



Basaveshwar Engineering College, Bagalkote

Department of Biotechnology

Scheme and Syllabus

2026-27

Vision of the Institute

To be an institution of excellence in education, research and innovation for a sustainable future

Mission of the Institute

1. Develop globally competent professionals for future talent requirements.
2. Nurture a culture of research, innovation and entrepreneurship.
3. Promote collaborations, extension and outreach programs for addressing industrial and societal needs.
4. Imbibe moral and ethical values.
5. Foster ecological and environmental consciousness.

Vision of the Department of Biotechnology

To be a centre for academic excellence in Biotechnology and innovative research for sustainable future.

Mission of the Department of Biotechnology

1. Develop technically competent and ethically oriented professionals
2. Promote collaborations with academia, industries and research institutes for societal needs.
3. Strengthen the culture of research, innovation, entrepreneurship and environmental consciousness.

PROGRAM EDUCATIONAL OBJECTIVES (PEOS)
OF
DEPARTMENT OF BIOTECHNOLOGY

PEO1: Graduates will apply fundamental knowledge of biological sciences and engineering principles to solve problems in Biotechnology and allied fields.

PEO2: Graduates will excel and succeed in industry/research/technical profession through global and rigorous education.

PEO3: Graduates will exhibit good scientific and engineering principles to comprehend, analyze, design and create novel products as well as solutions for the real time problems.

PEO4: Graduates will exhibit professionalism, ethical attitude, oral and written communication skills, team work, lifelong learning and ethical values for a successful professional career.

PROGRAM SPECIFIC OUTCOMES (PSOs):

PSO1: Graduates will be able to develop competency in applying engineering principles to environment, agriculture and healthcare systems.

PSO2: Graduates will be able to design, optimize, and manage bioprocesses for the development of bio-based products, ensuring quality, safety, and regulatory compliance in the industries.

PSO3: Graduates will be able to integrate bioethics, entrepreneurship, and environmental awareness to enhance technical skills in biotechnology applications.

Program Outcomes (POs):

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their

limitations to solve complex engineering problems. (WK2 and WK6)

- PO6: The Engineer and The World:** Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).
- PO7: Ethics:** Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)
- PO8: Individual and Collaborative Team work:** Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
- PO9: Communication:** Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences
- PO10: Project Management and Finance:** Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.
- PO11: Life-Long Learning:** Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

Knowledge and Attitude Profile (WK)

- WK1:** A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.
- WK2:** Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.
- WK3:** A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.
- WK4:** Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.
- WK5:** Knowledge, including efficient resource use, environmental impacts, whole-life cost, re-use of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area.
- WK6:** Knowledge of engineering practice (technology) in the practice areas in the engineering discipline.
- WK7:** Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development.
- WK8:** Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.
- WK9:** Ethics, inclusive behavior and conduct Knowledge of professional ethics, responsibilities and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc. with mutual understanding and respect, and of inclusive attitudes.

S.No.	Category	VTU	AICTE	BEC Present	BEC Revised
1.	HSMC: HSS (English:1, Kannada:1, UHV: 1, EV:1), HRM:3 (Offered by Dept) :7 AEC (IDT: 1, IPBL:1, SS:2, IKS: 1, MOOCS: 3) = 08	14+8=22	15	9+10=19	7+8=15
2.	BSC: Basic Science Courses (Physics, Chemistry, Mathematics and Biology for Engineers)	22	23	22	22
3.	ESC/ETC: Engineering Science Courses (Basic Elect/Electronics/Computer/Mechanics/Workshop/Drawing etc.)	18	17	18	16
4.	PCC: Professional Core Courses	57	61	56	65
5.	PEC: Professional Elective Courses relevant to the branch with at least one course either fully or partially supported by industry	12	12	12	12
6.	OEC: Open Electives Courses/ Subjects from other technical/Arts/Commerce (3 MOOCS + 6)	9	12	09	09
7.	Mini (2) and Major projects (9)/Industrial Internships (10)	20	20	24	21
8.	Mandatory Course: PE, Yoga, NSS, Constitution, Bridge course Maths 1 and 2 (lateral Entry)	00	00	00	00
Total		160	160	160	160

Suggestive Break-up of Credits for B.E (Common to all Branches)

(For the Students admitted to first year from 2025-2026 onwards
and to 2nd year lateral entry from 2026-2027 onwards)

Sem.	BSC	ESC/ETC	HSMC	AEC	PCC	PEC	OEC	Proj.	Int.	Total
1.	08	06	01	1(IPBL)	04					20
2.	08	10	01	1(IDT)						20
3.	03				17					20
4.	03		01		16					20
5.			01	2 (SS)	09	03	03	02		20
6.				1(IKS)	13	03	03			20
7.			03		06	06		09		24
8.				3 (MOOCS)			3 (MOOCS)		10	16
Tot.	22	16	07	08	65	12	09	11	10	160

B V V Sangha,
Basaveshwara Engineering College,
Bagalkot
Scheme of Teaching and Evaluation of
1st year
(Effective from the academic year 2026-
27)

I Semester			(Physics Group)												
Sl/No	Course Category	Course Code	Course Title	TD/PSB	Teaching-Learning Scheme				Examination Duration (Hrs/Sem.)		Total Hours	Examination Scheme and Evaluation			Credits (C) =Total Hours/30
					L Hrs/Week (Hrs/Sem.)	T Hrs/Week (Hrs/Sem.)	P Hrs/Week (Hrs/Sem.)	Term Work (TW) and Self Learning (SL) (TW+SL) Hrs/Sem	CIE	SEE		CIE Marks	SEE Marks	Total Marks	
1	ASC	1BMA101C	Calculus and Linear Algebra: CSE Stream	Maths Dept	3(42)	2(28)	0	44	3	3	120	50	50	100	4
2	ASC(IC)	1BPHS102C	Quantum Physics and Applications (CSE stream)	PHY Dept	3(42)	0	2(26)	44	5	3	120	50	50	100	4
3	ESC	1BME103C	Computer-Aided Engineering Drawing for CSE stream	ME Dept	2(28)	0	2(26)	28	5	3	90	50	50	100	3
4	ESC -I	1BEC A104N	Introduction to Electronics & Communication Engineering	Respective Engg Dept	3(42)	0	0	42	3	3	90	50	50	100	3
5	PSC	1BBTA105C	Elements of Biotechnology	BT Dept.	3(42)	0	0	42	3	3	90	50	50	100	3
6	AEC (NCMC)	1BHSA106M	Soft Skills	Humanities Dept	1(14)	0	0	14	2	-	30	100	-	100	PP
7	HSMS	1BHSA107C/ 1BHSA107C	Samskrutika Kannada/ Balake Kannada	Humanities Dept	1(14)	0	0	13	2	1	30	50	50	100	1
8	AEC/SDC	1BBTA108P	Innovation and Design Thinking (Project-based learning)	Respective Dept	Two contact hours/week for interaction between the faculty and students				1	3	30	50	50	100	1
9	PSCL	1BBTA109L	Elements of Biotechnology Lab	BT Dept	0	0	2(26)	-	2	2	30	50	50	100	1
TOTAL					16	2	6					50	40	90	20

									0	0	0	
10	AICTE Activity Points (students have to earn 100 activity points between 01 to 08 semesters)							Compulsory requirement for the award of a degree				

				Applied Physics	
	L	T	P	Code	Title
Differential Calculus And Linear Algebra: CV Stream	3	2	0	1BPHC102C	Physics for Sustainable Structural Systems (CV stream)
Differential Calculus and Linear Algebra: ME Stream	3	2	0	1BPHM102C	Physics of Materials (Mech stream)
Differential Calculus And Linear Algebra: EEE Stream	3	2	0	1BPHE102C	Quantum Physics and Electronics Sensors (EEE stream)
Differential Calculus and Linear Algebra: CSE Stream	3	2	0	1BPHS102C	Quantum Physics and Applications (CSE stream)
Computer-Aided Engineering Drawing				Engineering Science Courses-I(ESC-I)	
Computer-Aided Engineering Drawing for CV Stream	2	0	2	1BCVA104N	Introduction to Civil Engineering
Computer-Aided Engineering Drawing for ME Stream	2	0	2	1BEEA104N	Introduction to Electrical Engineering
Computer-Aided Engineering Drawing for EEE Stream	2	0	2	1BECA104N	Introduction to Electronics & Communication Engineering
Computer-Aided Engineering Drawing for CSE Stream	2	0	2	1BMEA104N	Introduction to Mechanical Engineering
				1BISA104N	Essentials of Information Technology
Courses (PSC)				Program-Specific Course Lab (PSCL)	
Engineering Mechanics	3	0	0	1BCVA109L	Mechanics and Materials Lab
Basics of Electrical Engineering	3	0	0	1BEEA109L	Basic Electrical Lab
Fundamentals of Electronics & Communication Engineering	3	0	0	1BCEA109L	Fundamentals of Electronics & Communication Engineering Lab
Elements of Mechanical Engineering	3	0	0	1BMEA109L	Elements of Mechanical Engineering Lab
Programming in C	3	0	0	1BCSA109L	C Programming Lab
Elements of Biotechnology	3	0	0	1BBTA109L	Elements of Biotechnology Lab

B V V Sangha,
 Basaveshwara Engineering College, Bagalkot
 Scheme of Teaching and Evaluation of 1st year
 (Effective from the academic year **2026-27**)

Course Code	(For those who have studied Physics Group in I semester)											
	Course Title	TD/PSB	Teaching-Learning Scheme				Examination Duration (Hrs/Sem.)		Total Hours	Examination Scheme and Evaluation		
			L Hrs/Week (Hrs/Sem.)	T Hrs/Week (Hrs/Sem.)	P Hrs/Week (Hrs/Sem.)	Term Work (TW) and Self Learning (SL) (TW+SL) Hrs/Sem	CIE	SEE		CIE Marks	SEE Marks	Total Marks
20S201	Differential Equations and Numerical Methods	Maths Dept	3(42)	2(28)	0	44	3	3	120	50	50	100
20S202	Applied Chemistry for CSE Stream(Stream	CHE Dept	3(42)	0	2(26)	44	5	3	120	50	50	100

	Specific)											
203C	Introduction to AI and Applications	Any Dept	3(42)	0	0	42	3	3	90	50	50	100
	ESC II	-	3(42)	0	0	42	3	3	90	50	50	100
205	Python Programming	CSE & allied Dept	3(42)	0	2(26)	44	5	3	120	50	50	100
206	Communication Skills	Humanities Dept.	1(14)	0	0	13	2	1	30	50	50	100
207	Indian Constitution & Engineering Ethics	Humanities Dept	1(14)	0	0	14	2	-	30	100	0	100
208	Interdisciplinary Project-Based Learning	Respective Dept	Two contact hours/week for interaction between the faculty and students				1	3	30	50	50	100
TOTAL			17	2	4					450	350	800
Points (students have to earn 100 activity points from 01 to 08 semesters)									Compulsory requirement for the award of degree			

Mathematics-II					Applied Chemistry		
	Title	L	T	P	Code	Title	
	Differential Calculus and Numerical Methods: CV Stream	3	2	0	1BCHC202C	Applied Chemistry for Sustainable Structure & Material Design (CV)	
	Multivariable Calculus and Numerical Methods: ME Stream	3	2	0	1BCHM202C	Applied Chemistry for Advanced Metal Protection and Sustainable Energy Systems (ME)	
	Calculus, Laplace Transform And Numerical Techniques: EEE stream	3	2	0	1BCHE202C	Applied Chemistry for Emerging Electronics and Futuristic Devices (EEE, ECE)	
	Numerical Methods: CSE Stream	3	2	0	1BCHS202C	Applied Chemistry for Smart Systems (CSE)	
Engineering Sciences Courses II(ESC-II)					Programming Language Courses (PLC)		
	Introduction to Civil Engineering	3	0	0	1BCSA205D	Introduction to C Programming (for non-IT programmes)	
	Introduction to Electrical Engineering	3	0	0	1BCSB205D	Python Programming (For CSE and allied programmes)	
	Introduction to Electronics & Communication Engineering	3	0	0			
	Introduction to Mechanical Engineering	3	0	0			
	Essentials of Information Technology	3	0	0			

B. E. III SEMESTER

S I. N o	Course Catego ry	Course Code	Course Title	Teaching-Learning Scheme				Examination Duration (Hrs/Sem.)		Total Hours	Examination Scheme and Evaluation			Credit s (C) =Total Hours /30
				L Hrs/ Week (Hrs/S em.)	T Hrs/ Week (Hrs/S em.)	P Hrs/ Wee k (Hrs/ Sem.)	Term Work (TW) and Self Learning (SL) (TW+SL) Hrs/Sem.	CIE	SEE		CIE	SEE	TOT AL	
1	PCC	1BBTA30 1C	Cell Biology & Genetics	3(42)	0	0	42	3	3	90	50	50	100	3
2	IPCC	1BBTA30 2C	Microbiology	3(42)	0	2(26)	44	5	3	120	50	50	100	4
3	IPCC	1BBTA30 3C	Biochemistry	3(42)	0	2(26)	44	5	3	120	50	50	100	4
4	IPCC	1BBTA30 4C	Immunotechnolo gy	3(42)	0	2(26)	44	5	3	120	50	50	100	4
5	PCC	1BBTA30 6C	Cell Culture Techniques	2(28)	0	0	26	3	3	60	50	50	100	2
6	PCC	1BBTA30 8C	Unit Operation and Transport Processes	3(42)	0	0	42	3	3	90	50	50	100	3
7	PCCL	1BBTA30 7L	Unit Operation and Transport Processes Lab	0	0	2(26)	-	2	2	30	50	50	100	1
8	Skill Lab	1BBTA30 9L	Skill Lab	0	0	3	-	-	-	-	-	-	-	-
9	MC	1BHSA36 0M	Yoga-I	0	0	2(28)	-	2	-	30	100	-	100	PP
		1BHSA36 0M	National Service Scheme (NSS)-I											
		1BHSC36 0M	Physical Education-I											
		1BHSD36 0M	Music-I											
Total				17	0	13					450	350	800	21

B. E. IV SEMESTER

Sl · N o	Cour se Cate gory	Course Code	Course Title	Teaching-Learning Scheme				Examin ation Duratio n (Hrs/Sem.)		Tot al Ho urs	Examination Scheme and Evaluation			Cre dits (C) =Tot al Hou rs/3 0
				L Hrs/ Wee k (Hrs/ Sem.)	T Hrs/ Wee k (Hrs /Sem.)	P Hrs/ Wee k (Hrs /Sem.)	Term Work (TW) and Self Learnin g (SL) (TW+SL)) Hrs/Sem.	CI E	SE E		CIE	SEE	TOTAL	
1.	IPCC	1BBTA401C	Biostatistics & Tools	3(42)	0	2(26)	44	5	3	120	50	50	100	04
2.	BSC	1BBTA402C	Biology for Engineers	3(42)	0	0	42	3	3	90	50	50	100	03
3.	PCC	1BBTA403C	Bioprocess Principles and Calculations	3(42)	0	0	42	3	3	90	50	50	100	03
4.	IPCC	1BBTA404C	Molecular Biology	3(42)	0	2(26)	44	5	3	120	50	50	100	04
5.	IPCC	1BBTA405C	Upstream Processing Technology	3(42)	0	2(26)	44	5	3	120	50	50	100	04
6.	UHV	1BHSA424C	UHV-II	1(14)	0	0	13	2	1	30	50	50	100	01
7.	MC	1BHSA460M	Yoga-II	0	0	2(28)	-	2	-	30	100	-	100	00
		1BHSB460M	National Service Scheme(NSS)-II											
		1BHSC460M	Physical Education-II											
		1BHSD460M	Music-II											
Total				16	0	08					400	300	700	19

B. E. V SEMESTER

S I. N o	Course Cate gory	Course Code	Course Title	Teaching-Learning Scheme				Examination Duration (Hrs/Sem.)		Total Hours	Examination Marks			Credits (C) =Total Hours/30
				L Hrs/W eek (Hrs/Sem.)	T Hrs/W eek (Hrs/Sem.)	P Hrs/W eek (Hrs/Sem.)	Term Work (TW) and Self Learning (SL) (TW+SL) Hrs/Sem	CIE	SEE		CIE	SEE	TOTAL	
1.	PCC	BBTA501C	Bioinformatics	3(42)	0	0	42	3	3	90	50	50	100	3
2.	IPCC	BBTA502C	Genetic Engineering & Applications + Lab	3(42)	0	2(26)	44	5	6	120	50	50	100	4
3.	PCC	BBTA503C	Bioprocess and Bioreaction Engineering	3(42)	0	0	42	3	3	90	50	50	100	3
4.	PEC	BBTX504E	Elective –I	3(42)	0	0	42	3	3	90	50	50	100	3
5.	OEC	BBTA505N	Open Elective-I	3(42)	0	0	42	3	3	90	50	50	100	3
6.	HSMS/ MC	BBTA523C	EVS	1(14)	0	0	13	2	1	30	50	50	100	1
7.	PCCL	BBTA506L	Bioinformatics Lab	0	0	2(26)	-	2	2	30	50	50	100	1
8.	PP	BBTA507P	Mini project	Two contact hours/week for interaction between the faculty and			-	1	3	60	50	50	100	2
9.	AEC	BHSA522C	Quantitative Aptitude and Professional Skills	2(28)	0	0	26	3	3	60	50	50	100	2
10.	MC	BHSA560M	Yoga-III	0	0	2(28)	-	2	-	30	100	-	100	00
		BHSB560M	National Service Scheme(NSS)-III											
		BHSC560M	Physical Education-III											
Total				18	0	10					475	450	800	22

Elective-I

BBTB504E: Nutraceuticals

BBTD504E: Protein Engineering and Drug Design

BBTE504E: Bio-refineries & Bioenergy Technologies

BBTF504E: Environmental Biotechnology

Open Elective

BBTA531N: Bio-refineries and Bioenergy Technologies

B. E. VI SEMESTER

Sl. No	Course Category	Course Code	Course Title	Teaching-Learning Scheme				Examination Duration (Hrs/Sem.)		Total Hours	Examination Marks			Credits (C) = Total Hours/30
				L Hrs/Week (Hrs/Sem.)	T Hrs/Week (Hrs/Sem.)	P Hrs/Week (Hrs/Sem.)	Term Work (TW) and Self Learning (SL) (TW+SL) Hrs/Sem.	CIE	SEE		CI E	SE E	TOT AL	
1.	PCC	BBTA601C	Downstream Processing Technology	3(42)	0	0	42	3	3	90	50	50	100	3
2.	PCC	BBTA602C	Biotransformation and Enzyme technology	3(42)	0	0	42	3	3	90	50	50	100	3
3.	PCC	BBTA603C	Genomics & Proteomics	3(42)	0	0	42	3	3	90	50	50	100	3
4.	PEC	BBTX604E	Elective-II	3(42)	0	0	42	3	3	90	50	50	100	3
5.	OEC	BBTA605N	Open Elective –II	3(42)	0	0	42	3	3	90	50	50	100	3
6.	AEC	BHSA600C	Indian Knowledge System	1(14)	0	0	13	2	1	30	50	50	100	1
7.	PCCL	BBTA606L	Biokinetics & Enzyme Technology Lab	0	0	2(26)	-	2	2	30	50	50	100	1
8.	PCCL	BBTA607L	Bioseparation Techniques Lab	0	0	2(26)	-	2	2	30	50	50	100	1
9.	MC	BHSA660M/ BHSE660M/ BHSC660M	Yoga-IV/ NSS-IV / PE-IV	0	0	2(28)	-	2	-	30	25	-	-	00
Total				16	0	6					425	400	800	18

Elective-II

BBTB604E: Food Biotechnology

BBTD604E: Bioreactor Design

BBTE604E: Biosensors technology

BBTF604E: Quality Management System and Regulatory Affairs

Open Elective

BBTA605N: Environmental Technology

B. E. VII SEMESTER

S l. N o	Cours e Categ ory	Course Code	Course Title	Teaching-Learning Scheme				Examina tion Duration (Hrs/Se m.)		Tot al Hou rs	Examination Marks			Credits (C) =Total Hours/ 30
				L Hrs/W eek (Hrs/S em.)	T Hrs/We ek (Hrs/Se m.)	P Hrs/W eek (Hrs/S em.)	Term Work (TW) and Self Learnin g (SL) (TW+SL) Hrs/Se m.	CIE	SEE		CI E	SE E	TOT AL	
1.	PCC	22UBT702C	Downstream Processing Technology	3(42)	0	0	42	3	3	90	50	50	100	3
2.	HSMC	22UBT703H	Bioenterpreneurship Development	3(42)	0	0	42	3	3	90	50	50	100	3
3.	HSS	22UHS711C	Research Methodology and Intellectual Property Rights	3(42)	0	0	42	3	3	90	50	50	100	3
4.	PEC	22UBT7XXE	Elective –III	3(42)	0	0	42	3	3	90	50	50	100	3
5.	PEC	22UBT7XXE	Electives – IV	3(42)	0	0	42	3	3	90	50	50	100	3
6.	PCCL	22UBT704L	Upstream process & Bioseparation Techniques Lab	0	0	2(26)	-	2	2	30	50	50	100	1
7.	PP	22UBT705P	Project	Two contact hours/week for interaction between the faculty and students			-	1	3	240	50	50	100	8
Total				15	0	28					350	350	700	24

Elective-III

22UBT732E: Food Processing Technology

22UBT733E: Biosimulations

22UBT734E: Bioanalytical techniques

22UBT735E: Industrial Biotechnology

Elective-IV

22UBT741E: Nanobiotechnology & Biomaterials

22UBT742E: Food Product Development

22UBT743E: Clinical Research

22UBT745E: Pharmaceutical Biotechnology

B. E. VIII SEMESTER

S l. N o	Course Catego ry	Course Code	Course Title	Teaching-Learning Scheme				Examination Duration (Hrs/Sem.)		Total Hours	Examination Marks			Credits (C) =Total Hours/30
				L Hrs/ Week (Hrs/ Sem.)	T Hrs/ Week (Hrs/S em.)	P Hrs/Week (Hrs/Sem.)	Term Work (TW) and Self Learning (SL) (TW+SL) Hrs/Sem.	CIE	SEE		CI E	SE E	TOTAL	
1.	AEC	22UBT0XXO	MOOCs *	3	0	0	90	-	-	90	50	50	100	3
2.	OEC	22UBT0XXO	MOOCs *	3	0	0	90	-	-	90	50	50	100	3
3.	INT	22UBT801I	Internship	Two contact hours/week for interaction between the faculty and students				3	3	300	50	50	100	10
Total				6	0	-					150	150	300	16

DEPARTMENT OF BIOTECHNOLOGY
Scheme and Syllabus
2026-27

I/II SEMESTER SYLLABUS

Course Code		:	1BBTA105C	ELEMENTS OF BIOTECHNOLOGY	Semester	:	1/2
L:T:P*		:	3:0:0		Course Type	:	PSC
Hours/Sem.	Teaching	:	42 Hrs.		CIE Marks	:	50
	Learning (TW+SL)	:	42 Hrs.		SEE Marks	:	50
	Exam	:	6 Hrs.		Total Marks	:	100
	Total Hrs.	:	90 Hrs.		Credits	:	03

COURSE OUTCOMES**

After completion of the course student will be able to

1. Explain the fundamental principles of biology and analyze the biomolecules.
2. Summarize the history, scope and apply the concept of sustainability to biotechnology.
3. Select and differentiate various domains of biotechnology.
4. Demonstrate the applications of Artificial Intelligence in biological research.

UNIT-I

10 Hrs.

Basics of Biology & Biomolecules:

Structure and functions of prokaryotic and eukaryotic cells. Central dogma of Biology (DNA to RNA to Protein), Biomolecules of life: Properties functions and applications of Carbohydrates, Nucleic acids, Proteins and Lipids. Importance of special biomolecules: Properties functions and applications of enzymes, vitamins and hormones.

UNIT-II

10 Hrs.

History and Scope of Biotechnology: Introduction to biotechnology- Definition, scope, importance & commercial potential of biotechnology. Eminent contributors to biotechnology. Stages of development of biotechnology: ancient biotechnology, classical biotechnology and modern biotechnology.

Biotechnology and developing World: Biotechnology institutes in India- Public and private sector, Biotech success stories, Public perception of biotechnology. Biotechnology in context of developing world.

Sustainable Biotechnology

Concept of sustainability: Triple bottom line (economic, environmental, social). Role of Biotechnology in achieving SDGs. Life cycle assessment (LCA) in biotechnology. Circular bioeconomy and biorefinery. Carbon capture and utilization by biotechnology.

UNIT-III

10 Hrs.

Overview of Biotechnology:

History, scope, and branches/types of biotechnology: Medical biotechnology (red) - focusing on healthcare; Agricultural biotechnology (green):improving crops and livestock; Industrial biotechnology (white): using biological systems for industrial processes; Environmental biotechnology (grey/brown):focused on environmental protection and remediation; Food production (yellow): probiotics. Marine biotechnology (blue): oil slick, Bioinformatics (blue): application of computational techniques to store, retrieve, organize and analyze biological data; Drug discovery.

UNIT-IV

10 Hrs.

AI application in Biological Research : study through flow charts of the following

Role of AI in genomics. Role of AI in drug development. AI-assisted target (receptor) design and

ligand (inhibitor) design. AI in medical imaging and disease diagnosis. AI-driven personalized medicine and predictive healthcare. Role of AI in agriculture and crop improvement. Role of AI in fermentation industry and bioprocess optimization. Role of AI in Protein and enzyme engineering. Role of AI in biosensors and diagnostics.

TEXT BOOKS *

1. Singh B.D., Biotechnology: Expanding Horizons, MedTech Science Press, 5th Edition, 2023.
2. Barnum, Susan R., Biotechnology: An Introduction, Cengage Learning, 2021.

REFERENCE BOOKS *

1. P.K.Gupta, Elements of Biotechnology, Rastogi Publications, 2010.
2. Herren, Ray V., Introduction to Biotechnology, Cengage Learning, 2018.
3. Nath, Bhaskar, Advances in Biotechnology, Atlantic Publishers, 2020.
4. Alok Kumar Srivastav, Priyanka Das and Babasaheb Ghodke, Artificial Intelligence in Biotechnology and Genomics Emerging Technologies, Innovations and Applications, IBP Books, 2025.
5. Arthur M Lusk, Introduction to bioinformatics, fifth edition, Oxford publication, 2019.
6. Vittal R Srinivas, Bioinformatics-a modern approach.

Web links and Video Lectures(e-Resources):

1. Bioengineering: An Interface with Biology and Medicine,
https://onlinecourses.nptel.ac.in/noc21_bt05/preview?utm_source=chatgpt.com.
2. Industrial Biotechnology,
https://onlinecourses.nptel.ac.in/noc20_bt21/preview?utm_source=chatgpt.com
3. Fundamentals of Bioprocess Engineering,
https://onlinecourses.nptel.ac.in/noc25_bt84/preview?utm_source=chatgpt.com.

Course Outcomes	Programme Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3 (WK1, WK2, WK3, and WK4)										3 (WK8)	1		
CO2	3 (WK1, WK2, WK3, and WK4)					3 (WK1, WK5 WK7)					3 (WK8)	1		
CO3	3 (WK1, WK2, WK3, and WK4)				1 (WK2, WK6)						3 (WK8)	1	2	2
CO4	3 (WK1, WK2, WK3, and WK4)				2 (WK2, WK6)						3 (WK8)	1	2	2

Course Code		:	1BBT109L/ 1BBT209L	ELEMENTS OF BIOTECHNOLOGY LABORATORY	Semester	:	1/2
L:T:P*		:	0:0:2		Course Type	:	PSCL
Hours/Sem.	Teaching	:	26 Hrs.		CIE Marks	:	50
	Learning (TW+SL)	:	00		SEE Marks	:	50
	Exam	:	4 Hrs.		Total Marks	:	100
	Total Hrs.	:	30 Hrs.		Credits	:	01

Professional Competency:

Integrating biological domain knowledge with computational tools and statistical methods to solve complex life science problems. Building practical expertise bridges traditional lab work with IT, opening doors in biotechnology, pharmaceuticals, and precision medicine

Course Outcomes:

After completion of the course, student will be able to:

CO1-Understand basic instruments and handling of instruments used in biotechnology laboratory.

CO2-Carry out the sterilization of media, decontamination of the used media and individual skills in enumeration of microbial counts in food

CO3-Prepare various concentrations of solutions and can able to isolate probiotics using prebiotics.

CO4-To carry out mitosis and meiosis and can able to identify the cell stages, and understand how to explore biological databases and classify the genome using AI tools.

List of Experiments OR Programs List

1. Basic instruments in Biotechnology-Working principle and applications
2. Safety measures in Biotechnology laboratory
3. Sterilization Techniques: Dry heat and Moist Heat Sterilization
4. Microbiological examination of bakery food product (Bread)
5. Preparation of Standard Solutions-Molar, Normal and percent, pH
6. Evaluation of growth of probiotics bacteria in the presence of prebiotic substrate
7. Cell counting by Hemocytometer and Cell Viability
8. Mitosis/Meiosis and Karyotyping
9. Biological database search tools in bioinformatics
10. Genome search by NCBI Genbank and AI in sequence classification

Open Ended Experiment(s) OR Open Ended Program(s)

1. Calculations and preparation of 0.1M NaOH solution, 0.1N HCL, 70% Alcohol
2. Cell counting using blood sample
3. Isolation of probiotic bacteria
4. Sterilization of glasswares by overkill method.

Reference Books:

Laboratory Manual

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3 (WK)	1	-	1 (WK8)	2 (WK2)	-	-	2	1	-	1 (WK8)	3	1	3

	1, WK2, WK3, and WK4)			).	and WK6)									
CO2	3 (WK 1, WK2, WK3, and WK4)	2 (WK 1, WK 2, WK 3, and WK4)	-	3 (WK8)	1 (WK2 and WK6)	2 (WK 1, WK5, and WK7).	2 (WK9)	2	1	-	1(WK 8)	3	1	3
CO3	3 (WK 1, WK2, WK3, and WK4)	2 (WK 1, WK 2, WK 3, and WK4)	2 (WK5)	3 (WK8)	1 (WK2 and WK6)	2 (WK 1, WK5, and WK7).	-	2	1	-	1 (WK8)	3	1	2
CO4	3 (WK 1, WK2, WK3, and WK4)	2 (WK 1, WK 2, WK 3, and WK4)	-	2 (WK8)	3 (WK 2, WK6)	-	1(WK 9)	2	1	-	2 (WK8)	2	3	2

B. E. III SEMESTER

Course Code		:	1BBTA301C	CELL BIOLOGY AND GENETICS	Semester	:	03
L:T:P		:	3:0:0		Course Type	:	PCC
Hours/Sem.	Teaching	:	42 Hrs		CIE Marks	:	50
	Learning (TW+SL)	:	42 Hrs		SEE Marks	:	50
	Exam	:	06 Hrs		Total Marks	:	100
	Total Hrs.	:	90		Credits	:	03

Professional Competency:

Graduates will apply the principles of cell biology and genetics to understand cellular functions, genetic mechanisms, and their applications in disease diagnosis, prevention, and therapeutic interventions while adhering to ethical and professional standards

Course Outcomes:

After completion of the course, student will be able to:

CO1: Explain the structure, organization, and functions of prokaryotic and eukaryotic cells, plasma membranes, cell organelles, cytoskeletal elements, and cell cycle events including senescence, apoptosis, and cancer.

CO2: Analyze mechanisms of cell signaling, membrane transport, protein trafficking, and the role of endomembrane systems in cellular communication and metabolism.

CO3: Apply the principles Mendelian genetics, gene interactions, and molecular genetics concepts to solve inheritance problems, identify genetic material, and evaluate chromosomal disorders

CO4: Apply population genetics, mutation, evolution, and the significance of genetic analysis methods in understanding human health and biodiversity.

UNIT-I

10 Hrs.

CYTOLOGY AND CYTOSKELETON

Prokaryotic and eukaryotic cell. Cell Architecture- physio-chemical nature of plasma membrane

Structure & functions of cell organelles: nucleus, mitochondria, chloroplast, ribosomes, peroxisomes, golgi bodies and endoplasmic reticulum.

Cytoskeletal elements: Cytoskeletal architecture & elements: Microtubules- structure & functions, shaping of the cells and mechanical support. Microfilaments- structure & functions. Structure of intermediate filaments. Cytoplasmic micro trabecular system (lattice).

CELL CYCLE

Cell cycle studies: mitosis and meiosis. Cell Birth, lineage and death, Cellular senescence and ageing, Senescence in ageing and age-related disease, Apoptosis and Necrosis. Cancer Cell, Biology. Stem cell types

UNIT-II

12 Hrs.

CELL SIGNALLING

Signalling molecules and cell surface, receptors; intracellular signal transduction; G protein coupled receptors; plant growth factors and hormones, Eukaryotic and Prokaryotic cell to cell signalling, endocrine signalling, quorum sensing and intercellular signalling, Signal peptides.

MEMBRANE TRANSPORT

Membrane transport, passive and active transport; transport into prokaryotic cells; Endomembrane System: Golgi, Lysosomes Vesicular Traffic, Secretion, and Endocytosis, exocytosis; entry of viruses and toxins into cells
Membrane trafficking: Translocation of secretory proteins across the ER membrane; protein modifications, folding and quality control in the ER; export and sorting of proteins to mitochondria, chloroplast and peroxisomes.

UNIT-III

10 Hrs.

GENETICS:

Nature of genetic material, Mendelian Laws of inheritance, monohybrid and dihybrid inheritance, law of segregation & independent assortment, Gene interactions, supplementary genes - Comb patterns in fowls, Complementary genes - Flower color in sweet peas, Epistasis- Inhibitory and colored genes in fowls, simple problems. Identification of genetic material, classical experiments- Hershey & Chase, Avery, McLeod etc., Multiple alleles and groups antigens. Numericals based on concepts

UNIT-IV

10 Hrs.

CHROMOSOMAL DISORDERS

Sex determination in plants, animals XX-XY, XX-XO, ZW-ZZ, ZO-ZZ types in animals. Chromosomal disorders. Sex linked inheritance molecular diseases, hemoglobinopathies. Disorders of coagulation, Colour blindness, hemophilia, Non-disjunction as a proof of chromosomal theory of inheritance, Linkage maps, crossing over. Chromosomal maps, interference coincidence.

POPULATION GENETICS: Introduction, Gene frequency, and equilibrium estimation, changes in gene frequency, inbreeding and heterosis, genetic structure of population, speciation and evolution, prospects for the control of human evolution. Spontaneous and induced mutations, Eugenics. Pedigree analysis

Text Books:

1. The Cell – A Molecular Approach, Cooper & Hausman, ASM Press, 2004.
2. Molecular Biology of the Cell, B. Alberts, et al., Garland Science, 4th ed. 2002.

Reference Books:

1. Molecular Cell Biology Hardcover, James E. Darnell, Harvey Lodish, David Baltimore, 1999

Web links and Video Lectures (e-Resources)

- <https://www.youtube.com/watch?v=LFyJBiltFI>
- <https://www.biologyonline.com/tutorials/biological-cell-introduction>
- <https://study.com/academy/topic/cell-biology.html>
- <https://www.edx.org/learn/cellular-biology>
- https://onlinecourses.swayam2.ac.in/cec19_bt12/preview

Course Outcomes	Programme Outcomes											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3 (WK1, WK2, WK3, and WK4)										1 (WK 8)	3	3	3
CO2	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)									1 (WK 8)	2	3	3
CO3	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	2 (WK5)	1 (WK8)								3	3	3
CO4	3 (WK1, WK2, WK3, and WK4)	2 (WK1, WK2, WK3, and WK4)	3 (WK5)	1 (WK8)							1 (WK 8)	2	3	3

Course Code		:	1BBTA302C	MICROBIOLOGY	Semester	:	03
L:T:P		:	3:0:2		Course Type	:	IPCC
Hours/Sem.	Teaching	:	42+26 Hrs.		CIE Marks	:	50
	Learning (TW+SL)	:	44 Hrs.		SEE Marks	:	50
	Exam	:	8 Hrs.		Total Marks	:	100
	Total Hrs.	:	120 Hrs.		Credits	:	4
Professional Competency:							
Evaluate the role of microorganisms in environmental, industrial, and agricultural processes, including water treatment, soil fertility, biofertilizers, fermentation, and production of industrially important microbial products.							
Course Outcomes:							
After completion of the course, student will be able to:							
CO1: Understand the basic concepts of Microbiology, scope ,organization and understand the techniques to study microorganisms through microscopy							
CO2: Analyze the structure of different microbes and interpret the techniques used to grow and identify the microbes							
CO3: Analyse the causative organisms of the disease ,their control mechanisms and their effect on society							
CO4: Analyse the applied techniques in the environment and create awareness to society.							
UNIT-I							10 Hrs.
Introduction:							
Scope of microbiology, History of microbiology-Evolution of microbes. Contributions of Scientist for the development of microbiology. Microbial diversity & taxonomy, Prokaryotes & Eukaryotes. Microscopy: Principles and applications of Bright field microscopy, Dark-Field Microscopy, Phase Contrast microscopy, Fluorescence Microscopy and Electron microscopy (SEM&TEM).							
UNIT-II							12 Hrs.
METHODS AND TECHNIQUES IN MICROBIOLOGY: Bacteria- Morphology and ultra structure of Bacteria, Culturing of bacteria, reproduction and growth pattern (continuous and batch).Viruses, fungi, algae, protozoa, actinomycetes- structure and modes of reproduction. Fastidious microorganisms. Microbial toxins. Microbial Techniques: Pure culture techniques- Aerobic and Anaerobic culture techniques. Fermentation (acid &alcohol). Staining techniques (Simple and differential).General features of true bacteria (Rickettsia, Mycoplasma and Chlamydia), Prions, Spirochetes							
UNIT-III							10 Hrs.
MICROBIAL GROWTH AND CONTROL:							
Microbial growth Phases, Factors affecting the growth, growth measurement and enumeration. Metabolism; Primary and Secondary metabolites with examples, Control of microorganisms by Physical methods and chemical methods, antibiotics, chemotherapeutic agents and Phage biotics. MICROBIOLOGY AND DISEASES: Common diseases caused by microbes: viruses (Polio,H1N1,SARS,Covid-19,HIV,Hepatitis), bacteria(TB, Cholera, Typhoid, Pneumonia, Plague, Diphtheria, <i>E.coli</i> infections), Protozoans (Malaria, Leishmaniasis and Amoebiasis).Common types of fungal infections (ringworm, yeast infection). Microbiome and gut health.							
UNIT-IV							10 Hrs.
MICROBIOLOGY OF AIR, WATER &SOIL							
Aerobiology, Air sampling techniques and commonly found atmospheric microbe profile. Water sampling techniques, Microbiology of potable water and waste water treatment. Microbiology of soil: Soil fertility, Biofertilizers: VAM, Rhizobium and Azotobacter. Industrial Microbiology: Microbial processes using yeasts and bacteria (production of alcohol, vinegar, cheese), Microbes as source of protein (SCP), gelatin agents (alginate, xanthin, agar agar) Microbial insecticides, Enzymes from Microbes							

List of Experiments														
1. Study of microscopes: Types, working principle, parts of the microscope, handling (operating) & caring. 2. Media preparation: NA, Peptone broth, PDA , Macconkey agar. 3. Isolation of bacteria by serial dilution, pour plate, spread plate and streak plate techniques 4. Isolation and identification of bacteria and fungi from different sources. 5. Study of colony characteristics and Morphology of bacteria, yeasts and fungi. 6. Study of different staining techniques.(Simple staining differential staining) 7. Observation of motility by hanging drop technique 8. Fermentation of Carbohydrates (gas production) 9. Growth curve of bacteria and yeast. 10. Antibiotic susceptibility testing of bacteria .														
Text Books:														
1. Pelczar, Chan and Noel Kreig, "Microbiology"- 5 th Edition Tata Macgraw Hill ,2010 2. Tortora, Funke and Case, "Microbiology an Introduction"-8 th Edition, Pearson Education, 2006. 3. S. Sundara Rajan" College Microbiology"- 2 nd edition, Bangalore Vardhana, 2007														
Reference Books:														
1. Prescott, Harley & Klein, "Microbiology" -7 th Edition, WCB/McGraw Hill, Int. Edition. 2008 2. Prescott and Dunn, "Industrial Microbiology"-Agribios India, 2002. 3. E Alcamo I. "Fundamentals of Microbiology"6 th Ed, Jones & Bartlet, Pub. 2001														
Course Outcomes	Programme Outcomes											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3 (WK1, WK2, WK3, and WK4)	2(WK 1, WK2, WK3, and WK4)	(WK 5)					1			2	3	3	3
CO2	3 WK1, WK2, WK3, and WK4)	3(WK 1, WK2, WK3, and WK4)	2 (WK 5)		2 (WK 6)	3(WK1, WK 5 and WK 7)					3 (WK 8)	2	2	3
CO3	3 (WK1, WK2, WK3, and WK4)	2(WK 1, WK2, WK3, and WK4)	2 (WK 5)		2 (WK 6)		1 (WK 9)				2	2	2	3
CO4	3 (WK1, WK2, WK3, and WK4)	2(WK 1, WK2, WK3, and WK4)	2 (WK 5)		2 (WK 6)	2(WK1, WK 5 and WK 7)	2 (WK 9)				3 (WK 8)	2	2	3

Course Code		:	1BBTA303C	BIOCHEMISTRY	Semester	:	03
L:T:P		:	3:0:2		Course Type	:	IPCC
Hours/Sem.	Teaching	:	42+26 Hrs.		CIE Marks	:	50
	Learning (TW+SL)	:	44 Hrs.		SEE Marks	:	50
	Exam	:	08 Hrs		Total Marks	:	100
	Total Hrs.	:	120		Credits	:	04

Professional Competency:

Analyse biomolecular structures, evaluate metabolic pathways, correlate pathway dysfunctions with clinical disorders, and execute quantitative bio-analytical laboratory techniques.

Course Outcomes:

After completion of the course, student will be able to:

CO1: Interpret the basic concepts of biochemistry and metabolic pathways of the carbohydrates with their disorders and energetic of metabolic reactions.

CO2: Explain lipids metabolism along with regulation and metabolic disorders. Also apply fundamental methods to identify the biomolecules and interpret the specific tests for qualitative analysis.

CO3: Recognize the biosynthetic precursors involved in the amino acid metabolism and its disorders and interpret biochemical data, perform relevant calculations, and draw conclusions from experimental results.

CO4: Comprehend nucleic acid metabolism along with disorders and Present biochemical concepts clearly through written reports, presentations, or discussions using appropriate scientific language.

UNIT-I	12 Hrs.
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UNIT-I	12 Hrs.
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INTRODUCTION TO BIOCHEMISTRY

Biomolecules – function and properties, pH, Henderson Hesselbalch equation, buffers and their properties, concentration of solutions.

METABOLISM OF CARBOHYDRATE

Introduction to metabolism. Principle biomolecules involved in the energy flow in the metabolic cycle. Glycolysis, TCA cycle, Glyoxylate cycle, NADPH Cycle, Calvin Cycle. Gluconeogenesis and regulation of gluconeogenesis, pentose phosphate pathway, Electron transport chain, oxidative phosphorylation, bioenergetics of reactions. Disorders of carbohydrate metabolism (lactose intolerance, galactosemia, diabetes).

UNIT-II	10 Hrs.
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UNIT-II	10 Hrs.
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Biosynthesis of fatty acids (palmitic acid cholesterol, phospholipids and glycolipids). Regulation of fatty acid

biosynthesis. Biodegradation of fatty acid. Ketone bodies production during starving and diabetes. Disorders of lipid metabolism (atherosclerosis, acidosis-kesosis, Gaucher disease and LDL-hypercholesterolemia).

UNIT-III	10 Hrs.
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UNIT-III	10 Hrs.
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Biosynthesis of amino acids starting from acetyl CoA (with reference to oxaloacetate family) - Aspartate,

Asparagine, Methionine, Lysine, Threonine. Biodegradation of amino acids- deamination, transamination and urea cycle. Regulation of amino acid metabolism.

Disorders of amino acid metabolism (Phenylketonuria, Albinism, Maple Syrup Urine Disease, Tyrosinemia).

UNIT-IV	10 Hrs.
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UNIT-IV	10 Hrs.
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Biosynthesis of purines - origin of ring atoms, formation of IMP, conversion of IMP to AMP and GMP. De novo

synthesis of pyrimidine nucleotides - biosynthesis of UTP & CTP. Biodegradation of purines & pyrimidines. Recycling of Purine and Pyrimidine nucleotides by salvage pathways. Disorders of nucleic acid metabolism. (Gout, Lesch-Nyhan syndrome, hyper and hypo uricemia, adenosine deaminase deficiency, SIDS).

List of Experiments:

1. pH measurements, volume / weight measurements, concentration units, sensitivity Specificity, precision, accuracy, preparation of reagents and buffers of constant strength.
2. Qualitative tests for carbohydrate and lipids.
3. Qualitative tests for amino acids and proteins.
4. Estimation of Glucose by Folin Wu method/ O-Toluidine method
5. Estimation of amino acid by ninhydrin method.

6. Estimation of DNA by DPA method
7. Determination of Saponification value and iodine value of lipids.
8. Estimation of proteins by Lowry's method.
9. Estimation of urea by DAMO method.
10. Estimation of iron by Wong's method.

Text Books:

1. David L. Nelson and Michael Cox., "Lehninger Principles of Biochemistry" 7th edition, W.H Freeman Co., Pub.2017
2. U. Sathyanarayana, "Biochemistry" -5th edition, Books and Allied Pub., 2022
3. Beedu Sashidhar Rao and Vijay Deshpande, "Experimental Biochemistry" -I. K. Intl., 2013

Reference Books:

1. Lubert Stryer, "Biochemistry" -8th edition Freeman & Co., Pub.,2021
2. Voet & Voet, "Biochemistry" - 4th edition, John Wiley, New York Pub.2011
3. Thomas M. Davlins, "Biochemistry with clinical correlations" 7th edition Wiley-Liss., 2010
4. Rodney Boyer, "Modern Experimental Biochemistry"-Pearson Education Pub, 2000.
5. Pattabhiraman, "Practical Biochemistry" 4th edition All India publisher and distributor., 2015
6. Plummer D. T., "Practical Biochemistry" -TMH Pub. 1988

Course Outcomes	Programme Outcomes											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3 (WK1, WK2, WK3, and WK4)	2 (WK1, WK2, WK3, and WK4)	3 (WK5)	-	3 (WK 2 and WK6)	-	3 (WK9)	-	-	-	3 (W K8)	3	3	3
CO2	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	3 (WK5)	-	3 (WK 2 and WK6)	-	3 (WK9)	-	-	-	3 (WK 8)	3	3	3
CO3	2 (WK 1, WK2 , and WK4)	3 (WK1, WK2, WK3, and WK4)	3 (WK5)	-	3 (WK 2 and WK6)	-	3 (WK9)	-	-	-	3 (WK 8)	3	3	3
CO4	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	3 (WK5)	-	3 (WK 2 and WK6)	-	3 (WK9)	-	-	-	3 (WK 8)	3	3	3

Course Code		:	1BBTA304C	IMMUNOTECHNOLOGY	Semester	:	03
L:T:P		:	3:0:2		Course Type	:	IPCC
Hours/Sem.	Teaching	:	42 + 26 Hrs.		CIE Marks	:	50
	Learning (TW+SL)	:	44 Hrs.		SEE Marks	:	50
	Exam	:	08 Hrs.		Total Marks	:	100
	Total Hrs.	:	120 Hrs.		Credits	:	04
Professional Competency:							
Analyze immune system functions, diagnose immunological disorders, develop vaccines, and perform advanced lab techniques for clinical and research purposes.							
Course Outcomes:							
After completion of the course student will be able to:							
1. Interpret the properties and functions of immune system for research and medicinal field. 2. Identify the functions of humoral and cell mediated immune system for disease diagnosis and analyzing the drug. 3. Asses the immunological disorders and develop the vaccines. 4. Apply the major immunological laboratory techniques and their application to both clinical analysis and experimental research.							
UNIT-I						12 Hrs.	
IMMUNE SYSTEM:							
Introduction, Cells and Organs of the immune system: Lymphoid cells and myeloid cells. Primary (thymus, bone marrow and lymphatic system) and secondary Lymphoid organs (lymph nodes, spleen, MALT). Innate and adaptive immunity. Antigens: Chemical and biological Factors affecting antigenicity/Immunogenicity and molecular nature, Haptens, adjuvants. Antibodies: their structure and function, Immunoglobulin classes (IgG, IgA, IgE, IgD and IgM) and subclasses (isotypic, allotypes, idiotypes and anti-idiotypic antibodies). Cytokines and their role in immune response.							
UNIT-II						10 Hrs.	
HUMORAL AND CELL MEDIATED IMMUNITY:							
Introduction to humoral and cell mediated immunity. B-lymphocytes maturation and mechanism of activation. Antibody genes and generation of diversity, Class Switching mechanism. T-cell maturation and mechanism of activation. Major Histocompatibility Complex: MHC I and MHC II structure and functions. Antigen processing and presentation process.							
Complement system and its pathways (classical, alternative and lectin pathway).							
UNIT-III						10 Hrs.	
IMMUNOLOGICAL DISORDERS:							
Hypersensitivity reactions and its types. Autoimmune disorders- Organ specific, Systemic Autoimmune disorders. Primary and secondary immunodeficiency disorders (AIDS). Transplantation Immunology: Types of transplantations, Immunological basis of graft rejection.							
Vaccines: Active and Passive immunization. Designing vaccines for active immunization: Live, attenuated vaccines, inactive vaccines, subunit vaccines, recombinant vector vaccines and DNA vaccines.							
UNIT-IV						10 Hrs.	
IMMUNODIAGNOSIS:							
Antigen-antibody reactions- Precipitation reactions, agglutination reactions, Blood typing A, B, ABO & Rh. Principal and applications of ELISA, Radio immuno assay (RIA), western blot analysis, Immuno-electrophoresis, Immunofluorescence, fluorescence activated cell sorting (FACS) analysis. Production of monoclonal and polyclonal antibodies and their applications.							
List of Experiments:							
1. Agglutination Technique: Blood group identification and Rh factor 2. Laboratory diagnosis of diseases-Widal test (Tube agglutination) and VDRL 3. Ouchterlony Double Diffusion (ODD) 4. Radial Immunodiffusion (RID) 5. Countercurrent immunoelectrophoresis (CCIEP) 6. Rocket immunoelectrophoresis (RIEP)							

7. Western blot (IGg Purification)

8. ELISA/ DOT Blot.

Text Books:

1. Roitts, "Essential Immunology" 13th edition, Wiley Blackwell, 2017
2. Kuby, J., "Immunology", 8th edition, W H Freeman Publishers, 2019
3. Rastogi, S. C., "Immunodiagnosics", 1st Edition, New Age International, 2005

Reference Books:

1. Chakravarthy, A.K. "Immunology & Immunotechnology", Oxford University Press, 2006

Course Outcomes	Programme Outcomes											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3 (WK1 to WK4)	2 (W K1 to WK 4)	2 (WK5)	1 (WK 8)	3 (WK2 and WK6)	-	-	-	-	-	3 (WK8)	3	3	-
CO2	3 (WK1 to WK4)	2 (W K1 to WK 4)	2 (WK5)	2 (WK 8)	3 (WK2 and WK6)	-	-	-	-	-	3 (WK8)	3	3	-
CO3	3 (WK1 to WK4)	3 (W K1 to WK 4)	3 (WK5)	2 (WK 8)	3 (WK2 and WK6)	-	-	1	-	-	3 (WK8)	3	3	2
CO4	3 (WK1 to WK4)	2 (W K1 to WK 4)	2 (WK5)	2 (WK 8)	3 (WK2 and WK6)	2 (WK1, WK5, and WK7)	-	1	-	-	3 (WK8)	3	3	2

CELL CULTURE TECHNIQUES

Apply plant and animal cell culture principles and laboratory techniques to establish, maintain, characterize, preserve, and utilize cell cultures for research, biopharmaceutical production, tissue engineering, regenerative medicine, and agricultural biotechnology while adhering to biosafety, bioethics, and quality assurance practices.

After completion of the course, student will be able to:

CO1: Apply the fundamental principles of plant cell culture in Plant Tissue culture laboratories.

C02: Apply various plant tissue culture techniques for crop improvement.

CO3: Demonstrate animal cell culture techniques including cell line establishment, sub culturing, and media formulation in cell culture.

CO4: Evaluate cell viability, cytotoxicity, and contamination in cultured cells using appropriate assays in animal cell culture research.

8 Hrs.

History and introduction, requirements, lab organisation, media constituents, choice of media sterilization of media, explant selection, sterilisation and preparation for inoculation, role of growth hormones in cell culture. Cellular totipotency, cytodifferentiation, organogenic differentiation, somatic embryogenesis. Plant growth hormones - auxins, gibberellins, cytokinins. Stoichiometry of cell growth and product formation.

6 Hrs.

Protoplast culture, somatic hybridization, haploid production, micro propagation, somaclonal variation, crop improvement, hairy root culture, synthetic seeds. Regeneration of plantlets-shooting, rooting and hardening.

8 Hrs.

History and development of mammalian cell culture. Lab layout and equipments, cell culture media (Natural and Artificial) - components of the medium, functions of media components. Role of antibiotics in media. Types of primary culture, establishment of primary culture, cell lines – mechanical and enzymatic mode of desegregation. Subculture - passage number, split ratio, seeding efficiency, criteria for subculture.

8 Hrs.

Measurement of Cell viability-Dye exclusion and inclusion tests and Cytotoxicity assay –MTT, clonogenic assay. Preservation of cell lines. Characterization of cell lines. Cell line contaminations, detection and control. Stem cells & their applications.

1. R. Ian Freshney, Culture of Animal cells A Manual of Basic Technique and Specialized Applications-8th Edition-.Wiley Less, 2021
2. H. S. Chawla, Introduction to Plant biotechnology by, 2nd Edition, Oxford and IBH Publishers, 2010
3. B. D. Singh, Biotech Expanding Horizons, Kalyani Publishers, 2010.

Reference Books:

1. Ranga, M. M. Animal Biotechnology (3rd Edition), 2021.
2. Bhojwani, S. S., & Dantu, P. K. Plant Tissue Culture: An Introductory Text. Springer, 2013.

Web links and Video Lectures (e-Resources)

1. https://www.getyoureducation.net/course/cell-culture-technologies-1?utm_source
2. https://www.getyoureducation.net/course/cell-culture-technologies-1?utm_source
3. IGNOU eGyanKosh – Animal Cell Culture Unit

Course Outcomes	Programme Outcomes											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3 (WK,WK 2 WK3,W K4)	2 (WK, WK2 WK3, WK4)	1 (WK 5)	1 (WK 8)	1 (WK2 and WK6)	2 (WK1, WK5, and WK7)	-	-	-	-	2 (W K8)	3	3	2
CO2	3 (WK,WK 2 WK3,W K4)	3 (WK, WK2 WK3, WK4)	2 (WK 5)	2 (WK 8)	2 (WK2 and WK6)	2 (WK1, WK5, and WK7)	-	-	-	-	2 (W K8)	3	3	2
CO3	3 (WK,WK 2 WK3,W K4)	2 (WK, WK2 WK3, WK4)	2 (WK 5)	2 (WK 8)	2 (WK2 and WK6)	2 (WK1, WK5, and WK7)	-	-	-	-	2 (W K8)	3	3	2
CO4	3 (WK,WK 2 WK3,W K4)	3 (WK, WK2 WK3, WK4)	2 (WK 5)	3 (WK 8)	2 (WK2 and WK6)	2 (WK1, WK5, and WK7)	-	-	-	-	2 (W K8)	3	3	2

Course Code		:	1BBTA308C	UNIT OPERATIONS AND TRANSPORT PROCESSES	Semester	:	03
L:T:P		:	3:0:0		Course Type	:	PCC
Hours/Sem.	Teaching	:	42 Hrs.		CIE Marks	:	50
	Learning (TW+SL)	:	42 Hrs.		SEE Marks	:	50
	Exam	:	6 Hrs.		Total Marks	:	100
	Total Hrs.	:	90 Hrs.		Credits	:	03

Professional Competency:

Ability to apply the fundamental principles of heat, and mass transfer to analyze, design, and optimize individual chemical engineering unit operations and fluid flow systems, ensuring efficient, safe, and sustainable industrial process operations.

Course Outcomes:

After completion of the course, student will be able to:

- CO1:** Analyse fluid behaviour, flow profiles, and transport dynamics in biological and industrial fluid systems using fundamental equations of fluid flow and flow measurement techniques.
- CO2:** Solve steady-state heat conduction problems and design heat exchange equipment by applying Fourier's Law, convective transport correlations, and the Log Mean Temperature Difference (LMTD) method.
- CO3:** Competent in solid-fluid mechanical separation and thermal processing operations to operate bioprocesses
- CO4:** Analyse molecular diffusion, design diffusional separation operations and evaluate bioreactor mixing behaviours.

UNIT-I

10 Hrs.

Fluid Flow Operations & Biofluid Mechanics

Fluid Properties and Rheology: Characteristics of fluids, density, and viscosity. Newton's law of viscosity. Distinction between Newtonian and non-Newtonian fluids. Rheological behavior and biological implications.

Fluid Statics: Pascal's law, barometric equation, and hydrostatic pressure. Manometers: types, working principles, and pressure measurement calculations.

Fluid Dynamics: Laminar and turbulent flow regimes. Reynolds number (Re) and its practical importance. Velocity distribution profiles in laminar and turbulent flows.

Basic Equations of Fluid Flow: Continuity equation (conservation of mass). Euler's equation of motion. Derivation of Bernoulli's theorem, its application, and engineering corrections (friction and pump work additions). Flow Measurement: Principles, working, and equations for variable head meters (Orifice meters, Venturi meters) and variable area meters (Rotameters).

UNIT-II

10 Hrs.

Conduction: Modes of heat transfer. Fourier's law of conduction and thermal conductivity (k). Steady-state heat conduction through single-layer slabs, multilayer composite walls, and cylindrical geometries. Conceptual numerical problems on conductive resistance.

Convection: Mechanism of forced and natural convection. Concept of individual and overall heat transfer coefficients (h and U). Combined heat transfer mechanisms (conduction-convection-conduction series). Fundamentals of boiling and condensation heat transfer phases.

Heat Transfer Equipment: Construction and working principles of Double Pipe and Shell and Tube heat exchangers. Flow configurations: co-current vs. counter-current flow. Thermal Design Concepts: Derivation and application of Log Mean Temperature Difference (LMTD). Numerical

UNIT-III

10 Hrs.

Mechanical and Separation Operations

Filtration: Mechanisms and types of filtration. Distribution of overall pressure drop across the cake and filter medium (resistance modeling). Filter media characteristics and the role of filter aids. Factors affecting the rate of filtration. Equipment: Operational principles of Plate and Frame Filter Presses and Rotary Drum Filters.

Theory of Settling & Sedimentation: Mechanics of particulate settling (Free vs. Hindered settling). Stoke's law, Newton's law, and terminal settling velocity. Concept of batch sedimentation and evaluation of the Settling Velocity Curve. Equipment: Industrial thickeners and cyclone separators.

Flotation: Principles of surface chemistry-driven separation and froth flotation mechanics.

Evaporation & Crystallization: Governing principles, heat balances and operations

Drying: Internal and external mass transfer mechanisms, drying rate curves (constant and falling rate periods), and calculation of total drying rate.														
UNIT-IV												10 Hrs.		
Mass Transfer Fundamentals & Bioreactor Transport Diffusion & Mass Transfer Coefficients: Fick’s law of molecular diffusion. Steady-state molecular diffusion in stagnant fluids and laminar flow regimes. Measurement techniques for diffusivity. Mass transfer coefficients and empirical correlations. Diffusional Separation Processes: Phase equilibrium principles and mass transfer phenomena in Liquid-Liquid Extraction, Gas Absorption, Adsorption, and Desorption operations. Distillation: Vapor-liquid equilibrium (VLE) relationship. Operational methods: Simple batch distillation, Flash (equilibrium) distillation, and Continuous Fractional distillation. Stage-Wise Calculations: Graphical estimation of ideal stages/trays in a distillation column using the McCabe-Thiele method. Agitation and Mixing: Dynamics of homogeneous and heterogeneous mixtures. Flow patterns generated by different impeller geometries (axial vs. radial flow). Mechanics of dispersing gases into liquids.														
Reference Books: 1. McCabe, W. L., Smith, J. C., & Harriott, P. Unit Operations of Chemical Engineering. McGraw-Hill. 2. Geankoplis, C. J. Transport Processes and Separation Process Principles. Prentice Hall. 3. Treybal, R. E. Mass-Transfer Operations. McGraw-Hill. 4. Doran, P. M. Bioprocess Engineering Principles. Academic Press.														
Web links and Video Lectures (e-Resources) 1. NPTEL: Mechanical Unit Operations: Instructor: Prof. Nanda Kishore (IIT Guwahati) 2. NPTEL: Transport Processes I: Heat and Mass Transfer Instructor: Chemical Engineering Faculty (NPTEL / Swayam Ecosystem) 3. NPTEL: Mass Transfer Operations I & II Instructor: Prof. Bishnupada Mandal (IIT Guwahati) 4. edX - Bioprocess Engineering Principles (Top Technical Universities)														
Course Outcomes	Programme Outcomes											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	2 (WK 5)	1 (W K8)	-	1 (WK 1,WK 5,WK 7)	-	-	-	-	1 (WK 8)	3	2	-
CO2	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	3 (WK 5)	2 (W K8)	1 (WK 2,WK 6)	1	-	-	-	1	1 (WK 8)	1	3	1
CO3	3 (WK1, WK2, WK3, and WK4)	2 (WK1, WK2, WK3, and WK4)	2 (WK 5)	2 (W K8)	-	2 (WK 1,WK 5,WK 7)	-	-	-	-	1 (WK 8)	2	3	2
CO4	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	3 (WK 5)	2 (W K8)	2 (WK 2,WK 6)	1 (WK 1,WK 5,WK 7)	-	-	-	1	1 (WK 8)	2	3	1

Course Code		:	1BBTA307L	UNIT OPERATIONS AND TRANSPORT PROCESSES LAB	Semester	:	06
L:T:P		:	0:0:2		Course Type	:	PCCL
Hours/Sem.	Teaching	:	26 Hrs.		CIE Marks	:	50
	Learning (TW+SL)	:	00 Hrs.		SEE Marks	:	50
	Exam	:	4 Hrs.		Total Marks	:	100
	Total Hrs.	:	30 Hrs.		Credits	:	01

Professional Competency:

Ability to apply the fundamental principles of heat, and mass transfer to analyze, design, and optimize individual chemical engineering unit operations and fluid flow systems, ensuring efficient, safe, and sustainable industrial process operations.

Course Outcomes:

After completion of the course, student will be able to:

- CO1:** Experimentally evaluate head losses, and calibrate differential pressure and variable-area flow meters.
- CO2:** Estimate thermal conductivity in composite matrices and analyze convective transport parameters and thermal effectiveness in multi-flow heat exchangers.
- CO3:** Construct and evaluate transport rate profiles for solid-fluid operations by analyzing particulate settling behaviors and biological product drying curves.
- CO4:** Evaluate phase-equilibria transport performance by executing binary fractional distillation and solid-liquid extraction operations.

List of Experiments

1. Verification of Bernoulli's Theorem & Head Loss Evaluation
2. Calibration of Flow Measurement Devices Objective
3. Thermal Conductivity of Composite Wall Structures
4. Evaluation of Convective Heat Transfer Coefficients
5. Performance Evaluation of a Double-Pipe Heat Exchanger
6. Batch Sedimentation
7. Settling Velocity Profile Analysis
8. Drying Kinetics of Biological Products
9. Extraction (S/L)/ Soxhlet extraction
10. Distillation of binary mixture

Open Ended Experiment(s) OR Open Ended Program(s)

1. Rheological Characterization of Biological Fluids
2. Visual Determination of Flow Regimes (Reynolds Experiment)
3. Filtration Kinetics Using a Plate and Frame Filter Press

Reference Books:

1. McCabe, W. L., Smith, J. C., & Harriott, P. Unit Operations of Chemical Engineering. McGraw-Hill.
2. Geankoplis, C. J. Transport Processes and Separation Process Principles. Prentice Hall.
3. Doran, P. M. Bioprocess Engineering Principles. Academic Press.

Web links and Video Lectures (e-Resources)

1. NPTEL: Mechanical Unit Operations: Instructor: Prof. Nanda Kishore (IIT Guwahati)
2. NPTEL: Transport Processes I: Heat and Mass Transfer Instructor: Chemical Engineering Faculty (NPTEL / Swayam Ecosystem)
3. NPTEL: Mass Transfer Operations I & II Instructor: Prof. Bishnupada Mandal (IIT Guwahati)
4. edX - Bioprocess Engineering Principles (Top Technical Universities)

Course Outcomes	Programme Outcomes											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	2 (WK5)	1 (WK8)	-	1 (WK1, WK5, WK7)	-	-	-	-	1 (WK8)	3	2	-
CO2	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	3 (WK5)	2 (WK8)	1 (WK2, WK6)	1	-	-	-	1	1 (WK8)	1	3	1
CO3	3 (WK1, WK2, WK3, and WK4)	2 (WK1, WK2, WK3, and WK4)	2 (WK5)	2 (WK8)	-	2 (WK1, WK5, WK7)	-	-	-	-	1 (WK8)	2	3	2
CO4	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	3 (WK5)	2 (WK8)	2 (WK2, WK6)	1 (WK1, WK5, WK7)	-	-	-	1	1 (WK8)	2	3	1

IV SEMESTER

	Code	:	1BBTA401C	BIostatistics and Tools	Semester	:	04
	LTP	:	3:0:2		Course Type	:	IPCC
Hours/Sem.	Teaching	:	42+26 Hrs.		CIE Marks	:	50
	Learning (TW+SL)	:	44 Hrs.		SEE Marks	:	50
	Exam	:	08 Hrs.		Total Marks	:	100
	Total Hrs.	:	120 Hrs.		Credits	:	04

Professional Competency:

Apply statistical methods and computational software to analyze biological data in the field of the research and industry.

Course Outcomes:

After completion of the course student will be able to:

CO1: Analyze the data using various statistical tools in the field of research and industry.

CO2: Investigate the probability distributions of the data.

CO3: Apply the knowledge of inferential statistics to analyze the data using statistical tools.

CO4: Design and analyze the experimentation using statistical software tools for the field of research and industry.

UNIT-I

12 Hrs.

INTRODUCTION AND DESCRIPTIVE STATISTICS

Scope of biostatistics, common terms in statistics. Types of numerical data, Sampling techniques- random (simple, stratified and systematic) non random sampling - (Judgement and convenience). Presentation of data: Diagrammatic and graphical represent, Measure of central tendency (meaning of central tendency, arithmetic mean, median, mode, geometric mean, harmonic mean their merits and demerits). Measure of dispersion: meaning, range, mean deviation and standard deviation, coefficient of variation.

UNIT-II

10 Hrs.

BIVARIATE ANALYSIS AND PROBABILITY DISTRIBUTIONS

Correlation- types, reasons and methods of estimating correlation, Karl Pearson's coefficient of correlation. Linear Regression analysis. Probability theories: Addition and Multiplication theorem of probability. Probability distributions: Discrete probability distributions: Binomial and Poisson distribution. Continuous probability distribution – normal, properties of normal curve.

UNIT-III

10 Hrs.

INFERENTIAL STATISTICS

Statistical Estimation: Point estimation and interval estimation, Testing of hypothesis (T, Z and Chi square - test), Types of Errors: Type-I and Type-II, Analysis of variance ANOVA: one way and two way classifications.

UNIT-IV

10 Hrs.

DESIGN AND ANALYSIS OF EXPERIMENTS:

Basic principles of experimental design and limitations-randomization, replication, local control, Types of statistical designs of biological experiments and limitations-CRD, RCBD, LSD, Plackett-Burman design, Response surface methodology (RSM).

List of Experiments

1. Create Data file and plot Diagram and Graphs in SPSS software.
2. Calculate and interpret Mean, Median, Mode, Standard Deviation and Variance for data.
3. Calculation & interpretation of correlation and regression between variables.
4. Perform t- test for determining a significance difference between two groups.
5. Calculation and interpretation of Chi-square test.
6. ANOVA- one-way analysis & two-way analysis.
7. Experimental Research Design – CRD- Analysis.
8. Experimental Research design – RCBD- Analysis.
9. Experimental Research design – Latin square Design- Analysis.
10. Design and analysis of screening experiments using Plackett–Burman designs.
11. Design and analysis of experiments based on response surface methodology (RSM).

Text Books:														
1. Khan and Khanum, “Fundamentals of Biostatistics” (6 rd edition), Ukaaz Publication, 2016														
2. Agarwal B.L. ,”Basic statistics” (6 th edition), New age international Publishers,2018														
Reference Books:														
1. Rastogi V. B., “Biostatistics”, 3 rd Edition, Medtech Publication, 2015														
2. Bradley Jones, Douglas C. Montgomery “Design of Experiments: A Modern Approach” 1st Edition, Wiley Publication, 2019														
Course Outcomes	Programme Outcomes											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3 (WK1 to WK4)	3 (WK1 to WK4)	2 (WK5)	3 (WK8)	3 (WK2 and WK6)	-	-	-	-	-	3 (WK8)	3	3	-
CO2	3 (WK1 to WK4)	3 (WK1 to WK4)	2 (WK5)	3 (WK8)	3 (WK2 and WK6)	-	-	-	-	-	3 (WK8)	3	3	-
CO3	3 (WK1 to WK4)	3 (WK1 to WK4)	3 (WK5)	3 (WK8)	3 (WK2 and WK6)	2 (WK1, WK5, and WK7).	-	-	-	-	3 (WK8)	3	3	-
CO4	3 (WK1 to WK4)	3 (WK1 to WK4)	3 (WK5)	3 (WK8).	3 (WK2 and WK6)	2 (WK1, WK5, and WK7)	-	-	-	-	3 (WK8)	3	3	2

Hours/Sem.	Code	:	1BBTA402C	BIOLOGY FOR ENGINEERS	Semester	:	4
	LTP	:	3:0:0		Course Type	:	PCC
	Teaching	:	42Hrs.		CIE Marks	:	50
	Learning (TW+SL)	:	42Hrs.		SEE Marks	:	50
	Exam	:	6Hrs.		Total Marks	:	100
	Total Hrs.	:	90Hrs.		Credits	:	03
Professional Competency:							
Understanding fundamentals of biological processes and apply to solve engineering problems, bridging the technical engineering with living systems.							
Course Outcomes:							
After completion of the course, student will be able to:							
CO1: Explain the structure and functions of cells and biomolecules, properties and applications of special biomolecules in engineering and industrial contexts.							
CO2: Interpret bio-inspired models and natural mechanisms and correlate them with engineering designs and technological innovations.							
CO3: Analyze the functional architecture of human organ systems as models to design and evaluate engineering solutions.							
CO4: Apply the concept of bioprinting, artificial intelligence, and microbial processes in the design and development of innovative solutions for healthcare, food science, and sustainable infrastructure.							
UNIT-I						10 Hrs.	
Introduction to Biology:							
The cell: Structure, and functions of a cell. Biomolecules: Properties and functions of Carbohydrates, Nucleic acids, Proteins and Lipids. Importance of special biomolecules: Enzymes, vitamins and hormones -properties and functions.							
Biomolecules and their Applications:							
Carbohydrates in bioplastics production, Proteins in food production, Lipids in biodiesel.							
UNIT-II						10 Hrs.	
Bio Inspiration Models Used in Engineering:							
Bio inspiration - Introduction, Alliance between Engineering and Biology, Biomimicry - Science mimicking nature. Bird flying (GPS and aircrafts), Lotus leaf effect (Super hydrophobic and self-cleaning surfaces), Gecko Feet, Plant burrs (Velcro), Shark skin (Friction reducing swimsuits), Kingfisher beak (Bullet train), Fire fly LED.							
Nature Bioinspired Mechanisms:							
BioEcholocation (ultrasonography, sonars), Photosynthesis (photovoltaic cells, bionic leaf), Respiration (MFCs) .							
UNIT-III						12 Hrs.	
Human Organ Systems and Bio Designs							
Brain as a CPU system -architecture, CNS and Peripheral Nervous System, signal transmission, EEG. Engineering solutions for Parkinson's disease.							
Heart as a pump system -architecture, electrical signalling - ECG monitoring and heart related issues, reasons for blockages of blood vessels, design of stents, pace makers, defibrillators.							
Lungs as purification system gas exchange mechanisms, spirometry, Ventilators.							
Eye as a Camera system, bionic eye. Kidney as a filtration system - dialysis systems.							
UNIT-IV						10 Hrs.	
Trends In Bioengineering							
Bioprinting techniques and materials, 3D printing of ear, bone and skin, electrical tongue and electrical nose in food science, Self-healing bioconcrete (based on bacillus spores, calcium lactate nutrients and biomineralization processes), Biomining via microbial surface adsorption. Artificial Intelligence for disease diagnosis. Biochips & their applications. Biosensors & their applications.							
Reference Books:							
1. Rajendra Singh C and Rathnakar Rao N, Rajendra Singh C and Rathnakar Rao, "Biology for Engineers" N Publishing, Bengaluru, 2023.							
2. S., Selvamurugan N., Rajesh M.P., Nazeer R.A., Thilagaraj W., Barathi S., and Jaganthan M.K., <i>Biology for Engineers</i> . Tata McGraw-Hill, New Delhi, 2012.							

3. Arthur T. Johnson, *Biology for Engineers*, 2nd Edition, CRC Press, Taylor & Francis Group, Boca Raton, FL, 2019.
4. Sohini Singh and Tanu Allen, *Biology for Engineers*, Vayu Education of India, New Delhi, 2014.
5. Yoseph Bar-Cohen, *Biomimetics: Nature-Based Innovation*, 1st edition, CRC Press., 2012
6. Ibrahim Ozbolat, *3D Bioprinting: Fundamentals, Principles and Applications*, Academic Press (Elsevier), 2016.
7. Rodríguez Méndez, M. L. (Ed.), *Electronic Noses and Tongues in Food Science*, 1st Edition, Academic Press (Elsevier), Cambridge, MA, USA, 2016.

Web links and Video Lectures (e-Resources)

- <https://nptel.ac.in/courses/121106008>
- <https://freevideolectures.com/course/4877/nptel-biology-engineers-other-non-biologists>
- <https://ocw.mit.edu/courses/20-020-introduction-to-biological-engineering-design-spring-2009>
- <https://ocw.mit.edu/courses/20-010j-introduction-to-bioengineering-be-010j-spring-2006>
- <https://www.coursera.org/courses?query=biology>
- https://onlinecourses.nptel.ac.in/noc19_ge31/preview
- <https://www.classcentral.com/subject/biology>
- <https://www.futurelearn.com/courses/biology-basic-concepts>

Course Outcomes	Programme Outcomes											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	3 (WK 5)	2 (WK 8)	2 (WK2, WK6)	2 (WK1, WK5, WK7)	2 (WK 9)	2			3 (WK8)	3	2	2
CO2	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	3 (WK 5)	2 (WK 8)	3 (WK2, WK6)	3 (WK1, WK5, WK7)	2 (WK 9)	2			3 (WK8)	3	2	2
CO3	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	3 (WK 5)	2 (WK 8)	3 (WK2, WK6)	3 (WK1, WK5, WK7)	3 (WK 9)	2			3 (WK8)	3	2	2
CO4	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	3 (WK 5)	2 (WK 8)	3 (WK2, WK6)	3 (WK1, WK5, WK7)	3 (WK 9)	2			3 (WK8)	3	2	2

Hours/Sem.	Code	:	1BBTA403C	BIOPROCESS PRINCIPLES AND CALCULATIONS	Semester	:	06
	LTP	:	3:0:0		Course Type	:	PCC
	Teaching	:	42 Hrs.		CIE Marks	:	50
	Learning (TW+SL)	:	42 Hrs.		SEE Marks	:	50
	Exam	:	6 Hrs.		Total Marks	:	100
	Total Hrs.	:	90 Hrs.		Credits	:	03
Professional Competency:							
Ability to apply engineering and mathematical fundamentals to formulate and systematically solve steady-state and unsteady-state mass and energy balances for physical unit operations, chemically reacting systems, and biological growth environments							
Course Outcomes:							
After completion of the course, student will be able to:							
CO1: Fundamentals & Gas Laws: Perform precise unit conversions, establish dimensional consistency, and apply gas laws to determine the volumetric, molar, and density characteristics of multi-component mixtures. (Bloom's Level: Apply) CO2: Material Balances (Non-Reacting Systems): Develop process block diagrams and formulate steady-state/unsteady-state material balance equations to solve quantitative operational problems in non-reacting systems like distillation, evaporation, and drying. (Bloom's Level: Analyze) CO3: Stoichiometry & Reacting Systems: Solve complex material balances for reacting chemical networks by identifying limiting/excess reactants and evaluating industrial process efficiency using conversion, yield, and selectivity metrics. (Bloom's Level: Analyze) CO4: Energy Balances & Bioprocess Stoichiometry: Apply standard thermal concepts (heats of reaction, formation, combustion) to perform industrial energy balances, and construct macro-chemical elemental balances to determine the yield coefficients and degrees of reduction for microbial growth systems. (Bloom's Level: Evaluate / Synthesize)							
UNIT-I						10 Hrs.	
Introduction to Engineering Calculations Dimensions and System of Units: Introduction, Fundamental and Derived Units, Fundamental and Derived Quantities; System of Units (FPS, CGS, MKS, SI); Conversion of Units, Inter-conversion; Conceptual Numericals Basic Chemical Engineering Calculations: Atomic, Molecular and Equivalent weights; molar concept; Gram atom; Gram mole; Equivalent Weight; Concept of Normality, Molarity and Molality. Method of Expressing the Composition of Mixtures and Solutions, weight fraction, mole fraction, Percentage by weight, mole percent and volume percent; Concept of PPM (Parts Per Million); Conceptual Numericals; Gases, Ideal Gas Law, Dalton's Law, Partial Pressure, Amagat's Law, Gaseous Mixtures, Relationship between Partial Pressure and Mole Fraction of Component Gas; Average Molecular Weight of Gas Mixture; Density of Gas Mixture; Conceptual Numericals							
UNIT-II						10 Hrs.	
Material Balance without Chemical Reactions General material balance equation for steady and unsteady states; Generalized Block Diagram of operations showing input and output; Material balance equations for Unit Operations like Distillation, Evaporation, Crystallization, Mixing, Drying, Extraction; Material balances and conceptual Numericals on Distillation, Evaporation, Crystallization, Mixing, and Drying Unit Operations.							
UNIT-III						12 Hrs.	
Material Balance Involving Chemical Reactions Generalized material balance equations, stoichiometry, Principles of stoichiometry, stoichiometric ratio, proportion, coefficient, Definitions of limiting and excess reactants, fractions and percentage conversion, yield and percentage yield, selectivity, Material Balance, and Conceptual Numericals on different Unit processes							

UNIT-IV	10 Hrs.
Energy Balance: General energy balance equation for steady state. Heat capacity, estimation of heat capacity for solids, liquids, gases, and their mixtures. Enthalpy, Standard Heat of formation, standard heat of reaction, Standard heat of combustion, and calorific value.	
Stoichiometry of Microbial growth and Product formation Stoichiometry of cell Growth and Product Formation- elemental balances, degrees of reduction of substrate and biomass; available-electron balances; yield coefficients of biomass and product formation	
Reference Books: 1. Basic Principles and Calculations in Chemical Engineering: Authors: David M. Himmelblau and James B. Riggs (Prentice Hall). 2. Bioprocess Engineering: Basic Concepts: Authors: Michael L. Shuler, Fikret Kargi, and Matthew DeLisa (Prentice Hall). 3. Chemical Process Calculations: D.C. Sikdar's (PHI Learning)	
Web links and Video Lectures (e-Resources) 1. NPTEL: Core Video Lecture Series (NPTEL / SWAYAM): Mass Balance Book keeping: Mass Transfer Operations I (IIT Bombay) 2. NPTEL: Bioprocess Engineering (IIT Roorkee) 3. Digital Portals & Solved Problem Repositories LearnChemE - Process Calculation Tutorials (University of Colorado Boulder) 4. Chemical Engineering Virtual Labs (NMEICT / MHRD)	

Course Outcomes	Programme Outcomes											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	3 (WK1, WK2, WK3, and WK4)	2 (WK1, WK2, WK3, and WK4)	-	-	1 (WK 2, WK6)	-	-	-	-	-	1 (WK8)	1	1	-
CO 2	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	2 (WK 5)	2 (WK 8)	1 (WK 2, WK6)	1 (WK 1, WK5, WK7)	-	-	-	1	1 (WK8)	1	3	-
CO 3	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	2 (WK 5)	2 (WK 8)	1 (WK 2, WK6)	1 (WK 1, WK5, WK7)	-	-	-	1	1 (WK8)	2	3	-
CO 4	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	3 (WK 5)	3 (WK 8)	2 (WK 2, WK6)	2 (WK 1, WK5, WK7)	-	-	-	2	2 (WK8)	3	3	2

	Code	:	1BBTA404C	MOLECULAR BIOLOGY	Semester	:	04
	LTP	:	3:0:2		Course Type	:	IPCC
Hours/Sem.	Teaching	:	42 Hrs+26 Hrs		CIE Marks	:	50
	Learning (TW+SL)	:	44 Hrs		SEE Marks	:	50
	Exam	:	08Hrs		Total Marks	:	100
	Total Hrs.	:	120 Hrs		Credits	:	04
Professional Competency:							
Apply molecular biology principles and experimental techniques to study gene structure, gene regulation, genetic engineering, and molecular diagnostics in biotechnology and pharmaceutical sciences.							
Course Outcomes:							
After completion of the course, student will be able to:							
CO1: Analyze the basic aspects of replication and apply the knowledge of practical aspects in various molecular biology based applications.							
CO2: Acquire working knowledge on the mechanism of transcription, translation and post translational processes along with their applications in research.							
CO3: Apply research-based knowledge of gene regulation mechanism in prokaryotes and eukaryotes in the field of Biotechnology.							
CO4: Select and apply the steps of transposition, Proto-oncogenes conversion and molecular mechanism of genetic recombination in treating diseases.							
UNIT-I							10 Hrs.
Introduction							
Genes and their location. Information flow in biological systems: Central Dogma, Cell Signaling (signal transduction)-molecular mechanism, types of intercellular signaling. Genetic code-its features, codon and anticodon. Wobble hypothesis, Reverse genetics.							
Replication							
Replication-basic concepts, structure and function of DNA polymerases, ligases, helicase. Mechanism of DNA replication in prokaryotes and eukaryotes, End replication problem in eukaryotes, telomerase and its role, DNA damage and Repair (Photo reactivation, excision repair, recombinational repair, SOS repair).							
UNIT-II							11 Hrs.
Transcription							
Mechanism of transcription in prokaryotes and eukaryotes, structure and function of RNA polymerases (prokaryotes & eukaryotes), general transcription factors, post transcriptional processing-Splicing, Capping and Polyadenylation, Si RNA, Antisense RNA technology.							
Translation							
Protein synthesis: Initiators, Elongation factors, termination codons, Mechanism of translation in Prokaryotes and Eukaryotes, Structure and function of prokaryotic and eukaryotic ribosomes, Differences between prokaryotic and eukaryotic protein synthesis, inhibitors of translation. Post translational modification.							
UNIT-III							11 Hrs.
Gene Expression In Prokaryotes							
Regulation of gene expression in prokaryotes: operon model-structure and function, galactose and lactose operon, tryptophan operon-regulation by Repression and Attenuation mechanism; positive versus negative regulation, cyclic AMP effect/catabolite repression.							
Gene Expression In Eukaryotes							
Regulation of eukaryotic gene expression, Gene regulation- transcriptional control-by chromatin modification and methylation, RNA processing control- micro RNAs, Translational control, and post-translational level control. Hormonal regulation- peptide and steroid hormones, super secondary structures-Helix turns Helix. Zinc fingers and Leucine							
UNIT-IV							10 Hrs.
Transposons And Oncogenes							
Transposons- replicative and non replicative mechanisms, Insertion sequences, AC/DS elements, transposition in maize (Mc Clintock's work), Cut and paste transposition, -Oncogenes and Protooncogenes, Tumour							

suppressor genes, retroviruses and its life cycle.

Genetic Recombination

Genetic recombination in bacteria- transformation, transduction and Conjugation, Molecular mechanism of recombination-homologous recombination (Holliday model), site specific recombination.

List of Experiments:

1. Study of standard practices in Molecular Biology lab
2. Preparation of common molecular biology lab buffers (TAE Buffer and TE Buffer)
3. Agarose gel electrophoresis.
4. Standard Operating Procedure for Centrifuge and Gel documentation unit.
5. Study of absorption spectra of nucleic acids.
6. Isolation of genomic DNA (plant / animal / microbial sources).
7. Isolation of plasmid DNA from E. coli.
8. Quantification of DNA using UV-Visible spectrophotometer
9. Estimation of RNA by orcinol method.
10. Purity of nucleic acids by UV-Vis Spectrophotometer.
11. UV -Vis survival curve of E.coli
12. PAGE (DEMO).

Text Books:

1. James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine, and Richard Losick, Molecular Biology of the Gene ,5th Edition, Pearson edition
2. David Nelson and Michael Cox, Lehninger, Principles of Biochemistry (6th Edition), W.H. Freeman, 2017.
3. B.R. Glick, J.J. Pasternak and C.L Patten, "Molecular Biotechnology – Principles and applications of recombinant DNA", ASM Press, 6th edition, 2022

Reference Books:

1. Lewin's genes XII Burlington, Massachusetts: Krebs, Jocelyn E., Goldstein, Elliott S., Kilpatrick, Stephen T., Jones & Bartlett Learning, 2018.
2. Gene Cloning and DNA Analysis – An Introduction, T.A. Brown, Wiley-Blackwell Science, 7th edition, 2018.
3. Sambrook & Russell, Molecular Cloning, (3rd Edition), Cold Spring Harbor Lab, 2002

Course Outcomes	Programme Outcomes											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	2 (WK1 WK2 WK3 WK4)	2 (WK1 WK2 WK3 WK4)	2 (WK5)	2 (WK8)	1 (WK2 and WK6)	2 (WK1, WK5, and WK7).	-	-	-	-	3 (WK8)	2	2	2
CO2	2 (WK WK2 WK3 WK4)	2 (WK1 WK2 WK3 WK4)	2 (WK5)	2 (WK8)	3 (WK2 and WK6)	2 (WK1 WK5 and WK7).	-	-	-	-	3 (WK8)	2	3	2
CO3	2 (WK WK2 WK3 WK4)	2 (WK1 WK2, WK3, WK4)	2 (WK5)	3 (WK8)	3 (WK2 and WK6)	2 (WK1, WK5, and WK7).	-	-	-	-	3 (WK8)	2	3	2
CO4	2 (WK,W K2,WK 3, WK4)	2 (WK1 ,WK2, WK3, WK4)	3 (WK5)	3 (WK8)	3 (WK2 and WK6)	2	-	-	-	-	3 (WK8)	2	3	2

Course Code		:	1BBTA405C	UPSTREAM PROCESSING TECHNOLOGY	Semester	:	04
L:T:P		:	3:0:2		Course Type	:	IPCC
Hours/Sem.	Teaching	:	42+26 Hrs		CIE Marks	:	50
	Learning (TW+SL)	:	44 Hrs		SEE Marks	:	50
	Exam	:	08 Hrs		Total Marks	:	100
	Total Hrs.	:	120		Credits	:	04

Professional Competency:

Develop the knowledge and skills to design, operate, monitor, and optimize upstream bioprocesses, including media preparation, sterilization, inoculum development, bioreactor operation, and process control for efficient and safe production of bioproducts.

Course Outcomes:

After completion of the course, student will be able to:

CO1: Identify the component parts of fermentor and fermentation system.

CO2: Select the raw material, prepare and sterilize the media and also to optimize the industrial media using Design of experiments.

CO3: Develop/design the industrially important microbes for industrial scale processes.

CO4: Operate the reactors for Plant, Animal and GMOs.

UNIT-I

12 Hrs.

FERMENTATION PROCESS

Range of fermentation processes, chronological development of fermentation industry, component of the fermentation process. Basic functions of a fermenter for microbial, plant and animal cell culture. Body parts of fermentor, aseptic operation and containment. Sterilization of fermentors. Classification of Fermentation Systems: Batch, fed batch and continuous process and their applications, Types of Fermentors.

Scale Up: Process engineering concepts, engineering considerations, mechanical considerations, energy considerations. Process GMP considerations of scale up, operations and quality.

UNIT-II

10 Hrs.

RAW MATERIALS AND MEDIA

Media requirement for typical fermentation process, selection of typical raw materials, types of fermentation media. Preparation and handling of fermentation media, sterilization and its practical limits, Batch sterilization, Continuous sterilization and Filter sterilization. Different methods for optimization (Plackett-Burman Design, RSM)

UNIT-III

10 Hrs.

MICROBIAL SYSTEM

Isolation of industrially important microorganisms, Strain development methods, Preservation of industrially important microorganisms. Development of inoculum from laboratory scale to pilot scale and large scale fermentation (for bacterial, yeast, mycelial processes). Criteria for the transfer of inoculum. Aseptic transfer of inoculum to the fermentor. Troubleshooting during fermentation process (microbial contamination).

SECONDARY METABOLITE PRODUCTION: secondary metabolite production in bacteria, yeast and fungi. Production of lactic acid, butanol, antibiotics and enzymes.

UNIT-IV

10 Hrs.

PLANT CELL SYSTEM

Isolation and culture of single cells, Bioprocess using plant cell cultures. Bioreactors for suspension cultures, immobilized cells and organized tissues. Secondary metabolite enhancement techniques (alkaloids, steroids, phenolics).

ANIMAL CELL SYSTEM

Scale up in suspension (stirred and static), monolayer (roller bottles, nunc cell factory microcarriers culture) and Perfusion culture (fixed and fluidized bed reactors). Factors affecting cell culture, Growth monitoring. Genetically engineered cells for bioprocessing; process, selection of host vectors, process constraints- genetic instability, mass transfer and others. Large scale production of insulin by mammalian cell culture. Cell bank preparation & cell reviving techniques.

MONOCLONAL ANTIBODY PRODUCTION: SUDBRCS (Single use disposable bioreactor configuration, types of production (perfusion culture, submerged culture, suspended adhered culture)).

LIST OF EXPERIMENTS

1. Microbial Growth kinetics and Estimation of Monod parameters in Batch Bioreactor/Batch culture.
2. Production and estimation of citric acid from *Aspergillus niger*.
3. Preparation and production of ethanol in fermenter: Study of growth, product formation, and substrate utilization.
4. Bioprocess Modeling using SuperPro Designer: Flow sheeting of the Bioprocess using SuperPro Designer, Design of various Bioreactors using SuperPro Designer.
5. Solid-liquid separation method: Removal of Intracellular Proteins by cell disruption methods.
6. Solid-liquid separation method: Separation of biomass and extracellular components by Filtration (Cross flow) and Centrifugation.
7. Product enrichment operations: Precipitation of a bioproducts from crude solution or the extract.
8. Product enrichment operations: Liquid-liquid and Aqueous two – phase extraction of bio products from biological sources.
9. Extraction and estimation of bioactive compounds from natural sources.
10. Lyophilization of any bioproducts
11. Analysis of biomolecules/bioactive compounds by HPLC

Text Books:

1. Principles of fermentation Technology by P.F. Stanbury and A. Whitaker, Aditya books (P) Ltd. New Delhi 1997.
2. Bioprocess Engineering by Michael L. Shuler, 2nd Edition Shuler & Kargi, Fikret Kargi, Academic Internet Publishers, 2006.
3. Culture of animal cells by Ian Freshney 4th Edition. John Willey & Sons Publ, 2008
4. Animal Biotechnology by Murray Moo-Young Pergamon Press, , 2008

Reference Books:

1. Introduction to plant Biotechnology by H.S. Chawla, Second edition, Oxford & IBH Publisher
2. Plant tissue Culture: Theory and Practice by S.S. Bhojwani and M.K. Razdan (1996). Elsevier

Course Outcomes:

Course Outcomes	Programme Outcomes											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3(WK1 WK2, WK3 ,WK4)	1(WK1 WK2, WK3 ,WK4)	-	-	-	-	-	-	-	-	-	1	3	-
CO2	-	3(WK1 WK2, WK3 ,WK4)	-	-	-	-	-	-	-	-	-	-	3	3
CO3	2(WK1 WK2, WK3 ,WK4)	2(WK1 WK2, WK3 ,WK4)	3(WK5)	1(WK8)	1(WK2 and WK6)	-	-	-	-	2	1(WK8)	3	3	-
CO4	2(WK1 WK2, WK3 ,WK4)	-	-	-	-	-	-	-	-	3	1(WK8)	-	3	-

Course Code		:	1BHSA424C	UNIVERSAL HUMAN VALUES-II	Semester	:	IV
L:T:P		:	1:0:0		Course Type	:	UHV
Hours/Sem.	Teaching	:	14Hrs		CIE Marks	:	50
	Learning (TW+SL)	:	13Hrs		SEE Marks	:	50
	Exam	:	3Hrs		Total Marks	:	100
	Total Hrs.	:	30Hrs		Credits	:	01

Professional Competency:

After completing the course, students will be able to understand and apply value-based principles to achieve personal harmony, nurture ethical relationships, and promote sustainable and responsible living in personal, social, and professional life.

Course Outcomes:

After completion of the course, student will be able to:

1. Understand the need and role of value education for holistic development
2. Differentiate between self and body, needs, and practice harmony within the human being.
3. Analyze relationship dynamics based on trust, respect, and justice within families and society.
4. Recognize harmony in nature and existence, and apply these ideas to sustainable living.
5. Explore ethical practices and professional conduct within personal and professional contexts.

UNIT-I

3 Hrs.

FERMENTATION PROCESS

Range of fermentation processes, chronological development of fermentation industry, component of the fermentation process. Basic functions of a fermenter for microbial, plant and animal cell culture. Body parts of fermentor, aseptic operation and containment. Sterilization of fermentors. Classification of Fermentation Systems: Batch, fed batch and continuous process and their applications, Types of Fermentors.

Scale Up: Process engineering concepts, engineering considerations, mechanical considerations, energy considerations. Process GMP considerations of scale up, operations and quality.

UNIT-II

4 Hrs.

Harmony in the Human Being :

Understanding Human being as the Co-existence of the Self and the Body, Distinguishing between the Needs of the Self and the Body, The Body as an Instrument of the Self, Understanding Harmony in the Self, Harmony of the Self with the Body, Programme to ensure self-regulation and Health

UNIT-III

3 Hrs.

Harmony in the Family and Society :

Harmony in the Family – the Basic Unit of Human Interaction, 'Trust' – the Foundational Value in Relationship, 'Respect' – as the Right Evaluation, Other Feelings, Justice in Human-to-Human Relationship, Understanding Harmony in the Society, Vision for the Universal Human Order

UNIT-IV

4 Hrs.

Harmony in the Nature/Existence Implications of the Holistic Understanding – a Look at Professional Ethics :

Understanding Harmony in the Nature, Interconnectedness, self-regulation and Mutual Fulfillment among the Four Orders of Nature, Realizing Existence as Co-existence at All Levels, The Holistic Perception of Harmony in Existence.

Natural Acceptance of Human Values, Definitiveness of (Ethical) Human Conduct, A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order, Competence in Professional Ethics Holistic Technologies, Production Systems and Management Models-Typical Case Studies, Strategies for Transition towards Value-based Life and Profession.

Reference Books:

1. Gaur R R, Asthana,R.G, Bagaria G P (2019).A Foundation Course in Human Values and Professional Ethics,2nd Revised Edition, Excel Books, New Delhi,
2. The Teacher"s Manual for A Foundation Course in Human Values and Professional

- Ethics, R R Gaur, R Asthana, G
3. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amar kantik, 1999.
 4. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
 5. The Story of Stuff (Book).
 6. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
 7. Small is Beautiful - E. F Schumacher.
 8. Andrews Cecile, Slow is Beautiful
 9. Kumarappa J C ,Economy of Permanence
 10. Pandit Sunderlal ,Bharat Mein Angreji Raj
 11. Dharampa I, Rediscovering India
 12. Gandhi Mohandas K, Hind Swaraj or Indian Home Rule.
 13. Maulana Abdul Kalam Azad :India Wins Freedom -
 14. Romain Rolland (English) Vivekananda
 15. Romain Rolland (English), Gandhi
 16. Sussan George, 1976, How the Other Half Dies, Penguin Press. Reprinted 1986, 1991
 17. Donella H. Meadows, Dennis L. Meadows, Jorgen Randers, William W. Behrens III, 1972, Limits to Growth – Club of Rome’s report, Universe Books.
 18. A Nagaraj, 1998, Jeevan Vidya Ek Parichay, Divya Path Sansthan, Amarkantik.
 19. P L Dhar, RR Gaur, 1990, Science and Humanism, Commonwealth Publishers.
 20. A N Tripathy, 2003, Human Values, New Age International Publishers.
 21. Subhas Palekar, 2000, How to practice Natural Farming, Pracheen (Vaidik)KrishiTantraShodh, Amravati.
 22. E G Seebauer & Robert L. Berry, 2000, Fundamentals of Ethics for Scientists & Engineers , Oxford University Press
 23. M Govindrajran, S Natrajan & V.S. Senthil Kumar, Engineering Ethics (including Human Values), Eastern Economy Edition, Prentice Hall of India Ltd.
 24. B P Banerjee, 2005, Foundations of Ethics and Management, Excel Books.
 25. B L Bajpai, 2004, Indian Ethos and Modern Management, New Royal Book Co., Lucknow. Reprinted 2008.

Web Links and Video Lectures:

Suggested Web Links:

1. Value Education websites,
2. <https://www.uhv.org.in/uhv-ii>,
3. <http://uhv.ac.in>,
4. <http://www.uptu.ac.in>
5. Story of Stuff,
6. <http://www.storyofstuff.com>
7. Al Gore, An Inconvenient Truth, Paramount Classics, USA
8. Charlie Chaplin, Modern Times, United Artists, USA
9. IIT Delhi, Modern Technology – the Untold Story
10. Gandhi A., Right Here Right Now, Cyclewala Productions
11. https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw
12. https://fdp-si.aicte-india.org/8dayUHV_download.php
13. <https://www.youtube.com/watch?v=8ovkLRYXlJE>
14. <https://www.youtube.com/watch?v=OgdNxOX923I>
15. <https://www.youtube.com/watch?v=nGRcbRpvGoU>
16. <https://www.youtube.com/watch?v=sDxGXOgYEKM>

Course Outcomes:

Course Outcomes	Programme Outcomes											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1							2				3			

							WK9							
C02						2 WK5& 7					3			
C03					2 WK5& 7					3	2 WK5& 7			
C04					2 WK5& 7					3	2 WK5& 7			
C05					2 WK5& 7					3	2 WK5& 7			

B. E. V SEMESTER

Hours/Sem.	Code	:	BBTA501C	BIOINFORMATICS	Semester	:	5
	LTP	:	3:0:0		Course Type	:	PCC
	Teaching	:	42Hrs.		CIE Marks	:	50
	Learning (TW+SL)	:	42Hrs.		SEE Marks	:	50
	Exam	:	6Hrs.		Total Marks	:	100
	Total Hrs.	:	90Hrs.		Credits	:	03

Professional Competency:

Combining biology, statistics, and computer science to analyze complex biological data. This skillset is in high demand for drug discovery, clinical diagnostics, and precision medicine, offering a competitive edge for both industry and academic roles

Course Outcomes:

After completion of the course, student will be able to:

1. Analyze the data bases involved in bioinformatics along with their file formats.
2. Identify similar sequences in data bases and find similarity between given set of sequences and they understand how to utilize programming for BIG Data management
3. Construct phylo-genetic tree and analysis and use of statistical tools in predicting the structure of genes and proteins.
4. Apply restriction mapping and primer designing, approaches involved insilico drug design and genome assembly.

UNIT-I

10 Hrs.

INTRODUCTION TO BIOINFORMATICS AND BIOLOGICAL DATABASE

Introduction: To bioinformatics, Components of bioinformatics and interdisciplinary nature of bioinformatics, Classification of biological databases; Primary database: NCBI, Gen Bank, DDBJ and EMBL, PIR, Uniprot; Secondary databases: PROSITE, PRINTS, BLOCKS and Pfam; Structure data bases: Protein Data Bank (PDB), MMDB, CATH, SCOP; Specialized databases: Pub Med, OMIM, Metabolic Pathway-KEGG; ExPasy and Pub Chemdata bases, File format: Gen Bank flat file, PDB flat file. Tutorials: Practices on other primary and secondary databases.

UNIT-II

10 Hrs.

PROGRAMMING FOR BIG DATA MANAGEMENT AND DATABASE SEARCHES,

SEQUENCE ALIGNMENT: Python and R: Deep focus on advanced libraries (Biopython, Pandas, Scikit-Learn, Bioconductor). Cloud & Workflow Management: Using platforms like AWS or Google Cloud for biological big data; implementation of reproducible pipelines (Nextflow or Snakemake). Biological Big Data: Data management strategies for petabyte-scale genomic datasets

Introduction, Types of sequence alignment, Comparison between global and local alignment, Pair wise sequence alignment: Dot matrix analysis, Dynamic programming, Global alignment-Needleman-Wunch algorithm, Local Alignment-Smith & Waterman algorithm, Substitution matrix-BLOSUM and PAM; GAP Penalty; Low complexity regions; Word/k-tuple method-BLAST, FASTA. Multiple Sequence Alignment: Introduction, applications of MSA; Types of MSA: Progressive method of MSA-Clustal W; Iterative method of MSA; Motifs and Patterns; Statistical models of MSA-Position Specific Scoring Matrix (PSSM) and Profiles.

Tutorials: Solving problems on pair wise sequence alignment and use of programming for BIG Data

UNIT-III

12 Hrs.

PHYLOGENETIC ANALYSIS AND PREDICTIVE METHODS USING SEQUENCES,

Introduction, concepts of trees, types of evolutionary trees, Rooted and un rooted trees, Steps in constructing phylogenetic trees, Tree building methods - Distance based methods: Neighbor Joining (NJ) method, Fitch Margoliash (FM) method; Character based method: Maximum parsimony; Tree Evaluation methods, Phylogenetic Softwares. Predictive Methods using sequences: Structure of Prokaryote and Eukaryote genes; Algorithms for Prokaryotic and Eukaryotic gene prediction, Web based tools for gene prediction (ORF finder, Gensan).

Protein Secondary Structure Prediction, Tertiary Structure Predictions: Homology modeling. Tutorials: Practices on prediction of phylogenetic trees

UNIT-IV		10 Hrs.
PLASMID MAPPING, PRIMER DESIGNING & MOLECULAR MODELING		
TECHNIQUES: Restriction mapping, Web based tools: Restriction Mapper and REBASE. Basics of Primer designing, Primer design softwares (PRIME3). Rational Approaches in Drug Design, molecular docking, deriving the Pharmacophoric Pattern, quantitative structure-activity relationship (QSAR), deriving bioactive conformations, Calculation of Molecular Properties, Docking softwares (AUTO DOCK, HEX), genome assembly and annotation: Databases: Specialized databases like KEGG, WIT, and COGs can function as annotation tools, Tools for domain identification: CDD and SMART, BUSCO Tutorials:Solving problems related to Restriction mapping and Primer designing		
Reference Books:		
1. Bioinformatics-A Modern Approach- Vittal R. Srinivas, PHI, 3rd Edition 2. Introduction to Bioinformatics–Arthur Lesk, Oxford, 2nd Edition, 2006. 3. Bioinformatics–Stuart M Brown, NYU Medical Center, NYUSA. 2000. 4. Fundamental Concepts of Bioinformatics–DE Krane & ML Raymer, Pearson, 2006. 5. Computational methods for macromolecular sequence analysis–RF Doo little. Academic Press, 1996		
Specialized Keys for e-Resources		
• Protein Structures: Access and visualize 3D biological macromolecules via the RCSB Protein Data Bank. https://www.rcsb.org/ • Genomic Context: Explore reference sequences and assemblies using the UCSC Genome Browser.		

Course Outcomes	Programme Outcomes											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	2 (WK1, WK2, WK3, and WK4)	2 (WK1, WK2, WK3, and WK4)	2 (WK1, WK2, WK3, and WK4)	2 (WK1, WK2, WK3, and WK4)	2 (WK1, WK2, WK3, and WK4)	-	-	3 (WK1, WK2, WK3, and WK4)	3	2	2
CO2	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	2 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	2 (WK1, WK2, WK3, and WK4)	2 (WK1, WK2, WK3, and WK4)	-	-	3 (WK1, WK2, WK3, and WK4)	3	2	2
CO3	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	2 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	2 (WK1, WK2, WK3, and WK4)	-	-	3 (WK1, WK2, WK3, and WK4)	3	2	2
CO4	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	2 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	2 (WK1, WK2, WK3, and WK4)	-	-	3 (WK1, WK2, WK3, and WK4)	3	2	2

Hours/Sem.	Code	:	BBTA502C	GENETIC ENGINEERING & APPLICATIONS	Semester	:	04
	LTP	:	3:0:2		Course Type	:	IPCC
	Teaching	:	42 Hrs+26 Hrs		CIE Marks	:	50
	Learning (TW+SL)	:	44		SEE Marks	:	50
	Exam	:	08 Hrs		Total Marks	:	100
	Total Hrs.	:	120 Hrs		Credits	:	04
Professional Competency:							
Apply the principles and techniques of molecular biology to analyze gene structure and gene expression, for solving problems in biotechnology, healthcare, agriculture, and research.							
Course Outcomes:							
After completion of the course, student will be able to:							
CO1: Apply the knowledge of various tools used in genetic engineering experiments.							
CO2: Select and apply recombinant DNA techniques including nucleic acid detection, hybridization and amplification for gene cloning and molecular analysis.							
CO3: Identify different methods of various gene transfer techniques in plants, animals and microbes for genetic improvement.							
CO4: Apply the knowledge of various strategies of Gene therapy in therapeutics and engineer microbes for the production of biopharmaceuticals.							
UNIT-I						10 Hrs.	
INTRODUCTION							
Methodology of recombinant DNA technology, Tools of genetic engineering- vectors in recombinant DNA technology, biology and salient features of naturally occurring plasmids, Types of vectors – plasmids (pBR, pUC plasmids) cosmids and bacteriophage lambda vectors. Yeast expression vectors, Viral vectors							
ENZYMES IN GENETIC ENGINEERING:							
Introduction- Restriction Endonucleases-classification, mode of action, applications. Enzymes used in nucleic acid modification – Alkaline phosphatase, polynucleotide Kinase, Ligases, terminal deoxy nucleotidyl transferase.							
UNIT-II						10 Hrs.	
NUCLEIC ACID HYBRIDIZATION AND AMPLIFICATION							
Methods of nucleic acid detection, Fluorescent In situ hybridization (FISH), colony hybridization, polymerase chain reaction (PCR), its types (Real-Time PCR (qPCR) Reverse Transcription PCR (RT-PCR), Multiplex PCR, Hot-Start PCR) and applications, methods of nucleic acid hybridization, Southern, Western and Northern hybridization techniques.							
CONSTRUCTION OF CDNA LIBRARIES:							
Construction of Complementary DNA (cDNA), genomic DNA libraries and cDNA libraries.							
UNIT-III						10 Hrs.	
GENE TRANSFER TECHNIQUES							
GENE TRANSFER TECHNIQUES							
Gene transfer techniques in plants, animals and microbes –Transformation, microinjection, electroporation, microprojectile system, and liposome mediated transfer, embryonic stem cell method. Agrobacterium-mediated gene transfer in plants – Ti & Ri Plasmid: structure and functions, Ti based vectors- Binary vectors and Cointegrate vectors.							
TRANSGENIC SCIENCE AND GENETIC IMPROVEMENT:							
Transgenic technology for plant and animal improvement-Application of plant transformation for productivity and performance – Herbicide resistance - glyphosate. insect resistance - Bt genes(<i>Bacillus thuringiensis</i> and its mode of action), Cry proteins – mechanism of action. Viral, fungal, drought and salinity resistant transgenic plants, Antisense RNA technology (Flavr savr tomatoes). Transgenic mice and Transgenic cow. Cloning by Somatic Cell Nuclear transfer-Dolly.							

UNIT-IV	Hrs.
GENE THERAPY Introduction, Methods of Gene therapy-gene targeting, gene augmentation, assisted killing, prodrug therapy and gene silencing. Gene therapy in the treatment of cancer, SCID, muscular dystrophy. Use of thrombolytic agents in blood clotting. Challenges in gene therapy. Gene editing by CRISPR. APPLICATIONS: Engineering microbes for the production of Insulin, growth hormones, Hepatitis B vaccine, Biopharming-plants and animals as bioreactors.	
List of experiments	
1. Study of Safety Data Sheets (SDS/MSDS) for Chemicals Used in Genetic Engineering Laboratory 2. Preparation of competent <i>Escherichia coli</i> cells (Calcium chloride method) 3. Transformation of competent <i>E. coli</i> with plasmid 4. Blue-White Screening of recombinant colonies 5. Thermal denaturation of DNA 6. Restriction Digestion 7. Ligation Experiment 8. Southern Blotting – Agarose Gel Electrophoresis 9. Electrobolting and analysis 10. Maintenance and Storage of bacterial cells by Lyophilization (biologic samples) 11. SOP for UV-Vis Spectrophotometer and Thermal cycler 12. Polymerase Chain Reaction (PCR)	
Text Books:	
1. B.R. Glick, J.J. Pasternak and C.L Patten, “Molecular Biotechnology – Principles and applications of recombinant DNA”, ASM Press, 6th edition, 2022 2. Watson et al., Recombinant DNA, second edition, Freeman Publishers 2010. 3. Primrose S.B, Principles of gene manipulation, Blackwell Scientific Publications, 2010. 4. B.D.Singh, Biotechnology Expanding Horizon, 3rd revised edition, Kalyani Publishers,2010	
Web links and Video Lectures (e-Resources)	
https://archive.nptel.ac.in/content/storage2/courses/102103013/module1/index.html?utm_source ce https://www.nptel.ac.in/courses/102103093?utm_source https://archive.nptel.ac.in/content/storage2/courses/102103013/module1/lec2/1.html?utm_source https://archive.nptel.ac.in/content/storage2/courses/102103013/module1/lec2/1.html?utm_source	
Reference Books:	
1. Sambrook & Russell, Molecular Cloning, (3rd Edition), Cold Spring Harbor Lab, 2002. 2. Sadashiva and Manickam, Biochemical Methods, (2nd Edition), W.H. Freeman, 2017, 3. David S Latchman, From Genetics to Gene Therapy – the molecular pathology of human disease by, BIOS scientific publishers, 2010. 4. Analytical Biochemistry And Separation Techniques P. Palanivelu V Edition, Digital Printing Press, 2016	

Course Articulation Matrix

Course Outcomes	Programme Outcomes											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3 (WK1, WK2, WK3, WK4)	2 (WK1, WK2, WK3, WK4)	2 (WK5)	2 (WK8)	3 (WK2 and WK6)	2 (WK1, WK5, and WK7)	2 (WK9)	-	-	-	3 (WK8)	3	3	2
CO2	3 (WK1, WK2, WK3, WK4)	2 (WK1, WK2, WK3, WK4)	3 (WK5)	2 (WK8)	3 (WK2 and WK6)	2 (WK1, WK5, and WK7)	2 (WK9)	-	-	-	3 (WK8)	3	3	2
CO3	3 (WK1, WK2, WK3, WK4)	2 (WK1, WK2, WK3, WK4)	3 (WK5)	2 (WK8)	3 (WK2 and WK6)	1 (WK1, WK5, and WK7)	3 (WK9)	-	-	-	3 (WK8)	3	3	2
CO4	3 (WK1, WK2, WK3, WK4)	2 (WK1, WK2, WK3, WK4)	3 (WK5)	2 (WK8)	3 (WK2 and WK6)	2 (WK1, WK5, and WK7)	3 (WK9)	-	-	-	3 (WK8)	3	3	2

Course Code		:	BBTA503C	BIOPROCESS AND BIOREACTION ENGINEERING	Semester	:	06
L:T:P*		:	3:0:0		Course Type	:	PCC
Hours/Sem.	Teaching	:	42 Hrs.		CIE Marks	:	50
	Learning (TW+SL)	:	42 Hrs.		SEE Marks	:	50
	Exam	:	6 Hrs.		Total Marks	:	100
	Total Hrs.	:	90 Hrs.		Credits	:	03

Professional Competency:

Ability to apply Engineering and Biological principles to design, scale up, optimize, and operate bioreactor systems for the efficient production of biopharmaceuticals, biofuels, and industrial biomolecules while ensuring economic viability, safety, and regulatory compliance.

Course Outcomes:

After completion of the course, student will be able to:

CO1: Formulate kinetic expressions for cell growth, substrate consumption, and product formation to simulate bioprocess profiles.

CO2: Apply fundamental design equations to size and evaluate performance criteria for Batch, CSTR, and PFR configurations.

CO3: Select appropriate bioreactor configurations for specific industrial bioprocess operations.

CO4: Quantify gas-liquid mass transfer rates and design aeration/agitation systems to prevent oxygen starvation in high-density cultures.

UNIT-I

10 Hrs.

Basics of Reaction Kinetics: Rate equations (concentration and temperature dependent), Rate Law, Rate constant, Molecularity and Order of the reactions, Calculation of order of the reactions using experimental data, Activation energy, Arrhenius equation, Integrated rate law equations for different orders and temperatures, graphical representation and estimations, Half life of reactions. Problems

Microbial Kinetics: Stoichiometry of cell growth and product formation; elemental balances; electron balances and theoretical oxygen demand. Growth kinetics: Batch Growth, Balanced Growth, Effect of Substrate Concentration, Substrate utilization, Biomass production, Monod model and other growth models.

Product Formation and Substrate Kinetics: Growth-associated, non-growth-associated, and mixed-growth-associated product formation. Maintenance coefficient and yield concepts ($Y_{X/S}$ and $Y_{P/S}$)

Sterilization: Death kinetics

UNIT-II

10 Hrs.

Ideal Reactor Engineering and Design Equations

Operating Characteristics of Ideal Reactors: General features, comparisons, and operational workflows of Ideal Batch Reactor, Semi-Batch (Fed-Batch) reactor, Continuous Stirred Tank Reactor (CSTR / Mixed Flow Reactor), and Plug Flow Reactor (PFR).

Fed-Batch and Continuous Operations: Chemostat kinetics, critical dilution rate, cell washout phenomena. Chemostat with cell recycle. Fed-batch operations: constant, exponential, and feedback feeding strategies for high cell density cultivation.

Core Performance Equations: Basic design equations linking concentration and conversion (C_A and X_A). Basic equation for Batch, PFR and CSTR, Performance equations for steady-state Batch reactors operating at constant volume and density.

Flow Metrics: Formulation of Batch cycle time. Definition, mathematical expressions, and derivation of Space-Time, Space-Velocity, and Holding Time for flow reactors (CSTR and PFR).

UNIT-III

12 Hrs.

Bioreactor Configurations, Monitoring, and Control

Mechanically Driven Bioreactors: Stirred Tank Bioreactor (STR)—geometry, impeller types (Rushton turbine, hydrofoil), baffling, etc.

Pneumatic and Non-Stirred Bioreactors: Bubble Column reactors; Airlift Bioreactors (internal loop and external loop configurations, riser and downcomer fluid dynamics).

Immobilized and Heterogeneous Systems: Stirred and air-driven configurations including Packed Bed, Fluidized Bed, and Trickle Bed bioreactors.

Instrumentation and Bioprocess Control: On-line, in-line, and off-line sensors. Monitoring and control loop configurations for physical variables (temperature, pressure, volume/level, agitation speed), chemical variables (pH, DO, redox potential, exhaust gas analysis for O₂ and CO₂), and biochemical variables (biomass concentration via optical density).

UNIT-IV**10 Hrs.****Mass and Heat Transfer in Bioreactors**

Oxygen Transfer Operations: The demand for dissolved oxygen (DO) in aerobic cultures. Critical oxygen concentration. Two-film theory for gas-liquid mass transfer. Mass-transfer equations: Volumetric oxygen mass-transfer coefficient (kLa). Determination of kLa: Experimental methods to measure kLa (Sulphite oxidation, Static gassing-out, Dynamic gassing-out, and Oxygen balance method).

Heat Transfer: Biological heat generation (Q_{gr}) during fermentation. Heat transfer requirements, cooling jackets, internal coils, and heat exchangers. Calculation of heat transfer coefficients in bioprocess vessels.

Reference Books

1. Bioprocess Engineering: Basic Concepts – Michael L. Shuler, Fikret Kargi, and Matthew DeLisa (Prentice Hall).
2. Chemical Reaction Engineering – Octave Levenspiel (John Wiley & Sons).
3. Bioprocess Engineering Principles – Pauline M. Doran (Academic Press).
4. Biochemical Engineering Fundamentals – James E. Bailey and David F. Ollis (McGraw-Hill).

Web links and Video Lectures (e-Resources)

1. NPTEL: Fundamentals of Bioprocess Engineering (IIT Guwahati)
2. NPTEL: Transport Phenomena in Bioprocesses (IIT Guwahati)
3. NPTEL: Aspects of Biochemical Engineering (IIT Kharagpur)
4. Digimat Video Learning Platform

Course Outcomes	Programme Outcomes											Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	2 (WK 5)	2 (WK 8)	2 (WK 2,W K6)	-	-	-	-	-	1 (WK 8)	3	2	-
CO 2	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	3 (WK 5)	2 (WK 8)	1 (WK 2,W K6)	-	-	-	-	1	3 (WK 8)	2	3	-
CO 3	2 (WK1, WK2, WK3, and	2 (WK1, WK2, WK3, and	3 (WK 5)			3 (WK 1,W K5,	1 (W K	-	-	2	2 (WK 8)	3	3	3

	WK4)	WK4)				WK7)	9)							
CO 4	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	3 (WK 5)	2 (WK 8)	2 (WK 2,W K6)	1 (WK 1,W K5, WK7)	-	-	-	-	1 (WK 8)	2	3	2

Hours/Sem.	Code	:	BBTB504E	NUTRACEUTICALS	Semester	:	5
	LTP	:	3:0:0		Course Type	:	PEC
	Teaching	:	42Hrs.		CIE Marks	:	50
	Learning (TW+SL)	:	42Hrs.		SEE Marks	:	50
	Exam	:	6Hrs.		Total Marks	:	100
	Total Hrs.	:	90Hrs.		Credits	:	03

Professional Competency:

Bridges the gap between nutrition and pharmaceuticals. Imparts multidisciplinary skill set encompassing evidence-based evaluation, regulatory compliance, product formulation, and targeted health applications

Course Outcomes:

After completion of the course student will be able to

1. Analyze the basic concepts of nutraceuticals and nutrition.
2. Analyze the scope of nutraceuticals and functional foods and identify the nutrition related health disorders and the role of Nutraceuticals.
3. Comprehend the classification of nutraceuticals and the role of nutraceuticals among different age groups and the basic aspects of nutraceuticals derived from microbial, plant and animal origin.
4. Distinguish about the role of biotechnology in production of plant secondary metabolites.

UNIT-I

10 Hrs.

INTRODUCTION TO NUTRACEUTICAL AND DIETETICS

Organizational elements, classification of nutraceuticals, dietary supplements, fortified foods, functional foods and Phyto nutraceuticals. Scope involved in the industry, Indian and global scenario. Recommended dietary intake (RDA), acceptable dietary intake, nitrogen balance, protein efficiency ratio, net protein utilization. Basics of energy balance - Basal Metabolic Rate (BMR), Body Mass Index (BMI) and Standard Dynamic Action (SDA) with special reference to nutraceutical industry.

UNIT-II

12 Hrs.

NUTRITION RELATED DISEASES AND DISORDERS

Carbohydrates, Protein, amino acids, Fat, vitamins and minerals - Excess and deficiency, symptoms, prevention and management. Role of nutraceuticals with special reference to diabetes mellitus, hypertension, hypercholesterolemia, cancer, glands in the prevention and treatment. Concept of antioxidants - use of antioxidants as dietary supplements in prevention and treatment of cancer, obesity and stress. Role of nutraceuticals and functional foods in pediatrics, geriatrics, sports, pregnancy and lactation.

UNIT-III

10 Hrs.

NUTRACEUTICALS OF MICROBIAL, PLANT AND ANIMAL ORIGIN

Concept of prebiotics and probiotics - principle, mechanism, production and technology involved, applications - examples of bacteria used as probiotics, use of prebiotics in maintaining the useful microflora - extraction from plant sources. Synbiotics for maintaining good health. Algae as source of omega - 3 fatty acids, antioxidants and minerals - extraction and enrichment. Plant secondary metabolites, classification and sub-classification - Alkaloids, phenols, Terpenoids. Animal metabolites - Sources and extraction of nutraceuticals of animal origin.

Examples: chitin, chitosan, glucosamine, chondroitin sulphate and other polysaccharides

UNIT-IV

10 Hrs.

BIOTECHNOLOGY IN PHYTONUTRACEUTICALS

Role of medicinal and aromatic plants in nutraceutical industry – propagation - conventional and tissue culture, cultivation, post-harvest technology and strategies for crop improvement, development of high yielding lines and yield enhancement, plant genomics and metabolomics. Biofortification and nutritional enhancement. GM foods with enhanced nutraceutical properties. Golden rice, GM Tomatoes

Reference Books:

1. srael Goldberg (Ed.) (1999) Functional foods, designer foods, pharma foods, Nutraceuticals, Aspen publishers Inc., USA.
2. L. Rapport and B. Lockwood, Nutraceuticals, Pharmaceutical Press, 2nd Edition, 2002.

3. M. Maffei, Dietary Supplements of Plant Origin, Taylor & Francis, 1st Edition, 2003.
4. Shahidi and Weerasinghe, Nutraceutical beverages Chemistry, Nutrition and health Effects, American Chemical Society, 1st Edition, 2004.
5. Richard Neeser & J. Bruce German (2004) Bioprocesses and Biotechnology for Functional Foods and Nutraceuticals, Jean, Marcel Dekker, Inc. Timothy S. Tracy, Richard L. Kingston, Herbal Products 2nd Edition, 2007.

Course Outcomes	Programme Outcomes											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3 (WK1, WK2, WK3, and WK4)	2(WK1, WK2, WK3, and WK4)	- (WK5)	-	2(WK2, WK6)	1 (WK1, WK5, WK7)	2 (WK9)	2		-	3 (WK8)	3	3	1
CO2	3 (WK1, WK2, WK3, and WK4)	2 (WK1, WK2, WK3, and WK4)	2 (WK5)	2 (WK8)	2 (WK2, WK6)	1 (WK1, WK5, WK7)	2 (WK9)	-	-	-	3 (WK8)	2	2	3
CO3	3 (WK1, WK2, WK3, and WK4)	2 (WK1, WK2, WK3, and WK4)	- (WK5)	1 (WK8)	- (WK2, WK6)	2 (WK1, WK5, WK7)	2 (WK9)	-	-	-	3 (WK8)	3	3	1
CO4	2 (WK1, WK2, WK3, and WK4)	2 (WK1, WK2, WK3, and WK4)	2	2(WK	2 (WK2, WK6)	2 (WK1, WK5, WK7)	1 (WK9)	2	-	-	1 (WK8)	3	3	2

	Code	:	BBTD504E	PROTEIN ENGINEERING AND DRUG DESIGN	Semester	:	V
	LTP	:	3:0:0		Course Type	:	PCC
Hours/Sem.	Teaching	:	42Hrs.		CIE Marks	:	50
	Learning (TW+SL)	:	42Hrs.		SEE Marks	:	50
	Exam	:	6Hrs.		Total Marks	:	100
	Total Hrs.	:	90Hrs.		Credits	:	03

Professional Competency:

Developing protein engineers are tasked with designing diverse drug designing platforms

Course Outcomes:

After completion of the course, student will be able to:

1. Perform protein structure prediction and protein engineering and design.
2. Understand molecular modeling.
3. Know computer assisted new lead design.
4. Identify docking methods and computer - assisted drug discovery.

UNIT-I

10 Hrs.

STRUCTURE OF PROTEINS Overview of protein structure, PDB, structure based classification, databases, visualization tools, structure alignment, domain architecture databases, protein-ligand interactions.

PROTEIN STRUCTURE PREDICTION Primary structure and its determination, secondary structure prediction and determination of motifs, profiles, patterns, fingerprints, super secondary structures, protein folding pathways, tertiary structure, quaternary structure, methods to determine tertiary and quaternary structure, post translational modification.

PROTEIN ENGINEERING AND DESIGN Methods of protein isolation, purification and quantitation; large scale synthesis of proteins, design and synthesis of peptides, use of peptides in biology, methods of detection and analysis of proteins. Protein database analysis, methods to alter primary structure of proteins, examples of engineered proteins, protein design, principles and examples

UNIT-II

12 Hrs.

MOLECULAR MODELING Constructing an Initial Model, Refining the Model, Manipulating the Model, Visualization. Structure Generation or Retrieval, Structure Visualization, Conformation Generation, Deriving Bioactive Conformations, Molecule Superposition and Alignment, Deriving the Pharmacophoric Pattern, Receptor Mapping, Estimating Biological Activities, Molecular Interactions: Docking, Calculation of Molecular Properties, Energy Calculations (no derivation), Examples of Small Molecular Modeling Work, Nicotinic Ligands, Sigma Ligands, Antimalarial Agents.

UNIT-III

12 Hrs.

INSILICO DRUG DESIGN Generation of Rational Approaches in Drug Design, Molecular Modeling: The Second Generation, Conceptual Frame and Methodology of Molecular Modeling, The Field Currently Covered, Importance of the "Bioactive Conformation", Molecular Mimicry and Structural Similarities, Molecular Mimicry, Structural Similarities and Superimposition Techniques, Rational Drug Design and Chemical Intuition, An Important Key and the Role of the Molecular Model, Limitations of Chemical Intuition Major Milestones and Future Perspectives. COMPUTER ASSISTED NEW LEAD DESIGN Introduction, Basic Concepts, Molecular Recognition by Receptor and Ligand Design, Active Conformation, Approaches to Discover New Functions, Approaches to the Cases with known and unknown receptor structure

UNIT-IV

10 Hrs.

DOCKING METHODS Program GREEN Grid: Three -Dimensional Description of Binding Site Environment and Energy Calculation, Automatic Docking Method, Three-Dimensional Database Search Approaches, Automated Structure Construction Methods, Structure Construction Methods with known Three-Dimensional Structure of the Receptor, Structure Construction in the case of Unknown Receptor Structure. Scope and Limitations, Points for Consideration in Structure, Construction Methods, Handling of X-Ray Structures of Proteins, Future Perspectives, Types of programs available for molecular modeling-scope and limitations-interpretation of results.

COMPUTER - ASSISTED DRUG DISCOVERY The Drug Development Process, Introduction, The Discovery and Development Process, New Lead Discovery Strategies, Composition of Drug Discovery Teams, The Practice of Computer-Assisted Drug Discovery (CADD), Current Practice of CADD in the pharmaceutical Industry,

Management Structures of CADD Groups, Contributions and Achievements of CADD Groups, Limitations of CADD Support, Inherent Limitations of CADD Support, State of Current Computational Models, Software and Hardware Constraints

Reference Books:

1. Bioinformatics Methods & Applications: Genomics, Proteomics & Drug Discovery, S C Rastogi, Mendiratta & P Rastogi, PHI, 4th Edition, 2013
2. Moody P.C.E. and A.J. Wilkinson Protein Engineering, IRL Press, Oxford, 3rd Edition, 2010.
3. Creighton T.E. Proteins, Freeman W.H. Second Edn, 1993.
4. Branden C. and Tooze R. Introduction of protein structure, Garland, 1993.
5. The molecular modeling perspective in drug design by N Claude Cohen, 2008, Academic Press.

Web links and Video Lectures (e-Resources)

Course Outcomes	Programme Outcomes											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	1(WK1, WK2, WK3, and WK4)	-	2 (WK 5)	-	1 (WK2 and WK6)	1 (WK1, WK5, and WK7).	2 (WK9)	2 (WK1)	-	-	1 (WK 8)	2	1	1
CO2	1(WK1, WK2, WK3, and WK4)	-	2 (WK 5)	-	-	2 (WK1, WK5, and WK7).	2 (WK9)	3 (WK1)	-	-	1 (WK 8)	2	1	2
CO3	-	-	1 (WK 5)	1 (WK 8).	2 (WK2 and WK6)	-	2 (WK9)	2 (WK5)	-	-	1 (WK 8)	2	1	-
CO4	2(WK1, WK2, WK3, and WK4)	-	2 (WK 5)	-	-	1 (WK1, WK5, and WK7).	2 (WK9)	2	-	-	1 (WK 8)	2	1	-

Course Code		:	BBTE504E	BIOREFINERIES & BIOENERGY TECHNOLOGIES	Semester	:	05
L:T:P		:	3:0:0		Course Type	:	PEC
Hours/Sem.	Teaching	:	42 Hrs		CIE Marks	:	50
	Learning (TW+SL)	:	42 Hrs		SEE Marks	:	50
	Exam	:	06 Hrs		Total Marks	:	100
	Total Hrs.	:	90		Credits	:	03

Professional Competency:

Graduate will apply the principles of bioenergy & Biorefinery concept, science and technology to evaluate feedstocks, production processes, technological innovations, and the economic and environmental sustainability of bioenergy for renewable energy applications

Course Outcomes:

After completion of the course, student will be able to:

CO1: Understand the role of biomass and biorefineries in the transition towards sustainable bioenergy and a circular bioeconomy.

CO2: Learn biomass conversion technologies for the production of bioenergy, biofuels, and value-added bioproducts.

CO3: Understand the design and operation of integrated biorefineries and their industrial applications.

CO4: Evaluate the sustainability, techno-economic feasibility, and emerging technologies in the bioenergy sector.

UNIT-I

10 Hrs.

INTRODUCTION TO BIOMASS, BIOREFINERY & BIOENERGY

Biomass Resources:

Classification and characteristics of biomass; agricultural residues, forestry residues, animal wastes, municipal solid waste, industrial organic wastes, algae and dedicated energy crops. Biomass composition & characteristics (cellulose, hemicellulose, lignin, starch, oils and proteins). Biomass availability, collection, storage, preprocessing and supply chain management.

Biorefinery Concept:

Definition and evolution of biorefineries; Concept of refinery vs. biorefinery, Types of biorefineries, Integrated biorefinery concept; Feedstock flexibility; biomass cascading approach; circular bioeconomy; waste-to-wealth concept; product diversification in modern biorefineries.

Introduction to Bioenergy:

Definition & Need for bioenergy, Global energy scenario; climate change and energy security; Renewable & Non renewable energy resources. Sustainable Development Goals (SDGs), role of biomass in sustainable development; Economic and innovation opportunities. India's bioenergy potential and National Bioenergy Programme..

UNIT-II

12 Hrs.

BIOREFINERY AND BIOMASS CONVERSION TECHNOLOGIES

Biofuel Feed Stocks:

Starch feed stocks-cereal grains, tubers & roots; Sugars feed stocks-sugarcane & sugarbeet; cellulosic feed stocks - forest residues, agricultural residues, Agricultural processing by-products, dedicated energy crops, municipal solid waste and paper waste. Lipid feed stocks :-Oilseed crops with examples, Algae, Waste oil, Animal fats. Next generation feed stocks.

Types Of Biofuels:

First generation biofuels-vegetable oil biodiesel, bioalcohols, bioethers, biogas syngas, solid biofuels. Second generation biofuels, third & future generation biofuels.

Fundamentals of Biorefinery:

Concept of petroleum refinery versus biorefinery, Biomass fractionation, Integrated sugarcane biorefinery, algae biorefineries, oilseed biorefineries, municipal solid waste biorefineries, co-production of fuels, power, chemicals and biomaterials, industrial case studies .

UNIT-III

10 Hrs.

TECHNOLOGIES FOR BIOENERGY :

Physicochemical Conversion:

Biodiesel production - Transesterification process; homogeneous, heterogeneous and enzymatic catalysts;

biodiesel purification and fuel quality standards														
Biochemical Conversion Technologies:														
Bioethanol production- 1G, 2G technologies, Innovations in 2G technology														
Biogas production - AD technology, microbial conversion pathways, design of biodigesters, CBG & current industrial scenario, Innovation scope in Biomethanation, CO2 capture & conversion. Aviation fuel														
Biohydrogen production Processes, Microbial fuel cells. Algal biofuels														
UNIT-IV													10 Hrs.	
BIOFUELS IN PERSPECTIVE														
Techno commercial feasibility of producing biodiesel, Issues with biofuel production & use. Strategies for new vehicle technologies. Market barriers of biofuels. Current research on bioenergy.														
Sustainability Assessment:														
Life Cycle Assessment (LCA), carbon footprint, greenhouse gas mitigation, Impact of biofuel in global climate change & food production, Environmental impact assessment, circular economy principles.														
Policies and Standards:														
National Bioenergy Programme; SATAT initiative; Ethanol Blending Programme (EBP); National Green Hydrogen Mission; renewable energy policies; sustainability certification and international standards.														
Text Books:														
1. Ashok Pandey et al., Biofuels: Alternative Feedstocks and Conversion Processes, 3rd Ed., Academic Press, 2019.														
2. Pratima Bajpai, Biorefinery: Integrated Sustainable Processes for Biomass Conversion to Biomaterials, Biofuels and Fertilizers, Springer, 2020.														
Reference Books:														
1. Robert C. Brown, Introduction to Thermochemical Processing of Biomass into Fuels, Chemicals and Power, 2nd Ed., Wiley, 2019.														
2. Yebo Li and Samir Kumar Khanal, Bioenergy: Principles and Applications, Wiley-Blackwell, 2016.														
3. Rafael Luque and James Clark (Eds.), Handbook of Biofuels Production, 2nd Ed., Woodhead Publishing, 2022.														
Course Outcomes	Programme Outcomes											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3 (WK1, WK2, WK3, and WK4)	2 (WK1, WK2, WK3, and WK4)	-	-	2 (WK 2 and WK6)		1 (WK9)	-	-	-	1 (WK 8)	3	2	-
CO2	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	-	3 (WK8)			2 (WK9)	-	-	-	1 (WK 8)	2	-	-
CO3	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	-	3 (WK8)	3 (WK 2 and WK6)		2 (WK9)	-	-	-	3 (WK 8)	-	2	-
CO4	3 (WK1, WK2, WK3,	3 (WK1, WK2, WK3,	-	3 (WK8)			2 (WK9)	-	-	-	3 (WK 8)	-	1	-

	and WK4)	and WK4)												
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Self reading: Soft copy materials from NPTEL is given to all the students

	Code	:	BBTF504E	ENVIRONMENTAL BIOTECHNOLOGY	Semester	:	04
	LTP	:	3:0:0		Course Type	:	PCC
Hours/Sem.	Teaching	:	42 Hrs		CIE Marks	:	50
	Learning (TW+SL)	:	42 Hrs		SEE Marks	:	50
	Exam	:	06 Hrs		Total Marks	:	100
	Total Hrs.	:	90 Hrs		Credits	:	03

Professional Competency:

Design and apply biological systems using microorganisms and plants to treat waste, clean up environmental pollutants, recover metals, and conserve biodiversity.

Course Outcomes:

After completion of the course student will be able to

CO1: Interpret the scope of Environmental Biotechnology and concepts of Bioaccumulation.

CO2: Develop different treatment methods for waste water and solid waste by using BT approach.

CO3: Apply bioleaching process for metal recovery and bioremediation processes to remove environmental contaminants.

CO4: Identify and apply BT approach for biodiversity conservation.

UNIT-I

10 Hrs.

INTRODUCTION

Issues and scope of Environmental BT. Interactions among soil microorganisms, biogeochemical role of soil microorganisms.

BIOACCUMULATION OF TOXICANTS

Characteristics of Xenobiotics, Relationship of Bioaccumulation with Chemical Structure, Ecophysiology of Bioaccumulation, Process of toxicants uptake, Factors affecting bioaccumulation, measurement of bioaccumulation.

UNIT-II

12 Hrs.

BIOLOGICAL TREATMENT OF WASTE WATER

Waste water characteristics BOD, COD, Primary & Secondary treatment, nanofiltration, ultrafiltration and microfiltration. Microbial removal of phosphorous and Nitrogen, Nutrient removal by Biomass production Wastewater treatment of food processing industries like sugar factories, vegetable oil industries, potato processing industries, dairy industries, beverages industries, and distilleries.

SOLID WASTE MANAGEMENT

Basic aspects, general composition of urban solid wastes, aerobic treatment, anaerobic treatment, biogas generation; Solid waste management through Biotechnological processes involving Hazardous wastes, Biomedical wastes, MoEF rules.

UNIT-III

10 Hrs.

BIOLEACHING & BIOMINING

BIOLEACHING & BIOMINING	Microbes	in	Bioleaching-
types, methods of bioleaching, Microbial recovery of metal, phosphate, petroleum.			

BIOREMEDIATION:

Major contaminants of air, water and soil, Biomonitoring of environment (Bioindicators), Bioremediation using microbes, Phytoremediation, Biofilms and its applications. Bio-stimulation of Naturally occurring microbial activities, Bio-augmentation.

UNIT-IV

10 Hrs.

BIOTECHNOLOGY IN BIODIVERSITY CONSERVATION

BIOTECHNOLOGY IN BIODIVERSITY CONSERVATION	Value of biodiversity, threats to biodiversity, Biosphere reserves and Ecosystem Conservation, Approaches to Bioresource conservation programme, Biotechnological processes for bioresource assessment, BT in ex situ conservation of Biodiversity, BT and its role in utilization of Biodiversity, International initiatives for biodiversity management.
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Text Books:

1. Mahopatra P K., "Textbook of Environmental Biotechnology", I K International Publishing House Pvt. Ltd, 2006
2. Indu Shekhar Thakur, Environmental Biotechnology Basic concepts & Applications, 2nd Edition, IK International Pvt. Ltd, 2015

Reference Books:

1. Bimal C. B and Rintu B., Environmental Biotechnology, Oxford University Press, 2023
2. Dubey R C and Maheshwari D K., "Text book of microbiology" 5th edition, S Chand and Company Ltd., 2022

Course Outcomes	Programme Outcomes											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3 (WK1 to WK4)	2 (WK1 to WK4)	2 (WK5)	1 (WK8)							3 (WK8)	2	3	2
CO2	3 (WK1 to WK4)	2 (WK1 to WK4)	3 (WK5)	1 (WK8)		2 (WK1, WK5, and WK7).	2(WK9)				3 (WK8)	3	3	3
CO3	3 (WK1 to WK4)	2 (WK1 to WK4)	3 (WK5)	1 (WK8)		2 (WK1, WK5, and WK7).	2(WK9)				3 (WK8)	3	3	3
CO4	3 (WK1 to WK4)	2 (WK1 to WK4)	3 (WK5)	1 (WK8)		2 (WK1, WK5, and WK7).	2(WK9)				3 (WK8)	3	3	3

Course Code		:	BBTA531N	BIOREFINERIES & BIOENERGY TECHNOLOGIES	Semester	:	05
L:T:P		:	3:0:0		Course Type	:	OEC
Hours/Sem.	Teaching	:	42 Hrs		CIE Marks	:	50
	Learning (TW+SL)	:	42 Hrs		SEE Marks	:	50
	Exam	:	06 Hrs		Total Marks	:	100
	Total Hrs.	:	90		Credits	:	03

Professional Competency:

Graduate will apply the principles of bioenergy & Biorefinery concept, science and technology to evaluate feedstocks, production processes, technological innovations, and the economic and environmental sustainability of bioenergy for renewable energy applications

Course Outcomes:

After completion of the course, student will be able to:

CO1: Understand the role of biomass and biorefineries in the transition towards sustainable bioenergy and a circular bioeconomy.

CO2: Learn biomass conversion technologies for the production of bioenergy, biofuels, and value-added bioproducts.

CO3: Understand the design and operation of integrated biorefineries and their industrial applications.

CO4: Evaluate the sustainability, techno-economic feasibility, and emerging technologies in the bioenergy sector.

UNIT-I

10 Hrs.

INTRODUCTION TO BIOMASS, BIOREFINERY & BIOENERGY

Biomass Resources:

Classification and characteristics of biomass; agricultural residues, forestry residues, animal wastes, municipal solid waste, industrial organic wastes, algae and dedicated energy crops. Biomass composition & characteristics (cellulose, hemicellulose, lignin, starch, oils and proteins). Biomass availability, collection, storage, preprocessing and supply chain management.

Biorefinery Concept:

Definition and evolution of biorefineries; Concept of refinery vs. biorefinery, Types of biorefineries, Integrated biorefinery concept; Feedstock flexibility; biomass cascading approach; circular bioeconomy; waste-to-wealth concept; product diversification in modern biorefineries.

Introduction to Bioenergy:

Defination & Need for bioenergy, Global energy scenario; climate change and energy security; Renewable & Non renewable energy resourcses. Sustainable Development Goals (SDGs), role of biomass in sustainable development; Economic and innovation opportunities. India's bioenergy potential and National Bioenergy Programme..

UNIT-II

12 Hrs.

BIOREFINERY AND BIOMASS CONVERSION TECHNOLOGIES

Biofuel Feed Stocks:

Starch feed stocks-cereal grains, tubers & roots; Sugars feed stocks-sugarcane & sugarbeet; cellulosic feed stocks - forest residues, agricultural residues, Agricultural processing by-products, dedicated energy crops, municipal solid waste and paper waste. Lipid feed stocks :-Oilseed crops with examples, Algae, Waste oil, Animal fats. Next generation feed stocks.

Types Of Biofuels:

First generation biofuels-vegetable oil biodiesel, bioalcohols, bioethers, biogas syngas, solid biofuels. Second generation biofuels, third & future generation biofuels.

Fundamentals of Biorefinery:

Concept of petroleum refinery versus biorefinery, Biomass fractionation, Integrated sugarcane biorefinery, algae biorefineries, oilseed biorefineries, municipal solid waste biorefineries, co-production of fuels, power, chemicals and biomaterials, industrial case studies .

UNIT-III

10 Hrs.

TECHNOLOGIES FOR BIOENERGY :

Physicochemical Conversion:

Biodiesel production - Transesterification process; homogeneous, heterogeneous and enzymatic catalysts; biodiesel purification and fuel quality standards

Biochemical Conversion Technologies: Bioethanol production- 1G, 2G technologies, Innovations in 2G technology Biogas production - AD technology, microbial conversion pathways, design of biodigesters, CBG & current industrial scenario, Innovation scope in Biomethanation, CO2 capture & conversion. Aviation fuel Biohydrogen production Processes, Microbial fuel cells. Algal biofuels														
UNIT-IV													10 Hrs.	
BIOFUELS IN PERSPECTIVE Techno commercial feasibility of producing biodiesel, Issues with biofuel production & use. Strategies for new vehicle technologies. Market barriers of biofuels. Current research on bioenergy. Sustainability Assessment: Life Cycle Assessment (LCA), carbon footprint, greenhouse gas mitigation, Impact of biofuel in global climate change & food production, Environmental impact assessment, circular economy principles. Policies and Standards: National Bioenergy Programme; SATAT initiative; Ethanol Blending Programme (EBP); National Green Hydrogen Mission; renewable energy policies; sustainability certification and international standards.														
Text Books: 1. Ashok Pandey et al., Biofuels: Alternative Feedstocks and Conversion Processes, 3rd Ed., Academic Press, 2019. 2. Pratima Bajpai, Biorefinery: Integrated Sustainable Processes for Biomass Conversion to Biomaterials, Biofuels and Fertilizers, Springer, 2020.														
Reference Books: 4. Robert C. Brown, Introduction to Thermochemical Processing of Biomass into Fuels, Chemicals and Power, 2nd Ed., Wiley, 2019. 5. Yebo Li and Samir Kumar Khanal, Bioenergy: Principles and Applications, Wiley-Blackwell, 2016. 6. Rafael Luque and James Clark (Eds.), Handbook of Biofuels Production, 2nd Ed., Woodhead Publishing, 2022.														
Course Outcomes	Programme Outcomes											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3 (WK1, WK2, WK3, and WK4)	2 (WK1, WK2, WK3, and WK4)	-	-	2 (W K2 and WK 6)		1 (WK9)	-	-	-	1 (WK 8)	3	2	-
CO2	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	-	3 (W K8)			2 (WK9)	-	-	-	1 (WK 8)	2	-	-
CO3	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	-	3 (W K8)	3 (W K2 and WK 6)		2 (WK9)	-	-	-	3 (WK 8)	-	2	-
CO4	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	-	3 (W K8)			2 (WK9)	-	-	-	3 (WK 8)	-	1	-

Self reading: Soft copy materials from NPTEL is given to all the students

Hours/Sem.	Code	:	BBTA523C	ENVIRONMENTAL STUDIES	Semester	:	05
	LTP	:	1:0:0		Course Type	:	MC
	Teaching	:	14 Hrs.		CIE Marks	:	50
	Learning (TW+SL)	:	13 Hrs.		SEE Marks	:	50
	Exam	:	03 Hr.		Total Marks	:	100
	Total Hrs.	:	30 Hrs.		Credits	:	01

Professional Competency:

Develop the ability to analyze environmental issues and implement sustainable solutions by applying environmental science principles, pollution control measures, and environmental legislation.

Course Outcomes:

After completion of the course, student will be able to:

CO1: Identify natural resources and its uses.

CO2: Understand pollution and its effects on environment and to implement sustainable future in the work place.

CO3: Analyze current environmental issues.

CO4: Apply the waste management techniques in various fields.

UNIT-I

10 Hrs.

Natural Resources:

Human activities and their impacts. Environmental Impact Assessment, **Renewable Energy:** Solar, Wind, Hydropower, Tidal, Ocean thermal, Geo thermal, Biomass energy, Biogas, Biodiesel, Bioethanol, Hydrogen as fuel.

Non renewable Energy: Coal, Petroleum, Natural gas, Nuclear energy.

UNIT-II

12 Hrs.

Environmental Pollution:

Water pollution, water quality standards, water borne diseases, Fluoride problem, Air pollution, Noise pollution. Effect of electromagnetic waves.

Sustainable future: Concept of sustainable development, threats to sustainability, strategies for sustainable development, Sustainable development goals (SDGs). Environment economics – concept of green building, Circular Economy.

UNIT-III

10 Hrs.

Current Environmental Issues of concern:

Greenhouse Effect- Greenhouse gases and Global Warming, Climate change, ozone layer depletion, Acid rain, Eutrophication Environmental policy legislation rules & regulations

UNIT-IV

10 Hrs.

Fundamentals of Waste management:

Solid waste management: Sources, classification, characteristics, collection & transportation, disposal, and processing methods. Hazardous waste management and handling.

Concept of waste water treatment, Bioremediation. Industrial waste management (Case studies: Cement, plastic, chemical, E-waste, food & construction industry waste management).

Text Books:

1. Benny Joseph, Environmental Studies, 3rd Edition, McGraw Hill Education (India) Pvt. Ltd., 2017.
2. Manjunath, D. L., Environmental Studies, 1st Edition, Pearson Education, New Delhi, 2007.
3. Anubha Kaushik and C. P. Kaushik, *Perspectives in Environmental Studies*, 8th Edition, New Age International (P) Ltd., New Delhi, 2025.
4. P. Meenakshi, Elements of Environmental Science and Engineering, 2nd Edition, PHI Learning Pvt. Ltd., New Delhi, 2012.

Course Outcomes	Programme Outcomes											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3

CO1	2 (WK1, WK2, WK3, and WK4)		2 (WK5)			3 (WK1, WK5 and WK7)					3 (WK8)	3		3
CO2	2 (WK1, WK2, WK3, and WK4)		2 (WK5)			3 (WK1, WK5 and WK7)					3 (WK8)	3		3
CO3	2 (WK1, WK2, WK3, and WK4)		2 (WK5)			3 (WK1, WK5 and WK7)					3 (WK8)	3		3
CO4	2 (WK1, WK2, WK3, and WK4)		2 (WK5)			3 (WK1, WK5 and WK7)					3 (WK8)	3		3

Hours/Sem.	Code	:	BBTA506L	BIOINFORMATICS LAB	Semester	:	5
	LTP	:	0:0 :2		Course Type	:	PCCL
	Teaching	:	26 Hrs.		CIE Marks	:	50
	Learning (TW+SL)	:	-		SEE Marks	:	50
	Exam	:	4 Hrs.		Total Marks	:	100
	Total Hrs.	:	30 Hrs.		Credits	:	01

Professional Competency:

Integrating biological domain knowledge with computational tools and statistical methods to solve complex life science problems. Building practical expertise bridges traditional lab work with IT, opening doors in biotechnology, pharmaceuticals, and precision medicine

Course Outcomes:

After completion of the course, student will be able to:

CO1-Search literature and sequence databases.

CO2-Retrieve and search sequences from databases.

CO3-Align pair wise and multiple sequences. Evaluate the evolutionary relationships and functional sites in genomes.

CO4-Carry out primer designing and restriction mapping. Perform Docking and superimpose the structures.

List of Experiments OR Programs List

1. Bibliographic search from PUBMED, SCIRUS and MEDMINER
2. Sequence retrieval from Nucleic acid and Protein databases.
3. Sequence searches using BLAST – Retrieval of homologs, paralogs, orthologs, and Xenologs
4. Pair wise comparison of sequences – Analysis of parameters affecting alignment.
5. Multiple alignments of sequences and pattern determination using PROSITE 6.Evolutionary studies / Phylogenetic analysis – Analysis of parameters affecting trees.
6. Identification of functional sites in Genes / Genomes.
7. Secondary structure prediction of proteins and comparison with PDB.
8. Restriction mapping: Analysis of maps for suitable molecular biology experiment.
9. Primer Design: Factors affecting primer design.
10. PDB structure retrieval and visualization: Analysis of homologous structures.
11. Determination of ligand-protein interactions using SPDBV/ LIGPLOT 13.Superposition of structures – Calculation of RMSD.
12. Docking studies – Analysis of substrate / ligand binding using homologous structures.

Reference Books:

1. Bioinformatics – Andreas D Boxevanis. Wiley Inter science, 1998.
2. Bioinformatics – David W Mount, cold spring harbor, 2001.
3. Bioinformatics – A biologist's guide to biocomputing and the internet. Stuart M brown,
4. Fundamental Concepts of Bioinformatics – D E Krane& M L Raymer, Pearson, 2006.
5. Computational methods in Molecular Biology – S. L. Salzberg, D B Searls, S Kasif, Elsevier, 1998.
Bioinformatics – methods and applications: Genomics, proteomics and drug Discovery – S C Rastogi, N. Mendiratta & Prastogi, phi, 2006.

Web Links and Video Lectures (e-Resources):

How to Construct a Phylogenetic Tree in MEGA 11: A Step-by-Step Guide:

<https://www.youtube.com/watch?v=hHTMmaJuEbg>

Protein - Protein Docking Beginner Tutorial <https://www.youtube.com/watch?v=bbVBKZM31PI> 2D image of protein and ligand by LigPlot+ <https://www.youtube.com/watch?v=tuwGNwTQmiM>

Course Outcome s	Programme Outcomes											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	3 (WK5)	-	3 (WK2, WK6)	1 (WK1, WK5, WK7)	-	3	-	-	-	3	3	1
CO2	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	3 (WK5)	-	3 (WK2, WK6)	1 (WK1, WK5, WK7)	-	-	-	-	-	2	3	1
CO3	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	2 (WK5)	2 (WK8)	3 (WK2, WK6)	1 (WK1, WK5, WK7)	1 (WK9)	-	-	-	-	3	3	1
CO4	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	2	2 (WK8)	3 (WK2, WK6)	1 (WK1, WK5, WK7)		-	-	-	-	3	3	2

Hours/Sem.	Code	:	BBTA507P	MINI PROJECTS	Semester	:	05
	LTP	:	0-0-2		Course Type	:	PP
	Teaching	:	-		CIE Marks	:	50
	Learning (TW+SL)	:	-		SEE Marks	:	50
	Exam	:	04 Hrs.		Total Marks	:	100
	Total Hrs.	:	60Hrs.		Credits	:	02

Professional Competency:

Apply fundamental biotechnological principles, research methodology, ethical practices, and scientific communication skills to plan, execute, analyze, and present a mini research project that addresses a defined biotechnology problem using a systematic and professional approach.

Course Outcomes:

After completion of the course, student will be able to:

CO 1: Apply Biotechnological principles and techniques to design and conduct experiments.

CO 2: Able to develop research skills and methodical approach to maintain for the collection, storage and analysis of data.

CO 3: Able to demonstrate an awareness of ethical issues associated with their chosen field of research.

CO4: Able to develop and demonstrate the ability to effectively communicate written and oral presentations scientifically

Course Outcomes	POs											PSOs		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	3 (W K5)	3 (W K8)	3 (WK2 and WK6)	3 (WK1, WK5 & WK7)	2 (WK 9)	2	2	3	2 (WK8)	3	3	3
CO 2	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	3 (W K5)	3 (W K8)	3 (WK2 and WK6)	2 (WK1, WK5 & WK7)	3 (WK 9)	2	2	3	3 (WK8)	3	3	3
CO 3	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	3 (W K5)	3 (W K8)	3 (WK2 and WK6)	2 (WK1, WK5 & WK7)	3 (WK 9)	3	2	2	2 (WK8)	3	3	3
CO 4	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	3 (W K5)	3 (W K8)	3 (WK2 and WK6)	3 (WK1, WK5 & WK7)	3 (WK 9)	3	2	2	3 (WK8)	3	3	3

	Code	:	BHSA522C	QUANTITATIVE APTITUDE AND PROFESSIONAL SKILLS	Semester	:	5
	LTP	:	2:0:0		Course Type	:	AEC
Hours/Sem.	Teaching	:	28 Hrs		CIE Marks	:	100
	Learning (TW+SL)	:	28 Hrs		SEE Marks	:	00
	Exam	:	04Hrs		Total Marks	:	100
	Total Hrs.	:	60Hrs		Credits	:	02

Professional Competency:

Demonstrate competency in enhancing vocabulary, improving verbal ability, analyzing problems systematically, and solving quantitative problems using appropriate language and numerical techniques.

Course Outcomes:

1. **Enhance** vocabulary and apply techniques to further improve word usage and language proficiency.
2. **Apply** techniques to improve verbal ability in communication and comprehension tasks.
3. **Analyze** problems step-by-step and **develop** appropriate methods for solving them effectively.
4. **Solve** quantitative problems by applying appropriate concepts and techniques to improve numerical ability.

UNIT-I

7 Hrs.

Vocabulary Development: Vocabulary Building Techniques, Root Words, Antonyms & Synonyms, Completion, Error Detection & Correction, Reading Comprehension	Sentence
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UNIT-II

7 Hrs.

Numbers, Proportion & Finance: Number System, Factors & Multiples, The God of Math – Linear Equations, Ratio-Proportion -Variation, Percentages, Profit & Loss, Interest, Averages & Alligations

UNIT-III

7 Hrs.

Time&Probability: Time&Work, TimeSpeed,&Distance, Permutations&Combinations, Probability

UNIT-IV

7 Hrs.

Verbal, Analytical, and Visual Reasoning: Human Relations, Direction Tests, Coding Decoding, Clocks and Calendars, Visual Reasoning, Analytical Puzzles, Mathematical, Arrangement & Classification Puzzles

Text Books:

1. R.S.Aggarwal,“AModernApproachtoVerbalandNon–VerbalReasoning”,SultanChand and Sons, New Delhi, 2018
2. R. S. Aggarwal, “Quantitative Aptitude”, Sultan Chand and Sons, New Delhi, 2018
3. Chopra, “Verbal and Non–Verbal Reasoning”, MacMillanIndia
4. MTyra, “Magical Book on Quicker Maths”, BSC Publications,2018
5. George J Summers, “The Great Book of Puzzles & Teasers”, Jaico Publishing House,1989
6. Shakuntala Devi, “Puzzles to Puzzle You”, Orient Paper Backs, NewDelhi,1976
7. R. S. Aggarwal, “A Modern Approach to Logical Reasoning”, Sultan Chand and Sons, New Delhi, 2018
8. Cambridge Advanced Learner’s Dictionary, Cambridge University Press. Kaplan’s G R Eguide

[illegible]

VI SEMESTER

Course Code		:	BBTA601C	DOWNSTREAM PROCESSING TECHNOLOGY	Semester	:	06
L:T:P		:	3:0:0		Course Type	:	PCC
Hours/Sem.	Teaching	:	42 Hrs.		CIE Marks	:	50
	Learning (TW+SL)	:	42 Hrs.		SEE Marks	:	50
	Exam	:	6 Hrs.		Total Marks	:	100
Total Hrs.		:	90 Hrs.	Credits	:	03	
Professional Competency:							
Ability to systematically isolate, purify, and formulate biological products from complex harvesting media by integrating physical, chemical, and analytical unit operations, while simultaneously optimizing process economics, structural stability, yield, and regulatory product safety.							
Course Outcomes:							
After completion of the course, student will be able to:							
CO1: Analyze solid-liquid separation profiles and select mechanical clarification unit operations like filtration, sedimentation, or centrifugation.							
CO2: Apply membrane separation mechanics, precipitation protocols, and advanced extraction principles to achieve partial purification of target fractions.							
CO3: Design high-resolution purification strategies utilizing specific chromatography matrices, electrophoresis parameters, and analytical instrumentation footprints.							
CO4: Formulate end-stage product finishing and preservation lines combining evaporation, crystallization, and freeze-drying setups.							
UNIT-I						10 Hrs.	
Scope and Importance of Bioseparations technology in biotechnology, Characteristics of bioproducts, Criteria for selection of bio-separation techniques. Economics of bio separations in biotechnology, cost-cutting strategies. Recovery of Intracellular Products: Cell disruption methods: physical methods (osmotic shock, grinding with abrasives, solid shear, liquid shear) – chemical methods (alkali, detergents) – enzymatic methods. Isolation of insolubles: Filtration, Sedimentation, Coagulation, Flocculation, and Centrifugation. Types of centrifuges and rotors, Differential, Density gradient (zonal and isopycnic).							
UNIT-II						10 Hrs.	
Product Recovery or Partial Purification: Precipitation of Proteins, Nucleic acids, and Bioproducts by Ammonium Sulfate, Polyethylene Glycol, and Solvents; Membrane separation processes: Dialysis, Reverse osmosis, Electrodialysis, Pervaporation, Ultrafiltration; Extraction methods: Solid-liquid and liquid-liquid extraction methods, Advanced Extraction Methods like Ultrasound, Microwave-assisted, Supercritical fluid Extractions, Solid-phase Extraction (Adsorption).							
UNIT-III						12 Hrs.	
Product Purification or Product Enrichment: Selective Separation Techniques: Aqueous Two-phase Extraction, Micellar and Reverse Micellar Extraction; Chromatographic separation and Electrophoresis methods: Principles of Chromatographic separation methods, Different types of chromatographic methods, Ion-exchange chromatography, Gel chromatography, Affinity chromatography. Principles of Electrophoresis and Electrophoresis mobility, applications. Application of analytical techniques: High-Performance Liquid Chromatography; Gas Chromatography; LC-MS; GC-MS; FTIR etc. used in bioprocess Industries.							
UNIT-IV						10 Hrs.	
Product Finishing: Product polishing and finishing: Crystallization, Drying (Tray, Freeze Drying, Spray Drying), Evaporation (Rotary Evaporator), Lyophilization, and Product stabilization.							
Reference Books:							
1. Bioseparations: Downstream Processing for Biotechnology: Authors: Paul A. Belter, E. L. Cussler, and Wei-Shou Hu (John Wiley & Sons).							

2. Bioseparations Science and Engineering: Authors: Roger G. Harrison, Paul W. Todd, Scott R. Rudge, and Demetri P. Petrides (Oxford University Press).
3. Bioseparations: Principles and Techniques: Author: B. Sivasankar (PHI Learning).

Web links and Video Lectures (e-Resources)

1. **NPTEL:** 1. Comprehensive Video Lecture Series (NPTEL / SWAYAM) Principles of Downstream Techniques in Bioprocess (IIT Madras) Instructor: Prof. Mukesh Doble
2. **NPTEL: Membrane Technology (IIT Guwahati)** Instructor: Prof. Kaustubha Mohanty
3. **NCBI Bookshelf** - Bioprocess and Separation Footprints

Course Outcomes	Programme Outcomes											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	2 (WK5)	2 (WK8)	2 (WK2, WK6)	1 (WK1, WK5, WK7)	-	-	-	-	1 (WK8)	2	3	-
CO2	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	2 (WK5)	2 (WK8)	1 (WK2, WK6)	1 (WK1, WK5, WK7)	-	-	-	-	1 (WK8)	2	3	-
CO3	3 (WK1, WK2, WK3, and WK4)	2 (WK1, WK2, WK3, and WK4)	3 (WK5)	3 (WK8)	3 (WK2, WK6)	-	-	-	-	-	2 (WK8)	2	3	1
CO4	3 (WK1, WK2, WK3, and WK4)	2 (WK1, WK2, WK3, and WK4)	3 (WK5)	2 (WK8)	1 (WK2, WK6)	2 (WK1, WK5, WK7)	1 (WK9)	-	-	2	1 (WK8)	2	3	2

Course Code		:	BBTA602C	BIOTRANSFORMATION AND ENZYME TECHNOLOGY	Semester	:	06
L:T:P		:	3:0:0		Course Type	:	PCC
Hours/Sem.	Teaching	:	42 Hrs		CIE Marks	:	50
	Learning (TW+SL)	:	42Hrs		SEE Marks	:	50
	Exam	:	06 Hrs		Total Marks	:	100
	Total Hrs.	:	90		Credits	:	03

Professional Competency:

Derive the kinetic expressions for the enzyme catalysed and multi substrate reactions. Apply the techniques to immobilize enzymes, comprehend the importance of enzymes in disease diagnosis and industrial application.

Course Outcomes:

After completion of the course, student will be able to:

CO 1. To explain mechanism of enzyme catalyzed reactions

CO 2. To analyze enzymatic techniques to characterize and immobilize the enzymes for industrial application

CO 3. To interpret the importance of enzymes for disease diagnosis.

Co 4. To apply their knowledge of using enzymes in detergent, wool, leather and food industries.

UNIT-I

12 Hrs.

Enzyme action:

Mechanism of enzyme action. Derivations of K_m value (Michaelis-Menton constant), Lineweaver-Burk plot., Enzyme inhibition and kinetics

Multi-Substrate Reactions:

Introduction to enzyme catalyzed reaction Ping-pong mechanism, Sequential mechanism (ordered and random), Enzyme models - Host guest complexation chemistry

UNIT-II

10 Hrs.

Enzymatic Techniques:

Strategies of purification of enzymes: choice of source, methods of homogenization, Criteria of purity: tests for purity, tests for catalytic activity, active site titrations, Molecular weight determination and characterization of enzymes.

Immobilization of enzymes:

Techniques of enzyme immobilization; design and configuration of immobilized enzyme reactions, Kinetics of immobilized enzymes, immobilized enzymes in bioconversion processes (uses). The design and construction of novel enzymes

UNIT-III

10 Hrs.

Enzymes of biological importance:

Enzyme pattern in diseases like in Myocardial infarctions (SGOT, SGPT, & LDH) Acetylcholinesterase, angiotensin converting enzyme (ACE), 5'- Nucleotidase (5NT), Glucose-6-phosphate dehydrogenase (GPD). Use of isozymes as markers in cancer.

UNIT-IV

10 Hrs.

Industrial uses of enzymes:

Enzymes used in detergents, use of proteases, leather and wool industries; methods involved in production of glucose syrup from starch (using starch hydrolyzing enzymes).Uses of lactase in dairy industry, glucose oxidase and catalase in food industry. Uses of proteases in food industries.

Text Books:

1. Trevor Palmer (2008). Enzymes: Biochemistry, Biotechnology, Clinical Chemistry. Horwood Publishing Ltd, East-West Press, 5th Edition.
2. David L. Nelson and Michael Cox (2017). "Lehninger Principles of Biochemistry" –7th Edition.

Reference Books:

1. Nicholas C. Price and Lewis Stevens (2009). Fundamental of Enzymology, Oxford University Press, 3rd edition.
2. James R Hanson (2017). "An Introduction to Biotransformation in Organic Chemistry" 5th edition, Oxford University Press,
3. K. Faber (2018). Biotransformations in Organic: Springer- Verlag.4th Edition.
4. Bailey and Ollis (2017). "Biochemical Engineering Fundamentals", Mcgraw Hill 2nd Ed.

Course Outcomes	Programme Outcomes											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	2 (WK 5)	-	3 (WK2 and WK6)	-	3 (WK9)	-	-	-	3 (WK8)	3	3	3
CO2	3(WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	2 (WK 5)	-	3 (WK2 and WK6)	-	2 (WK9)	-	-	-	3 (WK8)	3	3	3
CO3	3(WK1, WK2, WK3, and WK4)	2 (WK1, WK2, WK3, and WK4)	2 (WK 5)	-	3 (WK2 and WK6)	-	3 (WK9)	-	-	-	3 (WK8)	3	3	3
CO4	3(WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	2 (WK 5)	-	2 (WK2 and WK6)	-	3 (WK9)	-	-	-	3 (WK8)	3	3	3

Course Code		:	BBTA603C	GENOMICS AND PROTEOMICS	Semester	:	6
L:T:P		:	3:0:0		Course Type	:	PCC
Hours/ Sem.	Teaching	:	42Hrs.		CIE Marks	:	50
	Learning (TW+SL)	:	42Hrs.		SEE Marks	:	50
	Exam	:	6Hrs.		Total Marks	:	100
	Total Hrs.	:	90Hrs.		Credits	:	03
Professional Competency:							
To build professional competency among students to be mastered in multi-omics data integration and interpret the genomics and proteomics data							
Course Outcomes:							
After completion of the course, student will be able to:							
1. Know about genes, brief history, polymorphism, prediction methods, Biosimilars, business opportunities in diagnostic and medicine. Use tools in DNA sequencing methods and Human genome project, 2. Understand cancer Genomics, Functional and Comparative genomics using model organisms, functional genomics of different organisms and molecular markers, gene and physical mapping techniques 3. To know about Protein structure analysis and molecular interactions 4. Analysis of proteins, quantification, sequencing, identification, protein predictive methods and proteomics in medicine							
UNIT-I						10 Hrs.	
INTRODUCTION Genes and Proteins, Polymorphisms – types of polymorphism, commercializing the Genome - Revenue opportunities: a) genome sequences and database subscriptions, b) prediction of new genes and their function by databases. c) prediction of new genes and their function by databases, d) potential revenue in the area diagnostic and biomedical applications, e) biosimilars market and implications. Sequencing & genome projects: Early sequencing efforts. Methods of preparing genomic DNA for sequencing, DNA sequence analysis methods, Sanger Dideoxy method, Fluorescence method, shotgun approach. Next generation sequencing Genome projects on <i>E.coli.</i> , Arabidopsis and rice; Human genome project.							
UNIT-II						10 Hrs.	
CANCER GENOMICS AND FUNCTIONAL GENOMICS DNA and RNA alterations in tumors, genomic instability, oncogenes, and tumor suppressors drive on cogenesis. Next-Generation Sequencing (NGS) for distinguishing somatic from germ line mutations, and applying this data to precision oncology. Gene variation and Single Nucleotide Polymorphisms (SNPs) genotyping tools -DNA Chips, comparative genomics. Functional genomic studies with model systems such as Drosophila, Yeast or <i>C. elegans</i> . Applications in Functional genomics, medicine and Gene Knockdown. Metagenomics- definition & concept. C-Value and paradox of genomes, Repetitive and coding sequences, Genetic and physical maps, chromosome walking Methods of molecular mapping, Marker assisted selection, map based cloning, Bioinformatics analysis-clustering methods. Approaches to physical mapping.							
UNIT-III						10 Hrs.	
STRUCTURE OF PROTEINS Conformational analysis and forces that determine protein structures, geometries, phi, psi, omega angles, Ramachandran diagram, allowed chi angles of side chains in proteins, hydrogen bonding, disulphide bonds, Vanderwaal's force, salt bridges hydrophobic interactions, alpha helices, beta sheets, helix to coil transition, general features and thermodynamic aspects of protein folding, folding kinetics, protein-ligand interactions (Examples of bio-molecular interactions), fibrous proteins (structure of collagen, keratin) and Quaternary structures.							

UNIT-IV	10 Hrs.
PROTEOMICS Introduction to proteomics, Sample preparation, protein extraction Denovo protein synthesis, LCMS/MS, M/Z ratio, sequencing and identification, Predictive Methods using Protein sequences: Protein Identity based on composition, Related web based software (JPRED, PROSEC, NNPPREDICT and SOPMA) Proteome analysis "Protein Chip" - interactions and detection techniques, two dimensional PAGE for proteome analysis, Applications of proteome analysis to drug development and toxicology. Crisper-cas. Challenges in proteomics.	
Reference Books:	
1. Genetic Analysis – Principles, Scope and Objectives by JRS Finchman, Blackwell Science, 1st Edition, 1994. 2. A M Campbell & L J Heyer Discovering Genomics, Proteomics & Bioinformatics,- Pearson Education, 2nd Edition, 2006. 3. Genomics and Proteomics: Principles, Technologies, and Applications (D. Thangadurai & J. Sangeetha): Examines DNA chip technology, gene expression analysis, and structure-based functional genomics 4. Albala J S & I Humprey -Smith Protein Arrays, Biochips and Proteomics, CRC Press, 1st Edition, 2003. 5. Genomic, Proteomics, and Biotechnology (R.C. Sobti & Mukesh Sobti): A comprehensive overview connecting genomic sequencing, transcriptomics, and computational biolog 6. Sabesan, Genomics & Proteomics–Ane Books, 2007. 7. Pennington S. R. and M J Dunn Proteomics	
e-Resources to learn more about Genomics and Proteomics	
• NCI Genomic Data Commons (GDC): The official data repository for NCI-sponsored programs, including The Cancer Genome Atlas (TCGA) and Therapeutically Applicable Research to Generate Effective Treatments (TARGET). Access, query, and download massive clinical and molecular datasets via the GDC Data Portal. [1, 2, 3] • Gene Expression Omnibus (GEO): A highly utilized public repository maintained by the NIH that hosts high-throughput gene expression, microarray, and genomic datasets. Search global experiments using the NCBI GEO Database. • NCBI: Houses a vast collection of interconnected databases, including GenBank (DNA sequences) and Gene Expression Omnibus (GEO) for sequence and array-based functional genomics data. • Ensembl Project: A premier genome browser providing automated annotation, comparative genomics, and sequence variation data for vertebrate and model organism genomes. • UCSC Genome Browser: A highly interactive, web-based genomic data visualizer featuring extensive annotation tracks, gene expression profiles, and comparative genomics. • European Nucleotide Archive (ENA): Maintained by the EMBL-EBI, this platform provides free, comprehensive access to worldwide nucleotide sequencing data.	

Course Outcomes	Programme Outcomes											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	2 (WK5)	-	-	2 (WK1, WK5, and WK7).	2 (WK9)	-			1 (WK8)	-	2	3
CO2	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	1 (WK5)	-	-	2 (WK1, WK5, and WK7).		-			2 (WK8)	1	-	3
CO3	3 (WK1, WK2, WK3, and WK4)	2 (WK1, WK2, WK3, and WK4)	2 (WK5)	1 (WK8).	2 (WK2 and WK6)	-		-			1 (WK8)	1	2	2
CO4	2 (WK1, WK2, WK3, and WK4)	2 (WK1, WK2, WK3, and WK4)	2 (WK5)	2 (WK8).	2 (WK2 and WK6)	2 (WK1, WK5, and WK7).	2 (WK9)	2			1 (WK8)	1	2	2

Course Code		:	BBTB604E	FOOD BIOTECHNOLOGY	Semester	:	06
L:T:P		:	3:0:0		Course Type	:	PEC
Hours/Sem.	Teaching	:	42 Hrs		CIE Marks	:	50
	Learning (TW+SL)	:	42 Hrs		SEE Marks	:	50
	Exam	:	06 Hrs		Total Marks	:	100
	Total Hrs.	:	90 Hrs		Credits	:	03

Professional Competency:

Apply biotechnology principles and modern molecular techniques to develop, improve, process, and ensure the safety, quality, and nutritional value of food products while addressing global food security and regulatory requirements.

Course Outcomes:

After completion of the course, student will be able to:

CO1: Explain the principles of food biotechnology, nutrigenomics, novel food bioprocesses, and their role in improving food quality and addressing global food security.

CO2: Apply microbial biotechnology concepts for the production of food ingredients, enzymes, nutraceuticals, microbial polysaccharides, and fermented food products.

CO3: Analyze molecular and genetic approaches for improving the nutritional quality, shelf life, and functional properties of plant-derived food products.

CO4: Evaluate transgenic animal technologies, chloroplast engineering, food safety regulations, genetically modified foods, and intellectual property rights in food biotechnology.

UNIT-I

10 Hrs.

INTRODUCTION

Hunger, Technology and World food needs-nutritional problems, approaches to combat world hunger, roles of technology. Recent Developments in food biotechnology, introduction to molecular food biotechnology.

NOVEL BIOPROCESSING

Biosensors for food quality assessment, cold active enzymes in food processing, biotransformation in food industries.

NUTRIGENOMICS

Definition of Nutriomics, Nutrigenetics, and its applications, Nutritional genomics and applications in brief.
Nutrigenetics and cancer.

UNIT-II

11 Hrs.

MICROBIAL BIOTECHNOLOGY OF FOOD

Metabolic engineering of bacteria for food ingredients (Amino acids, organic acids, vitamins). Introduction to technologies for microbial production of food ingredients. Solid-state fermentation for food applications (enzymes, pigments). Biotechnology of microbial polysaccharides- natural occurrence of microbial polysaccharides in foods, additives (xanthan) and its future, Microbial biotechnology of food flavor, oils and fats. Food applications of algae-nutritional value, source of nutraceuticals and industrial production processes (chlorella, spirulina, Agar, alginate). Genetics of Dairy starter cultures.

UNIT-III

11 Hrs.

PLANT FOOD APPLICATIONS

Genomic basics for food improvement, molecular design of soybean proteins for enhanced food quality, Genetic modifications of plant starches, plant oils, for food applications. Bioprocessing of starch using enzyme technology. Molecular biotechnology for nutraceutical enrichment of food crops, Biotechnology of nonnutritive sweeteners, metabolic redesign of vitamin -E biosynthesis, production of new metabolites, Engineering of provitamin- A ,biosynthetic pathway into rice(Golden rice), Engineering of carotenoid biosynthesis for antioxidants, approaches to improve nutritional quality and shelf life of fruits and vegetables.

UNIT-IV

10 Hrs.

Enhancement of leaf quality protein for ruminant animals. Methods of chloroplast transformation, markers for transformation, engineering chloroplast for the production of edible vaccine, Transplastomic maize- a case study.

ANIMAL FOOD APPLICATIONS: Genetic modification of production traits in farm animals, Foods made from GM animals, applications of transgenic fish technology in sea food production, enzymatic synthesis of

oligosaccharides-progress and recent trends.

FOOD SAFETY: international aspects of the quality and safety, [genetically modified food controversies](#). Regulation of the release of genetic modified organisms, patenting inventions in food biotechnology.

Text Books:

1. Kalidas s, Gopinadhan P, Anthony P and Robert E.Levin- “ Food Biotechnology”- second edition, CRC press, 2006
2. Gustavo F.G and Gustavo V.B,-“ Food Science and Food Biotechnology” - CRC press, 2003

Reference Books:

1. Mahesh S.-“ Plant Molecular Biotechnology” - first edition, New age international publishers, , 2008
2. Norman N.Potter and Joseph H. Hotchkiss- Food Science- fifth edition- CBS publishers and distributors, 2007.

Course Outcomes:

Course Outcomes	Programme Outcomes											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3 (WK1, WK2, WK3, and WK4)	2 (WK1, WK2, WK3, and WK4)	–	1 (W K8)	2 (WK 2,W K6)	2 (WK1, WK5, WK7)	3 (WK 9)	2	–	–	1 (WK 8)	2	3	2
CO2	3(WK1, WK2, WK3, and WK4)	3(WK1, WK2, WK3, and WK4)	2 (W K5)	2(WK 8)	3(W K2, WK6)	1(WK 1,WK5 ,WK7)	2(W K9)	1	–	–	1 (WK 8)	2	3	2
CO3	3(WK1, WK2, WK3, and WK4)	3(WK1, WK2, WK3, and WK4)	3 (W K5)	2(WK 8)	3(W K2, WK6)	2(WK 1,WK5 ,WK7)	3(W K9)	2	–	–	1 (WK 8)	2	3	3
CO4	2(WK1, WK2, WK3, and WK4)	3(WK1, WK2, WK3, and WK4)	2 (W K5)	3(WK 8)	2(W K2, WK6)	3(WK 1,WK5 ,WK7)	3(W K9)	3	1	2	1 (WK 8)	2	3	3

Course Code		:	BBTD604E	BIOREACTOR DESIGN	Semester	:	06
L:T:P		:	3:0:0		Course Type	:	PEC
Hours/Sem.	Teaching	:	42 Hrs		CIE Marks	:	50
	Learning (TW+SL)	:	42 Hrs		SEE Marks	:	50
	Exam	:	06 Hrs		Total Marks	:	100
	Total Hrs.	:	90		Credits	:	03

Professional Competency:

Ability to apply mathematical, kinetic, and engineering transport principles to size, select, model, and operate scaled industrial bioreactor systems, translating cell line requirements into functional, stable, and highly productive automated fermentation equipment.

Course Outcomes:

After completion of the course, student will be able to:

CO1: Bioreactor Fundamentals & Configurations: Analyze microbial, plant, and animal cell rate expressions alongside fundamental material and energy balances to select and categorize appropriate bioreactor configurations for submerged and solid-state fermentations.

CO2: Operational Management & Control: Identify and optimize critical environmental and physical control factors required to ensure the smooth, aseptic operation of bioreactors handling free or immobilized biocatalysts and shear-sensitive cultures

CO3: Sizing and Design of Submerged Systems: Formulate kinetic and transport design equations to size, configure, and evaluate the performance parameters of industrial Batch, Fed-Batch (Semi-continuous), and continuous flow (CSTR and PFR) bioreactors.

CO4: Advanced Reactor Synthesis: Design specialized bioreactor configurations—including cell recycle loops, multi-stage cascading systems, and packed/fluidized beds—to maximize product yields in enzyme reactions and highly demanding biological processes.

UNIT-I

10 Hrs

BASICS OF BIOREACTORS

Overview of bioreactions, Elements in bioreactor design, Rate expression in biological systems, Basic concept of material and energy balances, Development and significance of bioreactors, Bioreactor configurations, Classification of bioreactors, Bioreactors for solid-state fermentation, plant and animal cell cultures

UNIT-II

10 Hrs

Common operations of bioreactor, Identification of common factors for smooth operation of bioreactors, Spectrum of basic bioreactor operations, Bioreactor operation for immobilised systems, plant and animal cell cultures.

UNIT-III

12 Hrs

BATCH, SEMICONTINUOUS AND CONTINUOUS BIOREACTOR DESIGN

Overview of bioreactor design, Batch and semi-continuous bioreactors for submerged fermentation of microbes, Continuous flow stirred tank and plug flow tubular bioreactors for submerged fermentation of microbes, Recycle bioreactors, Multistage bioreactors, Bioreactors for enzyme reactions and immobilized systems

UNIT-IV

10 Hrs

CASE STUDIES AND SCALE-UP

Design of packed bed, fluidized bed, airlift, hollow fibre, plant cell, mammalian cell bioreactors for various applications, Scale-up – Criteria, Similarity criteria, Methods, Generalized approaches.

Reference Books:

1. PBioreactor Design and Product Yield: Authors: BIOTOL Series (Butterworth-Heinemann).
2. Solid-State Fermentation Bioreactors: Authors: David A. Mitchell, Dr. Marin Berovič, and Dr. Nadia Krieger (Springer).
3. Bioreactor Engineering Research Horizon: Author: Samuel R. Catcheside (Nova Science Publishers).

Web links and Video Lectures (e-Resources)

1. NPTEL: Bioreactor Design and Analysis (IIT Madras): Instructor: Prof. Smita Srivastava
2. NPTEL: Aspects of Biochemical Engineering (IIT Kharagpur): Instructor: Prof. Debabrata Das
3. Interactive Process Design & Simulation Modules: LearnChemE - Biokinetics & Bioreactor Simulations

Course Outcomes:

Course Outcomes	Programme Outcomes											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	2 (W K5)	2 (W K8)	2 (WK2, WK6)	1 (WK1, WK5, W K7)	-	-	-	-	1 (W K8)	2	3	-
CO2	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	2 (W K5)	2 (W K8)	1 (WK2, WK6)	1 (WK1, WK5, W K7)	-	-	-	-	1 (W K8)	2	3	-
CO3	3 (WK1, WK2, WK3, and WK4)	2 (WK1, WK2, WK3, and WK4)	3 (W K5)	3 (W K8)	3 (WK2, WK6)	-	-	-	-	-	2 (W K8)	2	3	1
CO4	3 (WK1, WK2, WK3, and WK4)	2 (WK1, WK2, WK3, and WK4)	3 (W K5)	2 (W K8)	1 (WK2, WK6)	2 (WK1, WK5, W K7)	1 (W K9)	-	-	2	1 (W K8)	2	3	2

Course Code		:	BBTE604E	BIOSENSOR TECHNOLOGY	Semester	:	06
L:T:P		:	3:0:0		Course Type	:	PEC
Hours/Sem.	Teaching	:	42 Hrs		CIE Marks	:	50
	Learning (TW+SL)	:	42 Hrs		SEE Marks	:	50
	Exam	:	06 Hrs		Total Marks	:	100
	Total Hrs.	:	90		Credits	:	03
Professional Competency:							
Students will be able to design, evaluate, and apply biosensor technologies by integrating biological recognition systems, transduction mechanisms, advanced fabrication techniques, and emerging smart sensing technologies to solve real-world problems in healthcare, environmental monitoring, food safety, agriculture, and industry.							
Course Outcomes:							
After the completion of the course, students will be able to:							
CO1: Explain the fundamental principles, components and classification of biosensors.							
CO2: Compare different biosensor transduction mechanisms and evaluate their operating principles and performance.							
CO3: Apply knowledge of biomolecule immobilization, fabrication techniques and performance evaluation in biosensor development.							
CO4: Analyze the applications of biosensors in healthcare, environmental monitoring, food safety and emerging smart sensing technologies.							
UNIT-I						12 Hrs	
Fundamentals of Biosensors							
Introduction to biosensors: Definition, history and scope. Components of a biosensor Classification of biosensors. Biological recognition elements: Enzymes, antibodies, nucleic acids, cells, microorganisms. Characteristics of biosensors: Sensitivity, specificity, selectivity, response time and stability.							
UNIT-II						10 Hrs	
Biosensor Transduction MechanismsElectrochemical biosensors: Amperometric, potentiometric and conductometric biosensors. Optical biosensors: Fluorescence, Surface Plasmon Resonance (SPR), fiber-optic biosensors. Piezoelectric and thermal biosensors. Signal processing and data acquisition in biosensors							
UNIT-III						10 Hrs	
Design and Fabrication of Biosensors							
Design and fabrication of biosensors: Design Considerations: calibration, dynamic range, linear range, signal to noise, sensitivity, selectivity, Interference, reproducibility, detection limit, stability. Fabrication techniques: self-assembled monolayers, screen printing, photolithography, micro-contact printing, MEMS, Miniaturization, nanomaterial-based biosensors.							
UNIT-IV						10 Hrs	
Recent Advanced Applications							
Clinical diagnostics and point-of-care testing. Biosensors in environmental monitoring, current challenges. Food quality and safety analysis, Agricultural and industrial biosensors Lab-on-a-chip devices, Internet of Medical Things (IoMT), AI-integrated biosensors and future trends							
Text Books:							
1. Brian R. Eggins, Chemical Sensors and Biosensors, John Wiley& Sons, 2003, 1 st Edition							
2. Donald G. Buerk, Biosensors: Theory and Applications, CRC Press, 2009, 1 st Edition							
3. Chandra Mouli Pandey and Bansi Dhar Malhotra, Biosensors: Fundamentals and Applications, De Gruyter 2019, 1 st Edition							
Reference Books:							
7. Florinel-Gabriel Banica, Chemical Sensors and Biosensors: Fundamentals and Applications, Wiley, 2012, 1st Edition Department of Biotechnology							
8. Alice Cunningham, Introduction to Bioanalytical Sensors, John Wiley& Sons, 1st Edition Other Suggested Readings: https://www.edx.org/course/principles-of-electronic-biosensors							
Course Outcomes:							
Course	Programme Outcomes					Program Specific	

Outcome s												Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	-	2 (WK1, WK2, WK3, and WK4)	2 W K 5	3 WK8	2 WK2 & WK6	1 WK1 , WK5 & WK7	2 WK9	3	-	1	2 WK8	3	2	2
CO2	-	3 (WK1, WK2, WK3, and WK4)	2 W K 5	3 WK8	-	2 WK1 , WK5 & WK7	2 WK9	2	-	-	2 WK8	2	3	2
CO3	-	-	-	-	2 WK2 & WK6	3 WK1 , WK5 & WK7	2 WK9	3	-	1	3 WK8	1	2	3
CO4	-	-	-	2 WK8	3 WK2 & WK6	2 WK1 , WK5 & WK7	-	1	-	1	-	1	2	3

Course Code		:	BBTF604E	QUALITY MANAGEMENT SYSTEM AND REGULATORY AFFAIRS	Semester	:	06
L:T:P		:	3:0:0		Course Type	:	PEC
Hours/Sem.	Teaching	:	42 Hrs		CIE Marks	:	50
	Learning (TW+SL)	:	42 Hrs		SEE Marks	:	50
	Exam	:	06 Hrs		Total Marks	:	100
	Total Hrs.	:	90		Credits	:	03

Professional Competency:

Apply quality assurance and quality control principles to monitor, document, and continuously improve manufacturing processes, ensuring customer satisfaction and compliance with industrial quality standards.

Course Outcomes:

After completion of the course, student will be able to:

CO1: Comprehend the principles and types of validation, regulatory affairs, good practices in lab, clinical, manufacturing practices and Qualification procedures.

CO2: Understand the ISO standards and environmental management systems and analyse the analytical methods

of validation, issues and automated system and standards

CO3: Discuss the quality control measures used in industries

CO4: Analyse the Quality Assurance characteristics and Quality Management System.

UNIT-I

10 Hrs.

Introduction

Validation and Regulatory Affairs in Bio (Pharmaceutical) Manufacturing: An Introduction to FDA Operations & Industry Compliance Regulations, The Fundamentals of Regulatory Compliance with respect to Good Clinical Practice (GCP), Good Manufacturing Practice (GMP) & Good Laboratory Practice (GLP). An Introduction to the Basic Concepts of Process Validation & Qualification (IQ, OQ & PQ) Procedures, A Review of Prospective, Concurrent, Retrospective Validation & Revalidation . Validation of Water, Packaging Validation, Cleaning validation, Validation Master Plan, FAT, SAT.

UNIT-II

12 Hrs.

Validation of Analytical Methods, Validation of HVAC systems, Thermal system validation Computerized & Systems The Influence of Good Automated Manufacturing Practice (GAMP).

Standards Introduction, **ISO 9000 Series** of Standards, Management Responsibility, Quality System, Contract Review, Design Control, Document and Data Control, **ISO-9001-2000**, Scope, Normative Reference, Terms and Definitions, Quality Management, System, Documents Requirements, Management's Responsibility, Resource Management, Infrastructure, Product Realization, Measurement, Analysis and Improvement, **ISO-14001-2000**, Scope, Normative Reference, Terms and Definitions, Quality Management

MODULE-III

10 Hrs.

Quality Control :Quality System, Quality Objectives, Quality Policy, Quality Planning, Quality Control, Quality Characteristics, Quality Improvement, Handling, Storage, Packaging, Preservation and Delivery, Control of Quality Records, Internal Quality Audits, Training, Servicing, Statistical Techniques.

MODULE-IV

10 Hrs.

Quality Assurance

Terminology Relating to Quality, Quality Requirement, Customer Satisfaction, Capability; Terms Relating to Management, Management System, Quality Management System, Continual Improvement, Effectiveness, Efficiency; Relating to Process and Product, Process, Product, Procedure; Terms relating to Characteristics, Quality Characteristics; Terms Relating to Conformity, Non-Conformity, Defect, Preventive Action, Corrective Action, Correction, Rework, Regrade, Repair, Quality Manual, Objectives of Quality Assurance and its role in industries.

Text Books:

1. Validation of Pharmaceutical Processes: Sterile Products, Frederick J. Carlton (Ed.) and James Agalloco (Ed.), Marcel Dekker, 2nd Ed., 1998.

Reference Books:

1. Pharmaceutical Process Validation, 3rd Edition, Edited by Robert Nash and Alfred Wachter, Marcel Dekker, 2003
2. Good Manufacturing Practices for Pharmaceuticals: A Plan for Total Quality Control From Manufacturer to Consumer, Sidney J. Willig, Marcel Dekker, 5th Ed., 2000, 723 pp.,
3. Validation Standard Operating Procedures: A Step by Step Guide for Achieving Compliance
4. Pharmaceutical Equipment Validation: The Ultimate Qualification Handbook, Phillip A. Cloud, Interpharm Press, 1998.
5. Commissioning and Qualification, ISPE Pharmaceutical Engineering Baseline Guides Series,

Course Outcomes:

Course Outcomes	Programme Outcomes											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3 (WK1, WK2, WK3, and WK4)	2 (WK1, WK2, WK3, and WK4)	-	-	-	-	-	1	-	-	1	-	2	2
CO2	-	2 (WK1, WK2, WK3, and WK4)	3 (WK5)	-	3 (WK 6)	1 (WK1, WK5 and WK7)	1 (W K9)	1	1	-	1 (WK 8)	-	2	2
CO3	-	2 (WK1, WK2, WK3, and WK4)	3 (WK5)	-	3 (WK 6)	1 (WK1, WK5 and WK7)	-	1	1	-	1 (WK 8)	-	2	3
CO4	-	2 (WK1, WK2, WK3, and WK4)	2 (WK5)	-	-	1 (WK1, WK5 and WK7)	-	1	1	-	1 (WK 8)	-	2	

Course Code		:	BBTA605N	ENVIRONMENTAL TECHNOLOGY	Semester	:	06
L:T:P		:	3:0:0		Course Type	:	OEC
Hours/Sem.	Teaching	:	42 Hrs		CIE Marks	:	50
	Learning (TW+SL)	:	42 Hrs		SEE Marks	:	50
	Exam	:	06 Hrs		Total Marks	:	100
	Total Hrs.	:	90		Credits	:	03
Professional Competency:							
Assess renewable energy technologies and biodiversity conservation approaches for sustainable development							
Course Outcomes:							
After completion of the course, student will be able to:							
CO1: Analyze current environmental issues, environmental impact, bioaccumulation processes, and sustainable development concepts.							
CO2: Apply principles of environmental biotechnology for wastewater treatment, solid waste management, and pollution control.							
CO3: Evaluate bioleaching, biomining, and bioremediation technologies for environmental restoration and resource recovery.							
CO4: Analyse biofuel production technologies and biodiversity conservation strategies for sustainable environmental management.							
UNIT-I							12 Hrs.
Introduction:							
Current Environmental Issues and scope of Environmental science and technology biogeochemical role of soil microorganisms, Bioconcrete, Environment Impact Assessment							
Bioaccumulation of toxicants							
Characteristics of Xenobiotics, Relationship of Bioaccumulation with Chemical Structure, Ecophysiology of Bioaccumulation Process of toxicants uptake, Factors affecting bioaccumulation, measurement of bioaccumulation							
Sustainable future: Green building concept, Carbon foot print, crediting, trading and its calculation, Water foot print Rain water harvesting.							
UNIT-II							10 Hrs.
Waste water treatment:							
Waste water characteristics BOD, COD, Primary & Secondary treatment, nanofiltration. Ultrafiltration and microfiltration Microbial removal of phosphorous and Nitrogen Wastewater treatment of industries like sugar factories, food industries, beverages industries, and distilleries.							
Solid waste management							
Basic aspects, general composition of municipal solid wastes, aerobic treatment, anaerobic treatment biogas generation Solid waste management. Hazardous wastes, Biomedical Wastes, E waste management, MoEF rules.							
UNIT-III							10 Hrs.
Bioleaching & Biomining:							
Microbes in Bioleaching- types, methods of bioleaching, Microbial recovery of phosphate, petroleum.							
Bioremediation:							
Major contaminants of air, water and soil, Biomonitors of environment (Bioindicators), Bioremediation using microbes, Phytoremediation, Biofilms its applications Bio-stimulation of Naturally occurring microbial activities, Bio-augmentation							
UNIT-IV							10 Hrs.
Biofuels:							
Definition, Renewable and nonrenewable resources Advantages and disadvantages of biofuels Biofuel feed stocks-sugar starch, cellulose, lipid Types of biofuel- first, second and third generation Technologies for bio-fuel production-transesterification, gasification 2G technology, Biomethanation, Issues of biofuel production and its use. Microbial fuel cells.							

Biodiversity: Value of biodiversity, threats to biodiversity approaches of biodiversity conservation

Text Books:

1. Pradipta Kumar Mahopatra, Text Book of Environmental Biotechnology, I K Publishers, 2006.
2. R.C Dubey and D K Maheshwari, Text book of Microbiology, S Chand and Company Ltd,2013

Reference Books:

1. M Y Young, Comprehensive Biotechnology Vol 1-4 (Eds). Pergamon Press, 2004
2. EJ Dasilva, C Ratledge & A Sasson, Biotechnology, Economic & Social Aspects Cambridge Univ. Press, 2003
3. Indu Shekhar Thakur,2012,Environmental Biotechnology Basic concepts and applications, Second Edition, I K international Publishing House, Pvt, Ltd.

Course Outcomes:

Course Outcomes	Programme Outcomes											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	-	-	-	2(WK 1, WK5 and WK7)	3(W K9)	1	-	-	2(WK 8)		1	1
CO2	3(WK 1, WK2, WK3, and WK4)	2 (WK1, WK2, WK3, and WK4)	3 (W K5)	2(W K8)	2 (WK 6)	2 (WK1, WK5 and WK7)	3 (WK 9)		1	-	2(WK 8)	2	2	2
CO3	3(WK 1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	2 (W K5)	3(W K8)	2 (WK 6)	2 (WK1, WK5 and WK7)	3(W K9)			-	2 (W K8)	2	3	2
CO4	3(WK 1, WK2, WK3, and WK4)	2 (WK1, WK2, WK3, and WK4)	2 (W K5)	2(W K8)	2(W K6)	2 (WK1, WK5 and WK7)	3(W K9)	1		-	3 (W K8)	2	3	1

Course Code		:	BHSA600C	INDIAN KNOWLEDGE SYSTEM	Semester	:	VI
L:T:P		:	01:0:0		Course Type	:	AEC
Hours/Sem.	Teaching	:	14 Hrs		CIE Marks	:	50
	Learning (TW+SL)	:	13 Hrs		SEE Marks	:	50
	Exam	:	03 Hrs		Total Marks	:	100
	Total Hrs.	:	30 Hrs		Credits	:	01

Professional competency

Apply the principles of the Indian Knowledge System to appreciate, preserve, and utilize traditional knowledge for addressing contemporary societal and professional challenges.

COURSE OUTCOMES

After completion of the course, student will be able to:

CO1: Provide an overview of the concept of the Indian Knowledge System and its importance

CO2: Appreciate the need and importance of protecting traditional knowledge.

CO3: Recognize the relevance of Traditional knowledge in different domains.

CO4: Establish the significance of Indian Knowledge systems in the contemporary world

UNIT I

3 Hrs.

Indian Knowledge Systems (IKS)

Overview, Vedic Corpus, Philosophy in Indian Knowledge system.

UNIT II

4 Hrs.

Traditional Knowledge in Mathematics

Introduction to Indian Mathematics, Unique aspects of Indian Mathematics, Indian Mathematicians and their Contribution. Number Systems and Units of Measurement.

UNIT III

4 Hrs.

Traditional Knowledge in Science

Measurements for time, distance and weight, Astronomy, Indian contributions in astronomy, Astrology, The celestial coordinate system, Elements of the Indian calendar, Notion of years and month, Panchanga – The Indian calendar system

UNIT IV

4 Hrs.

Traditional Knowledge in Professional domain

Town Planning and Architecture, Agriculture, Governance and Public Administration

Text Books:

1. Mahadevan. B. Bhat Vinayak Rajat, Nagendra Pavana R.N. "Introduction to Indian Knowledge System: Concepts and Applications", PHI Learning Private Ltd. Delhi (2022). Pride of India: A Glimpse into India's Scientific Heritage, Samskrita Bharati, New Delhi

REFERENCE BOOKS

1. Sampad and Vijay "The Wonder that is Sanskrit", Sri Aurobindo Society, Puducherry. (2011).
2. Acarya. P.K. Indian Architecture, MunshiramManoharlal Publishers, New Delhi. (1996).
3. Kapoor Kapil, Singh Avadhesh "Indian Knowledge Systems Vol – I & II", Indian Institute of Advanced Study, Shimla, H.P. (2021).
4. Dasgupta, S. A History of Indian Philosophy- Volume 1, Motilal Banarsidass, New Delhi. (1975).
5. PLofer. K. (1963). Mathematics in India, Princeton University Press, New Jersey, USA"

Web Links and Video Lectures:

1. <https://www.youtube.com/watch?v=LZP1StpYEPM>
2. <http://nptel.ac.in/courses/121106003/>
3. <http://www.iitkgp.ac.in/departement/KS;jsessionid=C5042785F727F6EB46CBF432D7683B63>
(Centre of Excellence for Indian Knowledge System, IIT Kharagpur)
4. https://www.wipo.int/pressroom/en/briefs/tk_ip.html
5. https://unctad.org/system/files/official-document/ditcted10_en.pdf
6. http://nbaindia.org/uploaded/docs/traditionalknowledge_190707.pdf
development goals/?gclid=EAIaIQobChMInpJtb_p8gIVTeN3Ch2
7. <https://unfoundation.org/what-we-do/issues/sustainable>
developmentgoals/?gclid=EAIaIQobChMInp-

Course Outcomes	Programme Outcomes											Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	2 WK1	2 WK2 &7	-	1 WK4	-	2 WK7	1	3	-	2 WK1 0	2 W K1 1	-	-	-
CO 2	1 WK1	2 WK2 &7	-	-	-	3 WK7	2 WK 8	3 WK 9	-	1 WK1 0	2 WK 11	-	-	-
CO 3	2 WK1	2 WK2 &7	1 WK3 &8	-	1	3 WK7	3 WK 8	3 WK 9	-	2 WK1 0	2 WK 11	-	-	-
CO 4	2 WK1	2 WK2 &7	2 WK3 &8	-	1	3 WK7	2 WK 8	3 WK 9	1 WK 10	2 WK1 0	3 WK 11	-	-	-

Course Code		:	BBTA606L	BIOKINETICS AND ENZYME TECHNOLOGY LAB	Semester	:	06
L:T:P		:	0:0:2		Course Type	:	PCCL
Hours/Sem.	Teaching	:	26 Hrs		CIE Marks	:	50
	Learning (TW+SL)	:	00		SEE Marks	:	50
	Exam	:	04 Hrs		Total Marks	:	100
	Total Hrs.	:	30		Credits	:	01

Professional Competency:

Derive the kinetic expressions for the enzyme catalysed reactions. Estimate the activity and specific activity of free and immobilized enzymes, comprehend the importance of enzymes in disease diagnosis and industrial application.

Course Outcomes:

List of Experiments

1. Preparation of reagents and buffers of constant strengths.
2. Maltose calibration curve by DNS method
3. Determination of Alpha-amylase activity.
4. Determination of Specific activity of an enzyme.
5. Effect of pH and temperature on enzyme activity
6. Determination of Kinetics constants (Km & Vmax)
7. Urea calibration curve
8. Determine the activity of enzyme Urease
9. Effect of inhibitors on enzyme activity
10. Immobilization of enzyme and determination of immobilized enzyme activity.

Note: (Prediction of % error, standard deviation need to be calculated from expt. no 5 and 6)

Text Books:

1. Pattabiraman 2017. Laboratory manual of Biochemistry, 4th Edition, International Book Publishers, India.

Reference Books:

3. Sadasivam and Manickam, 2017, Biochemical methods, 2nd Edition, New age International Publishers.

Course Outcomes	Programme Outcomes											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	2 (WK 5)	-	3 (WK 2 and WK6)	-	3 (WK 9)	-	-	-	3 (WK8)	3	3	3
CO2	3(WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	2 (WK 5)	-	3 (WK 2 and WK6)	-	2 (WK 9)	-	-	-	3 (WK8)	3	3	3
CO3	3(WK1, WK2, WK3, and WK4)	2 (WK1, WK2, WK3, and WK4)	2 (WK 5)	-	3 (WK 2 and WK6)	-	3 (WK 9)	-	-	-	3 (WK8)	3	3	3

CO4	3(WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	2 (WK 5)	-	2 (WK 2 and WK6)	-	3 (WK 9)	-	-	-	3 (WK8)	3	3	3
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Course Code		:	BBTA607L	BIOSEPARATION TECHNIQUES LAB	Semester	:	06
L:T:P		:	0:0:2		Course Type	:	PCCL
Hours/Sem.	Teaching	:	26 Hrs		CIE Marks	:	50
	Learning (TW+SL)	:	00		SEE Marks	:	50
	Exam	:	04 Hrs.		Total Marks	:	100
	Total Hrs.	:	30Hrs.		Credits	:	01

Professional Competency:

Ability to design, execute, and troubleshoot a complete experimental purification sequence—transitioning smoothly from raw cell harvesting to high-resolution validation and stable formulation—while managing mass-transfer limitations, operating variables, and the structural integrity of sensitive biological entities.

Course Outcomes:

After completion of the course, student will be able to:

CO1: Clarification & Cell Disruption: Evaluate the quantitative release of intracellular biomolecules by comparing physical and chemical cell disruption methods, and analyze biomass sedimentation behavior using coagulation and flocculation kinetics.

CO2: Mechanics of Centrifugation & Extraction: Apply centrifugal transport equations to model particle settling velocity, and implement liquid-liquid, advanced, or Aqueous Two-Phase Extraction (ATPS) systems to isolate target solute fractions.

CO3: Primary Fractionation & Analytical Profiling: Design primary fractionation protocols using salting-out, solvent, or polymer precipitation strategies, and validate the resulting product purity profile using High-Performance Liquid Chromatography (HPLC) instrumentation footprints.

CO4: Dehydration & Product Polishing: Formulate late-stage dehydration and finishing protocols by optimizing vacuum parameters in rotary evaporation and sublimation cycle kinetics in lyophilization to ensure long-term product stability.

LIST OF EXPERIMENTS

26 per batch Hrs.

11. Mechanical vs. Chemical Cell Disruption
12. Flocculation and Coagulation Kinetics
13. Centrifugation Mechanics
14. Fractional Protein Precipitation
15. Solvent and Polymer Precipitation
16. Advanced Extraction methods
17. Aqueous Two-Phase Extraction (ATPS)
18. Product Concentration via Rotary Evaporation
19. Lyophilization (Freeze-Drying) Operations
20. Quantitative Product Profiling via HPLC

Open Ended Experiment(s) OR Open Ended Program(s)

1. Separation and Purification of bioactive compounds/proteins/Enzymes any other products different sources

Reference Books:

1. Bioseparations Science and Engineering: Authors: Roger G. Harrison, Paul W. Todd, Scott R. Rudge, and Demetri P. Petrides (Oxford University Press).
2. Laboratory Manual in Bioprocess Engineering: Author: N. Shanthi (MJP Publishers).
3. Protein Purification Protocols: Editor: Paul Cutler (Humana Press / Methods in Molecular Biology series)

Web links and Video Lectures (e-Resources)

1. Practical Industrial Handbooks & Methodologies Cytiva (GE Healthcare) Protein Purification Handbooks
2. Lyophilization Technology Application Notes (SP Scientific / Labconco)

Course Outcomes:

Course Outcomes	Programme Outcomes											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3 (WK1, WK2,	3 (WK1, WK2,	2 (WK 5)	2 (WK 8)	2 (WK2, WK6)	1 (WK 1,W	-	-	-	-	1 (W K8)	2	3	-

	WK3, and WK4)	WK3, and WK4)				K5, WK7)								
CO2	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	2 (WK 5)	2 (WK 8)	1 (WK2, WK6)	1 (WK 1,W K5, WK7)	-	-	-	-	1 (W K8)	2	3	-
CO3	3 (WK1, WK2, WK3, and WK4)	2 (WK1, WK2, WK3, and WK4)	3 (WK 5)	3 (WK 8)	3 (WK2, WK6)	-	-	-	-	-	2 (W K8)	2	3	1
CO4	3 (WK1, WK2, WK3, and WK4)	2 (WK1, WK2, WK3, and WK4)	3 (WK 5)	2 (WK 8)	1 (WK2, WK6)	2 (WK 1,W K5, WK7)	1 (W K9)	-	-	2	1 (W K8)	2	3	2

B. E. VII SEMESTER

Course Code		:	22UBT702C	DOWNSTREAM PROCESSING TECHNOLOGY	Semester	:	7
L:T:P		:	3:0:0		Course Type	:	PCC
Hours/Sem.	Teaching	:	42 Hrs.		CIE Marks	:	50
	Learning (TW+SL)	:	42 Hrs.		SEE Marks	:	50
	Exam	:	6 Hrs.		Total Marks	:	100
	Total Hrs.	:	90 Hrs.		Credits	:	3
Professional Competency:							
Ability to systematically isolate, purify, and formulate biological products from complex harvesting media by integrating physical, chemical, and analytical unit operations, while simultaneously optimizing process economics, structural stability, yield, and regulatory product safety.							
Course Objectives:							
After completion of the course, student will be able to:							
CO1: Analyze solid-liquid separation profiles and select mechanical clarification unit operations like filtration, sedimentation, or centrifugation.							
CO2: Apply membrane separation mechanics, precipitation protocols, and advanced extraction principles to achieve partial purification of target fractions.							
CO3: Design high-resolution purification strategies utilizing specific chromatography matrices, electrophoresis parameters, and analytical instrumentation footprints.							
CO4: Formulate end-stage product finishing and preservation lines combining evaporation, crystallization, and freeze-drying setups.							
UNIT-I					UNIT-I		
Scope and Importance of Bioseparations technology in biotechnology, Characteristics of bioproducts, Criteria for selection of bio-separation techniques. Economics of bio separations in biotechnology, cost-cutting strategies.							
Recovery of Intracellular Products: Cell disruption methods: physical methods (osmotic shock, grinding with abrasives, solid shear, liquid shear) – chemical methods (alkali, detergents) – enzymatic methods.							
Isolation of insolubles: Filtration, Sedimentation, Coagulation, Flocculation, and Centrifugation. Types of centrifuges and rotors, Differential, Density gradient (zonal and isopycnic).							
UNIT-II					UNIT-II		
Product Recovery or Partial Purification:							
Precipitation of Proteins, Nucleic acids, and Bioproducts by Ammonium Sulfate, Polyethylene Glycol, and Solvents;							
Membrane separation processes: Dialysis, Reverse osmosis, Electrodialysis, Pervaporation, Ultrafiltration;							
Extraction methods: Solid-liquid and liquid-liquid extraction methods, Advanced Extraction Methods like Ultrasound, Microwave-assisted, Supercritical fluid Extractions, Solid-phase Extraction (Adsorption).							
UNIT-III					UNIT-III		
Product Purification or Product Enrichment:							
Selective Separation Techniques: Aqueous Two-phase Extraction, Micellar and Reverse Micellar Extraction;							
Chromatographic separation and Electrophoresis methods: Principles of Chromatographic separation methods, Different types of chromatographic methods, Ion–exchange chromatography, Gel chromatography, Affinity chromatography. Principles of Electrophoresis and Electrophoresis mobility, applications.							
Application of analytical techniques: High-Performance Liquid Chromatography; Gas Chromatography; LC-MS; GC-MS; FTIR etc. used in bioprocess Industries.							
UNIT-IV					UNIT-IV		
Product Finishing:							
Product polishing and finishing: Crystallization, Drying (Tray, Freeze Drying, Spray Drying), Evaporation(Rotary Evaporator), Lyophilization, and Product stabilization.							
Reference Books:							
1. Bioseparations: Downstream Processing for Biotechnology: Authors: Paul A. Belter, E. L. Cussler, and Wei-							

Shou Hu (John Wiley & Sons).

2. Bioseparations Science and Engineering: Authors: Roger G. Harrison, Paul W. Todd, Scott R. Rudge, and Demetri P. Petrides (Oxford University Press).
3. Bioseparations: Principles and Techniques: Author: B. Sivasankar (PHI Learning).

Web links and Video Lectures (e-Resources)

1. **NPTEL:** Comprehensive Video Lecture Series (NPTEL / SWAYAM) Principles of Downstream Techniques in Bioprocess (IIT Madras) Instructor: Prof. Mukesh Doble
2. **NPTEL: Membrane Technology (IIT Guwahati)** Instructor: Prof. Kaustubha Mohanty
3. **NCBI Bookshelf** - Bioprocess and Separation Footprints

Course Outcomes:

Course Outcomes	Programme Outcomes											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	2 (W K5)	2 (WK 8)	2 (WK2, WK6)	1 (WK1, WK5, WK7)	-	-	-	-	1 (W K8)	2	3	-
CO2	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	2 (W K5)	2 (WK 8)	1 (WK2, WK6)	1 (WK1, WK5, WK7)	-	-	-	-	1 (W K8)	2	3	-
CO3	3 (WK1, WK2, WK3, and WK4)	2 (WK1, WK2, WK3, and WK4)	3 (W K5)	3 (WK 8)	3 (WK2, WK6)	-	-	-	-	-	2 (W K8)	2	3	1
CO4	3 (WK1, WK2, WK3, and WK4)	2 (WK1, WK2, WK3, and WK4)	3 (W K5)	2 (WK 8)	1 (WK2, WK6)	2 (WK1, WK5, WK7)	1 (W K9)	-	-	2	1 (W K8)	2	3	2

	Code	:	22UBT703H		Semester	:	7
	LTP	:	3:0:0		Course Type	:	HSMC
Hours/Sem.	Teaching	:	42 Hrs.	BIOENTREPRENEURSHIP DEVELOPMENT	CIE Marks	:	50
	Learning (TW+SL)	:	42 Hrs.		SEE Marks	:	50
	Exam	:	6 Hrs.		Total Marks	:	100
	Total Hrs.	:	90 Hrs.		Credits	:	3

Professional Competency:

Demonstrate the ability to understand entrepreneurial skills, market analysis, management functions, product and personnel management, material management, and preparation of project feasibility reports for successful venture creation and management.

Course Objectives:

After completion of the course, student will be able to:

CO1: Understand entrepreneur skill and to do market survey.

CO2: Understand entrepreneurship management functions.

CO3: Understand product and personal management in the entrepreneurial journey.

CO4: Understand the material management and to prepare project feasibility report

UNIT-I

10 Hrs.

ENTREPRENEUR & ENTREPRENEURSHIP: Definition, History, Concept, Characteristics, Need & Importance, types of entrepreneurship, Entrepreneurial process.

Soft Skills for entrepreneurs: Soft skills - Communicative skills, Creativity & Problem solving skills, & other managerial & leadership skills.

Business opportunity identification: Market survey tools, preparation of schedule and techniques of data collection. Production programme, plant capacity, manpower requirements and layout. Business plan format for micro and small enterprises. The financials of a project report.

UNIT-II

10 Hrs.

ENTREPRENEURSHIP MANAGEMENT AND ITS FUNCTIONS:

Principle functions of management: planning, organizing, staffing, coordinating & controlling. Concept of Authority & Responsibility. Social responsibilities of the management: to the owners, employees, customers, community & government.

Administration: Definition, Nature, Principles & Elements of management. Management VS administration.

UNIT-III

10 Hrs.

PRODUCTION MANAGEMENT:

Concept of productivity, measuring productivity, Productivity improvement techniques. Concept of budget, classifications of the budget, components of budget, effective budgetary control. Break even analysis. Manufacturing /material planning, factory planning. Systems of wage payments, bonus, automation. Organization of production planning.

PERSONNEL MANAGEMENT:

Elements of personnel management, role of personnel manager, functions of personnel management –man power planning, recruitment, employee selection & training of personnel.

Employer - Employee relationship. Settlement of disputes.

UNIT-IV

10 Hrs.

MATERIAL AND MARKETING MANAGEMENT :

Material Functions of purchasing & materials management, quality, quality standard & inspection, sources of supply, pricing, principles & practices, Inventory management (ABC analysis), product promotional strategy Entrepreneurship in Biobusiness: BioMedical field, Clinical research, Agriculture. Government schemes for commercialization of technology. Legal requirements

Entrepreneurship in India: Scope & opportunities in Biotechnology. Government schemes.

A case study on developing the financial scheme of a project report or business plan. Costing and pricing of products with one case study

Text Books:

1. O.P. Khanna - "Industrial Engineering & Management", Dhanpat Rai & Sons publications, 2006.

2. T. R. Banga & S. C. Sharma - "Industrial Engineering & Management Science", 6th. Edn, Khanna Publications, 2003

Reference Books:

1. Poornima Charanthimath – Entrepreneurship Development –small business enterprises, Pearson Education-2006
2. NSTEDB material for entrepreneurship development programme, EDI, Ahmadabad

Course Outcomes:

Course Outcomes	Programme Outcomes											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	1(WK1, WK2, WK3 andWK4)	1(WK1, WK2, WK3 andWK4)			1(WK2, andWK 6)			2		3	3(wk8)			
CO2	1(WK1, WK2, WK3 andWK4)				2(WK2, andWK 6)			1		3	3(wk8)			
CO3	1(WK1, WK2, WK3 andWK4)				2(WK2, andWK 6)			2		3	3(wk8)			
CO4	1(WK1, WK2, WK3 andWK4)	1(WK1, WK2, WK3 andWK4)			2(WK2, andWK 6)			1		3	3(wk8)			

	Code	:	22UHS711C	RESEARCH METHODOLOGY & INTELLECTUAL PROPERTY RIGHTS	Semester	:	7
	LTP	:	3:0:0		Course Type	:	HSS
Hours/Sem.	Teaching	:	42 Hrs		CIE Marks	:	50
	Learning (TW+SL)	:	42 Hrs		SEE Marks	:	50
	Exam	:	06 Hrs		Total Marks	:	100
	Total Hrs.	:	90		Credits	:	03
Professional Competency: Graduates will be able to prepare research projects and formulate the problems and do ethical and structured research and protect or convert that research into real-world value.							
Course Objectives: After completion of the course, student will be able to: CO1: Integrate research methodology in engineering sciences in relevant trades. CO2: Exhibit reflective thinking in problem solving exercises. CO3: Identify criteria to fit one's own intellectual work in particular form of IPRs and able to apply statutory provisions and procedure to protect different forms of IPRs at national and international level. CO4: Develop skill of making search using modern tools and techniques and also student is able to become patent agent by cracking patent agent exam.							
UNIT-I						12 Hrs.	
Introduction to Engineering Research Fundamentals of Research: Meaning, objectives, and motivation in engineering research. Types of Engineering Research: Basic, applied, and translational research; identifying and solving worthwhile problems. Research Ethics: Ethics in engineering research and practice, types of research misconduct, and ethical issues in authorship.							
UNIT-II						10 Hrs.	
Literature Review and Citations Technical Reading & Analysis: Methods for reviewing literature, analysing prior art, and synthesizing new and existing knowledge. Bibliographic Databases: Web of Science, Google, Google Scholar, effective search strategies. Conceptualizing Research: Critical and creative reading, taking notes, reading mathematical models, algorithms, and datasheets. Citations & Acknowledgments: Attribution, citation styles, impact of keywords, citing datasets, and knowledge dissemination.							
UNIT-III						10 Hrs.	
Intellectual Property Rights (IPR) & Patents: Introduction to Intellectual Property: Concepts of property and rights, forms of IPR, role in research and economic development, IP governance, and global innovation indicators. Patents: Definition, objectives, criteria for patentability, software/business method patents, infringement, compulsory licensing, and government use of inventions. Patent Process: Prior art search strategies, patent databases (free and paid), drafting specifications and claims, filing requirements, jurisdiction, opposition procedures, and renewal. Filing Requirement of patent: Patent Application Forms. Work flow chart in obtaining Patents, Jurisdiction of Filing Patent Application. Pre-grant & Post-grant Opposition. Forms to be submitted, filing mechanism through Individual patent office and PCT route. Need for a Patent Attorney/Agent Revocation. Term of Patent, Patent renewal and Fee Structure National Bodies Dealing with Patent Affairs. Utility Models							
UNIT-IV						10 Hrs.	
Copyrights and Related Rights: Classes of Copyrights. Criteria for Copyright. Ownership of Copyright. Copyrights of the Author. Copyright Infringements. Copyright Infringement and remedies in case of infringement. Fair Use Doctrine. Copyrights and Internet. Non-Copyright Work. Copyright Registration. Judicial Powers of the Registrar of Copyrights. Fee Structure. Validity of Copyright. Copyright Profile of India. Copyright and the word 'Publish'. Transfer of Copyrights to a Publisher. Copyrights and the Word 'Adaptation'. Copyrights and the Word							

'Indian Work'. Joint Authorship. Copyright Society. Copyright Board. Copyright Enforcement Advisory Council (CEAC). International Copyright Agreements, Conventions and Treaties. Interesting Copyrights Cases.

Trademarks: Eligibility Criteria. Who Can Apply for a Trademark. Acts and Laws. Classification of Trademarks. Registration of a Trademark. Process for Trademarks Registration. Prior Art Search. Validity of Trademark. Trademark Registry. Famous Case Law: Coca-Cola Company vs. Bisleri International Pvt. Ltd.

Industrial Designs: Eligibility Criteria. Acts and Laws to Govern Industrial Designs. Design Rights. Enforcement of Design Rights. Non-Protectable Industrial Designs India. Protection Term. Procedure for Registration of Industrial Designs. Prior Art Search. Application for Registration. Duration of the Registration of a Design. Importance of Design Registration. Cancellation of the Registered Design. Application Forms. Classification of Industrial Designs. Designs Registration Trend in India. International Treaties. Famous Case Law: Apple Inc. vs. Samsung Electronics Co.

Geographical Indications: Acts, Laws and Rules Pertaining to GI. Ownership of GI. Rights Granted to the Holders. Registered GI in India. Identification of Registered GI. Classes of GI. Non-Registerable GI. Protection of GI. Collective or Certification Marks. Enforcement of GI Rights. Procedure for GI Registration Documents Required for GI Registration. GI Ecosystem in India.

Case Studies on Patents. Case study of Curcuma (Turmeric) Patent, Case study of Neem Patent, Case study of Basmati patent. **IP Organizations In India. Schemes and Programmes.**

Text Books:

1. N.R. Subbaram. S. Viswanathan, (2008). "Hand book Indian Patent Law and, Practice" Printers and publishers Pvt., Ltd,
2. Dr. Nejakar Santosh M, Dr. Bendigeri Harish (2023-24) "Research Methodology and Intellectual Property Rights", ISBN 978-93-5987-928-4,
3. Thiel David V. "Research Methods for Engineers" Cambridge University Press,
4. Acharya N.K Intellectual Property Rights. 6th Edition, Asia Law House.

Reference Books:

9. P. Naryan, (2007). "Intellectual Property Law", 3rd Ed, Eastern Law House,
10. Dr. Myneni S.R., (2019) "Law of Intellectual Property", 9th edition, Asia law House,.
11. Dr. Reddy G.B, (2020) "Intellectual Property Rights and Law", Reprint edition, Gogia Law Agency. Hyderabad.
12. Cornish, "Intellectual Property Rights", Universal publications.
13. Dr. B. L. Wadehra, "Law Relating to Intellectual Property" 5th edition, Universal Law publishing Co, Delhi.
14. SWAYAM / NPTL/ MOOCS/ We blinks/ Internet sources/ YouTube videos and other materials / notes

Course Outcomes:

Course Outcomes	Programme Outcomes									Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	1	2	3
CO1	-	2 +(WK1, WK2, WK3, and WK4)	2 WK5	3 WK8	2 WK2 & WK6	1 WK1, WK5 & WK7	2 WK9	3	-	1	2 WK8	3
CO2	-	3 (WK1, WK2, WK3, and WK4)	2 WK5	3 WK8	-	2 WK1, WK5 & WK7	2 WK9	2	-	-	2 WK8	2
CO3	-	-	-	-	2 WK2 & WK6	3 WK1, WK5 & WK7	2 WK9	3	-	1	3 WK8	1
CO4	-	-	-	2 WK8	3 WK2 & WK6	2 WK1, WK5 & WK7	-	1	-	1	-	1

Course Code		:	22UBT732E	FOOD PROCESSING TECHNOLOGY	Semester	:	7
L:T:P		:	3: 0:0		Course Type	:	PEC
Hours/Sem.	Teaching	:	42 Hrs.		CIE Marks	:	50
	Learning (TW+SL)	:	42 Hrs.		SEE Marks	:	50
	Exam	:	6 Hrs.		Total Marks	:	100
	Total Hrs.	:	90 Hrs.		Credits	:	3

Professional Competency:

Ability to analyze food composition, quality, safety, spoilage, preservation, processing, packaging, and product development while applying food engineering principles and adhering to professional, ethical, regulatory, and sustainability requirements in the food industry.

Course Outcomes:

After completion of the course, student will be able to:

CO1: Analyze the basic constituents and importance various nutrients in food

CO2: Examine the techniques involved in detection of microbes in food industry, and analyse the steps in food production

CO3: Differentiate the microbes causing food spoilage and exhibit the preservation techniques and to know the Characteristics of food industry and scope

CO4: Apply the concepts of food Engineering and food waste management

UNIT-I

10 Hrs.

Introduction

Constituents of food, soluble fibres, protein rich foods, popular fats and oils in foods, Food flavors, Browning reactions and its effects. Intrinsic and extrinsic parameters of foods, effect of inhibitors, pH and temperature. Minerals in foods. Aroma compounds in foods. Food additives, Vitamins, aminoacids, Sweeteners, Food colours. Toxic-trace elements in food.

UNIT-II

12 Hrs.

Detection of Microorganisms

Culture, Microscopic and Sampling Methods, Conventional; SPC, Membrane Filters, Microscope colony Counts, Agar Droplets, Dry Films, Most probable Numbers (MPN), Dye reduction, Roll Tubes, Direct, Microscopic Count (DMC), Microbiological Examination of surfaces, Air Sampling, Metabolically Injured Organisms, Enumeration and Detection of Food-borne Organisms. Dairy products: Composition of milk, Sterilization of milk (Pasteurization and UHT), Cheese production, Acidophilus milk Yoghurt, Kumiss and Kefir. Marketingscopeofdairy&foodproductsFruitandvegetableprocessing:Jam,jelly,Juice, squash, wine, pickles and sauerkraut

UNIT-III

10 Hrs.

Food Spoilage & Preservation

The Role and Significance of Microorganisms, Primary Sources of Microorganisms found in Foods Synopsis of common borne bacteria, Molds& Yeasts. Microbial Spoilage of Vegetables, Fruits, Fresh and Processed Meats, Poultry, and Seafood. Spoilage of Miscellaneous Foods, Food Preservation: Principles Underlying in spoilage and preservation, Application, Effect and Legal Status of Food Irradiation, Food Preservation with Low Temperatures, High Temperatures and Drying. Food Industry: Characteristics of Food Industry. Nutritional food supplements. Food packaging, New trends in packing, edible films. Factors influencing food product development, marketing and promotional strategies, Risks and benefits of food industry

UNIT-IV

10 Hrs.

Food Engineering

Properties of fluid foods, Measurement of rheological parameters .Thermal properties of frozen foods. Food freezing equipment, storage of frozen foods. Food dehydration: Freeze Dehydration Calculation of drying times. Food waste management

Text Books:

1. Food Science & Nutrition, by Sunetra Roady, Oxford University Press, 2007.
2. Food microbiology byWilliam Frazier and Westhoff D.C,4thEdn,TATAMcGrawHill Pub(2005)

3. Modern Food Micro-Biology by James M.Jay,CBS Publishers.2005.														
Reference Books:														
1. Food Microbiology by K.Vijay Ramesh M J P Publishers, 2007.														
2. Plant biotechnology In Agriculture by K.Lindsey and M.G.K.Jones ,Prentice														
Course Outcomes:														
Course Outcomes	Programme Outcomes											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	2(WK 1, WK2, andWK K4)	“ “	2(WK 5)	“ “ “	“ “	3 (WK1, WK5 and WK7)	1(W K9)	“ “	“ “	“ “	3(W K8)	2	2	3
CO2	2(WK 1, WK2, andWK K4)	“ “	2(WK 5)	“ “	3 (W K6)	1 (WK1, WK5 and WK7)	1(W K9)	“ “	1 “	“ “	2(W K8)	2	3	3
CO3	2(WK 1, WK2, andWK K4)	1{ WK2, WK3, and WK4)	1(WK 5)	“ “	3 (W K6)	1 (WK1, WK5 and WK7)	2 (W K9)	“ “	1 “	“ “	1(W K8)	2	2	3
CO4	2(W K1, WK 2, and WK 4)	23(W K2, WK3, and WK4)	2 (W K5)	“ “	2 (W K 6)	1 (WK1 , WK5 and WK7)	2 (W K 9)	“ “	1 “	“ “	2(W K8)	2	1	3

Course Code		:	22UBT733E	BIOSIMULATIONS	Semester	:	7
L:T:P		:	3:0:0		Course Type	:	PEC
Hours/Sem.	Teaching	:	42 Hrs		CIE Marks	:	50
	Learning (TW+SL)	:	42 Hrs		SEE Marks	:	50
	Exam	:	06 Hrs		Total Marks	:	100
	Total Hrs.	:	90 Hrs		Credits	:	3

Professional Competency:

Develop the knowledge and skills to apply biotechnological principles, molecular techniques, and bioprocess technologies for the development, production, quality evaluation, and regulatory compliance of biopharmaceutical products while adhering to ethical and biosafety standards.

Course Outcomes:

After completion of the course, student will be able to:

CO1: Explain the principles of mathematical modeling and apply fundamental conservation laws, transport equations, and reaction kinetics to biological and biochemical systems.

CO2: Develop and analyze mathematical models for biochemical engineering processes including batch, continuous, and continuous stirred tank reactor (CSTR) systems.

CO3: Apply bioprocess simulation software such as SuperPro Designer, COPASI, and COBRA to perform material, energy, and metabolic flux balance analyses.

CO4: Use MATLAB and SIMULINK to analyze experimental data, solve engineering problems numerically, and simulate dynamic biochemical systems.

UNIT-I

10 Hrs.

Modelling Principles: Basic modeling principles, uses of mathematical modeling classification of modeling techniques Fundamental laws, energy equations, continuity equation, equations of motion, transport equations, equations of state, equilibrium states and chemical kinetics-examples.

UNIT-II

11 Hrs.

Mathematical Models for Biochemical Engineering Systems: Mathematical models for Biochemical engineering systems, Mathematical models in batch and continuous process, continuous flow tanks, reversible reaction., storage and stability of biotech products. Short study of current biotech products. Adverse drug reactions.

UNIT-III

11 Hrs.

Simulation Softwares in Bioprocess: Introduction to SuperPro Designer for Material balance, Software for mass and energy balance; Energy Balance with and without reaction. Metabolic Flux Balance Analysis: Introduction, Principle of steady state metabolic flux balance analysis, COPASI, COBRA

UNIT-IV

10 Hrs.

Matlab and Simulink: MATLAB for data analysis Basics, Data analysis, curve fittings, Numerical integration, Euler and fourth order RungeKutta method, Simulation of gravity flow tank, SIMULINK for dynamic systems.

Text Books:

1. Luben W.L. "Process Modelling Simulation and Control for Chemical Engineers", McGrawHill, International New York, 1990.
2. Franks RGE. "Mathematical Modeling in Chemical Engineering", John Wiley and Sons, Inc., New York, 2004.

Reference Books:

1. Biquette W.B. "Process Dynamics- Modeling analysis with simulation", Prentice Hall; 1 edition January 15, 1998.
2. William J. Palm. "Introduction to Matlab 7 for Engineers", III, McGraw Hill 2005.
3. Kenneth J. Beers. "Numerical Methods for Chemical Engineering Applications in MATLAB", Massachusetts Institute of Technology, Cambridge University press 2007 edition

Course Outcomes	Programme Outcomes											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3

CO1	3(WK1, WK2,W K3 WK4)	2(WK1, WK2,W K3 WK4)	-	1(WK 8)	-	-	-	-	-	-	1(W K8)	1	2	2
CO2	3(WK1, WK2,W K3 WK4)	3(WK1, WK2,W K3 WK4)	2(W K5)	2(WK 8)	1(W K6)	-	-	-	-	-	1(W K8)	1	2	2
CO3	2(WK1, WK2,W K3 WK4)	3(WK1, WK2,W K3 WK4)	22(WK5)	3(WK 8)	3(W K6)	-	-	-	1	-	1(W K8)	2	2	2
CO4	2(WK1, WK2,W K3 WK4)	3(WK1, WK2,W K3 WK4)	22(WK5)	3(WK 8)	3(W K6)	-	-	-	1	1	1(W K8)	2	2	2

Course Code		:	22UBT734E	BIOANALYTICAL TECHNIQUES	Semester	:	7
L:T:P		:	3:0:0		Course Type	:	PEC
Hours/Sem.	Teaching	:	42 Hrs.		CIE Marks	:	50
	Learning (TW+SL)	:	42 Hrs.		SEE Marks	:	50
	Exam	:	6 Hrs.		Total Marks	:	100
	Total Hrs.	:	90 Hrs.		Credits	:	3

Professional Competency:

Ability to strategically select, operate, and interpret data from a comprehensive suite of advanced analytical instruments (spectroscopic, chromatographic, electrophoretic, and crystallographic) to isolate, quantify, and deduce the precise structural and functional conformations of complex biological macromolecules.

Course Outcomes:

After completion of the course, student will be able to:

CO1: Optical Spectroscopy & Centrifugation: Apply the principles of preparatory/analytical centrifugation to isolate cell fractions, and utilize UV-Visible and Fluorescence spectroscopy to quantify biomolecule concentrations and probe protein binding sites.

CO2: Advanced Structural Spectroscopy & Spectrometry: Interpret analytical data from advanced spectroscopic instruments (FTIR, ORD/CD, NMR) and mass spectrometers (LC-MS, GC-MS) to elucidate the molecular mass, functional groups, and 3D conformations of biological macromolecules.

CO3: Chromatographic Separations: Evaluate and select appropriate chromatographic techniques (Gel Filtration, Ion-Exchange, Affinity, GC, and HPLC) to design high-resolution purification strategies and estimate the molecular weight of target bioproducts.

CO4: High-Resolution Electrophoresis & Crystallography: Resolve complex proteomic and genomic mixtures using advanced electrophoretic systems (2D-PAGE, Capillary, PFGE), and determine the atomic-level structural coordinates of biological crystals using X-ray diffraction mechanics.

UNIT-I

10 Hrs.

Centrifugation

Introduction: Basic, Types of centrifuges: Desktop, High Speed and Ultracentrifuge (Preparatory and Analytical), Design and their working principle, Types of Rotors, Wall-effect

Spectroscopy :

(i) Absorption Spectroscopy

Simple theory of absorption of light by molecules, Chromophore and terminologies associated with absorption of molecules

The Beer-Lambert Law and its deviations

Single and double beam spectrophotometers for measuring Visible and Ultraviolet light: Instrumentation and Parameters measured in absorption Spectroscopy (UV-Vis spectrophotometer)

Empirical rule for the absorption spectra of biological macromolecules

Chemical Analysis by absorption spectroscopy using Visible and Ultraviolet light

(ii) Fluorescence Spectroscopy

Simple theory of Fluorescence

Instrumentation and Technology of Fluorescence Spectroscopy (Fluorescence spectrometer) Intrinsic Fluorescence measurements for information about the conformation and binding sites of proteins

Extrinsic fluorescence measurements for information about the conformation and binding sites of proteins

UNIT-II

10 Hrs.

(iii) Infrared Spectroscopy

Infrared Spectroscopy: Basic Principle Instrumentation and Technology of Infrared Spectroscopy (Fourier-transform infrared spectroscopy (FTIR)) Information in Infrared Spectra and Applications of Infrared spectroscopy

(iv) Optical Rotatory Dispersion (ORD) & Circular Dichroism (CD)

Theory of Optical Rotatory Dispersion (ORD) & Circular Dichroism (CD) Relative values of ORD and CD measurements, Advantages of CD over ORD Instrumentation for measuring ORD and CD, Applications of ORD and CD

(v) Nuclear Magnetic Resonance (NMR) Spectroscopy Nuclear Magnetic Resonance (NMR) Spectroscopy : Principle Basic Instrumentation of NMR Spectrometer Applications of NMR Spectroscopy (vi) Mass spectrometry Mass spectrometry: Basic Principle Instrumentation and main components of mass spectrometers Ionization source, Mass analyzers, and Detectors (LC-MS and GC-MS) Applications of Mass Spectrometry	
UNIT-III	10 Hrs.
Chromatography Adsorption Chromatography: Simple Theory & Types Operations of columns : Terminologies and concept Elution : Types of elution methods Supports : Concept of mesh size and mesh screen Gas Chromatography: Principle, Basic set up of Gas chromatography system, Detectors and Uses of Gas chromatography Gel Chromatography (molecular-sieve chromatography): Simple Theory, Materials (dextran, agarose and polyacrylamide gels), Advantages of gel chromatography, Estimation of molecular weight and applications of gel chromatography Ion-Exchange Chromatography: Principle, Properties of Ion Exchangers, Choice of Ion Exchangers, Technique and application of Ion Exchange chromatography. High-Performance of Liquid Chromatography (HPLC): Principle, Application of pressure in HPLC, Advantages and uses of HPLC. Affinity Chromatography: Principle, Methods of Ligand immobilization (Cyanogen-bromide-activated agarose, Aminoethyl- and hydrazide-activated polyacrylamide), uses of affinity chromatography	
UNIT-IV	10 Hrs.
Iso-electric focusing (IEF): Principle, Technique and application, 2-D PAGE: Steps involved in 2-D PAGE, application in proteomics Pulse-field gel electrophoresis: Principle, Technique and Application Capillary electrophoresis: Principle, Technique and Application X-ray crystallography Interaction of X-ray with matter: Absorption, Scattering and diffraction (Bragg' s Law) Preparation of crystals : Hanging and sitting drop vapor diffusion methods X-ray diffraction methods Application of X-ray Diffraction in Crystal structure	
Reference Books:	
1. Principles and Techniques of Biochemistry and Molecular Biology: Authors: Keith Wilson and John Walker (Cambridge University Press). 2. Biophysical Chemistry (Principles and Techniques): Authors: Avinash Upadhyay, Kakoli Upadhyay, and Nirmalendu Nath (Himalaya Publishing House). 3. Physical Biochemistry: Principles and Applications: Author: David Sheehan (John Wiley & Sons).	
Web links and Video Lectures (e-Resources)	
1. NPTEL: Bioanalytical Techniques and Bioinformatics (IIT Guwahati): Instructors: Dr. Nitin Chaudhary and Dr. Vishal Trivedi 2. NPTEL: Biophysical Chemistry (IIT Delhi): Instructor: Prof. Pramit Kumar Chowdhury 3. Practical Industry Portals & Toolsets: Agilent Technologies & Waters Corporation Analytical Repositories	

Course Outcomes	Programme Outcomes											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	2 (WK5)	2 (WK8)	2 (WK2, WK6)	1 (WK1, WK5, WK7)	-	-	-	-	1 (WK8)	2	3	-
CO2	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	2 (WK5)	2 (WK8)	1 (WK2, WK6)	1 (WK1, WK5, WK7)	-	-	-	-	1 (WK8)	2	3	-
CO3	3 (WK1, WK2, WK3, and WK4)	2 (WK1, WK2, WK3, and WK4)	3 (WK5)	3 (WK8)	3 (WK2, WK6)	-	-	-	-	-	2 (WK8)	2	3	1
CO4	3 (WK1, WK2, WK3, and WK4)	2 (WK1, WK2, WK3, and WK4)	3 (WK5)	2 (WK8)	1 (WK2, WK6)	2 (WK1, WK5, WK7)	1 (WK9)	-	-	2	1 (WK8)	2	3	2

Course Code		:	22UBT735E	INDUSTRIAL BIOTECHNOLOGY	Semester	:	7
L:T:P		:	3: 0:0		Course Type	:	PEC
Hours/Sem.	Teaching	:	42 Hrs.		CIE Marks	:	50
	Learning (TW+SL)	:	42 Hrs.		SEE Marks	:	50
	Exam	:	6 Hrs.		Total Marks	:	100
	Total Hrs.	:	90 Hrs.		Credits	:	3

Professional Competency:

Demonstrate the ability to understand, analyze, and apply industrial bioprocess principles for the production of primary metabolites, secondary metabolites, industrial enzymes, microbial products, and recombinant biopharmaceuticals for applications in healthcare, agriculture, food, and industrial biotechnology sectors.

Course Outcomes:

After completion of the course, student will be able to:

CO1: Explain the principles of industrial biotechnology, fermentation processes, microorganisms used in industry, and modes of bioprocess operation.

CO2: Analyze the production processes and industrial applications of primary metabolites including organic acids, amino acids, and alcohols.

CO3: Evaluate the production and applications of secondary metabolites, industrial enzymes, and microbial bioproducts such as biofertilizers, biopesticides, biopolymers, and SCP.

CO4: Analyze the production and applications of modern biotechnology products including recombinant proteins, vaccines, and monoclonal antibodies.

UNIT-I

10 Hrs.

Introduction to Industrial Bioprocess: Biotechnology: Scope and importance, Commercial potential of Biotechnology in India. Historical overview of industrial fermentation process -traditional and modern Biotechnology. Industrial Fermentation- microorganisms, mode of operation, fermentation processes-pictorial representation.

UNIT-II

10 Hrs.

Production of Primary Metabolites: A brief outline of processes for the production of some commercially important organic acids (citric acid, lactic acid & acetic acid); amino acids (glutamic acid & tryptophan) and alcohols (ethanol & butanol)

UNIT-III

12 Hrs.

Production of Secondary Metabolites: Production processes for various classes of secondary metabolites: antibiotics (penicillin streptomycin & erythromycin), vitamins (Vit B12 and Vit B2) and steroid biotransformation.

Production of Enzymes and Other Bioproducts: Production of industrial enzymes (proteases & amylases), Production of biopesticide, Biofertilizers, bio-preservative (Nisin), biopolymers (xanthan gum & PHB), cheese, SCP.

UNIT-IV

10 Hrs.

Production of Modern Biotechnology Products: Production of recombinant proteins having therapeutic and diagnostic applications (insulin, human growth hormone), Production of recombinant vaccines (Hepatitis B vaccine, cholera vaccine), production of monoclonal antibodies

Text Books:

1. Lee, S.Y., Nielsen, J. and Stephanopoulos, G., Industrial Biotechnology: Products and Processes, John Wiley & Sons, 2016
2. Waites, M.J., Morgan, N.L., Rockey, J.S., Higon, G., Industrial Microbiology: An Introduction Blackwell, 2001
3. Cruger, W., Cruger, A., A Textbook of Industrial Microbiology, Panima Publishing Corporation, 2nd Edition, 2005
4. Stanbury, P.F., A. Whitaker and S.J. Hall, Principles of Fermentation Technology, Butterworth – Heinemann (an imprint of Elsevier), 1995, 2nd Edition
5. James D. Watson, Richard M. Myers, Amy A. Caudy, and Jan A. Witkowski, Recombinant DNA: Genes and Genomes: A Short Course - W. H. Freeman. 2007

Reference Books:

1. Prescott, S.C. and Cecil G. Dunn, Industrial Microbiology, Agrobios (India), 2005
2. Moo-Young, Murrey, Comprehensive Biotechnology, 4 Vols. Pergamon Press, (An Imprint of Elsevier), 2004
3. C. F. A Bryce and EL. Mansi, Fermentation microbiology & Biotechnology, 1999
4. K. G. Ramawat and Shaily Goyal, Comprehensive Biotechnology, 2009

Course Outcomes	Programme Outcomes											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3(WK1, WK2, WK3 andWK4)	2(WK1, WK2,WK3 andWK4)	1(WK5)	1(WK8)	""	1(WK1, WK53 andW K7)	""	""	""	""	2(WK8)	1	2	1
CO2	3(WK1, WK2,WK3 andWK4)	3(WK1, WK2,WK3 andWK4)	2(WK5)	2(WK8)	1	1(WK1, WK53 andW K7)	1(WK9)	""	""	""	2(WK8)	1	2	2
CO3	3(WK1, WK2,WK3 andWK4)	3(WK1, WK2,WK3 andWK4)	2(WK5)	3(WK8)	2	2(WK1, WK53 andW K7)	2(WK9)	1	1	""	2(WK8)	1	2	1
CO4	3(WK1, WK2,WK3 andWK4)	3(WK1, WK2,WK3 andWK4)	2(wk5)	2(WK8)	3	2(WK1, WK53 andW K7)	1(WK9)	1	1	1	2(WK8)	1	2	2

Course Code		:	22UBT741E	NANOBIOTECHNOLOGY AND BIOMATERIALS	Semester	:	7
L:T:P		:	3:0:0		Course Type	:	PEC
Hours/Sem.	Teaching	:	42 Hrs.		CIE Marks	:	50
	Learning (TW+SL)	:	42 Hrs.		SEE Marks	:	50
	Exam	:	6 Hrs.		Total Marks	:	100
	Total Hrs.	:	90 Hrs.		Credits	:	3
Professional Competency:							
To work professionally in nanobiotechnology & biomaterials sectors as there will be an intersection of biology, nanotechnology, materials science, and engineering techniques.							
Course Outcomes:							
After completion of the course, student will be able to:							
CO1: Ability to explain the characterization techniques and to understand the importance of nano-particles in drug delivery system.							
CO2: Ability to understand the importance of biopolymers.							
CO3: Ability to differentiate biopolymer and synthetic polymer.							
CO4: Ability to understand the importance of biocompatibility and apply the methods to test the implants and use in medical devices.							
UNIT-I						12 Hrs.	
Introduction to nanotechnology:							
A Brief History of the Nano particles: Bottom-Up versus Top-Down; What Is Nanobiotechnology. Discussions on nanofabrication, nanolithography, nanotubes, buckyballs, structure-property relationships in materials, materials characterization techniques, scanning electron, scanning tunneling and atomic force microscopy (SEM, STM & AFM), biomolecule-surface interactions, quantum dots,							
Applications of nanotechnology in the life sciences:							
Buckyballs and Buckytubes, Diagnostics and Sensors, Drug Delivery Revenues Health Risks and Challenge.							
UNIT-II						10 Hrs.	
Biopolymers:							
Polymers as biomaterials, microstructure, mechanical properties – effects of environment on elastic moduli, sterilization and disinfections of polymeric materials. Biocompatibility of polymers, chemically modified glycosaminoglycans, heparin like substances from non glycosaminoglycan polysaccharides and microbial glycosaminoglycan, surface immobilized heparins.							
UNIT-III						10 Hrs.	
Synthetic polymers:							
Polymers in biomedical use, polyethylene and polypropylene, perfluorinated polymers, acrylic polymers, hydrogels, polyurethanes, polyamides, biodegradable synthetic polymers, silicone rubber, plasma polymerization, micro-organisms in polymeric implants, polymer sterilization.							
UNIT-IV						10 Hrs.	
Biocompatibility:							
Definition, Wound healing process-bone healing, tendon healing. Material response: Function and Degradation of materials in vivo. Host response: Tissue response to biomaterials. Testing of implants: Methods of test for biological performance-In vitro and In vivo implant tests methods.							
Medical devices:							
Polyurethane elastomers, applications of polymers in medicine and surgery. Skin graft polymers, Properties of implant materials, metals and alloys.							

Text Books:														
1. B.Vishwanath (2011). "Nano Materials" Published by Narosa Publishing House Pvt. Ltd., New Delh. 2. Mark Ratner and Daniel Ratner (2003). "Nanotechnology: A Gentle Introduction to Next Gig Idea" Pearson Education Ltd.														
Reference Books:														
1. K Eric Drexler (1993). "Unbounding the future" Quill. 2. Stephen Lee and Lynn M Savage (2010). "Biological molecules in Nanotechnology".														
Web links and Video Lectures (e-Resources)														
Course Outcomes	Programme Outcomes											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3 (WK1, WK2, WK3 and WK4)	2 (WK1 WK2 WK3 and WK4)	3 (WK5)	-	3 (WK2 and WK6)	-	3 (WK 9)	-	-	-	3 (WK8)	3	3	3
CO2	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3 and WK4)	3 (WK5)	-	3 (WK2 and WK6)	-	3 (WK 9)	-	-	-	3 (WK8)	3	3	3
CO3	2 (WK1 WK2, WK3and WK4)	3 (WK1, WK2, WK3 and WK4)	3 (WK5)	-	3 (WK2 and WK6)	-	3 (WK 9)	-	-	-	3 (WK8)	3	3	3
CO4	3 (WK1, WK2, WK3 and WK4)	3 (WK1, WK2, WK3 and WK4)	3 (WK5)	-	3 (WK2 and WK6)	-	3 (WK 9)	-	-	-	3 (WK8)	3	3	3

Course Code		:	22UBT742E	FOOD PRODUCT DEVELOPMENT	Semester	:	7
L:T:P		:	3:0:0		Course Type	:	PEC
Hours/Sem.	Teaching	:	42 Hrs.		CIE Marks	:	50
	Learning (TW+SL)	:	42 Hrs.		SEE Marks	:	50
	Exam	:	6 Hrs.		Total Marks	:	100
	Total Hrs.	:	90 Hrs.		Credits	:	3

Professional Competency:

Develop innovative, safe, and market-oriented food products by applying principles of food formulation, processing, quality assurance, regulatory compliance, and commercialization while demonstrating professional and entrepreneurial skills.

Course Outcomes:

After completion of the course, student will be able to:

CO1: Demonstrate the principles, stages, regulations, and market aspects involved in food product development.

CO2: Apply formulation, processing, packaging, and quality assurance principles for developing safe and high-quality food products.

CO3: Evaluate food products using sensory, nutritional, physicochemical, and microbiological quality assessment techniques, and prepare technical documentation.

CO4: Apply the concepts of functional food development, product commercialization, entrepreneurship, and industrial scale-up to develop innovative food products.

UNIT-I

12 Hrs.

INTRODUCTION TO FOOD PRODUCT DEVELOPMENT

Food industry trends and market opportunities , Consumer needs and market research, Product development processes : Idea generation, screening, concept development, prototype development, commercialization ,Product life cycle ,Competitor analysis and benchmarking, Intellectual Property Rights (IPR) in food products ,Food regulations and labeling requirements Food standards (FSSAI, Codex Alimentarius) The product development process, privacy policies and Knowledge of basic laboratory procedures, Standard Operating Procedure (SOPs), process flows in manufacturing, product life cycle and competitor studies.

UNIT-II

10 Hrs.

FOOD FORMULATION AND PROCESSING

Selection of raw materials and ingredients, Functional properties of food ingredients, Product formulation techniques, Standardization of recipes, Processing methods for food products, Product optimization, Food packaging materials and technologies, Shelf-life studies and storage conditions Quality assurance and Good Manufacturing Practices (GMP)

UNIT-III

10 Hrs.

FOOD FORMULATION AND PROCESSING SELECTION OF RAW MATERIALS AND INGREDIENTS

Functional properties of food ingredients, Product formulation techniques, Standardization of recipes Processing methods for food products, Product optimization, Food packaging materials and technologies ,Shelf-life studies and storage conditions, Quality assurance and Good Manufacturing Practices (GMP)

UNIT-IV

10 Hrs.

FUNCTIONAL FOODS AND PRODUCT COMMERCIALIZATION

Functional foods and nutraceuticals, Probiotics and prebiotics, Fortified foods, Sports nutrition products, Geriatric and pediatric foods, Plant-based and alternative protein products, Product branding and marketing, Entrepreneurship in food product development, Scale-up from laboratory to pilot plant, Case studies on successful food product innovations.

Text Books:

1. Food Science & Nutrition, by Sunetra Roady, Oxford University Press, 2007.
2. FoodmicrobiologybyWilliamFrazierandWesthoffD.C,4thEdn,TATAMcGrawHill Pub(2005)

Reference Books:

1. Modern Food Micro-Biology by James M.Jay, CBS Publishers. 2005.
2. Food Microbiology by K. Vijay Ramesh M J P Publishers, 2007.

Web links and Video Lectures (e-Resources)

1. https://www.coursera.org/?utm_sourceWEB
2. https://swayam.gov.in/?utm_source
3. https://nptel.ac.in/?utm_source

Course Outcomes	Programme Outcomes											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3 (WK1, WK2, WK3 WK4)	2 (WK1, WK2,W K3 WK4)	1 (W K5)	-	-	1 (WK1WK5 , and WK7)	1(W K9)	-	1	-	2 (W K8)	2	3	2
CO2	3 (WK1, WK2, WK3 WK4)	3 (WK1, WK2,W K3 WK4)	3 (W K5)	2(WK 8)	2 (WK 2 and WK6)	3 (WK1,WK 5, and WK7)	1(W K9)	1	1	1	2 (W K8)	2	3	2
CO3	2 (WK1, WK2, WK3 WK4)	3 (WK1, WK2,W K3 WK4)	2 (W K5)	3(WK 8)	3 WK2 and WK6)	3 (WK1,WK 5, and WK7)	1(W K9)	2	3	1	2 (W K8)	2	3	3
CO4	2 (WK1, WK2, WK3 WK4)	2 (WK1, WK2,W K3 WK4)	3 (W K5)	2(WK 8)	2 WK2 and WK6)	3 (WK1WK5 , and WK7)	2(W K9)	2	2	3	3 (W K8)	2	3	3

Course Code		:	22UBT743E	CLINICAL RESEARCH	Semester	:	7
L:T:P		:	3:0:0		Course Type	:	PEC
Hours/Sem.	Teaching	:	42 Hrs.		CIE Marks	:	50
	Learning (TW+SL)	:	42 Hrs.		SEE Marks	:	50
	Exam	:	6 Hrs.		Total Marks	:	100
	Total Hrs.	:	90 Hrs.		Credits	:	3

Professional Competency:

Demonstrate the ability to understand therapeutic products, Analyze pharmaceutical marketing strategies, Apply principles of pharmaceutical research, drug regulation and epidemiological principles and interpret study designs.

Course Outcomes:

After completion of the course, student will be able to:

1. Exploit the knowledge to know the clinical importance of different therapeutic products and identify formulations, manufacturing and supply of materials
2. Study the philosophy behind organization of research Ability to understand control measures used in drug and its control.
3. Elucidate the marketing strategies of pharma products and compare the social and ethical issues.
4. Inculcate the epidemiology study designs, case reports and case series

UNIT-I

12 Hrs.

INTRODUCTION

The philosophy behind organization of research. Disease target identification and selection. Patenting new active substances. Receptor-based approaches, agonists, antagonists, enzyme inhibitors. Lead optimization and candidate selection of molecules for exploratory human investigation. In vitro and In vivo testing of new compounds Relationship between animal and human pharmacology.

CLINICAL PHARMACOLOGY

Pre-clinical development to support testing in humans. Safety testing, Pharmaceutical development - formulations, manufacture and supply of materials, labeling and presentation, stability and storage, purity, compatibility, disposal; Concepts of Pharmacovigilance

UNIT-II

10 Hrs.

THERAPEUTICS

Clinical importance of Therapeutic Proteins, Antibodies, Enzymes; Hormones and Growth Factors, Interferon's, Interleukins and Additional Regulatory Factors.

MANAGEMENT OF DRUGS

Management of common acute and chronic diseases. Major drug classes including biologicals. Measurement of drug effects Adverse drug reactions (short term & long term). Benefit and risk, Drug interactions; Prescribing for particular populations . Controlled drugs and drug dependence, Over dosage and treatment of poisoning. Patient compliance and information, Therapeutic Drug Monitoring.

UNIT-III

10 Hrs.

HEALTHCARE MARKETPLACE

National and local formularies. Product information (Generic v/s Rx), advertising and claims Product support and promotion Product life-cycle management Product liability Codes of practice including the MHRA Blue Principles of health economics Pharmacoepidemiology Competition, in-licensing, co-marketing.

SOCIAL, ETHICAL ISSUES

patents and copyrights. Social-genetic discrimination: insurance and employment, human cloning, foeticide, sex determination. Ethical: somatic and germ line gene therapy, clinical trials, the right to information, ethics committee function. Preservation and clinical use of blood and blood components.

UNIT-IV												10 Hrs.		
CLINICAL RESEARCH														
Types of Epidemiology study designs, ecological (correlation) studies, Case reports and case series, prevalence surveys or cross-sectional studies, case control studies, Clinical Trials, Small Clinical Trials, Placebo Responses in Clinical Trials, Large Clinical Trials and Registries – Clinical Research Institutes, Data Management in Clinical Research : General Principles and Guide to Sources, Clinical Research from Pharmaceutical Industry Perspective.														
Text Books:														
1. Gary Walsh., Biochemistry and Biotechnology, 2002, John Wiley & Sons Ltd. 2. Gallin and . J. I. Ognibene F. P, 2007 Principles and Practice of Clinical Research by, 2nd Edition, Elsevier Publication														
Reference Books:														
1. William J. Williams, Ernest Beutler, Allan JU. Erslev, Marshall A. Lichtman,2005, Hematology 2. John Wiley & Sons Ltd by Arunabha Ray & Kavitha Gulati, 2007,Current Trends in Pharmacology IK Intl.														
Web links and Video Lectures (e-Resources)														
Course Outcomes	Programme Outcomes											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	1 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	3 (WK5)	-	2 (WK2 and WK6)	-	2 (WK9)	1	-	-	2 (WK8)	2	2	1
CO2	1 (WK1, WK2, WK3, and WK4)	2 (WK1, WK2, WK3, and WK4)	3 (WK5)		1 (WK2 and WK6)		2 (WK9)	1			3 (WK8)	3	1	1
CO3	1 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	3 (WK5)	-	1 (WK2 and WK6)	-	1 (WK9)	1	-	-	2 (WK8)	2	1	1
CO4	1 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	3 (WK5)	-	1 (WK2 and WK6)	-	2 (WK9)				3 (WK8)	3	3	3

Course Code		:	22UBT745E	PHARMACEUTICAL BIOTECHNOLOGY	Semester	:	07
L:T:P		:	3:0:0		Course Type	:	PEC
Hours/Sem.	Teaching	:	42 Hrs		CIE Marks	:	50
	Learning (TW+SL)	:	42 Hrs		SEE Marks	:	50
	Exam	:	06 Hrs		Total Marks	:	100
Total Hrs.		:	90 Hrs	Credits	:	03	
Professional Competency:							
Develop the knowledge and skills to apply biotechnological principles, molecular techniques, and bioprocess technologies for the development, production, quality evaluation, and regulatory compliance of biopharmaceutical products while adhering to ethical and biosafety standards.							
Course Outcomes:							
After completion of the course, student will be able to:							
CO1: Apply the basics of biology in drug discovery, drug formulation and analyze the Pharmacokinetics and Pharmacodynamics parameters of drugs along with drug metabolism in drug development.							
CO2: Select and apply the knowledge of the techniques used in the manufacture of pharmaceutical products in the field of Biopharmaceuticals.							
CO3: Select and apply appropriate techniques and advanced techniques in drug delivery system and understand the role of biotherapeutics and stem cells in Biopharmaceuticals.							
CO4: Demonstrate an ability to apply principles of Pharmaceutical Biotechnology to protect the global community from various dreadful diseases.							
UNIT-I							10 Hrs.
Introduction: Introduction to Pharmaceutical Biotechnology, History of Pharmaceutical Industry. Drug design and development process, Fundamental principles and processes involved in preclinical and clinical development of a chemical or biological entity. Orphan drugs, Provisions for and use of unlicensed medicines, Drug abuse and dependence, Prescriptional and Non-prescriptional drugs.							
Drug metabolism: Evolution of Drug Metabolism as a Science, Phase I Metabolism (microsomal oxidation, Reduction, Hydrolysis), Phase II Metabolism (Drug conjugation reactions). Pharmacodynamics and Pharmacokinetics of drugs.							
UNIT-II							11 Hrs.
Toxicology: Branches of Toxicology-In vivo toxicity tests- Acute, Sub acute and chronic toxicity tests.							
Manufacturing principles and formulations: Tablets-Types of tablets, Role and composition of tablets, Preformulation of tablets-organoleptic, physical properties, compressibility and flowability, evaluation of tablets-hardness, disintegration, and friability. Preparation of tablets- Granulation and compression method, Tablet coating and its applications, Parental preparations, herbal extracts, Oral liquids, Ointments, Quality control, storage and stability of biotech products. Short study of current biotech products. Adverse drug reactions.							
UNIT-III							11 Hrs.
Biosimilars: Biosimilars, Characteristic of high selling peptides and proteins. Therapeutics Based on Biotechnology- Hematopoietic growth factor and Tissue plasminogen activators, Interferons and Hepatitis B vaccine.							
Stem cells and tissue engineering: stem cells-types of stem cells, embryonic stem cells, adult stem cells ,Tissue engineering, Cells as Therapeutic Agents for tissue defects, artificial liver and pancreas.							
Drug delivery system: Delivery of biopharmaceuticals-Use of Artificial Intelligence in drug delivery, , Advanced drug Delivery Systems, Liposomes and Nanoparticles Drug Delivery System, Hydrogel based Drug Delivery System.							
UNIT-IV							10 Hrs.
Analysis of biologicals & pharmaceuticals: Vitamins Cold remedies Laxatives Analgesics, NSAID, antiseptics, Antacids, Antibiotics and Biologicals. Packaging techniques – Glass containers, plastic containers, film wrappers and bottle seals.							

Advanced pharmacology:

Introduction to pharmaceutical chemistry, classification of drugs based on therapeutic actions using suitable examples. Antineoplastic agents, Immunomodulators, Heavy metals and heavy metal antagonists, Therapeutic gases. Free radical biology and antioxidants.

Text Books:

1. Gary Walsh, Biopharmaceuticals Biochemistry and Biotechnology (2nd Edition), Wiley Publishers, 2013,
2. Bartram Katzung, Basic & Clinical Pharmacology (9th Edition), McGrawHill, 2009
3. Leon Lachman, Herbert. Lieberman & Joseph Kanig, Vergese, The Theory & Practice of Industrial Pharmacy, (3rd Edition), Publishing House Bombay. 1987

Reference Books:

1. Pharmaceutical Biotechnology by K Sambamurthy & Ashutosh Kar, New Age, 2006.
2. Pharmaceutical Biotechnology by S P Vyas and V K Dixit, CBS Publishers, 2007
3. Hematology, William J. Williams, Ernest Beutler, Allan JU. Erslev, Marshall A. Lichtman

Course Outcomes	Programme Outcomes											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	2 (WK1, WK2, WK3 WK4)	3 (WK1, WK2, WK3 WK4)	2 (WK5)	2 (WK8)	2 (WK2 and WK6)	3 (WK1, WK5, and WK7)	1 (WK9)	-	-	1 (WK8)	3	3	3	2
CO2	2 (WK1, WK2, WK3 WK4)	2(WK1, WK2, WK3 WK4)	2 (WK5)	2 (WK8)	3 (WK2 and WK6)	3 (WK1, WK5, and WK7)	2 (WK9)	-	-	2 (WK8)	2	3	3	2
CO3	2 (WK1, WK2, WK3 WK4)	3(WK1, WK2, WK3 WK4)	3 (WK5)	2 (WK8)	3(WK2 and WK6)	3 (WK1, WK5, and WK7)	2 (WK9)	-	-	2 (WK8)	3	3	3	3
CO4	2(WK1, WK2, WK3 WK4)	3(WK1, WK2, WK3 WK4)	3 (WK5)	1 (WK8)	2(WK2 and WK6)	3 (WK1, WK5, and WK7)	3 (WK9)	-	-	2	2	3	3	3

Course Code		:	22UBT704L	UPSTREAM PROCESS AND BIOSEPARATION TECHNIQUES LAB	Semester	:	06
L:T:P		:	0:0:2		Course Type	:	PCCL
Hours/Sem.	Teaching	:	26 Hrs.		CIE Marks	:	50
	Learning (TW+SL)	:	00 Hrs.		SEE Marks	:	50
	Exam	:	4 Hrs.		Total Marks	:	100
Total Hrs.		:	30 Hrs.	Credits	:	01	
Professional Competency:							
Ability to systematically execute, analyze, and simulate an end-to-end industrial bioprocess—seamlessly linking raw upstream kinetic profiles and biological fermentations to rigid downstream extraction and analytical validation							
Course Outcomes:							
After completion of the course, student will be able to:							
CO1: Fermentation Kinetics & Primary Processing: Execute batch cultivation runs (such as ethanol and citric acid production via <i>Aspergillus niger</i>) to quantify microbial growth, and substrate-utilization kinetics.							
CO2: Primary Recovery & Phase Extraction: Apply mechanical cell disruption, cross-flow filtration, and centrifugation to clarify crude broths, and implement fractional precipitation or liquid-liquid / aqueous two-phase extraction (ATPS) to capture raw target fractions.							
CO3: High-Resolution Analytics & Product Stabilization: Formulate customized sublimation cycles for the lyophilization of biological samples, and resolve product purity and yield parameters from fermented broth using analytical HPLC / GC configurations.							
CO4: Computer-Aided Process Simulation: Construct integrated, economically viable bioprocess flowsheets inside industrial software environments like SuperPro Designer.							
LIST OF EXPERIMENTS					26 per batch Hrs.		
1. Production and estimation of citric acid from <i>Aspergillus niger</i>. Separation and estimation citric acid from fermented broth. 2. Preparation and production of ethanol in a fermenter: Study of growth, product formation, and substrate utilization. Separation and estimation of ethanol from fermented broth. 3. Bioprocess Modeling using SuperPro Designer: Flow sheeting of the Bioprocess using SuperPro Designer, Design of various Bioreactors using SuperPro Designer. 4. Solid-liquid separation method: Removal of Intracellular Proteins by cell disruption methods. 5. Solid-liquid separation method: Separation of biomass and extracellular components by Filtration (cross-flow) and Centrifugation. 6. Product enrichment operations: Precipitation of a bioproduct from crude solution or the extract. 7. Product enrichment operations: Liquid-liquid and aqueous two-phase extraction of bioproducts from biological sources. 8. Extraction and estimation of bioactive compounds from natural sources. 9. Lyophilization of any bioproduct 10. Analysis of biomolecules/bioactive compounds by HPLC / GC							
Open Ended Experiment (s) OR Open Ended Program(s)							
Separation and Purification of bioactive compounds/proteins/Enzymes any other products different sources							
Reference Books:							
1. Bioseparations Science and Engineering: Authors: Roger G. Harrison, Paul W. Todd, Scott R. Rudge, and Demetri P. Petrides (Oxford University Press). 2. Laboratory Manual in Bioprocess Engineering: Author: N. Shanthi (MJP Publishers). 3. Protein Purification Protocols: Editor: Paul Cutler (Humana Press / Methods in Molecular Biology series) 4. Bioprocess Engineering: Basic Concepts Authors: Michael L. Shuler, Fikret Kargi, and Matthew DeLisa (Prentice Hall). 5. Bioprocess Engineering Principles Author: Pauline M. Doran (Academic Press).							
Web links and Video Lectures (e-Resources)							
1. Practical Industrial Handbooks & Methodologies Cytiva (GE Healthcare) Protein Purification Handbooks 2. Lyophilization Technology Application Notes (SP Scientific / Labconco)							

Course Outcomes	Programme Outcomes											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	2 (WK 5)	2 (WK 8)	2 (WK 2,WK 6)	1 (WK1, WK5, WK7)	-	-	-	-	1 (W K8)	2	3	-
CO2	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	2 (WK 5)	2 (WK 8)	1 (WK 2,WK 6)	1 (WK1, WK5, WK7)	-	-	-	-	1 (W K8)	2	3	-
CO3	3 (WK1, WK2, WK3, and WK4)	2 (WK1, WK2, WK3, and WK4)	3 (WK 5)	3 (WK 8)	3 (WK 2,WK 6)	-	-	-	-	-	2 (W K8)	2	3	1
CO4	3 (WK1, WK2, WK3, and WK4)	2 (WK1, WK2, WK3, and WK4)	3 (WK 5)	2 (WK 8)	1 (WK 2,WK 6)	2 (WK1, WK5, WK7)	1 (W K9)	-	-	2	1 (W K8)	2	3	2

Course Code		:	22UBT705P	PROJECT	Semester	:	07
L:T:P		:	0-0-2		Course Type	:	PP
Hours/Sem.	Teaching	:	-		CIE Marks	:	50
	Learning (TW+SL)	:	-		SEE Marks	:	50
	Exam	:	04Hrs.		Total Marks	:	100
	Total Hrs.	:	240Hrs.		Credits	:	8

Professional Competency:

Apply biotechnological knowledge, research methodology, ethical practices, and scientific communication skills to independently design, execute, analyze, and present research or industry-oriented projects that address real-world biotechnology challenges.

Course Outcomes:

After completion of the course, student will be able to:

CO1 Able to improve industrial processes using biotechnological methods.

CO 2. Able to demonstrate an awareness of ethical issues associated with their chosen field of research.

CO 3. Able to apply the knowledge in field of design, record, analyze and economics of project.

CO 4. Able to develop and demonstrate the ability to effectively communicate written and oral presentations to a scientific audience.

Course Outcomes	Programme Outcomes											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	3 (WK5)	3 (WK8)	3 (WK2 and WK6)	3 (WK1, WK5 & WK7)	2 (WK9)	2	2	3	2 (WK8)	3	3	3
CO2	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	3 (WK5)	3 (WK8)	3 (WK2 and WK6)	2 (WK1, WK5 & WK7)	3 (WK9)	2	2	3	3 (WK8)	3	3	3
CO3	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	3 (WK5)	3 (WK8)	3 (WK2 and WK6)	2 (WK1, WK5 & WK7)	3 (WK9)	3	2	2	2 (WK8)	3	3	3

		an d WK 4)												
C04	3 (WK1, WK2, WK3, and WK4)	3 (W K1, WK 2, WK 3, an d WK 4)	3 (WK5)	3 (WK 8)	3 (WK 2 and WK 6)	3 (WK1, WK5 & WK7)	3 (W K9)	3	2	2	3 (W K8)	3	3	3

VIII SEMESTER

Course Code		:	22UBT801I	INTERNSHIP	Semester	:	08
L:T:P		:	0-0-2		Course Type	:	Int.
Hours/Sem.	Teaching	:	-		CIE Marks	:	50
	Learning (TW+SL)	:	-		SEE Marks	:	50
	Exam	:	6Hrs.		Total Marks	:	100
	Total Hrs.	:	300 Hrs		Credits	:	10

Professional Competency:

Develop professional competence by applying biotechnology knowledge and engineering skills in an industrial or research environment while demonstrating ethical practices, teamwork, communication, and problem-solving abilities

Course Outcomes:

After completion of the course, student will be able to:

CO1: Apply biotechnology principles and engineering knowledge to understand industrial processes, equipment, and standard operating procedures in a professional workplace.

CO2: Demonstrate technical skills by participating in laboratory, production, quality control, quality assurance, research, or related industrial activities while following safety and regulatory guidelines.

CO3: Analyze industrial practices, identify operational challenges, and propose feasible technical solutions using scientific and engineering approaches.

CO4: Prepare a comprehensive internship report and effectively communicate internship experiences through presentations, demonstrating professional ethics, teamwork, and lifelong learning.

Course Outcomes	Programme Outcomes											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3 (WK1, WK2, WK3, WK4)	2 (WK1, WK2, WK3, WK4)	–	2 (WK8)	2 (WK2 and WK6)	–	2 (WK9)	1	–	–	2 (WK8)	2	3	2
CO2	2 (WK1, WK2, WK3, WK4)	2 (WK1, WK2, WK3, WK4)	2 (WK5)	2 (WK8)	3 (WK2 and WK6)	2 (WK1, WK5, and WK7)	2 (WK9)	2	2	–	2 (WK8)	2	3	2
CO3	2 (WK1, WK2, WK3, WK4)	3 (WK1, WK2, WK3, WK4)	2 (WK5)	3 (WK8)	2 (WK2 and WK6)	1 (WK1, WK5, and WK7)	3 (WK9)	1	2	2	2 (WK8)	2	3	2
CO4	1 (WK1, WK2, WK3, WK4)	1 (WK1, WK2, WK3, WK4)	–	–	–	–	3 (WK9)	3	3	3	3 (WK8)	2	3	2