MUTHAYAMMAL ENGINEERING COLLEGE

An Autonomous Institution

(Approved by AICTE | Accredited by NBA & NAAC | Affiliated to Anna University)
Rasipuram - 637 408, Namakkal Dist., Tamil Nadu.

Curriculum/Syllabus

Programme Code : BT

Programme Name : B.Tech-Biotechnology

Regulation : 2023

MUTHAYAMMAL ENGINEERING COLLEGE

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Rasipuram - 637 408, Namakkal Dist., Tamil Nadu.

Ph. No.: 04287-220837
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Estd. 2000

Institution Vision & Mission

Institution Vision

- To be a Centre of Excellence in Engineering, Technology and Management on par with International Standards.

Institution Mission

- To prepare the students with high professional skills and ethical values.
- To impart knowledge through best practices.
- To instill a spirit of innovation through Training, Research and Development.
- To undertake continuous assessment and remedial measures.
- To achieve academic excellence through intellectual, emotional and social stimulation.

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Department Vision & Mission

Department Vision

- To be a premier department in Biotechnology education with a focus on sustainable technologies for the benefit of society and environment

Department Mission

- To equip the students fundamentally strong with ideal technical skills in the biotechnology field to face the competitive edge
- To provide quality collaborative research with industries
- To develop contemporary and sustainable technologies

Program Educational Objectives

PEO1 : To develop the fundamental knowledge and confidence in the field of biotechnology for pursuing research career in industry and academia.

PEO2 : To familiarize latest technologies advances for working in Biotechnology industries and excel in higher studies.

PEO3 : To promote student awareness of the life-long learning and to introduce them to bioethical issues, health, IPR and codes of Professional practice.

Program Specific Outcomes

PSO1 : An ability to apply the knowledge of fermentation technology, food and pharmaceutical biotechnology to solve problems by providing appropriate solutions.

PSO2 : An ability to understand and design solutions for bioprocess engineering related to biotechnology and environment.

PSO3 : An ability to employ Biotech techniques related advanced analytical equipments, environments and platform in creating innovative career paths to be a bio-enterpreneur and a zest for higher studies.

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 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 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 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 : **Lifelong learning:** Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

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B.Tech- Biotechnology

Grouping of Courses

I. Humanities and Social Sciences Courses (HS)

Sl.No.	Course Code	CourseTitle	Category	Contact Hours	Instruction Hours/Week/ Credit			
					L	T	P	C
1.	23HSS01	Technical and Communicative English –I	HS	4	3	0	0	3
2.	23HSS02	Technical and Communicative English –II	HS	4	3	0	0	3
3.	23HSS03	Technical English For Engineers	HS	3	2	0	0	2
4.	23HSS04	Communicative English for Engineers	HS	3	2	0	0	2
5.	23HSS05	Commercial English	HS	3	2	0	0	2
6.	23HSS06	Basics of Japanese Language	HS	3	2	0	0	2
7.	23HSS07	Basics of French	HS	3	2	0	0	2
8.	23HSS08	Heritage of Tamils	HS	2	1	0	0	1
9.	23HSS09	Tamils and Technology	HS	2	1	0	0	1

II. Basic Sciences (BS)

1.	23BSS01	Engineering Physics	BS	4	3	0	0	3
2.	23BSS02	Physics Laboratory	BS	3	0	0	2	2
3.	23BSS03	Bio and Nanomaterial Sciences	BS	4	3	0	0	3
4.	23BSS04	Materials Science	BS	4	3	0	0	3
5.	23BSS05	Applied Physics	BS	4	3	0	0	3
6.	23BSS11	Engineering Chemistry	BS	4	3	0	0	3
7.	23BSS12	Chemistry Laboratory	BS	3	0	0	2	2
8.	23BSS13	Applied Chemistry	BS	4	3	0	0	3
9.	23BSS21	Algebra and Calculus	BS	5	3	1	0	4
10.	23BSS22	Advanced Calculus and ComplexAnalysis	BS	5	3	1	0	4
11.	23BSS23	Differential Equations and Vector Analysis	BS	5	3	1	0	4
12.	23BSS24	Transforms and Boundary Value Problems	BS	5	3	1	0	4
13.	23BSS25	Discrete Mathematics	BS	5	3	1	0	4
14.	23BSS26	Statistics and Queuing Theory	BS	5	3	1	0	4
15.	23BSS27	Statistics and Numerical Methods	BS	5	3	1	0	4
16.	23BSS28	Numerical Methods	BS	5	3	1	0	4
17.	23BSS29	Probability and Random Processes	BS	5	3	1	0	4

III. General Engineering Science (GES)

1.	23GES01	Programming for Problem Solving Using C	GES	3	3	0	0	3
2.	23GES02	Programming in C Laboratory	GES	3	0	0	2	1
3.	23GES03	Python Programming	GES	4	3	0	0	3
4.	23GES04	Computer Peripherals and Programming Essentials	GES	4	3	0	0	3
5.	23GES05	Python Programming Laboratory	GES	3	0	0	2	1
6.	23GES06	Electrical and Electronics Sciences	GES	4	3	0	0	3
7.	23GES07	CAD Laboratory	GES	4	0	0	4	2
8.	23GES08	Electric Circuits	GES	4	3	0	0	3
9.	23GES09	Engineering Mechanics for Electrical Engineers	GES	4	3	0	0	3
10.	23GES10	Engineering Graphics	GES	4	3	0	0	3
11.	23GES11	Engineering Drawing	GES	4	3	0	0	3
12.	23GES12	Mechanical and Building Sciences	GES	4	3	0	0	3
13.	23GES13	Data Structures using Python	GES	4	3	0	0	3
14.	23GES14	Electronics Product Design	GES	4	3	0	0	3
15.	23GES15	Manufacturing Processes	GES	4	3	0	0	3
16.	23GES16	Fundamentals of Civil Engineering	GES	4	3	0	0	3
17.	23GES17	Bioorganic Chemistry	GES	4	3	0	0	3
18.	23GES18	Basics Electrical and Electronics Engineering	GES	4	3	0	0	3
19.	23GES19	Engineering Mechanics	GES	4	3	0	0	3
20.	23GES20	Basics of Human Anatomy	GES	4	3	0	0	3
21.	23GES21	Engineering Practices Laboratory	GES	4	0	0	4	2
22.	23GES22	Computer Aided Building Drawing Laboratory	GES	4	0	0	4	2
23.	23GES23	Bioorganic Chemistry Laboratory	GES	4	0	0	4	2
24.	23GES24	Electric Circuits Laboratory	GES	3	0	0	3	1
25.	23GES30	Fluid Mechanics	GES	4	3	0	0	3
26.	23GES31	Bioenergy	GES	3	3	0	0	3

IV. Professional Core (PC)

1.	23BTC01	Biochemistry	PCC	3	3	0	0	3
2.	23BTC02	Microbiology	PCC	3	3	0	0	3
3.	23BTC03	Cell Biology& Genetics	PCC	3	3	0	0	3
4.	23BTC04	Protein and Enzyme Engineering	PCC	3	3	0	0	3
5.	23BTC05	Molecular Biology	PCC	3	3	0	0	3
6.	23BTC06	Basic Industrial Biotechnology	PCC	3	3	0	0	3
7.	23BTC07	Basics of Unit Operation	PCC	3	2	2	0	3
8.	23BTC08	Instrumental Methods of Analysis	PCC	3	3	0	0	3
9.	23BTC09	Bioprocess Engineering	PCC	3	3	0	0	3
10.	23BTC10	Genetic Engineering& Genomics	PCC	3	3	0	0	3

11.	23BTC11	Immunology	PCC	3	3	0	0	3
12.	23BTC12	Bioinformatics	PCC	3	3	0	0	3
13.	23BTC13	Downstream Processing	PCC	3	3	0	0	3
14.	23BTC14	Plant Biotechnology	PCC	3	3	0	0	3
15.	23BTC15	Mass Transfer Operations	PCC	3	2	2	0	3
16.	23BTC16	Chemical Reaction Engineering	PCC	3	2	2	0	3
17.	23BTC19	Protein and Enzyme Engineering Laboratory	PCC	3	0	0	3	1
18.	23BTC20	Microbiology Laboratory	PCC	3	0	0	3	1
19.	23BTC21	Instrumental Methods of Analysis Laboratory	PCC	3	0	0	3	1
20.	23BTC22	Molecular Biology Laboratory	PCC	3	0	0	3	1
21.	23BTC23	Genetic Engineering Laboratory	PCC	3	0	0	3	1
22.	23BTC24	Bioprocess Engineering Laboratory	PCC	3	0	0	3	1
23.	23BTC25	Immunology Laboratory	PCC	3	0	0	3	1
24.	23BTC26	Computational Biology Laboratory	PCC	3	0	0	3	1
25.	23BTC27	Downstream Processing Laboratory	PCC	3	0	0	3	1

V. Professional Elective (PE)

1.	23BTE01	Food Technology	PEC	3	3	0	0	3
2.	23BTE02	Animal Biotechnology	PEC	3	3	0	0	3
3.	23BTE03	Chemistry of Medicines	PEC	3	3	0	0	3
4.	23BTE04	Life Style Diseases	PEC	3	3	0	0	3
5.	23BTE05	Intellectual Property Rights	PEC	3	3	0	0	3
6.	23BTE06	Biofuel	PEC	3	3	0	0	3
7.	23BTE07	Fundamentals of Nanoscience	PEC	3	3	0	0	3
8.	23BTE08	Human physiology	PEC	3	3	0	0	3
9.	23BTE09	Health and Pharmaceutical Biotechnology	PEC	3	3	0	0	3
10.	23BTE10	Neurobiology and Cognitive sciences	PEC	3	3	0	0	3
11.	23BTE11	Tissue Engineering	PEC	3	3	0	0	3
12.	23BTE12	Bioethics	PEC	3	3	0	0	3
13.	23BTE13	Stem cell Technology	PEC	3	3	0	0	3
14.	23BTE14	Biophysics	PEC	3	3	0	0	3
15.	23BTE15	Biohazard and Hazard Management	PEC	3	3	0	0	3
16.	23BTE16	Bio entrepreneurship	PEC	3	3	0	0	3
17.	23BTE17	Professional Ethics in Engineering	PEC	3	3	0	0	3
18.	23BTE18	Environmental Biotechnology	PEC	3	3	0	0	3
19.	23BTE19	Human Rights	PEC	3	3	0	0	3
20.	23BTE20	Bioethics and IPR	PEC	3	3	0	0	3
21.	23BTE21	Municipal Solid waste Management	PEC	3	3	0	0	3
22.	23BTE22	Disaster Management	PEC	3	3	0	0	3

23.	23BTE23	Clinical Trials	PEC	3	3	0	0	3

VI. Employability Enhancement Courses (EEC)

1.	23BTF01	Project Work I	EEC	5	0	0	5	5
2.	23BTF02	Project Work II	EEC	15	0	0	15	9
3.	23BTI01	Internship –I	EEC	2	0	0	2	1
4.	23BTI02	Internship – II	EEC	2	0	0	2	1
5.	23BTI03	Internship – III	EEC	2	0	0	2	1
6.	23BTM01	Mini Project	EEC	3	0	0	3	2

VII. Mandatory Courses (MC)

1.	23BTN01	Indian Constitution and Society	EEM	0	0	0	0	0
2.	23BTN02	Essence of Indian Traditional Knowledge	EEM	0	0	0	0	0
3.	23BTN03	Environmental Science and Engineering	EEM	0	0	0	0	0

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B.Tech.- Biotechnology
Curriculum | UG - R2023
Semester –I

Sl.No.	Course Code	Course Title	Category	Contact Hours	Instruction Hours/Week/ Credit			
					L	T	P	C
Theory								
1.	23HSS01	Technical and Communicative English - I	HS	3	3	0	3	3
2.	23BSS21	Algebraand Calculus	BS	4	3	1	0	4
3.	23BSS11	Engineering Chemistry	BS	3	3	0	0	3
4.	23GES01	Programming for Problem Solving Using C	GES	3	3	0	0	3
5.	23GES12	Mechanical and Building Sciences	GES	3	3	0	0	3
6.	23HSS08	Heritage of Tamils	HS	1	1	0	0	1
Practical								
7.	23BSS12	Chemistry Laboratory	BS	4	0	0	4	2
8.	23GES02	Programming in C Laboratory	GES	4	0	0	4	1
							Total Credit	**20**

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Semester –II

Sl.No.	Course Code	Course Title	Category	Contact Hours	Instruction Hours/Week/ Credit			
					L	T	P	C
Theory								
1.	23HSS02	Technical and Communicative English - I	HS	3	3	0	3	3
2.	23BSS22	Advanced Calculus and Complex Analysis	BS	4	3	1	0	4
3.	23BSS01	Engineering Physics	BS	3	3	0	0	3
4.	23GES03	Python Programming	GES	3	3	0	0	3
5.	23GES20	Basics of Human Anatomy	GES	3	3	0	0	3
6.	23HSS09	Tamils and Technology	HS	1	1	0	0	1
Practical								
7.	23BSS02	Physics Laboratory	BS	4	0	0	4	2
8.	23GES05	Python Programming Laboratory	GES	4	0	0	4	1
							Total Credit	**20**

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Semester –III

Sl.No.	Course Code	Course Title	Category	Contact Hours	Instruction Hours/Week/ Credit			
					L	T	P	C
Theory								
1.	23BSS24	Transform and Boundary Value Problems	BS	5	3	2	0	4
2.	23BTC01	Biochemistry	PC	3	3	0	0	3
3.	23BTC02	Microbiology	PC	3	3	0	0	3
4.	23BTC03	Cell Biology& Genetics	PC	3	3	0	0	3
5.	23BTC04	Protein and Enzyme Engineering	PC	3	3	0	0	3
6.	23GES30	Fluid Mechanics	GES	3	3	2	0	3
Practical								
7.	23BTC19	Protein and Enzyme Engineering Laboratory	PC	3	0	0	3	1
8.	23BTC20	Microbiology Laboratory	PC	3	0	0	3	1
							Total Credit	**21**

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Semester –IV

Sl.No.	Course Code	Course Title	Category	Contact Hours	Instruction Hours/Week/ Credit			
					L	T	P	C
Theory								
1.	23BSS28	Numerical Methods	BS	4	3	2	0	4
2.	23BTC05	Molecular Biology	PC	3	3	0	0	3
3.	23BTC06	Basic Industrial Biotechnology	PC	3	3	0	0	3
4.	23BTC07	Basics of Unit Operation	PC	3	2	2	0	3
5.	23BTC08	Instrumental Methods of Analysis	PC	3	3	0	0	3
6.	23GES31	Bioenergy	GES	3	3	0	0	3
Practical								
7.	23BTC21	Instrumental Methods of Analysis Laboratory	PC	3	0	0	3	1
8.	23BTC22	Molecular Biology Laboratory	PC	3	0	0	3	1
9.	23BTI01	Internship–I	EEC	1	0	0	1	1
							Total Credit	**22**

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Semester –V

Sl.No.	Course Code	Course Title	Category	Contact Hours	Instruction Hours/Week/ Credit			
					L	T	P	C
Theory								
1.	23BTC09	Bioprocess Engineering	PC	3	3	0	0	3
2.	23BTC10	Genetic Engineering & Genomics	PC	3	3	0	0	3
3.		Professional Elective – I	PE	3	3	0	0	3
4.		Professional Elective– II	PE	3	3	0	0	3
5.		Open Elective – I	OE	3	3	0	0	3
6.		NPTEL– I	PE	3	3	0	0	3
Practical								
7.	23BTC23	Genetic Engineering Laboratory	PC	3	0	0	3	1
8.	23BTC24	Bioprocess Engineering Laboratory	PC	3	0	0	3	1
9.	23BTI02	Internship– II	EEC	0	0	0	2	1
							Total Credit	**21**

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Semester –VI

Sl.No.	Course Code	CourseTitle	Category	Contact Hours	Instruction Hours/Week/ Credit			
					L	T	P	C
Theory								
1.	23BTC11	Immunology	PC	3	3	0	0	3
2.	23BTC12	Bioinformatics	PC	3	3	0	0	3
3.		Professional Elective III	PE	3	3	0	0	3
4.		Professional Elective IV	PE	3	3	0	0	3
5.		Open Elective II	OE	3	3	0	0	3
6.		NPTEL II	PE	3	3	0	0	3
Practical								
7.	23BTC25	Immunology Laboratory	PC	3	0	0	3	1
8.	23BTC26	Computational Biology Laboratory	PC	3	0	0	3	1
9.	23BTM01	Mini Project	EEC	3	0	0	3	3
							Total Credit	**23**

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Semester –VII

Sl.No.	Course Code	Course Title	Category	Contact Hours	Instruction Hours/Week/ Credit			
					L	T	P	C
Theory								
1.	23BTC13	Downstream Processing	PC	3	3	0	0	3
2.	23BTC14	Plant Biotechnology	PC	3	3	0	0	3
3.		Professional Electives – V	PE	3	3	0	0	3
4.		Professional Electives – VI	PE	3	3	0	0	3
5.		Open Elective III	OE	3	3	0	0	3
6.		NPTEL III	PE	3	3	0	0	3
Practical								
7.	23BTC27	Downstream Processing Laboratory	PC	3	0	0	3	1
8.	23BTF01	Project work I	EEC	5	0	0	5	5
							Total Credit	**24**

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B.Tech- Biotechnology
Curriculum | UG - R2023

Semester –VIII

Sl.No.	Course Code	CourseTitle	Category	Contact Hours	Instruction Hours/Week/ Credit			
					L	T	P	C
Theory								
1.	23EEM01	Indian Constitution and Society	EEM	0	0	0	0	0
2.	23EEM02	Essence of Indian Traditional Knowledge	EEM	0	0	0	0	0
3.	23EEM03	Environmental Science and Engineering	EEM	0	0	0	0	0
Practical								
4.	23BTF02	Project Work II	EEC	24	0	0	24	9
							Total Credit	**09**

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B.Tech- Biotechnology
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Summary of Course Component

Sl.No.	Course Area	Semesters								Total Credits	% of Credits
		I	II	III	IV	V	VI	VII	VIII		
1.	HS	4	4	-	-	-	-	-	-	8	5.00
2.	BS	9	9	4	4	-	-	-	-	26	16.25
3.	GES	7	7	3	3	-	-	-	-	20	12.50
4.	PC	-	-	14	14	8	8	7	-	51	31.87
5.	PE	-	-	-	-	9	9	9	-	27	16.87
6.	OE	-	-	-	-	3	3	3	-	9	5.62
7.	EEC	-	-	-	1	1	3	5	9	19	11.87
								Total		**160**	**100.00**

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23GES30	Fluid Mechanics	L	T	P	C
		3	0	0	3

Course Objective:

- To understand the basic properties of the fluid
- To understand fluid kinematics and fluid dynamics
- To analyze and appreciate the complexities in models
- To acquire basic knowledge on fluid flow properties
- To understand working of pumps and turbines
- To understand the basic properties of the fluid

Course Outcomes:

23GES30.CO1	Get a basic knowledge of fluids in static, kinematic and dynamic equilibrium
23GES30.CO2	Understand and solve the problems related to equation of motion.
23GES30.CO3	Gain knowledge about dimensional and model analysis.
23GES30.CO4	Learn types of flow and losses of flow in pipes
23GES30.CO5	Understand the pump and turbines instrumentation

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23GES30.CO1	X	X	X	X	-	-	X	-	X	-	X	X	X	-	-
23GES30.CO2	X	X	X	X	-	-	X	-	X	X	X	X	X	-	-
23GES30.CO2	X	X	X	-	X	-	X	-	-	-	X	X	-	X	-
23GES30.CO4	X	X	X	X	X	-	X	-	X	-	-	-	-	-	X
23GES30.CO5	X	X	X	X	-	-	X	-	X	-	-	-	X	-	-

Unit-I Fluid properties and fluid statics **9**

Fluid,definition, distinction between solid and fluid, Units and dimensions ,Properties of fluids , density, specific weight, specific volume, specific gravity, viscosity, compressibility, vapour pressure, capillarity and surface tension, Fluid statics: concept of fluid static pressure, absolute and gauge pressures, pressure measurements by manometers-forces on planes , centre of pressure ,buoyancy and floatation.

Unit-II Fluid kinematics and dynamics **9**

Fluid Kinematics, Classification and types of flow, velocity field and acceleration, continuity equation(one and three dimensional differential forms), Fluid dynamics, equations of motion, Euler's equation along a streamline - Bernoulli's equation, applications,venturi meter, orifice meter and Pitot tube.

Unit-III Dimensional analysis and model studies **9**

Fundamental dimensions, dimensional homogeneity, Rayleigh's method and Buckingham Pi-theorem, dimensionless parameters, similitudes and model studies, distorted models.

Unit-IV Flow through pipes **9**

Reynold's experiment, laminar flow through circular pipe (Hagen poiseulle's), hydraulic and energy gradient, Darcy weisbach's equation, friction factor, major and minor losses of flow in pipes, pipes in series and in parallel

Unit-V Hydraulic pumps & hydraulic turbines **9**

Pumps: definition and classifications , Centrifugal pump: classifications, working principle, Reciprocating pump: classification, working principle, Hydro turbines: definition and classifications ,Pelton turbine, Francis turbine, propeller turbine, Kaplan turbine, working principles.

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Modi P.N and Seth	Hydraulics and Fluid Mechanics including Hydraulic Machines	Standard Book House New Delhi	2009
2.	Jain.A.K	Fluid Mechanics	Khanna Publishers,	2016
3.	Subramanya.K	Fluid Mechanics and Hydraulic Machines	Tata McGrawHill	2010

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Streeter,V.L.,and Wylie,E.B.,	Fluid Mechanics	Tata McGraw Hill	2000
2.	White,F.M	Fluid Mechanics	Tata McGraw Hill	2017
3.	Bansa.R.K	Fluid Mechanics and Hydraulic Machines	Laxmi Publications Pvt.Ltd., New Delhi	2013

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23GES31	Bioenergy	L	T	P	C
		3	0	0	3

Course Objective:

- Analyze the fundamental concepts in bio energy production.
- Demonstrate the broad concept of second and third generation bio fuel production from biomass and other low-cost agri-residues and bio wastes
- Describe the biomass conversion technologies
- Identify various microbial resources available for bio energy production
- Evaluate the extraction mechanisms available for bio fuels and life cycle analysis of bio fuels
- Analyze the fundamental concepts in bio energy production.

Course Outcomes:

23GES31.CO1	Analyze the fundamental concepts in bio energy production
23GES31.CO1	Able to understand bio fuel production from biomass
23GES31.CO1	Able to understand the biomass conversion technologies
23GES31.CO1	Able to Identify various microbial available for bio energy production
23GES31.CO2	To understanding extraction mechanisms available for bio fuels and life cycle analysis of bio fuels.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23GES31.CO1	X	X	X	X	-	-	X	-	X	X	X	X	X	-	-
23GES31.CO2	X	X	X	X	-	-	X	--	X	X	X	X	X	-	-
23GES31.CO2	X	X	X	X	X	-	X	-	-	-	X	X	-	X	-
23GES31.CO4	X	X	X	X	X	-	X	-	X	X	-	-	-	-	X
23GES31.CO5	X	X	X	X	-	-	X	-	X	X	-	-	X	-	-

Unit-I **Concepts in bioenergy and biorefinery** **9**

Fundamentalconcepts in understanding biofuel/bioenergy production,Biopower, Bioheat, Biofuels, Advanced liquid fuels, Biobased products, various biofuels from biomass.

Unit-II **Biomass feedstocks** **9**

Feedstock's availability, Characterization and attributes for biofuel/bioenergy production, Renewable feed stocks and their production, Biomass feed stocks: Harvested feed stocks – Feed stocks for first generation Biofuels, Feed stocks for second generation biofuels, Feed stocks forthirdgeneration biofuels. Biomass feed stocks: Residue feed stocks .

Unit-III **Biomass conversion technologies** **9**

Biochemical conversion: Hydrolysis, enzyme & acid hydrolysis, Fermentation, Anaerobic digestion, trans-esterification. Enzymatic Conversion; Thermochemical conversion: Combustion, Gasification.

Unit-IV **Microbial energy resources** **9**

Bioethanol, biobutanol and biohydrogen from various microbes, fungi and yeast; Photoautotrophic production of ethanol by algae; Extraction of microbial lipids and transesterification into biodiesel; Microbial fuel cells.

Unit-V **Biofuel extraction technologies and LCA** **9**

Ultrasonic extraction, osmotic shock, solvent extraction, Supercritical fluid extraction and extraction using microwave; Life Cycle Analysis of biofuels: Environmental aspects of biofuel utilization, Techno-economic features of bio-fuels.

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Robert C. Brown	Biorenewable Resources: Engineering New Products from Agriculture	Wiley-Blackwell Publishing	2003
2.	Twidell.,J & Weir	Renewable energy resources(2nd Edition)	Taylor &Francis	2006

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Samir K .Khanal	Anaerobic Biotechnology for Bioenergy Production:Principles and Applications	Wiley-Blackwell Publishing	2008
2.	Luque,R.,Camp,J	Hand book of biofuel production processes and technologies, (1st Edition).	Woodhead publishing ltd	2011

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23BTC01	Biochemistry	L	T	P	C
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Course Objective:

- To provide the basic knowledge of various biomolecules.
- To understand the concept of structure and properties of important biomolecules
- To learn metabolism concepts
- To know the metabolism and its regulation
- To enable students, learn the fundamentals of Biochemical Processes and Biomolecules.

Course Outcomes:

23BTC01.CO1	Demonstrate the structure and reactions of Biomolecules.
23BTC01.CO2	Identify the metabolic pathways of the major biomolecules and relevance to clinical conditions.
23BTC01.CO3	Gain knowledge about Biochemical processes with Biotechnology applications.
23BTC01.CO4	Acquire knowledge related to functions and interrelationships of biomolecules in clinical research and industry.
23BTC01.CO5	Idea about the consequences of interpreting and solving clinical problems.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BTC01.CO1	X	X	X	X	-	-	-	-	X	X	X	X	X	-	-
23BTC01.CO2	X	X	X	X	-	-	X	-	X	X	X	X	X	-	-
23BTC01.CO3	X	X	X	-	X	-	X	-	-	-	X	X	-	X	-
23BTC01.CO4	X	X	X	X	X	-	X	-	X	X	-	-	-	-	X
23BTC01.CO5	X	X	X	X	-	-	X	-	X	X	-	-	X	-	-

Unit-I Introduction To Biomolecules – Carbohydrates 9

Introduction to biochemistry, Types of functional groups, Biomolecules, water as biological solvent, pH, Biological buffers, Handerson, Hasselbalch equation. Carbohydrates: Mono, Di, Oligo and Polysaccharides (Starch, Glycogen, Cellulose and Chitin). Proteoglycans, Glucosaminoglycans. Hyaluronic acid, Chondroitin sulfate.

Unit-II Structure And Properties of Other Biomolecules 9

Lipids: Fatty acids, Glycerol, Saponification, Iodination, Phospholipids, Glycolipids, Sphingolipids, Cholesterol, Steroids.Proteins: Amino Acids, Peptides, Polypeptides, Primary, Secondary, Tertiary and Quaternary structures, Glycoproteins, Lipoproteins. Nucleic acids: Purines, Pyrimidines, Nucleoside, Nucleotide, RNA, DNA-Watson and Crick structure of DNA

Unit-III Metabolism Concepts and Carbohydrate Metabolism 9

Metabolic pathways, Primary and Secondary metabolites. Enzymes-introduction to biocatalysts, Glycolysis, TCA cycle, Gluconeogenesis, Pentose phosphate shunt, Glyoxalate shunt

Unit-IV Metabolism And Regulation 9

Fatty acid synthesis and oxidation, Reactions of amino acids, Deamination, Transamination and Decarboxylation, Urea cycle, Metabolic disorders of carbohydrate metabolism (pathophysiology, clinical symptoms and treatment): Diabetes mellitus. Metabolic disorders of lipid metabolism: familial hypercholesterolemia. Metabolic disorders of amino acid metabolism: Phenyl ketonuria, Albinism Metabolic disorders of nucleic acid metabolism: Lesch-Nyhan syndrome, Gout

Unit-V Bioenergetics **9**

High energy compounds, Electronegative potential of compounds,Introduction of energy yielding, Oxidative phosphorylation and Energy requiring reactions-Respiratory chain, ATP cycle, Calculation of ATP yield during oxidation of glucose and fatty acids.

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Lehninger	Principles of Biochemistry	W.H. Freeman,	2008
2.	Satyanarayana, U. and U. Chakerapani	Biochemistry	Books & Allied (P) Ltd	2006

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Rastogi, S.C	Biochemistry	Tata McGraw-Hill	2003
2.	Conn, E.E	Outlines of Biochemistry	John Wiley & Sons	2005
3.	Berg, Jeremy M	Biochemistry	W.H. Freeman	2006
4.	Murray, R.K	Harper's Illustrated Biochemistry	McGraw-Hill	2006
5.	Voet, D. and Voet, J.G	Biochemistry	John Wiley & Sons	2004

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		L	T	P	C
23BTC02	**Microbiology**	**3**	**0**	**0**	**3**

Course Objective:

- To introduce students to the principles of Microbiology to emphasize structure and biochemical aspects of various microbes.
- To solve the problems in microbial infection and their control.
- To highlight the roles and characteristics of microorganisms.
- To impart knowledge on the basic concept of replication in microorganisms.
- To study in detail the growth of microorganisms and impact of environment on their growth.

Course Outcomes:

23BTC02.CO1 Demonstrate the classification of microorganism.

23BTC02.CO2 Identify the microorganism structure and multiplication.

23BTC02.CO3 Gain knowledge about metabolism.

23BTC02.CO4 Acquire knowledge related to the control of microorganism.

23BTC02.CO5 Idea about the environmental microbiology.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BTC02.CO1	X	X	X	X	-	-	X	-	X	X	X	X	X	-	-
23BTC02.CO2	X	X	X	X	-	-	X	-	X	X	X	X	X	-	-
23BTC02.CO3	X	X	X	X	X	-	X	-	-	-	X	X	-	X	-
23BTC02.CO4	X	X	X	X	X	-	X	-	X	X	-	-	-	-	X
23BTC02.CO5	X	X	X	X	-	-	X	-	X	X	-	-	X	-	-

Unit-I Introduction **9**

Basics of microbial existence; History of microbiology, Classification and nomenclature of microorganisms, Microscopic examination of microorganisms, Light and electron microscopy; Principles of different staining techniques like gram staining, Acid fast, Capsular staining, Flagellar staining.

Unit-II Microbes- Structure and Multiplication **9**

Structural organization and multiplication of bacteria, Viruses, Algae and Fungi, with special mentionof life history of actinomycetes, Yeast, Mycoplasma and Bacteriophages.

Unit-III Microbial Nutrition, Growth and Metabolism **9**

Nutritional requirements of bacteria; different media used for bacterial culture; Growth curve anddifferent methods to quantify bacterial growth; Aerobic and anaerobic bioenergetics and utilization of energy for biosynthesis of important molecules.

Unit-IV Control of Microorganisms **9**

Physical and chemical control of microorganisms; Host-microbe interactions; anti-bacterial, Antifungal and anti-viral agents; Mode of action and resistance to antibiotics; Clinically important microorganisms.

Unit-V Industrial and Environmental Microbiology **9**

Probiotics, Biosurfactants, Bioflocculants, Antimicrobial components.Biogas production; Microbial treatment of

wastewater, Aerobic and anaerobic methods, UASB, Trickling filter, Leaching of ores by microbes.

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Talaron K, Talaron A, Casita, Pelczar and Reid	Foundations in Microbiology	W.C. BrownPublishers	1993
2.	Pelczar MJ, Chan ECS and Krein NR	Microbiology	Tata McGraw Hill Edition, New Delhi	1999

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Prescott L.M., Harley J.P., Klein DA	Microbiology	W.C. BrownPublishers	1996
2.	G. J. Tortora, B. R. Funke and C. L. Case	Microbiology	Addison Wesley Longman, Inc	2001
3.	R. M. Atlas and Renk	Principles of Microbiology	McGraw-Hill Higher Education	1995
4.	M.J. Heboffee aw BE Pierce	Micro Biology: Laboratory Theory and applications	Morten PublishingHouse	2006
5.	Jeffrey C. Pommerville	Alcamo's Fundamentals of Microbiology	Jones & BartlettPublishers	2012

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23BTC03	Cellbiology and genetics	L	T	P	C
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Course Objective:

- To provide the basic knowledge in cell structure and organelles.
- To understand the cell division.
- To learn transport across membranes.
- To know about the signal transduction.
- To enable students to learn various techniques used to study the cells.

Course Outcomes:

23BTC03.CO1 Demonstrate the deeper understanding of cell at structural and functional Level

23BTC03.CO2 Identify the cell division and immortalization of cells

23BTC03.CO3 Gain knowledge about molecular interaction between cells

23BTC03.CO4 Demonstrate a clear understanding of the signal transduction,secondary messengers.

23BTC03.CO5 Develop skill on working principles of microscopy and identification of cell types

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BTC03.CO1	X	X	X	-	-	-	X	-	X	-	X	X	X	-	-
23BTC03.CO2	X	X	X	X	-	-	-	-	X	X		X	X	-	-
23BTC03.CO3	X	X	X	-	X	-	X	X	-	-	X	-	-	X	-
23BTC03.CO4	-	X	X	-	X	-	X	X	X	-	-	-	-	-	X
23BTC03.CO5	X	X	X	X	-	-	X	-	X	-	-	-	X	-	-

Unit-I Cell And Cell Organelles **9**

Prokaryotic cell, Eukaryoticcells, Cell membrane, Cell organelles, Principles of membrane organization membrane proteins,Cytoskeletal proteins.Extra cellular matrix, Cell celljunctions.

Unit-II Transport Across Cell Membranes and Cell Cycle **9**

Passive and Active Transport,Permeases,Ion channels,ATP pumps.Na+/K+/Ca+2Tpumps,Uniport,symport anti porter system.Ligand gated/voltage gated channels,Agonists and Antagonists, Cell cycle Mitosis, Meiosis, Cell cycle control system.

Unit-III SignalTransduction **9**

Receptors extracellular signaling, Cell surface/ Cytosolic receptors and examples,Different classes of receptors antocrine/paracrine/endocrinemodels, G- protein coupled signal transduction pathway involving cAMP,cGMP, IP_3, DAGand Ca^{2+} as Second messengers

Unit-IV Principle Of Inheritance and Heritable Variation **9**

Mendelian laws, Co-dominance, Incomplete dominance, Multiple alleles and gene interactions,quantitative and extra chromosomal inheritance, Linkage, crossing over, Sex linked inheritance and chromosomal mapping, Gene and chromosomal mutations

Unit-V Population Genetics and Evolution **9**

Hardy-Weinberg equilibrium, Extensions of Hardy- Weinberg equilibrium, non-random mating, Population analysis, Models for population genetics. Mutation and Migration size. Natural selection. Evolution: Darwinian evolution, Speciation, Genetic variation and Sociobiology.

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Lodish,Harvey	Molecular Cell Biology	W.H.Freeman	2005
2.	Sadava,D.E	Cell Biology:Organelle Structure and Function	Panima Publishing	2004

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Alberts,Bruce	MolecularBiologyof theCell	GarlandScience (TaylorsFrancis)	2002
2.	Cooper, G.M. and R.E. Hansman	The Cell: A Molecular Approach	ASM Press	2007
3.	Rastogi, S.C	Cell Biology	New Age International	2002

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		L	T	P	C
23BTC04	**Protein and enzyme engineering**	**3**	**0**	**0**	**3**

Course Objective:

- To learn the various topologies of proteins structure
- To understand the relationship between protein structure and function
- To apply the knowledge on enzymes for their applications
- To understand purification and immobilization
- To understand the applications of enzymes

Course Outcomes:

23BTC04.CO1	Analyze and demonstrate the secondary, super-secondary, tertiary and quaternary structures of proteins and structure-function relationship
23BTC04.CO2	Apply the knowledge on protein structures in protein engineering and protein prediction
23BTC04.CO3	Compare the enzyme properties and kinetics
23BTC04.CO4	Evaluate the immobilization of enzymes and its effectiveness
23BTC04.CO5	Apply the knowledge on design of enzyme-based biosensors and their applications

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BTC04.CO1	X	X	X	X	-	-	-	-	X	X	X	X	X	-	-
23BTC04.CO2	X	X	X	X	X	-	X	-	X	X	-	X	X	-	-
23BTC04.CO3	-	X	X	-	X	-	X	-	X	-	X	X	-	X	-
23BTC04.CO4	X	X	X	X	X	-	X	-	X	X	-	-	-	-	X
23BTC04.CO5	X	X	X	X	-	-	X	-	X	-	-	-	X	-	-

Unit-I Super Secondary, Tertiary and Quaternary Structures 9

Primary structure: Insulin; Secondary structures: Alpha (keratin), beta (silk fibroin), loop structures, structure of collagen; Super secondary structures: Helix-turn-helix, Hairpin β motif; Ramachandran plot. α-Domain:Four helix bundle; β-domain: Greek key; α / β domains: TIM barrel, Horseshoe fold; Protein folding by chaperones. Quaternary structure: Modular nature, Formation of complexes.

Unit-II Protein Structure-Function Relationship and Protein 9

DNA-binding proteins: helix-turn-helix motif of TRP- repressor & CRO protein in DNA binding; Eukaryotictranscription factors: TATA box-binding proteins, TFIIA and TFIIB and Zn-fingers; Membrane Proteins:Photosynthetic reaction center and Bacteriorhodopsin. de novo protein design

Unit-III Enzymes and Kinetics 9

Nomenclature and Classification of enzymes; Concept of active site, Substrate binding site,allosteric site, and allosteric regulation of enzymes; specificity of enzyme; Kinetics of single substrate reactions: Michaelis & Menten equation, LB Equation; bisubstrate reactions: single displacement Types of enzyme inhibition -Competitive, Non-competitive and Un-competitive.

Unit-IV Enzyme Purification and Immobilization 9

Extraction and purification of enzyme from plant, animal and microbial sources; Methods of characterization of enzymes; Development of enzymatic assays; Physical and chemical techniques for enzyme immobilization: adsorption, matrix entrapment, encapsulation, cross-linking and covalent binding. Kinetics of immobilized enzymes

Unit-V Enzyme Applications 9

Design of enzyme electrodes and their applications as biosensors in industries and health care. Application of

enzymes in industries: Food, Detergent, Leather, Wool, Brewery and environment;

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Shanmugham.S and Sathishkumar.T	Enzyme Technology, 2nd edition	I.K. International Publishing House Pvt. Ltd., New Delhi, India.	2012
2.	Palmer, T. and Bonner, P	Enzymes: Biochemistry, Biotechnology and Clinical chemistry	East - West Press Pvt. Ltd., New Delhi, India	2008

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Fersht, Alan.	Structure and mechanism in protein science: A Guide to Enzyme Catalysis and Protein Folding 3rd revised edition,	W.H.Freeman & Co Ltd.	2012
2.	Devasena T	Enzymlogy Second Edition	Oxford University Press, New Delhi, India	2014
3.	Moody, Peter CE, Anthony J. Wilkinson, and Tony Wilkinson	Protein engineering 2nd Edition,	Oxford University Press, USA	1999

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23BTC05	Molecularbiology	L	T	P	C
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Course Objective:

- To familiarize with the molecular biology of both Prokaryotes and Eukaryotes.
- To understand the replication process
- To familiarize students on macromolecule's properties, structures and functions
- To expose students to various molecular events in prokaryotes
- To create deeper understanding on regulation of genes activities

Course Outcomes:

23BTC05.CO1 Analyze three major macro molecules and their properties in living organisms.

23BTC05.CO2 Organize the mechanism of DNA replication.

23BTC05.CO3 Analyze the mechanism of transcription and universal genetic.

23BTC05.CO4 Analyze the process of translation and DNA repair system.

23BTC05.CO5 Apply the concept of gene regulation and its significance

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO 6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO 2	PSO 3
23BTC05.CO1	X	X	X	-	-	-	X	-	X	-	X	X	X	-	-
23BTC05.CO2	X	X	X	X	-	-	-	-	X	X		X	X	-	-
23BTC05.CO3	X	X	X	-	X	-	X	X	-	-	X	-	-	X	-
23BTC05.CO4	-	X	X	-	X	-	X	X	X	-	-	-	-	-	X
23BTC05.CO5	X	X	X	X	-	-	X	-	X	-	-	-	X	-	-

Unit-I Chemistry ofNucleicAcids 9

Introduction to nucleic acids: Nucleic acids as genetic material, Structure and physicochemical properties of elements in DNA and RNA, Biological significance of differences in DNA and RNA. Primary structure of DNA: Chemical and structural qualities of 3',5'-Phosphodiesterbond. Secondary Structure of DNA: Watson & Crick model, Chargaff's rule, X–ray diffraction analysis of DNA, Forces stabilizes DNA structure, Conformational variants of double helical DNA, Hogsteen base pairing, Triple helix, Quadruple helix, Reversible denaturation and hyperchromic effect. Tertiary structure of DNA: DNA supercoiling

Unit-II DNA Replication & Repair 9

Overview of Central dogma. Organization of prokaryotic and eukaryotic chromosomes. DNA replication: Meselson & Stahl experiment, bi–directional DNA replication, Okazaki fragments, Proteomics of DNA replication, Fidelity of DNA replication, Inhibitors of DNA replication, Overview of differences in prokaryotic and eukaryotic DNA replication,Telomere replication in eukaryotes. D-loop and rolling circle mode ofreplication. Mutagens,DNA mutations andtheir mechanism, various types of repair mechanisms.

Unit-III Transcription 9

Structure and function of mRNA, rRNA and tRNA. Characteristics of promoter and enhancer sequences. RNA synthesis: Initiation, elongation and termination of RNA synthesis, Proteins of RNA synthesis,Fidelity of RNA synthesis,Inhibitors of transcription,Differencesin prokaryotic and eukaryotic transcription. Basic concepts in RNA world: Ribozymes, RNA processing: 5'-Capping, Splicing-Alternative splicing, Poly 'A' tail addition and base modification.

Unit-IV Translation **9**

Introduction to Genetic code: Elucidation of genetic code, Codon degeneracy, Wobblehypothesis and its importance, Prokaryotic and eukaryotic ribosomes. Steps in translation: Initiation, Elongation and Termination of protein synthesis. Inhibitors of protein synthesis. Posttranslational modifications and its importance.

Unit-V Regulation Of Gene Expression **9**

Organization of genes in prokaryotic and eukaryotic chromosomes, Hierarchical levels of gene regulation, Prokaryotic gene regulation –lac and trp operon, Regulation of gene expression with reference to λ phage life cycle.

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Friefelder, David	Molecular Biology	Narosa Publications	1999
2.	Weaver,Robert F	Molecular Biology	TataMcGraw-Hill	2003

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Karp,Gerald	Cell and Molecular Biology:Concepts and Experiments	John Wiley	2005
2.	Friefelder, David and George M.Malacinski	Essentials of Molecular Biology	Panima Publishing	1993
3.	Tropp,BurtonE	Molecular Biology: Genes to Proteins	Jones and Bartlett	2008
4.	Glick,B.R.and J.J. Pasternak	Molecular Biotechnology: Principles and Applications of Recombinant DNA	ASM	2010
5.	Harvey Lodish, ArnoldBerk, S.L Zipursky, Paul Matsudaira, David Baltimore andJamesDanell	Molecular Cell Biology	W.H Freeman	2016

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23BTC06	Basic Industrial Biotechnology	L	T	P	C
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Course Objective:

- To make the students aware of the overall industrial bioprocess
- To evaluate the process to the requirement of the primary metabolites
- To gain the knowledge about the secondary metabolites
- To study the production of enzymes
- To understand the modern biotechnology products

Course Outcomes:

23BTC06.CO1	To explain the steps involved in the production of bioproducts and methods to improve modern Biotechnology.
23BTC06.CO2	To apply basic biotechnological principles, methods and models to solve biotechnological tasks
23BTC06.CO3	To identify and debate the ethical, legal, professional, and social issues in the field of biotechnology
23BTC06.CO4	To Explain the industrial application of bioproducts
23BTC06.CO5	To design and deliver useful modern biotechnology products to the society

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BTC06.CO1	X	X	X	X	-	-	-	-	X	X	X	X	X	-	-
23BTC06.CO2	X	X	X	X	-	-	X	-	X	X	X	X	X	-	-
23BTC06.CO3	X	X	X	-	X	-	X	-	-	-	X	X	-	X	-
23BTC06.CO4	X	X	X	X	X	-	X	-	X	X	-	-	-	-	X
23BTC06.CO5	X	X	X	X	-	-	X	-	X	X	-	-	X	-	-

Unit-I Introduction To Industrial Bioprocess **9**

Fermentation - Bacterial, Fungal and Yeast, Traditional and Modern industrial biotechnology, Basic concepts of Upstream and Downstream processing in Bioprocess, Process flow sheeting – block diagrams, pictorial representation

Unit-II Production of Primary Metabolites **9**

Primary Metabolites- Production of commercially important primary metabolites like organic acids (Citric acid, lactic acid), amino acids (glutamic acid, aspartic acid) and alcohols (ethanol, butanol)

Unit-III Production of Secondary Metabolites **9**

Secondary Metabolites- Production processes for various classes of secondary metabolites: Antibiotics (Penicillin), Vitamins and Steroids

Unit-IV Production Of Enzymes and Other Bioproducts **9**

Production of Industrial Enzymes (amalyase, lipase), Biopesticides, Biofertilizers, Biopolymers Biodiesel, Cheese, Beer, SCP & Mushroom culture, Bioremediation.

Unit-V Production Modern Biotechnology Products **9**

Production of recombinant proteins having diagnostic applications, Vaccines. Bioprocess strategies in Plant Cell and Animal Cell culture.

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Satya narayana, U	Biotechnology	Books & Allied (P) Ltd	2005
2.	Kumar, H.	A Textbook on Biotechnology	Affiliated East West Press Pvt.Ltd	2012

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Casida, L.E	Industrial Microbiology	New Age International (P) Ltd	2005
2.	Presscott, S.C. and Cecil G. Dunn	Industrial Microbiology	Agrobios (India)	2001
3.	Cruger, Wulf and Anneliese Crueger	Biotechnology: A Textbook of Industrial Microbiology	Panima Publishing	2005
4.	Moo-Young, Murrey	Comprehensive Biotechnology	Pergamon Press	2011
5.	Stanbury, P.F., A. Whitaker and S.J. Hall	Principles of Fermentation Technology	Butterworth – Heinemann	2014

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23BTC07	Basics of unit Operations	L	T	P	C
		3	0	0	3

Course Objective:

- To explain the basic principles of mass transfer operations and other separation processes with examples.
- To impart knowledge on how certain substances undergo the physical change with diffusion/mass transfer of components from one phase to other phases
- To focus on absorption and distillation operations and the process design aspects of the same operations.
- To understand extraction and leaching operations and their applications in bioprocessing
- To industry. understand adsorption and drying operations and the process design aspects of the same operations

Course Outcomes:

23BTC07.CO1	Ability to define the basic principles of mass transfer operations and the measurement of diffusivity
23BTC07.CO2	Ability to understand the importance of mass transfer phenomena in the design of process equipment in distillation operations
23BTC07.CO3	Ability to understand the HETP, NTU and HTU concepts of various gas absorption packed towercolumns
23BTC07.CO4	Ability to understand the design aspects of extraction and various leaching equipment
23BTC07.CO5	Ability to understand the importance of adsorption and drying processes and their industrial applications

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BTC07.CO1	X	X	X	X	-	-	X	-	X	X	X	X	X	-	-
23BTC07.CO2	X	X	X	-	-	-	X	-	X	X	X	X	X	-	-
23BTC07.CO3	X	X	X	-	X	-	X	-	X	X	-	-	X	X	-
23BTC07.CO4	X	X	-	X	X	-	X	-	X	X	-	-	-	-	X
23BTC07.CO5	X	X	X	X	-	-	X	-	X	X	-	-	X	-	-

Unit-I Mixing and Agitation **9**

Dimensional analysis; Power for agitation; Agitation of liquids; Gas-liquid systems; Gassolid suspensions; Agitator scale up.

Unit-II Filtration **9**

Constant pressure, Constant volume batch filtration; Continuous filtration; Industrial filters; Settling and sedimentation; Centrifugation

Unit-III Mechanism of Heat Transfer **9**

Steady state conduction; Combined resistances; Unsteady state conduction; ; Extended surfaces; Combined conduction and Convection

Unit-IV Convection Heat Transfer **9**

Dimensional analysis; Forced and natural convection; Convection in flow over surfaces through pipes boiling and condensation

Unit-V Heat Exchangers **9**

Equipments; Overall heat transfer coefficients; Design of heat exchangers; NTU concept; Evaporators; Single and

multiple effects; Mass and Enthalpy balances.

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Geankoplis C.J	Transport Processes And Unit Operation	Prentice Hall India	2002
2.	McCabe W.L., Smith J.C	Unit Operations In Chemical Engineering	Mcgraw hill	2000

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	IncroperaF.P	Fundamentals Of Heat And Mass Transfer	John Wiley	1998
2.	Gavhane, K.A	Unit Operations-I [Fluid Flow and Mechanical Operations]	Nirali Prakashan	2016
3.	Frank M. White	Fluid mechanics	McGraw-Hill Education	2017
4.	R.K.Bansal	A Textbook of Fluid Mechanics and Hydraulic Machines	Laxmi publications (P) Ltd	2011
5.	Badger W.L. and Banchero J.T	Introduction to Chemical Engineering	Tata McGraw Hill	2012

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23BTC08	Instrumental Methods of analysis	L	T	P	C
		3	0	0	3

Course Objective:

- To enable the students to have a fundamental knowledge about the Light spectrum, Absorption
- To expose students with electrical and electronic components used in the analytical instruments
- To learn and understand the principles and operation of different instrumentation techniques
- To acquire knowledge on the different chromatographic methods for separation of biological products
- To know the different molecular spectroscopic techniques and their analytical applications

Course Outcomes:

23BTC08.CO1	Ability to analyze the function of electrical and optical component in analytical instruments and their calibration
23BTC08.CO2	Ability to apply the spectroscopic techniques to identify, estimate and characterize analytes
23BTC08.CO3	Ability to analyze the thermal behavior of materials using thermal analysis
23BTC08.CO4	Ability to apply chromatographic and electrophoretic techniques to separate, purify and quantify molecules
23BTC08.CO5	Ability to analyze different types of electrodes and electroanalytical techniques for sensing and quantifying analytes.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BTC01.CO1	X	X	X	X	-	-	-	-	X	X	X	X	X	-	-
23BTC01.CO2	X	X	X	X	-	-	-	-	X	X	X	X	X	-	-
23BTC01.CO3	X	X	X	-	X	-	X	-	X	-	X	X	-	X	-
23BTC01.CO4	X	-	X	X	X	-	X	-	X	X	X	-	-	-	X
23BTC01.CO5	X	X	X	X	-	-	-	-	X	X	X	-	X	-	-

Unit-I Introduction To Spectrometry **9**

Properties of electromagnetic radiation, Wave properties, Components of optical instruments, Sources of radiation, Wavelength selectors, Sample containers, Radiation transducers, Signal process and read outs, Signal to noise ratio, Sources of noise, Enhancement of signal to noise, Types of optical instruments, Principle of Fourier Transform optical Measurements.

Unit-II Molecular Spectroscopy **9**

Molecular absorption spectrometry, Measurement of Transmittance and Absorbance, Beer's law, Instrumentation, Applications, Theory of fluorescence and Phosphorescence, Instrumentation, Applications, Theory of Infrared absorption spectrometry, IR instrumentation, Applications, Theory of Raman spectroscopy, Instrumentation, applications.

Unit-III Magnetic Resonance Spectroscopy and Mass Spectrometry **9**

Theory of NMR, Environmental effects on NMR spectra, Chemical shift, NMR, spectrometers, Applications of 1H and 13C NMR, Molecular mass spectra, Ion sources, Mass spectrometer. Applications of molecular mass, Electron paramagnetic resonance, G values, Instrumentation

Unit-IV Magnetic Resonance Spectroscopy and Mass Spectrometry **9**

General description of chromatography, Band broadening and optimization of column performance Liquid chromatography, Partition chromatography, Adsorption chromatography, Ion exchange chromatography -size exclusion chromatography, Affinity chromatography principles of GC and applications, HPLC- Capillary electrophoresis, Applications

Unit-V Electro Analysis and Surface Microscopy **9**

Electrochemical cells, Electrode potential cell potentials, Potentiometry, Reference electrode, Ion selective and molecular selective electrodes, Instrument for potentiometric studies, Voltametry, Cyclic and pulse voltammetry, Applications of voltametry , Study of surfaces, Scanning probe microscopes, AFM and STM

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Skoog, D.A. F. James Holler, and Stanky, R.Crouch	Instrumental Methods of Analysis	Cengage Learning	2007
2.	Willard, Hobart	Instrumental Methods of Analysis	CBS	2000

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Braun, Robert D	Introduction to Instrumental Analysis	Pharma Book Syndicate	1987
2.	Ewing,G.W	Instrumental Methods of Chemical Analysis	McGraw-Hill	2012
3.	Sharma, B.K	Instrumental Methods of Chemical Analysis: Analytical Chemistry	Goel Publishing House	2001
4.	Haven, Mary C	Laboratory Instrumentation	John Wiley	2012
5.	Arthur I. Vogel	Quantitative Inorganic Analysis including Elementary Instrumental Analysis	ELBS, Group	2015

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23BTC09	Bioprocess engineering	L	T	P	C
		3	0	0	3

Course Objective:

- To provide the students with the basics of bioreactor engineering.
- To develop bioengineering skills for the production of biochemical product using integrated biochemical processes
- To understand the role of biotechnologists in bioprocess industry.
- To apply the engineering concepts for biological conversion of raw materials
- To perform simulations of reactors and model the kinetics of product formation

Course Outcomes:

23BTC09.CO1	Ability to select appropriate bioreactor configurations and operation modes based upon the nature of bioproducts and cell lines and other process criteria.
23BTC09.CO2	Ability to plan a research career or to work in the biotechnology industry with strong foundation about bioreactor design and scale-up.
23BTC09.CO3	Ability to perform in enzyme systems
23BTC09.CO4	Ability to apply modeling and simulation of bioprocesses so as to reduce costs and to enhance the quality of products and systems.
23BTC09.CO5	Ability to integrate research lab and Industry; identify problems and seek practical solutions for large scale implementation of Biotechnology.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BTC09.CO1	X	X	X	X	-	-	-	-	X	X	X	X	X	-	-
23BTC09.CO2	X	X	X	X	-	-	X	-	X	X	X	X	X	-	-
23BTC09.CO3	X	X	X	-	X	-	X	-	-	-	X	X	-	X	-
23BTC09.CO4	X	X	X	X	X	-	X	-	X	X	-	-	-	-	X
23BTC09.CO5	X	X	X	X	-	-	X	-	X	X	-	-	X	-	-

Unit-I Configuration of Bioreactors **9**

Ideal reactors and its characteristics Fed batch cultivation, Cell recycle cultivation, Cell recycle cultivation in waste water treatment two stage cultivation Packed bed reactor, airlift reactor, introduction to fluidized bed reactor bubble column reactors

Unit-II Bioreactor Scale Up **9**

Regime analysis of bioreactor processes, Oxygen mass transfer in bioreactors, Microbial oxygen demands; Methods for the determination of mass transfer coefficients; Mass transfer correlations. Scale up criteria for bioreactors based on oxygen transfer, Power consumption and impeller tip speed

Unit-III Bioreactor Consideration in Enzyme Systems **9**

Analysis of film and pore diffusion effects on kinetics of immobilized enzyme reactions; Formulation of dimensionless groups and calculation of effectiveness factors. Design of immobilized enzyme reactors, Packed bed, Fluidized bed and Membrane reactors

Unit-IV Modelling And Simulation of Bioprocesses **9**

Study of structured models for analysis of various bioprocess, Compartmental models, Models of cellular energetics and metabolism, Single cell models, Plasmid replication and plasmid stability model. Dynamic simulation of batch, Fed batch, Steady and Transient culture metabolism

Unit-V Recombinant Cell Cultivation **9**

Different host vector system for recombinant cell cultivation strategies and advantages. E.coli, Yeast Pichia pastoris / Saccharomyces cereviseae, Animal cell cultivation, Plant cell cultivation, Insect cell cultivation. High

cell density cultivation, Process strategies, Reactor considerations in the above system

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Michael L. Shuler and Fikret Kargi	Bioprocess Engineering, Basic Concept	Prentice Hall PTR	2002
2.	Pauline Doran	Bioprocess Engineering Calculation	Academic Press	2012

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Bailey and Ollis	Biochemical Engineering Fundamentals	McGraw-Hill	2010
2.	Rajiv Dutta	Fundamentals of Biochemical Engineering	Ane Books India	2008
3.	Lee, J. M	Biochemical Engineering	NJ: Prentice Hall	2010
4.	Blanch H. W. And Clark D. S	Bioprocess Engineering and Technology	CRC Press	2007
5.	Stanbury P. F., Hall, S., and Whitaker A	Principles of Fermentation Technology	Butterworth-Heinesmann	2016

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23BTC10	Genetic Engineering and Genomics	L	T	P	C
		3	0	0	3

Course Objective:

- To discuss the gene cloning methods and the tools
- To understand the techniques involved in gene cloning and genome analysis and genomics.
- To explain the heterologous expression of cloned genes in different hosts
- To apply types of host-vector systems and steps in creating a recombinant DNA molecule
- To gain knowledge on various recombinant DNA techniques and their applications

Course Outcomes:

23BTC10.CO1 Ability to know how to clone commercially important genes.

23BTC10.CO2 Ability to know how to produce the commercially important recombinant proteins.

23BTC10.CO3 Ability to know about gene and genome sequencing techniques.

23BTC10.CO4 Ability to know about microarrays, Analysis of Gene expression and proteomics

23BTC10.CO5 Ability to know about genome sequencing

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BTC10.CO1	X	-	-	-	X	-	X	-	-	X	X	X	X	X	-
23BTC10.CO2	X	X	X	X	X	X	X	X	X	-	-	-	X	X	X
23BTC10.CO3	X	X	X	X	X	X	-	-	X	-	X	X	X	-	X
23BTC10.CO4	X	X	X	X	X	X	X	-	-	-	-	X	-	X	-
23BTC10.CO5	X	X	X	X	X	-	-	-	-	X	-	X	X	-	X

Unit-I Basics Of Recombinant Dna Technology 9

Manipulation of DNA – Restriction and Modification enzymes, Design of linkers and adaptors. Characteristics of cloning and expression vectors based on plasmid and bacteriophage, Vectors for insect, yeast and mammalian system, Prokaryotic and eukaryotic host systems, Introduction of recombinant DNA in to host cells and selection methods.

Unit-II Dna Libraries 9

Construction of genomic and cDNA libraries, Artificial chromosomes – BACs and YACs, Chromosomal walking, Screening of DNA libraries using nucleic acid probes and antisera.

Unit-III Sequencing And Amplification Of Dna 9

Maxam Gilbert's and Sanger's methods of DNA sequencing. Inverse PCR, Nested PCR, AFLP PCR, Allele specific PCR, Assembly PCR, Asymmetric PCR, Hot start PCR, inverse PCR, Colony PCR, single cell PCR, Real-time PCR/qPCR – SYBR green assay, Taqman assay, Molecular beacons. Site directed mutagenesis.

Unit-IV Organization And Structure Of Genomes 9

Organization and structure of genomes, Genome sequencing methods, Conventional and shotgun genome sequencing methods, Next generation sequencing technologies , Ordering the genome sequence, Genetic maps and Physical maps, STS content based mapping, Restriction Enzyme Finger Printing, Hybridization mapping, Radiation Hybrid Maps, Optical mapping. ORF finding and functional annotation.

Unit-V Current Status Of Genome Sequencing Projects **9**

Current status of genome sequencing projects, Introduction to Functional genomics, Microarrays, Serial Analysis of Gene expression (SAGE), Subtractive hybridization, DIGE, TOGA, Yeast Two hybrid System, Comparative Genomics, Proteogenomics, Web resources for Genomics, Applications of genome analysis and genomics.

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Brown T.A	Genomes	Bios Scientific Publishers Ltd	2017
2	Primrose S.B., Twyman RM	Pri Principles of Gene Manipulation and Genomics	Blackwell Science	2006

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Glick B.R.,and Pasternick J.J	Molecular Biotechnology: Principles and Applications of Recombinant DNA	ASM press	2017
2	Sathyanarayana U	Biotechnology	Books & Allied (p) ltd	2008
3	Howe C. J	Gene Cloning and Manipulation	Cambridge University Press	2007
4	Watson.J.D	Recombinant DNA	Scientific American Book	2005
5	T A Brown	Gene Cloning and DNA Analysis: An Introduction	Wiley – Blackwell Publications.	2006

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23BTC11	Immunology	L	T	P	C
		3	0	0	3

Course Objective:

- To discuss the structure, functions and integration of immune system.
- To mechanisms involved in immune system development and responsiveness
- To explain various techniques of monoclonal and engineered antibodies
- To understand of activation of system of a complement. Receptors. Negative immune regulation.
- To explain the antigen-antibody interactions and how the immune system is protecting the body from foreign pathogens.

Course Outcomes:

23BTC11.CO1	Ability to explain about immune system structure and functions.
23BTC11.CO2	Ability to describe immunity to various pathogens
23BTC11.CO3	Ability to know the concepts and mechanism behind tumour development, allergy and hypersensivity reactions.
23BTC11.CO4	Ability to understand the principles behind the production of therapeutic/diagnostic molecules.
23BTC11.CO5	Ability to explain about monoclonal antibodies

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BTC11.CO1	X	X	X	X	-	-	X	X	X	-	X	-	X	-	X
23BTC11.CO2	X	X	X	-	-	-	-	X	X	X	X	X	X	X	-
23BTC11.CO3	X	X	X	-	X	-	-	X	X	X	X	X	-	-	-
23BTC11.CO4	X	X	X	-	X	-	X	-	X	X	-	-	X	X	-
23BTC11.CO5	X	X	X	X	-	-	X	-	-	X	-	X	-	-	-

Unit-I Introduction to immune system **9**

Organisation and classification of immune system, immune cells and organs, innate and acquired immunity, Toll receptors and responses, classification of antigens,chemical and molecular nature; haptens, adjuvants, cytokines, complement pathway, antigen presenting cells,major histocompatibility complex

Unit-II Humoral and cellular immunity **9**

Development, maturation, activation, regulation, differentiation and classification of T-cells and Bcells, antigen processing and presentation, theory of clonal selection, TCR, antibodies: structure and functions; antibodies: genes and generation of diversity; antigen-antibody reactions

Unit-III Immunity against pathogens and tumors **9**

Inflammation; protective immune responses to virus, bacteria, fungi and parasites; tumor antigens, tumor immune response, tumor diagnosis, tumor immunotherapy

Unit-IV Immune tolerance and hypersensitivity **9**

Immune tolerance, Immuno deficiencies, Transplantation ,genetics of transplantation, laws of transplantation; Allergy and hypersensitivity , Types of hypersensitivity, Autoimmunity, Auto immune disorders and diagnosis

Unit-V Applied Immunology **9**

Monoclonal antibodies, engineering of antibodies; Classification of Vaccines, methods of vaccine development, immunodiagnostic methods (Immuno diffusion ELISA, FACS), immune modulatory drugs

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Peter J Delves, Seamus J Martin, Dennis R Burtn and Ivan M Roitt	Essential Immunology	Wiley –Blackwell	2016
2.	Judith a Owen, Jenni Punt and Sharon A Stranford, Kuby	Immunology	Macmillan International	2012

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Coico, Richard	Immunology: A Short Course	John Wiley	2008
2.	Khan, Fahim Halim	El Elements of Immunology	Pearson Education	2009
3.	Abbas. A., Lichman, A.H., Pillai, S	Cellular and Molecular Immunology	Elsevier Health Services	2017
4.	Pillai, A	A Textbook of Immunology and Immunotechnology	S.Chand& Co. New Delhi	2008
5.	Tizard, R.I	Immunology: An Introduction	Brooks/Cole publisher	2007

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23BTC12	Bioinformatics	L	T	P	C
		3	0	0	3

Course Objective:

- To understand the theory and background of commonly available bioinformatics tools
- To navigate through internet-based biological databases and genomic browsers
- To use online resources for biological applications
- To navigate through internet-based biological databases and genomic browsers
- To let the students know the recent evolution in biological science.

Course Outcomes:

23BTC12.CO1	Ability to understand the importance of bioinformatics and their basic requirements
23BTC12.CO2	Ability to apply the knowledge of bioinformatics in analysis of biological databases
23BTC12.CO3	Ability to analyze the concepts of dynamic programming
23BTC12.CO4	Ability to analyze the evolutionary concepts to build phylogenetic tree
23BTC12.CO5	Ability to evaluate the drug designing techniques with online resources

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BTC12.CO1	X	X	X	X	-	-	X	X	X	-	X	-	X	-	X
23BTC12.CO2	X	X	X	-	-	-	-	X	X	X	X	X	X	X	-
23BTC12.CO3	X	X	X	-	X	-	-	X	X	X	X	X	-	-	-
23BTC12.CO4	X	X	X	-	X	-	X	-	X	X	-	-	X	X	-
23BTC12.CO5	X	X	X	X	-	-	X	-	-	X	-	X	-	-	-

Unit-I Introduction **9**

Introduction to Bioinformatics – applications, Operating systems- types, Elementary UNIX commands, TCP/IP, Telnet, FTP, Protocols, Hardwares, Network topology, Search engines.

Unit-II Biological databases **9**

Introduction to databases – Data life cycle biological databases; Primary nucleotide databases (EMBL, GeneBank and DDBJ); Primary protein databases (SwissProt) Secondary protein databases (PROSITE); Structural databases – SCOP and CATH. Sequence retrieval from database

Unit-III Pattern matching and dynamic programming **9**

Introduction to pairwise sequence alignment – local vs. global; Dynamic programming – Needleman – Wunsch algorithm & Smith – Waterman algorithm; Dot matrix analysis; substitution matrices,BLAST – FASTA-– Statistical methods – Hidden Markov models

Unit-IV Phylogeny **9**

Introduction to multiple sequence alignment, Introduction; mutations; mutations as a measure of time; Phylogenetic analysis Distance matrix methods, character-based methods. Molecular clock theory, Bootstrapping.

Unit-V Advanced topics in bioinformatics **9**

Introduction to Systems Biology and Synthetic Biology, Microarray analysis - types and applications, Bioinformatics approaches for drug discovery.

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Lesk, A. K	Introduction to Bioinformatics	Oxford University Press	2013
2.	Dan Gusfield	Algorithms on Strings, Trees and Sequences: Computer Science and Computational Biology	Cambridge University Press	2012

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Durbin, R., Eddy, S., Krogh, A., and Mitchison, G	Biological Sequence Analysis Probabilistic Models of proteins and nucleic acids	Cambridge, UK: Cambridge University Press	2000
2.	Mount, D.W	Bioinformatics Sequence and Genome Analysis	Cold Spring Harbor Laboratory Press	2004
3.	Bergeron.B	Bioinformatics Computing	Prentice Hall of India Learning Pvt (Ltd)	2009
4.	Attwood, T.K and Parry Smith. D.J	Introduction to Bioinformatics	Pearson Education	2002
5.	Uri Alon	An Introduction to Systems Biology: Design Principles of Biological Circuits	Chapman & Hall	2006

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		L	T	P	C
23BTC13	**Downstream Processing**	**3**	**0**	**0**	**3**

Course Objective:

- To introduce the methods of separation technology
- To expose students to techniques of product fractionation
- To gain knowledge about isolation of products
- To create deeper understanding of final product purification
- To understand the methods to obtain pure proteins, enzymes

Course Outcomes:

23BTC13.CO1	Apply separation techniques used in downstream process for the purification of biomolecules
23BTC13.CO2	Analyze techniques of insoluble removal and predict the parameters for large scale operations
23BTC13.CO3	Analyze the techniques used in bulk product isolation
23BTC13.CO4	Evaluate the techniques of high-resolution product purification based on product characteristics and cost effectiveness
23BTC12.CO5	Evaluate the techniques of final product formulation

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BTC13.CO1	X	X	X	X	-	-	X	X	X	-	X	-	X	-	X
23BTC13.CO2	X	X	X	-	-	-	-	X	X	X	X	X	X	X	-
23BTC13.CO3	X	X	X	-	X	-	-	X	X	X	X	X	-	-	-
23BTC13.CO4	X	X	X	-	X	-	X	-	X	X	-	-	X	X	-
23BTC12.CO5	X	X	X	X	-	-	X	-	-	X	-	X	-	-	-

Unit-I Introduction **9**

Introduction to downstream processing, principles, characteristics of bio-molecules and bioprocesses. Cell disruption for product release – mechanical, enzymatic and chemical methods. Pre treatment and stabilisation of bio-products

Unit-II Physical methods of separation **9**

Unit operations for solid-liquid separation - filtration and centrifugation

Unit-III Isolation of products **9**

Adsorption, liquid-liquid extraction, aqueous two-phase extraction, membrane separation – ultrafiltration and reverse osmosis, dialysis, precipitation of proteins by different methods

Unit-IV Product purification **9**

Chromatography – principles, instruments and practice, adsorption, reverse phase, ion exchange, size exclusion, hydrophobic interaction, bio-affinity and pseudo affinity chromatographic techniques

Unit-V Product formulation and finishing operations **9**

Crystallization, drying and lyophilization in final product formulation.

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Belter, P.A., E.L. Cussler and Wei-Houhu	Biooseparations – Downstream Processing for Biotechnology	John Wiley	2013
2.	Sivasankar, B	Bioseparations: Principles and Techniques	PHI	2005

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Asenjo, Juan A	Separation Processes in Biotechnology	CRC / Taylor & Francis	2021
2.	Ghosh, Raja	Principles of Bio separations Engineering	World Scientific	2006
3.	R. G. Harrison, P. Todd, S. R. Rudger and D. P. Petrides	Bioseparation Science and Engineering	Oxford University Press	2003
4.	Nooralabetta Krishna Prasad	Downstream Process Technology – A new horizon in Biotechnology	PHI Learning Private Limited	2010
5.	Ajay Kumar	Bioseparation Engineering	IK Intl.Ltd	2006

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23BTC14	Plant Biotechnology	L	T	P	C
		3	0	0	3

Course Objective:

- To give the details of plant cells and its functions
- To provide the basics of agro bacterium and applications of plant biotechnology
- To introduce students to the principles, practices and application of plant tissue culture and transformation in science, agriculture and industry.
- To acquaint students with experimental design and analysis of plant biotechnology experiments.
- To give students hands-on experience and training in representative plant tissue culture and genetic engineering techniques.

Course Outcomes:

23BTC14.CO1 Ability to explain the fundamentals of plant cells, structure and functions

23BTC14.CO2 Ability to demonstrate the nitrogen fixation mechanism

23BTC14.CO3 Ability to familiarize about viral vectors

23BTC14.CO4 Ability to describe about the plant tissue culture and transgenic plants

23BTC14.CO5 Ability to explain the development of therapeutic products

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BTC14.CO1	X	X	X	X	-	-	X	X	X	-	X	-	X	-	X
23BTC14.CO2	X	X	X	-	-	-	-	X	X	X	X	X	X	X	-
23BTC14.CO3	X	X	X	-	X	-	-	X	X	X	X	X	-	-	-
23BTC14.CO4	X	X	X	-	X	-	X	-	X	X	-	-	X	X	-
23BTC14.CO5	X	X	X	X	-	-	X	-	-	X	-	X	-	-	-

Unit-I Organization of genetic material **9**

Genetic material of plant cells – nucleosome structure and its biological significance; junk and repeat sequences; outline of transcription and translation

Unit-II Chloroplast& Mitochondria **9**

Structure, function and genetic material; rubisco synthesis and assembly, coordination, regulation and transport of proteins. Mitochondria: Genome, cytoplasmic male sterility and import of proteins

Unit-III Nitrogen fixation **9**

Nitrogenase activity, nod genes, nif genes, bacteroids.

Unit-IV Agrobacterium &viral vectors **9**

Pathogenesis, crown gall disease, genes involved in the pathogenesis, Ti plasmid – t-DNA, importance in genetic engineering. Viral Vectors: Gemini virus, cauliflower mosaic virus, viral vectors and its benefits

Unit-V Application of plant biotechnology **9**

Outline of plant tissue culture, transgenic plants, herbicide and pest resistant plants, molecular pharming, therapeutic products.

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	M. K. Razdon	Introduction to Plant Tissue Culture	Oxford & IBH Publishing Company	2006
2.	S. Narayanaswamy	Plant Cell & Tissue Culture	Tata Mc Graw-Hill	2008

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	A. Slater, N. Scott and M	Fowler, Plant Biotechnology: The genetic manipulation of plants	Oxford University Press	2003
2.	Gamburg OL, Philips GC	Plant Tissue & Organ Culture fundamental Methods	Narosa Publications	2019
3.	Singh BD	Text Book of Biotechnology	Kalyani Publishers	2005
4.	Heldt HW	Plant Biochemistry & Molecular Biology	Oxford University Press	2020
5.	Ignacimuthu .S	Applied Plant Biotechnology	Tata McGraw Hill	2015

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		L	T	P	C
23BTC15	**Mass Transfer Operations**	**2**	**2**	**0**	**3**

Course Objective:

- To explain the basic principles of mass transfer operations and other separation processes with examples.
- To impart knowledge on how certain substances undergo the physical change with diffusion/mass transfer of components from one phase to other phases.
- To focus on absorption and distillation operations and the process design aspects of the same operations.
- To understand extraction and leaching operations and their applications in bioprocessing industry.
- To understand adsorption and drying operations and the process design aspects of the same operations

Course Outcomes:

23BTC15.CO1	Ability to define the basic principles of mass transfer operations and the measurement of diffusivity, mass transfer coefficient
23BTC15.CO2	Ability to understand the importance of mass transfer phenomena in the design of process equipment in distillation operations
23BTC15.CO3	Ability to understand the HETP, NTU and HTU concepts of various gas absorption packed tower columns
23BTC15.CO4	Ability to understand the design aspects of extraction and various leaching equipments
23BTC15.CO5	Ability to understand the importance of adsorption and drying processes and their industrial applications

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BTC15.CO1	X	X	X	X	-	-	X	X	X	-	X	-	X	-	X
23BTC15.CO2	X	X	X	-	-	-	-	X	X	X	X	X	X	X	-
23BTC15.CO3	X	X	X	-	X	-	-	X	X	X	X	X	-	-	-
23BTC15.CO4	X	X	X	-	X	-	X	-	X	X	-	-	X	X	-
23BTC15.CO5	X	X	X	X	-	-	X	-	-	X	-	X	-	-	-

Unit-I Diffusion and mass transfer **9**

Molecular diffusion in fluids and solids; Interphase Mass Transfer; Mass Transfer coefficients; Analogies in Transport Phenomenon.

Unit-II Gas liquid operations **9**

Principles of gas absorption; Single and multi component absorption; Absorption with Chemical Reaction; Design principles of absorbers; Industrial absorbers; HTU, NTU concepts

Unit-III Vapour liquid operations **9**

V-L Equilibria; Simple, Steam and Flash Distillation; Continuous distillation; McCabe-Thiele &Ponchon, Savarit Principles; Industrial distillation equipments, HETP, HTU and NTU concepts.

Unit-IV Extraction operations **9**

L-L equilibria, Staged and continuous extraction, Solid-liquid equilibria, Leaching Principles.

Unit-V Solid fluid operations **9**

Adsorption equilibria – Batch and fixed bed adsorption; Drying-Mechanism-Drying curves, Time of Drying; Batch and continuous dryers..

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Treybal R.E	Mass Transfer Operations	Mcgraw Hill	2017
2.	Geankoplis C.J	Transport Processes and Unit Operations	Prentice Hall of India	2002

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Coulson and Richardson's	Chemical Engineering. Vol I & II	Asian Books Pvt Ltd	1998
2.	Rajput, R.K	Heat and Mass Transfer	S. Chand and Co	2008
3.	G. K. Roy	Fundamentals of Heat and Mass Transfer	Kanna Publications	2004
4.	W. L. McCabe, J.C. Smith and P. Harriott	Unit Operations in Chemical Engineering	Tata McGraw-Hill Professional	2005
5.	Gavahne. K.A., Unit Operations-II	Heat & Mass Transfer	Nirali prakasan	2012

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23BTC16	Chemical Reaction Engineering	L	T	P	C
		2	2	0	3

Course Objective:

- To impart the basic concepts in reaction kinetics
- To provide the information about different reactor systems and deriving the performance equations for different reactor systems.
- To develop knowledge for design of non-ideal reactors
- To develop knowledge for design of ideal reactors
- To acquire knowledge in heterogeneous reactions and reactor types.

Course Outcomes:

23BTC16.CO1	Ability to elucidate the basic laws on chemical kinetics and its application on different types of reactions
23BTC16.CO2	Ability to apply the various ideal reactors and their design equations
23BTC16.CO3	Ability to elaborate the non-ideal behavior of reactors
23BTC16.CO4	Ability to conceptualize the basic of heterogeneous reacting systems
23BTC16.CO5	Ability to identify and analyse the various multiphase reactors

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BTC16.CO2	X	X	X	X	-	-	X	X	X	-	X	-	X	-	X
23BTC16.CO3	X	X	X	-	-	-	-	X	X	X	X	X	X	X	-
23BTC16.CO4	X	X	X	-	X	-	-	X	X	X	X	X	-	-	-
23BTC16.CO5	X	X	X	-	X	-	X	-	X	X	-	-	X	X	-
23BTC16.CO2	X	X	X	X	-	-	X	-	-	X	-	X	-	-	-

Unit-I Scope of chemical kinetics & chemical reaction engineering **9**

Broad outline of chemical reactors; rate equations; concentration and temperature dependence; development of rate equations for different homogeneous reactions. Industrial scale reactors.

Unit-II Ideal reactors **9**

Isothermal batch, flow, semi-batch reactors; performance equations for single reactors; multiple reactor systems; multiple reactions.

Unit-III Non ideal reactors **9**

RTD in non-ideal flow; non-ideal flow models; reactor performance with non-ideal flow

Unit-IV Ideal flow and non-ideal flow **9**

Resistances and rate equations; heterogeneous catalysis; reactions steps; resistances and rate equations.

Unit-V Fixed bed and fluid bed reactors **9**

G/L reactions on solid catalysis; trickle bed, slurry reactors; three phase-fluidized beds; reactors for fluid-fluid reactions; tank reactors.

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Levenspiel O	Chemical Reaction Engineering	John Wiley	2006
2.	Fogler H.S	Elements Of Chemical Reaction Engineering	Prentice Hall India	2002

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Missen R.W., Mims C.A., Saville B.A	Introduction to Chemical Reaction Engineering and Kinetics	John Wiley	2005
2.	Dawande, S.D	Principles of Reaction Engineerig	Central Techno Publications	2001
3.	Richardson, J.F. and Peacock, D.G, Coulson Richardson	Chemical Engineering Vol.III	Butterworth-Heinemann-Elsevier	2006
4.	Walker, D	Chemical Reactions	Evans Brothers	2007
5.	Forment G F and Bischoff K B	Chemical Reactor Analysis and Design	John Wiley A	2010

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23BTC19	Protein and Enzyme Engineering Laboratory	L	T	P	C
		0	0	3	1

Course Objective:

- To Provide knowledge on qualitative analysis of biomolecules
- To understand the concept of quantitative estimation of biomolecules
- To learn the principle and procedure for enzyme and protein purifications
- To know the specific activity and kinetics of enzymes

Course Outcomes:

23BTC19.CO1 Ability to differentiate qualitative analysis of biomolecules

23BTC19.CO2 Ability to assess quantitative estimation of biomolecules

23BTC19CO3 Ability to Construct the purification pattern for the given enzyme

23BTC19.CO4 Ability to compare the kinetic characteristics of free and immobilized enzymes

23BTC19.CO5 Ability to analyze the protein expression pattern

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BTC19.CO1	X	X	X	X	X	-	X	-	X	-	X	X	X	-	-
23BTC19.CO2	X	X	X	X	X	X	X	-	-	-	X	X	-	-	-
23BTC19CO3	X	X	X	X	-	-	X	-	X	-	-	X	-	X	-
23BTC19.CO4	X	X	X	-	X	X	X	-	-	-	X	-	-	-	X
23BTC19.CO5	X	X	-	X	X	-	X	-	X	-	X	-	-	-	-

Sl.No.	List of Experiments
1.	Qualitative tests for carbohydrates -distinguishing reducing from non-reducing sugars and keto from aldo sugars
2.	Quantitative method for amino acid estimation using ninhydrin -distinguishing amino acid from imino acid
3.	Protein estimation by Bluret and Lowrys methods
4.	Protein estimation by Bradford and spectroscopic methods
5.	Identification of enzyme in different sources
6.	Enzymatic assay: phosphatase from potato.
7.	Isolation of α-amylase from different sources
8.	Determination of α-amylase enzyme activity
9.	Digestion of milk protein into amino acids with quantification
10.	Immobilization of enzymes using gel entrapment method

Total Periods: 30

23BTC20	Microbiology laboratory	L	T	P	C
		0	0	3	1

Course Objective:

- To provide knowledge on laboratory safety and sterilization techniques.
- To understand the concept of culture media.
- To gain a preliminary understanding of staining techniques.
- To enhance awareness of isolation of microorganism from various sources
- To develop rudimentary ability to parameters of microbial growth.

Course Outcomes:

23BTC20.CO1 Ability to differentiate the microorganisms.

23BTC20.CO2 Ability to assess culture medias.

23BTC20.CO3 Ability to analyze the staining techniques

23BTC20.C04 Ability to emphasize the isolation of microorganisms

23BTC20.CO5 Ability to analyze the parameters for the microbial growth.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BTC20.CO1	X	-	-	-	X	-	X	-	X	-	X	X	X	-	-
23BTC20.CO2	X	X	X	-	X	X	X	-	X	-	X	X	X	-	-
23BTC20.CO3	X	X	X	-	X	-	X	-	X	-	X	X	-	X	-
23BTC20.C04	X	-	X	X	X	X	X	-	X	-	X	X	X	X	X
23BTC20.CO5	X	X	X	X	X	-	X	-	X	-	X	X	-	-	-

Sl.No.	List of Experiments
1.	Laboratory safety and sterilization techniques-Dry heat sterilization (Autoclave, hot air oven)
2.	Microscopic methods in the identification of microorganisms
3.	Preparation of culture media – nutrient broth and nutrient agar
4.	Culturing of microorganisms – in broth and in plates (pour plates, streak plates, spread plates isolation andpreservation of bacterial cultures)
5.	Staining techniques – Grams' and differential, lactophenol cotton blue
6.	Quantification of microorganisms-serial dilution and plating
7.	Effect of disinfectants on microbial flora
8.	Isolation of microorganisms from different sources – soil, water and milk
9.	Antibiotic sensitivity assay
10.	Growth curve – observation and growth characteristics of bacteria.
11.	Effect of different parameters on bacterial growth (pH, temperature, and substrate concentration)

Total Periods: 30

23BTC21	Instrumental Methods of Analysis Laboratory	L	T	P	C
		0	0	3	1

Course Objective:

- To provide students an exposure to spectroscopic methods.
- To have a practical hands on experience on Absorption Spectroscopic methods
- To acquire experience in the purification by performing thin layer chromatography
- To validate and analysis using spectrometric and microscopic techniques
- To enhance the knowledge on columnchromatography

Course Outcomes:

23BTC21.CO1 Ability to differentiate the spectroscopic methods.

23BTC21.CO2 Ability to assess absorption spectroscopic methods.

23BTC21.CO3 Ability to analyze the thin layer chromatography.

23BTC21.CO4 Ability to emphasize the spectrometric and microscopic techniques.

23BTC21.CO5 Ability to analyze the column chromatography

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BTC21.CO1	X	X	X	X	X	-	X	-	X	X	X	X	X	-	-
23BTC21.CO2	-	X	X	-	X	X	X	-	X	X	X	-	X	-	-
23BTC21.CO3	-	-	X	X	X	-	X	-	X	X	X	-	-	X	-
23BTC21.CO4	X	X	X	X	X	X	X	-	X	X	-	X	-	-	X
23BTC21.CO5	X	X	X	X	X	-	X	-	X	X	X	X	-	-	-

Sl.No.	List of Experiments
1.	Precision and validity in an experiment using absorption spectroscopy.
2.	Validating Lambert-Beer's law using KMnO4
3.	Finding the molar absorbtivity and stoichiometry of the Fe (1,10 phenanthroline) using absorption spectrometry.
4.	Finding the pKa of 4-nitrophenol using absorption spectroscopy.
5.	UV spectra of nucleic acids.
6.	Chemical actinometry using potassium ferrioxolate.
7.	Estimation of SO4-- by nephelometry.
8.	Estimation of Al3+ by Flourimetry.
9.	Limits of detection using aluminium alizarin complex.
10.	Chromatography analysis using TLC.
11.	Chromatography analysis using column chromatography.

Total Periods: 30

23BTC22	Molecular biology laboratory	L	T	P	C
		0	0	3	1

Course Objective:

- To provide hands-on experience in performing basic molecular biology techniques.
- To introduce students to the theory behind in each technique
- To describe common applications of each methodology in biological research.
- To take up specialized project in Molecular biology
- To develop pre-requisite knowledge for research work.

Course Outcomes:

23BTC22.CO1	Ability to demonstrate knowledge and understanding of the principles underpinning important techniques in molecular biology.
23BTC22.CO2	Ability to demonstrate knowledge and understanding of applications of these techniques.
23BTC22.CO3	Ability to demonstrate the ability to carry out laboratory experiments and interpret the results.
23BTC22.CO4	Ability to aware of the hazardous chemicals and safety precautions in case of emergency.
23BTC22.CO5	Ability to perform electrophoresis techniques

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BTC22.CO1	X	X	X	X	X	-	X	-	X	X	X	X	X	-	-
23BTC22.CO2	X	X	X	X	X	X	X	-	X	X	X	X	X	-	-
23BTC22.CO3	-	X	X	X	-	-	X	-	X	X	X	-	-	X	-
23BTC22.CO4	X	X	X	X	X	X	X	-	-	-	X	-	-	-	X
23BTC22.CO5	X	-	-	X	-	-	X	-	X	-	X	X	-	-	-

Sl.No.	List of Experiments
1.	Electrophoresis -Agarose and Polyacrylamide Gel
2.	Isolation of microbial DNA
3.	Isolation of genomic DNA
4.	Quantification of DNA (UV/ Vis) and analysis of purity
5.	Restriction enzyme digestion & Ligation
6.	Competent cells preparation
7.	Transformation
8.	Selection of recombinants – Antibiotic sensitivity assay
9.	Plating of λ phage
10.	Lamda phage lysis of liquid cultures

Total Periods: 30

23BTC23	Genetic Engineering Laboratory	L	T	P	C
		0	0	3	1

Course Objective:

- To provide students an exposure to cloning techniques.
- To ensure that students begin to understand the gene amplification methods.
- To gain a preliminary understanding of genetic and biotechnological techniques.
- To enhance awareness of hazardous chemicals
- To develop rudimentary ability to blotting techniques

Course Outcomes:

23BTC23.CO1	Ability to describe the main principles, methods for preparation and cloning of DNA in various organisms.
23BTC23.CO2	Ability to express clearly about the gene amplification and methods for analysis of DNA, such as hybridization, restriction analysis and gene expressions.
23BTC23.CO3	Ability to use genetic and biotechnological techniques to manipulate genetic materials and develops newand improved living organisms.
23BTC23.CO4	Ability to aware of the hazardous chemicals and safety precautions in case of emergency..
23BTC23.CO5	Ability to perform blotting techniques

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BTC23.CO1	X	X	X	X	-	-	X	-	X	X	X	X	X	-	-
23BTC23.CO2	-	X	-	X	X	X	X	-	X	X	X	X	X	-	-
23BTC23.CO3	-	X	X	X	-	-	X	-	X	-	X	-	-	X	-
23BTC23.CO4	X	X	X	-	X	X	X	-	-	-	X	-	-	-	X
23BTC23.CO5	X	X	X	X	X	-	X	-	X	-	X	X	-	-	-

Sl.No.	List of Experiments
1.	Preparation of plasmid DNA
2.	Elution of DNA from agarose gels
3.	Restriction digestion
4.	Ligation of DNA into expression vectors
5.	Transformation& Selection of recombinants – Blue white screening assay
6.	Optimisation of time of inducer for recombinant protein expression
7.	Expression of protein profiling by SDS - PAGE
8.	Western blotting, Southern blotting
9.	PCR amplification of genes
10.	Colony lysate PCR.

Total Periods: 30

23BTC24	Bioprocess Engineering laboratory	L	T	P	C
		0	0	3	1

Course Objective:

- To provide students an exposure to enzyme kinetics.
- To ensure that students begin to understand the growth kinetics of microorganism
- To gain a preliminary understanding of approaches of enzyme inhibition
- To enhance awareness of immobilization
- To develop rudimentary ability to optimization techniques

Course Outcomes:

23BTC24.CO1	Ability to explain about Enzyme kinetics and characterization and how to use them for practical applications.
23BTC24.CO2	Ability to evaluate the growth kinetics of microorganisms and become adept with medium optimization techniques.
23BTC24.CO3	Ability to determine an experimental objective, understand the theory behind the experiment, and operate the relevant equipment safely.
23BTC24.CO4	Ability to demonstrate good lab citizenry and the ability to work in team.
23BTC24.CO5	Ability to perform optimization techniques

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BTC24.CO1	X	X	X	X	X	-	X	-	X	X	X	X	X	-	-
23BTC24.CO2	X	-	-	X	X	X	-	-	X	-	X	X	X	-	-
23BTC24.CO3	-	X	X	X	X	-	X	-	X	X	X	-	-	X	-
23BTC24.CO4	X	X	-	X	-	X	-	-	-	-	X	-	-	-	X
23BTC24.CO5	X	X	X	X	X	-	X	X	X	-	X	X	-	-	-

Sl.No.	List of Experiments
1.	Enzyme kinetics – Determination of Michaelis - Menten parameters
2.	Enzyme inhibition kinetics
3.	Enzyme immobilization – Gel entrapment
4.	Growth of Bacteria – Estimation of Biomass, Calculation of Specific Growth Rate, Yield Coefficient
5.	Optimization by Response Surface Methodology
6.	Estimation of KLa – Sulphite Oxidation Method
7.	Estimation of Overall Heat Transfer Coefficient
8.	Batch Sterilization kinetics
9.	Residence time distribution
10.	Fed batch cultivation and Total cell retention cultivation

Total Periods: 30

23BTC25	Immunology laboratory	L	T	P	C
		0	0	3	1

Course Objective:

- To provide students an exposure to immune system cells and tissues
- To ensure that students begin to understand immunological test
- To gain a preliminary understanding of lymphocytes and monocytes
- To enhance awareness of various immune systems
- To develop rudimentary ability to immune cells

Course Outcomes:

23BTC25.CO1 Ability to aware of immune system cells and tissues

23BTC25.CO2 Ability to have knowledge on immunological /clinical tests.

23BTC25.CO3 Ability to isolate lymphocytes and monocytes.

23BTC25.CO4 Ability to identify various immune system cells.

23BTC25.CO5 Ability to differentiate the immune cells

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BTC25.CO1	-	X	X	X	X	X	X	-	X	-	X	X	X	-	-
23BTC25.CO2	X	X	X	-	-	X	X	X	X	-	-	X	X	-	-
23BTC25.CO3	X	-	-	X	X	-	X	X	X	X	-	-	-	X	-
23BTC25.CO4	-	X	X	-	-	X	X	-	-	X	-	-	-	-	X
23BTC25.CO5	X	X	X	X	X		X	X	X	X	X	X	-	-	-

Sl.No. **List of Experiments**

1. Identification of immune cells in a blood smear
2. Identification of blood group
3. Testing for typhoid antigens by Widal test
4. Immunodiffusion – Ouchterlony Double Diffusion
5. Immunoelectrophoresis – Rocket or Counter Current immunoelectrophoresis
6. Enzyme Linked ImmunoSorbent Assay (ELISA)
7. Isolation of peripheral blood mononuclear cells
8. Isolation of monocytes from blood
9. Immunofluorescence
10. Identification of t cells by T-cell rossetting using sheep RBC.

Total Periods: 30

23BTC26	Computational biology laboratory	L	T	P	C
		0	0	3	1

Course Objective:

- To provide students an exposure to sequence retrieval from databases
- To ensure that students begin to pair wise sequence alignment
- To gain a preliminary understanding of multiple sequence alignment
- To develop rudimentary ability to phylogenetic analysis
- To gain knowledge on 3D structure of protiens.

Course Outcomes:

23BTC26.CO1 Ability to retrieve the sequence for databases.

23BTC26.CO2 Ability to align the sequence by pair wise alignment

23BTC26.CO3 Ability to align the sequence by multiple sequence alignment

23BTC26.CO4 Ability to identify the phylogenetic analysis

23BTC26.CO5 Ability to emphasize the protein structures.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BTC26.CO1	-	-	X	X	X	-	X	-	X	-	X	X	X	-	-
23BTC26.CO2	X	X	-	X	-	X	-	X	X	-	X	X	X	-	-
23BTC26.CO3	X	X	X	-	X	-	X	-	X	-	X	-	-	X	-
23BTC26.CO4	-	-	X	X	X	X	-	X	-	-	X	-	-	-	X
23BTC26.CO5	X	X	-	X	X	-	X	-	X	-	X	X	-	-	-

Sl.No.	List of Experiments
1.	Retrieving files and information from biological databases (NCBI, PDB, PubChem)
2.	Sequence alignment –BLAST
3.	Sequence alignment –FASTA
4.	Sequence alignment -Clustal Omega
5.	Multiple Sequence alignment
6.	Protein 3D structure visualization
7.	Molecular phylogenetic analysis
8.	Gene annotation and gene finding
9.	Molecular modeling of protein and its visualization
10.	Computer aided drug design with online tools

Total Periods: 30

23BTC27	Downstream Processing laboratory	L	T	P	C
		0	0	3	1

Course Objective:

- To provide students an exposure to separation of whole cells.
- To ensure that students begin to understand the cell disruption techniques
- To gain a preliminary understanding of extraction and evaporation
- To develop rudimentary ability to respond to filtration techniques
- To gain knowledge on chromatographic techniques.

Course Outcomes:

23BTC27.CO1	Acquired knowledge for the separation of whole cells and other insoluble ingredients from the culture broth.
23BTC27.CO2	Learned cell disruption techniques to release intracellular products
23BTC27.CO3	Learned various techniques like evaporation, extraction, precipitation, membrane separation for concentrating biological products
23BTC27.CO4	Learned the basic principles and techniques of chromatography to purify the biological products and formulate the products for different end uses.
23BTC27.CO5	Ability to emphasize the filtration techniques

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BTC27.CO1	X	X	X	X	X	-	X	-	X	-	X	X	X	-	-
23BTC27.CO2	-	-	X	X	X	X	X	-	X	-	X	X	X	-	-
23BTC27.CO3	X	X	-	X	-	-	X	-	X	-	X	-	-	X	-
23BTC27.CO4	X	X	X	X	X	X	X	-		-	X	-	-	-	X
23BTC27.CO5	X	X	X	X	X	-	X	-	X	-	X	X	-	-	-

Sl.No.	List of Experiments
1.	Solid liquid separation – centrifugation.
2.	Solid liquid separation – microfiltration
3.	Cell disruption techniques – ultrasonication or French pressure cell or Dyno mill
4.	Precipitation – ammonium sulphite precipitation
5.	Ultra filtration separation
6.	Aqueous two phase extraction of biologicals
7.	High resolution purification – affinity chromatography
8.	High resolution purification – ion exchange chromatography
9.	Product polishing – spray drying or freeze drying
10.	Size exclusion chromatography

Total Periods: 30

23BTE01	Food Technology	L	T	P	C
		3	0	0	3

Course Objective:

- To acquire knowledge about food and energy
- To know about the general aspects in food.
- To gain knowledge about the production of food products
- To know the fundamentals of preservation methods
- To know different packing materials for the preservation of foods.

Course Outcomes:

23BTE01.CO1 Ability to differentiate the constituents present in food

23BTE01.CO2 Ability to understand the processing methods

23BTE01.CO3 Ability to distinguish the production and utilization of food.

23BTE01.CO4 Ability to know the preservation methods

23BTE01.CO5 Ability to understand the concept of food packing materials.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BTE01.CO1	X	X	X	X	-	-	X	X	X	-	X	-	X	-	X
23BTE01.CO2	X	X	X	-	-	-	-	X	X	X	X	X	X	X	-
23BTE01.CO3	X	X	X	-	X	-	-	X	X	X	X	X	-	-	-
23BTE01.CO4	X	X	X	-	X	-	X	-	X	X	-	-	X	X	-
23BTE01.CO5	X	X	X	X	-	-	X	-	-	X	-	X	-	-	-

Unit-I Food constituents and derivative factors **9**

Constituents of food – carbohydrates, lipids, proteins, vitamins and minerals, food additives; deteriorative factors and their control.

Unit-II General engineering aspects and processing methods **9**

Preliminary processing methods; conversion and preservation operations

Unit-III Production and utilization of food products **9**

Cereal grains; pulses; vegetables; fruits; spices; fats and oils; bakery; confectionery and chocolate products; soft and alcoholic beverages; dairy products; meat; poultry and fish products

Unit-IV Preservation method **9**

Preservation by heat and cold; Dehydration; Frying; Drying; Irradiation; Microwave heating sterilization and pasteurization; fermentation and pickling

Unit-V Food packaging **9**

Basic packaging materials, types of packaging materials used for different kinds of foods, HACCP Introduction and Principles, Introduction to Food Labeling.

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	B. Sivasanker	Food Processing & Preservation	Prentice-Hall Of India Pvt. Ltd.	2002
2.	Potter N.N.	Food Science	The AVI Publishing Co., Westport	2006

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	W.C. Frazier & D.C. Westhoff	Food Microbiology	Mcgraw-Hill Book Co.,	2017
2.	J.M. Jay	Modern Food Microbiology	Cbs Publications	2020
3.	Barbosa-Canovas, G. V., &Ibarz, A	Introduction to food process engineering	CRC Press	2014
4.	Sahu, J. K	Introduction to advanced food process engineering	CRC Press	2014
5.	P. Coultate	Food – The Chemistry of Its Components	Royal Society, London	1992

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23BTE02	Animal biotechnology	L	T	P	C
		3	0	0	3

Course Objective:

- To provide the fundamentals of animal cell culture
- To gain knowledge in animal diseases
- To know the fundamental therapies for animal diseases
- To offer the knowledge about the micromanipulation
- To provide the basics of transgenic animals

Course Outcomes:

23BTE02.CO1 Ability to understand the animal cell culture

23BTE02.CO2 Ability to know the animal diseases and its diagnosis

23BTE02.CO3 Ability to gain the knowledge for therapy of animal infections

23BTE02.CO4 Ability to know the concepts of micromanipulation technology

23BTE02.CO5 Ability to use the knowledge gained in in the field of clinical research

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BTE02.CO1	X	X	_	X	-	-	X	X	X	-	X	-	X	-	X
23BTE02.CO2	X	X	_	-	X	X	-	X	_	X	X	X	X	X	-
23BTE02.CO3	X	_	X	-	X	-	-	X	X	X	X	X	-	-	-
23BTE02.CO4	X	X	X	-	X	-	X	-	X	X	-	-	X	X	-
23BTE02.CO5	X	X	X	X	-	-	X	-	-	X	-	X	-	-	-

Unit-I Animal cell culture **9**

Introduction to basic tissue culture techniques; chemically defined and serum free media; animal cell cultures, their maintenance and preservation; various types of cultures suspension cultures, continuous flow cultures, immobilized cultures; somatic cell fusion; cell cultures as a source of valuable products; organ cultures

Unit-II Animal diseases andtheir diagnosis **9**

Bacterial and viral diseases in animals; monoclonal antibodies and their use in diagnosis; molecular diagnostic techniques like PCR, in-situ hybridization; northern and southern blotting; RFLP

Unit-III Therapy ofanimal diseases **9**

Recombinant cytokines and their use in the treatment of animal infections; monoclonal antibodies in therapy; vaccines and their applications in animal infections; gene therapy for animal diseases

Unit-IV Micromanipulation of embryo's **9**

What is micromanipulation technology; equipments used in micromanipulation; enrichment of x and y bearing sperms from semen samples of animals; artificial insemination and germ cell manipulations; in vitro fertilization and embryo transfer; micromanipulation technology and breeding of farm animals

Unit-V Transgenic animals **9**

Concepts of transgenic animal technology; strategies for the production of transgenic animals and their importance in biotechnology; stem cell cultures in the production of transgenic animals

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	RangaM.M	Animal Biotechnology	Agrobios India Limited	2002
2.	Ramadass P, Meera Rani S	Text Book Of Animal Biotechnology	Akshara Printers	2015

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Masters J.R.W	Animal Cell Culture: Practical Approach	Oxford University Press	2010
2.	Freshney R I	Culture of Animal Cells	Wiley-Liss	2008
3.	Spier RE and Griffiths JB	Animal Cell Biotechnology	Academic Press	2016
4.	Channarayappa	Molecular Biotechnology: Principles and Practices	University Press (India) Pvt. Ltd	2006
5.	Murray Moo- Young	Animal Biotechnology	Pergamon Press	2019

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23BTE03	Chemistry of medicines	L	T	P	C
		3	0	0	3

Course Objective:

- To impart comprehensive understanding of the chemical basis of drug action including physicochemical and steric properties of drug.
- To gain knowledge about the drugs acting on central nervous system
- To study the classification, chemical nomenclature, generic names and synthesis of various medicinal agents
- To understand the structure activity relationship, biochemical / molecular basis of mechanism of action and uses of drug.
- To gain knowledge about the drugs acting on cardiovascular system

Course Outcomes:

23BTE03.CO1	Ability to gain an appreciation of importance of the physical properties of drugs with respect to the ionization, solubility and efficacy of drugs
23BTE03.CO2	Ability to understand how changes in the chemical structure of drugs affect efficacy
23BTE03.CO3	Ability to obtain a working knowledge of chemical structures and nomenclature
23BTE03.CO4	Ability to develop the ability to suggest suitable techniques to synthesis different drug molecules.
23BTE03.CO5	Ability to understand how current drugs were developed and demonstrate the importance of chemistry in the development and application of therapeutic drugs.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BTE03.CO1	X	X	X	X	-	-	X	X	X	-	X	-	X	-	X
23BTE03.CO2	_	X	_	X	X	X	-	X	_	X	X	X	X	X	-
23BTE03.CO3	X	X	X	X	X	-	-	X	X	X	X	X	-	-	-
23BTE03.CO4	X	X	X	-	X	X	X	X	X	X	-	-	X	X	-
23BTE03.CO5	X	X	X	X	-	-	X	-	-	X	-	X	-	-	-

Unit-I Principles of medicinal chemistry **9**

Physicochemical properties in relation to biological action: Ionization, Drug distribution and pKa values and their relation to drug transport, hydrogen bonding, redox potential, surface activity and chelation. Steric properties of drugs: optical and geometrical isomerism. Functional group and their effects of on drug action: steric effect, concept of isosterism, bioisosterism, homologs and analogs.

Unit-II Drugs acting on synaptic and neuro-effector junction sites **9**

Classification, biochemical/molecular basis of mechanism of action, structure activity relationship including stereo chemical aspects, physiochemical properties and synthesis of selected drugs belonging to the class of Cholinergics, Anticholinergics, Anticholinesterases and Adrenergics

Unit-III Drugs acting on the central nervous system **9**

Classification, biochemical/molecular basis of mechanism of action, structure activity relationship and synthesis of Hypnotics and Sedatives, Opioid analgesics, Anticonvulsants and Psychopharmacological agents (neuroleptics, antidepressants, anxiolytics).

Unit-IV Drugs acting on cardiovascular system **9**

Structural basis of mechanism of action, structure activity relationship including stereo chemical aspects, physiochemical properties, and synthesis of selected drugs belonging to the class of anti- anginal, vasodilators, calcium channel blockers and cardiac glycosides

Unit-V Autocoids **9**

Synthetic procedures, mode of action, uses, structure activity relationship including physicochemical properties of the following classes of drugs Antihistamines, Eicosanoids, Analgesic-antipyretics, Anti-inflammatory (non-steroidal) agents

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Ashutosh Kar	Medicinal Chemistry	New Age International (P) Ltd.	2015
2.	Graham L. Patrick	An introduction to Medicinal Chemistry	Oxford University Press	2017

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Ilango, K. and Valentina, P	Text book of Medicinal Chemistry	Keerthi Publishers	2007
2.	Donald J. Abraham, Burger's	Medicinal Chemistry and Drug Discovery	John Wiley and Sons	2003
3.	Oliver Kayser and Heribert Warzecha	Pharmaceutical Biotechnology: Drug Discovery and Clinical Applications	John Wiley and Sons	2012
4.	Gary Walsh	Biopharmaceutical technology-biochemistry and biotechnology	John Wiley and Sons	2005
5.	Remington	Pharmaceutical sciences	Mack publishing and Co	2000

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23BTE04	Life Style Diseases	L	T	P	C
		3	0	0	3

Course Objective:

- To understand different types of diseases caused by life style
- To acquire in depth knowledge about cancer
- To know about the cardiovascular diseases
- To understand about diabetes and obesity
- To familiarize about respiratory disease

Course Outcomes:

23BTE04.CO1	Ability to explain about the diseases caused by life style.
23BTE04.CO2	Ability to identify the types of cancer.
23BTE04.CO3	Ability to describe about the cardiovascular diseases.
23BTE04.CO4	Ability to explain about diabetes and obesity.
23BTE04.CO5	Ability to identify the respiratory diseases.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23GES06.CO1	X	X	X	X	-	-	X	-	X	X	X	X	X	-	-
23GES06.CO2	X	X	X	X	X	-	-	X	X	-	-	-	-	-	-
23GES06.CO2	X	X	X	-	X	-	X	-	X	X	X	-	X	X	-
23GES06.CO4	X	X	X	-	X	-	X	-	X	-	-	-	-	-	X
23GES06.CO5	X	X	X	X	-	-	X	-	X	-	X	-	X	-	X

Unit-I Introduction **9**

Lifestyle diseases – Definition ; Risk factors – Eating, smoking, drinking, stress, physical activity, illicit drug use ; Obesity, diabetes, cardiovascular diseases, respiratory diseases, cancer; Prevention – Diet and exercise.

Unit-II Cancer **9**

Types - Lung cancer, Mouth cancer, Skin cancer, Cervical cancer, Carcinoma oesophagus; Causes Tobacco usage, Diagnosis – Biomarkers, Treatment.

Unit-III Cardiovascular Diseases **9**

Coronoary atherosclerosis – Coronary artery disease; Causes -Fat and lipids, Alcohol abuse -– Diagnosis - Electrocardiograph, echocardiograph, Treatment, Exercise and Cardiac rehabilitation.

Unit-IV Diabetes and Obesity **9**

Types of Diabetes mellitus; Blood glucose regulation; Complications of diabetes – Pediatric and adolescent obesity – Weight control and BMI.

Unit-V Respiratory Diseases **9**

Chronic lung disease, Asthma, COPD; Causes - Breathing pattern (Nasal vs mouth), Smoking – Diagnosis - Pulmonary function testing.

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	R.Kumar and Meenal Kumar	Guide to Prevention of Lifestyle Diseases	Deep & Deep Publications	2004
2.	Gary Eggar	Lifestyle Medicine	Academic Press	2017
3.	R.Kumar and Meenal Kumar	Guide to Prevention of Lifestyle Diseases	Deep & Deep Publications	2004

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Akira Miyazaki	New Frontiers in Lifestyle-Related Disease	Springer	2008
2.	William O Foye, Thomas L Lemke, David A Williams Foye's	Principles of Medicinal Chemistry	Wolters Kluwer Health Adis (ESP) Publisher	2019
3.	James M.R	Lifestyle Medicine	CRC Press	2022
4.	David E. B, Edward R. A. and Carl A. B	Fundamentals of Molecular Diagnostics	Saunders Group	2007
5.	Betty A. F., Daniel F. S., Alice S. W. and Ernest A. T	Bailey & Scott's Diagnostic Microbiology	Mosby Inc	2007

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23BTE05	**Intellectual Property Rights**	L	T	P	C
		3	0	0	3

Course Objective:

- To understand the basics of IPR
- To acquire in depth in registration of IPR
- To know the agreements and legislations
- To develop skills about digital products and law
- To familiarize about enforcement of IPR

Course Outcomes:

23BTE05.CO1	Ability to explain about IPR
23BTE05.CO2	Ability to identify the registration of IPR
23BTE05.CO3	Ability to describe about agreements and legislations
23BTE05.CO4	Ability to explain about digital products
23BTE05.CO5	Ability to describe about enforcement of IPR

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23GES05.CO1	X	X	X	X	-	-	X	-	X	-	X	X	X	-	-
23GES05.CO2	X	X	X	-	-	-	X	-	X	X	X	X	X	-	-
23GES05.CO2	X	X	X	-	X	-	X	-	-	-	X	X	-	X	-
23GES05.CO4	X	X	X	X	X	-	X	-	X	-	-	-	-	-	-
23GES05.CO5	X	X	X	X	-	-	X	-	X	-	-	-	X	-	-

Unit-I Introduction **9**

Introduction to IPRs, Basic concepts and need for Intellectual Property - Patents, Copyrights, Geographical Indications, IPR in India and Abroad – Genesis and Development – the way from WTO to WIPO –TRIPS, Nature of Intellectual Property, Industrial Property, technological Research, Inventions and Innovations – Important examples of IPR.

Unit-II Registration of IPRs **9**

Meaning and practical aspects of registration of Copy Rights, Trademarks, Patents, Geographical Indications, Trade Secrets and Industrial Design registration in India and Abroad

Unit-III Agreements And Legislations **9**

International Treaties and Conventions on IPRs, TRIPS Agreement, PCT Agreement, Patent Act of India, Patent Amendment Act, Design Act, Trademark Act, Geographical Indication Act.

Unit-IV Digital products and law **9**

Digital Innovations and Developments as Knowledge Assets – IP Laws, Cyber Law and Digital Content Protection – Unfair Competition – Meaning and Relationship between Unfair Competition and IP Laws – Case Studies.

Unit-V Enforcement of IPR **9**

Infringement of IPRs, Enforcement Measures, Emerging issues – Case Studies

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	V. Scople Vinod	Managing Intellectual Property	Prentice Hall of India pvt Ltd	2012
2.	S. V. Satakar	Intellectual Property Rights and Copy Rights	Ess Ess Publications	2003

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Deborah E. Bouchoux	Intellectual Property: The Law of Trademarks, Copyrights, Patents and Trade Secrets	Cengage Learning	2012
2.	Prabuddha Ganguli	Intellectual Property Rights: Unleashing the Knowledge Economy	McGraw Hill Education	2011
3.	Derek Bosworth and Elizabeth	The Management of Intellectual Property	Edward Elgar Publishing Ltd	2013
4.	Singh. K	Intellectual Property Rights in Biotechnology	BCLI, New Delhi	2010
5.	Deepa Goel and Shomini Parashar	IPR, Biosafety and Bioethics	Pearson Education publisher	2013

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		L	T	P	C
23BTE06	**Biofuel**	**3**	**0**	**0**	**3**

Course Objective:

- To gain knowledge about the biofuels
- To understand the production process of biodiesel
- To acquire knowledge about bioethanol
- To familiarize the concepts of biomethane and biohydrogen
- To gain knowledge about modern biofuels

Course Outcomes:

23BTE06.CO1	Ability to explain about the need of biofuels
23BTE06.CO2	Ability to describe about the production of biodiesel
23BTE06.CO3	Ability to demonstrate about bioethanol
23BTE06.CO4	Ability to explain the biomethane and biohydrogen
23BTE06.CO5	Ability to describe about the modern biofuels

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BTE06.CO1	X	X	X	X	X	-	X	-	X	-	X	X	X	-	-
23BTE06.CO2	X	X	X	X	X	X	X	-	X	-	X	X	X	-	-
23BTE06.CO2	X	X	X	X	X	-	X	-	-	-	X	X	-	X	-
23BTE06.CO4	X	X	X	X	X	X	X	-	X	-	X	X	-	-	X
23BTE06.CO5	X	X	X	X	X	-	X	-	X	-	X	X	-	-	-

Unit-I Overview of Biofuels **9**

Generation of biofuels – Development of biological conversion technologies – Integration of biofuels into biorefineries – Energy security and supply – Environmental sustainability of biofuels – Economic sustainability of biofuels.

Unit-II Biodiesel **9**

Biodiesel – Microorganisms and raw materials used for microbial Oil production – Treatment of the feedstocks prior to production of the Biodiesel – Current technologies of biodiesel production – Purification of biodiesel; Industrial production of biodiesel – Biodiesel production from single cell oil.

Unit-III Bioethanol **9**

Bioethanol – Properties – Feedstocks – Process technology – Pilot plant for ethanol production from lignocellulosic feedstock – Environmental aspects of ethanol as a biofuel.

Unit-IV Biomethane and Biohydrogen **9**

Biomethanol – Principles, materials and feedstocks – Process technologies and techniques – Advantages and limitations – Biological hydrogen production methods – Fermentative hydrogen production – Hydrogen economy – Advantages and limitations.

Unit-V Other Biofuels **9**

Biobutanol production – Principles, materials and feedstocks – Process technologies – Biopropanol – Bioglycerol – Production of bio-oils via catalytic pyrolysis – Life-Cycle environmental impacts of biofuels and Co-products.

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Sunggyu Lee and Y T Shah	Biofuels and Bioenergy- Process and Technology	CRC Press	2014
2.	Caye M. Drapcho, N.P. Nhuan and T. H. Walker	Biofuels Engineering Process Technology	McGraw Hill Publishers	2008

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Luque, R., Campelo, J.& Clark, J	Handbook of biofuels production	Woodhead Pub Limited	2011
2.	Gupta, V, K. and Tuohy, M, G	Biofuel Technologies	Springer	2013
3.	Moheimani, N. R., Boer, M, P, M, K, ParisaA. And Bahri	Biofuel and refining Technologies	Springer	2015
4.	Eckert, C, A. and Trinh, C	Biotechnology for Biofuel Production and Optimization	Elsevier	2016
5.	Bernardes, M	Biofuel production – recent developments and prospects	InTech	2011

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23BTE07	Fundamentals of Nanoscience	L	T	P	C
		3	0	0	3

Course Objective:

- To learn about basis of nanomaterial science
- To gain knowledge in nano material preparation method
- To familiarize with nano materials
- To acquire knowledge about nanomaterial characterization
- To learn about various applications of nano science.

Course Outcomes:

23BTE07.CO1	Ability to familiarize about the science of nanomaterials
23BTE07.CO2	Ability to demonstrate the preparation of nanomaterials
23BTE07.CO3	Ability to develop knowledge in characteristic nanomaterials
23BTE07.CO4	Ability to explain about nano material characterization
23BTE07.CO5	Ability to demonstrate about appilications of nano science

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BTE07.CO1	X	X	X	X	-	-	X	-	X	-	X	X	X	-	-
23BTE07.CO2	X	-	X	X	-	-	X	-	X	X	X	-	X	-	-
23BTE07.CO2	X	-	-	-	-	-	-	-	-	-	-	X	-	X	-
23BTE07.CO4	X	-	X	X	X	-	-	-	X	-	-	-	-	-	X
23BTE07.CO5	X	X	X		-	-	X	-	X	-	-	-	X	-	-

Unit-I Introduction **9**

Nano scale Science and Technology - Implications for Physics,Chemistry, Biology and Engineering-Classifications of nano structured materials- nano particles- quantum dots, nano wires-ultra-thin films-multilayered materials. Length Scales involved and effect on properties: Mechanic-al, Electronic, Optical, Magnetic and Thermal properties. Introduction to properties and motivation for study (qualitative only).

Unit-II General methods of Preparation **9**

Bottom-up Synthesis -Top-down Approach: Co-Precipitation, Ultrasonication, Mechanical Milling, Colloidal routes, Self-assembly, Vapour phase deposition, MOCVD, Sputtering, Evaporation, Molecular Beam Epitaxy, Atomic Layer Epitaxy, MOMBE.

Unit-III Nanomaterials **9**

Nanoforms of Carbon - Buckminster fullerene- graphene and carbon nanotube, Single wall carbon Nanotubes (SWCNT) and Multi wall carbon nanotubes (MWCNT)- methods of synthesis(arc- growth, laser ablation, CVD routes, Plasma CVD), structure-property Relationships applications- Nanometal oxides-ZnO, TiO2,MgO, ZrO2, NiO, nanoalumina, CaO, AgTiO2, Ferrites, Nanoclays- functionalization and applications-Quantum wires, Quantum dots-preparation, properties and applications.

Unit-IV Characterization Techniques **9**

X- ray diffraction technique, Scanning Electron Microscopy - environmental techniques, Transmission Electron Microscopy including high-resolution imaging, Surface Analysis techniques- AFM, SPM, STM, SNOM, ESCA,SIMS-Nanoindentation.

Unit-V Applications **9**

NanoInfoTech: Information storage- nanocomputer, molecular switch, super chip, nanocrystal, Nanobiotechlogy: nanoprobes in medical diagnostics and biotechnology, Nano medicines, Targetted drug delivery, Bioimaging - Micro Electro Mechanical Systems (MEMS), Nano Electro Mechanical Systems (NEMS)- Nanosensors, nano crystalline silver for bacterial inhibition, Nanoparticles for sunbarrier products - In Photostat, printing, solar cell, battery.

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Niemeyer, C. M., and CA Mirkin, C. A	NanoBiotechnology II – More conceptsand applications	Wiley –VCH publications	2010
2.	Rosenthal, S.J. and Wright, D.W	Nanobiotechnology Protocols	Humana Press	2010

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Oded shoseyov and Ilan Levy	Nanobiotechnology – Bioinspired and materials of the future	Humana press	2008
2.	Jain, K. K	Nano Biotechnology in molecular diagnostics –current technique and applications	Taylor and Francis	2006
3.	S. Edelstein and R.C. Cammearata	Nano materials: Synthesis, Properties and Applications	Institute of Physics Publishing, Bristol and Philadelphia	1996
4.	N JohnDinardo	Nanoscale Characterisation of surfaces & Interfaces	Weinheim Cambridge, Wiley-VCH	2000
5.	G Timp	Nanotechnology	AIP press/Springer	1999

23BTE08	Human Physiology	L	T	P	C
		3	0	0	3

Course Objective:

- To learn about basic elements of human body
- To gain knowledge in functions of human body
- To acquire knowledge about respiratory system and functions
- To acquire knowledge about digestive and excretory systems
- To learn about nervous and sensory system

Course Outcomes:

23BTE08.CO1	Ability to explain basic elements of human body
23BTE08.CO2	Ability to Explain the functions of skeletal and muscular system
23BTE08.CO3	Ability to Describe the structure, function of cardiovascular system and respiratory system
23BTE08.CO4	Ability to Explain the structure of digestive and excretory system.
23BTE08.CO5	Ability to explain basic elements of human body

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BTE08.CO1	X	X	X	-	-	-	-	-	X	-	X	X	X	-	-
23BTE08.CO2	X	X	X	-	-	-	-	-	X	-	X	X	X	-	-
23BTE08.CO2	X	X	X	X	X	-	-	-	X	-	X	X	-	X	-
23BTE08.CO4	X	X	X	X	X	-	-	-	X	-	-	-	-	-	X
23BTE08.CO5	X	X	X	X	-	-	-	-	X	-	-	-	-	-	-

Unit-I Basic elements of human body **9**

Cell – Cell Structure and organelles – Functions of each component in the cell. Cell membrane – transport across membrane – Action potential (Nernst, Goldman equation), Homeostasis. Tissue: Types, functions.

Unit-II Skeletal and muscular system **9**

Skeletal: Types of Bone and function – Physiology of Bone formation – Division of Skeleton -Types of joints and function – Types of cartilage and function. –Types of muscles – Structure and Properties of Skeletal Muscle-Changes during muscle contraction- Neuromuscular junction.

Unit-III Cardiovascular and respiratory system **9**

Cardiovascular System: Structure – Conduction System of heart – Cardiac Cycle – Cardiac output. Blood: Composition – Functions – Haemostasis – Blood groups and typing. Blood Vessels – Structure and types – Blood pressure – Respiratory system: Parts of respiratory system – Respiratory physiology – Lung volumes and capacities – Gaseous exchange.

Unit-IV Digestive and excretory systems **9**

Structure and functions of gastrointestinal system – secretory functions of the alimentary tract digestion and absorption in the gastrointestinal tract – structure of nephron – mechanism of urine formation – skin and sweat gland – temperature regulation.

Unit-V Nervous and sensory system **9**

Structure and function of nervous tissue – Brain and spinal cord – Functions of CNS – Nerve conduction and synapse – Reflex action– Somatic and Autonomic Nervous system. Physiology of Vision, Hearing, Integumentary, Olfactory systems. Taste buds.

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Elaine.N. Marieb	Essential of Human Anatomy and Physiology	Pearson Education, New Delhi	2018
2.	Gopal B. Saha	Physics and Radiobiology of Nuclear Medicine	Springer	2006

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Guyton & Hall	Textbook of Medical Physiology	Saunders	2015
2.	Ranganathan T S	Textbook of Human Anatomy	S.Chand& Co. Ltd., New Delhi	2012
3.	SaradaSubramanyam, K MadhavanKutty, Singh H D,	Textbook of Human Physiology	S. Chand and Company Ltd, New Delhi,	2012
4.	Guyton & Hall,	Text book of Medical Physiology	Saunders	2015

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23BTE09	Health and Pharmaceutical biotechnology	L	T	P	C
		3	0	0	3

Course Objective:

- To explain the basic principles of pharmacology
- To impart knowledge on drug discovery
- To focus on pharmacokinetics and transformation
- To understand pharmaceutical dosage forms
- To understand the biopharmaceuticals

Course Outcomes:

23BTE09.CO1	Ability to define the basic principles of pharmacology
23BTE09.CO2	Ability to understand the importance of drug discovery
23BTE09.CO3	Ability to understand the pharmacokinetics and transformation
23BTE09.CO4	Ability to understand the design pharmaceutical dosage forms
23BTE09.CO5	Ability to understand the importance of biopharmaceuticals

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BTE09.CO1	X	X	X	-	-	-	-	-	X	-	X	X	X	-	-
23BTE09.CO2	X	X	X	-	-	-	X	-	X	-	X	X	X	-	-
23BTE09.CO2	X	X	X	X	X	-	-	-	X	-	X	X	-	X	-
23BTE09.CO4	X	X	X	X	X	-	X	-	X	-	-	-	-	-	X
23BTE09.CO5	X	X	X	X	-	-	-	-	X	-	-	-	-	-	-

Unit-I Introduction to pharmacology **9**

Historical outlines of drugs, classification of drugs, physico-chemical properties of drugs, Routes of administration of drugs, drugs ,drugs metabolism , controlled release drug delivery system, drug stability ,Sources: plant, marine and microorganisms.

Unit-II Drug Discovery **9**

Drug discovery an introduction. Basic clinical evolution of new drugs, bioavailability of drugs, quantitative and qualitative assay of drugs by biological testing, packing techniques like compression of tablets ,wet&dry granulation ,direct compression ,tablet presses and coating.

Unit-III Pharmacokinetics and biotransformation **9**

Oral solid dosage forms, compressed tablets , types, pills, solutions, syrups, juices, nasal solutions, emulsions, lotions and extracts. Applications of various drugs in human body and site of action.

Unit-IV Pharmaceutical dosage forms and applications **9**

Structure and functions of gastrointestinal system – secretory functions of the alimentary tract digestion and absorption in the gastrointestinal tract – structure of nephron – mechanism of urine formation – skin and sweat gland – temperature regulation.

Unit-V Bio Pharmaceuticals **9**

Various categories of therapeutics like vitamins, laxatives, analgesics , contraceptives, common drugs which are abused, Antibiotics , human insulin, interferon, somatostalim, somatotropin- its preservation and analytical methods.

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Remington	The Science and practice of pharmacy	Lippincott Williams and Wilkins	2001
2	Gareth Thomas	Medical Chemistry an Introduction	John Wiley	2000

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Ram I. Mahato Ajit S.	Pharmaceutical Dosage Forms and Drug Delivery	CRC Press	2011
2.	Mohsen A. Hedaya	Basic Pharmacokinetics	Routledge	2012
3.	Tripathi, K. D	Essentials of Medical Pharmacology	John Wiley	2000
4.	Brahmankar, D.M and Jaiswal, S.B	Biopharmaceuticals and pharmacokinetics	Vallabh Prakashan Publication	2009

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23BTE10	Neurobiology and Cognitive sciences	L	T	P	C
		3	0	0	3

Course Objective:

- To know the general organization of brain and physiological and cognitive processes.
- To apply the molecular, cellular, and cognitive bases of learning and memory.
- To learn about the neuroanatomy and neurophysiology
- To understand the concept of synaptic transmission and mechanism of action of neurotransmitters
- To gain insight into the mechanism of sensations and disorders related to nervous system

Course Outcomes:

23BTE10.CO1	Ability to explain the anatomy and organization of nervous systems.
23BTE10.CO2	Ability to demonstrate the function of nervous systems.
23BTE10.CO3	Ability to analyze how drugs affect cellular function in the nervous system.
23BTE10.CO4	Ability to describe the basic mechanisms associated with behavioral science.
23BTE10.CO5	Ability to evaluate mechanism of sensations and skeletal muscle contraction.

Course Outcomes	Program Outcomes											Program Specific Outcomes			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BTE10.CO1	X	X	X	X	-	-	X	-	X	X	X	X	X	-	-
23BTE10.CO2	X	X	X	X	-	-	X	-	X	X	X	X	X	-	-
23BTE10.CO2	X	X	X	X	X	-	X	-	-	-	X	X	-	X	
23BTE10.CO4	X	X	X	X	X	-	X	-	X	X	-	-	-	-	X
23BTE10.CO5	X	X	X	X	-	-	X	-	X	X	-	-	X	-	

Unit-I Neuroanatomy **9**

What are central and peripheral nervous systems; Structure and function of neurons; types of neurons; Synapses; Glial cells; myelination; Blood Brain barrier; Neuronal differentiation; Characterization of neuronal cells; Meninges and Cerebrospinal fluid; Spinal Cord.

Unit-II Neurophysiology **9**

Resting and action potentials; Mechanism of action potential conduction; Voltage dependent channels; nodes of Ranvier; Chemical and electrical synaptic transmission; information representation and coding by neurons.

Unit-III Neuropharmacology **9**

Synaptic transmission, neurotransmitters and their release; fast and slow neuro transmission; characteristics of neurites; hormones and their effect on neuronal function.

Unit-IV Applied Neurobiology **9**

Basic mechanisms of sensations like touch, pain, smell and taste; neurological mechanisms of vision and audition; skeletal muscle contraction.

Unit-V Behaviour Science **9**

Basic mechanisms associated with motivation; control of feeding, sleep, hearing and memory; Disorders associated with the nervous system.

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Striedter, G. F	Neurobiology: a functional approach	Oxford University Press	2015
2.	Squire, L., Berg, D., Bloom, F.E., du Lac, S., Ghosh, A., Spitzer, N.C	Fundamental Neuroscience	UK: Academic Press	2012

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Abel, L. & Sylvester, E.V	Handbook of Neurochemistry and Molecular Neurobiology: Neurotransmitter systems	Springer	2008
2.	Bear, M., Connors, B., & Paradiso, M	Neuroscience – Exploring the Brain	Lippincott Williams & Wilkins	2006
3.	Mathews G G	Neurobiology: Molecules, cells and systems	Blackwell Science	2000
4.	Nelson, Charles A., Kathleen M. Thomas, and Michelle de Haan.. Hoboken, NJ	Neuroscience of Cognitive Development: The Role of Experience and the Developing Brain	John Wiley & Sons	2006
5.	Mason P	Medical Neurobiology	Oxford University Press	2011

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23BTE11	Tissue engineering	L	T	P	C
		3	0	0	3

Course Objective:

- To make the student gain knowledge in stem cell basics.
- To learn growing of ES cells in lab
- To understand the basic concept behind tissue engineering focusing on biomaterials and its applications
- To learn the fundamentals of tissue engineering and tissue repairing and differentiation of stem cells and application of stem cells
- To acquire knowledge on clinical applications of tissue engineering

Course Outcomes:

23BTE11.CO1	Ability to explain the concept of tissue engineering application for regenerative medicines
23BTE11.CO2	Ability to demonstrate the process carried out for tissue engineering application
23BTE11.CO3	Ability to know the techniques used for tissue engineering
23BTE11.CO4	Ability to grow ES in lab
23BTE11.CO5	Ability to explain the fundamentals of tissue repairing

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BTE11.CO1	X	X	X	X	-	-	X	-	X	X	X	X	X	-	-
23BTE11.CO2	X	X	X	X	-	-	X	-	X	X	X	X	X	-	-
23BTE11.CO2	X	X	X	X	X	-	X	-	-	-	X	X	-	X	-
23BTE11.CO4	X	X	X	X	X	-	X	-	X	X	-	-	-	-	X
23BTE11.CO5	X	X	X	X	-	-	X	-	X	X	-	-	X	-	-

Unit-I Introduction **9**

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

Unit-II Tissue Architecture **9**

Tissue types and Tissue components, Tissue repair, Engineering wound healing and sequence of events. Basic wound healing Applications of growth factors: VEGF/angiogenesis, Basic properties, Cell-Matrix& Cell-Cell Interactions, telomeres and Self-renewal, Control of cell migration in tissue engineering.

Unit-III Biomaterials **9**

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

Unit-IV Basic biology of stem cells **9**

Stem Cells: Introduction, hematopoietic differentiation pathway Potency and plasticity of stem cells, sources, embryonic stem cells, hematopoietic and mesenchymal stem cells, Stem Cell markers, FACS analysis, Differentiation, Stem cell systems- Liver, neuronal stem cells, Types & sources of stem cell with characteristics: embryonic, adult, haematopoetic, fetal, cord blood, placenta, bone marrow, primordial germ cells, cancer stem cells induced pleuripotent stem cells.

Unit-V Clinical Applications 9

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

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	D. Shi	Biomaterials and Tissue Engineering	Springer	2004
2.	Bernhard O.Palsson, SangeetaN.Bhatia	Tissue Engineering	Pearson Publishers	2009

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	B. Joon Park, D.B. Joseph and Boca Ration	Biomaterials: principles and applications	CRC,press	2003
2.	L. Hench and J. Jones	Biomaterials, Artificial Organs and Tissue Engineering	Wood head Publishing in Materials	2002
3.	Ratner, B. D	Biomaterials Science: An Introduction to Materials in Medicine	Academic Press	2004
4.	Bernard N. Kennedy	Stem cell transplantation, cancer applications	Nova Science	2008
5.	J B Park	Biomaterials - Science and Engineering	Plenum Press	1984

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23BTE12	Bioethics	L	T	P	C
		3	0	0	3

Course Objective:

- To Learn the Fundamental ethical to Advanced clinical trial management including drug development and trial planning
- To understand the basic concept of regulations of clinical trials
- To learn the management and ethics of clinical trials
- To acquire knowledge on Data Management and its applications
- To gain knowledge about quality control and guidelines

Course Outcomes:

23BTE012.CO1	Ability to explain aspect of clinical trials, management and ethical standards required to conduct clinical trials
23BTE12.CO2	Ability to know Drug development and trial plan ingand Legislative requirements for investigational medicinal products.
23BTE12.CO3	Ability to know advancement of medical technology
23BTE12.CO4	Ability to explain the Consent processes and Data protection
23BTE12.CO5	Ability to explain quality control and guidelines

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BTE12.CO1	X	X	X	X	-	-	X	-	X	X	X	X	X	-	-
23BTE12.CO2	X	X	X	X	-	-	X	-	X	X	X	X	X	-	-
23BTE12.CO2	X	X	X	X	X	-	X	-	-	-	X	X	-	X	-
23BTE12.CO4	X	X	X	X	X	-	X	-	X	X	-	-	-	-	X
23BTE12.CO5	X	X	X	X	-	-	X	-	X	X	-	-	X	-	-

Unit-I Introduction to clinical trials **9**

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

Unit-II Regulations of clinical trials **9**

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

Unit-III Management and ethics of clinical trials **9**

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

Unit-IV Informed consent **9**

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

Unit-V Quality control and guidelines **9**

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

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Lee, Chi-Jen	Clinical Trials or Drugs and Biopharmaceuticals.	CRC / Taylor &Francis	2011
2.	Matoren, Gary M	The Clinical Research Process in the Pharmaceutical Industry	Marcel Dekker	1984

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Sasson A	Biotechnologies and Development	UNESCO Publications	1998
2.	Sasson A	Biotechnologies in Developing countries present and future	UNESCO Publications	1993
3.	M.K. Sateesh	Bioethics and Biosafety	I.K International Publishing House pvt.Ltd	2008
4.	Fleming D.A., Hunt, D.L	Biological Safety Principles and practices	ASM Press., Washington	2000

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23BTE13	Stem Cell Technology	L	T	P	C
		3	0	0	3

Course Objective:

- 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
- To acquire knowledge about stem cell differentiation
- To gain knowledge about the ethical issues

Course Outcomes:

23BTE013.CO1	Ability to compare the characteristics of different types of stem cells and their origin
23BTE13.CO2	Ability to analyze the differentiation process of premature stem cells
23BTE13.CO3	Ability to compare the characteristic features of Embryonic and adult stem cells
23BTE13.CO4	Ability to evaluate the methods of stem cell identification and various sources
23BTE13.CO5	Ability to implement the therapeutic applications of stem cells in human diseases

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BTE13.CO1	X	X	X	-	-	-	X	-	X	X	X	X	X	-	-
23BTE13.CO2	X	X	X	X	-	-	X	-	X	X	X	X	X	-	-
23BTE13.CO2	X	X	X	X	X	-		-	X	-	X	X	-	X	-
23BTE13.CO4	X	X	X	-	X	-	X	-	X	X	-	-	-	-	X
23BTE13.CO5	X	X	X	-		-	X	-	X	X	-	-	X	-	-

Unit-I Stem cells and types **9**

Stem cells: Definition, Classification, Sources and Properties –Types of stem cells: methods of isolation, study of stem cells and their viability IPSC, embryonic stem cells, cancer stem cells. – Preservations of Stem cell. Embryonic stem cell: Isolation, Culturing, Differentiation, Properties – Adult stem cell: Isolation, Culturing, Differentiation, Trans-differentiation, Plasticity, and Properties.

Unit-II Stem cells in plants and animals **9**

Stem cell and founder zones in plants –particularly their roots – stem cells of shoot meristems of higher plants. Skeletal muscle stem cell – Mammary stem cells – intestinal stem cells – keratinocyte stem cells of cornea – skin and hair follicles –tumour stem cells.

Unit-III Stem cells differentiation **9**

Factors influencing proliferation, physical, chemical and molecular methods for differentiation of stem cells – hormonal role in differentiation.

Unit-IV Regeneration and experimental methods **9**

Germ cells, hematopoietic organs, and kidney, cord blood transplantation, donor selection, HLA matching, patient selection, peripheral blood and bone marrow transplantation, - Stem cell Techniques: fluorescence activated cell sorting (FACS), time lapse video, green fluorescent protein tagging.

Unit-V Application and ethical issues **9**

Stem cell Therapy for neuro degenerative diseases, spinal cord injury, heart disease, diabetes, burns, skin ulcers, muscular dystrophy and orthopaedic applications. Stem cell policy and ethics, stem cell research: Hype, hope and controversy.

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	C.S Potten	Stem cells	Elsevier	2006
2.	Robert Lanza., fourth edition	Essentials of Stem Cell Biology	Elsevier	2014

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Peter Quesenberry., First Edition	Stem cell biology and Gene Therapy	Wiley-Liss	1998
2.	KursadTurksen	Embryonic Stem cells – Protocols	Humana Press	2002
3.	Ariff Bongso, Eng Hin Lee	Stem Cells: From Bench to Bedside	World Scientific Publishing Company	2005
4.	Ali Gholam rezanezhad	Stem cells in clinic and Research	Intech	2013
5.	MD. Steward Sell	Stem cells	Human Press Inc	2004

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23BTE14	Biophysics	L	T	P	C
		3	0	0	3

Course Objective:

- To gain structural knowledge of biological systems.
- To understand transport and dynamic properties of biological systems.
- To expose students to the basics of membrane biophysics and molecular electrophysiology
- To learn the mechanism involved in activation and inactivation of ion channels
- To make students learn about the patch clamping technique

Course Outcomes:

23BTE14.CO1 Ability to analyze the various forces responsible for biological molecular structure

23BTE14.CO2 Ability to be familiar with different levels of conformation in nucleic acids

23BTE14.CO3 Ability to be familiar with different levels of conformation in nucleic acids

23BTE14.CO4 Ability to gain the knowledge of cellular permeability and ion transport.

23BTE14.CO5 Ability to understand thermodynamics of biological systems.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BTE14.CO1	X	X	X	X	-	-	X	X	X	-	X	-	X	-	X
23BTE14.CO2	X	X	X	-	-	-	-	X	X	X	X	X	X	X	-
23BTE14.CO3	X	X	X	-	X	-	-	X	X	X	X	X	-	-	-
23BTE14.CO4	X	X	X	-	X	-	X	-	X	X	-	-	X	X	-
23BTE14.CO5	X	X	X	X	-	-	X	-	-	X	-	X	-	-	-

Unit-I Molecular Structure of Biological Systems **9**

Intra molecular bonds, covalent, ionic and hydrogen bonds, biological structures, general features,water structure, hydration, interfacial phenomena and membranes, self-assembly and molecular structure of membranes.

Unit-II Conformation of Nucleic acids **9**

Primary structure, the bases, sugars and the phosphodiester bonds, double helical structure, the a b and z forms, properties of circular DNA, topology, polymorphism and flexibility of DNA, structure of ribonucleic acids, hydration of nucleicacids.

Unit-III Conformation of Proteins **9**

Conformation of the peptide bond, secondary structures, Ramachandran plots, use of potential functions, tertiary structure, folding, hydration of proteins, hydropathy index.

Unit-IV Cellular Permeability and ion –transport **9**

Ionic conductivity, transport across ion channels, mechanism, ion pumps, proton transfer, nerve conduction, techniques of studying ion transport and models.

Unit-V Energetics &Dynamics of Biological systems **9**

Concepts in thermodynamics, force and motion, entropy and stability, analyses of fluxes, diffusion potential, basic properties of fluids and biomaterials, laminar and turbulent flows.

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Andrey B. Rubin	Fundamental of Biophysics	Scrivener publishing	2014
2.	Raymond A. Serway and John W. Jewett, Jr	Physics for scientists and engineers	Thomson books	2008

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Cantor R. and Schimmel P.R	Biophysical Chemistry	W. H. Freeman and Company	2001
2.	R. Glaser	Biophysics	Springer Verlag	2000
3.	R. Duane	Biophysics: Molecules In Motion	Academic Press	2014
4.	Creighton, Freeman N	Proteins – Structure & Molecular Properties	Springer Verlag	2003
5.	Rodney Cotterill	Biophysics – An Introduction	Wiley Student Edition	2003

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23BTE15	Biosafety and Hazard Management	L	T	P	C
		3	0	0	3

Course Objective:

- To get acquainted to the principles of Biosafety and gain knowledge on laboratory safety
- To be aware of research guidelines and quality checks
- To gain knowledge about risk analysis
- To get familiarize with safety audits
- To acquire knowledge on hazardous operations

Course Outcomes:

23BTE15.CO1 Ability to describe various risk assessments and associated biosafety practiceal level.

23BTE15.CO2 Ability to demonstrate quality checks

23BTE15.CO3 Ability to elucidate various risk analysis.

23BTE15.CO4 Ability to assess safety audits

23BTE15.CO5 Ability to acquire knowledge on hazardous operations

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BTE15.CO1	X	X	X	X	X	-	X	X	X	-	X	-	X	-	X
23BTE15.CO2	X	X	X	X	-	-	-	X	X		X	X	X	X	-
23BTE15.CO3	X	X	X	-	X	X	-	X		X	X	X	-	-	X
23BTE15.CO4	X	X	X	-	X	-	X	-	X	X	-	X	X	X	-
23BTE15.CO5	X	X	X	X	-	-	X	-	-	X	-	X	-	-	X

Unit-I Introduction **9**

Need for safety in industries, Safety Programmes , components and realization, Potential hazards, extreme operating conditions, toxic chemicals, safe handling

Unit-II Quality checks **9**

Implementation of safety procedures, periodic inspection and replacement, Accidents, identification and prevention, promotion of industrial safety.

Unit-III Risk analysis **9**

Overall risk analysis, emergency planning-on site &off site emergency planning, risk management ISO 14000, EMS models case studies, Quantitative risk assessment, rapid and comprehensive risk analysis, Risk due to Radiation, explosion due to over pressure, jet fire-fire ball.

Unit-IV Safety audits **9**

Hazard identification safety audits, checklist, what if analysis, vulnerability models event tree analysis fault tree analysis, Hazan past accident analysis Fix borough, Mexico-Madras, Vizag Bhopal analysis.

Unit-V Hazardous operations **9**

Hazop-guide words, parameters, derivation, causes, consequences, recommendation, coarse Hazop study-case studies, pumping system, reactor-mass transfer system.

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Deepa Goel and Ms.Shomini Parashar	IPR, Biosafety and Bioethics	Pearson Education	2013
2.	Sateesh, M. K	Bioethics and biosafety	IK International Pvt Ltd	2010

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Fleming, D.A., Hunt, D.L	Biological safety Principles and practices	ASM Press, Washington	2000
2.	Fawatt, H.H. and Wood, W.S	Safety and Accident Prevention in Chemical Operation	Wiley Inter science	2010
3.	Marcel, V.C	Major Chemical Hazard	Ellis Harwood Ltd., Chi Chester	2014
4.	Handley, W	Industrial Safety Hand Book	McGraw-Hill Book Company	2007
5.	Heinrich, H.W. Dan Peterson, P.E. and Rood	Industrial Accident Prevention	McGraw-Hill Book Company	2010

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23BTE16	Bio entrepreneurship	L	T	P	C
		3	0	0	3

Course Objective:

- To deliver the knowledge about marketing and its functions
- To identify the problems in ownership and economy wise processes.
- To learn about the factors, attributes and indicators of bio-entrepreneurship
- To learn the business strategies and technology transfer in biotech companies.
- To study the various concepts on creativity, innovation, product development

Course Outcomes:

23BTE16.CO1 Ability to learn about the factors, attributes and indicators of bio-entrepreneurship

23BTE16.CO2 Ability to learn business strategies and technology transfer in biotech companies

23BTE16.CO3 Ability to illustrate the components of biotechnology companies

23BTE16.CO4 Ability to impart the knowledge on Creativity, Innovation and New product development.

23BTE16.CO5 Ability to inculcate novel strategies on identifying market demands, establishing market niche

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BTE16.CO1	X	X	X	X	X	-	X	X	X	-	X	-	X	-	X
23BTE16.CO2	X	X		X	-	-	-	X	X		X	X	X	X	-
23BTE16.CO3	X	X	X	X	X	X	-	X		X	X	X	-	-	X
23BTE16.CO4	X	X		X	X	-	X	-	X	X	-	X	X	X	-
23BTE16.CO5	X	X	X	X	-	-	X	-	-	X	-	X	-	-	X

Unit-I Enterpreneurship **9**

Should You Become an Entrepreneur? What Skills Do Entrepreneurs Need?, Identify and meet a market need, Entrepreneurs in market Economy, Select a type of Ownership.

Unit-II Business plan **9**

Develop a Business plan

Unit-III Business Marketing **9**

Choose your location and setup for business, Market your business, Hire and Manage a staff

Unit-IV Financial management **9**

Finance, product and insure your business, Record keeping and accounting, Financial management

Unit-V Ethics in Enterpreneurship **9**

Meet your legal, ethical, social obligations, Growth in todays market place

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication

1.	Jogdand, S.N	Enterpreneurship and business of biotechnology	Himalaya Publishing Home	2007
2.	Branson R	Business Stripped Bare: Adventure of a global Enterpreuner	Virgin Books	2009

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	S.S. Khanka	Entrepreneurship Development	S.Chand& Co	2006
2.	Robers Lusier	Management fundamentals-concepts, application , skill development	Cengage Learning	2010
3.	Poornima M Charanthimath	Entrepreneurship Development	Pearson Education	2006
4.	Shashi k Gupta	Entrepreneurship and management	Kalyani publishers	2005
5.	Stephen P Robbins, Timothy A. Judge, Neharika Vohra	Organizational behaviour	Pearson	2012

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23BTE17	Professional Ethics in Engineering	L	T	P	C
		3	0	0	3

Course Objective:

- To enable the students to create an awareness on Engineering Ethics and Human Values,
- To instill Moral and Social Values and Loyalty and to appreciate the rights of others.
- To understand Human Values and ethical theory
- To understand codes of ethics, work place responsibilities, rights, engineering experimentation, global issues and contemporary ethical issues.
- To understand personal ethics, legal ethics, cultural ethics and engineers responsibility

Course Outcomes:

23BTE17.CO1	Articulate engineering ethics theory with sustained lifelong learning
23BTE17.CO2	Adopt a good character and follow high professional ethical life
23BTE17.CO3	Contribute to shape a better character by following ethical actions.
23BTE17.CO4	Confront and resolve moral issues occurred during technological activities
23BTE17.CO5	Resolve moral and ethical problems through exploration and assessment by established experiments

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BTE17.CO1	X	X	X	X	X	-	X	X	X	-	X	-	X	-	X
23BTE17.CO2	X	X		X	-	-	-	X	X		X	X	X	X	-
23BTE17.CO3	X	X	X	X	X	X	-	X		X	X	X	-	-	X
23BTE17.CO4	X	X		X	X	-	X	-	X	X	-	X	X	X	-
23BTE17.CO5	X	X	X	X	-	-	X	-	-	X	-	X	-	-	X

Unit-I Human Values **9**

Morals, values and Ethics ,Integrity ,Work ethic, Service learning, Civic virtue, Respect for others , Living peacefully, Caring, Sharing , Honesty , Courage , Valuing time , Cooperation , Commitment , Empathy ,Self confidence , Character, Spirituality, Introduction to Yoga and meditation for professional excellence and stress management

Unit-II Engineering Ethics **9**

Senses of 'Engineering Ethics' ,Variety of moral issues , Types of inquiry, Moral dilemmas, Moral Autonomy, Kohlberg's theory, Gilligan's theory, Consensus and Controversy, Models of professional roles, Theories about right action , Self-interest, Customs and Religion, Uses of Ethical Theories

Unit-III Engineering As social Experimentation **9**

Engineering as Experimentation, Engineers as responsible Experimenters, Codes of Ethics, A Balanced Outlook on Law

Unit-IV Safety, Responsibilities and Rights **9**

Safety and Risk, Assessment of Safety and Risk, Risk Benefit Analysis and Reducing Risk, Respect for Authority , Collective Bargaining, Confidentiality, Conflicts of Interest, Occupational Crime, Professional Rights, Employee Rights, IntellectualProperty Rights(IPR), Discrimination.

Unit-V Global Issues **9**

Multinational Corporations, Environmental Ethics, Computer Ethics, Weapons Development, Engineers as Managers, Consulting Engineers, Engineers as Expert Witnesses and Advisors, Moral Leadership, Code of Conduct

,Corporate Social Responsibility.

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Mike W. Martin and Roland Schinzinger	Ethics in Engineering	Tata McGraw Hill, New Delhi	2003
2.	M Govindarajan, S Natarajan and V S Senthil Kumar	Engineering Ethics	PHI Learning PrivateLtd, New Delhi	2012

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Charles B. Fleddermann	Engineering Ethics	Pearson Prentice Hall, New Jersey	2004
2.	Charles E. Harris, Michael S. Pritchard and Michael J. Rabins	Engineering Ethics– Concepts and Cases	Cengage Learning	2009
3.	John R Boatright	Ethics and the Conduct of Business	Pearson Education, New Delhi	2003
4.	Edmund G Seebauer and Robert L Barry	Fundamentals of Ethics for Scientists and Engineers	Oxford University Press, Oxford	2001
5.	R S Naagarazan	A text book on professional ethics and human values	New age international(P) limited New Delhi	2006

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23BTE18	Environmental Biotechnology	L	T	P	C
		3	0	0	3

Course Objective:

- To understand the basic knowledge of biodegradation process
- To understand the involvement of microbes in waste water treatment
- To learn the characteristics of Biological Treatment of Wastewater
- To acquire knowledge about Air pollution and Solid Waste Management
- To learn about the bioproducts from renewable source.

Course Outcomes:

23BTE18.CO1 Ability to know the importance of biodegradation

23BTE18.CO2 Ability to recognize the microbial processes for the treatment of wastewater

23BTE18.CO3 Ability to develop the various biological processes for wastewater treatment

23BTE18.CO4 Ability to integrate the biotechnology concepts for the control of air pollution.

23BTE18.CO5 Ability to apply the knowledge for the development of bioproducts from renewable sources.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BTE18.CO1	X	X	X	X	X	-	X	X	X	-	X	-	X	-	X
23BTE18.CO2	X	X		X	-	-	-	X	X		X	X	X	X	-
23BTE18.CO3	X	X	X	X	X	X	-	X		X	X	X	-	-	X
23BTE18.CO4	X	X		X	X	-	X	-	X	X	-	X	X	X	-
23BTE18.CO5	X	X	X	X	-	-	X	-	-	X	-	X	-	-	X

Unit-I Biodegradation 9

Aerobic degradation of aliphatic and aromatic compounds ,Co-metabolic degradation of organopollutants, Biodegradation of pesticides, bioaccumulation and biosorption of heavy metals

Unit-II Microbial Metabolism and wastewater treatment 9

Biological treatment of anaerobic and aerobic, methanogenesis, Anaerobic degradation of carbohydrates, proteins, fats and lipids , Nitrogen removal, Ammonification, nitrification, denitrification, anaerobic ammonia oxidation

Unit-III Biological Treatment of waste water 9

Physico-chemical characteristics of wastewater, Overview of aerobic and anaerobic treatment processes, Activated sludge process, Trickling filter, Upflow anaerobic sludge blanket reactor (UASB) – Membrane bioreactors , Algal photosynthesis in wastewater treatment

Unit-IV Air pollution and Solid waste management 9

Air pollution control and treatment strategies, Biotechnology for treating air pollutants, Biotechnology for the management of agricultural, plastic, textile, leather, hospital and pharmaceutical industrial wastes.

Unit-V Bioproducts from Renewable sources 9

Overview of renewable sources, Production of biocompost and vermicompost, Production of biopesticides, Production of biomethane, bioethanol, biohydrogen, biodiesel.

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Jordening, H.J. and Winter, J.	Environmental Biotechnology: Concepts and Application	Wiley-VCH Verlag GmbH & Co.	2005
2.	Evans, G.G. and Furlong, J	Environmental Biotechnology: Theory and Application, 2nd Edition	John Wiley & Sons	2011

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Henze, M., Harremoes, P., Jansen, J.C. and Arvin. E	Wastewater Treatment: Biological and Chemical Processes, 2 nd Edition	Springer	2013
2.	Zarook, S. and Ajay,S	Biotechnology for Odour and Air Pollution Control	Springer	2005
3.	Wong J.W-C., Tyagi R.D., and Pandey. A	Current Developments in Biotechnology and Bioengineering Solid waste	Elsevier	2016

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23BTE19	Human Rights	L	T	P	C
		3	0	0	3

Course Objective:

- To gain knowledge about the human rights
- To understand the theories of human rights
- To acquire knowledge about UN laws
- To familiarize the concepts of human rights
- To gain knowledge about commission and judiciary

Course Outcomes:

23BTE19.CO1 Ability to explain about the need of human rights

23BTE19.CO2 Ability to describe about the evolution of human rights

23BTE19.CO3 Ability to demonstrate about UN laws

23BTE19.CO4 Ability to explain the constitutional provisions

23BTE19.CO5 Ability to describe about the commission and judiciary.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BTE18.CO1	X	X	X	X	X	-	X	X	X	-	X	-	X	-	X
23BTE18.CO2	X	X		X	-	-	-	X	X		X	X	X	X	-
23BTE18.CO3	X	X	X	X	X	X	-	X		X	X	X	-	-	X
23BTE18.CO4	X	X		X	X	-	X	-	X	X	-	X	X	X	-
23BTE18.CO5	X	X	X	X	-	-	X	-	-	X	-	X	-	-	X

Unit-I Human rights **9**

Human Rights, Meaning, origin and Development.Notion and classification of Rights, Natural, Moral and Legal Rights. Civil and Political Rights, Economic, Social and Cultural Rights; collective / Solidarity Rights.

Unit-II Evolution of human rights **9**

Evolution of the concept of Human Rights Magana carta, Geneva convention of 1864. Universal Declaration of Human Rights, 1948. Theories of Human Rights.

Unit-III Laws about Human Rights **9**

Theories and perspectives of UN Laws, UN Agencies to monitor and compliance.

Unit-IV Constitutional Provisions of human rights **9**

Human Rights in India, Constitutional Provisions / Guarantees.

Unit-V Implementation of Human rights **9**

Human Rights of Disadvantaged People, Women, Children, Displaced persons and Disabled persons, including Aged and HIV Infected People. Implementation of Human Rights, National and State Human Rights Commission, Judiciary ,Role of NGO's, Media, Educational Institutions, Social Movements

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Kapoor S.K	Human Rights under International law and Indian Laws	Central Law Agency, Allahabad	2014
2.	Chandra U	Human Rights	Allahabad Law Agency, Allahabad	2014

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Upendra Baxi, ,	The Future of Human Rights	Oxford University Press, New Delhi	2004
2.	Shubham Singles, Charles E. Haries	Constitution of India,Professional Ethics and Human Rights	Cengage Learning India	2018
3.	M. Govindarajan, S. Natarajan, V. S. Senthilkumar	Engineering Ethics	Prentice –Hall,	2004
4.	Alfred Basta	Cyber Security and Cyber Laws	Cengage Learning India	2018
5.	Durga Das Basu	Introduction to the Constitution of India	Prentice –Hall,	2008

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		L	T	P	C
23BTE20	**Bioethics and IPR**	**3**	**0**	**0**	**3**

Course Objective:

- To create awareness about IPR and Engineering ethics
- To follow Professional ethics and follow in their career
- To create awareness and responsibilities about environment
- To understand the basics of IPR
- To Develop entrepreneur skills

Course Outcomes:

23BTE23.CO1	Ability to know the fundamental values, such as human dignity
23BTE23.CO2	Ability to serve basic human needs such as human health, food and a safe environment
23BTE23.CO3	To raise human rights issues such as access to health and benefits from scientific progress
23BTE23.CO4	Ability to concerns over equitable access to the fruits of new technologies, the consent of those involved in research
23BTE23.CO5	Ability to obtaining a clear information on the entrepreneurship and understand their economic values

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23GES06.CO1	X	X	-	-	-	-	X	-	-	-	-	-	-	-	X
23GES06.CO2	-	X	-	X	X	-	-	X	X	X	-	-	X	X	-
23GES06.CO2	-	-	-	X	-	X	-	-	-	X	X	-	-	X	-
23GES06.CO4	-	X	X	-	-	-	X	X	-	-	-	-	-	-	X
23GES06.CO5	X	-	-	-	X	X	-	-	-	-	-	-	X	-	-

Unit-I History of Bioethics **9**

Bioethics as a discipline, philosophical reflections on experimenting with human subjects, activeand passive euthanasia; culture assumption in the history of Bioethics, medical ethics in India and America.

Unit-II Methods of Ethical Analysis **9**

Ethical reasoning- philosophical, clinical and cultural dimensions; challenge of ethical relativism;methods of philosophical theories and principles, Equality and its implications; methods of casuistry and methods of narrative approaches

Unit-III Ethics in Biotechnology **9**

Ethics committee (hospital),Inner working of an ethics committee; ethics consultation,skills, rolesand training; Biosafety regulation, national and International guidelines; rDNA guidelines, guidelines forrDNA research activities, mechanism of implementation of biosafety guidelines

Unit-IV Patenting, IPR and Applications **9**

Introduction to Intellectual property rights, types: patents, copy right, trade mark, trade secret,geographical indications, importance of IPR, Patenting and non patenting life, TRIPS

Unit-V Entrepreneurship in Biotechnology **9**

The Significance of the Biotechnology Entrepreneur; The Integration of Two Distinctly Different Disciplines; Biotechnology Entrepreneurship Versus General Entrepreneurship ; Entrepreneurship and Intrapreneurship; Essential Biotechnology Entrepreneurial Characteristics; Four Backgrounds of Biotechnology Entrepreneurs

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Nancy S.Jecker, Albert R.Jonsen, Robert A	Bioethics	Pearlman. Jones and Bartlett Publishers	2003
2.	Singh K	Intellectual Property Rights on Biotechnology	BCIL, New Delhi	2001

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	M.K. Sateesh	Bioethics and Biosafety	I.K. International Publishing House pvt. Ltd	2008
2.	Poornima. M. Charantimath	Entrepreneurship Development	Pearson Education	2006
3.	Fleming, D.A., Hunt, D.L	Biological safety Principles and practices	ASMPress,Washington	2000

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23BTE21	Municipal Solid Waste Management	L	T	P	C
		3	0	0	3

Course Objective:

- To know about the different sources and types of municipal solid waste
- To provide the knowledge about onsite processing and storage of municipal solid waste.
- To study about collection and transfer of municipal solid waste.
- To knowledge about off-site processing of solid waste.
- To understand the various disposal techniques.

Course Outcomes:

23BTE21.CO1 Get an idea about different sources and types of municipal solid waste.

23BTE21.CO2 Know about onsite storage and processing system

23BTE21.CO3 Understand the different methods of collection and transfer of solid waste.

23BTE21.CO4 Select the suitable offsite processing method for various solid wastes.

23BTE21.CO5 Select the appropriate waste disposal method.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BTE21.CO1	X	X	X	X	-	-	X	-	X	-	X	X	X	-	-
23BTE21.CO2	X	X	X	X	-	-	X	-	X	X	X	X	X	-	-
23BTE21.CO3	X	X	X	-	X	-	X	-	-	-	X	X	-	X	-
23BTE21.CO4	X	X	X	X	X	-	X	-	X	-	-	-	-	-	X
23BTE21.CO5	X	X	X	X		-	X	-	X	-	-	-	X	-	-

Unit-I Sources And Types Of Municipal Solid Waste **9**

Solid waste , sources , types, quantity, factors affecting generation , characteristics , Methods of sampling , effects of improper disposal of solid wastes, Public health effects and awareness, Elements of solid waste Management, Social and economic aspects, Municipal solid waste, Integrated management, Role of NGOs; Legislation, Public awareness.

Unit-II On-Site Storage and Processing **9**

On-site storage methods, materials used for containers, on-site segregation of solid wastes, Public health and Economic aspects of storage, waste segregation and storage, Reduction, Reuse and Recycling, options under Indian conditions, Critical Evaluation of Options.

Unit-III Collection and Transfer **9**

Methods of Collection, types of vehicles, Manpower requirement, collection route, transfer stations, Need for transfer and transport, Selection of location, operation and maintenance, options under Indian Conditions, Field problems, solving

Unit-IV Off-Site Processing **9**

Objectives of waste processing,Physical processing techniques and equipment, resource recovery from solid wastes, composting and biomethanation, Thermal processing options, Incineration, Pyrolysis

Unit-V Disposal **9**

Land disposal of solid waste, sanitary landfills, site selection, design and operation of sanitary landfills,Management of leachate and landfill gas, landfill closure and environmental monitoring, Leachate collection and treatment, Landslide rehabilitation.

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	George Tchobanoglous	Integrated Solid Waste Management	McGraw- Hill	2014
2.	Sasikumar K & Krishna Sanoop Gopi	Solid Waste Management	PHI, New Delhi	2012
3.	Vesilind, Aarne P & Worrell, William A & Reinhart, Debra R	Solid Waste Engineering	Cengage Learning Pvt. Ltd, New Delhi	2011

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Landreth.R.E and Rebers.P.A	Municipal Solid Wastes– Problems and Solutions	Lewis Publishers	2015
2.	Bhide.A.D. and Sundaresan.B.B	Solid Waste Management in Developing Countries	Dhanpat Rai and Sons	2012

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23BTE22	Disaster Management	L	T	P	C
		3	0	0	3

Course Objective:

- To provide students an exposure to disasters, their significance and types
- To ensure that students begin to understand the relationship between vulnerability, disasters, disaster prevention and risk reduction
- To gain a preliminary understanding of approaches of Disaster Risk Reduction (DRR)
- To enhance awareness of institutional processes in the country A
- To develop rudimentary ability to respond to their surroundings with potential disaster response in areas where they live, with due sensitivity

Course Outcomes:

23BTE22.CO1	Ability to know the disaster impacts and climate change
23BTE22.CO2	Ability to understanding of approaches of Disaster Risk Reduction
23BTE22.CO3	Ability to Differentiate the types of disasters, causes and their impact on environment and society Assess vulnerability and various methods of risk reduction measures as well as mitigation
23BTE22.CO4	Ability to understand hazard and vulnerability profile of India, Scenarious in the Indian context, Disaster damage assessment and management
23BTE22.CO5	Ability to obtaining a clear information applications and case studies and field works

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO2	PSO3
23BTE22.CO1	X	X	X	X	-	-	X	-	X	-	X	X	X	-	-
23BTE22.CO2	X	X	X	X		-	X	-	X	X	X	X	X	-	-
23BTE22.CO3	X	X	X	-	X	-	X	-	-	-	X	X	-	X	-
23BTE22.CO4	X	X	X	X	X	-	X	-	X	-	-	-	-	-	X
23BTE22.CO5	X	X	X	X		-	X	-	X	-	-	-	X	-	-

Unit-I Introduction To Disasters **9**

Definition: Disaster, Hazard, Vulnerability, Resilience, Risks, Disasters: Types of disasters, Earthquake, Landslide, Flood, Drought, Fire etc, Classification, Causes, Impacts including social, economic, political, environmental, health, psychosocial, etc.Global trends in disasters: urban disasters, pandemics, complex emergencies, Climate change, Dos and Don'ts during various types of Disasters.

Unit-II Approaches To Disaster Risk Reduction (DRR) **9**

Disaster cycle, Phases, Culture of safety, prevention, mitigation and preparedness community based DRR, Structural- nonstructural measures, Roles and responsibilities of- community, Panchayati Raj Institutions/Urban Local Bodies (PRIs/ULBs), States, Centre, and other stake-holders- Institutional Processess and Framework at State and Central Level, State Disaster Management Authority(SDMA), Early Warning System, Advisories from Appropriate Agencies.

Unit-III Inter-Relationship Between Disasters And Development **9**

Factors affecting Vulnerabilities, differential impacts, impact of Development projects such as dams, embankments, changes in Land-use etc. Climate Change Adaptation, IPCC Scenario and Scenarios in the context of India, Relevance of indigenous knowledge, appropriate technology and local resources.

Unit-IV Disaster Risk Management In India **9**

Hazard and Vulnerability profile of India, Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management, Institutional arrangements (Mitigation, Response and Preparedness, Disaster Management Act

and Policy, other related policies, plans, programmes and legislation, Role of GIS and information Components in Preparedness, Risk Assessment, Response and Recovery phases of Disaster Damage Assessment

Unit-V Disaster Management : Applications and case studies and field works 9

Landslide Hazard Zonation: Case Studies, Earthquake Vulnerability Assessment of Buildings and Infrastructure: Case Studies, Drought Assessment: Case Studies, Coastal Flooding: Storm Surge Assessment, Floods: Fluvial and Pluvial Flooding: Case Studies; Forest Fire: Case Studies, Man Made disasters: Case Studies, Space Based Inputs for Disaster Mitigation and Management and field works related to disaster management.

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Singhal J.P.	Disaster Management	Disaster Management", Laxmi Publications,	2003
2.	Tushar Bhattacharya	Disaster Science and Management	McGraw Hill India Education Pvt	2001
3.	Vesilind, Aarne P & Worrell, William A & Reinhart, Debra R	Solid Waste Engineering	Cengage Learning Pvt. Ltd, New Delhi	2011

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Gupta Anil K, Sreeja	Environmental Knowledge for Disaster Risk Management	NIDM, New Delhi	2011
2.	Poornima. M. Charantimath	Entrepreneurship Development	Pearson Education	2006

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Board of Studies
Department of Biotechnology
Muthayammal Engineering College (Autonomous)
Rasipuram, Namakkal Dist - 637 408

23BTE23	Clinical Trials	L	T	P	C
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Course Objective:

- To learn about role of clinical trials in new drug development
- To ensure that students begin to understand the fundamentals of trial design
- To gain a Preliminary understanding about alternate trial designs
- To learn about basics of statistical analysis
- To learn about developing trial

Course Outcomes:

23BTE23.CO1	Ability to Explain key concepts in the design of clinical trials.
23BTE23.CO2	Ability to Describe study designs used, identify key issues in data management for clinical trials
23BTE23.CO3	Ability to Describe the roles of regulatory affairs in clinical trials.
23BTE23.CO4	Ability to describe the principles involved in ethical, legal and regulatory issues in clinical trials
23BTE23.CO5	Ability to obtaining a clear information in bio-statistical techniques involved in clinical research.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BTE23.CO1	X	-	-	-	-	-	X	-	-	-	-	X	-	-	X
23BTE23.CO2	-	X	X	X	-	X	-	X	X	-	X	X	-	X	X
23BTE23.CO3	X	X	X	-	X	-	X	X	X	X	-	X	X	-	-
23BTE23.CO4	X	-	X	-	X	X	-	X	X	X	-	X	-	X	-
23BTE23.CO5	X	-	X	X	-	-	-	-	X	-	-	-	X	-	-

Unit-I **Role of Clinical Trials in New Drug Development** **9**

Drug Discovery, regulatory guidance and governance, pharmaceutical manufacturing, nonclinical research, clinical trials, post-marketing surveillance, ethical conduct during clinical trials.

Unit-II **Fundamentals Of Trial Design** **9**

Randomised clinical trials, uncontrolled trials. Protocol development, endpoints, patient selection, source and control of bias, randomization, blinding, sample size and power.

Unit-III **Alternate Trial Designs** **9**

Crossover design, factorial design, equivalence trials, bioequivalence trials, non inferiority trials, cluster randomized trials, multi center trials.

Unit-IV **Basics of Statistical Analysis** **9**

Crossover design, factorial design, equivalence trials, bioequivalence trials, non-inferiority trials, cluster randomized trials, multi-center trials.

Unit-V **Reporting of Trials** **9**

Overview of reporting, trial profile, presenting baseline data, use of tables, figures, critical appraisal of report, meta-analysis.

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Lawrence M. Friedman	Fundamentals of Clinical Trials	Springer Science & Business Media,	2010
2	David Machin, Simon Day,	Textbook of Clinical Trials	Springer	2010

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Duolao Wang and AmeetBakhai.	Fundamentals of Clinical Trials	Remedica	2006
2	T.A. Durham and J Rick Turner	Production to statistics in pharmaceutical clinical trials	Pharmaceutical Press	2006
3	Lee, Chi-Jen	Clinical Trials or Drugs and Biopharmaceuticals	CRC / Taylor &Francis	2011

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