RAJALAKSHMI ENGINEERING COLLEGE
(An Autonomous Institution Affiliated to Anna University Chennai)
DEPARTMENT OF BIOTECHNOLOGY
CURRICULUM AND SYLLABUS REGULATIONS – 2023
M.TECH –BIOTECHNOLOGY
CHOICE BASED CREDIT SYSTEM

VISION OF THE INSTITUTION

To be an institution of excellence in Engineering, Technology and Management Education & Research.

To provide competent and ethical professionals with a concern for society.

MISSION OF THE INSTITUTION

To impart quality technical education imbibed with proficiency and humane values

To provide right ambience and opportunities for the students to develop into creative, talented and globally competent professionals

To promote research and development in technology and management for the benefit of the society

VISION OF THE DEPARTMENT

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

MISSION OF THE DEPARTMENT

- 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

S. No	COURSE CODE	COURSE TITLE	CONTACT PERIODS	L	T	P	C	Category
THEORY								
1	MH23131	Statistical Techniques for Biotechnologist	4	3	1	0	4	BS
2	BY23111	Gene Manipulation and DNA analysis	3	3	0	0	3	PC
3	BY23112	Enzyme Technology and Fermentation Technology	3	3	0	0	3	PC
4	PG23111	Research Methodology and IPR	3	3	0	0	3	HS
5		Professional Elective I	3	3	0	0	3	PE
		Professional Elective II	3	3	0	0	3	PE
6	AC23111	English for Research Paper Writing	3	3	0	0	0	MC
PRACTICAL								
7	BY23121	Preparative and Analytical Techniques in Biotechnology	4	0	0	4	2	PC
8	BY23122	Recombinant DNA Technology Laboratory	6	0	0	6	3	PC
		TOTAL	**32**	**21**	**1**	**10**	**24**	

SEMESTER II

S. No	COURSE CODE	COURSE TITLE	CONTACT PERIODS	L	T	P	C	Category
THEORY								
1	BY23211	Bio separation Technology	3	3	0	0	3	PC
2	BY23212	Bioreaction Engineering	3	3	0	0	3	PC
3	BY23213	Biopharmaceuticals and Biosimilars	3	3	0	0	3	PC
4	BY23214	Immunotechnology	3	3	0	0	3	PC
5	BY23215	Advanced Genomics and Proteomics	3	3	0	0	3	PC
6		Professional Elective III	3	3	0	0	3	PE
7	AC23211	Constitution of India	3	3	0	0	0	MC
PRACTICAL								
8	BY23221	Immunotechnology Laboratory	4	0	0	4	2	PC
9	BY23222	Bioprocess and Downstream processing Laboratory	6	0	0	6	3	PC
10	BY23223	Artificial Intelligence and Machine Learning	2	0	0	2	1	PC
		TOTAL	**33**	**21**	**0**	**12**	**24**	

SEMESTER III

S. No	COURSE CODE	COURSE TITLE	CONTACT PERIODS	L	T	P	C	Category
PRACTICAL								
1		Professional Elective IV	3	3	0	0	3	PE
2		Open elective I	3	3	0	0	3	OE
PROJECT								
4	BY23321	Project Phase – I	12	0	0	12	6	EEC
		TOTAL	**18**	**6**	**0**	**12**	**12**	

SEMESTER IV

S. No	COURSE CODE	COURSE TITLE	CONTACT PERIODS	L	T	P	C	Category
PROJECT								
1	BY23421	Project Phase – II	24	0	0	24	12	EEC
		TOTAL	**24**	**0**	**0**	**24**	**12**	

TOTAL NO. OF CREDITS: 72

PROFESSIONAL ELECTIVES - I (SEMESTER I)

Sl. No	COURSE CODE	COURSETITLE	CONTACT PERIODS	L	T	P	C
1	BY23P11	Biomaterials	3	3	0	0	3
2	BY23P12	Analytical Techniques in Biotechnology	3	3	0	0	3
4	BY23P13	Food Processing and Technology	3	3	0	0	3
5	BY23P14	Bionanotechnology	3	3	0	0	3

PROFESSIONAL ELECTIVES - II (SEMESTER I)

Sl. No	COURSE CODE	COURSETITLE	CONTACT PERIODS	L	T	P	C
1	BY23P15	Advances in Animal Biotechnology	3	3	0	0	3
2	BY23P16	Oncogenetics	3	3	0	0	3
3	BY23P17	Plant Tissue Culture and Gene Manipulation	3	3	0	0	3
4	BY23P18	Vaccinology	3	3	0	0	3
5	BY23P19	Advances in Molecular pathogenesis	3	3	0	0	3

PROFESSIONAL ELECTIVES -III (SEMESTER II)

Sl. No	COURSE CODE	COURSETITLE	CONTACT PERIODS	L	T	P	C
1	BY23P21	Bioreactor Design and Analysis	3	3	0	0	3
2	BY23P22	Bioprocess Modeling and Simulation	3	3	0	0	3
3	BY23P23	Biosafety and Bioethics	3	3	0	0	3
4	BY23P24	Bioenergy and Biofuels	3	3	0	0	3
5	BY23P25	Advances in Environmental Biotechnology	3	3	0	0	3

PROFESSIONAL ELECTIVES - IV (SEMESTER III)

Sl. No	COURSE CODE	COURSETITLE	CONTACT PERIODS	L	T	P	C
1	BY23P41	Tissue Engineering	3	3	0	0	3
2	BY23P42	Stem Cell Technology	3	3	0	0	3
3	BY23P43	Bioconjugate Technology	3	3	0	0	3
4	BY23P44	Data mining and machine learning for bioinformatics	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	21			32
4	PE	6	3	3		12
5	OE			3		3
6	EEC			6	12	18
7	MC	*	*			
TOTAL		24	24	12	12	72

MH23131	STATISTICAL TECHNIQUES FOR BIOTECHNOLOGIST	Category	L	T	P	C
	Common to I sem. - M.TECH. BT	BS	3	0	2	4

Objectives:
• To analyse data pertaining to discrete and continuous variables and to interpret the results.
• To provide the principles underlying sampling as a means of making inferences about a population and different methods of estimation.
• To exhibit proficiency with statistical analysis of data and to apply data science concepts and methods to solve problems in real-world contexts.
• To describe mathematical background of the nonparametric statistical methods.
• To plan, design and conduct experiments efficiently and effectively, and analyse the resulting data to obtain objective conclusions.

UNIT-I	RANDOM VARIABLE AND PROBABILITY DISTRIBUTION	9
Conditional Probability, Random variables – Probability mass function – Properties – Probability density function – Properties – Moments: Mean and variance with properties – Measures of Skewness and Kurtosis - Simple Problems. Introduction to analysis of DNA Sequence.		
UNIT-II	**SAMPLING DISTRIBUTIONAND ESTIMATION THEORY**	9
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.		
UNIT-III	**DATA ANALYSIS AND INTERPRETATION**	9
Cluster analysis: Clustering by partitioning methods, hierarchical clustering, overlapping clustering, K-Means Clustering – Profiling and Interpreting Clusters – Factor analysis: Factor analysis model, Extracting common factors, determining number of factors, Factor scores.		
UNIT-IV	**NON PARAMETRIC STATISTICS**	9
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**	9
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: 45		

S.No.	List of Experiments (using Data Analysis Lab with R)	Total Contact Hours: 30
1	Introduction to R, Functions, Control flow and Loops	
2	Working with Vectors and Matrices	
3	Reading in and Writing Data	
4	Working with Data	
5	Graphics in R	

6	Differentiation and Integration
7	Simulation
8	Linear model
9	Data Frame – Factor analysis
10	Cluster analysis

Course Outcomes:

On completion of the course , the students will be able to

- Apply the basic concepts of probability, one dimensional and two dimensional random variables in engineering problems.
- Use the principles underlying sampling as a means of making inferences about a population and different methods of estimation.
- Demonstrate proficiency with statistical **analysis of data** and to apply data science concepts and methods to **solve** problems in real-world contexts.
- Illustrate the nonparametric tests for solving various statistical problems.
- Apply the concept of ANOVA in decision making in the lab testing and clinical trials.

SUGGESTED ACTIVITIES

- Problem solving sessions
- Activity Based Learning
- Implementation of small module

SUGGESTED EVALUATION METHODS

- Tutorial problems
- Assignment problems
- Quizzes
- Class Presentation/Discussion

Text Book(s):

1.	Veerarajan T, Probability, statistics and random process with queueing theory and queueing networks, 4th edition, McGraw - Hill Publishing Company Limited.
2.	Spiegel Libschutz, “Probability and Statistics ”, 4th Edition, McGraw Hill, New Delhi, 2010.
3.	Miller I and Miller M., “Mathematical Statistics ”, 7th Edition, Pearson Education Inc. (10th impression), 2012.
4.	Warren J. Ewens, Gregory R. Grant, “Statistical Methods in Bioinformatics: An Introduction”, Second Edition, Springer New York, 2005.

Reference Books(s) / Web links:

1.	Jay L. Devore,” Probability and Statistics for Engineering and Sciences”, 8th Edition, Cengage

	Learning Pvt. Ltd., New Delhi, 2014.
2.	Johnson, R.A and Gupta C. B., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education Int., Asia, 8th Edition, 2011.
3.	Gupta, S.C. and Kapoor, V. K, "Fundamentals of Mathematical Statistics", Sultan Chand and Sons, 14th Edition, 2016.
4.	D.A. Belsey, E. Kuh and R.E. Welsch ,"Regression Diagnostics , Identifying Influential Data and Sources of Collinearety".
5.	M.R. Anderberg, "Cluster Analysis for Applications", Academic Press.

PO / CO	PO1	PO2	PO3	PO4
MH23131.1	2	1	2	3
MH23131.2	2	1	2	3
MH23131.3	2	1	2	3
MH23131.4	2	1	2	3
MH23131.5	2	1	2	3
Average	2	1	2	3

BY23111	**GENE MANIPULATION AND DNA ANALYSIS**	**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, Next Generation Automated Sequencing, 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, Colony PCR, , RACE PCR – Primer design strategies, Real-time PCR, 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 ,Ferre Francois,Gibbs "The polymerase chain reaction"1994

Reference books:	
•	Primrose SB and R. Twyman "Principles Of Gene Manipulation & Genomics Blackwell Science Publications, 2006.
•	Genomes 3 by T.A.Brown, Fourth Edition 2017 (Garland Science Publishing)

SUGGESTED EVALUATION METHODS

- Assignment/Case study
- Quizzes
- Class Presentation/Discussion
- Question/Problem Formulation

PO / CO	PO1	PO2	PO3	PO4
BY23111.1	2	3	3	3
BY23111.2	3	3	3	3
BY23111.3	2	3	3	3
BY23111.4	3	3	3	3
BY23111.5	3	3	3	3
Average	2.6	3	3	3

BY23112	ENZYME TECHNOLOGY AND FERMENTATION TECHNOLOGY	Category	L	T	P	C
		PC	3	0	0	3

Course objectives:
This course will enable the students

- To realise the importance of fundamental concepts and important parameters in fermentation processes
- To acquire advanced knowledge about the use of fermentation processes in enzyme production
- To comprehend the process involved in the production of various enzymes and metabolites
- To investigate enzyme kinetics
- To assess different industrial applications of enzymes

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.

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 – case study, – Immobilization of enzymes – Biotransformation with crude enzymes and whole cells.

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* –Case study on 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. Case studies on bioproduct formation imbibing free enzymes/immobilized enzymes.

Total Contact Hours	:	45

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

- Outline the fundamentals and important parameters in fermentation processes
- Apply the knowledge of industrial fermentation process for enzyme production
- Access the production process of industrially important enzymes and metabolites
- Comprehend enzyme kinetics for research and industrial applications

•	Evaluate the applications of enzymes in various industries

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.
•	Michael L. Shuler, Fikret Kargi, Matthew DeLisa, Bioprocess Engineering 3rd edition, Pearson Education, 2017.

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.
•	Trevor Palmer , Enzymes 2nd edition, Horwood Publishing Ltd., 2007
•	Peter F. Stanbury, A. Whitaker & Stephen J. Hall , Principles of Fermentation Technology, 3rd edition, Elsevier Ltd., 2016.
Weblink:	
•	https://nptel.ac.in/courses/102106053

SUGGESTED EVALUATION METHODS

- Assignment/Case study
- Quizzes
- Class Presentation/Discussion
- Question/Problem Formulation

PO / CO	PO1	PO2	PO3	PO4
BY23112.1	1	1	2	2
BY23112.2	2	1	2	2
BY23112.3	2	2	2	2
BY23112.4	3	3	2	3
BY23112.5	3	3	2	3
Average	2.2	2	2	2.4

PG23111	**RESEARCH METHODOLOGY AND IPR**	**Category**	**L**	**T**	**P**	**C**
		HS	**3**	**0**	**0**	**3**

Course objectives:
This course will enable the students

•	To understand the research problem formulation and analyse the research related information by following research ethics.
•	To understand today's computer, information technology and also understand tomorrows world of ideas and creativity.
•	To Emphasize the role of IPR in individual and nations growth

UNIT I	**INTRODUCTION TO RESEARCH METHODOLOGY**	**9**
Objectives and Motivation of Research - Types of Research - Defining and Formulating the Research Problem - Errors in selecting a research problem - Features of research design, Different Research Designs-Criteria of good research - Problems encountered by researchers in India - Benefits to the society in general.		
UNIT-II	**DATA ANALYSIS AND HYPOTHESIS TESTING**	**9**
Data collection: Primary data - Secondary data - Data organization - Sample design - Estimation of population - Parametric vs. non parametric methods - Measures of central tendency and dispersion. ANOVA; Principles of least squares-Regression and correlation; Normal DistributionProperties of Normal Distribution; Testing of Hypothesis – Hypothesis Testing Procedure, Types of errors, t-Distribution - Chi-Square Test as a Test of Goodness of Fit - Use of statistical softwares.		
UNIT-III	**LITERATURE REVIEW AND RESEARCH REPORT WRITING**	**9**
Effective literature studies approaches- Importance of literature survey - Sources of information– analysis – Plagiarism - Research ethics. Interpretation and Report Writing - Techniques and Precautions; Report Writing – Significance - Different Steps – Layout - Types of reports, Mechanics of Writing a Research Report - Precautions in Writing Reports; Format of the research report		
UNIT-IV	**INTRODUCTION TO INTELLECTUAL PROPERTY, TRADE MARKS, GRAPHICAL INDICATION AND INDUSTRIAL DESIGN**	**9**
Importance of intellectual property rights; types of intellectual property-international organizations; Purpose and function of trademarks - acquisition of trade mark rights - protectable matter - selecting and evaluating trade mark - trade mark registration processes. Industrial designs and IC Layout design - Registrations of designs-Semiconductor Integrated circuits and layout design Act - Geographical indications-potential benefits of Geographical Indications.		
UNIT-V	**LAW OF COPYRIGHTS & PATENTS**	**9**
Fundamental of copy right law - originality of material - rights of reproduction - rights to perform the work publicly -copy right ownership issues - copy right registration -notice of copy right, international copy right law. Law of patents: Foundation of patent law, patent searching process - ownership rights and transfer New Developments in IPR: Administration of Patent System.		
	Total Contact Hours : 45	

Course outcomes: Upon completion of the course, the students will be able to	
•	Understand the research problem and research process
•	To formulate the hypothesis, data collection and processing, analyzing the data using statistical methods
•	Interpret the observations and communicating the novel findings through a research report.
•	Apply the conceptual knowledge of intellectual property rights for filing patents and trade mark registration process.
•	Understand the adequate knowledge on copyright and patent law and rights.

Text/Reference books:	
•	C.R. Kothari, Research Methodology: Methods and Techniques, 2nd revised edition, New Age International Publishers, New Delhi, 2004.
•	Deborah, E. Bouchoux, Intellectual property right, 5th edition, Cengage learning, 2017.
•	R. Panneerselvam, Research Methodology, PHI learning Pvt. Ltd., 2009.
•	Prabuddha Ganguli, Intellectual property right - Unleashing the knowledge economy, Tata McGraw

	Hill Publishing Company Ltd, 2001.
•	Donald R. Cooper and Ramela S. Schindler, Business Research Methods, Tata McGraw- Hill Publishing Company Limited, New Delhi, 2000
•	Uma Sekaran, Research Methods for Business, John Wiley and Sons Inc., New York, 2000.
•	Ranjit Kumar, Research Methodology, Sage Publications, London, New Delhi, 1999.
•	T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

PO / CO	PO1	PO2	PO3	PO4
PG23111.1	1	3	3	2
PG23111.2	1	3	3	2
PG23111.3	1	3	3	2
PG23111.4	1	3	3	2
PG23111.5	1	3	3	2
Average	1	3	3	2

AC23111	**ENGLISH FOR RESEARCH WRITING**	**Category**	**L**	**T**	**P**	**C**
	For I Semester M.E/M.TECH		**3**	**0**	**0**	**0**

Objectives:	
●	To facilitate the students to express technical ideas in writing
●	To train the students in using language structures appropriately
●	To enable students to plan and organize the research paper
●	To assist the students in understanding the structure and familiarise the mechanics of organised writing
●	To equip the students 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 - Proofreading - Preparing the Manuscript- Submitting - Resubmitting - Follow up - Publishing		
	Total Contact Hours :	**45**

Course Outcomes: At the end of the course the learner 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
●	Follow the process of writing a research paper and write one
●	Emulate the process of publishing journal paper and publish papers

SUGGESTED ACTIVITIES

- Group Discussions
- Writing review of literature
- Presentations
- Case study
- Writing a paper

SUGGESTED EVALUATION METHODS

- Assignment topics
- Quizzes
- Class Presentation/Discussion
- Continuous Assessment Tests

References	
1	Adrian Wallwork: “English for Writing Research Papers”, Springer Science Business Media, Second Edition, LLC 2011
2	Stephen Howe and Kristina Henrikssion: “Phrasebook for Writing Papers and Research in English”, The Whole World Company Press, Cambridge, Fourth edition 2007
3	The Modern Language Association of America: “MLA Handbook for Writers of Research Papers” 8th Edition, The Modern Language Association of America, 2016
4	Rowena Murray: The Handbook of Academic Writing: A Fresh Approach, Sarah Moore Open University Press, 2006
5	Stephen Bailey: Academic Writing: A Practical Guide for Students Routledge Falmer: 2003
6	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
AC23111.1	1	1	1	1
AC23111.2	2	2	2	2
AC23111.3	3	3	3	3
AC23111.4	3	3	3	3
AC23111.5	3	3	3	3
Average	2.4	2.4	2.4	2.4

BY23121	PREPARATIVE AND ANALYTICAL TECHNIQUES IN BIOTECHNOLOGY	Category	L	T	P	C
		PC	0	0	4	2

Course objectives:
This course will enable the students

- To learn and understand the principles behind the qualitative and quantitative estimation of biomolecules
- To gain hands-on experience in spectroscopic and chromatographic methods of analysis
- To comprehend the principle behind spectroscopic analysis and its application in biomolecule identification and assay of enzyme activity
- To acquire practical experience by performing recovery and subsequent purification of target biological products through chromatographic techniques
- To excel in all latest preparative and analytical techniques required in future research or industry based work

LIST OF EXPERIMENTS	
1	Preparation of Acetate, Tris and Phosphate Buffer. Validation of Henderson Hasselbach equation.
2	Reactions of amino acids with Ninhydrin reagent.
3	Differential estimations of carbohydrates – reducing vs non-reducing, polymeric vs oligomeric, hexose vs pentose.
4	Estimation of protein concentration using Lowrys' method and Dye-binding method.
5	DNA determination by UV-Vis Spectrophotometer – hyperchromic effect.
6	Separation of lipids by TLC.
7	Preparative and quantitative estimation of biomolecules by HPLC analysis.
8	Assay of enzyme activity and specific enzyme activity.
9	Assessing purity of proteins using SDS-PAGE Gel Electrophoresis
10	Preparation of Casein using Isoelectric precipitation and its estimation
11	Separation and identification of water soluble colours in foods by paper chromatography
12	FTIR and GC-MS analysis of biomolecules –Demonstration
	TOTAL PERIODS: 45

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

- Understand the principles behind buffer preparation, the qualitative and quantitative estimation of carbohydrates, aminoacids and DNA.
- Gain experience in spectroscopic and chromatographic methods of analysis.
- Comprehend the principle behind spectroscopic analysis and its application in biomolecules and enzyme activity studies.
- Acquire practical experience in purification and recovery of target biological products through chromatographic techniques.
- Carry out all latest preparative and analytical techniques required in future research or industry based work.

Text/Reference books:

- Principles and Techniques of Biochemistry and Molecular Biology, Author: Wilson, K. and Walker, J., Cambridge University Press, 8th Edition, 2018.
- Advances in chemical Bioanalysis –Bioanalytical reviews, edited by Frank –Michael Matysik, Springer, first edition 2016.

•	High throughput Bioanalytical sample preparation: Methods and Automation Strategies, Author: David A .Wells Elsevier Second Edition, 2020.

PO / CO	PO1	PO2	PO3	PO4
BY23121.1	3	3	3	2
BY23121.2	3	3	2	3
BY23121.3	3	2	2	3
BY23121.4	3	3	2	3
BY23121.5	3	3	2	3
Average	3	2.8	2.2	2.8

BY23122	**RECOMBINANT DNA TECHNOLOGY 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
•	To learn and understand the principles behind the cloning and expression of agene
•	To perform nucleic acid assays

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	Real Time PCR
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 and quantify the gene
•	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
BY23122.1	3	2	1	3
BY23122.2	2	3	3	1
BY23122.3	3	3	3	2
BY23122.4	2	1	3	3
BY23122.5	3	2	3	3
Average	2.6	2.2	2.6	2.4

PROFESSIONAL ELECTIVES

BY23P11	**BIOMATERIALS**	**Category**	**L**	**T**	**P**	**C**
		PE	**3**	**0**	**0**	**3**

Course objectives:
This course will enable the students to

•	Learn characteristics and classification of Biomaterials
•	Understand different metals, ceramics and its nanomaterials characteristics as biomaterials
•	Learn polymeric materials and its combinations that could be used as a tissue replacement implants
•	Get familiarized with the concepts of host reactions to biomaterials
•	Understand the concept of biocompatibility for artificial organs

UNIT I	**INTRODUCTION TO BIO-MATERIALS**	**9**
Definition and classification of biomaterials, Characterization of biomaterials: mechanical properties, surface properties, physical properties of materials, wound healing process, body response to implants, Effects of physiological fluid on the properties of biomaterials, blood compatibility.		
UNIT-II	**METALLIC, CERAMIC MATERIALS AND POLYMERIC IMPLANT**	**9**
Metallic implants: Stainless steels, co-based alloys, Ti-based alloys, shape memory alloy. Ceramic implant: bioinert, biodegradable or bio resorbable, bioactive ceramics, applications of ceramic and metallic implants. Polymerization, factors influencing the properties of polymers, polyamides, Acryrilic polymers, rubbers, high strength Thermoplastic, Bio polymers: Collagen and Elastin, Medical Textiles: Silica, Chitosan, PLA composites, medical applications		
UNIT-III	**TISSUE REPLACEMENT IMPLANTS**	**9**
Soft tissue replacements, sutures, surgical tapes, adhesive, Percutaneous and skin implants, maxillofacial augmentation, Vascular grafts, hard tissue replacement Implants, Internal fixation device, joint replacements.		
UNIT-IV	**HOST REACTIONS TO BIOMATERIALS**	**9**
– Inflammation; Wound healing and the foreign body response; Systemic toxicity and Hypersensitivity; Blood coagulation and Blood-materials Interactions; Tumorigenesis. Degradation of Materials in Biological Environment: Degradation of Polymers, Metals and Ceramics.		
UNIT-V	**ARTIFICIAL ORGANS AND BIOCOMPATIBILITY**	**9**

Artificial blood, Artificial skin, Artificial Heart, Cardiac pacemaker, Prosthetic Cardiac Valves, Artificial lung (oxygenator), Artificial Kidney (Dialyser membrane), Dental Implants. biocompatibility, blood compatibility and tissue compatibility. Toxicity tests: acute and chronic toxicity studies (in situimplantation, tissue culture, haemolysis, thrombogenic potential test, systemic toxicity, intracutaneous irritation test), sensitization, carcinogenicity, mutagenicity and special tests.			
	Total Contact Hours	**:**	**45**

Course outcomes: Upon completion of the course, the students will be able to	
•	Analyze different types of Biomaterials and its classification and apply the concept of nanotechnology towards biomaterials use.
•	Identify significant gap required to overcome challenges and further development in metallic and ceramic materials
•	Identify significant gap required to overcome challenges and further development in polymeric materials
•	Create combinations of materials that could be used as a tissue replacement implant
•	Understand the testing standards applied for biomaterials.

Text books:	
•	Sujata V. Bhatt, Biomaterials, Second Edition, Narosa Publishing House, 2005.
•	Sreeram Ramakrishna, MuruganRamalingam, T. S. Sampath Kumar, and Winston O. Soboyejo, Biomaterials: A Nano Approach, CRC Press, 2010.

Reference books:	
•	Myer Kutz, Standard Handbook of Biomedical Engineering and Design, McGraw Hill, 2003
•	John Enderle, Joseph D. Bronzino, Susan M.Blanchard, Introduction to Biomedical Engineering, Elsevier, 2005.
•	Park J.B., Biomaterials Science and Engineering, Plenum Press, 1984.
•	A.C Anand, J F Kennedy, M.Miraftab, S.Rajendran,Woodhead Medical Textiles and Biomaterials for Healthcare, Publishing Limited 2006.
•	D F Williams, Materials Science and Technology: Volume 14, Medical and Dental Materials: A comprehensive Treatment Volume, VCH Publishers 1992.

SUGGESTED EVALUATION METHODS

- Assignment/Case study
- Quizzes
- Class Presentation/Discussion
- Continuous Assessment Tests

PO / CO	PO1	PO2	PO3	PO4
BY23P11.1	3	2	3	2
BY23P11.2	3	2	3	2
BY23P11.3	3	2	3	2

BY23P11.4	3	2	3	2
BY23P11.5	3	2	3	2
Average	3	2	3	2

BY23P12	**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.

SUGGESTED EVALUATION METHODS

- Assignment/Case study
- Quizzes
- Continuous Assessment Tests

PO / CO	PO1	PO2	PO3	PO4
BY23P12.1	3	3	1	3
BY23P12.2	3	3	1	3
BY23P12.3	3	3	1	3
BY23P12.4	3	3	1	3
BY23P12.5	3	3	1	3
Average	3	3	1	3

BY23P13	FOOD PROCESSING 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 AND PRESERVATION	8

Raw material characteristics; cleaning, sorting and grading of foods; physical conversion operations – mixing, emulsification, extraction, filtration, centrifugation, membrane separation, crystallization, heat processing. 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-IV	MANUFACTURE OF FOOD PRODUCTS	8

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.

UNIT-V	APPLIED FOOD SCIENCE AND QUALITY MANAGEMENT	9

Concept of balanced Diet, Food Groups: Food adulteration- common adulterants, techniques used identify the food adulterants, Food quality and Safety Management System- ISO 22000, GMP, GHP, HACCP, FSMS, FSSAI, Entrepreneurial development- Business opportunity Identification, Assessment, development of entrepreneurial skills and become a successful entrepreneur.

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", 1st Edition, 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.

SUGGESTED EVALUATION METHODS

- Assignment/Case study
- Quizzes
- Class Presentation/Discussion
- Continuous Assessment Tests

PO / CO	PO1	PO2	PO3	PO4
BY23P13.1	2	2	3	3
BY23P13.2	2	2	3	3
BY23P13.3	2	1	1	3
BY23P13.4	3	2	2	3
BY23P13.5	2	1	-	3
Average	2.2	1.6	1.8	3

BY23P14	**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.

SUGGESTED EVALUATION METHODS

- Assignment/Case study
- Quizzes
- Class Presentation/Discussion
- Continuous Assessment Tests

PO / CO	PO1	PO2	PO3	PO4
BY23P14.1	1	1	2	1
BY23P14.2	1	3	1	2
BY23P14.3	3	2	3	3
BY23P14.4	2	3	2	2
BY23P14.5	1	2	2	3
Average	2	2	2	2

BY23P15	**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
BY23P15.1	3	1	3	2
BY23P15.2	-	2	2	3
BY23P15.3	1	3	2	1
BY23P15.4	3	2	3	1
BY23P15.5	2	3	3	1
Average	2	2	3	2

BY23P16	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
BY23P16.1	3	2	3	2
BY23P16.2	3	2	3	3
BY23P16.3	3	2	3	3
BY23P16.4	3	2	3	2
BY23P16.5	3	2	3	3
Average	3	2	3	2.6

BY23P17	**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.

SUGGESTED EVALUATION METHODS

- Assignment/Case study
- Quizzes
- Class Presentation/Discussion
- Continuous Assessment Tests

PO / CO	PO1	PO2	PO3	PO4
BY23P17.1	2	2	3	3
BY23P17.2	2	2	3	3
BY23P17.3	2	2	3	3
BY23P17.4	2	2	3	3
BY23P17.5	2	2	3	3
Average	2	2	3	3

BY23P18	**VACCINOLOGY**	**Category**	**L**	**T**	**P**	**C**
		PE	**3**	**0**	**0**	**3**

Course objectives:	
•	To provide knowledge on conventional and recent technologies of vaccine production.
•	To provide immunological background on vaccine production.
•	To describe the immune response to vaccines.
•	To impart the regulatory requirements for vaccine formulations.
•	To articulate the modern methods for vaccine development

UNIT I	**INTRODUCTION TO VACCINE**	**9**
Historical aspects of vaccination, vaccine are a tool for prevention of infectious diseases, human vaccines manufacturer and licensed vaccines. Over view of bacterial and viral vaccines and their importance. Epidemiology and pathophysiology of vaccine preventable diseases with special emphasison Diphtheria, Tetanus and Pertussis.		
UNIT-II	**VACCINE RSEARCH**	**9**

Fundamental aspect of rational vaccine design. Antigen identification, T-Cell expression cloning for identification of vaccine targets for intracellular pathogens, Fundamentals of Immune recognition, implications for manipulating the T-Cell repertoire, Targeting Macrophage; a rational approach for Vaccine development, Cellular basis of T- Cell memory, Rational design of new vectors.		
UNIT-III	**VACCINE PRODUCTION**	**9**
Seed strain characterization for vaccine production. Adjuvants: types, mechanisms and current achievements. New vaccines development and prominent delivery systems. Production of inactivated bacterial vaccines with respect to Diphtheria, Tetanus and Whole cell pertussis (DTwP).Immune response(s) to vaccines. Immunization strategies for disease control and eradication.		
UNIT-IV	**REGULATROTY ASPECTS**	**9**
Overview of national and international regulatory requirements for vaccine approval and guidance for production, quality control and Current Good Manufacturing Practices (cGMP) implementation. Importance and implementation of cGMP in the production of safe and efficacious biological products/vaccines, and clean-in-place(CIP)cycle development for process equipment.		
UNIT-V	**QUALITY CONTROL**	**9**
Consistency approach for vaccine quality improvement. Toxicity and potency evaluation of bacterial and viral vaccines: overview of currently approved methods and alternative methods under development.		
	Total Contact Hours : 45	

Course outcomes: Upon completion of the course, the students will be able to	
•	Describe the role of vaccine in prevention and eradication of infectious diseases.
•	Explain the role of adjuvant in vaccines production.
•	Demonstrate the immunization strategies for disease control
•	Understand the international regulatory requirements for vaccine approval.
•	Articulate adverse effect of vaccination

Text books:	
•	Ronald W. Ellis, “New Vaccine Technologies”, Landes Bioscience, 2001.
•	Cheryl Barton, “Advances in Vaccine Technology and Delivery”, Espicom Business Intelligence, 2009.
•	Male, David et al., “Immunology”, 7th Edition, Mosby Publication, 2007.

Reference books:	
•	Coico, R. etal., “Immunology: A Short Course”, 5th Edition, Wiley – Liss, 2003.
•	Parham, Peter “The Immune System”, 2nd Edition, Garland Science, 2005.
•	Abbas, A.K. etal., “The Cellular and Molecular Immunology”, 6th Edition, Sanders / Elsevier, 2007.
•	Weir, D.M. and Stewart, John “Immunology”, 8th Edition, Churchill Pvt. Ltd., 2000

PO / CO	PO1	PO2	PO3	PO4
BY23P18.1	2	2	3	3
BY23P18.2	3	2	3	3
BY23P18.3	2	2	3	3
BY23P18.4	3	2	3	2
BY23P18.5	3	2	3	3
Average	2.6	2	3	2.8

BY23P19	**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
BY23P19.1	3	3	3	2
BY23P19.2	3	3	3	3
BY23P19.3	3	3	2	3
BY23P19.4	3	3	3	2
BY23P19.5	3	3	3	3
Average	3	3	2.8	2.6