methods – Solving the problems using MATLAB/SCILAB –ISIM-Simulation of bioprocesses using models from literature sources.

	Total Contact Hours	**:**	**45**

Course outcomes:
Upon completion of the course, the students will be able to

- Basic concepts and principles in bioprocess modelling.
- Study different structured and unstructured models
- Study non-ideal behaviour of different types of bioreactors
- Dynamic simulation of biochemical reactors
- Different software solution strategies for solving bioprocess parameters and models.

Text books:

- Hangos, K.M. and Cameron, I.T., "Process Modelling and Simulation",2001.

•	Heinzle, E., Biwer, A.P. and Cooney, C.A.L., "Development of Sustainable Bioprocess: Modeling", Wiley, 2007.

Reference books:	
•	Boudreau, M.A. and McMillan, G.K.," New Directions in Bioprocess Modelling and Control", ISA, 2006.
•	Bequette, B.W., "Process Control:Modeling, Design & Stimulating", Prentice Hall,2003.
•	Bailey, J.A. and Ollis, D. F., Fundamentals of Biochemical Engineering", McGraw Hill–1986.

PO / CO	PO1	PO2	PO3	PO4
BY19P25.1	3	3	3	2
BY19P25.2	3	2	3	1
BY19P25.3	3	2	2	3
BY19P25.4	3	2	3	1
BY19P25.5	3	2	3	3
Average	3	2.2	2.8	2

BY19P26	**TISSUE ENGINEERING**	**Category**	**L**	**T**	**P**	**C**
		PE	**3**	**0**	**0**	**3**

Course objectives:	
•	To learn the fundamentals of tissue engineering ,tissue characteristics and the measurement of cellular components, the type of tissues and growth factors involved in tissue repairing and the wound healing mechanism.
•	To study the construction of biomaterials and measurement of its physical and mechanical properties.
•	To explore naturally available biomaterials and synthetic nano materials for developing potential scaffolds for drug delivery and other regenerative medicine.
•	To get familiarize with the characteristics and the role of stem cells in tissue architecture.
•	To acquire knowledge on clinical applications of tissue engineering and associated ethical issues.

UNIT I	**FUNDAMENTAL OF TISSUE ENGINEERING**	**9**
Cells and tissue grade organization in living system - Cell cycle – Stem cells – Types, factors influencing stem cells – Mechanical properties of cells and tissues, cell adhesion – Extracellular matrix – Glycans, laminin, fibronectin, collagen, elastin, extracellular matrix functions – Signalling – Mechanics and receptors – Ligand diffusion and binding, trafficking and signal transduction –*In vitro* cell proliferation – Scope of tissue engineering.		
UNIT-II	**BIOMATERIALS FOR TISSUE ENGINEERING**	**9**
Preparation of biomaterials and their types - Measurement of protein adsorption – Direct and indirect methods, fibrinogen adsorption –Displaceable and non-displaceable – Changes in protein conformation upon adsorption – Vroman effect principle to maximize the amount of fibrinogen adsorption – Devices for tissue engineering transplant cells.		
UNIT-III	**DELIVERY OF MOLECULAR AGENTS AND CELL INTERACTIONS WITH POLYMERS**	**9**
Molecular agents in tissue engineering – Controlled released of agents – Future applications of controlled delivery – Microfluidic systems – Cell interactions – Factors influencing cell interactions – Cell interactions with polymer surfaces and suspension – Cell interactions with two and three-dimensional polymer.		
UNIT-IV	**POLYMERS AND CONTROLLED DRUG DELIVERY**	**9**
Natural and synthetic biodegradable Polymers – Engineered tissues – Skin regeneration – Nerve regeneration – Liver, cartilage, bone – Biodegradable polymers in drug delivery –Polymeric drug delivery systems – Applications of biodegradable polymers.		

UNIT-V	BIOPOLYMER-BASED BIOMATERIALS AS SCAFFOLDS AND STEM CELLS		9
Synthesis of bio polymer - Natural polymers – Structural and chemical properties, scaffold processing, mechanical properties and biodegradability – Biocompatibility and host response – Application of scaffolds in tissue engineering. Use of stem cells in tissue engineering – Embryonic stem cells, mesenchymal stem cells (MSC), adult stem cells, markers for detection of stem cells – Risks with the use of stem cells – Application of stem cells in tissue engineering.			
	Total Contact Hours	**:**	**45**

Course outcomes: Upon completion of the course, the students will be able to	
•	Students will gain knowledge on the components of the tissue architecture, the type of tissues and growth factors involved in tissue repairing.
•	Students will be able to understand construction of biomaterials and measurement of its physical and mechanical properties.
•	Students will be aware about the drug delivery mechanisms and broad applications of biomaterials.
•	Students can be familiarized with the stem cell characteristics and their relevance in medicine.
•	Students will be able to get ideas on overall exposure to the role of tissue engineering and stem cell therapy in organogenesis and associated patent and ethical issues.

Text books:	
•	Pallua, N. and Suscheck, C.V., "Tissue Engineering: From Lab to Clinic" Springer,2010
•	Saltzman, W.M., "Tissue Engineering", Oxford University Press,2004.
•	Meyer, U.; Meyer, Th.; Handschel, J.; Wiesmann H.P. Fundamentals of Tissue Engineering and Regenerative Medicine.2009.

Reference books:	
•	Palsson, B., Hubbell, J.A., Plonsey, R. and Bronzino, J.D., "Tissue Engineering", CRC Press, 2003.
•	Palsson, B.O. and Bhatia, S., "Tissue Engineering", Pearson Prentice Hall, 2004.
•	Scheper, T., Lee, K. and Kaplan, D., "Advances in Biochemical Engineering / Biotechnology – Tissue Engineering I", Volume 102, Springer-Verlag Berlin Heidelberg, 2006.

PO / CO	PO1	PO2	PO3	PO4
BY19P26.1	2	2	3	2
BY19P26.2	3	2	3	2
BY19P26.3	2	2	3	2
BY19P26.4	2	2	3	2
BY19P26.5	3	2	3	3
Average	2	2	3	2

BY19P27	BIOFUELS AND PLATFORM CHEMICALS	Category	L	T	P	C
		PE	3	0	0	3

Course objectives:
To enable the students

- To gain knowledge about Physical and chemical pretreatment of lignocellulosic biomass.
- To know the engineering strains for ethanol production from variety of carbon sources to improved productivity.
- To describe the Energetics of biodiesel production and effects on greenhouse gas emissions Issues of Eco toxicity and sustainability
- To understand the production of Biodiesel from microalgae and microbes in detail.
- To learn the processes involved in the production of C3 to C6 chemicals in-depth.

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 emissions. Issues 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, 1,3propanediol, propionic acid, succinic acid, glucaric acid, cis-cis muconic acid.

	Total Contact Hours	:	45

Course outcomes:
Upon completion of the course, the students will be able to

- Have knowledge about Physical and chemical pretreatment of lignocellulosic biomass.
- Know the engineering strains for ethanol production from variety of carbon sources to improved productivity.
- Describe the Energetics of biodiesel production and effects on greenhouse gas emissions Issues of Eco toxicity and sustainability
- Understand the production of Biodiesel from microalgae and microbes in detail.
- Learn the processes involved in the production of C3 to C6 chemicals in depth.

Text books:

- Lee, Sunggyu; Shah, Y.T. “Biofuels and Bioenergy”. CRC / Taylor & Francis, 2013.
- Samir K. Khanal, “Anaerobic Biotechnology for Bioenergy Production: Principles and Applications”, Wiley-Blackwell Publishing, 2008.
- David M. Mousdale, “Biofuels: Biotechnology, Chemistry, and Sustainable Development “CRC Press, 2008.

- Gupta, Vijai Kumar; Tuohy, Maria G. (Eds.), “Biofuel Technologies Recent Developments”, Springer, 2013.

PO / CO	PO1	PO2	PO3	PO4
BY19P27.1	1	-	2	3
BY19P27.2	-	2	3	3
BY19P27.3	1	2	2	3
BY19P27.4	2	3	2	2
BY19P27.5	3	3	3	3
Average	1.4	2	2.4	2.8