SCHEME & SYLLABUS OF

V & VI SEMESTERS

(160 Credits)

B.E. BIOTECHNOLOGY 2025-26

VISION AND MISSION OF THE DEPARTMENT

VISION:

To be a center of excellence in education and research in Biotechnology to address the global challenges

MISSION:

1. To offer industry relevant curriculum and research through industry collaborations.

2. To continuously upgrade the infrastructure to develop the facilities for training and research.

3. To provide a good learning environment to help students imbibe professional ethics, communication skills, team spirit and societal commitment.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

The Program Educational Objectives are as follows:

1. The graduates of the program are practicing engineering profession in IT sectors (IT system engineers, data analyst and computer programmer), and BT sectors (clinical data coordinator, clinical research associate, Quality controller and Quality assurance analyst, Molecular biologist and Business development executive)

2. The graduates of the program are engaged in higher studies leading to professional degree in specific domain such as biological sciences, computational biology and also engaged in life-long learning.

3. The graduates of the program practice profession with high ethical and moral values and have developed good communication skills and leadership qualities while working as a member of the team or as a team leader.

PROGRAM SPECIFIC OUTCOMES (PSOs):

1. Students will be able to conduct the Upstream and Downstream experiments to produce, optimize, separate, purify and characterize biological compounds.

2. Students will be able to solve advanced biological problems with the technical skills of Bioinformatics, Biomolecular simulation, Proteomics and Genomics using computational techniques.

3. Students will be able to analyse Biopharmaceutical challenges of Biological systems by applying the concepts of Biological sciences

PROGRAMME OUTCOMES (POs)

PO1	**Engineering Knowledge:** Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization 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.
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.
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.
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.
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.
PO7	**Ethics:** Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws
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.

SIDDAGANGA INSTITUTE OF TECHNOLOGY, TUMAKURU

(An autonomous institution affiliated to VTU, Belagavi, Approved by AICTE, New Delhi, Accredited by NAAC with 'A' grade & ISO 9001:2015 Certified)

B.E. in Biotechnology

SCHEME OF TEACHING AND EXAMINATION (NEP II: batch 2) 2023-2027

V Semester

Sl. No.	Course and Course Code		Course Title	Teaching / Paper setting Dept.	Teaching hrs./week				Examination				Credits
					Lecture	Tutorial	Practical/ Drawing	TW+ SL Component	Duration in hrs.	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1.	HSMS	SHS08	Management and Entrepreneurship	BT	42	-	-	48	3	50	50	100	3
2.	IPCC	S5BTI02	Green Biotechnology and pollution abatement	BT	42	0	28	50	3	50	50	100	4
3.	IPCC	S5BTI03	Biomolecular Simulations	BT	42	0	28	50	3	50	50	100	4
4.	PCCL	S5BTL02	Bioseparation Lab	BT/CH	0	0	28	02	3	50	50	100	1
5.	PEC	S5BTPEXX	Professional Elective Course-I	BT	42	-	-	48	3	50	50	100	3
6.	PROJ	BTMP	Mini Project / Extension Survey Project	BT	0	0	46	14	3	100	-	100	2
7.	AEC	SHS04	Research Methodology and IPR **(Board: IEM)**	BT	42	-	-	48	3	50	50	100	3
8.	HSMS	SHS05	Environmental Studies **(Board: CV)**	CV/BT/CH	28	0	0	32	3	50	50	100	2
9.	AEC	ARAS	Aptitude Related Analytical Skill	T&P	36	0	0	0	1.5	50	50	100	1
10.	NCMC	SMC01	National Service Scheme (NSS)	NSS CO						100	-	100	0
		SMC02	Physical Education (PE) (Sports and Athletics)	PE									
		SMC03	Yoga	YO									
			Total		**274**	**0**	**130**	**292**		**600**	**400**	**1000**	**23**
11.		AAP	AICTE Activity Points (Applicable for both Regular and Lateral Entry students)	40 hours community service to be documented and produced for the examination									

Note: HSMS: Humanity and Social Science and management Course; **IPCC**: Integrated Professional Core Course, **PCCL**: Professional Core Course laboratory, **PEC**: Professional Elective Course; **PROJ**: Project/Mini Project; **AEC**: Ability Enhancement Course; **NCMC**: Non-Credit Mandatory Course, **L**: Lecture, **T**: Tutorial, **P**: Practical **S= SDA**: Skill Development Activity, **CIE**: Continuous Internal Evaluation, **SEE**: Semester End Evaluation. **TW + SL**: Term Work and Self learning.

Professional Elective Course (PEC) (Offered by the Department)			
S5BTPE12	Marine Biosources and applications	**S5BTPE16**	Downstream Process Technology (Includes Tutorials)
S5BTPE14	Animal Biotechnology	**S5BTPE17**	Biomedical imaging and health informatics

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B.E. in Biotechnology

SCHEME OF TEACHING AND EXAMINATION (2022 Scheme: batch 2) 2023-2027

VI Semester

Sl. No.	Course and Course Code		Course Title	Teaching / Paper setting Dept.	Teaching hrs./week				Examination				Credits
					Lecture	Tutorial	Practical/ Drawing	TW+ SL Component	Duration in hrs.	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1.	IPCC	S6BTI01	Genomics and Proteomics	BT	42	0	28	50	3	50	50	100	4
2.	PCC	S6BT01	Immunology & Immunotechnology	BT	56	0	0	64	3	50	50	100	4
3.	PEC	S6BTPE	Professional Elective Course-II	BT	42	0	0	48	3	50	50	100	3
4.	OEC	S6OEXX	Open Elective Course-I	BT	42	0	0	48	3	50	50	100	3
5.	PROJ	BTMP	Major Project Phase I	BT	0	0	46	14	3	100	-	100	2
6.	PCCL	S6BTL01	Immunology & Immunotechnology Laboratory	BT	0	0	28	02	3	50	50	100	1
7.	AEC	SHS06	Soft Skills	T&P	36	0	0	0	1.5	50	50	100	0
8.	HSMS	SHS07	Indian Knowledge System (**Board: ECE**)	BT	14	0	0	0	0	100	-	100	0
9.	NCMC	SMC01	National Service Scheme (NSS)	NSS CO									
		SMC02	Physical Education (PE) (Sports and Athletics)	PED						100	-	100	0
		SMC03	Yoga	PED									
			Total		**232**	**0**	**102**	**226**		**600**	**300**	**900**	**17**
		AAP	AICTE Activity Points (Applicable for both Regular and Lateral Entry students)	40 hours community service to be documented and produced for the examination									

Note: **IPCC**: Integrated Professional Core Course, **PCC**: Professional Core Course; **PEC**: Professional Elective Course; **OEC**: Open Elective Course; **PROJ**: Project Phase –I; **PCCL**: Professional Core Course laboratory; **AEC**: Ability Enhancement Course, **SEC**: Skill Enhancement Course; **NCMC**: Non Credit Mandatory Course; **L**: Lecture, **T**: Tutorial, **P**: Practical **S= SDA**: Skill Development Activity, **CIE**: Continuous Internal Evaluation, **SEE**: Semester End Evaluation. **TW + SL**: Term Work and Self learning.

Professional Elective Course (PEC) (Offered by the Department)

S6BTPE12	Food Biotechnology	S6BTPE14	System Biology
S6BTPE13	Vaccine Technology	S6BTPE15	Bioreaction Engineering (Includes Tutorials)

MANAGEMENT AND ENTREPRENEURSHIP

Contact Hours/ Week:	L:T:P:: 3:0:0	**Credits:**	3
Total Lecture Hours:	42	**CIE Marks:**	50
Course Code:	SHS08	**SEE Marks:**	50

Course objectives: This course will enable students to:	
1.	Understand the principles and functions of management through planning
2.	Analyze the importance of organizing and staffing in an organization
3.	Analyze the importance of leading and controlling in an organization
4.	Inculcate entrepreneurial qualities and understand the need of rural entrepreneurship
5.	Acquire knowledge about funding agencies, understand procedure in applying for funds and analyze the cases of successful entrepreneurs

UNIT I
Introduction to Management: Definition of management, management skills, productivity and effectiveness, efficiency, functions and principles of management. Planning: Nature of planning, types of plans- purpose of vision, mission, goals, objectives strategies, policies; steps in planning, MBO, Strategic planning.
7 Hours

UNIT II
Organizing: Formal and informal organization, span of management, the structure and Process of organizing, Organizational structure: line and staff organization, Functional organization, matrix organization. Staffing: Definition, systems approach to HRM, factors affecting staffing, recruitment and selection, job design, skill and characteristics of a manager, selection process and techniques
8 Hours

UNIT III
Leading: Human factors in managing, motivation, Theory X and Y, the hierarchy of needs theory, leadership behavior and styles. Controlling: Basic control process, critical control points and standards, Benchmarking requirements for effective control.
8 Hours

UNIT IV
Entrepreneur & Entrepreneurship: Introduction, concept of Entrepreneur, characteristics of an entrepreneur, and qualities of an entrepreneur, functions of an entrepreneur, characteristics of entrepreneurship, factors affecting entrepreneurial growth. Entrepreneurship and economic development-rural, woman and social entrepreneurship Financing and Institutional Support for Entrepreneurship: Startups, business plans, venture capitalists, angel investors, funding agencies - commercial banks, development banks, NBFCS and incubation centers. Innovations and project trends.
12 Hours

UNIT V
Taxation benefits: Depreciation allowances, rehabilitation allowance, investment allowance and other tax concession benefits to an entrepreneur. Case studies 1. Happily Bootstrapping: Zoho CEO Sridhar Vembu (2007) 2. Thought Leaders in Cloud Computing: Sridhar Vembu, CEO of Zoho (2016) 3. Building India's Amazon: Flipkart CEO Sachin Bansal 4. Rohith Bhat's Exhilarating Journey with Robosoft from Udupi, Karnataka
7 Hours

TEXT BOOKS		
1	Harold Koontz, Heinz Weihric	Harold Koontz, Heinz Weihric Essentials of Management, McGraw Hill Education, 10th Edition, 2015
2	Lucy C. Morse	Managing Engineering and Technology, Pearson Education, 6th Edition, 2015.
3	S.S. Khanka	Entrepreneurial Development, S. Chand Publishing, 4th Edition, Reprint, 2020, ISBN 978-81-219-1801-5

REFERENCE BOOKS		
1	James A.F. Stoner, R. Edward Freeman, Daniel R. Gilbert	Gilbert Management, Pearson Education, 6 th Edition, 2018

Course Outcomes:
Upon completion of this course the student will be able to:

CO1	Explain various functions of management.
CO2	Apply the knowledge of management principles and strategies in various functional areas such as organizing and staffing.
CO3	Apply the knowledge of management principles and strategies in various functional areas such as Leading and Controlling.
CO4	Describe entrepreneurship, its characteristics, and benefits and identify various funding sources for starting a business venture
CO5	Explain various taxation benefits enjoyed by an entrepreneur and analyze the characteristics and strategies adopted3 by successful entrepreneurs.

Course Articulation Matrix

		POs											**PSOs**		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
COs	**CO1**	3					1						3	3	
	CO2	3										3	3	3	
	CO3	3										3	3	3	
	CO4	3					2				2	3	3	3	
	CO5	3	3									3	3	3	3

GREEN BIOTECHNOLOGY AND POLLUTION ABATEMENT

Contact Hours/ Week:	L:T:P::3:0:2	**Credits:**	4
Total Lecture Hours:	42	**CIE Marks:**	50
Course Code:	S5BTI02	**SEE Marks:**	50

Course objectives: This course will enable students to:	
1.	Recognize the various global and regional environmental concerns due to natural causes and/or human activities, and the impact of these on various forms of life including native biodiversity.
2.	Understand the physiology of a microorganism and how their structure dictates their function in the environment.
3.	Enable students to acquire comprehensive knowledge of environmental biotechnological processes for wastewater treatment, bioremediation and metal recovery.
4.	Understand the bases for microbial metabolism of environmental contaminants and to know various techniques to modify and augment microorganisms in the laboratory and environment.
5.	Understand the principles of composting and Phytoremediation

UNIT I
Bioremediation: Definition, approaches to bioremediation, environmental modification, microbial seeding. Bioengineering approaches to the bioremediation of pollutants – engineering of bioremediation processes – needs and limitations. Xenobiotics, biodegradation of lignin, hydrocarbons, plastic.
8 Hours

UNIT II
Bioremediation of contaminated soils: Diversity and magnitude of soil contaminants, criteria for bioremediation, biological mechanism of transformation, strategies for bioremediation, Case studies of bioremediation. Biodegradable organic pollutants - Pesticides, aerobic and anaerobic bacteria degradation, co metabolic degradation, degradative capacities of fungi.
8 Hours

UNIT III
Bioremediation of various ecosystems: Bioremediation of contaminated water (oil slicks, heavy metals), bioremediation of industrial wastes - distillery-processes and production in the distillery, characteristics of effluent and treatment, textile industry- source and origin of dyes, Environmental impact of dyes and its intermediates and treatment, leather – processes and production, characteristics of effluent, Environmental impact of tannery effluents and treatment, paper and pulp manufacturing industries, Processes and production.
9 Hours

UNIT IV
Bioremediation Techniques: Bioaerosols, Biofiltration, microbial control of environmental pollution –role of genetic engineering in environmental pollution abatement, catabolic plasmids as natural vectors, genetic engineering of genes for augmenting pollution abatement in microbes and plants, use of immobilized microbes for waste recycling, immobilized enzymes in pollution abatement.
8 Hours

UNIT V
Composting and Phytoremediation: Exploitation of agricultural wastes for food, feed and fuel, humus formation, sludge composting, vermi composting, aerobic and anaerobic composting. Introduction to phytoremediation, phytoextraction, phytostabilization, phytoremediation of inorganics, translocation mechanisms for inorganics, plant accumulation.
9 Hours

TEXT BOOKS		
1.	Indu shekhar Thakur	Environmental Biotechnology, Basic concepts and Applications, I K International Publishing House Pvt. Ltd 2nd Edition, 2013, 9380578474.

REFERENCE BOOKS		
1	D. K. Maheshwari and R. C. Dubey	Bioremediation of Pollutants Hardcover IK International Publishing House Pvt. Ltd; 1st Edition, 2012, 9381141053.
2	Pradipta Kumar Mohaptra	Text book of Environmental Biotechnology, I K International Pvt. Ltd. 1st edition, 2013, 818823754X

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Describe the various methods of bioremediation of xenobiotics.
CO2	Explain the biological mechanism of transformation of xenobiotics in various environmental conditions.
CO3	Discuss the different types of treatment for industrial effluents.
CO4	Recognize and apply genetic engineering practices in environmental biotechnology.
CO5	Illustrate the application of microbes and plants in treating solid waste management as well as heavy metals.

Course Articulation Matrix

		POs											**PSOs**		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
COs	**CO1**	2	2			2									2
	CO2	2	2			2									2
	CO3		2	2		2									2
	CO4		2	2		3									2
	CO5				3	3	2		2	3	2				2

GREEN BIOTECHNOLOGY AND POLLUTION ABATEMENT LABORATORY

Contact Hours/ Week:	L:T:P: 0+0+2	**Credits:**	0
Total Lecture Hours:	28	**CIE Marks:**	50
Course Code:	S5BTI02	**SEE Marks:**	0

Course objectives: This course will enable students to:	
1.	Study the basic concepts of isolating microorganisms from different environmental conditions.
2.	Understand the impact of xenobiotics on growth of microbes
3.	Learn the techniques of identifying contaminants in the water sample by PCR.
4.	Study the interaction of natural material with petrochemical compounds.
5.	Understand the importance of medicinal plants against disease causing microbes.

List of Experiments

1.	Introduction and Orientation/ Review of Microbial Techniques
2.	Isolation and Characterization of Bacteria from Crude Petroleum Oil Contaminated Soil
3.	Isolation of xenobiotic degrading bacteria by selective enrichment technique
4.	Growth Response of Bacteria on Petroleum Fuel (Diesel)
5.	Enrichment for Uric Acid Utilizing Bacteria
6.	Environmental Detection of Streptomycin-Producing Streptomyces spp.by Using strb1 and 16S rDNA-Targeted PCR
7.	Molecular Detection of Fecal Coliforms (*E. coli*) in Water by PCR
8.	Estimation of fluoride in drinking water.
9.	Estimation of residual chlorine in drinking water
10.	Interaction of Plant Seeds with Diesel for Potential Use in the remediation of Diesel fuel Contaminated Soils
11.	Detection of Alkyl benzene sulfonate-Degrading Microorganisms
12.	In vitro evaluation of medicinal plants against pathogenic microbes

TEXT BOOKS		
1	S. K. Agarwal	Environmental Biotechnology Principles and Applications Pearson, 5th Edition, 2013, 97801956884

REFERENCE BOOKS		
1	Martin Alexander	Biodegradation and Bioremediation Academic Press Inc; 2nd edition 1999, 978-0120498611
2	Jayanta Kumar Patra	A Practical Guide to Environmental Biotechnology, Springer Verlag, Singapore; 1st ed. 2020 978-9811562518

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Analyze diversity, function, ecological adaptation of microorganisms within the

	environment
CO2	Describe the importance of microbial life to key ecosystem process and the role of biotechnology to address environmental issues
CO3	Perform the techniques of identifying contaminants in the water sample by PCR.
CO4	Interpret the interaction of natural material with petrochemical compounds.
CO5	Analyze case studies representatives of key areas of environmental biotechnology

Course Articulation Matrix

		POs											PSOs		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
COs	**CO1**	2	2			2						2			2
	CO2	2	2			2						2			2
	CO3		2	2		2						2			2
	CO4		2	2		3						2			2
	CO5				3	3	2		2	3	2	2			2

1: Low, 2: Medium, 3: High

BIOMOLECULAR SIMULATIONS

Contact Hours/ Week:	L:T:P:: 3:0:2	**Credits:**	4
Total Lecture Hours:	42	**CIE Marks:**	50
Course Code:	S5BTI03	**SEE Marks:**	50

Course objectives: This course will enable students to:	
1.	Know the basic concepts of molecular dynamics (MD) simulations.
2.	Learn molecular mechanics, force-field and atomic interactions.
3.	Understand the preparation of a system for molecular dynamics simulation and its minimization.
4.	Learn the ensemble system and its associated concepts.
5.	Understand the applications of molecular dynamics simulations

UNIT I
Basic concepts of Molecular dynamics simulations: Structural aspects of Biomolecules: Nucleic acids, Proteins, Lipids and Carbohydrates. A brief history of computer simulations; Motivation to perform computer simulation; Introduction to molecular dynamics simulation, Principles of Molecular dynamics simulation: Newton's laws of motions, assumptions in Molecular dynamics simulation; Global Molecular dynamics algorithm; Preparation of Biomolecules for Molecular dynamics simulation: Proteins, Lipids, Nucleic acids and Carbohydrates. Protein modelling (Homology modelling only), Ligand preparation for molecular dynamics simulations and Preparation of the Protein-ligand complex. Protein Solvation: Necessity of solvation, Implicit solvation, explicit solvation. Adding Ions: Necessity of adding ions, points to remember while adding ions. Comparison between all-atom, united- atom and coarse-grained simulations.
9 Hours

UNIT II
Molecular mechanics force field: Bond theory, Bonded and non- bonded interactions in biomolecules, Simple Molecular mechanics force field: Four-component model (inter and intra molecular components); Properties of force fields; Bonded and non-bonded terms in force fields, Bond stretching, Angle bending, Torsion angle, Electrostatic interactions, Van der Waals interactions (Lennard-Jones potential) (only expressions with graphs for bonded and non-bonded terms except Bond stretching where derivation is also included). A simple force-filed model for the simulation of liquid water, Force field parameterization, Transferability of molecules, tools to prepare force-field parameters for ligands. List of force fields for different Biomolecules.
8 Hours

UNIT III
Energy Minimization and ensemble systems: Essentiality of energy minimization; Energy minimization techniques: Non-derivative energy minimization (simplex method and sequential univariate method) and derivative energy minimizations methods (Steepest descents method, line search in one dimension method, and conjugate gradients minimization) System equilibration: Ensembles; Microcanonical ensemble, canonical ensemble, Isothermal-Isobaric ensemble, Grand canonical ensemble; Production run in Molecular dynamics simulation. Simple packages of Molecular dynamics simulation and its force fields: GROMACS, AMBER, and NAMD.
8 Hours

UNIT IV
Molecular dynamics (MD) simulation method: A simple molecular dynamics simulation; Interaction potential and Reduced Units; Time averages and ensemble averages, Calculation of simple thermodynamic properties; Radial distribution function; Phase space; Setting up and running simulation; Choosing the initial configuration (MD and Steered molecular dynamics); Boundaries and periodic boundary condition; Truncating potential and minimum image convention; Long range forces; System initialization: A simple MD algorithm; Calculation of forces; Numerical integration: Verlet algorithm, Velocity Verlet algorithm, Leap frog algorithm, and Predictor Corrector algorithm.
8 Hours

UNIT V
Applications of MD simulations: Simple analysis of MD simulations: RMSD (Root mean square deviation), RMSF (Root mean square fluctuation), Secondary structure prediction, H-bond analysis, MMPBSA (Molecular mechanics Poisson-Boltzmann surface area) analysis, Analysis of protein cavities, Protein domain's orientation analysis, SASA (Solvent accessible surface area), RDF (Radial distribution function), Rg (Radius of gyration). MD simulations for Protein-ligand interactions (One case study); MD simulations for protein domain movement (One case study); MD simulations lipid bilayer and Biphasic system (One case study). **Note:** Scientific articles used as case study, will be open access and freely available journals.
9 Hours

TEXT BOOKS		
1	Andrew R. Leach	Molecular Modeling: Principles and Applications, Pearson, 5th Edition, 2013, 97801956884

REFERENCE BOOKS		
1	Ben Leimkuhler, C Matthews	Molecular Dynamics, Springer International publishing, 4th Edition, 2015, 87801956884

2	Guy Fanacis Mongelli	Molecular dynamics simulations: Key operations in GROMACS, Walter de Gruyter, 7th Edition, 2018, 87801956884

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Analyze concepts of molecular mechanics at the atomic level using concepts of biomolecular structures.
CO2	Apply the appropriate force field for MD simulations using the force field parameters
CO3	Classify various energy minimization and system equilibration methods for molecular dynamics simulations.
CO4	Interpret and analyze the aspects of the simulation box for system preparation.
CO5	Apply and interpret the various analysis methods used to evaluate the simulated trajectory.

Course Articulation Matrix

		POs											**PSOs**		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
COs	**CO1**	2	1											2	
	CO2	2	1											2	
	CO3	2	1											2	
	CO4	2	1											2	
	CO5	2	1								1			2	

1: Low, 2: Medium, 3: High

BIOMOLECULAR SIMULATION LABORATORY

Contact Hours/ Week:	L:T:P::0:0:2	**Credits:**	0
Total Lecture Hours:	28	**CIE Marks:**	50
Course Code:	S5BTI03	**SEE Marks:**	0

Course objectives: This course will enable students to:	
1.	Learn the basic concepts in preparing the protein, ligand and other bio molecular system.
2.	Perform the preparation of Protein-ligand complex followed by system minimization
3.	Learn to perform system equilibration and molecular dynamics production run.
4.	Learn the basic analysis tools and perform molecular dynamics simulation in Desmond
5.	Perform the complete moleculardynamics simulation using GROMACS and DESMOND

List of Experiments:

1.	Protein preparation and protein modelling using Modeller and other tools
2.	Ligand preparation and preparation of ligand force field
3.	Preparing other biomolecules for molecular dynamics simulation for GROMACS simulation package
4.	Preparation of the protein-ligand complex, vacuum minimization, periodic boundary condition, system solvation, adding ions and energy minimization
5.	System equilibration in NVT and NPT ensemble system and production run
6.	RMSD, RMSF, Rg, SASA and secondary structure analysis
7.	Hydrogen bond, protein pocket analysis
8.	MMPBSA analysis on simulation trajectory
9.	PCA analysis on simulation trajectory
10.	A simple protein-ligand simulation and result analysis using GROMACS
11.	A simple protein-ligand simulation and result analysis using DESMOND
12.	Open ended experiment

TEXT BOOKS		
1	Andrew R. Leach	Molecular Modeling: Principles and applications, Pearson, 5th edition, 2013, 97801956884

REFERENCE BOOKS		
1	Ben Leimkuhler, C Matthews	Molecular Dynamics, Springer International publishing, 4th Edition, 2015, 87801956884
2	Guy Fanacis Mongelli	Molecular dynamics simulations: Key operations in GROMACS, Walter de Gruyter, 7th Edition,

Course Outcomes:
Upon completion of this course the student will be able to:

CO1	Prepare the protein, ligand and bio molecular system suitable for performing molecular dynamics simulation
CO2	Perform basic MD operations to prepare protein-ligand complex followed by system minimization.
CO3	Carryout system equilibration of ensemble systems and perform molecular dynamics simulation using GROMACS package.
CO4	Use various data analysis tools to validate the system.
CO5	Independently perform an open-ended experiment.

Course Articulation Matrix

	POs	**PSOs**

		1	2	3	4	5	6	7	8	9	10	11	1	2	3
COs	CO1	2	2			2						2		2	
	CO2	2	2			2						2		2	
	CO3		2	2		2						2		2	
	CO4		2	2		3						2		2	
	CO5				3	3	2		2	3	2	2		2	

1: Low, 2: Medium, 3: High

BIOSEPARATION LABORATORY

Contact Hours/ Week:	L:T:P:: 0+0+2	**Credits:**	1
Total Lecture Hours:	28	**CIE Marks:**	50
Course Code:	S5BTL02	**SEE Marks:**	50

Course objectives: This course will enable students to:	
1.	Study the Basic Concepts of Isolation & amp; Purification of products at commercial scale from fermented broth
2.	Learn about industrial applications of various processes for isolation of products such as Enzymes, Antibiotics, Organic acids
3.	Study the Membrane Separation Process
4.	Understand the Product enrichment operations
5.	Learn about the Principle & amp; Operation of Chromatography Techniques

List of Experiments

1.	Solid liquid separation- Centrifugation studies
2.	Solid liquid separation-Batch sedimentation
3.	Precipitation of protein from crude yeast extract by ammonium sulphate
4.	Aqueous two-phase extraction
5.	Thin layer Chromatography
6.	Simple distillation
7.	Product enrichment operation by distillation
8.	Estimation of citric acid from fermentation broth
9.	Atmospheric batch drying
10.	Protein isolation and separation by SDS-PAGE
11.	Dialysis method for protein purification
12.	Mechanical cell disruption
13.	Solid liquid separation- Filtration
14.	Freeze drying

TEXT BOOKS		
1	Belter P.A., Cussier E. and Wei, Shan Hu.	Bioseparation- Downstream Processing for Biotechnology, Wiley Blackwell Publications, 1988, 978-0471847373
2	Avinash Upadhyay Kakoli Upadhyay	Biophysical Chemistry, Himalaya Publishing House,2009.

REFERENCE BOOKS		
1	Shuler and Kargi	Bioprocess Engineering Prentice Hall, 1992
2	Wolf R. Vieth	Bioprocess Engineering–Kinetics, Mass Transport, Reactors and Gene Expression –Interscience Publication, 1992

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Explain how Downstream Process is applied in the Pharmaceutical Industry for Production of Life Saving Drugs
CO2	Describe & Apply the Isolation & Purification of Products from Microbial origin
CO3	Explain the Principles of Membrane Separation Process
CO4	Apply sophisticated Analytical Equipment for Detection of Various Impurities to ascertain its Permissible Level
CO5	Describe the Equipment required for Commercial Scale Downstream

Course Articulation Matrix

		POs										PSOs		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
COs	**CO1**	2	2			2						2	2		
	CO2	2	2			2						2	2		
	CO3		2	2		2						2	2		
	CO4		2	2		3						2	2		
	CO5				3	3	2		2	3	2	2	2		

1: Low, 2: Medium, 3: High

MARINE BIORESOURCES AND APPLICATIONS

Contact Hours/ Week:	L:T:P:: 3:0:0	**Credits:**	3
Total Lecture Hours:	42	**CIE Marks:**	50
Course Code:	S5BTPE12	**SEE Marks:**	50

Course objectives: This course will enable students to:	
1.	Understand the ocean environment and its ecosystem
2.	Learn the concepts of marine bioactive components.
3.	Understand the concepts of marine pharmacology resources.
4.	Understand the toxic environment of marine ecosystem
5.	Study the different sources of marine pollution.

UNIT I
THE OCEANIC ENVIRONMENT: Classification of the marine environment – Geography of the Global Ocean, biotic and abiotic divisions, Marine life: Marine microbes, Marine algae and plants (seaweeds, sea grasses, mangrove plants), Invertebrates: sponges, cnidarians, polychaetes, crustaceans, molluscs, echinoderms, arthropods, Noncraniate (non-vertebrate) chordates, Vertebrates, Marine fishes (bony, cartilaginous, jawless fishes) Marine tetrapods, Marine zoogeography with reference to Indian, Artic and Antartic oceans, Adaptations of organisms to different habitats. Wealth of the sea- Economically important marine animals- fin fishes, shrimp, crab, edible oysters and pearl oysters
8 Hours

UNIT II
BIOACTIVE COMPOUNDS FROM THE OCEAN: Important products isolated from marine organisms and their uses, Seaweed: Nutritional Value, Bioactive Properties, and Uses. Seafood Processing Wastes: Chitin, Chitosan, and other compounds, Seaweed Hydrocolloids; agarose, agar, alginates, carrageenans, chitin, chitosans and glucosamines- Biological Activities, uses and importance, Marine enzymes; Isolation and applications, Marine enzymes in Cancer, Biotechnological Applications of Marine Enzymes from Algae, Bacteria, Fungi, and Sponges, Antifreeze Proteins, Cold-Adapted Enzymes, applications. marine flavourants, lectins, heparin and carotene. Microbial Enzymes in Biotechnology. Probiotics for Animal Health, Production and Applications for Human Health, Biomedical Applications of Enzymes from Marine Actinobacteria.
8 Hours

UNIT III
PHARMACEUTICALLY IMPORTANT PRODUCTS: Need, importance and potentialities of marine drugs and sources. Drugs and Pharmaceuticals from Marine Sources, Development and problems in Marine Drug Development, Global Interests and Commercial Status. Marine Microalgae, Bioactive compounds from Microalgae, Bioactive natural products – anti-bacterial, anti-fungal, anti-viral, anti-inflammatory, anti-tumour, anti-parasitic and anti-helminthic, nutraceuticals. Marine Sources of Carotenoids, Isolation, Characterization, Antioxidant Activities of carotenoids. Marine Products; B-carotene, vitamins, immunomodulators, anticancer and cytotoxic compounds from marine sources- their extraction process and characterization. Marine Lipids, PUFA, Omega-3 PUFA-

Rich Oils from Marine Fish, Health Benefits. Seafood Proteins as Dietary Component, Bioactive Peptides from Seafood, Isolation of Seafood Peptides, Functional Roles of Marine Peptides in Foods. Marine Sources of Vitamins and Minerals with examples. Marine 16.07.2023 Annexure-II 18 Nutraceuticals for Food Fortification and Enrichment, examples. Marine Sponge Compounds with Anti-inflammatory Activity. Safety Hazards with Marine Products and Their Control.

8 Hours

UNIT IV

MARINE TOXINS AND TOXICOLOGY: Classifications of Marine Based-Toxins. Seafood Poisoning, Toxicity related to seafood, Different Routes of Exposure of Marine Toxins. Puffer Fish Poisoning (PEP), Scombroid Fish Poisoning, Saxitoxin, Brevetoxins, Ciguatera Fish Poisoning, Paralytic Shellfish Poisoning, Neurotoxic Shellfish Poisoning., Marine Invertebrate Toxins, Limu-Make-o-Hana (the Deadly Seaweed of Hana). Diarrhoeic Shellfish Poisoning (DSP). The Cone Shells. Sea Snakes, Venomous Fish. Tetrodotoxin, Amnesic Shellfish poisoning, Azaspiracid, Palytoxin Poisoning, Other Marine Biotoxin; Conotoxins, nodularin, cylindrospermopsin, microcystins, anatoxins, yessotoxin, and palytoxin (PTX) and their effects on human health. Treatments of Marine-Based Food Poisoning, Prevention Aspects of Marine Toxin for Humans. Safety Hazards with Marine Products and Their Control, Food-Borne Hazards, Types, Algal Toxins Influenza Viruses: A Threat to Marine Mammals Populations.

9 Hours

UNIT V

MARINE POLLUTION: Sources of marine pollution, its dynamics, transport paths and agents. Composition of domestic, industrial and agricultural discharges. Their fate in the marine environment. Toxicity and treatment methods. Oil pollution: Sources, composition, and its fate in marine habitats. Toxicity and treatment methods. Thermal and radioactive pollution: sources, effects, and remedial measures. Solid dumping, mining and dredging operations: their effects on marine ecosystem. Role of biotechnology in marine pollution control. Biofouling and biodeterioration: Agents and protection methods. Global environmental monitoring methods: status, objectives and limitations. Bioinformatics Techniques on Marine Genomics, Omics Approaches in Marine Biotechnology: genomics, proteomics, transcriptomics, nutrigenomics, and metabolomics. Applications of Omics Tools in Blue Biotechnology.

9 Hours

TEXT BOOKS

1	Vazhiyil Venugopal	Marine Products for Healthcare: Functional and Bioactive Nutraceutical Compounds from the Ocean (Functional Foods and Nutraceuticals Book 13) 1st Edition, 2009, CRC Press

REFERENCE BOOKS

1	Philip V. Mladenov	Marine Biology: A Very Short Introduction (2nd edn), Online, 2020, ISBN: 9780198841715, Oxford University Press
2	Se-Kwon Kim	Springer Handbook of Marine Biotechnology, (1st Ed.), 2015, ISBN: 978-3-642-53970-1, Springer Handbooks.

Course Outcomes:
Upon completion of this course the student will be able to:

CO1	Classify the various marines organisms based on their geographic location

CO2	Analyze the various bioactive components from marine life by assessing their biological potential
CO3	Identify the various biological and pharmaceutical potential of the marine products
CO4	Classify the marine based toxin by various biological assessments
CO5	Understand the source, dynamics and outcomes of the marine pollution

Course Articulation Matrix

		POs											PSOs		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
COs	**CO1**	3	2												2
	CO2	3	2												2
	CO3	3	2												2
	CO4	3	2												2
	CO5	3	2												2

1: Low, 2: Medium, 3: High

ANIMAL BIOTECHNOLOGY

Contact Hours/ Week:	L:T:P::3:0:0	**Credits:**	3
Total Lecture Hours:	42	**CIE Marks:**	50
Course Code:	S5BTPE14	**SEE Marks:**	50

Course objectives: This course will enable students to:	
1.	Understand the basic concepts of animal cell culture techniques
2.	Know about the media preparation and culture characters
3.	Learn about animal cell culture tools and methods.
4.	Learn about the production of transgenic animals and its applications
5.	Learn about cell culture techniques for the improvements of animals and its ethics.

UNIT I
Introduction to animal biotechnology: Introduction, History and Scope; Cell culture Laboratory design & Equipment's: Layout; Maintenance of sterility; CO_2 incubator; Inverted stage microscope Biosafety cabinet, flow cytometer. Cell culture vessels; Cryopreservation; Media and reagents, CO_2 and bicarbonates buffering, Different Types culture Media-Natural and Artificial Media. Features of MEM, DMEM, RPMI, role of antibiotics in media.
8 Hours

UNIT II
Animal cell culture: Initiation of Cell culture- Preparation and Sterilization of media, Primary animal cell culture: Isolation of Explants, Disaggregation of explants, contamination. Monolayer

culture. Secondary culture; Trypsinization; Passage, split ratio, criteria for sub culture. Different tissue culture techniques; Continuous cell lines; Suspension culture; Organ culture etc.; Behavior of cells in culture conditions: Morphology, division, growth pattern; Development of cell lines Characterization and maintenance of cell lines. Hemocytometer, electronic cell counter.
8 Hours

UNIT III
Animal cell culture applications: Application of animal cell culture for in vitro testing of drugs: MTT, assay for cytotoxicity: dye exclusion and dye inclusion, Development of spheroids and organoids in cancer research, Applications of IPSCs and organs on chip. Application of cell culture technology in production of human and animal viral vaccines, Hybridoma Culture- monoclonal antibody Production and its applications. Cell culture products- interferons, hybrid antibodies.
8 Hours

UNIT IV
Development and use of transgenic animals: Transgenic animals; Transgenic-mice methodology: Mammalian virus vector- Retroviral vector method, SV40 vector DNA microinjection method, Engineered-embryonic stem cell method, Nuclear reprogramming method, Transgenic animals produced- Mice, Rabbits, etc Transgene integration. Targeted gene transfer- Gene disruption and Gene replacement. Knocking in and knocking out of genes; Applications: transgenic animals as bioreactors for production of proteins of pharmaceutical value.
9 Hours

UNIT V
Biotechnology for animal improvement: Conventional methods of animal improvement: cross breeding, artificial insemination, in vitro fertilization, embryo transfer technology; Ethical issues related to IVF. Cryopreservation- procedure and applications. Gene mapping, marker assisted selection and genetic improvement of desired characters of domestic animals. Detection of Transgene and transgene function. Rapid diagnosis of diseases in live-stock via RIA, ELISA and PCR.
9 Hours

TEXT BOOKS		
1	Freshney RI	Culture of Animal Cells, Wiley-Blackwell Publisher, 8th Edition. (2021) 978-1-119-51304-9
2	Gorakh Mal, Manishi Mukesh, Sanjeev K. Gautam, Birbal Singh	Advances in Animal Biotechnology, Springer Publications. (2019) 978-3030213084

REFERENCE BOOKS		
1	John RW, Masters,	Animal Cell Culture: Practical Approach, 3rd Edn, Oxford. (2000) 978-0199637973
2	Anchal Singh, Ashish S. Verma Anchal Singh, Ashish S. Verma	Animal Biotechnology: Models in Discovery and Translation, Second Edition, Academic press in imprint of Elsevier. (2020) 978-0128117101

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Apply the basics and principles of animal biotechnology
CO2	Theoretical Knowledge of basics animal cell culture techniques
CO3	Application of stem cells, cloning, large animal models for disease and development of therapies and treatments
CO4	Apply the gene transfer techniques for the development of transgenic animal production
CO5	Apply the basic Knowledge of Breeding Technology, diagnosis techniques using ELISA, PCR and RIA.

Course Articulation Matrix

		POs											**PSOs**		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
COs	**CO1**	2	2												3
	CO2	2	2												3
	CO3	2	2												3
	CO4	2	2												3
	CO5	2	2												3

1: Low, 2: Medium, 3: High

DOWNTREAM PROCESS TECHNOLOGY

Contact Hours/ Week:	L:T:P:2:2:0	**Credits:**	3
Total Lecture Hours:	28+28	**CIE Marks:**	50
Course Code:	S5BTPE16	**SEE Marks:**	50

Course objectives: This course will enable students to:	
1.	Study the basic concepts of isolation & purification of products at commercial scale from fermented broth
2.	Learn about Industrial Applications of various processes for isolation of products such as enzymes, antibiotics, and organic acids
3.	Study the membrane separation process
4.	Understand the product enrichment operations
5.	Learn about the principle & operation of chromatography techniques

UNIT I
Industrial Bio-separation Process: Introduction, Different sectors in biotechnology, Characterization of starting materials, Characterization of bioprocess, Selection of Operations in Separation Processes, Selection of Separation sequence, Process design criteria for various classes of Bioproducts (schematic, flow-chart). Characteristics of fermentation broth: Morphology of cells and Structure of Cell Wall.
6+6 Hours

UNIT II
Primary Separation and Recovery Process: Recovery of High Volume, Low Value products e.g. Citric acid, Ethanol & Penicillin and Low Volume, High Value Products e.g. Recombinant Proteins: Insulin. Intracellular Products, Cell wall, Cell disruption -Physical, Chemical & Enzymatic and Mechanical, Removal of Insoluble, Biomass (and Particulate Debris): Flocculation, Sedimentation, Centrifugation and Filtration.
5+5 Hours

UNIT III
Primary Separation and Recovery Process: Recovery of High Volume, Low Value products e.g. Citric acid, Ethanol & Penicillin and Low Volume, High Value Products e.g. Recombinant Proteins: Insulin. Intracellular Products, Cell wall, Cell disruption -Physical, Chemical & Enzymatic and Mechanical, Removal of Insoluble, Biomass (and Particulate Debris): Flocculation, Sedimentation, Centrifugation and Filtration.
6+6 Hours

UNIT IV
Enrichment Operations: Precipitation Methods with Salts: Principle e.g. taking Ammonium Sulfate Salt, Organic Solvents (e.g. Polyethylene Glycol) (Principles & Methods). Extractive Separations: Liquid-Liquid Extraction, Aqueous Two-phase Extractions, Supercritical Extraction, In-situ product removal/Integrated Bioprocessing. Enzyme processing using Ultrafiltration membranes; Separation by Liquid Membranes, Ultra filtration & Reverse osmosis.
6+6 Hours

UNIT V
Product Resolution & Fractionation: Adsorptive Chromatographic Separation Processes-TLC, PC, Normal Phase, HPLC Principle, Description & Example of Separation of compounds. Hybrid separation technologies, Membrane Chromatography Electro Chromatography-Principle, Gel Permeation Chromatography-Principle, Equipment & Applications, GC (Principle, equipment & applications). Dialysis-Principle, Different Membranes. Crystallization-Principles, Methods & Examples.
5+5 Hours

TEXT BOOKS		
1	Belter P.A., Cussier E. and Wei, Shan Hu.	Bioseparation–Downstream Processing for Biotechnology, Wiley Interscience Pub, 1988.

REFERENCE BOOKS		
1	Raja Ghosh	Principles of Bioseparations Engineering, 2006

2	Shuler and Kargi	Bioprocess Engineering Prentice Hall, 1992

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Explain how downstream process is applied in the Pharmaceutical Industry for Production of Life Saving Drugs
CO2	Describe & Apply the Isolation & Purification of Products from Microbial Origin
CO3	Explain the Principles of Membrane Separation Process
CO4	Apply sophisticated Analytical Equipment for Detection of Various Impurities to ascertain its Permissible Level
CO5	Describe the Equipment required for Commercial Scale Downstream Process along with its Operating Procedures

Course Articulation Matrix

		POs											**PSOs**		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
COs	**CO1**	2	2			2							2		
	CO2	2	2			2							2		
	CO3		2	2		2							2		
	CO4		2	2		3							2		
	CO5				3	3	2		2	3	2		2		

BIOMEDICAL IMAGING AND HEALTH INFORMATICS

Contact Hours/ Week:	L:T:P:: 3:0:0	**Credits:**	3
Total Lecture Hours:	42	**CIE Marks:**	50
Course Code:	S5BTPE17	**SEE Marks:**	50

Course objectives: This course will enable students to:	
1.	Study basic skills and knowledge in health imaging
2.	Understand the role of nuclear imaging
3.	Understand the role of information in health management
4.	Study the health management systems
5.	Learn ethical and diversity issues in health informatics.

UNIT I
Biomedical Imaging: Introduction to Biomedical Imaging, its history and development, Imaging with ionizing radiation: Physics of x-ray imaging, X-ray generators and detectors. Dual-energy X-ray absorptiometry (DEXA), Computed Tomography: Principles of image formation and reconstruction techniques, Computed Tomography: Instrumentation and Data analysis.
9 Hours

UNIT II
Nuclear Imaging modalities: Scintigraphy, positron emission tomography (PET) & single-photon emission computed tomography (SPECT), Magnetic Resonance Imaging: Physical foundations of Magnetic Resonance Imaging: Image formation. Role of fluorophores, Ultrasound Imaging, spectral imaging, and medical image processing labs. Outlook and trends in biomedical imaging. Use of fluorophores in imaging.
8 Hours

UNIT III
Medical Imaging Applications: Digital radiography, Imaging informatics, Patient registration, Radiology information system, Picture archiving and communication system, Analysis of Functional NeuroImages, 3DSlicer, Analyze, CARET, CAVEman, FreeSurfer, ImageJ, InVesalius, ITK-SNAP, Mango, OsiriX. **Medical and biological signal applications**: Medical monitor, Holtermonitor, Automated ECG interpretation, Open ECG project ,MECIF Protocol, SCP-ECG, European Data Format, OpenXDF
9 Hours

UNIT IV
Hospital management and Information systems: Hospital Management and Information Systems (HMIS), its need, benefits, capabilities, development, functional areas. Modules forming HMIS and Internet, Pre-requisites for HMIS, why HMIS fails, health information system, disaster management plans, advantages of HMIS. Health Level 7 (HL7). Study of picture archival & communication systems (PACS), PACS Administrator, PACS Technology overview, PACS Administration: The Business Perspective.
8 Hours

UNIT V
Electronic Health Records: Pathology Laboratory Module, Blood Bank Module, Operation Theatre Module, Medical Stores Module, Pharmacy Module, Inventory Module, Radiology Module, Medical Records Index Module, Administration Module, Personal Registration Module, Employee Information Module, Financial modules, Health & Family Welfare, Medical Research, Communication, General Information.
8 Hours

TEXT BOOKS		
1	Phillip Olla, Phillip Olla, Joseph Tan	Digital Health Care: Perspectives, Applications, and Cases, First edition, 2023

REFERENCE BOOKS		
1	Edward H. Shortliffe,	Medical Imaging: Technology and Applications: 0387289860,

	James J. Cimino	2019, Springer, 1st edition
2	Edward H. Shortliffe, James J. Cimino	Foundation of Knowledge: Integrating Informatics into Healthcare Practice, 2nd edition, 2021, Jones & Bartlett Learning; 1284182096

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Understand the different instrumentation related to medical imaging
CO2	Comprehend the mechanism of action of nuclear-based medical imaging
CO3	Relate the need of information technology in Healthcare sector
CO4	Analyse the role of information technology in healthcare data management system
CO5	Appreciate the role of electronic databases in the healthcare system

Course Articulation Matrix

		POs											**PSOs**		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
COs	**CO1**	2				3									2
	CO2	2	1			3	1	1							3
	CO3	2	1												1
	CO4	2	1				1	1	1						1
	CO5	1	1			2									2

1: Low, 2: Medium, 3: High

RESEARCH METHODOLOGY AND IPR

Contact Hours/ Week:	L:T:P:: 3:0:0	**Credits:**	3
Total Lecture Hours:	42	**CIE Marks:**	50
Course Code:	SHS04	**SEE Marks:**	50

Course objectives: This course will enable students to:	
1.	Differentiate between alternative research methods and methodology
2.	Prepare a literature review and data collection plan
3.	Develop a research methodology and interpret the key elements of report.
4.	Demonstrate the basic concepts of Intellectual Property Rights(IPR) and the
5.	Procedure of obtaining Patents, Copyrights and Trade marks.

UNIT I
RESEARCH METHODOLOGY: Objectives and motivation of research - Types of research - Research approaches - Significance of research - Research methods verses methodology - Research and scientific method - Importance of research methodology - Research process - Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, necessary instrumentations- Criteria of good research. Defining the research problem: Definition of research problem - Problem formulation - Necessity of defining the problem - Technique involved in defining a problem.
8 Hours

UNIT II
LITERATURE SURVEY AND DATA COLLECTION: Importance of literature survey - Sources of information - Assessment of quality of journals and articles - Information through internet. Effective literature studies approaches, analysis, plagiarism, and research ethics. Data - Preparing, Exploring, examining and displaying. Referencing methods
8 Hours

UNIT III
RESEARCH DESIGN AND ANALYSIS: Meaning of research design - Need of research design - Different research designs - Basic principles of experimental design - Developing a research plan - Design of experimental set-up - Use of standards and codes. Overview of Univariate/Multivariate analysis, Hypotheses testing and Measures of Association. Presenting Insights and findings using written reports and oral presentation.
8 Hours

UNIT IV
INTELLECTUAL PROPERTY RIGHTS (IPR): Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. Role of WIPO and WTO in IPR establishments, Right of Property, Common rules of IPR practices, Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance.
9 Hours

UNIT V
PATENT RIGHTS (PR): Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System, IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs. Licenses, Licensing of related patents, patent agents, Registration of patent agents.
9 Hours

TEXT BOOKS		
1	Prof. Kothari C. R.	"Research methodology: Methods and techniques", New Age International, 5th Edition, 2023. ISBN-13: 978-9389802559
2	R. Ganesan	"Research Methodology for Engineers", MJP Publishers, Chennai, 2011.

REFERENCE BOOKS		
1	Cooper Donald R, Schindler Pamela S and Sharma JK	"Business Research Methods", Tata McGraw Hill Education, 11th Edition, 2012.
2	Catherine J. Holland	"Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets", Entrepreneur Press, 2007.
3	David Hunt, Long Nguyen, Matthew Rodgers	"Patent searching: tools &techniques", Wiley, 2007.
4	The Institute of Company Secretaries of India, Statutory body under an Act of parliament	"Professional Programme Intellectual Property Rights, Law and practice", September 2013.
5	Peter S. Menel Mark A. Lemley, Robert P. Merges	"Intellectual Property in the New Technological-Vol. I Perspectives, 2021.
6	Laura R. Ford	"The Intellectual Property of Nations: Sociological and Historical Perspectives on a Modern Legal Institution Paperback -2021.

Course Outcomes:
Upon completion of this course the student will be able to:

CO1	Describe the research process & formulate research problem
CO2	Perform literature review, manage data & practice research ethics
CO3	Practice basic principles of experimental design, use standard codes and carry out research analysis
CO4	Distinguish between types of innovation, describe patenting procedure, maintenance and role of IPR establishments
CO5	Identify the significance of patent rights, licensing, technology transfer & manage patenting system

Course Articulation Matrix

		POs											PSOs		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
COs	**CO1**		3	2			1	2	1			2	1		
	CO2		3	2				2	1	1		2		1	
	CO3		3	2				2	1			2			1
	CO4		3	2				2				2	1	1	1
	CO5		3	2				2				2	1	1	1

1: Low, 2: Medium, 3: High

ENVIRONMENTAL STUDIES

Contact Hours/ Week:	L:T:P:: 2:0:0	**Credits:**	2
Total Lecture Hours:	28	**CIE Marks:**	50
Course Code:	SHS05	**SEE Marks:**	50

Course objectives: This course will enable students to:	
1.	Describe the problems of depletion of natural resources due to deforestation, agricultural practices, and adverse environmental effects, pesticides, soil erosion, mining.
2.	Explain the different types of energy- renewable, non-renewable and energy conservation, the impact of environmental pollution on water quality, air quality, soil pollution and noise pollution.
3.	Describe solid waste management- disposal, treatment of different types of solid waste including MSW, e-waste, biomedical waste, the societal impact of environmental issues- ozone layer depletion, GHG effects, water conservation and harvesting and environmental protection & Acts

UNIT I
Introduction: Components of Environment and their interactions **Natural Resources:** Forest Resources-Deforestation, Causes of deforestation, Environmental effects of deforestation and solutions • Water resources, World's water reserves, Hydrological cycle • Land resources, Land degradation. Soil erosion, Causes and prevention, Soil conservation and its types• Numerical problems on rainfall & runoff.
6 Hours

UNIT II
Energy and resources: • Types of Energy-Renewable, Non-renewable & sustainable energy & their advantages and disadvantages• Renewable energy sources- Solar energy, Wind energy, Tidal energy, Ocean thermal energy. Geothermal energy, Hydroelectric power, Biomass energy, Hydrogen energy, Thermal power- environmental impacts • Conservation of energy • Numerical problems on Solar energy, Wind power .
6 Hours

UNIT III
Environmental pollution: • Sources of pollution- Natural and anthropogenic sources • Pollutants – Classification & their effects on environment • Air Pollution -Composition of clean air, Sources of air pollution, Effect of air pollution on human health and climate • Water quality – Potable water, Wholesome water, Sources of water pollution Polluted water & Contaminated water• Common impurities in water(physical, chemical and bacteriological), Effects of impurities on human health • Soil Pollution – Sources, effects, and its control • Noise pollution- Sources of noise, Effects on human health & its control Numerical problems on pH, hardness of water, noise pollution .
6 Hours

UNIT IV
Solid Waste Management: • Refuse, Garbage, Rubbish, Ash, types of solid waste• Necessity of safe disposal, Impacts on human health and environment• Classification of solid wastes- Quantity and

composition of MSW, Collection of solid waste- methods• Disposal of solid waste-Sanitary land-fill• E-waste- Problems and solutions• Biomedical waste-Impacts on human health, storage, treatment methods and disposal• Numerical problems on moisture content, density & proportioning of land fill .
5 Hours

UNIT V
Sustainable development: Issues on energy utilization, water conservation, concept of 3 R's, Rain water harvesting- methods • Global environmental issues: Population growth, Urbanization, Global warming, Acid rains, Ozone layer depletion & controlling measures. • Environmental acts, Regulations, Role of state & central governments, • Numerical problem on carbon foot print & rainwater harvesting.
5 Hours

TEXT BOOKS		
1	Joseph, B	Environmental Studies (2009), India: Tata McGraw-Hill. ISBN: 9781283922524
2	Tripathi, A. K	Environmental Studies(2016), India: Energy and Resources Institute. ISBN:9788179935828

REFERENCE BOOKS		
1	Erach Bharucha	Environmental studies for Undergraduate Courses, 1st Edition, University Press, (2013)
2	Santhosh Kumar Garg	Environmental Science and Engineering Ecology and Environmental Studies, Khanna Publishers, (2015), ISBN-10 : 8174092188 ISBN-13 : 978-8174092182

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Explain the importance of forestation, effects of deforestation, land degradation, adverse effects of mining on environment, using the principles of natural sciences compute the runoff from rainfall & estimates the conservation of water for beneficial use of humans.
CO2	Choose appropriate renewable energy sources by formulating, reviewing the literature, calculating the power potential of solar & wind energy and using the principles of natural sciences.
CO3	Explain the effects of pollution of air, water, soil & noise on humans and the environment, identify and analyze the pollution problems related to air, water, soil & noise and quantify pollution levels & draw valid inferences using the principles of engineering sciences
CO4	Describe Impact of solid waste on human health and environment, its safe disposal. Use population data & compute percapita solid waste generation, land area requirement for sanitary landfill
CO5	Appreciate the importance of sustainable development, current global environmental issues, present state & central governments protection acts, compute carbon footprint using data(vehicles/industries) & asses its impact on the environment.

Course Articulation Matrix

		POs											PSOs		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
COs	**CO1**	2					2								1
	CO2	2					2								1
	CO3	2					2								1
	CO4	2					2								1
	CO5	2					2								1

1: Low, 2: Medium, 3: High

Semester VI
2025-2026

GENOMICS AND PROTEOMICS

Contact Hours/ Week:	L:T:P:: 3:0:2	**Credits:**	4
Total Lecture Hours:	42	**CIE Marks:**	50
Course Code:	S6BTI01	**SEE Marks:**	50

Course objectives: This course will enable students to:	
1.	Grasp the concepts of chromosome content, gene localization within the genome, and the roles of non-coding and repetitive DNA segments in the context of genomics.
2.	Gain a deep understanding of advanced DNA sequencing techniques and related concepts essential for executing genome projects.
3.	Develop a comprehensive understanding of protein sequencing techniques and the use of mass spectrometry for protein identification in proteomics.
4.	Gain a thorough understanding of various techniques used for protein identification and expression analysis in quantitative proteomics
5.	Understand the bioinformatics techniques for analyzing genomics and proteomics data using computational tools and algorithms.

UNIT I
Introduction to Genomics: Major Differences between Eukaryotic, Bacterial and Archaea chromosomes. General features of the Eukaryotic genome and chromosomes. C value paradox, organization of eukaryotic genomes into chromosomes. Analysis of chromosomes using Genome Browser, BioMart. Analysis of chromosomes by the ENCODE project (scope and conclusions). Eukaryotic genome (noncoding and repetitive DNA sequence, Transposon derived repeats). Gene content of eukaryotic chromosomes, finding genes in eukaryotic genomes.
8 Hours

UNIT II
Genome Sequencing & Genome Projects: DNA sequencing methods: Sanger dideoxy method, Maxam Gilbert method, Automated Fluorescence method. Introduction to Next Generation Sequencing technology (NGS). Significant applications of NGS technologies. Comparison of NGS technologies with Sanger sequencing. Workflow of NGS experiments (from experimental design to analysis) – the experimental design and sample preparation, generating sequence data to FASTQ analysis and Genome assembly. Software: FASTQC and velvet. Genome analysis: Main types of genome analysis: Denovo sequencing, sequencing, transcriptome and epigenetics. Large scale – model organism sequencing projects: 1001 genome project, genome 10k project
8 Hours

UNIT III
Introduction to Proteomics: Structural Organization of Proteins. Proteomics: introduction, basic principles of proteomics. The origin and scope of proteomics. Proteomics and the new biology. Overview of analytical proteomics. Evolution from protein chemistry to proteomics. Protein sequencing and techniques: Protein sequencing by Edman technique. Molecular biology techniques mass spectrometry techniques. Mass spectrometry-based methods for protein identification: Proteomics approaches: The bottom-up approach and top-down methods. Steps involved in

proteomics. Ionization techniques: MALDI and ESI: Concepts, principles and methodology.
8 Hours

UNIT IV
Mass spectrometry: Basic principles and instrumentation. Schematic representation of a mass spectrometer. Mass analysers, ion trap and LTQ orbitrap. Quantitative proteomics and protein modifications: Protein quantification: Introduction, types of quantification, principles, and methodology. Isobaric tagging for relative and absolute quantitation (iTRAQ), Tandem mass tag (TMT), stable isotope labelling by amino acids in cell
9 Hours

UNIT V
Bioinformatics analysis of genomics and proteomics data: Concepts of Genomic and proteomics data, file formats, public databases, analyzing genome and proteome data. Functional analysis of genomics and proteomics data: GO term identification and enrichment analysis, pathway analysis, analysis of protein-protein-interactions. Protein domain and motif analysis.
9 Hours

TEXT BOOKS		
1	Richard M. Twyman	Principles of Proteomics, Garland Science, 2nd Edition, 2008, 978-0133779421
2	Devarajan Thangadurai, Jeyabalan Sangeetha	Genomics and Proteomics, 978-981-5179-93-4, Apple Academic Press Inc, 978-1771881142, 2015, 1st edition

REFERENCE BOOKS		
1	S.B. Primrose and R.M. Twyman	Principles of Genome analysis and Genomics, Blackwell Publishing, 3 rd Edition, 2003, 978 1405101202
2	Gibson G & Muse SV	A Primer of Genome Science, Sinauer Associates, 2nd Edition, 2004, 978-1025101156

Course Outcomes:
Upon completion of this course the student will be able to:

CO1	Describe the concepts of chromosome content, gene localization within the genome, and the functions of non-coding and repetitive DNA segments in genomics.
CO2	Apply the advanced DNA sequencing techniques and related concepts for executing genome projects.
CO3	Illustrate protein sequencing techniques and Apply the concept of mass spectrometry for protein identification in proteomics.
CO4	Apply various techniques used for protein identification and expression analysis in quantitative proteomics.
CO5	Develop proficiency in bioinformatics techniques for analyzing genomics and proteomics data using computational tools and algorithms.

Course Articulation Matrix

		POs										PSOs		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
COs	**CO1**	2	1											2	
	CO2	2	1											2	
	CO3	2	2											2	
	CO4	2												2	
	CO5	2	2											2	

1: Low, 2: Medium, 3: High

GENOMICS AND PROTEOMICS LABORATORY

Contact Hours/ Week:	L:T:P:: 0+0+2	**Credits:**	0
Total Lecture Hours:	28	**CIE Marks:**	50
Sub. Code:	S6BTI01	**SEE Marks:**	0

Course objectives: This course will enable students to:	
1.	Grasp the concepts of chromosome content, gene localization within the genome, and the roles of non-coding and repetitive DNA segments in the context of genomics.
2.	Gain a deep understanding of advanced DNA sequencing techniques and related concepts essential for executing genome projects.
3.	Develop a comprehensive understanding of protein sequencing techniques and the use of mass spectrometry for protein identification in proteomics.
4.	Gain a thorough understanding of various techniques used for protein identification and expression analysis in quantitative proteomics
5.	Understand the bioinformatics techniques for analyzing genomics and proteomics data using computational tools and algorithms.

List of Experiments

1	Working with SRA database for uploading and downloading genomics data
2	Working with PRIDE database for uploading and downloading proteomics data
3	NGS raw data quality checking and validation
4	NGS raw data trimming and validation
5	De novo assembly for RNA data sets
6	Functional analysis of Genomic and proteomics data sets using Gene ontology (GO)
7	Differential expression analysis of Gene / protein list
8	Integrated transcriptomic and proteomics data analysis and protein-protein interaction analysis
9	References genome alignment of Whole Genome (WGS) data sets
10	References genome alignment of Whole Exome (WES) data sets
11	Working with genome browser and genome visualization
12	Demo on CLC genomic workbench

TEXT BOOKS

1	Richard M. Twyman	Principles of Proteomics, Garland Science, 2nd Edition, 2008, 978-0133779421
2	Devarajan Thangadurai, Jeyabalan Sangeetha	Genomics and Proteomics, 978-981-5179-93-4, Apple Academic Press Inc, 978-1771881142, 2015, 1st edition

REFERENCE BOOKS		
1	S.B. Primrose and R.M. Twyman	Principles of Genome analysis and Genomics, Blackwell Publishing, 3 rd Edition, 2003, 978 1405101202
2	Gibson G & Muse SV	A Primer of Genome Science, Sinauer Associates, 2 nd Edition, 2004, 978-1025101156

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Describe the concepts of chromosome content, gene localization within the genome, and the functions of non-coding and repetitive DNA segments in genomics.
CO2	Apply the advanced DNA sequencing techniques and related concepts for executing genome projects.
CO3	Illustrate protein sequencing techniques and Apply the concept of mass spectrometry for protein identification in proteomics.
CO4	Apply various techniques used for protein identification and expression analysis in quantitative proteomics.
CO5	Develop proficiency in bioinformatics techniques for analyzing genomics and proteomics data using computational tools and algorithms.

Program Articulation matrix Mapping of course outcomes with program outcomes

		POs										**PSOs**			
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
COs	**CO1**	2	1											2	
	CO2	2	1											2	
	CO3	2	2											2	
	CO4	2												2	
	CO5	2	2											2	

1: Low, 2: Medium, 3: High

IMMUNOLOGY AND IMMUNOTECHNOLOGY

Contact Hours/ Week:	L:T:P:: 4+0+0	**Credits:**	4
Total Lecture Hours:	56	**CIE Marks:**	50
Sub. Code:	S6BT01	**SEE Marks:**	50

Course objectives:	
This course will enable students to:	
1.	Study the different types of cells and organs of immune system
2.	Understand the importance of B-cell and T-cell functions in immune response.
3.	Learn the concepts of tolerance, hypersensitivity reactions and autoimmune diseases.
4.	Study the mechanism of transplantation and role of immunosuppressant.
5.	Understand the concepts of immunological techniques in diagnosis of diseases.

UNIT I

The Immune System: Introduction - Anatomy of immune system, cells and organs of the immune system - Primary and secondary Lymphoid organs, antigens, different characteristics of antigens, mitogens, hapten, immunogen and adjuvants.

Classification of Immune Responses: Types of immune response – Racial, special and individual, Classification of immune system – innate - Skin and mucosal surface, Physiological Barriers, Phagocytic Barriers, Inflammation and adaptive immunity.

11 Hours

UNIT II

Humoral Mediated Immunity: B-lymphocytes and their activation - T-cell dependent activation and T-cell independent activation; structure and function of immunoglobulins, immunoglobulin classes and subclasses, idiotypes and anti-idiotypic antibodies, genetic control of antibody production.

Cell-Mediated Immunity: Thymus derived lymphocytes (T cells) - their ontogeny and types- T_H cells, T_S cells, Tc cells and T_D cells, mechanism of T cell activation,MHC Complex – Structure, classification and its biological role, antigen presenting cells (APC) – professional and non-professional, macrophages, dendritic cells, langerhans cells, mechanism of phagocytosis, Antigen processing and presentation – class I and class II MHC.

Aging and the immune system (immunosenescence): Effects of aging on innate immunity, The effects of aging on T cell immunity, The effects of aging on humoral immunity,Immunosenescence and morbidity, mortality and longevity.

13 Hours

UNIT III

Immune Regulation and Tolerance: Complement activation - classical, properdin and lectin pathway and their biological functions, complement fixation test, cytokines and their role in immune response, immunotolerance and its types - Low zone, High zone, Classical and Infectious tolerance, Theories of Tolerance Induction – central and peripheral, Hypersensitivity & its types - immediate and delayed type; Coombs and Gells classification.

Immunological Disorder: Overview of Autoimmunity, criteria and causes of autoimmune diseases - Autoimmune haemolytic anemia, myasthenia gravis and rheumatoid arthritis.

12 Hours

UNIT IV
Transplantation Immunology: Immunological basis of graft and its types - autograft, allograft, isograft and xenograft, types of rejection – hyperacute, acute and chronic and mechanism of graft rejection, role of HLA in graft rejection; cellular and molecular mechanism – direct and indirect presentation, tissue typing, immunosuppression - definition and immunosuppressive drugs – glucocorticoids, cytostatics, antibodies and drugs on immunophilins. **Tumor of the Immune System:** Tumor specific antigens and its types – TSA and TAA, tumor potent immune response – NK cells and Macrophages.
10 Hours

UNIT V
Molecular Immunology: Application of PCR technology to produce antibodies, Production of monoclonal and polyclonal antibodies and their applications. Stem cells isolation, culturing and applications to immunology. **Immunological Techniques:** Antigen antibody interaction – Precipitation reactions, Agglutination reactions, Blood typing- A, B, ABO & Rh, principles and applications of ELISA, Radioimmunoassay (RIA), immuno-electrophoresis, Immunofluorescence, chemiluminescence assays and flow cytometry.
10 Hours

TEXT BOOKS		
1.	Kuby	Immunology, W. H. Freeman & Company, 8th Edition, 2018, 1319114709
2.	Abul Abbas Andrew Lichtman Shiv Pillai -	Cellular and Molecular Immunology is included 9th Edition, 2017, 9780323479783 is included.

REFERENCE BOOKS		
1	Roitt I	Essential Immunology, Wiley-Blackwell Publications, 13th Edition, 2017, 9781118415771
2	Ashim K Chakravarthy	Immunology & Immunotechnology, Oxford University Press, 1st Edition, 2011, 9780195676884

Course Outcomes:

Upon completion of this course the student will be able to:

CO1	Classify and describe the functions of the cells and organs of the immune system in defensive mechanism.
CO2	Illustrate the immune response against infectious antigens.
CO3	Interpret and analyse the role of complement system and tolerance against foreign elements and compare different types of hypersensitivity reactions.
CO4	Analyse the mechanism of graft rejection in transplantation and the importance of immunosuppressant.
CO5	Outline the concepts of vaccine and antibody production and apply immunological techniques to diagnose diseases.

Program Articulation matrix Mapping of course outcomes with program outcomes

		POs											PSOs		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
COs	**CO1**	2	1												2
	CO2	2	1												2
	CO3	2	2												2
	CO4	2	2												2
	CO5	2	2												2

1: Low, 2: Medium, 3: High

FOOD BIOTECHNOLOGY

Contact Hours/ Week:	L:T:P::3:0:0	**Credits:**	3
Total Lecture Hours:	42	**CIE Marks:**	50
Course Code:	S6BTPE12	**SEE Marks:**	50

Course objectives: This course will enable students to:	
1.	Learn the various constituents of food, intrinsic and extrinsic parameters that influence the food.
2.	Understand the Characteristics, manufacturing process and role of biotechnology in the food industry.
3.	Know the various types of microorganisms found in foods and their detection.
4.	Understand the different types of food preservation techniques.
5.	Understand the principles of fluid foods and measurement of various rheological properties.

UNIT I

Food science: Introduction, constituents of food, colloidal systems in food, stability of colloidal systems, types of food starches, soluble fiber (pectin, gums, mucilage), protein rich foods, popular fats and oils in foods, factors leading to rancidity and reversion, prevention of rancidity, commercial uses of fats and oils.

Intrinsic and extrinsic parameters of foods: Minerals in foods. Aroma compounds in foods, Food flavours, Browning reactions; Food additives: Vitamins, amino acids, minerals. Aroma substances flavour enhancers (monosodium glutamate, nucleotides). Sugar substitutes (sorbitol Sweeteners-saccharin, cyclamate). Food colours. Anti-nutritional factors and Food contaminants. Chemical changes during processing of volatile compounds.

9 Hours

UNIT II

Food industry: Characteristics of Food Industry. Food manufacturing& processing: Objectives of

food processing, effect of processing on food constituents, methods of evaluation of food, proximate analysis of food constituents, Nutritional value, labeling of constituents (soya foods, organic foods, dietary foods (for individuals, for specific groups), nutritional food supplements). Food packaging, edible films. Factors influencing food product development: marketing, and promotional strategies, Market Place, ecologically sustainable production; Risks and benefits of food industry.

Biotechnology in food industry: Applications of Biotechnology to food industry, impact on nutritional quality, utilization of enzymes (hydrolases and lipases), applications of immobilized enzymes in food industry, economic aspects, enzyme generation of flavor and aroma compounds, flavor lipid modifications. Tissue Culture techniques, microbial transformations, regulatory and social aspects of BT.

9 Hours

UNIT III

Microorganisms in foods: Primary Sources of microorganisms found in Foods Synopsis of Common Food-borne bacteria, genera of Molds, genera of Yeasts. Microbial spoilage of vegetables, fruits, fresh and processed meats, poultry and seafood.

Detection of microorganisms: Culture, Microscopic and Sampling Methods; 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.

8 Hours

UNIT IV

Food preservation: Food Preservation using irradiation: Characteristics of Radiations of Interest in Food Preservation, Principles underlying the Destruction of Microorganisms by Irradiation, Processing of Foods for Irradiation, Application of Radiation. Legal Status of Food Irradiation, Effect of Irradiation on Food constituents; Food Preservation with Low Temperatures, Food Preservation with High Temperatures, Preservation of Foods by Drying. Packaging materials; Characteristics, properties and their design. Packaging requirement for Different processed and unprocessed foods.

8 Hours

UNIT V

Food technology: Properties of fluid foods, Measurement of rheological parameters, properties of granular food and powders; properties of solids foods. Measurement of food texture. Thermal properties of frozen foods. Prediction of freezing rates: Qualitative explanation via Plank's equation, and Neumann problem. Food freezing equipment: Air blast freezers, Plate freezers and immersion freezers. Food dehydration: Estimation of drying time, constant rate period and falling rate period dehydration. Equipment: fixed tray dehydration, cabinet drying, tunnel drying. Freeze Dehydration, calculation of drying times, Industrial freeze-drying. Equipment related to pulping, Fruit juice extraction, Dehulling, and distillation. Conceptual numerical.

8 Hours

TEXT BOOKS

1	William C. Frazier, Dennis C. Westhoff, N.M. Vanitha	Food Microbiology, McGraw Hill. 5th Edition, 2017, 978-1259062513.
2	Jay, James M, Loessner, Martin J, Golden, David A.	Modern Food Microbiology, Springer. 7th Edition. 2008, 978-0-387-23413-8.

REFERENCE BOOKS		
1	Gustavo F Gutierrez Lopez, Gustavo V Barbosa Canovas	Food Science and Food Biotechnology, CRC Press Inc, 1st Edition, 2003, 9781566768924.
2	S. Bielecki, J. Polak, J. Tramper. Elsevier,	Food Biotechnology, Elsevier Science Ltd, 1st Edition, 2000, 978-0444505194.

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Describe the various constituents of food, intrinsic and extrinsic parameters that influences the food.
CO2	Explain the Characteristics, manufacturing process and role of biotechnology in food industry
CO3	Analyze the different types of Sources of microorganisms found in Foods and their detection.
CO4	Apply different types to food preservation techniques for various types of food products. Illustrate the principles of fluid foods and measurement of various rheological properties.
CO5	Illustrate the principles of fluid foods and measurement of various rheological properties.

Course Articulation Matrix

		POs											PSOs		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
COs	**CO1**	2	1												2
	CO2	2	1												2
	CO3	2	2												2
	CO4	2	2												2
	CO5	2	2												2

VACCINE TECHNOLOGY

Contact Hours/ Week:	L:T:P::3:0:0	**Credits:**	3
Total Lecture Hours:	42	**CIE Marks:**	50
Course Code:	S6BTPE13	**SEE Marks:**	50

Course objectives: This course will enable students to:	
1.	Study the various forms of vaccines
2.	Learn the techniques of vaccine production and their delivery methods

3.	Equip with various techniques for vaccine production
4.	Learn various methods of delivery of vaccines
5.	Give an exposure on the regulatory and biosafety measures of vaccine

UNIT I
Vaccines: Vaccines - definition, History of vaccine development, requirements for immunity, Basics of immunization- Epitopes, linear and conformational epitopes, characterization and location of APC, MHC and immunogenicity; immunization programs and role of WHO in immunization programs
8 Hours

UNIT II
Types and methods of application: Active and passive immunization; Viral/bacterial/parasite vaccine differences, methods of vaccine preparation - Live, killed, attenuated, sub unit vaccines; Vaccine technology- Role and properties of adjuvants, recombinant DNA and protein based vaccines, plant-based vaccines, edible vaccines, reverse vaccinology, combination vaccines, therapeutic vaccines; Peptide vaccines, conjugate vaccines; Cell based vaccines. Uses of nanoparticles in vaccine application. Reverse Vaccinology.
10 Hours

UNIT III
Delivery methods: Needle free Vaccine delivery, ISCOMS, Adjuvant delivery systems, Intranasal and inhaled vaccine delivery, liquid jet and solid dose injectors, development of gene-based vectors, topical method of delivery, intranasal method, benefits and disadvantages of each method of delivery .
8 Hours

UNIT IV
Techniques in vaccine production Purification, preservation and formulation techniques. Commercial production of DPT, TT, polio, rabies and hepatitis vaccines, case studies of different vaccinations, Covid vaccines case study
8 Hours

UNIT V
Regulatory and biosafety measures: Quality assurance in vaccine production. Regulatory issues - Environmental concerns with the use of recombinant vaccines - Disease security and biosecurity principles and OIE guidelines .
8 Hours

TEXT BOOKS		
1	Blaine A. Pfeifer, Andrew Hill	Vaccine Delivery Technology: Methods and Protocols, 2021 [1st ed.] 9781071607947, 9781071607954

REFERENCE BOOKS		
1	Camilla Foged, Thomas Rades, Yvonne Perrie,	Advances in Delivery Science and Technology Subunit Vaccine Delivery, 2016 1 ed.

	Sarah Hook (eds.)	978-1-4939-1416-6, 978-1-4939-1417-3

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Describe the principle of vaccination for immunization processes and elaborate on their applications
CO2	Elaborate on the types of vaccines and their method of application
CO3	Describe the vaccine formulation, purification and preservation
CO4	Explain the advanced methods of vaccine delivery
CO5	Discuss the quality measures and regulatory issues concerned with vaccine production

Course Articulation Matrix

		POs											**PSOs**		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
COs	**CO1**	3	1												2
	CO2	3	2												2
	CO3	3	2												2
	CO4	3	2												2
	CO5	3	2												2

1: Low, 2: Medium, 3: High

SYSTEM BIOLOGY

Contact Hours/ Week:	L:T:P:: 3:0:0	**Credits:**	3
Total Lecture Hours:	42	**CIE Marks:**	50
Course Code:	S6BTPE14	**SEE Marks:**	50

Course objectives: This course will enable students to:	
1.	Understand the basic concepts of biological networks, their models, tools and statistical measures to characterize their properties.
2.	Learn the basic concepts, principles and methods of metabolic engineering networks and flux balance analysis
3.	Understand the process of drug development, from target identification to final drug registration via computational tools.
4.	Understand the process of drug development and techniques used in assessing the structural

	similarities.
5.	Understand the use of Proteomics in developing personalized medicines and drugs for globally important diseases

UNIT I
Introduction: Introduction and basic concepts in biological systems. Genotype-phenotype mapping - Concepts of genotypes and phenotypes, genotype networks and fitness landscapes. Gene regulation networks - Negative and positive regulation in transcription networks. Feed-forward loops - Oscillatory circuits. Optimality and robustness - Robustness in biological systems. Principles of optimality. Stochasticity in biological processes
9 Hours

UNIT II
Network biology: Introduction to Static Networks, Network Biology and Applications, Reconstruction of Biological Networks, Dynamic Modelling of Biological Systems: Introduction, Solving ODEs & Parameter Estimation, Constraint based approaches to Modelling Metabolic Networks, Perturbations to Metabolic Networks, Elementary Modes, Applications of Constraint based Modelling, Metabolic Flux balance Analysis, Modelling Regulation, Host-pathogen interactions, Robustness of Biological Systems.
9 Hours

UNIT III
Drug design and development: Rational Approaches to Drug Design and Development, Drug targets, Lead Identification and Modification, Computer-Aided Drug Design, Drug Delivery, Pre-clinical and Clinical Testing. Steps in Computational drug 16.07.2023 MKV-TEMPLATE for IPCC (26.04.2022) Annexure-III design: Molecular Modelling, Importance of the Bioactive Conformation, Molecular Mimicry, Structural Similarities and Superimposition Techniques, Three – Dimensional Description of Binding Site Environment and Energy Calculation, Automatic Docking Methods, Database Search Approaches, Structure Construction Methods with known and unknown 3D Structures of the Receptor, Web based programs available for molecular modelling, molecular docking, energy minimization techniques, ADME studies and validations.
8 Hours

UNIT IV
Biological system modelling: Modeling the Activity of Single Gene - A Probabilistic Model of a Prokaryotic Gene and its regulation. Modeling Biochemical Networks - Atomic-Level Simulation and Modeling of Biomacromolecules, Kinetic Models of Excitable Membranes and Synaptic Interactions - Stochastic Simulation of Cell Signaling Pathways -Analysis of Complex Dynamics in Cell Cycle Regulation. Modeling Large Biological Systems from Functional Genomic Data: Parameter Estimation -Cellular Simulation - Towards a Virtual Biology Laboratory - Computational Cell Biology: The Stochastic Approach, Computer Simulation of the Whole Cell - Computer Simulation of the Cell: Human, Erythrocyte Model and its Application - Software for Modeling and Simulation – E-CELL, V-CELL and GROMOS.
8 Hours

UNIT V
Proteomics and systems biology: Application in Drug Discovery and Development, Systems Biology Approaches and Tools for Analysis of Interactomes and Multi-target Drugs, Translational Bioinformatics and Systems Biology Approaches for Personalized Medicine, Systems Biology Methods for Disease Treatment and Translational Medicine: Systems Biology and Inflammation, Systems Biology of Cardiovascular Drugs, Cancer Systems Biology, Systemic Lupus Erythematosus: From Genes to Organ Damage, Systems Biology of Influenza, Methods in Systems Biology of Experimental Methamphetamine Drug Abuse, Systems Biology and Theranostic Approach to Drug Discovery and Development to Treat Traumatic Brain Injury.
8 Hours

TEXT BOOKS		
1	Edda Klipp, Ralf Herwig	Systems Biology in Practice-Concepts, Implementation and Application- I Edition, Wiley VCH, 2005.
2	Lilia Alberghina, Hans V. Westerhoff	Systems Biology: Definitions and Perspectives- Springer, 2005.

REFERENCE BOOKS		
1	Hiroaki Kitano	Foundations of Systems Biology- new edition, MIT Press, 2001
2	James M. Bower, Hamid Bolouri	Computational Modeling of Genetic and Biochemical Networks- new edition, MIT Press, 2000.

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Apply different dynamic programming algorithms on biological systems
CO2	Describe signal transduction at cell membranes.
CO3	Employ signal transduction databases for their laboratory use & research
CO4	Apply the principles of computer simulation to understand the structural behavior of whole cell
CO5	Apply molecular modeling software to analyze the interactions

Course Articulation Matrix

		POs											**PSOs**		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
COs	**CO1**	3	2			2								2	
	CO2	3	2			2								2	

	CO3	3	2		1	2							2	
	CO4	3	2			2							2	
	CO5	3	2			2							2	

1: Low, 2: Medium, 3: High

BIOREACTION ENGINEERING

Contact Hours/ Week:	L:T:P:: 2:2:0	**Credits:**	3
Total Lecture Hours:	28+28	**CIE Marks:**	50
Course Code:	S6BTPE15	**SEE Marks:**	50

Course objectives: This course will enable students to:	
1.	Understand the rate mechanism of reactions
2.	Learn the various types of inhibition and kinetics of cell and enzyme
3.	Study the effect of mass transfer on the cellular and enzymatic reactions
4.	Understand the concepts and operations of bioreactors
5.	Learn the immobilized cells reactions in chemostat and plug flow reactors and compare them.

UNIT I
Homogeneous reactions: Introduction, Elementary and Non-Elementary reactions, Representation of elementary reaction, Molecularity and order of reaction, Basic reaction theory: Reaction rate. Effect of temperature on reaction rate, General reaction kinetics for biological systems, Zero-order kinetics, First order kinetics, Second order kinetics, Enzyme Kinetics, Michelis-Meneten kinetics, Lineweaver-burk plot, Eadie-Hofstee plot, Langmuir plot.
6+6 Hours

UNIT II
Regulation of enzyme activity: Reversible inhibition, Competitive inhibition, Noncompetitive inhibition, Uncompetitive inhibition, Partial inhibition, Irreversible inhibition, Numerical Conceptual Allosteric regulation, Kinetics of enzyme deactivation, Cell growth kinetics, Batch growth and numerical conceptual.
5+5 Hours

UNIT III
Heterogeneous Reactions: Heterogeneous reactions in bioprocessing, Concentration gradients and reaction rates in solid catalysts, Steady state shell mass balance, **Concentration Profile**-First order kinetics and spherical geometry.
6+6 Hours

UNIT IV
Reactor engineering: Bioreactor engineering in perspective, Bioreactor configuration-Stirred tank, Bubble column, Airlift reactor, Stirred and Air-driven reactors-comparison, Packed bed, Fluidized bed, Trickle bed, Disposable bioreactors. **Ideal reactor operation:-** Batch operation of a mixed reactor: Enzyme reaction, Cell culture, Total time for batch reaction cycle.

	6+6 Hours

UNIT V
Chemostat: Fed-batch operations of a mixed reactor, Continuous operation of a mixed reactor-Enzyme reaction, Cell culture, Chemostat with immobilized cells, Chemostat Cascade, Chemostat with cell recycle, Continuous operation of a plug flow reactor-Enzyme reaction, Cell culture. Comparison between Major models of reactor operation, Evaluation of Kinetic and yield parameters inchemostat culture.
5+5 Hours

TEXT BOOKS		
1	Paulin M. Doran	Bioprocessing Engineering, Principles, Elsevier, 2nd Edition, 2012, 012220851X

REFERENCE BOOKS		
1	Octave Levenspiel	Chemical Reaction Engineering, Wiley Publisher, 3rd Edition, 2006, 9788126510009
2	Michael L. Shuler, FikretKargi	Basic Concepts in Bioprocess Engineering, Prentice Hall, 2nd Edition, 2015, 978-0130819086

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Classify types of reactions with respect to order, molecularity and MM kinetic equations.
CO2	Analyse the effects of inhibition and allosteric regulations on enzyme kinetics and determine kinetic parameters.
CO3	Describe the mechanism of internal mass transfer and reactions in solid biocatalyst.
CO4	Illustrate the various bioreactor configurations and also design the model for ideal reactor operations.
CO5	Design model for cell culture and enzymatic reaction in chemostat and PFR.

Course Articulation Matrix

		POs											**PSOs**		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
COs	**CO1**	2	1										2		
	CO2	2	2										2		
	CO3	2	2										2		
	CO4	2	2	1									2		
	CO5	2	2	1									2		

1: Low, 2: Medium, 3: High

IMMUNOLOGY AND IMMUNOTECHNOLOGY LAB

Contact Hours/ Week:	L:T:P::0:0:28	**Credits:**	1
Total Lecture Hours:	28	**CIE Marks:**	50
Course Code:	S6BTL01	**SEE Marks:**	50

Course objectives: This course will enable students to:	
1.	Understand the basic concept of Blood Grouping and Rh typing.
2.	Isolate and identify different types of lymphocytes from blood sample.
3.	Study the importance of antigen-antibody interaction in various techniques.
4.	Study the basics of blotting technique and their importance in diagnosis of antigen/antibody.
5.	Study different types of body fluids for the presence of antibodies and antigens like blood, urine and saliva.

List of Experiments:

1.	Agglutination techniques: (a) Blood group identification (b) Rh typing.
2.	Separation of Lymphocytes from blood.
3.	Total red blood cell (RBC) count using hemocytometer (micro dilution & macro dilution method).
4.	Total white blood cell (WBC) count.
5.	Ouchterlony double diffusion: antigen-antibody patterns.
6.	Radial immunodiffusion.
7.	Countercurrent immunoelectrophoresis.
8.	Rocket immunoelectrophoresis.
9.	Dot Elisa.
10.	Western Blot.
11.	Southern Blot – Demo
12.	Northern Blot – Demo
13.	Latex Agglutination
14.	Alkaline Hemoglobin Electrophoresis

TEXT BOOKS		
1	Harper and Row	Principles of Microbiology and Immunology, Parker International, 1st Edition,1968, 006356131X

REFERENCE BOOKS		
1	Gabriel Virella	Medical Immunology, CRC Press, 7th Edition, 2019, 0367224887
2	Thomas J. Kindt, Barbara A. and Osborne	Kuby Immunology, W. H. Freeman, 6th Edition, 2006, 9780716767640.

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Describe the immune-technique which are used as diagnostic tools in detection of various diseases.
CO2	Analyze and interpret the basic concept of Blood Grouping and Rh typing.
CO3	Isolate and identify different types of lymphocytes from blood sample.
CO4	Explain the principle blotting technique and their importance in diagnosis of antigen /antibody.
CO5	Analyse variety of body fluids for the presence antibodies and antigens like blood, urine and saliva.

Course Articulation Matrix

		POs											**PSOs**		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
COs	**CO1**	2			2	2	2			2		2			2
	CO2	2			2	2	2			2		2			2
	CO3	2			2	2	2			2		2			2
	CO4	2			2	2	2			2		2			2
	CO5	2			2	2	2			2		2			2

1: Low, 2: Medium, 3: High

INDIAN KNOWLEDGE SYSTEM

Contact Hours/ Week:	L:T:P:: 1:0:0	**Credits:**	0
Total Lecture Hours:	14	**CIE Marks:**	100
Course Code:	SHS07	**SEE Marks:**	0

Course objectives: This course will enable students to:	
1.	Rejuvenate and mainstream Indian Knowledge Systems by integrating it into the fabric of education research ecosystem.
2.	Bridge the gap between Traditional Indian Knowledge Systems and contemporary knowledge systems.
3.	Make a tangible difference to the contemporary world by mainstreaming Indian Knowledge Systems.

UNIT I
Overview: Need of IKS, Importance of ancient knowledge. Defining IKS, History of IKS, Indian philosophical systems- Development and unique features, Yoga-darsana, Number system in India-

Historical evidence, salient features of Indian number system, the concept of zero and its importance
5 Hours

UNIT II
Knowledge: Framework and classification. The knowledge triangle. Prameya – A Vaisesikan approach to physical reality. Dravyas – the constituents of physical reality. Attributes – the properties of substances. Unique aspects of Indian Mathematics. Great Mathematicians and their contributions. Arithmetic. Square of a number. Unique aspects of Indian astronomy. Elements of Indian calendar. Pancanga – the Indian calendar system.
5 Hours

UNIT III
Ayurveda-Definition of health, Tri-dosas - Relationship to health, yoga way of life –relevance to health and wellness, Indian approach to psychology, The tri-guna system, The body-mind-intellect – consciousness complex, consciousness- the true nature of an individual, Arthasastra- Governance and administration, the Kautilyan state
5 Hours

TEXT BOOKS		
1	B Mahadevan, Vinayak Rajat Bhat, Nagendra Pavana	Introduction to Indian Knowledge System- concepts and applications, 2022, PHI Learning Private Ltd, ISBN-978-93-91818-21-0
2	Amit Jha	Traditional Knowledge System in India, Atlantic Publishers and Distributors(P) Ltd., ISBN-13: 978-8126912230,

REFERENCE BOOKS		
1	Kapil Kapoor, Avadesh Kumar Singh	Knowledge Traditions and Practices of India, Vol. 1, 2005, DK Print World (P) Ltd., ISBN 81-246-0334,

Course Outcomes:
Upon completion of this course the student will be able to:

CO1	Analyse the continuous unbroken knowledge traditions of Bhārata since time immemorial.
CO2	Recognize the relevance of traditional knowledge in science
CO3	Recognize the relevance of traditional knowledge in Humanities and Social sciences

Course Articulation Matrix

		POs											**PSOs**		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
COs	**CO1**						1	1				1			
	CO2	2					2	1				2	2		
	CO3	1										2	1		

1: Low, 2: Medium, 3: High