VIVEKANANDHA

COLLEGE OF ENGINEERING FOR WOMEN

(An Autonomous Institution Affiliated to Anna University-Chennai

Approved by AICTE – Accredited by NBA New Delhi and ISO 9001:2015 Certified)

Elayampalayam, Tiruchengode – 637 205, Namakkal District, Tamilnadu.

DEPARTMENT OF BIOTECHNOLOGY

CURRICULUM & SYLLABI

FOR

PG – M.TECH. BIOTECHNOLOGY

REGULATION 2023

(CBCS)

After 16th BoS

Department of Biotechnology

Department Vision

To nourish the world of Technology & research with highly skilled women Biotechnologists to invent, innovate and disseminate the knowledge for the benefit of society & environment.

Department Mission

- To create excellent prospects for multifaceted bioengineering exercise and research in biotechnology.
- To produce tailored human resource to drive innovative biotechnological processes.
- To disseminate the knowledge in upcoming opportunities evolving sustainable entrepreneurship and research in the field of biotechnology for present and future.

Program Outcomes

PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and

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	modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society:** : Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Educational Objectives

PEO1	The ability to provide the students with a solid foundation and the ability to apply mathematics, science in Biotechnology and to analyze data and technical concepts for application in **Quality assurance** and enabling **placements/higher education**.
PEO2	An ability to inculcate the professional and ethical attitudes, effective communication skills,team work skills, multidisciplinary approach among the students and an ability to relate environmental issues in broader **social context.**
PEO3	To provide with an excellent training to enhance the core profession career in the field of agriculture, pharmaceutics, biochemical, food tech and other allied biosciences.

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Program Specific Outcomes

PSO1	Demonstrate expertise in basic sciences and foundation courses.
PSO2	Demonstrate a working knowledge of advanced biological sciences
PSO3	Demonstrate competence in application of engineering principles to biological systems.

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COURSE WITH PROGRAMME OUTCOMES:

SEM	Subject Name	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	P0 12
SEM1	Applied Statistics for Biotechnologists	√	√	√		√						√	√
	Clinical Trial Management	√	√	√	√	√		√		√	√	√	√
	Advanced Recombinant DNA Technology	√	√	√		√	√		√	√		√	
	Advanced Bioprocess Technology	√	√		√	√	√	√			√	√	√
	Professional Elective-I												
	Professional Elective –II												
	Audit Course - I												
	Preparative and Analytical Techniques in Biotechnology Laboratory	√	√	√	√	√	√	√	√	√	√		
SEM 2	Advanced Bioseparation Technology	√	√	√		√		√	√			√	
	Advanced Protein Engineering	√	√	√		√	√		√			√	√
	Green Energy Technology	√	√	√		√		√				√	√
	Professional Elective-III												
	Professional Elective-IV												
	Professional Elective-V												
	Audit Course-II												
	Bioprocess and Downstream Processing Laboratory	√	√	√	√	√	√				√	√	√
SEM 3	Microbial and Immunotechnology Laboratory	√	√	√	√	√	√	√	√	√	√	√	√
	Molecular and Genetic Engineering Laboratory	√	√	√	√	√	√	√	√	√	√	√	√
	Open Elective-I												
	Project Phase-I	√	√	√	√	√	√	√	√	√	√	√	√
SEM 4	Project Phase-II	√	√	√	√	√	√	√	√	√	√	√	√

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Programme	**M.Tech.**	Programme Code	**206**	Regulation	**2023**	
Department	**BIOTECHNOLOGY**			Semester	**I**	

CURRICULUM

(Applicable to the students admitted from the academic year 2023 – 2024 onwards)

Course Code	Course Name	Category	Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	ESE	Total
THEORY									
P23MA103	Applied Statistics for Biotechnologists	FC	3	0	0	3	40	60	100
P23BT101	Clinical Trial Management	PCC	3	0	0	3	40	60	100
P23BT102	Advanced Recombinant DNA Technology	PCC	3	0	0	3	40	60	100
P23BT103	Advanced Bioprocess Technology	PCC	3	0	0	3	40	60	100
-	Professional Elective – I	PEC	3	0	0	3	40	60	100
-	Professional Elective – II	PEC	3	0	0	3	40	60	100
-	Audit Course - I	AC	2	-	-	0	100	-	100
PRACTICAL									
P23BT104	Preparative and Analytical Techniques in Biotechnology Laboratory	PCC	0	0	4	2	60	40	100
					Total	**20**	**400**	**400**	**800**

PCC - Professional Core Courses, PEC - Professional Elective Courses, PAC – Program Audit Courses, HS -Humanities And Social Sciences, CA - Continuous Assessment, ESE - End Semester Examination

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Programme	**M.Tech.**	Programme Code	**206**	Regulation	**2023**
Department	**BIOTECHNOLOGY**			Semester	**II**

CURRICULUM

(Applicable to the students admitted from the academic year 2023 – 2024 onwards)

Course Code	Course Name	Category	Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	ESE	Total
THEORY									
P23BT205	Advanced Bioseparation Technology	PCC	3	0	0	3	40	60	100
P23BT206	Advanced Protein Engineering	PCC	3	0	0	3	40	60	100
P23BT207	Green Energy Technology	PCC	3	0	0	3	40	60	100
-	Professional Elective-III	PEC	3	0	0	3	40	60	100
-	Professional Elective-IV	PEC	3	0	0	3	40	60	100
-	Professional Elective-V	PEC	3	0	0	3	40	60	100
-	Audit Course-II	AC	2	-	-	0	100	-	100
PRACTICAL									
P23BT208	Bioprocess and Downstream Processing Laboratory	PCC	0	0	4	2	60	40	100
					Total	**20**	**400**	**400**	**800**

PCC - Professional Core Courses, PEC - Professional Elective Courses, PAC – Program Audit Courses, HS -Humanities And Social Sciences , CA - Continuous Assessment, ESE - End Semester Examination

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Programme	**M.Tech.**	Programme Code	**206**	Regulation	**2023**	
Department	**BIOTECHNOLOGY**			Semester	**III**	

CURRICULUM

(Applicable to the students admitted from the academic year 2023 – 2024 onwards)

Course Code	Course Name	Category	Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	ESE	Total
THEORY									
-	Open Elective-I	OEC	3	0	0	3	40	60	100
PRACTICAL									
P23BT309	Microbial and Immunotechnology Laboratory	PCC	0	0	4	2	40	60	100
P23BT310	Molecular and Genetic Engineering Laboratory	PCC	0	0	4	2	40	60	100
P23BT311	Project Phase-I	EEC	0	0	16	8	60	40	100
					Total	**15**	**180**	**220**	**400**

OEC – Open Elective Course, PCC – Professional Core Course, EEC – Employability Enhancement Course, CA - Continuous Assessment, ESE - End Semester Examination

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Programme	**M.Tech.**	Programme Code	**206**	Regulation	**2023**				
Department	**BIOTECHNOLOGY**			Semester	**IV**				
CURRICULUM (Applicable to the students admitted from the academic year 2023 – 2024 onwards)									
Course Code	Course Name	Category	Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	ESE	Total
PRACTICAL									
P23BT412	Project Phase - II	EEC	0	0	32	16	60	40	100
					Total	**16**	**60**	**40**	**100**

EEC – Employability Enhancement Course, CA - Continuous Assessment, ESE - End Semester Examination

Cumulative Course Credit: 71

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PROFESSIONAL ELECTIVE COURSES (PEC)

PROFESSIONAL ELECTIVE - I										
S.NO	COURSE CODE	COURSE NAME	CATEGORY	L	T	P	C	Maximum Marks		
								CA	ESE	Total
1	P23BTE01	Plant Metabolite Technology	PEC	3	0	0	3	40	60	100
2	P23BTE02	Advanced Computational Biology	PEC	3	0	0	3	40	60	100
3	P23BTE03	Food Processing and Biotechnology	PEC	3	0	0	3	40	60	100
4	P23BTE04	Enzyme Engineering & Technology	PEC	3	0	0	3	40	60	100
5	P23BTE05	Stem cell Research and applications	PEC	3	0	0	3	40	60	100
PROFESSIONAL ELECTIVE - II										
S.NO	COURSE CODE	COURSE NAME	CATEGORY	L	T	P	C	Maximum Marks		
								CA	ESE	Total
1	P23BTE06	Molecular Diagnostics and Therapeutics	PEC	3	0	0	3	40	60	100
2	P23BTE07	Animal Biotechnology	PEC	3	0	0	3	40	60	100
3	P23BTE08	Pharmaceutical Technology	PEC	3	0	0	3	40	60	100
4	P23BTE09	Bioentrepreneurship	PEC	3	0	0	3	40	60	100
5	P23BTE10	Analytical Instrumentation Techniques	PEC	3	0	0	3	40	60	100
PROFESSIONAL ELECTIVE – III										
S.NO	COURSE CODE	COURSE NAME	CATEGORY	L	T	P	C	Maximum Marks		
								CA	ESE	Total
1	P23BTE11	Bio fertilizer and Bio pesticides	PEC	3	0	0	3	40	60	100
2	P23BTE12	Molecular Modelling & Drug Discovery	PEC	3	0	0	3	40	60	100
3	P23BTE13	Bioreactor Design & Analysis	PEC	3	0	0	3	40	60	100
4	P23BTE14	Pharmacovigilance	PEC	3	0	0	3	40	60	100
5	P23BTE15	Marine Biotechnology	PEC	3	0	0	3	40	60	100

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PROFESSIONAL ELECTIVE – IV										
S.NO	COURSE CODE	COURSE NAME	CATEGORY	L	T	P	C	MaximumMarks		
								CA	ESE	Total
1	P23BTE16	Agriculture Biotechnology	PEC	3	0	0	3	40	60	100
2	P23BTE17	Omics Technology	PEC	3	0	0	3	40	60	100
3	P23BTE18	Biofuels & Bioenergy	PEC	3	0	0	3	40	60	100
4	P23BTE19	Clinical genetics & Counselling	PEC	3	0	0	3	40	60	100
5	P23BTE20	Advanced Nanobiotechnology	PEC	3	0	0	3	40	60	100
PROFESSIONAL ELECTIVE – V										
S.NO	COURSE CODE	COURSE NAME	CATEGORY	L	T	P	C	MaximumMarks		
								CA	ESE	Total
1	P23BTE21	Tissue culture Techniques	PEC	3	0	0	3	40	60	100
2	P23BTE22	Advanced cancer Biology	PEC	3	0	0	3	40	60	100
3	P23BTE23	Metabolic Process & Engineering	PEC	3	0	0	3	40	60	100
4	P23BTE24	Essentials of Medical Microbiology	PEC	3	0	0	3	40	60	100
5	P23BTE25	Forensic Biotechnology	PEC	3	0	0	3	40	60	100

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AUDIT COURSES (AC)

Course Code	Course Name	Category	Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	ESE	Total
P23AC001	Research Process and Methodologies	AC	2	0	0	0	100	0	100
P23AC002	Pedagogy Studies	AC	2	0	0	0	100	0	100
P23AC003	Disaster Management	AC	2	0	0	0	100	0	100
P23AC004	Value Education	AC	2	0	0	0	100	0	100
P23AC005	Constitution of India	AC	2	0	0	0	100	0	100
P23AC006	English for Research Paper Writing	AC	2	0	0	0	100	0	100
P23AC007	Personality Development through Life Enlightenment Skills	AC	2	0	0	0	100	0	100
P23AC008	Universal Human Values	AC	2	0	0	0	100	0	100
P23AC009	Online Course	AC	2	0	0	0	100	0	100

OPEN ELECTIVE COURSES (OEC)

S.NO	COURSE CODE	COURSE NAME	CATEGORY	L	T	P	C	Maximum Marks		
								CA	ESE	Total
1	P23BTOE1	Bioethics and Biosafety	OEC	3	0	0	3	40	60	100
2	P23BTOE2	Renewable Bioenergy	OEC	3	0	0	3	40	60	100
3	P23BTOE3	Waste Management	OEC	3	0	0	3	40	60	100

PEC - Professional Elective Courses, PAC – Program Audit Courses, OEC – Open Elective Course.

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Curriculum Credit Distribution

S.No.	Course Components	Credits per semester				Total number of credits for each component
		I	II	III	IV	
1	Foundation Course (FC)	3	-	-	-	3
2	Programme Core Courses (PCC)	11	11	4	-	26
3	Programme Elective Courses (PEC)	6	9	-	-	15
4	Open Electives (OE)	-	-	3	-	3
5	Employability Enhancing Courses (EEC)	-	-	6	15	21
6	Audit Course (AC)	-	-	-	-	-
					Total Credits	68

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OPEN ELECTIVE COURSES OFFERED BY OTHER DEPARTMENTS

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

S.NO	COURSE CODE	COURSE NAME	CATEGORY	L	T	P	C	Maximum Marks		
								CA	ESE	Total
1	P23CSOE1	Business Analytics	OEC	3	0	0	3	40	60	100
2	P23CSOE2	Machine Learning Techniques	OEC	3	0	0	3	40	60	100
3	P23CSOE3	Web Engineering	OEC	3	0	0	3	40	60	100
4	P23CSOE4	Cost Management of Engineering Projects	OEC	3	0	0	3	40	60	100
5	P23CSOE5	Internet of Things	OEC	3	0	0	3	40	60	100
6	P23CSOE6	Data Science and Analytics	OEC	3	0	0	3	40	60	100

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

S.NO	COURSE CODE	COURSE NAME	CATEGORY	L	T	P	C	Maximum Marks		
								CA	ESE	Total
1	P23PSOE1	Industrial Safety	OEC	3	0	0	3	40	60	100
2	P23PSOE2	Energy Storage Technologies	OEC	3	0	0	3	40	60	100
3	P23PSOE3	Energy Management and Auditing	OEC	3	0	0	3	40	60	100
4	P23PSOE4	Electrical circuit design for Hazardous in Industries	OEC	3	0	0	3	40	60	100

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

S.NO	COURSE CODE	COURSE NAME	CATEGORY	L	T	P	C	Maximum Marks		
								CA	ESE	Total
1	P23VDOE1	Micro sensors and MEMS	OEC	3	0	0	3	40	60	100
2	P23VDOE2	Basics of VLSI	OEC	3	0	0	3	40	60	100
3	P23VDOE3	Communication Busses and Interfaces	OEC	3	0	0	3	40	60	100

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DEPARTMENT OF INFORMATION TECHNOLOGY

S.NO	COURSE CODE	COURSE NAME	CATEGORY	L	T	P	C	Maximum Marks		
								CA	ESE	Total
1	P23ITOE1	Cloud Computing Principles	OEC	3	0	0	3	40	60	100
2	P23ITOE2	Research Publication Ethics	OEC	3	0	0	3	40	60	100
3	P23ITOE3	Game Development	OEC	3	0	0	3	40	60	100
4	P23ITOE4	IoT for Smart Systems	OEC	3	0	0	3	40	60	100
5	P23ITOE5	Robotics	OEC	3	0	0	3	40	60	100

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Programme	**M.Tech**	Programme Code		**206**	Regulation		**2023**	
Department	**Biotechnology**				Semester		**I**	
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
P23MA103	**Applied Statistics for Biotechnologists**	**3**	**0**	**0**	**3**	**40**	**60**	**100**

Course Objective	The main objective of the course is to • Review the basic concepts of probability and apply in a real life situation. • Give the applications of probability distributions • Understand the concept of association between variables applicable in biological data. • Provide information about testing of hypothesis regarding biostatistics • Learn the basics of design of experiment.	
Course Outcome	At the end of the course, the student should be able to	Knowledge Level
	CO1: Understand the basic concepts of probability and its application.	K1,K2
	CO2: Apply probability distributions in their field.	K2, K4
	CO3: Use statistical techniques for analyzing biological data.	K2, K3
	CO4: Apply the hypothesis test in real life problems.	K3, K4
	CO5: Use various techniques of ANOVA in bio statistics.	K4, K5
Pre-requisites	-	

CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak												CO/PSO Mapping		
COs	Programme Outcomes (POs)											PSOs		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	3	3											2		
CO 2	3	3											2		
CO 3	3	3											2		
CO 4	3	3											2		
CO 5	3	3											2		

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment and Seminar 3. End-Semester examinations
Indirect
1. Course - end survey

Content of the syllabus

Unit – I	**PROBABILITY & RANDOM VARIABLES**	Periods	9

Sample spaces – Events - Axiomatic approach to probability - conditional probability - addition theorem -

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Multiplication theorem - Random variables - discrete and continuous - Distribution function - Expectation with properties – Moments – Mean – Variance.			
Unit - II	**STANDARD DISTRIBUTIONS**	Periods	**9**
Discrete distribution - Binomial, Poisson and Geometric distribution - Continuous distribution - Exponential, Gamma and Normal distribution – simple properties - Bivariate distribution - conditional and marginal distribution.			
Unit – III	**CORRELATION, REGRESSION & CURVE FITTING**	Periods	**9**
Correlation coefficient – Properties - Rank correlation - Regression equations - curve fitting by the method of least squares - fitting curves of the form ax+b, ax^2 +bx+c, ab^x and ax^b - Bivariate correlation application to biotechnologists.			
Unit - IV	**TESTING OF HYPOTHESIS**	Periods	**9**
Sampling distributions and Standard Error - Small samples and large samples - Test of hypothesis - Type I, Type II Errors - Critical region - Large sample tests for proportion and mean - Exact test based on normal, t, F and chi-square distribution -Test for goodness of fit.			
Unit – V	**DESIGN OF EXPERIMENTS**	Periods	**9**
Basic principles of experimentation - Analysis of variance – one-way, Two-way classifications - Randomized block design and Latin square design.			
		Total Periods	**45**
Text Books			
1.	Gupta S.C. and Kapoor V.K, Fundamentals of Mathematical Statistics, 4th Edition, Sultan and Sons, 2014.		
2.	Johnson.R.A., Miller and Freund's Probability and Statistics for Engineers, 8th Edition, 2014		
References			
1.	Devore, J.L., Probability and Statistics for Engineering and the Sciences, 8th Edition, Cengage Learning, 2011.		
2.	Montgomery, D.C. and Runger, C.G., Applied Statistics and Probability for Engineers, 6th Edition, Wiley Students Edition, Wiley, 2016.		
3.	Ravichandran, J., Probability and statistics for Engineers, 1st Edition, Wiley India Ltd, 2012.		
4.	Ronald E.Walpole; Raymond H.M.Yers; Stiaron L. Myers,Probability and Statistics for Engineering and the Scientists, Pearson Publishers, 7th Edition,2004		
5.	William Navidi, Statistics for Engineers and Scientists, TMH Publishers, New Delhi, 3rd Edition, 2013.		
E-Resources			
1.	https://www.youtube.com/		
2.	www.learnerstv.com/Free-engineering-Video-lectures		
3.	www.nptel.ac.in		

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Programme	**M. Tech**	Programme Code		**206**	Regulation		**2023**	
Department	**BIOTECHNOLOGY**				Semester		**I**	
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
P23BT101	**Clinical Trial Management**	3	0	0	3	40	60	100

Course Objective	The student should be made ➢ To Acquire knowledge on drug discovery and development ➢ To understand the process of clinical trial, its ethics and follow the regulatory framework important for benefit for the society ➢ To prepare the necessary documents required for conducting clinical trials & project management strategies for efficient trials	
Course Outcome	At the end of the course, the student should be able to,	Knowledge Level
	CO1: Understand key areas of drug development, clinical research regulations, trial management	K2
	CO2: Understand the ethical considerations in clinical trials	K2
	CO3: Apply the guidelines in clinical research	K3
	CO4: Analyze the necessary documents required for clinical research and Evaluate the clinical trial management process	K4 & K5
	CO5: Apply and demonstrate critical analysis skills using tools of CDM	K3

CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak													CO/PSO Mapping		
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO 1	2					2			3			2	3	3	3
CO 2	3	3		2	3					2			2	1	2
CO 3	3		3							2			2	2	1
CO 4		2		3	3	2			2			2	3	3	2
CO 5	3	2		2						2			3	1	1

Pre-requisites	Biopharmaceutical Technology

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment 3. End-Semester examinations
Indirect
1. Course - end survey

Content of the syllabus

Unit – I	**FUNDAMENTALS OF DRUG DEVELOPMENT AND CLINICAL TRIALS**	Periods	**9**

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Origin and History of Clinical Research, Introduction to Drug Discovery and drug Development, Clinical Trials in India-The National Perspective, Clinical Trial Phase I, Clinical Trial Phase II, Clinical Trial Phase III, Clinical Trial Phase IV-methods, Principles of sampling-Inclusion and exclusion criteria, Methods of allocation and randomization, Termination of trial			
Unit – II	**GOOD CLINICAL PRACTICE**	Periods	**9**
Historical guidelines in Clinical Research-Nuremberg code, Declaration of Helsinki, Belmont report, Research ethics and Bioethics-Principles of research ethics-Ethical issues in clinical trials-Use of humans in Scientific Experiments-the informed consent-Introduction to ethical codes and conduct Introduction to animal ethics-Animal rights and use of animals in the advancement of medical technology			
Unit – III	**REGULATIONS IN CLINICAL RESEARCH**	Periods	**9**
History of Regulations in Clinical Research, Patents US Regulatory Structure, IND, NDA, ANDA, Post Drug Approval Activities, PMS, FDA Audits and Inspections EU Regulatory Affairs, EMEA Organization and Function, INDIAN Regulatory system, Indian GCP guidelines (CDCSO guidelines), ICMR Guidelines - Ethical Guidelines for Biomedical Research on Human Subjects Schedule Y, Schedule Y- Rules and Regulations, Health Insurance Portability and Accountability Act (HIPAA).			
Unit – IV	**CLINICAL TRIAL MANAGEMENT AND ESSENTIAL DOCUMENTS**	Periods	**9**
Project management in clinical trials-principles of project management-Application in clinical trial management-Risk assessment Pharmacovigilance, Project Auditing, Inspection., Essential Documents in Clinical Trials: SOP, Clinical Trial Protocol and Protocol Amendment(S), Investigator Brochure, Master Files, Informed Consent Forms, Consort statement, Case Record Form			
Unit – V	**CLINICAL RESEARCH METHODOLOGY AND CLINICAL DATA**	Periods	**9**
Designing of Protocol, CRF, e-CRF, IB, ICF, SOP, Pharmaco-epidemiology, BA/BE Studies, Report writing, Publication, Introduction to CDM, tools for CDM, CDM process, CRF Design, Clinical Data Entry, Electronic Data Capture, Data Validation, Discrepancy Management, Clinical Data Coding, SAE Reconciliation, Quality Assurance & Clinical Data Management, Guideline & Regulation in Clinical trial data.			
		Total Periods	**45**

Text Books	
1.	Lee, Chi-Jen et al., Clinical Trials or Drugs and Biopharmaceuticals. CRC / Taylor & Francis, 2011
2.	Richard Chamberlain, "Project Management of Clinical Trials" Xlibris Us, 2019
3.	Abdel-aleem, Salah M., The Design and Management of Medical Device Clinical Trials: Strategies and Challenges. Wiley, 2011
4.	Friedman, L.M., Furberg, C.D., DeMets, D., Reboussin, D.M., Granger, C.B. Fundamentals of Clinical Trials, springer, 2015
References	
1.	Clinical Trials: Study Design, Endpoints and Biomarkers, Drug Safety, and FDA and ICH Guidelines, Tom Brody, Academic Press, 2016
2.	John I. Gallin, M.D, Frederick P Ognibene (2012), Principles and Practice of Clinical Research, Academic Press, 3 edition
3.	Clinical trials, A practical guide to design, analysis and reporting. Duolao Wang and Ameet Bakhai. Remedica. 2006.
E-Resources	
1.	https://archive.nptel.ac.in/courses/127/106/127106137/
2.	https://archive.nptel.ac.in/noc/courses/noc21/SEM1/noc21-ge14/
3.	https://archive.nptel.ac.in/courses/127/106/127106009/

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University, Chennai) Elayampalayam, Tiruchengode – 637 205						
Programme	**M.Tech**	Programme Code	**206**	Regulation	**2023**		
Department	**BIOTECHNOLOGY**			Semester	**I**		
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks	
		L	T	P	C	CA	ESE	Total
P23BT102	**Advanced Recombinant DNA Technology**	3	0	0	3	40	60	100

Course Objective	The student should be made • To gain knowledge on recombinant molecules. • To understand about chromosomal organization. • To understand the difference between cloning and expression. • To gain knowledge in editing tools.

Course Outcome	At the end of the course, the student should be able to,	Knowledge Level
	CO1: To understand the vector system.	K2
	CO2: Awareness about transformation methods.	K4
	CO3: Usage of genetic and biotechnological techniques to manipulate genetic materials and their application.	K4
	CO4: Analysis of gene expression.	K2
	CO5: To get familiarized gene editing.	K2

Pre-requisites

CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak													CO/PSO Mapping		
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	2			2	3	2			2		2	3	3	3
CO 2	2		1		2			2			2		3	2	2
CO 3	3		2		1	3	2			2		2	3	2	2
CO 4	2			1		3	2	2	2				3	3	2
CO 5	3		2			2		2	2	2		2	3	2	2

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment 3. End-Semester examinations
Indirect
1. Course - end survey

Content of the syllabus

Unit – I	VECTOR SYSTEMS	Periods	9

Overview of tools in recombinant DNA technology. Artificial chromosomes – YACs and BACs. Principles for maximizing gene expression – expression vectors, pMal, GST, pET-based vectors. Protein purification – GST-tag. Intein-based vectors; Inclusion bodies; methodologies to reduce formation of inclusion bodies; mammalian expression and replicating vectors; Baculovirus and Pichia vectors system, plant based vectors, Ti and Ri plasmids as vectors, yeast vectors, shuttle vectors.

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Unit - II	CREATION OF RECOMBINANT MOLECULES	Periods	9
Construction of recombinant DNA molecules, transformation of r-DNA molecules into target host organisms; Calcium chloride mediated- electroporation- micro injection, gene gun, selection methods for recombinants; antibiotic resistance - blue & white selection, GFP and Luciferase based selection.			
Unit – III	**GENE CLONING AND EXPRESSION METHODS**	Periods	9
Construction of genomic and cDNA libraries, synthesis and labeling of DNA and RNA probes, PCR based cloning, library screening methods; nucleic acid hybridization based screening , nucleic acid Probe preparation methods -radioactive and non-radioactive -PCR based screening- immunochemical screening, over-expression and purification of recombinant His tag fusion proteins using Ni+ column.			
Unit - IV	**GENE EXPRESSION ANALYSIS**	Periods	9
Overview of gene expression and its significance. Hybridization methods: Southern and Northern. PCR methods: Reverse transcriptase PCR, End point Vs. Real time PCR, Relative quantitation, Absolute quantification – Standard curve method and digital PCR. Endogenous/loading controls.High throughput analysis:Multiplex PCR, Microarray, Serial analysis of gene expression (SAGE) and Small Amplified RNA-SAGE (SAR-SAGE), Total analysis of gene expression (TOGA), Gene calling, RNA-seq and Ribosome profiling.			
Unit – V	**GENOME EDITING TECHNOLOGIES**	Periods	9
Basicsand applications of genome editing methods - Zinc-finger nuclease (ZFN), Transcription activator-like effector nucleases (TALEN), Meganucleases, CRISPR-Cas systems – Types and applications, Homing endonucleases, Transposons and Cre/lox P systems.Gene delivery systems – Physicochemical methods and viral vectors. Gene therapy for human diseases.			
		Total Periods	**45**

Text Books	
1.	Old, R. W. and Primrose, S. B., "Principles Of Gene Manipulation: An introduction To Genetic Engineering", Blackwell Science. 7th edition,2006
2.	Clark DP and Pasternick NJ, Biotechnology: Aademic Cell Updates, Academic Press, Elsevier, 2012.
References	
1.	Gupta, P.K., "Biotechnology and Genomics", Rastogi Publications,1st Ed, 2014
2.	Brown, T.A., "Gene Cloning and DNA Analysis", Blackwell Science Ltd,2006
E-Resources	
1.	https://nptel.ac.in/courses/102/102/102102033/
2.	https://onlinecourses.swayam2.ac.in/cec20_bt20/preview

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Programme	**M.Tech.**	Programme Code	**206**	Regulation	**2023**		
Department	**Biotechnology**			Semester	**I**		

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	**T**	**P**	**C**	**CA**	**ESE**	**Total**
P23BT103	**Advanced Bioprocess Technology**	**3**	**0**	**0**	**3**	**40**	**60**	**100**

Course Objective	To make the students to design and develop conventional and high-performance bioreactor.	
Course Outcome	At the end of the course, the student should be able to,	Knowledge Level
	CO1: Understand then basic requirements, screening and optimization.	K2
	CO2: Design and develop conventional basic bioreactors.	K3
	CO3: Design and develop high-performance basic bioreactors.	K3
	CO4: Analyze the scale up process and economy.	K3
	CO5: Design the bioreactor in software	K4
Pre-requisites	-	

CO / PO Mapping
(3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 - Weak**

COs	Programme Outcomes (POs)												**CO/PSO Mapping** PSOs		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO 1	2		2								2	3	3	1	3
CO 2	2	2	3	1		1	2	2	2		3	3	1	3	2
CO 3	2	3	2								2	3	3	2	2
CO 4	2		2	2					2				3	1	2
CO 5	2		3			3		3	2		2		2	3	3

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment & Quiz 3. End-Semester examinations
Indirect
1. Course - end survey

Content of the syllabus

Unit – I	**Medium requirements and optimization**	Periods	**9**

Fermentation – Medium requirements for fermentation processes -Material balance for fermentation process using examples (batch and continuous fermentation); Material Balance with Recycle, By-pass and Purge stream – medium optimisation: Plackett- Burman Design and Response surface method and their usage in fermentations; specific medium formulation for the cultivation of bacteria, yeast, fungal and mammalian cells

Unit - II	**Bioreactors – I**	Periods	**9**

Batch, fed-batch & simple chemostat, kinetic parameters and yield coefficient evaluation in simple chemostat, Immobilized cell chemostat, chemostat in series, two-stage chemostat, internal and external feedback systems in chemostat, cell recycle in chemostat with sludge removal, plug flow reactor and multiple fermenters

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connected in series.			
Unit – III	**Bioreactors – II**	Periods	**9**
Design & analysis of packed-bed. Design and operation of novel bioreactors –column fermenter; air-lift loop-reactors, fluidized-bed, trickle-bed bioreactors, Rotating disc bioreactor; spinning basket Bioreactor; Solid state bioreactors; Introduction to micro bioreactors and membrane bioreactors.			
Unit - IV	**Scale-up and Scale-down - Economic analysis**	Periods	**9**
Various approaches to scale-up including regime analysis & scale-down. Scale-up methods by currently used rules-of-thumb, viz., constant P/V, kLa etc. Economic analysis: Stages in plant design project- General fermentation process economics- capital investment estimate- fermentation plant utilities- production cost estimate.			
Unit – V	**Computer applications for Bioprocess**	Periods	**9**
Simulation of biofuels production using Design Pro Software – Algal oil production, Bio-diesel production from soybean oil, Bio-ethanol production from lignocellulosic biomass. Flowsheet creation of Bioprocess unit operations.			
		Total Periods	**45**

Text Books	
1.	Doran, P. M., Bioprocess Engineering Principles, 1/e, Academic press, New Delhi, 2013
2.	Shuler, M., and F. Kargi, Bioprocess Engineering, 2/e, Prentice-Hall, Englewood Cliffs, NJ, 2002.
3.	Stanbery, P.F., and A. Whitaker, Principles of Fermentation Technology, 2/e, Elsevier, 2017.
References	
1.	Bailey, J.E., and D.F. Ollis, Biochemical Engineering Fundamentals, 2/e, McGraw-Hill, New York, 1986.
2.	Rao, D.G., Introduction to Biochemical Engineering, 3/e, Tata McGraw Hill, New Delhi, 2005
E-Resources	
1.	https://www.springer.com/journal/12257
2.	https://www.coursera.org/lecture/industrial-biotech/introduction-to-biochemical-and-bioprocess-engineering-hoHUU

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PROFESSIONAL ELECTIVE - I

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Programme	**M.Tech.**	Programme Code	**206**	Regulation	**2023**		
Department	**BIOTECHNOLOGY**			Semester	**I**		
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks	
		L	**T**	**P**	**C**	**CA**	**ESE**	**Total**
P23BTE01	**PLANT METABOLITE**	**3**	**0**	**0**	**3**	**40**	**60**	**100**

Course Objective

The student should be made to,

- Understand the concept of plant secondary metabolites
- Know the Plant bioprocess optimization strategies for large-scale production of useful secondary metabolites
- Realize advances in biotransformation ,metabolic engineering and plant transgenics for the production of secondary metabolites

Course Outcome	At the end of the course, the student should be able to,	Knowledge Level
	CO1: Understand how metabolomics technology can enhance research in plant sciences	K2
	CO2: Predict the roles and pharmacological uses of secondary metabolites	K2
	CO3: Apply the Knowledge of biosynthesis pathway of the main plant secondary metabolites	K3
	CO4: Analyze the Strategies to enhance yield and productivity of plant secondary metabolites	K4
	CO5: Integrate metabolomics technologies to their own research interests	K4
Pre-requisites	-	

CO / PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak

COs	Programme Outcomes (POs)												**CO/PSO Mapping** PSOs		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	3	2	1		3	1	3					1	3	2	3
CO 2	3											1	3		3
CO 3	3	3	3		3	1						1	3		3
CO 4	3	3	3		3	3	3					1	3	2	3
CO 5	3	3	3		3	3	3					3	3	3	3

Course Assessment Methods

Direct

1. Continuous Assessment Test I, II & III
2. Assignment & Quiz
3. End-Semester examinations

Indirect

1. Course - end survey

Content of the syllabus

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Unit – I	INTRODUCTION TO METABOLOMICS	Periods	9
Plants, their metabolism and metabolomics, The structural diversity of metabolites, The chemical and physical properties, Metabolite abundance, Metabolites in Fruits, Vegetables, Beverages and Oher Plant-Based Dietary Components, Phytopharmaceuticals of importance BT approaches for plant-derived secondary metabolites			
Unit - II	**PRIMARY AND SECONDARY METABOLISM**	**Periods**	**9**
Primary and secondary metabolism, Central carbon metabolism, Nitrogen metabolism , Antibiotics, Pigments ,Floral scent, The main classes of secondary metabolites in plants : terpenes, alkaloids, flavonoids and their roles and their pharmacological uses, Molecular pharming			
Unit – III	**ANALYTICAL METHODS IN METABOLOMICS**	**Periods**	**9**
Principles of PME, Biosynthesis metabolic pathway, Mechanisms of gene expression regulation, Methods for identification and analyse plant secondary metabolites and bioactive properties, Capillary electrophoresis, Gas chromatography, HPLC systems, Mass spectrometry, Tandem MS and advanced scanning techniques, NMR spectrometry			
Unit - IV	**PRODUCTION OF SECONDARY METABOLITES**	**Periods**	**9**
Strategies to enhance yield and productivity of plant secondary metabolites in in vitro cell/tissue cultures , Biotransformation using plant cell and organ cultures, Transgenic protein production ,Immobilization of plant cells for secondary metabolite production, Genetic transformations in plant cells ,Scale-up of plant cell cultivation, Metabolic engineering for enhanced secondary metabolite production, Large-scale Production in Bioreactors ,Bioreactors for hairy root cultures, Factors Affecting the Production of Secondary Metabolites			
Unit – V	**APPLICATION PLANT-ORIGINATED SECONDARY METABOLITES**	**Periods**	**9**
Secondary metabolism in plant cells: Its role and commercial applications ,Secondary Metabolites of Pulse, Spices, Medicinal plants, Microalgae and Horticultural Crops, Spirulina: Functional Compounds and Health Benefits, , Applications of metabolomics approaches in plant research,Mechanisms and Roles in Insect Pest Management, Pathogen-Induced Plant Defense			
		Total Periods	**45**

Text Books	
1.	S. S. Bhojwani and M. K. Razdan, "Plant Tissue Culture: Theory and Practice, Elsevier Science", First Edition, Volume 5, 1996.
2.	H.S. Chawla, "Introduction to Plant Biotechnology", Science Publishers , Second edition, 2002.
References	
1.	Nigel W. Scott, Mark R. Fowler, Adrian Slater, Plant Biotechnology: The genetic manipulation of plants, Oxford University Press , Second edition, 2008.
2.	A. Altman and P. Hasegawa, Plant biotechnology and agriculture, Academic Press , Edition 1, 2012.
3.	Karl-Hermann Neumann, "Plant cell/tissue culture-A tool in Biotechnology: Basics and Application" Springer-Verlag Berlin. ISBN:978-3-540-93883-5 ,2009.
E-Resources	
1.	The Handbook of Plant Metabolomics. Print ISBN: 9783527327775; Online ISBN: 9783527669882; DOI: 10.1002/9783527669882 (available online for free through UIUC libraries)
2.	https://nptel.ac.in/courses/102106080
3.	https://nptel.ac.in/courses/102103016

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University, Chennai) Elayampalayam, Tiruchengode – 637 205							
Programme	**M.Tech**	Programme Code	**206**	Regulation	**2023**			
Department	**BIOTECHNOLOGY**			Semester	**I**			
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	**T**	**P**	**C**	**CA**	**ESE**	**Total**
P23BTE02	**ADVANCED COMPUTATIONAL BIOLOGY**	**3**	**0**	**0**	**3**	**40**	**60**	**100**

Course Objective

The student should be made to,

- Understand scope of Bioinformatics
- Understanding of basic techniques in bioinformatics
- Gain knowledge of fundamentals of phylogenetics
- Acquire knowledge on different bioinformatics tools
- Understand the applications of the field

Course Outcome

At the end of the course, the student should be able to,	Knowledge Level
CO1: Understand the basics of sequence data and analysis of the same	K2
CO2: Interpret phylogenetic relationships among different species	K3
CO3: Explain different approaches in protein structure prediction and evaluation	K3
CO4: Know the importance of machine learning and advanced techniques in analysis of biological data	K3
CO5: Interpret and analyze the biological data using perl programming	K4

Pre-requisites -

CO / PO Mapping (3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 - Weak**

COs	Programme Outcomes (POs)												**CO/PSO Mapping** PSOs		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	2	2			3	3		2	2	3			3	2	3
CO 2	2			3	3		2		3		3		2	3	2
CO 3	2	3	2		2	3		2				3	2	3	3
CO 4	2	2			3	3	2			2			2	3	3
CO 5	2	3		3	3	2			2		2		3	3	2

Course Assessment Methods

Direct

1. Continuous Assessment Test I, II & III
2. Assignment & Quiz
3. End-Semester examinations

Indirect

1. Course - end survey

Content of the syllabus

Unit – I	**INTRODUCTION AND SEQUENCE ANALYSIS**	Periods	**9**

Molecular sequences, Genome sequencing: pipeline and data, Next generation sequencing data, Biological databases: Protein and Nucleotide databases, Sequence Alignment, Dynamic Programming for computing edit

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distance and string similarity, Local and Global Alignment, Needleman Wunsch Algorithm, Smith Waterman Algorithm, BLAST family of programs, FASTA algorithm, Functional Annotation, Progressive and Iterative Methods for Multiple sequence alignment, Applications.			
Unit - II	**PHYLOGENETICS**	Periods	**7**
Introduction to Phylogenetics, Distance and Character based methods for phylogenetic tree construction: UPGMA, Neighbour joining, Ultrametric and Min ultrametric trees, Parsimonous trees, Additive trees, Bootstrapping.			
Unit – III	**PROTEIN STRUCTURE, MODELLING AND SIMULATIONS**	Periods	**9**
Protein Structure Basics, Visualization, Prediction of Secondary Structure and Tertiary Structure, Homology Modeling, Structural Genomics, Molecular Docking principles and applications, Molecular dynamics simulations.			
Unit - IV	**MACHINE LEARNING, SYSTEMS BIOLOGY AND OTHER APPLICATIONS**	Periods	**11**
Machine learning techniques: Artificial Neural Networks and Hidden Markov Models: Applications in Protein Secondary Structure Prediction and Gene Finding, Introduction to Systems Biology and its applications in whole cell modelling, Microarrays and Clustering techniques for microarray data analysis, informatics in Genomics and Proteomics, DNA computing.			
Unit – V	**PERL FOR BIOINFORMATICS**	Periods	**9**
Variables, Data types, control flow constructs, Pattern Matching, String manipulation, arrays, lists and hashes, File handling, Programs to handle biological data and parse output files for interpretation			
		Total Periods	**45**
Text Books			
1.	David W. Mount Bioinformatics: Sequence and Genome Analysis, Cold Spring Harbor Laboratory Press, Second Edition, 2004.		
2.	Arthur M. Lesk, Introduction to Bioinformatics by Oxford University Press, 2008.		
References			
1.	Durbin, R. Eddy S., Krogh A., Mitchison G. Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids. Cambridge University Press, 1998.		
2.	Baldi, P., Brunak, S. Bioinformatics: The Machine Learning Approach, 2nd ed., East West Press, 2003.		
3.	Baxevanis A.D. and Oullette, B.F.F. A Practical Guide to the Analysis of Genes and Proteins, 2nd ed., John Wiley, 2002.		
4.	Tisdall, James, Beginning PERL for Bioinformatics, O'Reilley Publications, 2001.		
5.	Andrew R. Leach, Molecular Modeling Principles And Applications, Second Edition, Prentice Hall, 2001.		
E-Resources			
1.	https://nptel.ac.in/courses/102/106/102106065/		
2.	https://openlab.citytech.cuny.edu/biology/bioinformatics-online-resources/		
3.	https://www.coursera.org/learn/bioinformatics-pku		

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Programme	**M.Tech.**	Programme Code	**206**	Regulation		**2023**	
Department	**BIOTECHNOLOGY**			Semester		**1**	
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks	
		L	**T**	**P**	**C**	**CA**	**ESE**	**Total**
P23BTE03	**FOOD PROCESSING AND BIOTECHNOLOGY**	3	0	0	3	40	60	100

Course Objective	• To know about the constituents and additives present in the food. • To gain knowledge about the microorganisms, food spoilage diseases. • To know different techniques used for the preservation of foods.	
Course Outcome	At the end of the course, the student should be able to,	Knowledge Level
	CO1: To remember different constituents present in food and microorganism involved in processing of food.	K1
	CO2: Principles and different preservations techniques of food can also be known.	K2
	CO3: Unit operations in modern food processing and impact of the process on food quality.	K3
	CO4: Various types of food preservation techniques can be known	K4
	CO5: Quality control and various regulation of food also be known	K4
Pre-requisites	-	

CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak													CO/PSO Mapping		
COs	Programme Outcomes (POs)												PSOs		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	1	1	2	3		1	2	2	1	2	3	3	3	2	3
CO 2	2	2	1	2				2					2	3	2
CO 3	2	2	3	2									2	3	3
CO 4	1				3	3		1					2	3	3
CO 5		2	3	2	3	2		2					3	3	2

Course Assessment Methods

Direct

1. Continuous Assessment Test I, II & III
2. Assignment & Quiz
3. End-Semester examinations

Indirect

1. Course - end survey

Content of the syllabus

Unit – I	**FOOD PROCESSING**	Periods	**9**

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Heat Processing using steam or water (Blanching, Pasteurization) – Heat sterilization (Evaporation and distillation) – Heat processing using hot air (Dehydration, baking and roasting) – Heat processing using hot oils – Processing by the removal of heat (chilling, Freezing) – High pressure processing of foods – Pulsed electric field processing of liquids and beverages – Non-thermal processing by radiofrequency electric fields.			
Unit - II	**FOOD FERMENTATION**	Periods	**9**
Fermentative production of foods – Single cell protein (yeast, mushroom) – Microorganisms responsible for production of fermented foods – Enzyme in bakery and cereal products – Enzymes in fat/oil industries – Protease in cheese making and beverage production – Production of Pectinases and Utilization in Food Processing – Food Flavor Production – Utilization of food waste for production of valuables.			
Unit – III	**FERMENTED FOODS**	Periods	**9**
Overview of fermented foods – Bean-based – Grain-based – Vegetable-based – Fruit-based – Honey-based – Dairy-based – Fish-based – Meat-based – Tea-based – Advantages of fermented foods Health benefits of fermented foods – Nutritive value of fermented food – Biotechnological approaches to improve nutritional quality – Microbial changes in fermented food.			
Unit - IV	**FOOD PRESERVATION TECHNIQUES**	Periods	**9**
Spoilage of food - Microbiology of water, meat, milk, vegetables – Food poisoning – Cold preservation – Heat conservation – Ionizing radiation – High pressure – Electric field – Chemical food preservation – Combination of techniques for food preservation – Natural antioxidants – Antimicrobial enzymes – Edible coatings – Control of pH and water activity.			
Unit – V	**FOOD QUALITY AND CONTROL**	Periods	**9**
Analysis of food – Major ingredients present in different product – Food additives, vitamins – Analysis of heavy metal, fungal toxins, pesticide and herbicide contamination in food – Microbial safety of food products – Chemical safety of food products – Good manufacturing practice.			
	Total Periods		**45**
Text Books			
1.	Adams M., Adams M. R. and Robert Nout M. J., "Fermentation and food safety", Springer, 2001.		
2.	Da-Wen S., "Emerging Technologies for Food Processing", Academic Press, 2005		
References			
1.	Pometto A, Shetty K, Paliyath G and Levin R. E., "Food Biotechnology", 2nd Edition , CRC press, 2005.		
2.	Zeuthen P. and Bogh-Sorensen, L., "Food Preservation Techniques", 1st Edition, CRC Press, 2003.		
E-Resources			
1.	https://archive.nptel.ac.in/		
2.	https://onlinecourses.nptel.ac.in/		

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University, Chennai) Elayampalayam, Tiruchengode – 637 205							
Programme	**M.Tech.**	Programme Code		**206**	Regulation		**2023**	
Department	**BIOTECHNOLOGY**				Semester		**I**	
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
P23BTE04	**ENZYME ENGINEERING & TECHNOLOGY**	3	0	0	3	40	60	100

Course Objective

The student should be made

- To study about the nomenclature and classifications of enzymes.
- To understand the various kinetics of enzymes.
- To understand the method of enzyme immobilization.
- To understand the enzymes in functional group transformation.
- To analyze the role and applications of different enzymes in various industries.

Course Outcome

At the end of the course, the student should be able to,	Knowledge Level
CO1: Understand the basic concept of enzyme classifications and specifications.	K2
CO2: Explain the kinetics of enzyme action.	K1
CO3: Describe the enzyme immobilization.	K1
CO4: Explain the role of enzyme in functional group transformation.	K1
CO 5: Illustrate the applications of enzymes.	K4

Pre-requisites

Knowledge of basic biology, biochemistry and bio-process engineering will be essential.

CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak

CO/PSO Mapping

COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2												3	2	3
CO 2	3	3	3									3	2	3	2
CO 3	3	3	3		3							3	2	2	2
CO 4	3	3	1		3							3	2	3	3
CO 5	3	3	3	3	3				3	3	3	3	3	3	3

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment 3. End-Semester examinations
Indirect
1. Course - end survey

Content of the syllabus

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Unit – I	**INTRODUCTION**	Periods	**9**
Introduction to enzymes, Classification, Sources, Mechanism of enzyme action. Strategies of purification of enzymes, criteria of purity, molecular weight determination and characterization of enzymes, Methods for investigating the kinetics of enzyme catalyzed reactions – Initial velocity Studies, Estimation of Michaelis Menten parameters, Effect of pH and temperature on enzyme activity, kinetics of inhibition. Modeling of rate equations for single and multiple substrate reactions.			
Unit - II	**BIOLOGICAL IMPORTANCE OF ENZYMES**	Periods	**9**
Enzymes of biological importance - Acetyl cholinesterase, angiotensin converting enzyme (ACE), ACE Inhibitors, HMG Co A reductase inhibitors, pseudo cholinesterase, 5'-nucleotidase (5NT), glucose-6-phosphate dehydrogenase (GPD), Isoforms, immunoreactive trypsinogen (IRT) and chymotrypsin; amylase isoenzymes.			
Unit – III	**IMMOBILIZED ENZYMES**	Periods	**9**
Techniques of enzyme immobilization; kinetics of immobilized enzymes, effect of solute, partition & diffusion on the kinetics of immobilized enzymes, design and configuration of immobilized enzyme reactors; applications of immobilized enzyme technology, Economic argument for immobilization.			
Unit – IV	**ENZYMES IN FUNCTIONAL GROUP TRANSFORMATION**	Periods	**9**
Functional group interconversion using enzymes (hydrolysis reaction, oxidation/reduction reactions, C-C bond formations), Retrosynthetic biocatalysis, Chemoenzymatic synthesis of natural products. Industrial process using enzymes for production of drugs, fine chemicals and chiral intermediates, Catalytic antibodies, The design and construction of novel enzymes, artificial enzymes, Biotransformation of drugs (hydroxylation of Steroids).			
Unit – V	**APPLICATIONS OF ENZYMES**	Periods	**9**
Enzymes in organic synthesis, Enzymes as biosensors, Enzyme for environmental application, Enzymes for molecular biology research, Enzymes for analytical and diagnostic applications, Enzymes for food, pharmaceutical, tannery, textile, paper and pulp industries.			
		Total Periods	**45**

Text Books

1.	Yeh W.K., Yang H.C., James R.M., "Enzyme Technologies: Metagenomics, Biocatalysis and Biosynsthesis", WileyBlackwell, 1st Edition, 2010.

References

1.	Bailey J.E., Ollis D.F. "Biochemical Engineering Fundamentals.". McGraw Hill, 2nd Edition 1986.
2.	Faber, Kurt "Biotransformations in Organic Chemistry: A Textbook.", 5th Edition. Springer, 2008.
3.	Palmer, Trevor. "Enzymes: Biochemistry, Biotechnology, Clinical Chemistry." 2nd Edition, East West Press, 2008.
4.	Blanch H.W., Clark D. S., "Biochemical Engineering", Marcel Dekker, Inc. 2nd Edition, 1997.
5.	Lee, James M., "Biochemical Engineering." PHI, 1st Edition, 1992.

E-Resources

1.	https://nptel.ac.in/courses/102/102/102102033/
2.	http://www.nptelvideos.in/2012/11/enzyme-science-and-engineering.html
3.	https://onlinecourses.swayam2.ac.in/cec20_bt20/preview

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University, Chennai) Elayampalayam, Tiruchengode – 637 205							
Programme	**M.Tech**	Programme Code		**206**	Regulation		**2023**	
Department	**BIOTECHNOLOGY**				Semester		**I**	
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
P23BTE05	**STEM CELL RESEARCH AND APPLICATIONS**	3	0	0	3	40	60	100

Course Objective	**The main objective of this course is to:** • To study the unique properties of stem cell with its classification. • To understand its application in the treatment of diseases. • To gain knowledge on the basics of stem cells and their origin • To learn the methods of stem cell identification and various sources • To give way to the therapeutic treatment using stem cells	
Course Outcome	At the end of the course, the student should be able to,	Knowledge Level
	CO1:To understand the Basic properties of stem cells	K2
	CO2:To comprehend the source and characterization of Human embryonic stem cell.	K2
	CO3: To isolate and identify the different types of adult stem cell.	K2
	CO4: To explain the role of stem cell in tissue engineering.	K4
	CO5: To demonstrate the various medical applications of stem cell.	K4
Pre-requisites	Nil	

CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak													CO/PSO Mapping		
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2			2		1							1		
CO 2	2			2		2				1	2				2
CO 3	2			2	2	2				1	2		2		2
CO 4	2		1	1	2					2	1		1	1	2
CO 5	1		1	1	1	1				2	2		1	2	1

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment 3. End-Semester examinations
Indirect
1. Course - end survey

Content of the syllabus

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Unit – I	INTRODUCTION TO STEM CELLS	Periods	9
Scope of Stem Cells -Unique properties of stem cells – differentiation , maturation , proliferation , pluripotency, self – maintenance and self – renewal –classification- problems in measuring stem cells – preservation protocols.			
Unit - II	**HUMAN EMBRYONIC STEM CELL**	Periods	**9**
Stem cells and their developmental potential. Invitro fertilization-culturing of embryos-blastocyst-inner cell mass-isolation and growing ES cells in lab-Identification and characterization of human ES cells-Cloning and controlled differentiation of human embryonic stem cells. Applications of Embryonic stem cells – Ethical issues and regulations.			
Unit – III	**HUMAN ADULT STEM CELL**	Periods	**9**
Somatic stem cells-test for identification of adult stem cells- adult stem cell differentiation-trans differentiation-plasticity-different types of adult stem cells-liver stem cells-skeletal muscle stem cells-bone marrow derived stem cells.			
Unit - IV	**STEM CELLS IN TISSUE ENGINEERING**	Periods	**9**
Haematopoietic Stem Cells-Growth factors and the regulation of haematopoietic stem cells-clinical applications of haematopoietic stem cells. Mesenchymal stem cells and their role in bone tissue engineering-bone repair. Stem cell based gene therapy and benefits to human.			
Unit – V	**APPLICATIONS OF STEM CELL**	Periods	**9**
Therapeutic applications-Parkinsons disease, Cancer stem cell – Neural stem cell for central nervous system repair – Spinal cord injury – use of ESC to treat heart disease – Burns and skin ulcers – Orthopaedic applications of stem cell - Insulin-producing Cells Derived from Stem Cells: A Potential Treatment for Diabetes.			
		Total Periods	**45**

Text Books	
1.	Potten.C S, "Stem Cells," Elsevier, 1996.
2.	Stem Cell Biology, David Gottlieb, Cold Spring Harbor, 2002
3.	Essentials of Stem Cell Biology 3rd Edition,Robert Lanza Anthony Atala,2013
References	
1.	Ariff Bongso, Eng Hin Lee "Stem Cells: From Bench to Bedside" World Scientific Publishing Company. 2005
2.	Daniel R. Marshak, "Stem cell biology," Cold Spring Harbor Laboratory Press, 2001.
3.	Peter Quesenberry, "Stem cell biology and Gene Therapy," Wiley-Liss, 1998.
e-resources	
1.	http://ocw.mit.edu/courses/biology/7-344-the-fountain-of-life-from-dolly-to-customized-embryonic-stem-cells-fall-2007/download-course-materials/
2.	https://embryology.med.unsw.edu.au/embryology/index.php/Talk:Lecture_-_Stem_Cells

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PROFESSIONAL ELECTIVE - II

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Programme	**M.Tech.**	Programme Code	**206**		Regulation		**2023**
Department	**BIOTECHNOLOGY**				Semester		1
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks	
		L	**T**	**P**	**C**	**CA**	**ESE**	**Total**
P23BTE06	**Molecular Diagnostics and Therapeutics**	3	0	0	3	40	60	100

Course Objective	The objectives of this course are • to sensitize students about recent advances in molecular biology and various facets of molecular medicine. • Understand the vantages of molecular diagnostics in precision diagnosis and learn about state-of-the-art techniques that are used in clinical diagnosis of diseases • To learn the production of recombinant proteins and immunotherapeutics • To relate the technique of gene silencing in therapeutics.	
Course Outcome	At the end of the course, the student should be able to,	KL
	CO1: Understand the disease types and their diagnosis. Obtain knowledge about ethical and regulatory aspects of conducting diagnostic tests.	K1
	CO2: Develop skills to interpret the results of molecular techniques when performing them practically.	K2
	CO3: Learn the production of recombinant products and their significance in therapy	K3
	CO4: Illustrate the strategies of immunotherapy using monoclonal antibodies and vaccines	K3
	CO5: Understand the mechanism of gene silencing and method of gene cloning	K4
Pre-requisites	Molecular biology, Genetics.	

CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak													CO/PSO Mapping		
COs	Programme Outcomes (POs)												PSOs		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	3	2	2	2	1	2		3				2	3	2	3
CO 2	3	3		2	2	2		2			2	3	2	3	2
CO 3	3	3	3	2				1			3	1	2	3	3
CO 4	2	3			3	3		1			3	3	2	3	3
CO 5	3	2	3	2	3	2		2				3	3	3	2

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Course Assessment Methods

Direct

1. Continuous Assessment Test I, II & III
2. Assignment & Quiz
3. End-Semester examinations

Indirect

1. Course - end survey

Content of the syllabus

Unit – I	INTRODUCTION TO MOLECULAR DIAGNOSTICS	Periods	9

Definition - History – Diseases- infectious, physiological and metabolic errors, and inherited diseases. Biomarkers- types, potential uses and limitations. Diagnostics – types and importance in clinical decision making. Benefits of molecular diagnostics over conventional diagnostics. Ethical issues related to molecular diagnostics. Clinical specimens: National and International guidelines for Sample collection- method of collection, transport and processing of samples, Personal safety and laboratory safety. GLP for handling highly infectious disease samples and documentation.

Unit – II	DIAGNOSTIC AND GENE EDITING TOOLS	Periods	9

Instruments for diagnostic, therapeutic, and assistive purpose; Magnetic Resonance Imaging (MRI), X-ray radiography, and Computed Tomography, Fluorescence in situ hybridization (FISH), Identification of Single Nucleotide Polymorphisms (SNPs), Quantitative PCR, and Gene chip (or) microarrays, ZFNs (Zinc Finger Nucleases), TALENs (Transcription Activator Like Effector Nucleases), CRISPR (Clustered Regularly Interspaced Short Palindromic Repeats)

Unit – III	GENE AND RDNA THERAPY	Periods	9

Gene therapy; Intracellular barriers to gene delivery; Overview of inherited and acquired diseases for gene therapy; Retro and adeno virus mediated gene transfer; Liposome and nanoparticles mediated gene delivery. Recombinant therapy; Clinical applications of recombinant technology; Erythropoietin; Insulin analogs and its role in diabetes; Recombinant human growth hormone; Streptokinase and urokinase in thrombosis; Recombinant coagulation factors.

Unit – IV	STEM CELL AND IMMUNO THERAPY	Periods	9

Cellular therapy; Stem cells: definition, properties and potency of stem cells; Sources: embryonic and adult stem cells; Concept of tissue engineering; Role of scaffolds; Role of growth factors; Role of adult and embryonic stem cells; Clinical applications; Ethical issues.

Immunotherapy; Monoclonal antibodies and their role in cancer; Role of recombinant interferons; Immunostimulants; Immunosupressors in organ transplants; Role of cytokine therapy in cancers; Vaccines: types, recombinant vaccines and clinical applications. Gene silencing technology; Antisense therapy; siRNA

Unit – V	GENE SILENCING AND CLONING	Periods	9

Gene silencing technology - Antisense therapy; triple helix technology, si RNA - mechanism; Tissue and organ transplantation; Transgenics production and their uses; Reproductive cloning – Dolly as an example; Ethical issues.

Total Periods	**45**

Text Books

1. Tietz textbook of clinical chemistry and molecular diagnostics. Carl Burtis, Edward Ashwood, David Bruns, Elsevier Press. 5th Edition 2012.
2. Bernhard Palsson and Sangeeta N Bhatia, Tissue Engineering, 2nd Edition, Prentice Hall, 2004.
3. T. A. Brown "Gene Cloning: An Introduction" Wiley-Blackwell, 2020

References

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1.	Molecular Diagnostics: Fundamentals, Methods and Clinical Applications. Lela Buckingham and Maribeth L. Flaws. 2011
2.	Pamela Greenwell, Michelle McCulley, 2008, Molecular Therapeutics: 21st Century Medicine, 1st Edition, Springer.
3.	Modern Blood Banking & Transfusion Practices. Denise M. Harmening. 2018
4.	Molecular Diagnostics: Fundamentals, Methods & Clinical applications (2007). Lele Buckingham and Maribeth L. Flaws
5.	Molecular Diagnostics for the Clinical Laboratorian 2Ed. 2006, W.B. Coleman. Humana Press.
6.	Fundamentals of Molecular Diagnostics (2007). David E. Bruns, Edward R. Ashwood, Carl A. Burtis. Saunders Group.
E-Resources	
1.	https://onlinecourses.nptel.ac.in/noc22_bt07/preview
2.	https://nptel.ac.in/courses/102103041
3.	https://archive.nptel.ac.in/courses/102/103/102103038/

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University, Chennai) Elayampalayam, Tiruchengode – 637 205							
Programme	**M.Tech**	Programme Code		**206**	Regulation		**2023**	
Department	**BIOTECHNOLOGY**				Semester		**I**	
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
P23BTE07	**ANIMAL BIOTECHNOLOGY**	3	0	0	3	40	60	100

Course Objective	The objective of this course is to introduce students to technologies that can be used for animal, human health and research. To provide the knowledge of gene transfer methods. Students will analyze literature on stem cells, cloning, large animal models for disease and development of therapies and treatments. This class will cover cellular and molecular biology techniques and their applications in animal biotechnology.	
Course Outcome	At the end of the course, the student should be able to,	Knowledge Level
	CO1: Understand the classification of various media used in animal cell culture	K2
	CO2: Identify the gene transfer methods	K4
	CO3: Gain the knowledge of therapy by embryo transfer.	K3
	CO4: Apply their knowledge in concepts of transgenic animal technology	K4
	CO5: Understand the concepts of micro manipulation technology	K3
Pre-requisites		

CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak													CO/PSO Mapping		
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	2			2	3	2			2		2	3	3	3
CO 2	2		1		2			2			2		3	2	2
CO 3	3		2		1	3	2			2		2	3	2	2
CO 4	2			1		3	2	2	2				3	3	2
CO 5	3		2			2		2	2	2		2	3	2	2

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment 3. End-Semester examinations
Indirect
1. Course - end survey

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Content of the syllabus			
Unit – I	**ANIMAL CELL CULTURE**	Periods	**8**
Media for culturing cells - Chemically defined and serum free media for cell culture; Sterilization of various equipments and apparatus - Cell culture substrates – Animal cell culture; types and methods - Development of cell lines; Development, Maintenance, Preservation and Characterization of animal cells , Scaling up of animal cell cultures – Cell culture as source of valuable products-Protein production by genetically engineered mammalian cell lines, Stem cells and their applications.			
Unit - II	**GENE TRANSFER METHODS**	Periods	**8**
Gene transfer methods - Virus mediated methods; Biology and Construction of viral vectors like adenovirus, lentivirus, herpes virus, and adeno associated virus, baculovirus , Transfection methods; stable and transient methods.			
Unit – III	**MICROMANIPULATION & TRANSFER OF EMBRYO**	Periods	**10**
Micromanipulation technology; Artificial insemination, Superovulation, Embryo transfer, Invitro fertilization - Pregnancy diagnosis - Sexing of embryos, Embryo splitting; Cryopreservation of embryo - Cloning and SCNT - Breeding of farm animals.			
Unit - IV	**TRANSGENIC ANIMALS**	Periods	**10**
Concepts of transgenic animal technology - Various strategies for the production of transgenic animals and their importance in biotechnology; pronuclear microinjection, embryonic stem cells and somatic cell nuclear transfer in the production of transgenic animals. - Transgenic animals as bioreactors for producing pharmaceutically important compounds and therapeutics etc. Role of gene knock out and gene knock in mice model for studying human genetic disorder. Genome editing technique.			
Unit – V	**BIOTECHNOLOGICAL ANIMAL PRODUCTION**	Periods	**9**
Manipulation of Growth hormone; Somatotropic hormone and Thyroid hormone – Probiotics as growth promoters; Ideal characteristics of probiotics; Mode of action and uses of probiotics-Manipulation of lactation -Lactogenesis- galactopoiesis, wool growth and rumen microbial digestive system.			
		Total Periods	**45**
Text Books			
1.	Ramadoss, P., Animal Biotechnology: Recent Concepts and Developments, MJb Publishers, Chennai, 1st Edition, 2008.		
2.	Davis, D., Animal Biotechnology, National Academic Press, Washington, 1st Edition, 2002.		
References			
1.	Freshney, R. I., Culture of Animal Cells: A manual of Basic technique, John ,Wiley & sons, 2010.		
2.	Masters, J.R.W., Animal Cell Culture: Practical Approach, Oxford University Press, New York, 2000.		
E-Resources			
1.	https://nptel.ac.in/courses/102/102/102102033/		
2.	https://onlinecourses.swayam2.ac.in/cec20_bt20/preview		

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Programme	**M.Tech**	Programme Code		**206**	Regulation		**2023**	
Department	**BIOTECHNOLOGY**			Semester			**I**	
Course Code	Course Name	Periods Per Week		Credit	Maximum Marks			
		L	T	P	C	CA	ESE	Total
P23BTE08	**PHARMACEUTICAL TECHNOLOGY**	3	0	0	3	40	60	100

Course Objective	The student should be made ➢ To remember the basics of drug, drug target and routes of drug administration ➢ To understand the mechanism of drug metabolism and excretion ➢ To provide an insight about in-silico based drug discovery techniques ➢ To gain knowledge about drug development and clinical trials ➢ To acquire knowledge about cGMP and regulatory affairs	
Course Outcome	At the end of the course, the student should be able to,	**KL**
	CO1: Highlight the various principles involved in the drug discovery and various routes of drug administration	K1
	CO2: Interpret the various mechanisms of drug absorption and metabolism in drug development.	K2
	CO3: Integrate how molecular modelling used in drug development.	K3
	CO4: Analyze the role of different phases in drug development and clinical trials.	K4
	CO5: Analyze the importance of current regulatory acts and cGMP for pharmaceutical industries.	K4
Pre-requisites	Cell Biology, Biochemistry, Microbiology, Molecular Biology, Immunology	

CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak													**CO/PSO Mapping**		
COs	Programme Outcomes (POs)												PSOs		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**	**PSO3**
CO 1	2	2		2	1					1	1	1	1	1	1
CO 2	2	1	2	2	2	1	2	1		3		1	3	1	2
CO 3	3	2	2	2	2	2	2		2	2	2	2	2	3	3
CO 4	3	2	2	2	2	2	2	2	3	2	2	2	3	3	3
CO 5	2	2	1	3	2				3	2	2	2	2	3	2

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III

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2. Assignment 3. End-Semester examinations	
Indirect	
1. Course - End survey	

Content of the syllabus

Unit – I	**INTRODUCTION TO DRUG**	Periods	**9**
Drug - Definition, Classification - Various approaches in drug discovery process - Basic Terminologies in Drug – Principles of ligand chemistry – lead optimization, Lipinski "rule of 5", Drug Target – Lipids, Proteins, Carbohydrates - Routes of drug administration.			
Unit – II	**MECHANISM AND PRINCIPLES OF DRUG ACTION**	Periods	**9**
Pharmacokinetics: Drug Absorption, Distribution, Metabolism and Elimination (ADME)-Pharmacodynamics: Basic principles, Biotransformation of drugs, pathways and enzymes of drug metabolism, Phase I and Phase II, drugs excretion – renal and non-renal routes, Pharmacokinetics and Pharmacodynamics of Nano drug carriers. Critical Factors in drug delivery, controlled drug release			
Unit – III	**IN-SILICO METHODS FOR DRUG DISCOVERY**	Periods	**9**
Introduction to molecular docking, Principles of macromolecule-ligand docking, docking algorithms, AUTODOCK, de novo pharmacophore elucidation/ drug design for structurally well-defined receptor targets from case studies (Eg. HIV protease inhibition); Molecular dynamic simulations, relative energy, energy minimization methods, ligand binding free energy calculations, GROMOS and GROMACS.			
Unit – IV	**DRUG DEVELOPMENT & CLINICAL TRIALS**	Periods	**9**
Drug development stages, Regulation of preclinical studies, Schedule-Y, pre-clinical study, Introduction to animal ethics, Animal rights and use of animals in the advancement of medical technology, Introduction to laws and regulations regarding the use of animals in research.			
Unit – V	**REGULATORY AFFAIRS & cGMP**	Periods	**9**
cGMP concepts – Development, Manufacturing Record, Analytical & process Validation, Equipment & utility Qualification and Calibration, Personnel procedures; Regulatory bodies & requirements - Indian FDA, WHO GMP, U.S. FDA, Australian TGA.			
		Total Periods	**45**

Text Books

1.	Harvey, R.A., Clark, M.A., Finkle, R., "Pharmacology", Lippincott Illustrated Reviews Series, LWW Publishers, 5th Edition, 2011.
2.	Gary Walsh, "Biopharmaceuticals: Biochemistry and Biotechnology", John Wiley & Sons, Inc, 2nd Edition, 2003.

References

1.	Katzung, B., Masters, S., Trevor, A., "Basic and Clinical Pharmacology (LANGE Basic Science)", McGraw-Hill Medical, 11th edition, 2009.
2.	Manohar A. Potdar and Ramkumar Dubey, "cGMP Current Good Manufacturing Practices for Pharmaceuticals", Pharmamed Press / Bsp Books, Second Edition, 2018.
3.	Ansel H.C, "Pharmaceutical dosage forms and drug delivery systems", Lippincott Williams & Wilkins, 8th edition, 2007.
4.	Gary Walsh, "Pharmaceutical Biotechnology: Concepts and Applications", John Wiley & Sons, Inc., 2007.
5.	Ram B. Gupta, Uday B. Kompella, "Nanoparticle Technology for Drug Delivery", Taylor & Francis, 2006.
6.	Lee, Chi-Jen et. al, "Clinical Trials or Drugs and Biopharmaceuticals." CRC/Taylor & Francis, 2011.

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7.	Ansel, H.C. "Pharmaceutical Dosage Forms and Drug Delivery Systems", 11th Edition, Lippincott Williams &Wilkins, 2018.
8.	Misra, Ambikanandan, Shahiwala, Aliasgar "Novel Drug Delivery Technologies", 1st Edition, Springer, 2019
9.	Lieberman, H.A. "Pharmaceutical Dosage Forms: Tablets". Vol.1-3, 2nd Edition, Marcel Dekker, 2005.
10.	Vyas S.P, Khar K.R. "Targeted & Controlled Drug Delivery -Novel Carrier Systems", 1st Edition, CBS Publishers, 2012.
11.	Surendra Nimesh, Ramesh Chandra, Nidhi Gupta. "Nanotechnology for the Delivery of Therapeutic Nucleic Acids". 1st Edition, Woodhead Publishing, 2017.
12.	Leach, AR, "Molecular Modeling & Drug Design", 2nd Edition, John Willy, 2000.
13.	GROMOS and GROMACS Manuals.
Resources	
1.	https://ocw.mit.edu/courses/health-sciences-and-technology/hst-151-principles-of-pharmacology-spring-2005/lecture-notes/
2.	https://medcraveonline.com/JMEN/natural-useful-therapeutic-products-from-microbes.html
3.	https://onlinelibrary.wiley.com/doi/book/10.1002/9780470259818
4.	https://nptel.ac.in/courses/102/108/102108077/

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University, Chennai) Elayampalayam, Tiruchengode – 637 205						
Programme	M.Tech.	Programme Code		206	Regulation		2023
Department	BIOTECHNOLOGY			Semester			I
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks	
		L	T	P	C	CA	ESE	Total
P23BTE09	BIOENTREPRENEURSHIP	3	0	0	3	40	60	100
Course Objective	At the end of the course, the students would have learnt about entrepreneurship and starting a small business.							

Course Outcome	Course Outcomes	Knowledge Level
	CO1:Understand the basic concepts of Entrepreneurship	K2
	CO2:Explain establishment and marketing of biotechnology company	K3
	CO3:Describe Budgeting Project business plan Preparation	K3
	CO4:Explain the small business launching and management	K4
	CO5:Illustrate Management of small business and bioentrepreneurship	K4

Pre-requisites	-

CO/POMapping (3/2/1 indicates strength of correlation)3-Strong,2–Medium,1-Weak												CO/PSO Mapping		
COs	Programme Outcomes(POs)												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3					2	3	3	3			2	3	3	3
CO2	3	3		2	3			3		2	3		2	3	2
CO3	3	3	3	3			3	3	3	2	3		2	2	3
CO4	3	2	3	3	3	2		3	2		3	2	3	3	2
CO5	3	2	3	2			3	3	3	2		3	3	3	3

Course Assessment Methods

Direct

1. Continuous Assessment Test I, II & III
2. Assignment
3. End-Semester examinations

Indirect

1.Course-endsurvey

Content of the syllabus

Unit –I	INTRODUCTION TO ENTREPRENEURSHIP	Periods	9

Entrepreneurship concept, Entrepreneurship as a Career, Entrepreneur, Personality Characteristics of Successful. Entrepreneur, Knowledge and Skills Required for an Entrepreneur. Bioindustry- concepts and recent trends in the development of bioindustries; translational biotechnology industry overview (include the commercialization pathways for drug, medical device, diagnostic companies)

Unit - II	ENTREPRENEURSHIP TRAITS & MOTIVATION	Periods	9

Growth of entrepreneurship, The marketing and selling of Biotechnology, Establishment and marketing of biotechnology company, Effective advertising.

Unit –III	BUSINESS PLAN PREPARATION	Periods	9

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Criteria for Selection of Product-Ownership-Capital Budgeting Project Profile Preparation-Matching Entrepreneur with the Project-Feasibility Report Preparation and Evaluation Criteria. Finance and Human Resource Mobilization Operations Planning-Market and Channel Selection-Growth Strategies-Product Launching.			
Unit –IV	**LAUNCHING OF START-UP**	Periods	**9**
Importance types or requirements; sources: non-institutional and institutional:existing rural credit delivery system(multi-agency approach); Monitoring and Evaluation of Business-Preventing Sickness and Rehabilitation of Business Units. Effective Management of small Business. Entrepreneurship development programs of public and private agencies (MSME, DBT, BIRAC, Make In India)			
Unit –V	**ENTREPRENEURIAL DEVELOPMENT**	Periods	**9**
Entrepreneurship Development Training and Other Support Organizational Services-Central and State Government Industrial Policies and Regulations-International Sources of Product for Business. Self employment schemes in relation to bioindustries, Problem and Solution of Entrepreneurship: Risk and benefit, Steps involved in commercialization of a biotechnological product, Case studies.			
		Total Periods	**45**
Text Books			
1	Hisrich, Entrepreneurship, Tata McGrawHill, NewDelhi, 2001.		
2	S.S.Khanka, Entrepreneurial Development, S.ChandandCompany Limited, New Delhi, 2001.		
References			
1.	Bloxham: Scion. 8. Shimasaki, C. D. (2014). Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies. Amsterdam: Elsevier. Academic Press is an imprint of Elsevier.		
2.	Adams, D. J., & Sparrow, J. C. (2008). Enterprise for Life Scientists: Developing Innovation and Entrepreneurship in the Biosciences. 9. 10. 11.		
3.	Onetti, A., &Zucchella, A. Business Modeling for Life Science and Biotech Companies: Creating Value and Competitive Advantage with the Milestone Bridge. Routledge.		
4.	Jordan, J. F. (2014). Innovation, Commercialization, and Start-Ups in Life Sciences. London: CRC Press.		
5.	Desai, V. (2009). The Dynamics of Entrepreneurial Development and Management. New Delhi: Himalaya Pub. House.		
E-Resources			
1.	https://nptel.ac.in/courses/127/105/127105007/		
2.	https://nptel.ac.in/courses/110/107/110107094/		
3.	https://nptel.ac.in/courses/110/106/110106141/		

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University, Chennai) Elayampalayam, Tiruchengode – 637 205						
Programme	**M.Tech.**	Programme Code		**206**	Regulation		**2023**
Department	**BIOTECHNOLOGY**				Semester		**I**
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks	
		L	T	P	C	CA	ESE	Total
P23BTE10	**ANALYTICAL INSTRUMENTATION TECHNIQUES**	3	0	0	3	40	60	100

Course Objective

The student should be made,

- To learn the methods and techniques of materials sampling
- To understand the principles, working and applications of various chromatography methods.
- To gain a knowledge on particle size determination, properties and their analysis
- To gain exposure about the principles and applications of various electro-analytical techniques
- To have basic idea Principles and applications of various spectroscopic methods

Course Outcome

At the end of the course, the student should be able to,	Knowledge Level
CO1: Gain the knowledge about sampling and processing of materials	K1
CO2: Understand the principles, working and applications of various chromatography methods	K2
CO3: Analysis the particle size distribution and rheological behavior	K3
CO4: Enhancement of knowledge about various electro-analytical techniques and their application	K3
CO5: Apply the principles and application of various spectroscopic methods	K3

Pre-requisites: Nil

CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak													CO/PSO Mapping		
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	3		3						2	2	2		
CO 2	2				2							2	2		
CO 3	3		2									2	2		
CO 4	3	2		3	2						2	2	2		2
CO 5	3				2							2	2		2

Course Assessment Methods

Direct

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1. Continuous Assessment Test I, II & III 2. Assignment 3. End-Semester examinations	
Indirect	
1. Course - end survey	

Content of the syllabus

Unit – I	**SPECTROMETRY**	Periods	**9**
Components of optical instruments, Signal process and read outs - signal to noise ratio, sources of noise, Enhancement of signal to noise. Types of optical instruments, Electromagnetic radiation- wave properties			
Unit - II	**X-RAYDIFFRACTION**	Periods	**9**
X- ray Sources, absorption of X-rays, X-ray diffraction, X-ray detectors, Thermo-gravimetric methods, Differential thermal analysis, Differential scanning calorimetry, NMR spectrometers– applications, X-ray fluorescence.			
Unit – III	**SEPARATION AND PURIFICATION**	Periods	**9**
Principles of centrifugation, Thin Layer Chromatography (TLC), Paper and column chromatography, Ion exchange, Size exclusion, Gas chromatography, High Performance Liquid Chromatography (HPLC)			
Unit - IV	**ANALYTICAL TECHNIQUES**	Periods	**9**
Electro-analytical techniques: Principle and applications of Potentiometry, Voltametery, Polarography, Coulometer and electro Gravimetry, Principle of Fourier Transform optical Measurements			
Unit – V	**MOLECULAR SPECTROSCOPY**	Periods	**9**
Modern instrumental Methods of analysis - Principles and applications of UV-Visible Spectroscopy, IR Spectroscopy and Non –dispersive IR, Raman spectroscopy, NMR Spectroscopy, Atomic absorption spectroscopy			
		Total Periods	**45**

Text Books

1.	Willard H.H., Merrit I., Dean J.A., and Settle F.A," Instrumental Methods of Analysis ", 7th edition, CBS publishers New Delhi, 2012
2.	Ewing Galen W., "Instrument Methods of Chemical Analysis "., 7th edition McGraw Hill company, New Delhi,1985

References

1.	Skoog D.A and West D.M "Fundamental of Analytical Chemistry", 7th edition, Saunders college publishing, New York,1996
2.	Banwell.G.C, "Fundamentals of Analytical Chemistry ", Tata McGraw Hill, New Delhi, 2006
3.	Siva Sankar B., "Instrumental methods of analysis" OxfordUniversityPress,2012
4.	Chatwal G.R, and Anand Sham K., Instrumental Methods of ChemicalAnalysis"5thEdition, HimalayaPublishingHouse,2016.

E-Resources

1.	http://www.digimat.in/nptel/courses/video/103108100/L15.html
2.	https://link.springer.com/book/10.1007/978-94-011-1812-5
3.	https://en.wikipedia.org/wiki/Chromatography

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Programme	**M. Tech.**	Programme code		**206**	Regulation		**2023**	
Department	**BIOTECHNOLOGY**				Semester		**I**	
Course code	Course Name	Periods per week			Credit	Maximum Marks		
		L	**T**	**P**	**C**	**CA**	**ESE**	**Total**
P23BT104	**PREPARATIVE AND ANALYTICAL TECHNIQUES IN BIOTECHNOLOGY LABORATORY**	**0**	**0**	**4**	**2**	**60**	**40**	**100**

Course Objective	The main objective of this course is to make students, • Understand the basic calculations and measurement in preparation of different chemicals • Infer knowledge in preparation of buffers • Infer knowledge in estimation of biomolecules • Acquire knowledge on determination of enzyme kinetic parameters • Interpretation of biomolecules by HPLC and GC
Course Outcome	**CO1:** Infer the principle on various solvents & buffers and demonstrate the suitable method of analysis for different carbohydrates **CO2:** Determine the quantity of protein in different methods **CO3:** Estimate the nucleic acids and lipids in different sample preparations **CO4:** Apply proper method for plant pigment extraction, separation and antioxidant activity analysis **CO5:** Demonstrate the enzyme reaction and able to determine the enzyme kinetic parameters

LIST OF EXPERIMENTS	**Course Outcomes**
1. Preparation of Acetate & Phosphate Buffer systems and validation of Henderson-Hasselbach equation.	**CO1**
2. Estimation of amino acids by Ninhydrin method	**CO1**
3. Qualitative tests for carbohydrates –distinguishing reducing from non-reducing sugars and aldo from keto sugars.	**CO1**
4. Estimation of protein concentration using Lowrys' and Bradford method	**CO2**
5. Qualitative analysis of nucleic acids in spectrophotometric method and hyperchromic effect.	**CO3**
6. Extraction of lipids from oil seeds and analysis by Thin layer chromatography.	**CO3**
7. Extraction of polyphenol compound from different plant sources and determination of antioxidant activity using DPPH method.	**CO4**
8. Separation of plant pigments using Column chromatography.	**CO4**
9. Determination of kinetic parameters (K_m and V_{max}) for a given enzyme solution.	**CO5**
10. Use of Excel and Origin Pro (Trial version) software to plot the data and statistical analysis.	**CO5**
11. Non-edible/Algal oil extraction using Soxhlet apparatus	**CO5**
12. Fatty acid profile analysis and data interpretation using GC	**CO5**
13. Production and Quantification of ethanol, data interpretation using HPLC	**CO5**
Total Periods : 60	**CO4**

References:

1. R.C. Gupta and S. Bhargavan, "Practical Biochemistry" Fifth Edition, CBS Publishers, 2020.
2. V.W.Rodwell, David A Bender, Kathleen M Botham, Peter J Kennely, P Antony Weil, "Harper's Illustrated Biochemistry" Thirty First Edition, McGraw-Hill Education Publisher.
3. Thomas M. Devlin, "Textbook of Biochemistry with clinical correlations", Sixth Edition, Wiley Liss Publishers.
4. David T. Phummer, "Introduction of Practical Biochemistry" Third Edition, McGraw Hill Publisher.
5. Anju Dahiya, "Bioenergy: Biomass to Biofuels", Academic Press, 2014

Ashok Pandey , Christian Larroche, Steven Ricke, Claude-Gilles, Dussap Edgard Gnansouno, "Biofuels", Academic Press, 2011

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AUDIT COURSES

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Programme	M. Tech.	Programme Code	206	Regulation	2023
Department	BIOTECHNOLOGY			Semester	--

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
P23AC001	Research Process and Methodologies	2	0	0	0	100	-	100

Course Objective

The main objective of the course is

- To understand the importance of Research
- To acquire knowledge in Data Collection and Analysis
- To effectively write reports

Course Outcome

At the end of the course, the student should be able to	Knowledge Level
CO1: Understand research problem types and data collection methods.	K2
CO2: Understand research design methodologies	K2
CO3: Analyze research related information	K4
CO4: Follow research ethics	K2
CO5: Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.	K2

Pre-requisites --

CO / PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak

Cos	Programme Outcomes (POs)												**CO/PSO Mapping** PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	2									3	2	2
CO 2	3	3	3	2					2				2	2	3
CO 3	3	3	3	2					2				2	3	2
CO 4	3	3	3	2					2				3	2	2
CO 5	3	3	3	2									2	3	3

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment and Seminar
Indirect
1. Course - end survey

Content of the syllabus

Unit - I	INTRODUCTION TO RESEARCH	Periods	9

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research Meaning of Research - Types of Research - Research Process - Problem definition - Objectives of Research - Research design - Approaches to Research - Quantitative vs. Qualitative Approach - Research Methods versus Methodology - Research and Scientific Method - Research Process - Criteria of Good Research.

Unit – II	RESEARCH DESIGN	Periods	9

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Meaning of Research Design - Need for Research Design - Features of a Good Design - Important Concepts Relating to Research Design - Different Research Designs - Basic Principles of Experimental Designs.			
Unit – III	**DATA COLLECTION**	Periods	**9**
Data Collection: Collection of Primary Data - Observation Method - Interview Method - Collection of Data through Questionnaires - Collection of Data through Schedules - Difference between Questionnaires and Schedules - Collection of Secondary Data - Processing Operations - Elements/Types of Analysis - Statistics in Research.			
Unit – IV	**DATA ANALYSIS AND INTERPRETATION**	Periods	**9**
Data analysis - Statistical techniques and choosing an appropriate statistical technique - Hypothesis, Hypothesis testing - Data processing software (e.g. SPSS etc.) - statistical inference - Interpretation of results.			
Unit - V	**REPORT WRITING**	Periods	**9**
Types of research report: Dissertation and Thesis, research paper, review article, short communication, conference presentation etc., Referencing and referencing styles, Research Journals, Indexing and citation of Journals, Intellectual property, Plagiarism.			
		Total Periods	**45**
References			
1.	C. R. Kothari, "Research Methodology – Methods and Techniques", 2nd Edition, New Age International Publishers		
2.	Bordens, K. S. and Abbott, B. B., "Research Design and Methods – A Process Approach", 8th Edition, McGraw-Hill, 2011		
3.	Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age", 2016.		
4.	Davis, M., Davis K., and Dunagan M., "Scientific Papers and Presentations", 3rd Edition, Elsevier Inc.		
E-Resources			
1.	https://www.oreilly.com/library/view/research-methodology/9789353067090/		
2.	https://bbamantra.com/research-methodology/		

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Programme	M.Tech.	Programme Code	206	Regulation	2023
Department	BIOTECHNOLOGY			Semester	--

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
P23AC002	Pedagogy Studies	2	0	0	0	100	-	100

Course Objective

The main objective of the course is

- Understand the concept of programme design through evidences.
- Illustrate the practice of innovative teaching methodology.
- Analyze the method of teacher education.
- Enhance the infrastructure in the class room.
- Elaborate the directions of future research

Course Outcome	At the end of the course, the student should be able to	Knowledge Level
	CO1: Describe about the concept of programme design through evidences	K2
	CO2: Demonstrate the practice of innovative teaching methodology	K2
	CO3: Evaluate the method of teacher education	K4
	CO4: Examine the infrastructure in the class room	K3
	CO5: Define the directions of future research	K3

Pre-requisites

CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak													CO/PSO Mapping		
Cos	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	2									3	2	2
CO 2	3	3	3	2									2	2	3
CO 3	3	3	3	2						2	2		2	3	2
CO 4	3	3	2	2						2	2		3	2	2
CO 5	3	3	2	2									2	3	3

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment and Seminar
Indirect
1. Course - end survey

Content of the syllabus

Unit - I	INTRODUCTION	Periods	9

Introduction and Methodology: Aims and rationale, Policy background, Conceptual framework and terminology, Theories of learning, Curriculum, Teacher education. Conceptual framework, Research questions. Overview of methodology and Searching.

Unit – II	THEMATIC OVERVIEW	Periods	9

Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries. Curriculum, Teacher education.

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Unit – III	PEDAGOGICAL PRACTICES	Periods	9
Evidence on the effectiveness of pedagogical practices Methodology for the in depth stage: quality assessment of included studies. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? Theory of change. Strength and nature of the body of evidence for effective pedagogical practices. Pedagogic theory and pedagogical approaches. Teachers' attitudes and beliefs and Pedagogic strategies.			
Unit – IV	**PROFESSIONAL DEVELOPMENT**	Periods	9
Professional development: alignment with classroom practices and follow-up support -Peer support from the head teacher and the community. Curriculum and assessment Barriers to learning: limited resources and large class sizes.			
Unit - V	**RESEARCH GAPS AND FUTURE DIRECTIONS**	Periods	9
Research gaps and future directions, Research design, Contexts, Pedagogy, Teacher education, Curriculum and assessment, Dissemination and research impact.			
		Total Periods	**45**

References

1.	Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.
2.	Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.
3.	Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.

E-Resources

1.	https://nptel.ac.in/courses/121/105/121105010/ CO-ORDINATED BY : IIT KHARAGPUR
2.	https://nptel.ac.in/courses/109/105/109105122/ CO-ORDINATED BY : IIT KHARAGPUR

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Programme	M.Tech.	Programme Code	206	Regulation	2023
Department	BIOTECHNOLOGY			Semester	--

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
P23AC003	Disaster Management	2	0	0	0	100	-	100

Course Objective

The main objective of the course is

- Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work.
- Categorize the Risk Assessment in national level and global level.

Course Outcome

At the end of the course, the student should be able to	Knowledge Level
CO1: Understand the effects of disaster	K2
CO2: Analyze differences between disasters and hazards	K2
CO3: Disaster management techniques	K3
CO4: Risk management techniques	K3
CO5: Elaborate the Risk assessment in world level	K4

Pre-requisites --

CO / PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak

CO/PSO Mapping

Cos	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1					2	2	2				2	1	3	2	2
CO 2					2	2	2				2	1	2	2	3
CO 3					2	2	2				2	1	2	3	2
CO 4					2	2	2				2	1	3	2	2
CO 5					2	2	2				2	1	2	3	3

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment and Seminar
Indirect
1. Course - end survey

Content of the syllabus

Unit - I	INTRODUCTION	Periods	9

Introduction Disaster: Definition, Factors and Significance; Difference Between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

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Unit – II	REPERCUSSIONS OF DISASTERS AND HAZARDS	Periods	9
Repercussions of Disasters and Hazards: Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease and Epidemics, War and Conflicts.			
Unit – III	DISASTER PRONE AREAS IN INDIA	Periods	9
Disaster Prone Areas in India Study of Seismic Zones; Areas Prone to Floods and Droughts, Landslides and Avalanches; Areas Prone to Cyclonic and Coastal Hazards with Special Reference to Tsunami; Post-Disaster Diseases and Epidemics			
Unit – IV	DISASTER PREPAREDNESS AND MANAGEMENT PREPAREDNESS	Periods	9
Disaster Preparedness and Management Preparedness: Monitoring of Phenomena Triggering A Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological and Other Agencies, Media Reports: Governmental and Community Preparedness.			
Unit – IV	RISK ASSESSMENT	Periods	9
Risk Assessment Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival. Disaster Mitigation Meaning, Concept and Strategies of Disaster Mitigation, Emerging Trends in Mitigation. Structural Mitigation and Non-Structural Mitigation, Programs of Disaster Mitigation in India.			
		Total Periods	**45**

References	
1.	R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company.
2.	Sahni, Pardeep et.al. (Eds.)," Disaster Mitigation Experiences and Reflections", Prentice Hall of India, New Delhi.
3.	Goel S. L., Disaster Administration and Management Text And Case Studies", Deep & Deep Publication Pvt. Ltd., New Delhi.
E-Resources	
1.	https://www.digimat.in/nptel/courses/video/124107010/L36.html
2.	https://media.ifrc.org/ifrc/what-we-do/disaster-and-crisis-management/disaster-preparedness/

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Elayampalayam, Tiruchengode – 637 205

Programme	**M.Tech.**	Programme Code	**206**	Regulation	**2023**
Department	**BIOTECHNOLOGY**			Semester	--

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
P23AC004	**Value Education**	2	0	0	0	100	-	100

Course Objective

The main objective of the course is

- To introduce the value of education and self- development.
- To interpret good values in students.
- To elaborate the importance of character.
- To distinguish the relationship and their cooperation.
- To interpret the religions and equality.

Course Outcome

At the end of the course, the student should be able to	Knowledge Level
CO1: Understand education values	K2
CO2: Analyze importance of cultivation values	K2
CO3: Importance of personality development	K3
CO4: Character maintenance	K3
CO5: Examine the religions and honesty.	K4

Pre-requisites -

CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak													CO/PSO Mapping		
Cos	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	2									2	2	2
CO 2	3	3	3	2									2	2	3
CO 3	3	3	3	2									2	2	2
CO 4	3	3	3	2									3	2	2
CO 5	3	3	3	2									2	2	2

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment and Seminar
Indirect
1. Course - end survey

Content of the syllabus

Unit - I	INTRODUCTION	Periods	9

Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non- moral valuation, Standards and principles, Value judgments.

Unit – II	IMPORTANCE OF CULTIVATION OF VALUES	Periods	9

Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration.

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Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism. Love for nature, Discipline.			
Unit – III	**PERSONALITY AND BEHAVIOR DEVELOPMENT**	Periods	**9**
Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labour.			
Unit – IV	**RELATIONSHIP MANAGEMENT**	Periods	**9**
Universal brotherhood and religious tolerance True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature.			
Unit - V	**CHARACTER AND COMPETENCE**	Periods	**9**
Character and Competence –Holy books vs Blind faith. Self-management and Good health. Science of reincarnation. Equality, Nonviolence, Humility, Role of Women. All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively.			
		Total Periods	**45**
References			
1.	Chakroborty, S.K. "Values and Ethics for organizations Theory and practice", Oxford University Press, New Delhi 2011.		
E-Resources			
1.	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5132380/		
2.	https://www.examrace.com/Study-Material/Education/Value-Education-YouTube-Lecture-Handouts.html		

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University ,Chennai) Elayampalayam, Tiruchengode – 637 205						
Programme	**M.Tech.**	Programme Code	**206**	Regulation	**2023**		
Department	**BIOTECHNOLOGY**			Semester	--		
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks	
		L	T	P	C	CA	ESE	Total
P23AC005	**Constitution of India**	2	0	0	0	100	-	100

Course Objective

The main objective of the course is

- To understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To identify the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
- To illustrate the role of socialism in India after the commencement of the Bolshevik Revolution and its impact on the initial drafting of the Indian Constitution.
- To categorize the governance bodies in the organization.
- To interpret the various administration in states.

Course Outcome	At the end of the course, the student should be able to	Knowledge Level
	CO1: Define the history of Indian Constitution	K2
	CO2: Categorize the importance of constitutional rights and duties.	K3
	CO3:Understand the functions of Local administration	K2
	CO4:Demonstratethegovernance bodies in the organization.	K4
	CO5:Prioritize the local and district administration in states.	K4

Pre-requisites --

CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak													CO/PSO Mapping		
Cos	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	2	2									3	2	2
CO 2	3	3	2	2									2	2	3
CO 3	3	3	2	2									2	3	2
CO 4	3	3	2	2									3	2	2
CO 5	3	3	2	2									2	3	3

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment and Seminar
Indirect
1. Course - end survey

Content of the syllabus

Unit - I	INTRODUCTION	Periods	9

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History of Making of the Indian Constitution: History Drafting Committee, (Composition & Working)			
Unit – II	**PHILOSOPHY OF THE INDIAN CONSTITUTION**	Periods	**9**
Philosophy of the Indian Constitution: Preamble, Salient Features			
Unit – III	**CONTOURS OF CONSTITUTIONAL RIGHTS & DUTIES**	Periods	**9**
Contours of Constitutional Rights& Duties: Fundamental Rights- Right to Equality- Right to Freedom Right against Exploitation- Right to Freedom of Religion ,Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties			
Unit – IV	**ORGANS OF GOVERNANCE**	Periods	**9**
Organs of Governance: Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.			
Unit - V	**LOCAL ADMINISTRATION**	Periods	**9**
Local Administration: District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Pachayati raj: Introduction, PRI: ZilaPachayat. Elected officials and their roles, CEO ZilaPachayat: Position and role. Block level: Organizational Hierarchy (Different departments) Village level: Role of Elected and Appointed officials, Importance of grass root democracy			
		Total Periods	**45**

References	
1.	The Constitution of India, 1950 (Bare Act), Government Publication.
2.	Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3.	M. P. Jain, Indian Constitution Law, 7th Edition., Lexis Nexis, 2014.
E-Resources	
1.	https://nptel.ac.in/courses/129/106/129106002/ CO-ORDINATED BY : IIT MADRAS
2.	https://niti.gov.in/niti-lecture

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Programme	**M.Tech.**	Programme Code	**206**	Regulation	**2023**		
Department	**BIOTECHNOLOGY**			Semester	--		
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks	
		L	T	P	C	CA	ESE	Total
P23AC006	**English for Research Paper Writing**	2	0	0	0	100	-	100

Course Objective

The main objective of the course is

- Illustrate the improve your writing skills and level of readability
- Categorize to write in each section.
- Understand the skills needed when writing a Title
- Ensure the good quality of paper at very first-time submission.
- Elaborate the concept of writing skills for submission of paper.

Course Outcome	At the end of the course, the student should be able to	Knowledge Level
	CO1: Understand forming and brake up sentences.	K2
	CO2: Importance of finding plagiarism.	K4
	CO3: Summarize the concept of literature reviews.	K2
	CO4: Extend the focus on skill development activities.	K2
	CO5: Develop the writing skills in the paper.	K3

Pre-requisites --

CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak												CO/PSO Mapping		
Cos	Programme Outcomes (POs)											PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	2									3	2	2
CO 2	3	3	3	2									2	2	3
CO 3	3	3	3	2									2	3	2
CO 4	3	3	3	2									3	2	2
CO 5	3	3	2	2									2	3	3

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment and Seminar
Indirect
1. Course - end survey

Content of the syllabus

Unit - I	**PLANNING AND PREPARATION**	Periods	**9**

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness.

Unit – II	**CLARIFICATIONS**	Periods	**9**

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction.

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Unit – III	LITERATURE REVIEW	Periods	9
Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.			
Unit – IV	**SKILL DEVELOPMENT - I**	Periods	9
Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature.			
Unit - V	**SKILL DEVELOPMENT - II**	Periods	9
Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions, useful phrases, how to ensure paper is as good as it could possibly be the first- time submission			
		Total Periods	**45**

References

1.	Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2.	Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3.	Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

E-Resources

1.	https://nptel.ac.in/courses/110/105/110105091/ CO-ORDINATED BY : IIT KHARAGPUR
2.	https://www.udemy.com/topic/research-paper-writing

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Programme	**M.Tech.**	Programme Code	**206**	Regulation	**2023**		
Department	**BIOTECHNOLOGY**			Semester	--		
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks	
		L	T	P	C	CA	ESE	Total
P23AC007	**Personality Development through Life Enlightenment Skills**	2	0	0	0	100	-	100

Course Objective

The main objective of the course is

- Learn to achieve the highest goal happily.
- Identify a person with stable mind, pleasing personality and determination.
- Determine wisdom in students.
- Interpret managing others effectively.
- Extend the increasing productivity.

Course Outcome	At the end of the course, the student should be able to	Knowledge Level
	CO1: Identify goals	K2
	CO2: Analyze Personality development	K2
	CO3: Make use of appropriate life and career goals	K3
	CO4: Developing relationships with others	K3
	CO5: Understand the value of diversity	K2

Pre-requisites --

CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak													CO/PSO Mapping		
Cos	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	2					2				3	2	2
CO 2	3	3	3	2					2				2	2	3
CO 3	3	3	3	2					2	2			2	3	2
CO 4	3	3	3	2						2			3	2	2
CO 5	3	3	3	2									2	3	3

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment and Seminar
Indirect
1. Course - end survey

Content of the syllabus

Unit - I	**NEETISATAKAM – I**	Periods	**9**

Neetisatakam-Holistic development of personality
Verses- 19,20,21,22 (wisdom)
Verses- 29,31,32 (pride & heroism)
Verses- 26,28,63,65 (virtue)

Unit – II	**NEETISATAKAM – II**	Periods	**9**

Neetisatakam-Holistic development of personality
Verses- 52,53,59 (dont's)
Verses- 71,73,75,78 (do's)

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Unit – III	**APPROACH TO DAY TO DAY WORK AND DUTIES**	Periods	**9**
Approach to day to day work and duties. Shrimad Bhagwad Geeta : Chapter 2-Verses 41, 47,48, Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, 23, 35, Chapter 18-Verses 45, 46, 48.			
Unit – IV	**STATEMENTS OF BASIC KNOWLEDGE**	Periods	**9**
Statements of basic knowledge. Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68 Chapter 12 -Verses 13, 14, 15, 16,17, 18			
Unit - V	**PERSONALITY OF ROLE MODEL**	Periods	**9**
Personality of Role model. Shrimad Bhagwad Geeta: Chapter2-Verses 17, Chapter 3-Verses 36,37,42, Chapter 4-Verses 18, 38,39 Chapter18 – Verses 37,38,63			
		Total Periods	**45**

References	
1.	"Srimad Bhagavad Gita" by Swami SwarupanandaAdvaita Ashram (Publication Department), Kolkata
2.	Bhartrihari's Three Satakam (Niti-sringar-vairagya) by P.Gopinath,
3.	Rashtriya Sanskrit Sansthanam, New Delhi.
E-Resources	
1.	https://library.um.edu.mo/ebooks/b17771201.pdf
2.	https://www.staticcontents.youth4work.com/university/Documents/Colleges/CollegeSummaryAttach/29f57018-6412-4dee-b24b-ac29e54a0f9e.pdf

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Programme	**M.Tech.**	Programme Code	**206**	Regulation	**2023**		
Department	**BIOTECHNOLOGY**			Semester	--		

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
P23AC008	**UNIVERSAL HUMAN VALUES**	2	0	0	0	100	-	100

Course Objective	The student should be made to, • To assist students in understanding the differences between values and skills, and in understanding the need, basic guidelines, content and the process of value education. • To help students initiate a process of dialog within themselves to understand what they 'really want to be' in their lives and professions • To help students understand the meaning of happiness and prosperity for human beings. • To help students understand harmony at all the levels of human living and to lead an ethical life	
Course Outcome	At the end of the course, the student should be able to	Knowledge Level
	At the end of the course, the student should be able to,	K2
	CO1: Evaluate the significance of value inputs in formal education and start applying them in their life and profession	K4
	CO2: Distinguish between values and skills, happiness and accumulation of physical facilities, the Self and the Body, Intention and Competence of an individual, etc.	K2
	CO3: Analyze the value of harmonious relationship based on trust and respect in their life and profession	K2
	CO4: Examine the role of a human being in ensuring harmony in society and nature.	K3
Pre-requisites	--	

CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak													**CO/PSO Mapping**		
COs	Programme Outcomes (POs)												PSOs		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO 1	1	1		3	3	1	2	3	3	2	3	1	3	2	2
CO 2	2	1	2	3	2	2	2	2	1	1	3	1	2	2	3
CO 3	3	1	2	3	3	1	3	2	2	1	2	3	2	3	2
CO4	1	2	3	1	3	2	2	2	3	1	2	1	3	2	2
CO5	2	1	2	1	2	1	3	3	2	2	1		2	3	3

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment and Seminar
Indirect
1. Course - end survey

Content of the syllabus

Unit - I	**Introduction-Basic Human Aspiration**	Periods	**9**

The basic human aspirations and their fulfillment through Right understanding and Resolution, Right

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understanding and Resolution as the activities of the Self, Self being central to Human Existence; All-encompassing Resolution for a Human Being, its details and solution of problems in the light of Resolution.			
Unit – II	**Right Understanding (Knowing)**	Periods	**9**
The domain of right understanding starting from understanding the human being (the knower, the experiencer and the doer) and extending up to understanding nature/existence – its interconnectedness and co-existence; and finally understanding the role of human being in existence (human conduct).			
Unit – III	**Understanding Human Being**	Periods	**9**
Understanding the human being comprehensively as the first step and the core theme of this course; human being as co-existence of the self and the body; the activities and potentialities of the self; Basis for harmony/contradiction in the self			
Unit – IV	**Understanding Nature and Existence**	Periods	**9**
A comprehensive understanding (knowledge) about the existence, Nature being included; the need and process of inner evolution (through self-exploration, self awareness and self-evaluation), particularly awakening to activities of the Self: Realization, Understanding and Contemplation in the self.			
Unit - V	**Understanding Human Conduct**	Periods	**9**
Understanding Human Conduct, different aspects of All-encompassing Resolution (understanding, wisdom, science etc.), Holistic way of living for Human Being with Allen compassing Resolution covering all four dimensions of human endeavor viz., realization, thought, behavior and work (participation in the larger order) leading to harmony at all levels from Self to Nature and entire Existence			
		Total Periods	**45**
Text Books			
1.	R R Gaur, R Asthana, G P Bagaria, 2019 (2nd Revised Edition), A Foundation Course in Human Values and Professional Ethics. ISBN 978-93-87034-47-1, Excel Books, New Delhi.		
2.	Premvir Kapoor, Professional Ethics and Human Values, Khanna Book Publishing, New Delhi, 2022.		
References E-Resources			
1.	Ivan Illich, 1974, Energy & Equity, The Trinity Press, Worcester, and Harper Collins, USA		
2.	E.F. Schumacher, 1973, Small is Beautiful: a study of economics as if people mattered, Blond & Briggs, Britain		
E-Resources			
1.	https://nptel.ac.in/courses/109104068		
2.	https://fdp-si.aicte-india.org/UHV-I		

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Programme	M.Tech.	Programme Code	206	Regulation	2023
Department	BIOTECHNOLOGY			Semester	--

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
P23AC009	Online Course	2	0	0	0	100	-	100

Course Objective

The main objective of the course is

- Illustrate about various online certification courses.
- Understand the importance of online certification courses.
- Distinguish about job opportunities.
- Make use of this course can prepare the competitive examination.
- Classify the online tools for course.

Course Outcome

At the end of the course, the student should be able to	Knowledge Level
CO1: Evaluatethe programming skills.	K3
CO2: Identify online certifications.	K2
CO3: Appraise the value of the courses and job opportunities	K5
CO4: Categorize in Quantitative Reasoning and Technological Literacy.	K4
CO5: Develop the ICT tools for the specific course.	K4

Pre-requisites --

CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak													CO/PSO Mapping		
Cos	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	2	2						2			3	2	2
CO 2	3	3	2	2						2			2	2	3
CO 3	3	3	2	2						2	2		2	3	2
CO 4	3	3	2	2						2	2		3	2	2
CO 5	3	3	2	2							2		2	3	3

Course Assessment Methods

Direct
1. Online Assignments and Assessments
Indirect
1. Course - end survey

LIST OF COURSES

Online Courses such as :

1. NPTEL Courses
2. SWAYAM Courses
3. IIT-B Spoken Tutorials
4. UDEMY Courses
5. CCNA Courses
6. MOOC Courses
7. Microsoft Virtual Academy Certification courses etc.,

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SEMESTER II

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Programme	**M.Tech**	Programme Code	**206**	Regulation	**2023**		
Department	**Biotechnology**			Semester	**II**		
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks	
		L	**T**	**P**	**C**	**CA**	**ESE**	**Total**
P23BT205	**Advanced Bioseparation Technology**	**3**	**0**	**0**	**3**	**40**	**60**	**100**

Course Objective	To impart knowledge on ➢ Cell disruption and solid-liquid separation techniques in the downstream process. ➢ Compare and contrast various membrane separation techniques. ➢ Assess the selection of appropriate equipment for product isolation based on the nature of the product and the desired purity. ➢ Examine various purification techniques, including chromatography, crystallization, and drying. ➢ Enhance understanding and application of various methods in food, environmental, and industrial sectors.	
Course Outcome	At the end of the course, students will be able to	Knowledge Level
	CO1: Comprehend the principle of separating insoluble solids from fermentation broth.	K2
	CO2: Understand the principles behind each technique and their specific applications.	K3
	CO3: Compare different types of separation equipment and their applications.	K4
	CO4: Analyze the strategy for purification of bioproducts using chromatography, crystallization, and drying.	K4
	CO5: Select the unit operations for polishing of bioproducts in food processing, environmental remediation, and industrial applications.	K4
Pre-requisites	-	

CO / PO Mapping (3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 - Weak**													**CO/PSO Mapping**		
COs	Programme Outcomes (POs)												PSOs		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O 2**	**PS O 3**
CO 1	3	3	2		2	3			1				3	2	3
CO 2	3	2	3		2	3		2		2	2		2	3	2
CO 3	3	2	3	3	2	2	2			2	2		2	3	3
CO 4	3	3	2		3	3			2				2	3	3
CO 5	2	2	2		2	3		2		2	2		3	3	2

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment

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3. End-Semester examinations	
Indirect	
1. Course - End survey	

Content of the syllabus

Unit - I	SOLID-LIQUID SEPARATION	Periods	9
Classification of bio-products: Pretreatment of fermentation broth; Unit operations involved in the development of a bio-product; Cell harvesting techniques, Filtration, and centrifugation equipment; Cell disruption, cell debris, and biomass separation, Scale-up of filtration and centrifugation			
Unit – II	**MEMBRANE-BASED SEPARATION PROCESS**	Periods	9
Principles, operation, and application of microfiltration; Ultrafiltration; Ultrafiltration; Nanofiltration, Reverse osmosis, Dialysis and Electro-dialysis process, Integrated Membrane reactor.			
Unit - III	**PRODUCT ISOLATION**	Periods	9
Adsorption, Equilibrium relationships for adsorption, Performance characteristics of fixed bed adsorber; Concept of breakthrough curve, Engineering analysis of fixed bed adsorber, Aqueous two-phase liquid extraction, Separation of protein and enzymes using ATPS systems, Supercritical fluid extraction for separation of biomolecules.			
Unit – IV	**PRODUCT PURIFICATION**	Periods	9
Chromatography column selection; Packing material selection; Testing procedure for packed columns; Calculation for the number of theoretical plates; Asymmetry and design aspects; Theory, practices, and application of Affinity chromatography, Gel permeation chromatography, Ion exchange chromatography, and Hydrophobic interaction chromatography, Lyophilization, Spray Drying.			
Unit – V	**CASE STUDIES**	Periods	9
Membrane processes in the production of functional whey components, Separation and fractionation of milk fat globules, Fractionation of milk proteins for making cheeses, caseins, and whey proteins and for milk protein standardization, Sewage treatment using membrane bioreactors, Membrane separations for removal of microorganisms, Desalination of seawater using RO and Electrodialysis.			
		Total Periods	**45**

Text Books	
1	Harrison R.G, Todd P.W, Rudge S.R, Petrides D.P., "Bioseparations Science and Engineering". Oxford University Press., 2nd Edition, 2015
2	Ghosh R., "Principles of Bioseparation Engineering." World Scientific Co. Ltd., 1st Edition, 2006.
3	Belter, P.A., E.L. Cussler and Wei-Houhu "Bioseparations – Downstream Processing for Biotechnology", John Wiley, 1988.

References	
1.	Wei-Shou Hu., "Engineering Principles in Biotechnology", Wiley, 2017
2.	Basile, A., Charcosset. C., "Integrated Membrane Systems and Processes", Wiley, 2015.
3.	Forciniti, D., "Industrial Bioseparation: Principles & Practice", Wiley-Blackwell., 1st Edition, 2008
4.	Mccabe W., Smith J., Harriott W., "Unit Operations in Chemical Engineering" McGraw Hill, 7th Edition, 2017.
5.	Green D. W., Perry H. R., "Perry's Chemical Engineer Handbook", McGraw Hill, 8th Edition, 2008.
Resources	
1.	https://archive.nptel.ac.in/courses/102/106/102106022/
2.	https://digimat.in/nptel/courses/video/103103163/L27.html

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN Elayampalayam, Tiruchengode – 637 205 (Autonomous Institution, Affiliated to Anna University ,Chennai)						
Programme	**M.Tech**	Programme Code		**206**	Regulation	**2023**	
Department	**BIOTECHNOLOGY**				Semester	**II**	
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks	
		L	T	P	C	CA	ESE	Total
P23BT206	**Advanced Protein Engineering**	3	0	0	3	40	60	100

Course Objective	**The main objective of this course is to:** • Relate structure and function relationship in proteins. • Choose the right methods for protein engineering. • Learn engineering principles from therapeutic proteins. • Apply engineering principles for developing protein-based biomaterials. • Apply engineering principles for improving protein function and specificity.	
Course Outcome	At the end of the course, the student should be able to,	Knowledge Level
	CO1: Relate structure and function relationship in proteins.	K2
	CO2: Identify the right methods for protein engineering techniques.	K2
	CO3: Discuss engineering principles from therapeutic proteins.	K2
	CO4: Apply engineering principles for developing protein-based biomaterials.	K3
	CO5: Apply engineering principles for improving protein function and specificity.	K3
Pre-requisites	Protein Engineering	

CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak													CO/PSO Mapping		
COs	Programme Outcomes (POs)												PSOs		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	3	1	1	3	2	1						3	2	2	2
CO 2	2	3	1	3	3					1	2	1	2	1	2
CO 3	3	2	2	2		2		1		1	1	1	2	1	1
CO 4	2	1	1	2	1					2	1	1	2	1	1
CO 5	3	3	2	3	2	1				3	3	2	2	2	3

Course Assessment Methods

Direct

1. Continuous Assessment Test I, II & III
2. Assignment
3. End-Semester examinations
4. Quiz
5. Mind mapping

Indirect

1. Course - end survey

Content of the syllabus

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Unit – I	PROTEIN ENGINEERING FUNDAMENTALS	Periods	9
Primary structure: peptide mapping, peptide sequencing; Secondary structure: Alpha, beta and loop structures, Super-secondary structure; Domains, folding, denaturation and renaturation; Quaternary structure: Modular nature, formation of complexes; overview of spectroscopic techniques for the analysis of protein secondary and tertiary structure.			
Unit - II	**PROTEIN ENGINEERING TECHNIQUES**	Periods	**9**
Rational Design: Random and site-directed mutagenesis - Various PCR based strategies, recombinative – non-recombinative methods, Protein backbone changes; Next-Generation Engineering: laboratory-directed evolution, Cell surface and phage display technologies, Cell-free protein engineering technologies, Library creation and screening/selection, Protein modifications, Protein structure modeling and design, Engineering multi-functional proteins, Alternative scaffolds for protein engineering			
Unit – III	**THERAPEUTIC PROTEIN ENGINEERING**	Periods	**9**
Therapeutic protein engineering – slow-acting and fast-acting insulin, tissue plasminogen activator, Antibody engineering - Abzymes, Antibody Humanization Primatized Antibodies, Bispecific antibody, Immunotoxins, Engineered vaccines.			
Unit - IV	**PROTEIN ENGINEERING FOR BIOMATERIALS**	Periods	**9**
Modular Protein Domains – engineering proteins towards functional biomaterials; tunable tissue engineering scaffolds, Protein based smart materials , multifunctional materials designing, protein cross-linking tools for construction of nanomaterials, recombinant protein polymers, biomaterials from coiled-coil peptides, protein engineered hydrogels			
Unit – V	**PROTEIN ENGINEERING APPLICATIONS**	Periods	**9**
Applications of protein engineering in biotechnology industries – Engineering Strategies for thermal stability - addition of disulphide bonds and other modifications. Oxidation-resistant proteases, modifying metal cofactor requirements, Engineering protein for post-translational modifications, increasing enzyme activity, decreasing protease sensitivity, modifying protein specificity and altering multiple properties in a single protein. Engineered oxygenases for biodegradation of environmental pollutants.			
		Total Periods	**45**

Text Books

1.	Voet D., Prat W.C., Voet J., "Principles of Biochemistry", John Wiley and Sons, 4th Edition 2012.
2.	Branden C., Tooze J., "Introduction to Protein Structure", Garland Publishing, NY, USA, 2nd Edition, 2012.
3.	Alberghina L, "Protein Engineering for Industrial Biotechnology", CRC Press, 2000.

References

1.	Glick B. R. and Pasternak J. J., "Molecular Biotechnology: Principles and Applications of Recombinant DNA", ASM Press, 6th Edition, 2022.
2.	Sheldon J. Park (Editor), Jennifer R. Cochran "Protein Engineering and Design", CRC Press, 1st Edition, 2009.
3.	Khudyakov Y.E., "Medicinal Protein Engineering", CRC Press, 1st Edition, 2008.

E-Resources

1.	https://www.mdpi.com/2073-4344/9/2/190
2.	https://www.sciencedirect.com/science/article/abs/pii/S0958166916300349
3.	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8914701/

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Elayampalayam, Tiruchengode – 637 205

Programme	M.Tech	Programme Code	206	Regulation	2023
Department	BIOTECHNOLOGY			Semester	

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
P23BT207	Green Energy Technology	3	0	0	3	40	60	100

Course Objective

The student should be made
- To know about the basics of renewable and non-renewable energy sources.
- To understand the concept of bioconversion process.
- To aware the modeling and fundamentals of Programming of green energy system.

Course Outcome

At the end of the course, the student should be able to,	Knowledge Level
CO1: Learn about the basic concepts of energy, environment and renewable resources.	K1
CO2: Understand the overall biochemical pathway of biomolecules and their bioconversion.	K2
CO3: Discuss about types, combustion of fuel and the cleaner technology.	K2
CO4: Analyze the thermal characteristics of solar flat plate collectors and solar concentrating collectors.	K4
CO5: Provide a basic understanding of probability theory in modelling and simulation environment.	K3

CO / PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak

COs	Programme Outcomes (POs)												CO/PSO Mapping PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO 1	2	3	2	2	3	2	2	1				1	3	1	1
CO 2	3	2	1		2		3	2			1		3	1	2
CO 3	3	2	1	2	2		3	3					1	3	3
CO 4	2	2	2		2		2	2			1		1	2	3
CO 5	1	2	2		2		1	1					2	2	3

Pre-requisites -

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III
2. Assignment
3. End-Semester examinations

Indirect
1. Course - end survey

Content of the syllabus

Unit – I	ENERGY, ENVIRONMENT AND RENEWABLE	Periods	9

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	ENERGY TECHNOLOGIES		
Energy sources - Over view and classification, Sun as the source of energy, fossil fuel reserves and resources, overview of global/ India's energy scenario; Concept and theories of ecosystems - energy flow in major man-made ecosystems - agricultural, industrial and urban ecosystems; Renewable sources of energy-Solar Energy, Wind Energy, Ocean Energy and Bioenergy.			
Unit – II	**BIOENERGY CONVERSION SYSTEMS**	Periods	**9**
Biological systems - Biochemical pathways and chemical kinetics- Biosynthesis and Breakdown of biomolecules, Biomass resources and Biochemical conversions- Microbial biomass. Large scale culture and harvest of photosynthetic organism - photo bioreactors, Bioconversion of lignocellulosic feedstock to sugars - Bioconversion of sugars and starches to fuels.			
Unit – III	**FUELS, COMBUSTION AND CLEANER TECHNOLOGY**	Periods	**9**
Solid fuels, Liquid and gaseous fuels – origin, classification and recovery; Theory of combustion process - Concept, 3Ts, ignition, auto- and force ignition - Combustion Stoichiometry and thermodynamics; Advance clean coal combustion and gasification and co-gasification - Pulverized, fluidized bed combustion, and recent advance technologies. Emission reduction and carbon-di-oxide capture and storage.			
Unit – IV	**SOLAR THERMAL ENERGY CONVERSION**	Periods	**9**
Solar radiation Geometry - solar angles, the earth and solar constant, day length, solar radiation at the earth's surface, solar radiation data; Heat transfer – concepts and definition; Solar flat plate collectors - Basic flat-plate energy balance, overall loss coefficient, collector efficiency factor and heat removal factor; efficiency of flat plate collectors; Solar concentrating collectors.			
Unit – V	**MODELLING AND SIMULATIONS OF GREEN ENERGY SYSTEMS**	Periods	**9**
Introduction to Mathematical Modeling - Basic principles of modeling, Physical and mathematical models, Fundamentals of Programming, Introduction to computational softwares; Date, script and function files; Power electronic system modeling, Simulation of solar, wind and hybrid systems-Optimization and curve fitting techniques, least square methods, lagrange multiplier, interpolation techniques.			
	Total Periods		**45**
Text Books			
1.	Ristinen, Robert A. Kraushaar, Jack J. A Kraushaar, Jack P. Ristinen, Robert A.,"Energy and Environment", 2nd Edition, John Wiley, 2006.		
2.	Samir Sarkar, "Fuels and Combustion", Orient Longman Pvt. Ltd, 3rd edition, 2009.		
3.	Leuis G, "Modelling and Simulation: Exploring Dynamic System Behaviour",Birta Publisher: Springer, 2007		
References			
1.	Energy and the Challenge of Sustainability, World Energy assessment, UNDP, N York, 2000.		
2.	Cleaner Combustion and Sustainable World-HaiyingQi, Bo Zhao, Springer 2013.		
E-Resources			
1.	Green Energy and Technology | Book series home (springer.com)		

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Elayampalayam, Tiruchengode – 637 205

Programme	M.Tech	Programme code	206	Regulation	2023
Department	BIOTECHNOLOGY			Semester	II

Course code	Course name	Periods / week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
P23BT208	Bioprocess and Downstream Processing Laboratory	0	0	4	2	60	40	100

Objective

The main objective of this course is to equip the students in the following

1. Hands-on training in enzyme catalysis.
2. Formulate and optimize the medium for the effective fermentation process.
3. Operation of the bioreactor.
4. Techniques and equipment involved in analyzing the biomolecules in Biotechnology
5. Purification of the biomolecules through various techniques.

CO / PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak

CO/PSO Mapping

COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O 2	PS O 3
CO 1	3	3	2		2	3			1				3	2	3
CO 2	3	2			2	3				2	2		2	3	2
CO 3	3	3	3	3	2	2	2			2	2		2	3	3
CO 4	3	3			2	3			2				2	3	3
CO 5	2	2			3	3		2		2	2		3	3	2

LIST OF EXPERIMENTS

	Course Outcomes
1. Enzyme kinetics, inhibition, the effect of pH, temperature on enzyme catalysis	CO1
2. Enzyme immobilization studies – Gel entrapment, adsorption, and ion exchange immobilization	CO1
3. Optimization techniques – Plackett-Burman, Response surface methodology, Taguchi and MATLAB	CO2
4. Batch cultivation – recombinant *E.coli* – growth rate, substrate utilization kinetics, product analysis after induction	CO3
5. Bioreactor studies: Sterilization kinetics, kL_a determination, Residence Time Distribution	CO3
6. Fed-batch cultivation of *E. coli*	CO3
7. Metabolite analysis by HPLC	CO4
8. Cell separation methods: Centrifugation and microfiltration	CO4
9. Product concentration: Precipitation, ATPS, Ultrafiltration	CO5
10. High-resolution purification: Ion exchange, affinity, and gel filtration	CO5

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Total periods: 90	

Outcomes:

Students who complete this course successfully are expected to

1. CO1: Learn the mechanism and kinetics of the enzyme reaction
2. CO2: Learn the importance of medium formulation and optimization of medium for their role in the economy of the process
3. CO3: Evaluate the successful aseptic fermentations using a bioreactor
4. CO4: Identify the biomolecules based on their specific features
5. CO5: Analyze the biomolecules and concentrated products through various techniques such as precipitation and ultrafiltration, chromatography

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PROFESSIONAL ELECTIVE –III

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Programme	**M.Tech**	Programme Code	**206**	Regulation	**2023**		
Department	**Biotechnology**			Semester	-		
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	**T**	**P**	**C**	**CA**	**ESE**	**Total**
P23BTE11	**BIO FERTILIZER AND BIO PESTICIDES**	**3**	**0**	**0**	**3**	**40**	**60**	**100**

Course Objective	To make the students aware about environment friendly alternatives in agriculture	
Course Outcome	At the end of the course, the student should be able to,	Knowledge Level
	CO1: Learn about the importance of Bio fertilizers.	K2
	CO2: Understand Nitrogen fixation -Free living and symbiotic nitrogen	K3
	CO3: Study the Structure and characteristic features of bio fertilizers	K3
	CO4: Learn about the importance of Bio pesticides	K3
	CO5: Provide knowledge of Mass production technology of bio-pesticides	K4
Pre-requisites	-	

CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak													CO/PSO Mapping		
COs	Programme Outcomes (POs)												PSOs		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	2	2	2	1	2	2	1				2	3	3	1	3
CO 2	2	2	3	1	2	1	2	2	2		3	3	1	3	2
CO 3	2	3	2	2	1	1	2				2	3	3	2	2
CO 4	2	1	2	2	1	1	2		2				3	1	2
CO 5	2		3	2	2	3	1	3	2		2		2	3	3

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment & Quiz 3. End-Semester examinations
Indirect
1. Course - end survey

Content of the syllabus

Unit – I	**INTRODUCTION ON BIOFERTILIZER**	Periods	**9**

Biofertilizers - Introduction, status and scope, Structure and characteristic features of bacterial biofertilizers *Azospirillum, Azotobacter, Bacillus, Pseudomonas, Rhizobium* and *Frankia,* Cynobacterial biofertilizers- *Anabaena, Nostoc,* Hapalosiphon and fungal biofertilizers- AMmycorrhiza and ectomycorhiza.

Unit - II	**MICROORGANISIMS INVOLVED IN NITROGEN FIXATION**	Periods	**9**

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Nitrogen fixation -Free living and symbiotic nitrogen fixation, Mechanism of phosphate solubilisation and phosphate mobilization, K solubilisation. Production technology: Strain selection, sterilization, growth and fermentation, Mass production of carrier based and liquid biofertilizers.			
Unit – III	**CHARACTERISTICS OF BIOFERTILIZER**	Periods	**9**
FCO specifications and quality control of biofertilizers, Application technology for seeds, seedlings, tubers, sets etc, Biofertilizers -Storage, shelf life, quality control and marketing, Factors influencing the efficacy of biofertilizers.			
Unit - IV	**IMPORTANCE OF BIOPESTICIDES**	Periods	**9**
History and concept of bio-pesticides, Importance, scope and potential of bio-pesticide, Definitions, concepts and classification of bio- pesticides viz. pathogen, botanical pesticides, and biorationales, Botanicals and their uses.			
Unit – V	**PRODUCTION OF BIOPESTICIDES**	Periods	**9**
Mass production technology of bio-pesticides, Virulence, pathogenicity and symptoms of entomo-pathogenic pathogens and nematodes, Methods of application of bio-pesticides, Methods of quality control and Techniques of bio-pesticides, Impediments and limitation in production and use of bio-pesticide.			
		Total Periods	**45**
Text Books			
1.	Field crops Production, Foodgrain crops Volume-I, by Dr. Rajendra Prasad, Indian Council of Agricultural Research, New Delhi, 2013.		
2.	Field crop Production, Commercial crops Volume-II by Dr. Rajendra Prasad, Indian Council of Agricultural Research, New Delhi, 2017.		
References			
1.	Principles Of Crop Production, by S.R REDDY, C NAGAMANI, Kalyani Publications, 2019.		
2.	Modern techniques of raising field crops ChhiddaSingh,Prem Singh and Rajbir Singh, second edition, 2020.		
3.	A Manual on Crop Production Technology (Kharif and Rabi), Lokesh Kumar Jain, 2021.		
4.	Crop Production Technology I & II — Kharif and Rabi Crops — As per 5th Deans Committee Recommendations, B. S. Lalitha, N. Mavarkar, B. R. Premalatha, 2020		
E-Resources			
1.	https://courseware.cutm.ac.in/wp-content/uploads/2020/06/Lec-11-Biofertilizer-and-biopesticide.pdf		

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University, Chennai) Elayampalayam, Tiruchengode–637205							
Programme	**M.Tech**	Programme Code		**206**	Regulation		**2023**	
Department	**BIOTECHNOLOGY**			Semester			-	
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
P23BTE12	**MOLECULAR MODELLING & DRUG DISCOVERY**	3	0	0	3	40	60	100

Course Objective	The student should be made ➢ To describe the basic theoretical aspects of molecular modeling techniques ➢ To analyze the results of molecular modeling calculations ➢ To gain knowledge about molecular dynamics and simulations ➢ To acquire knowledge on Homology Modelling To acquire knowledge about drug discovery and development	
Course Outcome	At the end of the course, the student should be able to,	**KL**
	CO1:Highlight the various principles involved in the drug discovery and various routes of drug administration	K1
	CO2: Interpret the various mechanisms of drug absorption and metabolism in drug development.	K2
	CO3: Integrate how molecular modelling used in drug development.	K3
	CO4: Apply the role of homology modelling in modelling of proteins.	K4
	CO5: Analyze the importance of molecular modelling in drug discovery.	K4
Pre-requisites	Biochemistry, Molecular Biology, Bioinformatics	

CO/POMapping (3/2/1indicates strength of correlation)3-Strong,2–Medium,1-Weak													CO/PSO Mapping		
COs	Programme Outcomes(POs)												PSOs		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO3**
CO1	3	2											3	3	3
CO2	3	2	3	3	3			2	2	2	2	3	3	3	3
CO3	3	3	3	3	3			2	2	2	3	3	3	3	3
CO4	3	3	3	3	3			2			3	3	3	3	3
CO5	3				3			2			3	3	3	3	3

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment 3. End-Semester examinations
Indirect
1.Course-end survey

Content of the syllabus

Unit –I	**CONCEPTS IN MOLECULAR MODELING**	Periods	**9**

Introduction – coordinate systems – potential energy surfaces – introduction to quantum mechanics – postulates – Schrodinger wave equation – hydrogen molecule – Born-Oppenheimer approximation, introduction to computer

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hardware and software.			
Unit - II	**MOLECULAR MECHANICS AND ENERGY MINIMIZATION**	Periods	**9**
Empirical force field models – Bond stretching – angle bending – torsional term – nonbonding interactions – thermodynamics properties using a forcefield – derived and non - derived energy minimization method – simplex – sequential univariate method – steepest descent method – conjugate gradient method- Newton-Rapson method.			
Unit –III	**MOLECULAR DYNAMICS AND MONTE CARLO SIMULATION**	Periods	**9**
Molecular dynamic simulations - relative energy- energy minimization methods - ligand binding free energy calculations (both simulation and empirical methods) - Setting up MD – energy conservation in MD Simulation - Difference in MD & MC.			
Unit –IV	**HOMOLOGY MODELING**	Periods	**9**
Comparative modeling of proteins – comparison of 3D structure – Homology – steps in homology modeling – tools – databases – side chain modeling – loop modeling.			
Unit –V	**DRUG DESIGN**	Periods	**9**
General approach to discovery of new drugs - lead discovery – lead modification – physiochemical principles of drug action – drug stereo chemistry –drug action - 3D database search – computer aided drug design – docking - molecular modeling in drug design – structure-based drug design – pharmacophores - QSAR.			
		Total Periods	**45**
Text Books			
1.	Leach,A. R. "Molecular Modeling Principles and Application", 2nd edition, Longman Publications, 1996.		
2.	Baxivanis, D and Foulette," Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins", Wiely Indian Edition, 2001.		
References			
1.	Kenneth M Merz, DagmarJr,"Drug design: Structure and ligand based approaches",2010		
2	Leach, AR, "Molecular Modeling& Drug Design", 2nd Edition, John Willy, 2000.		
3.	Alan Hinchliffe, "Molecular modeling for Beginners" 2nd edition,Wiley Publisher , 2008.		
E-Resources			
1.	https://gyansanchay.csjmu.ac.in/wp-content/uploads/2022/02/Drug-Discovery-Process_Med.Chem-converted.pdf		
2.	http://www.ncbi.nlm.nih.gov/guide/all/		
3.	https://nptel.ac.in/courses/102/108/102108077/		

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Programme	**M.Tech**	Programme Code	**206**	Regulation	**2023**		
Department	**BIOTECHNOLOGY**			Semester	**-**		
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks	
		L	**T**	**P**	**C**	**CA**	**ESE**	**Total**
P23BTE13	**BIOREACTOR DESIGN AND ANALYSIS**	**3**	**0**	**0**	**3**	**40**	**60**	**100**

Course Objective	The objective of the course is to make the students • Understand the basic configuration of bioreactors. • Develop skills in designing of bioreactors. • Apply bioengineering skills for the production of biochemical product	
Course Outcome	At the end of the course, the student should be able to,	Knowledge Level
	CO1: Understand the basic features of a bioreactor.	K2
	CO2: Design a bioreactor for industrial use.	K2
	CO3: Apply the Knowledge of mass transfer and heat transfer for developing new industrial process and product	K3
	CO4: Analyze the Strategies to enhance yield and productivity by scale up	K4
	CO5: Integrate to their own research interests to solve problems of non ideal real time reactors	K4
Pre-requisites	Basic knowledge in chemical engineering and Bioprocess	

CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak												CO/PSO Mapping		
COs	Programme Outcomes (POs)											PSOs		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	3	2	1	1	3	1	2					1	3	2	3
CO 2	3	3	3	2	3	2	2					2	3	1	3
CO 3	3	3	3	3	3	1	1					1	3	1	3
CO 4	3	3	3	2	3	2	1					1	3	2	3
CO 5	3	3	3	2	3	2	1					3	3	3	3

Course Assessment Methods

Direct

1. Continuous Assessment Test I, II & III
2. Assignment & Quiz
3. End-Semester examinations

Indirect

1. Course - end survey

Content of the syllabus

Unit – I	**BIOREACTOR CONFIGURATION AND OPERATION**	**Periods**	**9**

Basic features and parts of a bioreactor, Classification of Bioreactors-Aerobic, Anaerobic, Configuration of various Bioreactors– Tank-type, Column-type biological reactors, Spectrum of bioreactor operational mode- Batch operation, fed-batch operation and Continuous Operation.

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Unit - II	DESIGN CONSIDERATION OF VARIOUS BIOREACTOR	Periods	9
Batch Growth Kinetics, Design equation and product kinetics of Batch, fed batch and continuous Bioreactor, Ideal CSTR-Chemostat and Turbidostat, Ideal plug flow reactor with design equation, continuous reactor with recycle, Productivity of batch Vs continuous reactor.			
Unit – III	**MASS AND HEAT TRANSFER IN A BIOREACTOR**	**Periods**	**9**
Theories of interphase mass transfer-Two film theory and penetration theory, oxygen transfer from gas bubble to fermentation broth, Determination of volumetric mass transfer coefficient -Static, Dynamic and oxygen balance method ,Rheology of fermentation broths, Heterogeneous reactions in bioprocesses, Design of Batch and continuous heat exchanger system in a bioreactor.			
Unit - IV	**SCALE UP IN A BIOREACTOR**	**Periods**	**9**
Scale up principles-Geometric and Dynamic flow fluids, key variables in a scale up, challenges in a scale up process-physical and biological factors, Criteria for scale up –power consumption, impeller speed, K_La, Mixing rate, Steps in a scale up operation.			
Unit – V	**NON IDEAL BIOREACTORS**	**Periods**	**9**
Factors causing deviation from ideal flow pattern- RTD, Stages of Aggregation, Mixing, Methods to determine RTD, Closed vessel boundary-Steady state assumption, misbehaving plug flow models, Convolution			
		Total Periods	**45**

Text Books	
1.	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
2.	Mansi, E.M.T.EL., Bryce, C.F.A., Demain, A.L. and Allman, A.R., "Fermentation Microbiology and Biotechnology", 5th edition Taylor and Francis, 2022.
References	
1.	Mann, U., "Principles of Chemical Reactors Analysis & Design: New tools for Industrial Chemical Reactor Operations", 3rd Edition, Willey–VCH, 2019.
2.	Towler, G. and Sinnott, R., "Chemical Engineering Design: Principles, Practice, Economics of Plant and Process Design", 2 nd edition, Butterworth – Heinemann ltd., Elsevier, 2012.
3.	Shuler and Kargi, "Bioprocess Engineering ", 3rd Edition, Prentice Hall, 2017.
E-Resources	
1.	https://archive.nptel.ac.in/courses/102/106/102106086/
2.	https://microbenotes.com/bioreactor/#:~:text=with%20BioRender.com.-,Bioreactor%20Design,and%20its%20scale%20of%20production.
3.	https://www.researchgate.net/publication/301680545_Bioreactors_-_Technology_Design_Analysis

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Tiruchengode - 637 205

	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University, Chennai) Elayampalayam, Tiruchengode–637205						
Programme	M.Tech	Programme Code	206	Regulation	2023		
Department	BIOTECHNOLOGY		Semester	-			
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks	
		L	T	P	C	CA	ESE	Total
P23BTE14	PHARMACOVIGILANCE	3	0	0	3	40	60	100

Course Objective

The course aims to

- Understand the basic definitions of terms used in pharmacovigilance
- Apply the basic concepts and principles of signal detection in the safety surveillance of drug products
- Analyze case studies and current events to appreciate the pending issues and apply applicable laws, regulations and guidelines to recommend possible solutions

Course Outcome	At the end of the course, the student should be able to,	Knowledge Level
	CO1: Explain the principles and regulatory framework for pharmacovigilance.	K1
	CO2: Apply the international guidance, legal and regulatory principles applicable to safety surveillance regulatory requirement	K2
	CO3: Execute the operations and establishments in pharmacovigilance programmes	K3
	CO4: Execute the clinical investigations of bioproducts	K4
	CO5: Evaluate the relation between Indian and global pharmacovigilance programmes	K5

Pre-requisites -

CO/POMapping (3/2/1indicates strength of correlation)3-Strong,2–Medium,1-Weak												CO/PSO Mapping		
COs	Programme Outcomes(POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO2	PSO3
CO1	3	2		2	2								3	3	3
CO2	3	2	2	3	3			2		2	2	2	3	3	3
CO3	3	3	3	3	3			2		2	3	3	3	3	3
CO4	3	3	3	3	3			2			3	3	3	3	3
CO5	3	3	3	3	3			2			3	3	3	3	3

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment 3. End-Semester examinations
Indirect
1.Course-end survey

Content of the syllabus

Unit –I	BASIC CONCEPTS OF PHARMACOVIGILANCE	Periods	9

Historical perspective of pharmacovigilance, importance of safety monitoring of medicine, safety databases, WHO international drug monitoring programme, pharmacovigilance program of India, basic definitions and classification of

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ADRs, detection and reporting, management of adverse drug reactions, terminologies of adverse medication related events and regulatory terminologies.			
Unit - II	**LAWS, REGULATIONS AND GUIDELINES OF PHARMACOVIGILANCE**	Periods	**9**
ICH guidelines, FDA regulations and guidelines, EU regulations and guidelines, laws, legal cases and legislations on drug safety, role of preclinical safety studies in drug development, non-clinical safety evaluation and adverse events in phase I trials, safety reporting requirements in pre-marketing phase, ethical and societal considerations.			
Unit –III	**DRUG DICTIONARIES AND ESTABLISHMENT OF PV PROGRAMMES**	Periods	**9**
Anatomical, therapeutic and chemical classification of drugs, international nonproprietary names for drugs, WHO adverse reaction terminologies, MedDRA and Standardized MedDRA queries, WHO drug dictionary, Eudravigilance medicinal product dictionary, basic and specialized drug information resources for ADRs in PV, establishing pharmacovigilance programme in a hospital, establishment & operation of drug safety department in industry, Contract Research Organizations(CROs), establishing a national programme on pharmacovigilance.			
Unit –IV	**VACCINE SAFETY SURVEILLANCE AND COMMUNICATION IN PV**	Periods	**9**
Adverse events following vaccination, passive surveillance - spontaneous reports and case series, stimulated reporting, active surveillance - sentinel sites, drug event monitoring and registries, comparative observational studies - cross sectional study, case control study and cohort study, targeted clinical investigations, effective communication in pharmacovigilance, communication in drug safety crisis management, communicating with regulatory agencies, business partners, health care facilities and media			
Unit –V	**PHARMACOGENOMICS AND PHARMACOVIGILANCE**	Periods	**9**
Pharmacogenomics of adverse drug reactions, genetics related ADR with example focusing PK parameters, drug safety evaluation in special population - Paediatrics, Pregnancy and lactation, geriatrics, CIOMS working groups, CIOMS form, CDSCO (India) and Pharmacovigilance, D&C Act and Schedule Y, differences in Indian and global pharmacovigilance requirements.			
		Total Periods	**45**
Text Books			
1.	Elizabeth B. Andrews and Nicholas Moore (eds.). Mann's Pharmacovigilance, 3rd Edition, Wiley-Blackwell, 2014.		
2.	Waller P, An Introduction to Pharmacovigilance, 1st Edition, Wiley-Blackwell, 2009		
References			
1.	Klepper M. J. and Barton Cobert, Drug Safety Data: How to Analyze, Summarize and Interpret to Determine Risk, Jones & Bartlett Publishers, 2011		
2	Gupta S. K (eds). Textbook of Pharmacovigilance, 1st Edition, Jaypee Brothers Medical Publishers (P) Ltd., 2011		
E-Resources			
1.	https://www.studocu.com/en-gb/document/university-of-strathclyde/evidence-based-medicine/notes-pharmacovigilance/14534001		
2.	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3781681/		
3.	https://pharmacovigilancetutorials.wordpress.com/2020/04/11/introduction-to-pharmacovigilance/		

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Programme	**M.Tech**	Programme Code		**206**	Regulation			**2023**
Department	**BIOTECHNOLOGY**				Semester			-
Course Code	Course Name	Periods Per Week		Credit	Maximum Marks			
		L	T	P	C	CA	ESE	Total
P23BTE15	**MARINE BIOTECHNOLOGY**	3	0	0	3	40	60	100

Course Objective	• To provide the knowledge about the marine diversity • To know about the marine microbes and the aquatic animals • To learn the ways and means to protect the environment from various types of pollution. • To study about the biopharma products derived from marine biodiversity • To know the marine food products and its processing.	
Course Outcome	At the end of the course, the student should be able to,	**KL**
	CO1: explain the different habitats of marine biodiversity and its nutrient requirements.	K2
	CO2: describe the aquaculture related to artificial insemination, eye stalk ablation, transgenic fish technology and the role of probiotic bacteria in aquaculture.	K3
	CO3: Aware of the ways and means to protect the environment from various types of pollution.	K3
	CO4: get knowledge about the medicinal properties of marine pharma products.	K4
	CO5: Understand the marine food products applications and its processing methods.	K4
Pre-requisites	-	

CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak													CO/PSO Mapping		
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO 1	3	2	3	2			2	3	1	2	2	1	1	2	1
CO 2	3		3	2	2	2		2		1	2	3	2	3	2
CO 3	3		2	2			2		2	2			2	3	2
CO 4	3	2	2	2	2	1	3	2			3		2	3	2
CO 5	3	2	3	3	2	2			1	3	3	2	2	2	2

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment 3. End-Semester examinations
Indirect

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1. Course - End survey			
Content of the syllabus			
Unit – I	**INTRODUCTION TO MARINE BIODIVERSITY**	Periods	**9**
Marine microbial diversity: symbiotic, free-living, biofilm, proximity to ocean surface or sediments: Euphotic, Mesopelagic, Bathopelagic, Benthos - concentration of nutrients and growth substrates: Oligotrophic, Mesotrophic, Eutrophic, algal blooms - hydrothermal vents: vent biodiversity - applications of extremozymes.			
Unit – II	**MARINE AQUACULTURE**	Periods	**10**
Marine aquaculture Shellfish and crustacean culture: shrimps, edible mussels, pearl oyster, crabs, fish aquaculture: artificial insemination, eye stalk ablation-transgenic fish technology, transgenic fishes with growth hormone (GH)and antifreeze genes, development of healthy fish diets, probiotics bacteria and their importance in aquaculture, vaccines for aquaculture.			
Unit – III	**MARINE ENVIRONMENTAL BIOTECHNOLOGY**	Periods	**7**
Marine pollution – biology indicators (marine micro, algae) - biofilm – biodegradation and bioremediation – marine fouling and corrosion			
Unit – IV	**MARINE PHARMACOLOGY**	Periods	**9**
Medicinal compounds from marine flora (seaweeds, seagrass, mangroves) and fauna (sponges, coelenterates, bryozoans, tunicates, dinoflagellates, marine bacteria) – Pharmacological activities – antimicrobial, anti-tumor, anti-viral, anti-helminthic, anti-parasitic, anti-inflammatory.			
Unit – V	**MARINE FOOD PRODUCTS AND PROCESSING**	Periods	**10**
Area selection, layout, receiving area, processing area, processing methods, preservation (physical, chemical and biological) and packing methods, Storage plate and IQF freezers, cold stores, sanitary maintenance. Value added products development. ISO standards for quality control. Food Safety and Standard Authority of India (FSSAI).			
	Total Periods	**45**	
Text Books			
1.	Microbiology by J. Michael Pelczar, E.C.S. Chan, Nobel R. Krieg fifth edition published by Affiliated East West Press Private Limited New Delhi,2023		
2.	Karleskint, G., Turner, R. and Small, J.W. Introduction to Marine Biology, 4th edition. Thomson Brooks/Cole, Belmont CA, 2013		
References			
1.	Bioactive Marine Natural Products by D.S. Bhakuni, Anamaya Publishers,2005		
2.	Technological Processes for Marine Foods, From Water to For Bioactive Compounds, Industrial Applications, and Genomics 1st Edition by Megh R. Goyal, Hafiz Ansar Rasul Suleria, Shanmugam Kirubanandan, 2019		
3.	Aquaculture: An Introductory Text by Stickney, Robert R, 2017 - CABI (Publisher)		
Resources			
1.	https://nptel.ac.in/courses/120108002		
2.	https://onlinecourses.swayam2.ac.in/cec23_bt22/preview		

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PROFESSIONAL ELECTIVE – IV

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Programme	M.Tech	Programme Code	206	Regulation	2023
Department	BIOTECHNOLOGY			Semester	-

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
P23BTE16	AGRICULTURE BIOTECHNOLOGY	3	0	0	3	40	60	100

Course Objective

- The course aims to expose students to the basic scientific evidence and technical aspects of the different disciplines of agricultural biotechnologies (mainly for plants and crops).
- It clarifies major scientific, ecological and sociological aspects of biotechnology in agriculture and food production.

Course Outcome	At the end of the course, the students should able to,	Knowledge Level
	CO1: Understand basic knowledge on plant biology seed technology in agricultural biotechnology.	K1
	CO2: Integrate tissue culture technology and biotechnology	K2
	CO3: Evaluate basic scientific methods and agricultural systems	K3
	CO4: Identify the seeds of agricultural crops	K4
	CO5:Acquire knowledge on transgenic plants and its current status	K5

Pre-requisites -

CO/PO Mapping (3/2/1indicates strength of correlation)3-Strong,2 –Medium,1-Weak												CO/PSO Mapping		
COs	Programme Outcomes(POs)											PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	2	2	2	2	2	2	2	3	3	3
CO2	3	2	3	2	2	2	3	3	3	2	3	2	2	2	2
CO3	3	2	2	3	2	3	2	2	3	2	3	2	3	2	1
CO4	3	2	3	2	3	3	3	3	2			2	3	3	2
CO5	3	3	2	2	2	2	2	2	3			2	3	2	1

Course Assessment Methods

Direct

1. Continuous Assessment Test I,II&III
2. Assignment
3. End-Semester examinations

Indirect

1. Course-end survey

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Content of the syllabus			
Unit –I	**PLANT BIOLOGY, PHYSIOLOGY MOLECULAR BIOLOGY AND SEED TECHNOLOGY**	Periods	**9**
Plant cell structure and function, phloem transport, plant storage proteins and protein biosynthesis, natural pesticides. Concept of plasticity in plant development; Analyzing plant growth; Floral Induction and Development; Photoperiodism and its significance; Vernalization and hormonal control; Inflorescence and floral determination; Light harvesting complexes; mechanisms of electron transport; C3, C4and CAM pathways. Respiration and photorespiration Citric acid cycle; plant mitochondrial electron transport and ATP synthesis; alternate oxidase; photo respiratory pathway, Carbon Assimilation.			
Unit - II	**TISSUE CULTURE, TRANSGENIC TECHNOLOGIES AND BIOTECHNOLOGY**	Periods	**9**
Totipotency; Tissue culture media; Plant hormones and morphogenesis; embryogenesis; Cell suspension culture; Micropropagation shoot tip culture, somatic embryos, artificial seeds; Applications of tissue culture; shoot tip culture; Wide hybridization, Anther culture and dihaploids.Production of alkaloids and other secondary metabolites; Protoplast isolation and purification; Protoplast culture; Protoplast fusion; Somatic hybrids; Cybrids.c) Direct transformation of protoplasts using PEG.			
Unit –III	**MICROBES BASED FERTILIZER**	Periods	**9**
Microbes based Biofertilizers: Azolla and Anabena, Rhizobium, Azotobacter, Azospirillum, Mycorrhiza. Biochemistry of nitrogen fixation, Nif genes. Biopesticide – Trichoderma, Bt and NPV. Plant growth regulators from soil microbes.			
Unit - IV	**SEED PRODUCTION TECHNIQUES OF AGRICULTURAL CROPS**	Periods	**9**
Floral biology and pollination behavior - seed production techniques of rice, maize, sorghum and bajra varieties and hybrids - redgram varieties and hybrids - blackgam and greengram varieties - groundnut and sesame varieties - sunflower, castor and cotton varieties and hybrids – Bt cotton.			
Unit –V	**CURRENT STATUS TRANSGENIC PLANTS**	Periods	**9**
Transgenic plants in quality modifications –Starch, Oil, Protein, and Golden Rice. Plants derived vaccines, flower modification and color. Advantages and applications of transgenic plants. Current status of transgenics, Biosafety norms and controlled field trails and release of transgenics (GMO).			
		Total Periods	**45**
Text Books			
1.	Ahindra Nag. (2008). Text book of Agricultural Biotechnology, PHI Learning Private Limited, New Delhi.		
2.	Rajmohan joshi. (2006). Agricultural Biotechnology, Isha Books, Delhi.		
References			
1.	Nester E. W., Anderson D. G. and Nester M. T. 2006. Microbiology: A Human Perspective, McGraw-Hill, U.S.A.		
2.	Ryan K. J. and Ryan C.G. (2004) Sherris Medical Microbiology: An Introduction to infectious diseases. 2nd edition. McGraw-Hill, U.S.A.		
3.	Bauman, R.W. (2005). 4th Edition. Microbiology: with diseases by body system; Pearson Education, Inc., U.S.A.		
4.	Murray P.R., Pfaller M.A., Tenover F.C., and Yolken R.H. (2007). Medical Microbiology 6 th Edn., ASM Press, U.S.A.		
E-Resources			
1.	https://archive.nptel.ac.in/courses/102/103/102103015/		
2.	https://vlab.amrita.edu/?sub=3&brch=187&sim=323&cnt=1		
3.	https://www.youtube.com/watch?v=ei6Z7orCpPk		

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Elayampalayam, Tiruchengode–637205

Programme	M.Tech	Programme Code	206	Regulation	2023
Department	BIOTECHNOLOGY		Semester		-

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
P23BTE17	OMICS TECHNOLOGY	3	0	0	3	40	60	100

Course Objective

The course aims to
- To make students identify about the major techniques involved in sequence analysis and assembly
- To summarise the basic principles of instrumentation and techniques in proteomics and genomics
- To develop and organize application based knowledge on various omics tools

Course Outcome

At the end of the course, the student should be able to,	KL
CO1: Explain variegated fields in omics and gain deep Knowledge in that field	K1
CO2:Apply different techniques involved in biomolecules analysis	K2
CO3:Analyze data and profiles of biomolecules obtained using this technology	K3
CO4: Evaluate its importance in the field of biotechnology and bioinformatics	K4
CO5:Create new tools and techniques as a up gradation from the presently available technology	K5

Pre-requisites -

CO/POMapping (3/2/1indicates strength of correlation)3-Strong,2–Medium,1-Weak													CO/PSO Mapping		
COs	Programme Outcomes(POs)												PSOs		
	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO3
CO1	3	2		2	2								3	3	3
CO2	3	2	3	3	3			2	2	2	2	3	3	3	3
CO3	3	3	3	3	3			2	2	2	3	3	3	3	3
CO4	3	3	3	3	3			2			3	3	3	3	3
CO5	3			2	3			2			3	3	3	3	3

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment 3. End-Semester examinations
Indirect
1.Course-end survey

Content of the syllabus

Unit –I	GENOMICS	Periods	9

Structure and organization of prokaryotic and eukaryotic (*Saccharomyces cerevisiae, Drosophila melanogaster*, Homo sapiens) genomes, Evolution of bacterial operons and operonisation, Yeast two-hybrid system, Evolution and structure of mitochondrial genomes, Genome Mapping,Genome Sequencing, Genome annotation, Genome Networks

Unit - II	TRANSCRIPTOMICS	Periods	9

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Expression Profiling, Microarray profiling methods and data analysis, Technology for Transcriptomics, Data capture and preliminary checks, Transcriptome data analysis, Generation of transcriptional regulatory networks, Introduction of databases and software for Transcriptomics			
Unit –III	**PROTEOMICS**	Periods	**9**
Proteomics classification, 1D-SDS-PAGE and 2D-SDS PAGE, Detection and quantitation of proteins in gels, Basics of mass spectrometry, MaldiTof and ESI and their application in proteomics, Tandem MS/MS spectrometry, Peptide sequencing by tandem mass spectrometry, Affinity purification of protein, TAP tag.			
Unit –IV	**BIOINFORMATICS**	Periods	**9**
Bioinformatics and its application, Major online databases, Practical use of databases, DNA, RNA, Proteins in bioinformatics, Amino acid classification, Similarity, homology, local and global sequence alignment, Scoring matrices (PAM, BLOSUM), Pairwise alignment, Dot sequence alignment, BLAST and its variants, FASTA, ClustalW, BOXSHADE., Phylogenetic analysis			
Unit –V	**METABOLOMICS**	Periods	**9**
Sampling in metabolomics, Data handling in metabolomics, Metabolite Identification and Annotation, Uncertainty of measurements, Role of CE-MS in metabolomics, NMR based metabolomics analysis, Data Integration, Applications and the Future of Metabolomics, Current and future challenges for metabolomics.			
		Total Periods	**45**
Text Books			
1.	Heyer L, Campbell A, 2006, Discovering Genomics, Proteomics and Bioinformatics, Cold Spring Harbor Lab Press		
2.	S.B Primrose and R.M Twyman, 2006, Principles of Gene Manipulation and Genomics, Blackwell Publishing.		
References			
1.	Daniel C. Liebler, 2002, Introduction to Proteomics: Tools for the New Biology, Humana Press		
2	Michael Lammerhofer, Wolfram Weckwerth, Metabolomics in Practice: Successful Strategies to Generate and Analyze Matabolic data, 2010.		
E-Resources			
1.	https://www.studocu.com/en-gb/document/university-of-salford/genomics/omics/2207068		
2.	https://nptel.ac.in/courses/102101082		
3.	https://www.mooc-list.com/tags/metabolic-engineering		

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Programme	**M.Tech**	Programme Code	**206**	Regulation	**2023**		
Department	**Biotechnology**			Semester	-		
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks	
		L	**T**	**P**	**C**	**CA**	**ESE**	**Total**
P23BTE18	**BIOFUELS AND BIOENERGY**	**3**	**0**	**0**	**3**	**40**	**60**	**100**

Course Objective	The student will have an elaborate knowledge on, • Environmental aspects of bioenergy. • Bioenergy and biofuel technologies • Biomass fuels production and treatment. • Conversion of biomass for energy application. • Economic aspect of bioenergy and biofuel.	
Course Outcome	At the end of the course, the student should be able to,	Knowledge Level
	CO1: Understand the overview of bioenergy and sources of biomass.	K2
	CO2: Acquire knowledge about different sources of biofuels and its production	K3
	CO3: Identify the Sources and methods for ethanol production.	K3
	CO4: Evaluate the waste distribution and importance of converting into product	K4
	CO5: Awareness about estimation of economic aspect of bioenergy and biofuel.	K4
Pre-requisite	-	

CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak													CO/PSO Mapping		
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	2	2	1		1		1	1		2	2	3	1	2
CO 2	2	2	2	2	2						3	3	3	3	3
CO 3	3	2	2	2	3	2	1		2		3	3	3	3	3
CO 4	3	1	2	2	2				2		2	2	3	2	2
CO 5	2	3	3	2	2	2		1			2	3	3	2	2

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment & Quiz 3. End-Semester examinations
Indirect
1. Course - end survey

Content of the syllabus

Unit – I	**INTRODUCTION TO BIOFUELS AND BIOENERGY**	Periods	9

Definition, Global Energy Outlook, Carbon cycle, Climate change, Sustainability, Biomass Feedstocks - food and fiber production – meat and dairy production, Processes and Technologies, Environment and Ecology

Unit - II	**CROP OILS, BIODIESEL, AND ALGAE FUELS**	Periods	9

Vegetable Oils - Production and Use of Vegetable Oils - Composition of Vegetable Oils - Use of Vegetabl

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Oil as Alternative Diesel Fuel - Use of Vegetable Oil in direct heating - Use of Vegetable Oil for Combined Heat and Power - Algae Oil Extraction - Microalgae and Growth - Algae Harvesting - Algae Oil Extraction methods - By-Product Utilization, Manufacture of Biodiesel - Historical Background of Biodiesel Manufacture - Transesterification Process for Biodiesel Manufacture - Properties of Biodiesel			
Unit – III	**ETHANOL PRODUCTION**	Periods	**9**
Fuel Ethanol from Corn - Corn-to-Ethanol Process Technology - By-Products/Coproducts of Corn Ethanol Ethanol as Oxygenated and Renewable Fuel - Ethanol Vehicles, Ethanol from Lignocellulose Lignocellulose and Its Utilization - Lignocellulose Conversion - Agricultural Lignocellulosic Feedstock Cellulosic Ethanol Technology - Energy Balance for Ethanol Production from Biomass			
Unit - IV	**CONVERSION OF WASTE TO BIOFUELS, BIOPRODUCTS, AND BIOENERGY**	Periods	**9**
Types of Waste and Their Distributions - Waste Preparation and Pretreatment for Conversion - Technologies for Conversion of Waste to Energy and Products - Future of the Waste Industry			
Unit – V	**ECONOMICS**	Periods	**9**
Factors Affecting Economics, Economic Analyses, Life-Cycle Costs, Present Worth and Levelized Costs, Externalities, Project Development, Cost (Value) of Energy for Different Sources			
		Total Periods	**45**
Text Books			
1.	Sunggyu Lee, Y.T. Shah, "Biofuels and Bioenergy Processes and Technologies", CRC Press Taylor & Francis Group, 2012		
2.	Vaughn, Nelson, Kenneth Starcher," Introduction to Bioenergy", Garland Science., New York, 2002		
References			
1.	Anju Dahiya, "Bioenergy: Biomass to Biofuels and Waste to Energy", Elsevier Science, 2020		
2.	Yebo Li and Samir Kumar Khanal, "Bioenergy: Principles and Applications", Wiley-Blackwell, 2016		
3.	Judy D. Wall and Caroline S. Harwood, "Bioenergy", ASM press 2008		
4.	Ted Weyland, "Bioenergy: Sustainable Perspectives" Callisto, 2016		
5.	Ozcan Konur, "Bioenergy and Biofuels", 2018		
E-Resources			
1.	https://www.etipbioenergy.eu/advanced-biofuels-overview		
2.	https://www.iea.org/fuels-and-technologies/bioenergy		
3.	https://www.renewableenergyworld.com/types-of-renewable-energy/tech/biofuels/		

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Elayampalayam, Tiruchengode – 637 205

Programme	M.Tech	Programme Code	206	Regulation	2023
Department	BIOTECHNOLOGY			Semester	-

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
P23BTE19	CLINICAL GENETICS & COUNSELLING	3	0	0	3	40	60	100

Course Objective

The student should be made
- To know about the drug design and its development.
- To understand the role of biostatistical methods in clinical research.
- To acquire a knowledge of some regulatory approaches and ethical values in clinical research.

Course Outcome	At the end of the course, the student should be able to,	KL
	CO1: Address the formulations and discovery of drug.	K1
	CO2: Be aware of the manufacturing practices and quality assurance of drugs,	K4
	CO3: Differentiate the clinical modelling from statistical modelling.	K5
	CO4: Well-verse in laws and regulations of clinical research.	K2
	CO5: Conclude ethical procedure of clinical research.	K3

CO / PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak

CO/PSO Mapping

Cos	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	2	3	1		3	1	1	3	3	1	1	2	3	3
CO 2	3	2	2	2	1	1	1	2	3	2	1	1	2	2	3
CO 3	2		3		3	1	1	2		1		1	2	2	3
CO 4	2	3		1		1	2	1		2		2	3	2	2
CO 5	3	1	3	2			1	3	1	1		1	3	3	2

Pre-requisites -

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III
2. Assignment
3. End-Semester examinations
Indirect
1. Course - end survey

Content of the syllabus

Unit – I	INTRODUCTION TO CLINICAL RESEARCH	Periods	9

Drug development process and Drug discovery - The drug development process, high throughput screening (HTS), Combinatorial chemistry, Lead optimization, target-cantered drug design; Formulation Development - Introduction to different formulations, advantages and disadvantages of common

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formulations.			
Unit – II	**DRUG EVALUATION AND DRUG DEVELOPMENT**	Periods	**9**
Introduction to manufacturing of drugs and Good Manufacturing Practices, Quality assurance and Quality control; Phases of developmental clinical trials - Phase 0, Phase-I, Phase-II, Phase-III, Phase-IV - Placebo response, advantages and disadvantages of placebo.			
Unit – III	**BIOSTATISTICAL METHODS IN CLINICAL RESEARCH**	Periods	**9**
Biostatics principles: Randomization, Replication and Local control; Clinical trial design: Purpose and key components; Statistical Modelling: Techniques, Machine learning vs Clinical modelling, Reasons for learning statistical modelling; Importance and role of biostatistics in clinical research.			
Unit – IV	**REGULATORY ASPECTS OF CLINICAL RESEARCH**	Periods	**9**
Introduction of Evolution of regulatory control - An international comparison - Pure food drugs act, Drugs and cosmetic act 1945; Regulatory aspects of different regions - Investigational New Drug (IND), New Drug Application (NDA), Abbreviated New Drug Application (ANDA) - Market authorization holders (MAH) - Post-marketing Surveillance (PMS) - Regulation of medical devices - Regulation of vaccines - Safety Report filing - Regulation of prescription drugs and non-prescription drugs.			
Unit – V	**ETHICS IN CLINICAL RESEARCH**	Periods	**9**
Evolution of ethics in clinical research - Tuskegee experiment, Nuremberg Code, Declaration of Helsinki, Belmont report, Establishment of CIOMS, NIH and ICMR guidelines, Legal Liability in Clinical research, negligence, strict liability, criminal liability; Legal obligations of the investigator - Compensation to patients for clinical trial related injuries; Ethics review Procedure.			
		Total Periods	**45**
Text Books			
1.	Lionel D. Edwards, Andrew J Fletcher, Anthony W Fox, "Principles and practice of Pharmaceutical Medicine" edited by Wiley, 2003.		
2.	Olga V. Marchenko, Natallia V.katenka,"Quantitative methods in Pharmaceutical Research and Development", 2020.		
Reference			
1.	Alan A. Rubin, "New Drugs: Discovery and development" edited by Marcel Dekker,2012.		
E-Resources			
1.	https://www.researchgate.net		
2.	https://www.coursera.org		

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University, Chennai) Elayampalayam, Tiruchengode – 637 205							
Programme	**M.Tech.**	Programme Code	**206**	Regulation	**2023**			
Department	**BIOTECHNOLOGY**			Semester	-			
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	**T**	**P**	**C**	**CA**	**ESE**	**Total**
P23BTE20	**ADVANCED NANO BIOTECHNOLOGY**	**3**	**0**	**0**	**3**	**40**	**60**	**100**

Course Objective	The student should be made to, • Understand the various methods for synthesis of nanomaterials • Impart knowledge on biomedical applications of nanotechnology • Realize advances in cancer diagnosis and therapy, medical implants, tissue engineering etc.	
Course Outcome	At the end of the course, the student should be able to,	Knowledge Level
	CO1: Understand how nanomaterials synthesized and characterized	K2
	CO2: Predict the roles and uses of biomolecules in nanobiology	K2
	CO3: Apply the nanomaterials in nanomedicine	K3
	CO4: Analyze the Strategies to enhance targeted drug delivery	K4
	CO5: Illustrate the potential impacts of nanoparticles on human health and environment	K4
Pre-requisites	Nanobiotechnology	

CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak													CO/PSO Mapping		
COs	Programme Outcomes (POs)												PSOs		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	3	2	1	1	3	1	3	3	1	1	1	1	3	2	3
CO 2	3							2	1	1	1	1	3		3
CO 3	3	3	3		3	1		2	1	1	1	1	3		3
CO 4	3	3	3		3	3	3	2	1	1	1	1	3	2	3
CO 5	3	3	3	1	3	3	3	3	1	1	1	3	3	3	3

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment & Quiz 3. End-Semester examinations
Indirect
1. Course - end survey

Content of the syllabus

Unit – I	**NANOMATERIALS SYNTHESIS**	**Periods**	**9**

Introduction to nano, Nano-biomimicry, Synthesis of nanomaterials by physical and chemical methods, Synthesis of nanomaterials by biological methods, Characterisation of nanomaterials

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Unit - II	NANOBIOLOGY	Periods	9
DNA nanotechnology, Protein & glyco nanotechnology, Lipid nanotechnology, Bio-nanomachines, Carbon nanotube and its bio-applications.			
Unit – III	**NANOMEDICINE**	**Periods**	**9**
Nanomaterials for cancer diagnosis, Nanomaterials for cancer therapy, Nanotechnology in tissue engineering, Nano artificial cells, Nanotechnology in organ printing.			
Unit - IV	**NANOTCHNOLOGY IN DRUG DELIVERY SYSTEMS**	**Periods**	**9**
Nanotechnology in point-of-care diagnostics, Nano pharmacology & drug targeting, Cellular uptake mechanisms of nanomaterials, In vitro methods to study antibacterial and anticancer properties of nanomaterials.			
Unit – V	**NANOTOXICOLOGY**	**Periods**	**9**
Nanotoxicology: basics of cellular and organ level toxicity, effect of nano size, shape, surface properties and composition on toxicity of nanomedicines, Case studies: Ag, ZnO, TiO2, Quantum dots, carbon-based nanomaterials, polymeric, protein and lipid nanoparticles.			
		Total Periods	**45**

Text Books	
1.	Mirkin, C.A. and Niemeyer, C.M., "Nanobiotechnology II: More Concepts and Applications", Wiley-VCH. (2012).
2.	Jain, K.K., "The Handbook of Nanomedicine", Humana press. (2017).
References	
1.	Malsch, N.H., "Biomedical Nanotechnology", CRC Press. (2005).
2.	Kumar, C. S. S. R., Hormes, J. and Leuschner C., "Nanofabrication Towards Biomedical applications: Techniques, Tools, Applications, and Impact", WILEY -VCH Verlag GmbH & Co. (2005).
3.	Lamprecht, A., "Nanotherapeutics: Drug Delivery Concepts in Nanoscience", Pan Stanford Publishing Pte. Ltd. (2009).
E-Resources	
1.	https://onlinecourses.nptel.ac.in/noc19_bt28/preview
2.	https://nptel.ac.in/courses/102107058
3.	https://archive.nptel.ac.in/courses/118/102/118102003/

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PROFESSIONAL ELECTIVE –V

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN Elayampalayam, Tiruchengode – 637 205 (Autonomous Institution, Affiliated to Anna University ,Chennai)							
Programme	**M.Tech**	Programme Code		**205**	Regulation		**2023**	
Department	**Biotechnology**				Semester		**II**	
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	**T**	**P**	**C**	**CA**	**ESE**	**Total**
P23BTE21	**TISSUE CULTURE TECHNIQUES**	**3**	**0**	**0**	**3**	**40**	**60**	**100**
Course Objective	To impart knowledge on • To gain knowledge on fundamental concepts of animal and plant cell system. • To meet challenges of new and emerging areas of biotechnology industry. • To understand the difference between plant and animal based cell cultures system. • To gain knowledge in bioprocess monitoring and downstream processing.							
Course Outcome	At the end of the course, the student should be able to,							Knowledge Level
	CO1: To understand the concepts of plant tissue culture							K2
	CO2: Awareness about the process of conservation of plants for future.							K3
	CO3: Usage of genetic and biotechnological techniques to manipulate genetic materials and their application.							K4
	CO4: Learn the prospects and problems of transgenic animals along with the ethical guidelines.							K4
	CO5: To understand the importance of cell culture							K4
Pre-requisites	-							

CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak													CO/PSO Mapping		
COs	Programme Outcomes (POs)												PSOs		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	3	3	2	2	2	3	1	1	1				3	2	3
CO 2	3	2	2	2	1	3	1	1	1				2	3	2
CO 3	3	2	3	3	2	2	1	1	1				2	3	3
CO 4	3	2	2	2	2	3	1	1	1				2	3	3
CO 5	2	2	2	2	1	3	1	2	1				3	3	2

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment 3. End-Semester examinations
Indirect
1. Course - End survey

Content of the syllabus

Unit – I	**PLANT CELL CULTURE**	Periods	**9**

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Totipotency; Plant growth regulators; Regeneration and micropropagation of plants: clonal propagation, organogenesis, shoot-tip and meristem culture, haploid culture, triploid culture, protoplast culture; Somaclonal variation; Tissue culture and Cell suspension culture system: methodology, growth kinetics and nutrient optimization; Precursors and elicitors; Plant products of industrial importance, Production of secondary metabolites.			
Unit - II	**TRANSGENIC PLANTS**	Periods	**9**
Organization and expression of chloroplast genome and mitochondrial genome- Gene transformation techniques: Direct gene transformation: Electroporation, particle gun method, Lipofection, Microinjection, Fibre mediated DNA delivery and Laser induced DNA delivery. Biological gene transfer: Agrobacterium mediated gene transformation Transgenic plants: Disease resistance; Insect resistance, virus resistance, Biotic and abiotic stress resistance, GM Crops- Prospects and problems.			
Unit – III	**ANIMAL CELL CULTURE**	Periods	**9**
Animal cell culture; media composition and growth conditions; Animal cell and tissue preservation; Anchorage and non- anchorage dependent cell culture; Primary and secondary culture; Animal cell growth characteristics and kinetics; Micro & macrocarrier culture; Hybridoma technology; Stem cell technology; Mechanisms of drug resistance and cell death.			
Unit - IV	**TRANSGENIC ANIMALS**	Periods	**9**
Cloning techniques in animals, Gene transformation techniques in animals. Transgenic animals: Transgenic mice, transgenic rabbits, Transgenic cattle, Transgenic Pig and Transgenic Fish, Ethical issues related to transgenic animals. Organ culture technology- production of complete organ. Biotechnology in animal production, manipulation of growth hormone, somatotropic hormone.			
Unit – V	**SECONDARY METABOLITE PRODUCTION**	Periods	**9**
Principles, design and operation of bioreactors: specific design criteria for mammalian and plant systems; Strategies for fermentation with recombinant organisms; Isolation, characterization and production of secondary metabolites from different plant cell types; Bioprocess monitoring and control: current practices in the bioprocess industries, advanced methodologies; Overview of downstream processing: centrifugation, filtration and chromatographic techniques.			
		Total Periods	**45**
Text Books			
1.	Singh, B.D., "Biotechnology", First Edition, Kalyani Publishers, New Delhi, India, 2015.		
2.	Ranga, M.M., "Animal Biotechnology", Third Edition, Agrobios India limited, Jodhpur. India, 2013.		
References			
1.	Purohit, S. S., "Plant Tissue Culture", Student Edition, Jodhpur, India, 2010.		
2.	Iyan freshney, R., "Culture of Animal Cells", Fifth Edition, Wiley Publications, New Delhi, India, 2006.		
Resources			
1.	https://nptel.ac.in/courses/102/102/102102033/		
2.	https://onlinecourses.swayam2.ac.in/cec20_bt20/preview		

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VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN
Elayampalayam, Tiruchengode – 637 205
(Autonomous Institution, Affiliated to Anna University ,Chennai)

Programme	M.Tech	Programme Code	206	Regulation	2023
Department	BIOTECHNOLOGY			Semester	-

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
P19BTE22	ADVANCED CANCER BIOLOGY	3	0	0	3	40	60	100

Course Objective

The goal of this course is to enable the students to

- Understand the basics of cancer and cancerous cells
- Discuss the significance of carcinogenesis in the development of cancer
- Interpret the role of oncogenes and their growth factors
- Make understanding on process of cancer metastasis and their dysregulation factors
- Gain knowledge on the advancement in cancer treatment
- Design the novel drugs to treat cancer or to reduce the effect of carcinogenesis

Course Outcome

At the end of the course, the student should be able to,	Knowledge Level
CO1:Explain the development and proliferation of cancer with specific causes	K2
CO2: Describe the influence of carcinogenesis in the cancer development	K2
CO3: Identify the pathways and therapeutic targets of cancer	K2
CO4: Outline the steps involved in metastasis and tumour cell invasion	K4
CO5: Develop novel drugs and technologies for the treatment of cancer	K4

Pre-requisites Nil

CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak

CO/PSO Mapping

COs	Programme Outcomes (POs)												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	2	2	2	2	1						1	2	3	3	3
CO 2	2	3	2	2	1	1						2	3	3	3
CO 3	2	3	2	2	1	1	1					2	3	3	3
CO 4	2	3	2	2	1	1					1	2	3	3	3
CO 5	2	3	3	3	1	1	1	3			1	2	3	3	3

Course Assessment Methods

Direct

1. Continuous Assessment Test I, II & III
2. Assignment
3. End-Semester examinations

Indirect

1. Course - end survey

Content of the syllabus

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Unit – I	**FUNDAMENTALS OF CANCER BIOLOGY**	Periods	**9**
Introduction, historical perspective, cancer initiation, promotion & progression, pathways of spread-Regulation of cell cycle, mutations that cause changes in signal molecules, effects on receptor, signal switches, tumour suppressor genes, modulation of cell cycle in cancer. Screening and detection of cancer using biochemical assays, tumor markers, molecular tools.			
Unit - II	**PRINCIPLES OF CARCINOGENESIS**	Periods	**9**
Theory of carcinogenesis, Classification carcinogenesis, Chemical carcinogenesis, metabolism of carcinogenesis, principles of Physical carcinogenesis, x-ray radiation-mechanisms of radiation carcinogenesis.			
Unit – III	**MOLECULAR BIOLOGY OF CANCER**	Periods	**9**
Clinical significances of invasion, Molecular genetic of metastasis development, stromal microenvironment and carcinogenesis, dysregulation of cancer, associated genes. Clinical significances of invasion, heterogeneity of metastatic phenotype, metastatic cascade, basement membrane disruption, three step theory of invasion, proteinases and tumour cell invasion.			
Unit - IV	**CANCER METASTASIS**	Periods	**9**
Clinical significances of invasion, Molecular genetic of metastasis development, stromal microenvironment and carcinogenesis, dysregulation of cancer, associated genes Clinical significances of invasion, heterogeneity of metastatic phenotype, metastatic cascade, basement membrane disruption, three step theory of invasion, proteinases and tumour cell invasion.			
Unit – V	**ADVANCES IN CANCER THERAPY**	Periods	**9**
Different forms of therapy, Chemotherapy, Radiation Therapy, targeted therapy versus conventional chemotherapy, Immunotherapy, stem cell therapy, Bone marrow Therapy, Hormone therapy. Combination therapy - Post cancer therapy			
		Total Periods	**45**
Text Books			
1.	Weinberg, R.A. "The Biology of Cancer" Garland Science, 2013		
2.	Pezzella, F., Tavassoli, M., & Kerr, D. J. (Eds.). (2019). Oxford textbook of cancer biology. Oxford University Press.		
References			
1.	McDonald, F et al., " Molecular Biology of Cancer" IInd Edition. Taylor & Francis, 2004.		
2.	Pelengaris, S., & Khan, M. (Eds.). (2013). The molecular biology of cancer: A bridge from bench to bedside.		
3.	Hejmadi, M. (2014). Introduction to cancer biology. Book boon.		
e-resources			
1.	https://oncouasd.files.wordpress.com/2014/09/cancer-principles-and-practice ofoncology-6e.pdf		
2.	https://archive.org/details/biologyofcancera00burc.		
3.	http://csbl.bmb.uga.edu/mirrors/JLU/DragonStar2017/download/introduction-to-cancerbiology.pdf		

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN Elayampalayam, Tiruchengode – 637 205 (Autonomous Institution, Affiliated to Anna University ,Chennai)						
Programme	M.Tech	Programme Code	206	Regulation	2023		
Department	BIOTECHNOLOGY			Semester			

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
P23BTE23	METABOLIC PROCESS & ENGINEERING	3	0	0	3	40	60	100

Course Objective

The student should be made

- To know about the principles, importance, challenge of metabolic Engineering.
- To understand the cellular metabolism and its networks.
- To acquire a knowledge of real-time applications of metabolic engineering.

Course Outcome

At the end of the course, the student should be able to,	Knowledge Level
CO1: Speak about the importance of Metabolic Engineering.	K1
CO2: Suggest the basic concepts of metabolic Engineering in analysis and synthesis.	K4
CO3: Discuss the metabolic networks and its reconstruction.	K5
CO4: Give an overview of cellular metabolism and organization of biochemical reactions.	K3
CO5: Apply the concept of Metabolic Engineering in the production of value-added products.	K3

CO / PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak

CO/PSO Mapping

COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO 1	2	1	3	2	1	2	2	1		2		1	2	3	3
CO 2	3	2		2		3	2	3	1	3		3	1	2	3
CO 3	2	2	2	1	3	2	2	3	2		2	3	2	2	3
CO 4	3		2		2	2	2	3		2		3	2	1	3
CO 5	3	1		2		2	3	2		2	1	2	2	1	2

Pre-requisites -

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment 3. End-Semester examinations
Indirect
1. Course - end survey

Content of the syllabus

Unit – I	INTRODUCTION TO METABOLIC ENGINEERING	Periods	9

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Introduction – Essence of Metabolic engineering – Principles, Importance, Challenges and Applications of Metabolic engineering.			
Unit – II	**BASIC CONCEPT OF METABOLIC ENGINEERING**	Periods	**9**
Introduction – Micro-organism as source of useful chemical, Mutation based strains improvement, Role of recombinant DNA technology, Defining steps of metabolic engineering: Analysis and Synthesis.			
Unit – III	**METABOLIC NETWORKS**	Periods	**9**
Introduction – Bioenergetics- Major metabolic pathways – Law of mass action – Regulation of metabolic networks - Reconstruction of metabolic networks.			
Unit – IV	**CELLULAR METABOLISM**	Periods	**9**
Overview of cellular metabolism – Reactions involved in synthesis and organization of macromolecules – interconnections among different biochemical pathways – organization of biochemical reactions and concept of relaxation time.			
Unit – V	**APPLICATIONS OF METABOLIC ENGINEERING**	Periods	**9**
Biofuel production – metabolic engineering of microorganisms for conversion of lignocellulose sugars to ethanol, Major aspects of converting the raw material to ethanol; Amino acid production – History and advancement, strategies for systems metabolic engineering of metabolisms for production of amino acids.			
		Total Periods	**45**

Text Books	
1.	Jens Nielsen, Gregory Stephanopoulos, Sang Yup Lee, "Metabolic Engineering: Concepts and Applications", Published by WILEY-VCH, 2021.
2.	Jens Nielson, "Metabolic Engineering", Springer Berlin Heidelberg, 2010.
Reference	
1.	Marco Fondi, "Metabolic Network Reconstruction and Modeling", Published by Humana New York, 2018.
2.	Bernhard O.Palsson ,"Systems Biology", Published by Cambridge University, 2012.
E-Resources	
1.	NPTEL :: Biotechnology - NOC:Metabolic Engineering
2.	https://bio.libretexts.org/Bookshelves

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Programme	**M.Tech**	Programme Code	**206**	Regulation	**2023**		
Department	**BIOTECHNOLOGY**			Semester	-		
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks	
		L	T	P	C	CA	ESE	Total
P23BTE24	**ESSENTIALS OF MEDICAL MICROBIOLOGY**	3	0	0	3	40	60	100

Course Objective	The objective of this course is to create awareness of microbial diseases of human beings and causes and cures.	
Course Outcome	At the end of the course, the student should be able to,	KL
	CO1: Understand Host-pathogen interactions and methods of disinfection	K1
	CO2: Describe the mechanism of pathogens causing diseases in human	K2
	CO3: Explain the various pathological events during the progression of an infectious disease.	K3
	CO4: Analyse the causative agents for various organ infection	K4
	CO5: Apply the principle of epidemiological sciences in studying the underlying mechanisms of spread of disease and controls required thereof to combat the spread of pathogens	K5
Pre-requisites	-	

CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak													CO/PSO Mapping		
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	3	3	2	2			2	2		3	3	3
CO 2	3	2	3	2	2	2	3			2	3		2	2	2
CO 3	3	2	2	3	2	3	2			2	3		3	2	2
CO 4	3	2	3	2	3	3	3						3	3	2
CO 5	3	3	2	2	2	2	2						3	2	2

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment 3. End-Semester examinations
Indirect

1. Course - end survey

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Content of the syllabus			
Unit – I	**General Aspects of Medical Microbiology**	Periods	**9**
Infectious Diseases, Pathogens, Host–Pathogen Interactions, Defenses against Infection, General Epidemiology, Principles of Sterilization and Disinfection			
Unit - II	**Bacteria and Virus as human pathogen**	Periods	**9**
Bacteriology - Characteristics, pathogenesis, prevention and control of diseases caused by *Staphylococci, Streptococci, Bacillus, Clostridium, Corynebacterium, Escherichia, Salmonella, Shigella* Virology - Structure, multiplication, classification, prevention and control of diseases caused by Pox, Herpes, Hepatitis, Adeno; RNA viruses - Picorna, Orthomyxo, Paramyxo, Rabdo and HIV virus.			
Unit – III	**Fungi and Protozoa as Human pathogen**	Periods	**9**
Mycology - Characteristics, classification, pathogenesis, prevention and control of diseases caused by Candidiasis, Histoplasmosis, Blastomycosis, Coccidiomycosis, Dermatomycosis Parasitology - *Giardia intestinalis, Trichomonas vaginalis, Trypanosoma, Toxoplasma gondii*. Microspora			
Unit - IV	**Organ System Infections**	Periods	**9**
Infections of the Respiratory System, Circulatory System, Nervous System, Gastrointestinal Tract, Genitourinary System			
Unit – V	**Diagnosis Methods**	Periods	**9**
Diagnosis of microbial diseases - Collection, transport and preliminary processing of clinical pathogens. Clinical, microbiological, immunological and molecular diagnosis of microbial diseases, Modern methods of microbial diagnosis.			
		Total Periods	**45**

Text Books	
1.	Brooks, G.F., Carroll, K. C., Butel, J. S. and Morse, S. A. (2007) Jawetz, Mel nick, & Adelberg's Medical Microbiology, Twenty-Fourth Edition. McGraw-Hill Companies, UK
2.	Murray P.R., Pfaller M.A., Tenover F.C., and Yolken R.H. (2007). Medical Microbiology 6th Edn., ASM Press, U.S.A.
References	
1.	Nester E. W., Anderson D. G. and Nester M. T. 2006. Microbiology: A Human Perspective, McGraw-Hill, U.S.A.
2.	Ryan K. J. and Ryan C.G. (2004) Sherris Medical Microbiology: An Introduction to infectious diseases. 2nd edition. McGraw-Hill, U.S.A.
3.	Bauman, R.W. (2005). 4th Edition. Microbiology: with diseases by body system; Pearson Education, Inc., U.S.A.
4.	Murray P.R., Pfaller M.A., Tenover F.C., and Yolken R.H. (2007). Medical Microbiology 6th Edn., ASM Press, U.S.A.
5.	Brogden, K. A., Minion, C., Roth, J.A., Bolin, C.A. and Stanton, T. B. (2000) Virulence Mechanisms of Bacterial Pathogens 2nd Edition. ASM Press, U.S.A.
E-Resources	
1.	https://archive.nptel.ac.in/courses/102/103/102103015/
2.	https://vlab.amrita.edu/?sub=3&brch=187&sim=323&cnt=1
3.	https://www.youtube.com/watch?v=ei6Z7orCpPk

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Programme	**M.Tech**	Programme Code		**206**	Regulation			**2023**
Department	**BIOTECHNOLOGY**				Semester			-
Course Code	Course Name	Periods Per Week		Credit	Maximum Marks			
		L	T	P	C	CA	ESE	Total
P23BTE25	**FORENSIC BIOTECHNOLOGY**	3	0	0	3	40	60	100

Course Objective

- The Forensic Technology Program is designed to prepare students for entry-level positions in the fields of forensic technology
- To create deeper understanding of Biotechnology application in forensic science
- To render knowledge of how to perform research in interdisciplinary fields like forensic studies

Course Outcome	At the end of the course, the student should be able to,	**KL**
	CO1: Recognize forensic science and crime investigation	K2
	CO2: Understand the principles and operation of analytical methods.	K2
	CO3: Analyze various biological samples for forensic studies	K3
	CO4: Organize non biological sample characteristics	K4
	CO5: Implement forensic examination	K4
Pre-requisites	-	

CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak													CO/PSO Mapping		
COs	Programme Outcomes (POs)												PSOs		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	2	1	2	2		2		3		3	3	1	1	2	1
CO 2	2		2	2	2		3		2	2		3	2	3	2
CO 3	3	2	3	1		3	2		3		2	2	2	3	2
CO 4	2	3	2	2	3		3	1	2		3		2	3	2
CO 5	3	2	3	3		2		2	1	2		2	2	2	2

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment 3. End-Semester examinations
Indirect
1. Course - End survey

Content of the syllabus

Unit – I	**BASICS OF FORENSIC SCIENCE**	Periods	**9**

History and development of forensic science-Crime Scene Investigation of Biological Evidence -collection, types of evidence- Processing of crime scene-Documentation-packing and Transportation, crime scene

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reconstruction.			
Unit – II	**ANALYTICAL TECHNIQUES IN FORENSIC BIOTECHNOLOGY**	Periods	**9**
DNA extraction principles- Methods of DNA extraction- Methods of RNA extraction-DNA Quantitation- Slot Blot Assay, Fluorescent Intercalating Dye Assay- Quantitative PCR Assay- Amplification by Polymerase Chain Reaction- DNA Electrophoresis- Detection Methods-DNA Fingerprinting Techniques.			
Unit – III	**ANALYSIS OF BIOLOGICAL SAMPLES**	Periods	**9**
Forensic serology- Blood typing- Heredity and paternity- Detection of Blood – Presumptive tests- Confirmation tests- Bloodstain Pattern Analysis- Species Identification-Individualization- seminal analysis- Protocols for collecting, packaging, and preserving Rape Evidence-Analytical Techniques for Identification of Saliva, Urine and Sweat.			
Unit – IV	**CHARACTERIZATION OF NON-BIOLOGICAL SAMPLE**	Periods	**9**
Physical evidence - Fiber, Types of Fibers, Examination of Fibers-Fingerprint Analysis-principles, prints detected at crime scenes, collection and Preservation, Discovery and development of Prints.			
Unit – V	**DRUGS AND TOXICOLOGY**	Periods	**9**
Forensic toxicologist-collection and preserving toxicological Evidence, Techniques used in the analysis of controlled substances and toxins-Toxicological Analysis of Alcohol- Drugs-types of drugs- Forensic Pathology-Forensic Anthropology.			
	Total Periods	**45**	
Text Books			
1.	John M. Butler "Fundamentals of Forensic DNA Typing" Academic press , 2018		
2.	Richard Li "Forensic Biology" Second edition, CRC Press Taylor & Francis Group, 2014		
References			
1.	Jay A. Siegel "Forensic Chemistry Fundamentals and Applications" Wiley Blackwell ,2016		
2.	Stuart H. James and Jon J. Nordby "Forensic Science "An Introduction to Scientific and Investigative Techniques" CRC press, 2010		
3.	Gautam Biswas "Review of Forensic Medicine and Toxicology Forensic Medicine and Toxicology" jaypee brothers medical publishers (p) ltd,2012		
E- Resources			
1.	https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=eCJfy23Kjy3c0vICLa6VYg==		
2.	https://www.coursera.org/learn/forensic-science		

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SEMESTER - III

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Programme	**M.Tech**	Programme code	**105**	Regulation	**2023**		
Department	**BIOTECHNOLOGY**			Semester	**III**		
Course code	Course name	Periods / week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
P23BT309	**Microbial and Immunotechnology Laboratory**	**0**	**0**	**4**	**2**	**60**	**40**	**100**
Objective	The main objective of this course is to make students, 1. Demonstrate the basic idea of biosafety, sterilization and microscopic techniques 2. Identify the components, present in blood and their separation 3. To identify and understand the concept of various immune cells present in blood 4. To learn the significance of the immune diffusion technique 5. To understand the concepts of specific antigen and antibody reactions in identifying diseases						

CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak												CO/PSO Mapping		
COs	Programme Outcomes (POs)											PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	3	2		2	3							3	2	3
CO 2	3					3							2	3	2
CO 3	3	2	3			2							2	3	3
CO 4	3					3							2	3	3
CO 5	2					3		2					3	3	2

LIST OF EXPERIMENTS

	Course Outcomes
1. Sterilization, disinfection and safety in a microbiological laboratory.	CO1
2. Preparation of media for growth of various microorganisms.	CO2
3. Identification and culturing of various microorganisms.	CO2
4. Staining and enumeration of microorganisms.	CO2
5. Growth curve, measure of the bacterial population by turbidometry.	CO2
6. Blood smear identification of leucocytes by Giemsa stain.	CO3
7. Separation of mononuclear cells by Ficoll-Hypaque.	CO3
8. Double diffusion, Immuno-electrophoresis and Radial Immunodiffusion.	CO4
9. Evaluation of Antibody titre by direct ELISA.	CO5
10. Evaluation of Antigen by Sandwich ELISA.	CO5
11. Characterization of antigens by Western Blotting.	CO5
12. Isolation and purification of IgG from serum or IgY from chicken egg.	CO5
13. Preparation of antigen and Routes of immunization (Intraperitoneal, Subcutaneous,	

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Intramuscular, Intra- nasal, Oral). **Total periods : 60**	CO5

Outcomes:

Students who complete this course successfully are expected to

1. CO1: Infer knowledge in media preparation and sterilization
2. CO2: Infer knowledge in cultivation, enumeration, staining, biochemical and control of microorganisms
3. CO3: Evaluate the different types of blood cells and know about their functions.
4. CO4: Identify the presence of antigen and antibody in the sample and their related functions based on immune diffusion technique
5. CO5: Identify the binding of antigens and antibodies and their interaction through the ELISA Technique

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Programme	M.Tech	Programme code	206	Regulation	2023
Department	BIOTECHNOLOGY			Semester	

Course code	Course name	Periods / week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
P23BT310	Molecular and Genetic Engineering Laboratory	0	0	4	2	60	40	100

Objective

The main objective of this course is

1. To provide hands on practical training in the isolation of genomic DNA from different sources.
2. To discuss the principles behind the recombinant DNA technology.
3. To explain the concept of transformation.
4. To provide in depth knowledge in protein characterization techniques.
5. To develop the skills of the students by providing hands on practical training in Molecular biology

CO / PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak

COs	Programme Outcomes (POs)												CO/PSO Mapping PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO 1	2			2	2				2		2	2	3	2	3
CO 2	2	2	2	2	2	2	2		2		2	1	3	3	2
CO 3	2	2	2	2	2			1	2		1	1	2	3	2
CO 4	2	3	2	3	3				3	1	2	2	3	2	2
CO 5	3	2	3	3				1	1		1	1	2	2	2

LIST OF EXPERIMENTS

	Course Outcomes
1. Isolation of Genomic DNA and Plasmid DNA from bacteria	CO1
2. Agarose Gel Electrophoresis	CO1
3. Check the purity of DNA by using UV- Spectrophotometer	CO2
4. Elution of DNA from agarose gel.	CO2
5. PCR Amplification of DNA fragment	CO3
6. Restriction enzyme digestion.	CO4
7. Ligation	CO4
8. Competent cells preparation, transformation and blue white screening method	CO4
9. SDS-PAGE.	CO5
10. Western blotting	CO5
Total periods : 60	

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Outcomes:

Students who complete this course successfully are expected to

1. Demonstrate basic techniques of DNA isolation and manipulation.
2. Illustrate the principle behind each techniques and applications of each methodology in applied biological research.
3. Acquire ability to use PCR techniques.
4. Apply genetic and biotechnological techniques to manipulate genetic materials and their application.
5. Demonstrate basic techniques involved in analysis of gene expression at nucleic acids and proteins level

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Programme	M.Tech	Programme Code	206	Regulation	2023
Department	BIOTECHNOLOGY			Semester	-

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
P23BTOE1	Bioethics and Biosafety	3	0	0	3	40	60	100

Course Objective

The objective of the course is
- To introduces students to basic concepts of Bioethics & Biosafety.
- To inculcate the importance, need & applications of Bioethics in biotechnological research
- It will provide information about rules, regulations, laws, acts & protocols regarding bioethics & biosafety.

Course Outcome

At the end of the course, the student should be able to,	Knowledge Level
CO1: Appreciate the importance of Bioethics & Biosafety	K2
CO2: Predict the Ethical, Legal, Social implication of biotechnological research	K2
CO3: Segregate and handle hazardous material from laboratory	K3
CO4: Comprehend the benefits of Risk Assessment & Containment	K4
CO5: Apply the Ethical regulations and Biosafety guidelines to device sustainable technology for mankind	K4

Pre-requisites -

CO / PO Mapping
(3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 - Weak**

CO/PSO Mapping

COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO 1	1					1		3				1	1	2	1
CO 2		1	1		1	2		3				1	2	2	1
CO 3	2	2	1		1	1	2	3				1	2	2	1
CO 4		1	1		2	1		3				1	1	2	1
CO 5	2	1	1		1	2	3	3				2	2	2	1

Course Assessment Methods

Direct

1. Continuous Assessment Test I, II & III
2. Assignment & Quiz
3. End-Semester examinations

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Indirect	
1. Course - end survey	

Content of the syllabus

Unit – I	INTRODUCTION TO BIOETHICS AND BIOSAFETY	Periods	9

History & Definitions of Ethics & bioethics, Introduction to Safety & Biosafety, Applications of Bioethics, Applications of Biosafety, Biosafety during industrial production Environment Ethics, Ethical, implication of biotechnological research

Unit - II	ETHICAL, LEGAL, SOCIAL ISSUES OF BIOTECHNOLOGY	Periods	9

Ethical, implication of Prenatal Diagnosis, Genetic manipulation, Environmental release of GMOs;, Stem Cell Research, Organ transplantation & Xenotransplantation, Human & animal Cloning, Animal Testing & Animals in Research and Testing of Drugs on Human Volunteers.

Unit – III	HAZARDOUS MATERIALS – HANDLING & DISPOSAL	Periods	9

Hazards & Biohazards (biological agents) with their types/ categories, Disposal of chemical wastes & hazardous wastes, Material Safety Data Sheet (MSDs), Controlling the exposure to hazardous substances
Duties, immunization & first aid of employees

Unit - IV	RISK ASSESSMENT & CONTAINMENT	Periods	9

Risk Assessment & Safety management for Biotechnology products, Introduction to Biological Safety Cabinets; Primary Containment and containment levels ,Biosafety Levels; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals,

Unit – V	ETHICAL REGULATIONS AND BIOSAFETY GUIDELINES	Periods	9

Ethical Guidelines for Biomedical research involving human subjects, NIH guidelines, ICH International Community Harmonization guidelines, Regulatory Framework for GE Plants in India, ,Laboratory Biosafety Manual of WHO, Roles of Institutional Biosafety Committee, Overview of National Regulations and International Agreements including Cartegana Protocol.

	Total Periods	45

Text Books

1.	M K Sateesh , Bioethics & Biosafety, I K International Pub. Ltd,2014
2.	B D Singh ,Biotechnology Expanding Horizons, Kalyani Pub, 2017

References

1.	Anuradha, R.V., Regulatory and governance issues relating to genetically modified crops and food: An Indian case study by Independent Consultant, New Delhi, India.
2.	Degrass, G., Alexandrova, N. and Ripandell, D., "Databases on biotechnology and biosafety of GMOs," *Environmental and Biosafety Research*, 3, 2000, 145–160.
3.	Chakrabarty, A. M., "Genetics research and the judicial decision", *Notizie Di Politeia*, 18, 2002, 99–102.

E-Resources

1.	https://www.who.int/csr/resources/publications/biosafety/Biosafety7.pdf
2.	https://ethics.ncdirindia.org/
3.	https://sist.sathyabama.ac.in/sist_coursematerial/uploads/SBB1615.pdf

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Programme	M.Tech.	Programme Code	206	Regulation	2023
Department	BIOTECHNOLOGY			Semester	-

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
P23BTOE2	RENEWABLE BIOENERGY	3	0	0	3	40	60	100

Course Objective

The student will have an elaborate knowledge on,

- biomass resources, their classification, availability, and analytical techniques
- renewable energy principles, including their importance in sustainable development and their social implications
- various biomass conversion processes
- hydrogen energy technologies, including fuel cells and hydrogen production methods,

Course Outcome	At the end of the course, the student should be able to,	Knowledge Level
	CO1: Explain the basic principles of renewable energy and its importance.	K2
	CO2: Apply methods to estimate the availability, consumption, and surplus of biomass	K3
	CO3: Identify and evaluate various biomass energy resources	K3
	CO4: Analyze various methods of hydrogen energy storage, assessing their advantages and limitations in practical applications.	K5
	CO5: Evaluate the relationship between bioenergy and sustainability, identifying how bioenergy contributes to sustainable development	K4

Pre-requisites -

CO / PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak

COs	Programme Outcomes (POs)												**CO/PSO Mapping** PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO 1	2	1	2	1		2	3	3				1	1	2	1
CO 2	2		2	2	2	3	3					3	2	3	2
CO 3	3		1	1			2						2	3	2
CO 4	2	2	2	2	2	1	2	1					2	3	2
CO 5	3	2	3	3	2	2	3	2			3	2	2	2	2

Course Assessment Methods

Direct

1. Continuous Assessment Test I, II & III
2. Assignment & Quiz
3. End-Semester examinations

Indirect

1. Course - end survey

Content of the syllabus

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Unit – I	**INTRODUCTION**	Periods	**9**
Principles of renewable energy; energy and sustainable development, fundamentals and social implications. worldwide renewable energy availability, renewable energy availability in India, Greenhouse effect – Ozone depletion - Climate Change – UNFCCC - Energy Pricing – Fuel and Energy Substitution			
Unit - II	**RENEWABLE BIOMASS ANALYSIS**	Periods	**9**
Biomass resources and biomass properties, biomass classification, availability, estimation of availability, consumption and surplus biomass; energy plantations, proximate analysis, ultimate analysis, thermo gravimetric analysis and summative analysis of biomass, briquetting and Pellatisation, Environmental Benefits			
Unit – III	**CONVERSION PROCESSES**	Periods	**9**
Origin of Biomass, Hydrocarbon Family, Biomass Energy Resources, Biomass Conversion Process, Direct Combustion of Biomass (Incineration), Thermo chemical Conversion of Biomass, Biochemical Conversion, Fermentation, Gaseous Fuels from Biomass, Applications of Biomass Energy Conversion Processes.			
Unit - IV	**GREEN ENERGY**	Periods	**9**
Fuel cells: Classification of fuel cells – H_2; Operating principles, Zero energy Concepts. Benefits of hydrogen energy, hydrogen production technologies (electrolysis method only), hydrogen energy storage, applications of hydrogen energy, problem associated with hydrogen energy.			
Unit – V	**SUSTAINABILITY AND RESILIENCE**	Periods	**9**
Sustainability - Environmental sustainability Bioenergy and sustainability, General understanding of LCA - Cradle-to-grave, field-to-wheels concept Goal and scope determination, defining LCA boundaries			
		Total Periods	**45**
Text Books			
1.	B. H. Khan, "Conventional Energy Resources", Tata McGraw-Hill Education Private Limited, New Delhi, 3rd Edition, 2007		
2.	Biomass- Application, technology & production, N.C. Cheremenisoff, P.N. Cheremenisoff& F. Ellurbrush, Marcel Dekker, New York		
References			
1.	John Twideu and Tony Weir, "Renewal Energy Resources" BSP Publications, 2006		
2.	Biomass for Renewable Energy, Fuels, and Chemicals, Donald L. Klass, Reed, Elsevier India Private Limited		
3.	D.P.Kothari, K.C.Singhal, Renewable energy sources and emerging technologies, P.H.I.		
4.	D.S.Chauhan, S.K. Srivastava, Non – Conventional Energy Resources, New Age Publishers, 2006.		
E-Resources			
1.	E-book URL: https://archive.nptel.ac.in/courses/102/104/102104057/		
2.	E-book URL: https://archive.nptel.ac.in/courses/102/104/102104057/		
3.	E-bookURL:https://www.pdfdrive.com/renewable-energy-sources-and-their-applications- e33423592.html		

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Programme	**M.Tech.**	Programme Code		**206**	Regulation		**2023**	
Department	**Biotechnology**				Semester		-	
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	**T**	**P**	**C**	**CA**	**ESE**	**Total**
P23BTOE3	**Waste Management**	**3**	**0**	**0**	**3**	**40**	**60**	**100**

Course Objective	To make the students aware of the basic concept and techniques of environmental biotechnology and its application	
Course Outcome	At the end of the course, the student should be able to,	Knowledge Level
	CO1: Understand various sources of waste and they are classified.	K2
	CO2: Acquire knowledge on how to reduce the waste.	K3
	CO3: Gain ideas on how to dispose and transport the waste.	K3
	CO4: Develop technologies to process the waste.	K3
	CO5: Understand how waste are disposed in lands	K4
Pre-requisites	-	

CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak												CO/PSO Mapping		
COs	Programme Outcomes (POs)											PSOs		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO 1	2		2								2	3	3	1	3
CO 2	2	2	3	1		1	2	2	2		3	3	1	3	2
CO 3	2	3	2								2	3	3	2	2
CO 4	2		2	2					2				3	1	2
CO 5	2		3			3		3	2		2		2	3	3

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment & Quiz 3. End-Semester examinations
Indirect
1. Course - end survey

Content of the syllabus

Unit – I	**SOURCES, CLASSIFICATION AND REGULATORY FRAMEWORK**	Periods	**9**

Types and Sources of solid and hazardous wastes - Need for solid and hazardous waste management – Elements of integrated waste management and roles of stakeholders - Salient features of Indian legislations on management and handling of municipal solid wastes, hazardous wastes, biomedical wastes, lead acid batteries, electronic wastes , plastics and fly ash – Financing waste management.

Unit - II	**WASTE CHARACTERIZATION AND SOURCE REDUCTION**	Periods	**9**

Waste generation rates and variation - Composition, physical, chemical and biological properties of solid

wastes – Hazardous Characteristics – TCLP tests –waste sampling and characterization plan - Source reduction of wastes –Waste exchange - Extended producer responsibility - Recycling and reuse.			
Unit – III	**STORAGE, COLLECTION AND TRANSPORT OF WASTES**	Periods	9
Handling and segregation of wastes at source – storage and collection of municipal solid wastes – Analysis of Collection systems - Need for transfer and transport – Transfer stations Optimizing waste allocation– compatibility, storage, labeling and handling of hazardous wastes – hazardous waste manifests and transport			
Unit - IV	**WASTE PROCESSING TECHNOLOGIES**	Periods	9
Objectives of waste processing – material separation and processing technologies – biological & chemical conversion technologies – methods and controls of Composting - thermal conversion technologies, energy recovery – incineration – solidification & stabilization of hazardous wastes- treatment of biomedical wastes			
Unit – V	**WASTE DISPOSAL**	Periods	9
Waste disposal options – Disposal in landfills - Landfill Classification, types and methods – site selection - design and operation of sanitary landfills, secure landfills and landfill bioreactors – leachate and landfill gas management – landfill closure and environmental monitoring – Rehabilitation of open dumps – landfill remediation			
		Total Periods	**45**
Text Books			
1.	George Techobanoglous, Integrated Solid Waste Managementl, McGraw - Hill, 2014.		
2.	Manual on Municipal Solid Waste Management, CPHEEO, Ministry of Urban Development, Govt. of. India, New Delhi, 2000.		
References			
1.	R.E.Landrefh and P.A.Rebers, Municipal Solid Wastes-Problems & Solutions ,Lewis, 1997.		
2.	Wealth from Waste - Agricultural food and chemical Processing Waste by S.C.Bhatia		
3.	Georges E. Ekosse, Rogers W'O Okut-Uma, Pollution control & Waste management in Developing Countries, Commonwealth Publishers, New Delhi, 2000.		
4.	B. B. Sundaresan, A. D. Bhide – Solid Waste Management, Collection, Processing and Disposal, Mudrashilpa Offset Printers, 2001.		
E-Resources			
1.	https://courses.lumenlearning.com/suny-sustainability-a-comprehensive-foundation/chapter/systems-of-waste-management/		
2.	https://www.conserve-energy-future.com/waste-management-and-waste-disposal-methods.php		

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