ACADEMIC CURRICULA

UNDERGRADUATE/ INTEGRATED POST GRADUATE DEGREE PROGRAMMES

(With exit option of Diploma)

(Choice Based Flexible Credit System)

Regulations 2021

Volume – 8
(Syllabi for Biotechnology Programming Courses)
(Revised on August 2024)

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu, India

ACADEMIC CURRICULA

Engineering Science Courses

Regulations 2021

SRM INSTITUTE OF SCIENCE & TECHNOLOGY
(Deemed to be University u/s 3 of UGC Act, 1956)

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

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Kattankulathur, Chengalpattu District 603203, Tamil Nadu, India

Course Code	21CHS251T	Course Name	BASIC CHEMICAL ENGINEERING	Course Category	S	ENGINEERING SCIENCES	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Chemical Engineering*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*describe the basic principles of process calculation*
CLR-2:	*explain the concepts of Stoichiometry equations and material balances*
CLR-3:	*demonstrate the behavior of fluids and fluid flow phenomena*
CLR-4:	*describe the principles of filtration, working of filtration equipment's and concept of agitation*
CLR-5:	*illustrate the basic concepts and laws of thermodynamics*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*perform unit conversions and stoichiometric calculations*	*2*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	*interpret material balance for non-reactive unit operations*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	*apply fluid properties, continuity and Bernoulli equation for fluid flow*	*2*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	*formulate the concepts of filtration and agitation in processes*	*1*	*2*	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	*comprehend the basic concepts and laws of thermodynamics for different processes*	*2*	*2*	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Fundamental Concepts of Stoichiometry	***9 Hour***
Concept of units and dimensions, system of units, unit conversions, basis of calculation, concept of mole, expressing composition of mixture of solids, liquids and gases - percentage by weight, mole and volume and density calculation, concentrations - molality, molarity, normality, ppm, predicting P-V-T properties of gases using ideal gas law	
Unit-2 - Material Balance in Unit Operations	***9 Hour***
Introduction to material balance, material balance for non-reactive chemical process systems - Mixing, Drying, Crystallization, Extraction, Chemical reactions and stoichiometric equations - limiting reactant, excess reactant, conversion, degree of completion, selectivity and yield, concept of recycle, purge and bypass stream	
Unit-3 - Fluid Flow Phenomena	***9 Hour***
Fluid, properties of fluids, type of fluids and flow, Fluid statics - hydrostatic equilibrium, Pressure measurement by manometers - simple U-tube, differential U-tube, inclined differential manometers, Reynolds number, continuity equation, Bernoulli equation	
Unit-4 - Filtration and Agitation	***9 Hour***
Concept of Filtration, Filter media, filter aid, principles of cake filtration, pressure drop through filter cake, Compressible and incompressible filter cakes, filter medium resistance, Constant pressure filtration, constant rate filtration, Filtration equipment's - principle and working of filter press, Vacuum leaf filter, rotary drum filters. Introduction to agitation, agitation equipment, impeller, turbines, flow patterns, prevention of swirling, draft tubes	
Unit-5 - Basic Concepts in Thermodynamics	***9 Hour***
Chemical Engineering Thermodynamics- System, surrounding, boundary, Work, Energy, Heat, Internal energy, Intensive and Extensive properties, State and path functions, processes and its type, equilibrium, enthalpy. Heat capacity- derivation for constant volume and constant pressure processes. First Law of Thermodynamics-Mathematical statement, sign convention, problems, Limitations of First Law of Thermodynamics, Energy balance for closed system. statement of second law of thermodynamics, concept of entropy, Third law of thermodynamics	

Learning Resources	1. *Himmelblau D.H. and James B. Riggs, Basic Principles and Calculations in Chemical Engineering, 8th Edition, Prentice Hall, 2012* 2. *Bhatt, B.I. and Thakore S.M., Stoichiometry, 5th Edition, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2010* 3. *Warren L. McCabe, Julian C. Smith and Peter Harriott, "Unit Operations of Chemical Engineering", 7th Edn., McGraw Hill Education (India) Edition, 2022*	4. *Noel de Nevers, Fluid Mechanics for Chemical Engineers, 2nd ed., McGraw Hill International Editions, 1991* 5. *Smith, J.M., Van Ness, H.C., Abbott, M.M., Introduction to Chemical Engineering Thermodynamics, 8 th ed., McGraw Hill International Edition, 2018*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	-	*20%*	-	*20%*	-
Level 2	*Understand*	*20%*	-	*20%*	-	*20%*	-
Level 3	*Apply*	*30%*	-	*30%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*30%*	-	*30%*	-
Level 5	*Evaluate*	-	-	-	-	-	-
Level 6	*Create*	-	-	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Mr. A. Subramaniam, PESCO Beam Environmental Solutions Pvt. Ltd*	1. *Dr. Lima Rose Miranda, Anna University*	1. *Dr. S. Kiruthika, SRMIST*
2. *Mr. S. Stalin, Course Director, Chem Skill Development Centre*	2. *Dr. N. Anantharaman, Former Professor, NIT Trichy*	2. *Dr. E. Poonguzhali, SRMIST*

Course Code	21CHS252J	Course Name	CHEMICAL ENGINEERING PRINCIPLES	Course Category	S	ENGINEERING SCIENCE	L	T	P	C
							3	0	2	4

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Chemical Engineering*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*describe the various modes of heat transfer and evaluate the rate of steady state heat transfer*
CLR-2:	*explain and analyze the basic concepts of convection as applied to various flows and geometry*
CLR-3:	*illustrate principles of mass transfer, Diffusion phenomena, and calculate mass transfer rates*
CLR-4:	*elucidate the principles of drying, different types of drier and calculate drying time for different drying periods*
CLR-5:	*demonstrate the concept of distillation, extraction and adsorption*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*analyze steady state heat conduction and calculate the rate of heat transfer*	*2*	*2*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*
CO-2:	*apply the basic concepts of convection and calculate the heat transfer coefficient*	*-*	*3*	*3*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*
CO-3:	*interpret mass transfer principles and solve diffusion problems*	*-*	*2*	*3*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*
CO-4:	*calculate drying time for different periods of drying*	*-*	*2*	*2*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*
CO-5:	*comprehend the various types of distillation, extraction and adsorption for different processes*	*-*	*2*	*2*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*

Unit-1 - Conduction	***15 Hour***
Introduction to various modes of heat transfer, Concept of rate of heat transfer, heat flux, conduction, Fourier's law of heat conduction, Thermal conductivity, Steady state heat conduction through plane wall, composite wall, hollow cylinder, coaxial cylinders	
Unit-2 - Convection and Heat Exchangers	***15 Hour***
Concept of heat transfer by convection, Newton's law of cooling, Natural and forced convection- Dimensional analysis- Empirical correlations, Heat exchange equipment, Parallel and counter flow, LMTD, heat transfer area	
Unit-3 - Mass Transfer and Diffusion	***15 Hour***
Introduction to Mass Transfer, Diffusion, Types, Fick's law of Diffusion, Molecular diffusion in gases: steady state diffusion of A through non-diffusing B, Gas phase equimolal counter diffusion, Diffusion in Multicomponent gas mixtures, Molecular diffusion in liquids: steady state diffusion of A through non-diffusing B, Liquid phase equimolal counter diffusion, Effect of temperature and pressure on diffusivity	
Unit-4 - Drying	***15 Hour***
Drying - Importance of drying in processes, principles of drying, wet Basis, dry basis, Free moisture, equilibrium moisture, bound and unbound moisture, Mechanism of drying, drying curve, Calculation of drying time under constant drying conditions: constant rate and falling rate period, Total drying time, Classification of dryers, solids handling in dryers, tray, rotary, spray and fluidized bed drier	
Unit-5 - Distillation, Leaching and Adsorption	***15 Hour***
Introduction to Distillation, principle, Raoult's law, relative volatility, Types of distillation, batch distillation - Rayleigh's equation, flash and steam distillation, General principles of extraction, choice of solvent, mixer-settler, Introduction to leaching, adsorption – isotherm	

Practice	
Practice 1: Heat transfer through composite wall *Practice 2: Heat Transfer through composite lagged pipe* *Practice 3: Heat transfer by natural convection* *Practice 4: Heat transfer by forced convection* *Practice 5: Stefan-Boltzmann apparatus* *Practice 6: Double pipe heat exchanger* *Practice 7: Shell and tube heat exchanger*	*Practice 8: Estimation of Diffusivity* *Practice 9: Drying characteristics* *Practice 10: Batch distillation* *Practice 11: Steam distillation* *Practice 12: Single stage leaching* *Practice 13: Multi stage leaching* *Practice 14: Soxhlet Extractor* *Practice 15: Adsorption*

Learning Resources	1. *Robert E. Treybal, "Mass-Transfer Operations", 3rd Edn., McGraw Hill Education (India) Edition, 2012.* 2. *Warren L. McCabe, Julian C. Smith and Peter Harriott, "Unit Operations of Chemical Engineering", 7th Edn, McGraw Hill Education (India) Edition, 2022.* 3. *Christie John Geankoplis, "Transport Processes and Separation Process Principles (Includes Unit Operations)", 4thEdn, Pearson India Education Services Pvt. Ltd., 2015.*	4. *Binay K. Dutta, "Principles of Mass transfer and Separation Processes", Prentice- Hall of India, New Delhi, 2016.* 5. *N. Anantharaman and K. M. Meera Sheriffa Begum, "Mass Transfer Theory and Practice", Prentice Hall of India Pvt. Ltd., New Delhi, 2017.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (45%)		*Life-Long Learning CLA-2 (15%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	-	*20%*	-	*20%*	-
Level 2	*Understand*	*20%*	-	*20%*	-	*20%*	-
Level 3	*Apply*	*30%*	-	*30%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*30%*	-	*30%*	-
Level 5	*Evaluate*	-	-	-	-	-	-
Level 6	*Create*	-	-	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Mr. A. Subramaniam, PESCO Beam Environmental Solutions Pvt. Ltd*	1. *Dr. Lima Rose Miranda, Anna University*	1. *Dr.S. Kiruthika, SRMIST*
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ACADEMIC CURRICULA

Professional Core Courses

Regulations 2021

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu, India

Course Code	21BTC201L	Course Name	BIOCHEMISTRY LABORATORY	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							0	0	4	2

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Biotechnology*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*understand the preparation of laboratory reagents with competence and proficiency*
CLR-2:	*analyze the different forms of carbohydrates in samples qualitatively using different chemical tests*
CLR-3:	*determine the types of fatty acids, and use a variety of tests and reagents*
CLR-4:	*become familiar with chromatographic methods and use them to isolate and characterize various biological substances*
CLR-5:	*recognize the fundamentals of various reagents and how they interact with biomolecules for measurement*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*perform basic professional skills related to solutions, pH, and buffer preparation, as well as numerical calculations, focusing on the laboratory*	*3*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	*3*	-
CO-2:	*identify the various ways in which different types of carbohydrates respond to chemical tests*	-	*3*	*3*	-	-	-	-	-	-	-	-	-	-	*3*	-
CO-3:	*explain how various chemicals interact with fatty acids to determine the distinct types*	*3*	*3*	-	*3*	-	-	-	-	-	-	-	-	-	-	*3*
CO-4:	*develop methods for separating and detecting amino acids*	*3*	*3*	-	*3*	-	-	-	-	-	-	-	-	-	*3*	-
CO-5:	*describe the measurement of biomolecules in clinical and dietary samples*	-	*3*	-	*3*	-	-	-	-	-	-	-	-	-	*3*	-

Unit-1 - Basics of Analytical Biochemistry — ***12 Hour***

Practice:

1. Stoichiometric calculations – Molecular weight calculation, Molarity, Normality, Molality, % solution, w/w, v/w, v/v, etc.
2. Verifying the influence of H+ and OH- ions in the test solutions by pH meter.
3. Preparation of biological buffers.

Unit-2 - Qualitative Analysis of Biomolecules - Carbohydrates — ***12 Hour***

Practice:

1. Differentiate between aldose and ketose sugars with standards and natural food samples.
2. Identify whether the given sugar is pentose/reducing sugar or not with standards and food samples.
3. Distinguishes between mono or disaccharides also to check to reduce or non-reducing disaccharides with standards and food samples such as milk, malted sugars, and sugarcane juice/Jaggery.

Unit-3 - Qualitative Analysis of Biomolecules- Carbohydrates, Fatty Acids /Lipids — ***12 Hour***

Practice:

1. Verifying the given carbohydrate is starch – polysaccharide.
2. Qualitative analysis of fatty acids and cooking oils/fish oils.

Unit-4 - Separation of Biomolecules and Quantitative Analysis of Biomolecules	***12 Hour***
Practice: *1. Separation of amino acids from the mixture and boiled legumes as test samples by TLC and detection by using ninhydrin solution.* *2. Estimation of reducing sugar-glucose from the blood by 3, 5-Dinitrosalicylic acid (DNS) method.*	
Unit-5 - Quantitative Analysis of Biomolecules	***12 Hour***
Practice: *1. Estimation of protein from food samples by Lowry's method.* *2. Quantification of cholesterol from egg yolk by Zak's method.*	

Learning Resources	1. *Biochemistry Practical Manual - 2023.* 2. *Varley's Practical Clinical Biochemistry by Gowenlock A.H., 6th Edition, 2022 (8th Reprint), ISBN: 9788123904276, CBS Publishers & Distributors.*	3. *Principles and Techniques of Practical Biochemistry (5th Ed.).Wilson, K., Walker, J. (eds.); Cambridge University Press, Cambridge, 2000, 784 pp., ISBN 0-521-65873-X.* 4. *An Introduction to practical biochemistry (2nd edition): By David T. Plummer. Pp 362 McGraw-Hill Book Company (U.K.) Ltd., London 1978. https://doi.org/10.1016/0307-4412(78)90089-4*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Summative Final Examination (0% weightage)	
		CLA-1 Average of first cycle experiments (30%)		CLA-2 Average of second cycle experiments (30%)		Practical Examination (40% weightage)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	*Remember*	-	*15%*	-	*15%*	-	*15%*	-	-
Level 2	*Understand*	-	*20%*	-	*20%*	-	*20%*	-	-
Level 3	*Apply*	-	*25%*	-	*25%*	-	*25%*	-	-
Level 4	*Analyze*	-	*25%*	-	*25%*	-	*25%*	-	-
Level 5	*Evaluate*	-	*10%*	-	*10%*	-	*10%*	-	-
Level 6	*Create*	-	*5%*	-	*5%*	-	*5%*	-	-
	Total	*100 %*		*100 %*		*100 %*		-	

Course Designers

Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***
1. *Dr. G. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com*	1. *Prof. K Subramaniam, IITM, Chennai, suubu@iitm.ac.in*	1. *Dr. Pachiappan, SRMIST*
2. *Dr. Karthik Periyasamy, Scientist, Biocon, karthik.periyasamy@biocon.com*	2. *Prof. R. B. Narayanan, Anna University, Chennai arbeen09@gmail.com*	2. *Dr. S Subashini, SRMIST*

Course Code	21BTC202T	Course Name	MICROBIOLOGY	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Biotechnology*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*introduce the concept of Microbiology and Microorganisms*
CLR-2:	*understand the growth, metabolism and adaptation of bacteria*
CLR-3:	*illustrate the structure and life cycle of eukaryotes*
CLR-4:	*illustrate the structure and life cycle of viruses*
CLR-5:	*analyze the applications of Microbiology in various fields*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	**Program Outcomes (PO)**												**Program Specific Outcomes**		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*illustrate the structure of prokaryotes*	*2*	*2*	*2*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*2*	*-*	*-*
CO-2:	*understanding the growth of prokaryotes*	*2*	*2*	*2*	*-*	*2*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*2*	*-*	*-*
CO-3:	*explain the growth and life cycle of microbial eukaryotes*	*3*	*2*	*2*	*2*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*3*	*-*	*-*
CO-4:	*discuss the life cycle and pathogenicity of viruses*	*3*	*2*	*3*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*3*	*-*	*-*
CO-5:	*discuss the role of microbes and microbial products in various fields*	*3*	*2*	*2*	*-*	*3*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*3*	*-*	*-*

Unit-1 - Microscopy and Structure of Prokaryotes	***9 Hour***
Introduction to Microbiology. Characterization, Classification and Identification of microbes. Microscopy - Light, Electron and Advanced Microscopy. Structure of prokaryotes - Bacteria, Mycoplasma. Morphology, Structure, Cultivation, Reproduction and Pathogenicity of Actinomycetes	
Unit-2 - Metabolism and Adaptation of Prokaryotes	***9 Hour***
Metabolism of Prokaryotes: Bacteria - Growth curve and kinetics. Quantification of bacterial growth. Microbial metabolism: Non-biosynthetic and biosynthetic pathway. Adaptation mechanism of Halophiles, Alkaliphiles, Psychrophiles, Piezophiles, Xerophiles. Bacterial Recombination: Transformation, Transduction, Conjugation	
Unit-3 - Eukaryotes Structure and Methods of Microbial Control	***9 Hour***
Structure of eukaryotes: Fungi, Algae and Protozoa - Characteristics, Morphology, Reproduction, Physiology and Pathogenicity. Control of Microorganisms: Physical Control and Chemical Control. Antibiotics	
Unit-4 - Structure of Virus	***9 Hour***
Virus: Morphology, Structure, Classification and Pathogenicity. Bacteriophages: Lytic and Lysogenic life cycle of bacteriophages. Animal viruses, Plant viruses and Oncoviruses. Plaque assay.	
Unit-5 - Applications of Microbiology	***9 Hour***
Applications of Microbiology: Soil Microbiology - Microbial Interactions, Biogeochemical roles of Microbes.Aquatic Microbiology - Waste water treatment.Agricultural Microbiology - Biofertilizers. Environmental Microbiology - Bioremediation, Bioplastics, Biopolymers. Industrial Microbiology - Microbial metabolites. Medical Microbiology - Antibiotics and Vaccines	

Learning Resources	1. Pelczar MJ, Chan ECS and Krein NR: Microbiology, Mc Graw Hill, 10 th Edition, 2016. 2. Michael T. Madigan, Kelly S. Bender, Daniel H. Buckley, W. Matthew Sattley and David A. Stahl: Brock Biology of Microorganisms, Pearson. 15 th Edition, 2017.	3. Joanne M. Willey, Linda M. Sherwood, Christopher J. Woolverton: Prescott, Harley and Klein's Microbiology, Mc Graw Hill, International Edition, 10 th Edition, 2016. 4. Jawetz, MA Brooks, GF Butel JS and Morse SA: Medical Microbiology, Mc Graw Hill, 26 th Edition, 2012.

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. G. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com	1. Prof. K Subramaniam, IITM, Chennai, suubu@iitm.ac.in	1. Dr. J. Lavanya, SRMIST.
2. Dr. Karthik Periyasamy, Scientist, Biocon, karthik.periyasamy@biocon.com	2. Prof. R. B. Narayanan, Anna University, Chennai arbeen09@gmail.com	2. Dr. R. Muthukumar, SRMIST.

Course Code	21BTC203L	Course Name	CELL AND MICROBIOLOGY LABORATORY	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							0	0	4	2

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Biotechnology*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*provide basic differences between prokaryotic and eukaryotic organisms*
CLR-2:	*understand the different strategies of organization of cellular structures*
CLR-3:	*provide hands on training in isolation of cells and cell organelles*
CLR-4:	*focus on the cellular response to stimulus*
CLR-5:	*comprehend the mechanism of bacterial pathogenesis*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*distinguish between prokaryotic and eukaryotic cells using microscopic analysis*	-	*3*	*3*	-	-	-	-	-	-	-	-	-	-	*3*	-
CO-2:	*gain proficiency in identifying the cellular structures*	-	-	*3*	*3*	-	-	-	-	-	-	-	-	-	-	*3*
CO-3:	*acquire skills to isolate cells and cell organelles and relate with cell division*	-	*3*	*3*	-	-	-	-	-	-	-	-	-	-	*3*	-
CO-4:	*critique the cell's response to stimuli thereby correlating cell signaling*	-	-	*3*	*3*	-	-	-	-	-	-	-	-	-	*3*	-
CO-5:	*integrate cell biology & microbiology to understand the bacterial pathogenesis in host*	-	-	-	*3*	-	-	-	-	-	-	-	-	-	-	*3*

Unit-1 - Distinguish Between Prokaryotic and Eukaryotic Cells — ***12 Hour***

Practice:

1. Microscopic observation of cells: Simple staining & Cross section of plant & animal tissues
2. Biochemical characterization of bacteria - IMVIC tests
3. Specific enzyme assays and substrate hydrolysis for bacterial identification

Unit-2 - Visualization of Cellular Structures Using Differential Staining — ***12 Hour***

Practice:

1. Cell wall staining – Gram staining/ Lactophenol cotton blue staining of fungi
2. Nuclear staining of cells using Giemsa
3. Bacterial Spore staining.

Unit-3 - Isolation of Cells/Cell Organelles and Cell Division — ***12 Hour***

Practice:

1. Isolation of bacteria by pour plate/spread plate and culturing techniques (Streak, Slant & Deep).
2. Isolation of Chloroplast from leaves and determination of chlorophyll content
3. Mitosis cell division in vegetative cells

Unit-4 - Response of Cell to Stimuli	***12 Hour***
Practice: *1. Stomatal movement in response to stimulus* *2. Bacterial motility using hanging drop technique* *3. Determination of cell viability using tryphan blue*	
Unit-5 - Understand the Mechanism of Bacterial Pathogenesis	***12 Hour***
Practice: *1. Bacterial Growth curve* *2. Antibiotic sensitivity tests using Kirby Bauer assay* *3. Adherence of Enteropathogenic E.coli on host cells.*	

Learning Resources	*1. Lab manual* *2. Chaitanya, k. V. Cell and molecular biology: A Lab Manual. India, PHI Learning, 2013.*	*3. Lorrence H. Green, Emanuel Goldman. Practical Handbook of Microbiology: Fourth Edition, CRC Press. Taylor and Francis; 2021.* *4. Julio E.Cellis. Cell Biology: A Laboratory Handbook. (2008). United Kingdom: Academic Press*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*						*Summative Final Examination (0% weightage)*	
		CLA-1 Average of first cycle experiments (30%)		*CLA-2 Average of second cycle experiments (30%)*		*Practical Examination (40% weightage)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	-	*15%*	-	*15%*	-	*15%*	-	-
Level 2	*Understand*	-	*20%*	-	*20%*	-	*20%*	-	-
Level 3	*Apply*	-	*25%*	-	*25%*	-	*25%*	-	-
Level 4	*Analyze*	-	*25%*	-	*25%*	-	*25%*	-	-
Level 5	*Evaluate*	-	*10%*	-	*10%*	-	*10%*	-	-
Level 6	*Create*	-	*5%*	-	*5%*	-	*5%*	-	-
	Total	*100 %*		*100 %*		*100 %*		-	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. Dr. G. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com	*1. Prof. K Subramaniam, IITM, Chennai, suubu@iitm.ac.in*	*1. Dr.S.Sujatha, SRMIST*
2. Dr. Karthik Periyasamy, Scientist, Biocon, karthik.periyasamy@biocon.com	*2. Prof. R. B. Narayanan, Anna University, Chennai arbeen09@gmail.com*	*2. Dr.J.Lavanya, SRMIST*

Course Code	21BTC204T	Course Name	BIOPROCESS PRINCIPLES	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Biotechnology*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*describe the basics of the fermentation process*
CLR-2:	*explain the process of media formulation and sterilization kinetics*
CLR-3:	*study the basics of reactor design and its control systems*
CLR-4:	*analyze the metabolic stoichiometry and energetics of the biochemical process*
CLR-5:	*illuminate the various types of reactors for suspension and immobilized cell systems*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*understand the basics of the fermentation process*	*1*	-	*2*	-	-	-	-	-	-	-	-	-	*2*	*2*	*2*
CO-2:	*comprehend the process of media formulation and sterilization kinetics*	*2*	*2*	*2*	*2*	*2*	-	-	-	-	-	-	-	-	*2*	*1*
CO-3:	*acquire the basics of reactor design and its control systems*	*2*	-	*2*	*1*	*2*	-	-	-	-	-	-	-	*2*	*2*	*1*
CO-4:	*evaluate the metabolic stoichiometry and energetics of the biochemical process*	*2*	*3*	*1*	*2*	-	-	-	-	-	-	-	-	*2*	-	-
CO-5:	*explore the various types of reactors for suspension and immobilized cell systems*	*3*	-	*2*	*2*	-	-	-	-	-	-	-	-	*2*	*2*	*2*

Unit-1 - Microbial Cell Factories ***9 Hour***

Cellular systems as molecular factories and its industrial importance, Isolation and improvement of industrially important organisms, Types of fermentation, Upstream and downstream bioprocess, Process flow sheets of primary and secondary metabolites production- eg. ethanol, lactic acid, lysine, poly-L-lactic acid, lipase, rhamnolipid, streptomycin, insulin, Interferon, monoclonal antibody, tumour necrosis factor inhibitor, Pneumococcal conjugate vaccine.

Unit-2 - Design and Preparation of Media for Bioprocess ***9 Hour***

Bioreaction theory, Kinetics of biological systems, Growth patterns and kinetics of cells, Quantifying cell growth kinetic parameters, Optimization of cell growth environment, Types of media and classes of medium components. Media formulation and optimization of medium for the industrially important cultures - Microbial, plant and animal cells, Sterilization, Types of sterilization - batch, continuous and air sterilization

Unit-3 - Bioprocess Design - Instrumentation and Control Systems ***9 Hour***

Fermentation facility, equipment and space requirements - Fermenter design and its configuration, Body construction, Agitators, Stirrer glands and bearings, Spargers and valves, Aseptic operation and containment, Bioinstrumentation and its control - Methods of measuring process variables, Online analysis of chemical factors, Control systems, Combination of methods of the controller, Troubleshooting in a fermentation plant.

Unit-4 - Fundamentals of Biological Engineering ***9 Hour***

Material and energy balances for reactive and non-reactive systems; Stoichiometry of growth and product formation; Degree of reduction, electron balance and theoretical oxygen demand, Determination of stoichiometric coefficients, Theoretical prediction of yield coefficients, Conductive and convective heat transfer; Overall heat transfer coefficient, Bio-thermodynamics.

Unit-5 - Bioreactors for Suspension and Immobilized Cultures ***9 Hour***

Strategies for choosing a bioreactor, Microbial and immobilized cell system, Active and passive immobilization of Cells, novel reactors - Airlift Bioreactor, Fluidized Bed Bioreactor, Membrane Bioreactor, Photobioreactor, Biofilm reactor, Single-use bioreactors, Various modes of operation in Bioreactors, Performance equation of a batch, fed-batch and continuous reactors, Stability analysis of bioreactor.

Learning Resources	1. *Pauline M. Doran "Bioprocess Engineering Principles", 2nd Edition, Academic Press, 2012.* 2. *Michael L. Shuler, Fikret Kargi, Matthew DeLisa "Bioprocess Engineering: Basic Concepts", 3rd Edition, Prentice-Hall, 2017.*	3. *Hall, Stephen J., Stanbury, Peter F., Whitaker, Allan, "Principles of Fermentation Technology", 3rd Edition, Butterworth– Heinemann, 2017.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	-	*15%*	-	*15%*	-
Level 2	*Understand*	*25%*	-	*20%*	-	*25%*	-
Level 3	*Apply*	*30%*	-	*25%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*25%*	-	*30%*	-
Level 5	*Evaluate*	-	-	*10%*	-	-	-
Level 6	*Create*	-	-	*5%*	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. S. Sam Gunasekar, Orchid Chemicals and Pharmaceuticals Ltd., Chennai., sam@orchidpharma.com*	1. *Prof. K Subramaniam, IITM, Chennai, suubu@iitm.ac.in*	1. *Dr. V. Vinoth Kumar, SRMIST*
2. *Dr. G. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com*	2. *Prof. R. B. Narayanan, Anna University, Chennai arbeen09@gmail.com*	2. *Dr. P. Radha, SRMIST*

Course Code	21BTC205L	Course Name	BIOPROCESS PRINCIPLES LABORATORY	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							0	0	4	2

Pre-requisite Courses	*Nil*	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	*Biotechnology*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*describe the basics of the fermentation process*
CLR-2:	*explain the process of media formulation and sterilization kinetics*
CLR-3:	*study the basics of reactor design and its control systems*
CLR-4:	*analyze the metabolic stoichiometry and energetics of the biochemical process*
CLR-5:	*illuminate the various types of reactors for suspension and immobilized cell systems*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*understand the basics of the fermentation process*	*1*	-	*2*	-	-	-	-	-	-	-	-	-	*2*	*2*	*2*
CO-2:	*comprehend the process of media formulation and sterilization kinetics*	*2*	*2*	*2*	*2*	*2*	-	-	-	-	-	-	-	-	*2*	*1*
CO-3:	*acquire the basics of reactor design and its control systems*	*2*	-	*2*	*1*	*2*	-	-	-	-	-	-	-	*2*	*2*	*1*
CO-4:	*evaluate the metabolic stoichiometry and energetics of the biochemical process*	*3*	*3*	*1*	*2*	-	-	-	-	-	-	-	-	*2*	-	-
CO-5:	*explore the various types of reactors for suspension and immobilized cell systems*	*3*	-	*2*	*2*	*3*	-	-	-	-	-	-	-	*2*	*2*	*2*

Unit-1 - Microbial Cell Factories — ***12 Hour***

Practice:

1. Estimation of glucose by DNS assay method
2. Production of enzymes by solid state fermentation
3. Production of enzymes by submerged fermentation
4. Effect of pH and temperature on enzyme activity

Unit-2 - Design and Preparation of Media for Bioprocess — ***12 Hour***

Practice:

1. Batch sterilization kinetics
2. Measurements of Cell Biomass Concentration
3. Medium optimization by Plackett - Burman design

Unit-3 - Bioprocess Design - Instrumentation and Control Systems — ***12 Hour***

Practice:

1. Fermenter operation – Demonstration/Explanation
2. Methods of measuring process variables during yeast fermentation in fermenter

Unit-4 - Fundamentals of Biological Engineering	***12 Hour***
Practice: *1. Microbial growth kinetics to determine the doubling time* *2. Microbial growth kinetics to determine the yield coefficient* *3. Enzyme kinetics – Michaelis Menten Kinetics and Lineweaver Burk – Plot*	
Unit-5 - Bioreactors for Suspension and Immobilized Cultures	***12 Hour***
Practice: *1. Preparation of immobilized cells/ enzyme* *2. Enzyme immobilization kinetics* *3. Production of ethanol by yeast*	

Learning Resources	*1. Debabrata Das, Debayan Das," Biochemical Engineering- A Laboratory Manual" Jenny Stanford Publishing, 2021.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*						*Summative Final Examination (0% weightage)*	
		CLA-1 Average of first cycle experiments (30%)		*CLA-2 Average of second cycle experiments (30%)*		*Practical Examination (40% weightage)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	-	*15%*	-	*15%*	-	*15%*	-	-
Level 2	*Understand*	-	*20%*	-	*20%*	-	*20%*	-	-
Level 3	*Apply*	-	*25%*	-	*25%*	-	*25%*	-	-
Level 4	*Analyze*	-	*25%*	-	*25%*	-	*25%*	-	-
Level 5	*Evaluate*	-	*10%*	-	*10%*	-	*10%*	-	-
Level 6	*Create*	-	*5%*	-	*5%*	-	*5%*	-	-
	Total	*100 %*		*100 %*		*100 %*		-	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. Dr. S. Sam Gunasekar,Orchid Chemicals and Pharmaceuticals Ltd., Chennai.sam@orchidpharma.com	*1. Prof. K Subramaniam, IITM, Chennai, suubu@iitm.ac.in*	*1. Dr.M.Venkatesh Prabhu, SRMIST*
2. Dr. G. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com	*2. Prof. R. B. Narayanan, Anna University, Chennai arbeen09@gmail.com*	*2. Dr. Vinoth kumar, SRMIST*

Course Code	21BTC206T	Course Name	GENETICS AND CYTOGENETICS	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	*Biotechnology*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*describe the fundamental Laws of Genetics and interaction of genes*
CLR-2:	*explain the concepts and experiments in the preparation of linkage map*
CLR-3:	*describe the elements of Genetic Counseling*
CLR-4:	*analyze gene transfer and its role in mapping in bacteria*
CLR-5:	*differentiate factors that lead to genetic variation in a population*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	Program Outcomes (PO)												Program Specific Outcomes		
		1 Engineering Knowledge	2 Problem Analysis	3 Design/development of solutions	4 Conduct investigations of complex problems	5 Modern Tool Usage	6 The engineer and society	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*analyze the pattern of inheritance of genes and its interaction*	*2*	*2*	*2*	*2*	-	-	-	-	-	-	-	-	*3*	-	-
CO-2:	*construct linkage maps from inheritance pattern of different genes*	*3*	*3*	*3*	*2*	-	-	-	-	-	-	-	-	*3*	-	-
CO-3:	*illustrate the role of Genetic Counselor and techniques in genetic testing*	*3*	*2*	*2*	*3*	-	-	-	-	-	-	-	-	*3*	-	-
CO-4:	*illustrate gene mapping based on the type of recombination in Bacteria*	*3*	*3*	*3*	*2*	-	-	-	-	-	-	-	-	*2*	-	-
CO-5:	*analyze genetic variations in a population*	*2*	*2*	-	*2*	-	-	-	-	-	-	-	-	*2*	-	-

Unit-1 - Pattern of Inheritance and Gene Interaction	***9 Hour***
Mendel's Experiments - Law of segregation, Law of independent assortment - Problems in Mendelian inheritance; Allelic interaction -Lethal genes, Non-allelic interaction – Epistasis, Duplicate genes, Complementary and inhibitory genes; Multiple allelism –ABO, Rh factor in Humans; Cytoplasmic inheritance; Mechanisms of sex determination and sex linked inheritance; Epigenetics - histone modification, methylation - x-inactivation, dosage compensation, Lyon hypothesis	
Unit-2 - Linkage and Chromosome Mapping	***9 Hour***
Chromosome structure, Chromosome organization, Giant chromosomes - polytene chromosome, Lampbrush chromosome; Linkage - Arrangement and types of linkage; Crossing over - Frequency of recombination, Cytological basis of crossing over - Stern's experiment; Chromosome mapping - Mapping by two factor cross, Mapping by three factor cross, Interference and Coincidence, Solving Problems, Combining of map segments, Preparation of linkage map; Somatic cell hybridization - HAT selection procedure	
Unit-3 - Basic Human Genetics	***9 Hour***
Mutation - classification, structural chromosomal aberration - deletion, duplication-tandem and dispersed repeats, inversion, translocation; Numerical aberration; Genetic counseling – History and pedigree construction – Autosomal and X-linked, Diagnosis - Human karyotype preparation, FACS, FISH, Counseling, Follow-up - Prenatal diagnosis – amniocentesis, chorionic villus sampling; Multifactorial inheritance – congenital malformation, diabetes, comparative genome hybridization	
Unit-4 - Bacterial Genetics	***9 Hour***
Bacterial genetics, Mechanisms of recombination, Transformation in bacteria - Mapping by transformation, Recombination by generalized transduction - Mapping by generalized transduction, Specialized transduction by lambda phage - Mapping by specialized transduction; Recombination by conjugation - Mapping by Interrupted mating analysis, Preparation of linkage map in bacteria, Fine structure mapping by Merozygote analysis	

Unit-5 - Population Genetics	***9 Hour***
Population genetics, Allele frequency - Calculation of allele frequency in a population, Calculation of genotype frequency - Hardy-Weinberg equilibrium, Applications of Hardy Weinberg equilibrium; Changes in allele frequency - Changes in allele frequency by mutation, changes in allele frequency by migration - migration dynamics, changes in allele frequency by selection - selection dynamics, Random genetic drift - Loss of heterozygotes, Genetic equilibrium	

Learning Resources	1. *Gardner, Simmons, Sunstad, "Principles of Genetics," 8 th edition – John Wiley and Sons, Inc., 2006.*	2. *Monroe W. Strickberger, "Genetics," 3 rd edition – Phi Learning, 2015* 3. *Peter Sunstad and Michael Simmons "Principles of Genetics" 7th edition, Wiley, 2015*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	-	*15%*	-	*15%*	-
Level 2	*Understand*	*25%*	-	*20%*	-	*25%*	-
Level 3	*Apply*	*30%*	-	*25%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*25%*	-	*30%*	-
Level 5	*Evaluate*	-	-	*10%*	-	-	-
Level 6	*Create*	-	-	*5%*	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. C. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com*	1. *Prof. K Subramaniam, IITM, Chennai, subbu@iitm.ac.in*	1. *Dr. S. Barathi, SRMIST*
2. *Dr. Karthik Periyasamy, Scientist, Biocon, karthik.periyasamy@biocon.com*	2. *Prof. R. B. Narayanan, Anna University, Chennai arbeen09@gmail.com*	2. *Dr. K.T. Ramya Devi, SRMIST*

Course Code	21BTC207T	Course Name	MOLECULAR BIOLOGY	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	*Biotechnology*	**Data Book / Codes / Standards**		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*know the structures of nucleic acids and their role as hereditary materials*
CLR-2:	*adopt the structure of nucleic acids for their expression and regulation*
CLR-3:	*explain the basis and mechanism of protein synthesis and activity*
CLR-4:	*understand the regulatory role of nucleic acids in cell functioning*
CLR-5:	*scrutinize the controlling events of gene expression under anabolic and catabolic conditions*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	**Program Outcomes (PO)**												**Program Specific Outcomes**		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*reminisce the structure of nucleic acids at the DNA and RNA levels*	-	*3*	-	-	-	-	-	-	-	-	-	-	-	*2*	*3*
CO-2:	*comprehend the analysis of functioning of nucleic acids*	-	*2*	*2*	-	-	-	-	-	-	-	-	-	-	*2*	*2*
CO-3:	*relate the expression of DNA at the different levels*	*3*	-	*1*	-	-	-	-	-	-	-	-	-	-	*3*	*3*
CO-4:	*assess the mechanisms of protein synthesis with the genetic code*	*3*	*2*	*3*	-	-	-	-	-	-	-	-	-	-	*3*	*3*
CO-5:	*invoke the various regulatory elements and mechanisms controlling gene expression*	*3*	*2*	*2*	*1*	-	-	-	-	-	-	-	-	-	*3*	*3*

Unit-1 - Structure and Composition of Nucleic Acids	***9 Hour***
Genetic information and its perpetuation; Development of molecular biology; History of nucleic acids; Landmark experiments of DNA as the genetic material; Modes of DNA replication; DNA constituents; DNA structure and its stability; DNA models; A-, B- and Z-DNA forms; Central dogma; DNA topology	
Unit-2 - Replication and Repair of DNA	***9 Hour***
Basic rules for replication; Chemistry of DNA synthesis; Types and the mechanisms of DNA replication; Replication enzymes; DNA polymerases in prokaryotic and eukaryotic replications; Proof reading activity of DNA polymerase; Topoisomerases; Events in the replication fork; Models of DNA replication; DNA repair mechanism	
Unit-3 - Transcription and Post Transcription	***9 Hour***
Basic features of RNA synthesis; RNA polymerases; Types and function of RNA polymerases; DNA promoters- structure and function; Epigenetics Fundamentals; RNA transcription; Transcription of mRNA, rRNA, and tRNA genes; RNA processing; Posttranscriptional modifications of mRNAs; RNA editing-RNAi and miRNAs	
Unit-4 - Translation and Post Translation	***9 Hour***
Coding of genetic information; Outline of translation; Translation in prokaryotes and eukaryotes; Polyribosome; Posttranslational modifications; Protein folding and sorting; Protein targeting into mitochondria and nucleus;	
Unit-5 - Gene Regulation	***9 hour***
General aspects of Regulation; Gene regulators; Silencers and Enhancers; Operons; Positive and negative gene regulations; The operon models; Lac, Trp, Ara and Gal operons and their regulations	

Learning Resources	1. *Robert Weaver, Molecular Biology, McGraw-Hill, 2011*	2. *James D Watson, Molecular Biology of Gene, Pearson Publisher, 2017*

Learning Assessment							
	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	-	*15%*	-	*15%*	-
Level 2	*Understand*	*25%*	-	*20%*	-	*25%*	-
Level 3	*Apply*	*30%*	-	*25%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*25%*	-	*30%*	-
Level 5	*Evaluate*	-	-	*10%*	-	-	-
Level 6	*Create*	-	-	*5%*	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers		
Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. S. Sam Gunasekar, Orchid Chemicals and Pharmaceuticals Ltd., sam@orchidpharma.com*	1. *Dr. Aravind Rengan, Indian Institute of Technology Hyderabad. aravind@bme.iith.ac.in*	1. *Dr. N. Selvamurugan, SRMIST*
2. *Dr. D. Gunaseelan, BIOCON Ltd., guna.sachin@gmail.com*	2. *Dr. K. Subramanian, Indian Institute of Technology Madras. subbu@iitm.ac.in*	2. *Dr. S. Barathi, SRMIST*

Course Code	21BTC208L	Course Name	MOLECULAR BIOLOGY LABORATORY	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							0	0	4	2

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Biotechnology*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*understand the genetic material as DNA in prokaryotes*
CLR-2:	*evaluation of the DNA in prokaryotes*
CLR-3:	*understand the extrachromosomal element and gene transcripts in prokaryotes*
CLR-4:	*dissection of extrachromosomal element and gene transcripts*
CLR-5:	*know DNA damage in prokaryotes*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*reminisce genetic materials in unicellular organisms*	-	*3*	-	-	-	-	-	-	-	-	-	-	-	*2*	*3*
CO-2:	*comprehend the isolation and characterization of genetic materials*	*3*	*2*	*2*	-	-	-	-	-	-	-	-	-	-	*2*	*2*
CO-3:	*retrospect the genetic materials at different levels*	*3*	-	*1*	-	-	-	-	-	-	-	-	-	-	*3*	*3*
CO-4:	*relate the co-existence of these materials*	*3*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	*3*	*3*
CO-5:	*invoke the genetic defect causing cell death*	*3*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	*3*	*3*

Unit-1 - Genomic DNA Isolation and Analysis — ***12 Hour***

Practice:

1. Isolation of Genomic DNA from E.coli
2. Quantitative Analysis of Genomic DNA
3. Qualitative Analysis Genomic DNA

Unit-2 - Plasmid DNA Isolation and Analysis — ***12 Hour***

Practice:

1. Isolation of Plasmid DNA from E.coli
2. Quantitative Analysis of Plasmid DNA
3. Qualitative Analysis of Plasmid DNA

Unit-3 - Total RNA Isolation and Analysis — ***12 Hour***

Practice:

1. Isolation of Total RNA from E.coli
2. Quantitative Analysis of Total RNA
3. Qualitative Analysis of Total RNA

Unit-4 - DNA Cloning Enzymes	***12 Hour***
Practice: *1. Restriction Enzyme Digestion of DNA* *2. Ligation of DNA Fragment into Plasmid* *3. E.coli Transformation*	
Unit-5 - DNA Damage	***12 Hour***
Practice: *1. Effect of UV radiation on Bacterial Growth*	

Learning Resources	*1. Molecular Cloning, A Laboratory Manual by M. R. Green and J. Sambrook, 2012, Cold Spring Harbor Laboratory Press*	*2. Molecular Biology Techniques, A Classroom Laboratory Manual, 2019, Elsevier Press*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Final Examination (0% weightage)	
		CLA-1 Average of first cycle experiments (30%)		CLA-2 Average of second cycle experiments (30%)		Practical Examination (40% weightage)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	*Remember*	-	*15%*	-	*15%*	-	*15%*	-	-
Level 2	*Understand*	-	*20%*	-	*20%*	-	*20%*	-	-
Level 3	*Apply*	-	*25%*	-	*25%*	-	*25%*	-	-
Level 4	*Analyze*	-	*25%*	-	*25%*	-	*25%*	-	-
Level 5	*Evaluate*	-	*10%*	-	*10%*	-	*10%*	-	-
Level 6	*Create*	-	*5%*	-	*5%*	-	*5%*	-	-
	Total	*100 %*		*100 %*		*100 %*		-	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. S. Sam Gunasekar, Orchid Chemicals and Pharmaceuticals Ltd., sam@orchidpharma.com	*1. Dr. K. Subramanian, Indian Institute of Technology Madras. subbu@iitm.ac.in*	*1. Dr. N. Selvamurugan, SRMIST*
2. Dr. D. Gunaseelan, BIOCON Ltd., guna.sachin@gmail.com	*2. Dr. Sudha Warrier, Professor and Dean, Manipal University, sudha.warrier@mannipal.edu*	*2. Dr. S. Barathi, SRMIST*

Course Code	21BTC209T	Course Name	BIOPROCESS ENGINEERING	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Biotechnology*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*enumerate the Ideal and Non- Ideal Reactors*
CLR-2:	*discuss the fluid flow and its mixing in the reactor*
CLR-3:	*explain the mass and heat transfer in the reactor, and scale up in Bioreactor*
CLR-4:	*describe the structured and unstructured models of microbial system*
CLR-5:	*discuss modern tools in Bioprocess Engineering*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*understand the ideal and non-ideal systems in bioprocess engineering*	*3*	*3*	*3*	-		-	-	-	-	-	-	-	*1*	-	-
CO-2:	*gain knowledge on fluid flow and its mixing property*	*3*	*2*	*1*	*2*	-	-	-	-	-	-	-	-	*2*	*2*	-
CO-3:	*acquire knowledge in transport phenomena and scale up studies*	*3*	*2*	*1*	*1*	-	-	-	-	-	-	-	-	*2*	*2*	*2*
CO-4:	*understand structured and Unstructured models*	*2*	*1*	*3*	*1*	-	-	-	-	-	-	-	-	*2*	-	-
CO-5:	*apply modern tools in modelling of bioprocess system*	*1*	*1*	*3*	*3*	*3*	-	-	-	-	-	-	-	*2*	*2*	-

Unit-1 - Ideal and Non- Ideal Bioreactors — ***9 Hour***

Ideal Batch, Fed-Batch, Continuous, Enzymatic catalyzed reaction in CSTR, CSTR with Recycle, Ideal Plug flow reactor. Reactors with Nonideal mixing-mixing times in RTD, Models for Non-ideal reactors-Tanks in Series Model- Dispersion models.

Unit-2 - Fluid Flow and Mixing in Bioreactors — ***9 Hour***

Classification in fluids, Reynolds Number, Viscosity, Momentum Transfer, Non-Newtonian fluid, Rheological Properties of Fermentation Broths, Factors Affecting Broth Viscosity, Mixing- Power Requirements for Mixing- Scale-Up of Mixing Systems- Improving Mixing in Fermenters- Effect of Rheological Properties on Mixing- Role of Shear in Stirred Fermenters

Unit-3 - Transport Phenomena and Scaleup in Bioreactors — ***9 Hour***

Gas liquid mass transfer in cellular systems, Determination of Oxygen Transfer Rates, Forced Convection mass transfer, Correlation for Mass Transfer Coefficients, and Interfacial areas. Heat Transfer correlations. Scale up concerns in Microbial, Mammalian and plant cell Process-Scale up criteria-Selection of scaleup criteria-scaleup of genetically engineered cell culture fermentation.

Unit-4 - Models in Bioprocess — ***9 Hour***

Model classification- Model Formulation- Unstructured Models- Phases of batch growth cycles-Monod Models-Multiple substrate models and model Inhibition, Models of growth and non-growth product inhibition, Models for the growth of fungi, Plant cell and Animal cells, Structured models- Models of metabolites and growth-compartmental Models-Models of product formation.

Unit-5 - Modelling and Simulation in Bioprocessing — ***9 Hour***

Introduction to modelling and Simulation. Modelling and simulation of Batch, Fed-Batch and Continuous system using MATLAB. Artificial Intelligence and Machine Learning in bioprocessing. Introduction of object-oriented modelling in bioprocess using Python.

Learning Resources	1. *James E.Bailey, David F.Ollis "Biochemical Engineering Fundamentals", 2nd Edition, Mc Graw Hill, 1986.* 2. *Pauline M. Doran "Bioprocess Engineering Principles", 2nd Edition, Academic press, 2012.*	3. *S.N.Mukhopadhyay "Process Biotechnology Fundamentals", 2nd Edition, 2004.* 4. *Michael L. Shuler, Fikret Kargi, Matthew De Lisa "Bioprocess Engineering: Basic Concepts", 3rd Edition, Prentice-Hall, 2017.* 5. *Ravindra Pogaku,"Horizons in Bioprocess Engineering"Springer,2019*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	*Remember*	*15%*	-	*15%*	-	*15%*	-
Level 2	*Understand*	*25%*	-	*20%*	-	*25%*	-
Level 3	*Apply*	*30%*	-	*25%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*25%*	-	*30%*	-
Level 5	*Evaluate*	-	-	*10%*	-	-	-
Level 6	*Create*	-	-	*5%*	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Dr. S. Sam Gunasekar,Orchid Chemicals and Pharmaceuticals Ltd., Chennai,sam@orchidpharma.com*	1. *Dr.S.Senthil Kumar, IITG*	1. *Dr.M.Venkatesh Prabhu, SRMIST*
2. *Dr. G. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com*	2. *Dr.N.Selvaraj, IITG*	2. *Dr.P.Radha, SRMIST*

Course Code	21BTC210L	Course Name	BIOPROCESS ENGINEERING LABORATORY	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							0	0	4	2

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Biotechnology*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*explain the Residence Time Distribution in Stirred tank and Plug flow reactor*
CLR-2:	*describe the rheological and mixing behavior of fermented fluid*
CLR-3:	*analyze the oxygen mass transfer coefficient and deactivation kinetics*
CLR-4:	*evaluate the model parameters in microbial growth*
CLR-5:	*discuss the modern tool of programming microbial cultures*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*explore the Residence Time Distribution studies in Stirred tank and Plug flow reactor*	*3*	*3*	*2*	-	-	-	-	-	-	-	-	-	*2*	-	-
CO-2:	*understand the rheological and mixing behavior of fermented fluid*	*3*	*3*	*1*	-	-	-	-	-	-	-	-	-	*2*	*2*	-
CO-3:	*measure the oxygen mass transfer coefficient and deactivation kinetics parameters*	*3*	*3*	*2*	-	-	-	-	-	-	-	-	-	*2*	*2*	-
CO-4:	*estimate the model parameters in microbial growth*	*3*	*3*	*1*	-	-	-	-	-	-	-	-	-	*2*	*2*	-
CO-5:	*learn the modern tool for programming the microbial cultures*	*1*	*2*	*3*	-	*3*	-	-	-	-	-	-	-	*2*	*2*	-

Unit-1 - Non-Ideal Reactors	***12 Hour***
Practice: *1. RTD studies in Stirred tank reactor* *2. RTD studies in Plug flow reactor*	
Unit-2 - Fluid Flow and Mixing in Bioreactors	***12 Hour***
Practice: *1. Rheological study of fermented fluids* *2. Regime analysis of a stirred tank reactor* *3. Determination of mixing time in a stirred tank reactor*	
Unit-3 - Transport Phenomena and Scale-up in Bioreactors	***12 Hour***
Practice: *1. Determination of KLa by power correlation method* *2. Determination of KLa by dynamic gassing out method* *3. Deactivation kinetics of enzymatic reaction* *4. Deactivation kinetics of microbial growth*	

Unit-4 - Models in Bioprocess	***12 Hour***
Practice: *1. Estimation of unstructured model parameters of bacterial culture* *2. Estimation of unstructured model parameters of yeast culture*	
Unit-5 - Modelling and Simulation in Bioprocessing	***12 Hour***
Practice: *1. Modelling and simulation of Batch culture using MATLAB* *2. Modelling and simulation of continuous culture using MATLAB* *3. Modelling and simulation of Fed culture using MATLAB* *4. Modelling of batch reactor using Python*	

Learning Resources	*1. Hans-Peter Schmauder,"Methods in Biotechnology" Taylor and Francis Ltd, 2003.* *2. Arvind Kumar Bhatt,"Basic Biotechniques for Bioprocess and Bioentrepreneurship"Academic Press, Elsevier ,2023*	*3. Shijie Liu,"Bioprocess Engineering Kinetics, Sustainability, and Reactor Design"Elsevier, 2020.*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Final Examination (0% weightage)	
		CLA-1 Average of first cycle experiments (30%)		CLA-2 Average of second cycle experiments (30%)		Practical Examination (40% weightage)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	*Remember*	-	*15%*	-	*15%*	-	*15%*	-	-
Level 2	*Understand*	-	*20%*	-	*20%*	-	*20%*	-	-
Level 3	*Apply*	-	*25%*	-	*25%*	-	*25%*	-	-
Level 4	*Analyze*	-	*25%*	-	*25%*	-	*25%*	-	-
Level 5	*Evaluate*	-	*10%*	-	*10%*	-	*10%*	-	-
Level 6	*Create*	-	*5%*	-	*5%*	-	*5%*	-	-
	Total	*100 %*		*100 %*		*100 %*		-	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. S. Sam Gunasekar,Orchid Chemicals and Pharmaceuticals Ltd., Chennai.sam@orchidpharma.com	*1. Dr.S.Senthil Kumar, IITG, senthilkumar@iitg.ac.in*	*1. Dr.M.Venkatesh Prabhu, SRMIST*
2. Dr. G. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com	*2. Dr.N.Selvaraj, IITG, selva@iitg.ac.in*	*2. Dr.P.Radha, SRMIST*

Course Code	21BTC301J	Course Name	GENE MANIPULATION AND GENOMICS	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							3	0	2	4

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Biotechnology*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*assess the basic concepts and principles of utilization of different expression vectors for cloning from the perspective of engineers*
CLR-2:	*demonstrate the different strategies of gene cloning and construction of genomic and cDNA libraries*
CLR-3:	*analyze the concepts of structural and functional genomics with advanced cutting-edge technologies*
CLR-4:	*assess the applications of recombinant DNA technology in animals, plants, and microbial organisms*
CLR-5:	*develop and apply the strategies on altering gene expression in vitro and in vivo*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*describe the foundations of modern biotechnology*	-	-	*3*	-	-	-	-	-	-	-	-	-	-	*2*	-
CO-2:	*design and conduct experiments involving genetic manipulation*	-	-	*2*	-	-	*2*	-	-	-	-	-	-	-	-	*3*
CO-3:	*illustrate the steps involved in the production of biopharmaceuticals in microbial and mammalian cell systems*	*2*	-	-	-	-	-	-	*2*	-	-	-	-	-	-	*3*
CO-4:	*apply modern biotechnology in the different areas like medicine, microbes, environment, and agriculture*	*3*	-	-	-	-	*3*	-	-	-	-	-	-	-	-	*3*
CO-5:	*discuss the cutting-edge techniques and their applications such as plant transformation, protein expression and genomic DNA library construction etc.*	*3*	-	*2*	-	-	-	-	*2*	-	-	-	-	-	-	*3*

Unit-1 - Overview of Cloning and Vectors ***15 Hour***

Introduction to genomics and gene regulation; Fundamental requirement for DNA cloning; Prokaryotic and eukaryotic vectors; Phage vectors; Strategies for gene cloning; Enzymes in genetic engineering

Practice*: 1. Genomic DNA isolation*
2. Double digestion of Genomic DNA

Unit-2 - Preparation and Screening of DNA library ***15 Hour***

DNA Library; Preparation of DNA Libraries; Genomic DNA library; Overlapping and non-overlapping DNA fragments; Choice of vectors; Evaluation of genomic DNA library; cDNA library; Purification and separation of mRNA; cDNA synthesis; cDNA library construction; Evaluation of cDNA library; Screening libraries; Polymerase chain reaction (PCR) and its applications

Practice*: 1. Double digestion of Vector*
2. Preparation of recombinant vector
3. E. coli Transformation

Unit-3 - DNA Sequencing and Genomics ***15 Hour***

DNA sequencing strategies; Principles of DNA sequencing; Sanger's Dideoxy sequencing method; Automated DNA sequencing; Next generation sequencing; Genome sequencing; Next generation sequencing and its applications; Methods of nucleic acid detection; Random priming; Nick translation and End labeling; RNA labeling; Non-isotopic labeling; Structural genomics; comparative genomics; Microarray

Practice*: 1. Colony PCR*
2. Functional Assay

Unit-4 - Analysis and Manipulation of Gene Expression and Function	***15 Hour***
Regulation of gene expression at different levels; Factors influencing gene expression; Epigenetic regulation; Protein expression in prokaryotic and eukaryotic cells; Alteration of gene expression by mutagenesis; Methods for site directed mutagenesis ***Practice**: 1. RNA isolation* *2. cDNA synthesis* *3. Semi-quantitative PCR*	
Unit-5 - Applications of Cloning	***15 Hour***
Medical applications; Human and genetic diseases; DNA vaccines; Gene therapy; Study of gene function in vivo; Embryonic stem cells; Applications in Embryonic stem cells; Transgenics; Methods of producing transgenic mice; Over-expression; Gene knock-in; Gene knock-out; Conditional knock-out; Genome editing; CRISPER-Cas9; Guide RNA; Gene inactivation ***Practice**: 1. Quantitative PCR* *2. Fold and Relative Gene Expression*	

Learning Resources	1. *Jeremy W. Dale and Malcolm von Schantz, "From Genes to Genomes," John Willey and Sons Publications, 2002* 2. *Old. R.W and Primrose. S.B, "Principles of Gene Manipulation, An Introduction to Genetic Engineering," Blackwell Scientific Publications, 2014*	3. *S. B. Primrose and R. M. Twyman, "Principles of Gene Manipulation and Genomics"7th Edition,Wiley-Blackwell, 2006* 4. *T A Brown Gene Cloning and DNA Analysis: An Introduction 8th Edition, Wiley Blackwell Publisher 2020*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (45%)		*CLA-2-Practice (15%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	-	-	*15%*	*15%*	-
Level 2	*Understand*	*25%*	-	-	*20%*	*25%*	-
Level 3	*Apply*	*30%*	-	-	*25%*	*30%*	-
Level 4	*Analyze*	*30%*	-	-	*25%*	*30%*	-
Level 5	*Evaluate*	-	-	-	*10%*	-	-
Level 6	*Create*	-	-	-	*5%*	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. C. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com*	1. *Prof. K Subramaniam, IITM, Chennai, subbu@iitm.ac.in*	1. *Dr. N. Selvamurugan, SRMIST*
2. *Dr. Karthik Periyasamy, Scientist, Biocon, karthik.periyasamy@biocon.com*	2. *Prof. R. B. Narayanan, Anna University, Chennai arbeen09@gmail.com*	2. *Dr. S. Barathi, SRMIST*

Course Code	21BTC302J	Course Name	IMMUNOLOGY	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							3	0	2	4

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Biotechnology*	Data Book / Codes / Standards	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*introduce the science of immunology and a detailed study of various types of immune cells*
CLR-2:	*provide knowledge about immune systems produced molecules and their classification, structure, and function*
CLR-3:	*provide students with experience in methods used in immunology, particularly the use of specific antibody in biomolecular applications*
CLR-4:	*provide knowledge about major histocompatibility complex and acquired immune system, their cells and its interaction and how they fight against infectious diseases*
CLR-5:	*provide knowledge about dysregulation of immune system functioning, ways to strengthen immune system and how human body is designed and protected to fight against various pathogens*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*describe the immune system, their structure, classification and function*	-	-	*2*	-	-	-	-	-	-	-	-	-	*1*	-	*1*
CO-2:	*summarize genetic control of antibody diversity, monoclonal antibodies and cellular immunology*	-	-	*2*	*2*	*2*	-	-	-	-	-	-	-	*1*	-	*2*
CO-3:	*determine various methods to assess immune function, their application and interpretation of the results*	-	-	-	*2*	*3*	-	-	-	-	-	-	-	*3*	-	*3*
CO-4:	*outline major histocompatibility complex, types, function and the role of acquired immune cells signalling and its function*	-	-	*2*	*3*	-	-	-	-	-	-	-	-	*2*	-	*2*
CO-5:	*categorize hypersensitive immune reaction, autoimmunity, vaccination and cancer immunology and Illustrate the processes function to protect human body against infective agents*	-	-	-	*3*	-	*1*	-	-	-	-	-	-	*1*	-	*2*

Unit-1 - Immune System for Health ***15 Hour***

Overview of the immune system; Development and differentiation of the hematopoietic stem cells, Myeloid and Lymphoid lineage; Lymphatic system; Lymphoid organs – types; Innate lymphoid cells; Rhesus group types; incompatible blood transfusion and hemolytic disease; Receptors of Innate Immune system; Types of Immune cells, Innate Immunity; Anatomical and Physiological barriers; Acquired Immunity, Clonal selection theory; Comparative immunity - Plant Immune system, Vertebrate and Invertebrate Immune system; Immunogens, Antigens and Haptens; Requirements for immunogenicity; major classes of antigens; antigen recognition by T and B lymphocytes

Practice : *1: Laboratory safety principles and Blood grouping; Agglutination principle, blood group types, 2: Total Leukocyte count; Types of blood cells - Leukocyte counting, 3: Differential Leukocyte count*

Unit-2 - Immunity of Secretory Proteins ***15 Hour***

Immunoglobulin structure, types and function; Antibodies biological and functional properties - Proteolytic digestion of antibodies; Monoclonal antibodies production and applications; B Cell differentiation -B cell receptor structure and B cell signal transduction; Antibody diversity - Light chain synthesis; Heavy chain synthesis;; Cytokine types and function; Cytokine receptor structure; Role of cytokines in diseases; Complement system - Regulation of complement pathway; Role of complement proteins in diseases

Practice: *1. Antigen – Antibody reaction I – Widal test- slide method, 2. Antigen – Antibody reaction II -rapid plasma reagin (RPR) test, 3. Single radial immunodiffusion (SRID) - titer value, zone of equivalence*

Unit-3 - Methods to Assess Immune Status	***15 Hour***
Isolation of immune cells from Human and animals; Antigen- antibody interaction; antibody affinity and avidity; Hemaagglutination reaction - Coombs test – direct and indirect; precipitation reaction;; Quantitative Immuno assays; passive Immunodiffusion; Precipitation reaction; Active Immunodiffusion – Rocket immunoelectrophoresis, SDS-PAGE and Western blot; Quantitative Immuno assays - Radio-immunoassay, Immunoprecipitation; Immunofluorescence – Direct and indirect; Immunohistochemistry; flow cytometry, ELISA and types; Cell culture and experimental models, analysis of gene expression	
Practice: *1. Ouchterlony gel diffusion - Antigen-Antibody specificity, 2. Active Immunodiffusion I - Rocket Immunoelectrophoresis, 3. Active immunodiffusion – II – Counter Current Immunoelectrophoresis*	
Unit-4 - T Cell Signalling and Major Histocompatibility Complex	***15 Hour***
Major histo-compatibility Complex(MHC) – types and function; antigen processing and presentations – Endogenous and Exogenous; Diversity of MHC molecules;; Antigen – Antibody interaction Standard and test antigen; Rocket Immunoelectrophoresis; Biology of T lymphocyte - T cell receptors and interaction with MHC; T-cell maturation - T-cell activation and differentiation; Thymic selection – Positive and negative selection; T-cell activation and cytokine secretion; Cytokine control of TH1 and TH2 CD4+; Function of CD8+ T cells, T Regulatory cells; T-cell and B-cell cooperation, Pathways of Activation	
Practice: *1. Enzyme linked Immunosorbent assay (ELISA) – Qualitative, 2. Enzyme linked Immunosorbent assay (ELISA) – Quantitative, 3. Immunoprecipitation*	
Unit-5 - Immunity of Infection, Autoimmune Disorder and Cancer	***15 Hour***
Hypersensitive reactions - Type I, Type II, Type III and Type IV reaction; Immune responses to infectious diseases introduction; Viral disease-HIV infection; Bacterial disease-Tuberculosis; Parasitic disease - Malaria; Evading Mechanisms of pathogens; Vaccine history and principle; Active and passive Immunization; DNA vaccine, Edible vaccine and Adjuvants; Cancer Immunology introduction; Evidence for cancer Immunity; cancer Immuno therapy; Autoimmunity introduction; Genetic Basis of Autoimmunity; Classification of auto-immunity	
Practice: *1. SDS-PAGE, 2. Western blotting – Demo, 3. Flow cytometry - Demo*	

Learning Resources	*1. Sudha Gangal, Shubhangi Sontakke, Textbook of basic and clinical immunology, Universities Press, 2013*	*2. Jenni Punt, Sharon Stranford, Patricia Jones, Judith A Owen, Kuby Immunology, 8th ed., W. H. Freeman and Company, 2018*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		CLA-2-Practice (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	-	15%	15%	-
Level 2	Understand	25%	-	-	20%	25%	-
Level 3	Apply	30%	-	-	25%	30%	-
Level 4	Analyze	30%	-	-	25%	30%	-
Level 5	Evaluate	-	-	-	10%	-	-
Level 6	Create	-	-	-	5%	-	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. C. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com	*1. Dr. Joe Varghese, CMC Vellore, joevarghese@cmcvellore.ac.in*	*1. Dr.S.Nageswaran, SRMIST*
2. Dr. Karthik Periyasamy, Scientist, Biocon, karthik.periyasamy@biocon.com	*2. Prof. K Subramaniam, IITM, Chennai, subbu@iitm.ac.in*	*2. Dr.S.Rupachandra, SRMIST*

Course Code	21BTC303T	Course Name	PROTEIN ENGINEERING	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Biotechnology*	Data Book / Codes / Standards	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*distinguish the organizational levels of protein structure*
CLR-2:	*appraise the structure-function correlation in selected proteins*
CLR-3:	*understand Mutagenesis based protein design*
CLR-4:	*construct 3D structure of protein from amino acid sequence*
CLR-5:	*discuss on the experimental techniques available for protein structure characterization*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*outline proteins and its properties at the elemental, molecular and structural levels*	-	*2*	-	-	-	-	-	-	-	-	-	-	-	*3*	-
CO-2:	*group the proteins based on super secondary structure of protein with its function*	-	*2*	-	-	*3*	-	-	-	-	-	-	-	-	*3*	-
CO-3:	*integrate protein biochemistry to design efficient protein structures*	-	*2*	-	-	*3*	-	-	-	-	-	-	-	-	*3*	-
CO-4:	*scoring and validating the methods of obtain protein structural data*	-	-	-	*2*	*3*	-	-	-	-	-	-	-	-	-	*3*
CO-5:	*mutagenesis experiments to test protein stability and/or function*	*2*	-	-	*2*	*3*	-	-	-	-	-	-	-	-	-	*3*

Unit-1 - Characteristics of Proteins — ***9 Hour***

Structure of amino acids- Properties of amino acids- Role of Glycine and Proline in structure determination- Ramachandran plot and its significance- Interactions that stabilize secondary -Structures, Structural features of alpha helix- Types of alpha helices- Parallel beta-strand structure-Anti-parallel beta-strand structure- Beta turns- loops and other secondary structures- Super- Secondary structures- Difference between motifs & domains- Types of motifs, Types of domains, Monomeric and polymeric proteins- hydrophobic collapse & theories of folding- Levinthal paradox- Role of chaperones- and heat shock proteins

Unit-2 - Structural features of Different Classes of Proteins — ***9 Hour***

Role of Transcription factors in gene - Nature of interaction between p53 and DNA- effect of mutations in the DNA binding domain of p53- Effects of mutations in the oligomerization and Nuclear localization region-Structural elucidation of leucine zipper- Interaction of leucine zipper and DNA- - Structural elucidation of GPCR- Types of GPCR- Mechanism of activation of GPCR- Structural features of serine proteases

Unit-3 - Experimental Protein Structure and Functional Analysis — ***9 Hour***

Methods of generating crystals- (ITC) Principle- Instrumentation of ITC- Determination enthalpy- entropy and free energy- Prediction of binding energy and multiple binding sites by ITC- Prediction of 3D structure from amino acid sequence, Homology modelling and threading

Unit-4 - Increasing Efficacy of Proteins — ***9 Hour***

Protein Engineering in Basic and Applied Biotechnology- engineering new protein function- Engineering enzymes- Specificity- stability- antibodies- Denovo designs Fusion proteins- Protein engineering in Vaccine development- Protein engineering in biosensors- Case Study: Enhancing binding affinity of T4 lysozyme- Enhancing stability in T4 lysozyme

Unit-5 - Protein Expression Purification and Characterization — ***9 Hour***

The isolation and characterization of proteins, Recombinant DNA technology and protein expression- Protein Digestion Techniques- Chemical and Enzymatic- Mass spectrometry - Tandem LC MS-/MS- Tools for mass spectrum analysis

Learning Resources	1. *Whitford, David. Proteins: Structure and Function. Wiley, 2013.* 2. *Tooze, John, and Branden, Carl Ivar. Introduction to Protein Structure. United States, CRC Press, 2012.* 3. *Ben-Tal, Nir. Kessel, Amit. Introduction to Proteins: Structure, Function, and Motion. United Kingdom: CRC Press, Taylor & Francis Group, 2018.*	4. *Buxbaum, Engelbert. Fundamentals of Protein Structure and Function. Germany: Springer International Publishing, 2015* 5. *Lilia Alberghina, Protein Engineering For Industrial Biotechnology, Taylor & Francis, 2003.* 6. *Chatwal. G. R, "Instrumental methods of Chemical Analysis", Himalaya Publishing House, 5th Edition, 2011.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	-	*15%*	-	*15%*	-
Level 2	*Understand*	*25%*	-	*20%*	-	*25%*	-
Level 3	*Apply*	*30%*	-	*25%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*25%*	-	*30%*	-
Level 5	*Evaluate*	-	-	*10%*	-	-	-
Level 6	*Create*	-	-	*5%*	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. C. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com*	1. *Prof. K Subramaniam, IITM, Chennai, subbu@iitm.ac.in*	1. *Dr. Priya Swaminathan, SRMIST*
2. *Dr. Karthik Periyasamy, Scientist, Biocon, karthik.periyasamy@biocon.com*	2. *Prof. R. B. Narayanan, Anna University, Chennai arbeen09@gmail.com*	2. *Dr. Vasantharekha R, SRMIST*

Course Code	21BTC304T	Course Name	ANIMAL BIOTECHNOLOGY	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Biotechnology*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*provide a basic understanding of animal breeding and animal health*
CLR-2:	*develop an understanding on raising animals using assisted reproductive techniques*
CLR-3:	*inculcate the understanding of cell culture technique and production of valuable products from them*
CLR-4:	*provide an understanding of alteration of animal body biological system*
CLR-5:	*give emphasis to transgenesis thereby improving livestock production*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*familiarize the students about breeding, biological markers for genetic diseases and managing animal health using vaccines*	-	*3*	*3*	-	-	-	-	-	-	-	-	-	-	*3*	*3*
CO-2:	*impart an understanding about Embryo transfer, fertilization methods and animal production*	-	*3*	*3*	-	-	-	-	-	-	-	-	-	-	*3*	*3*
CO-3:	*provide knowledge about different culture techniques, Characterization of cell lines and in vitro testing of drugs*	-	*3*	*2*	-	-	-	-	-	-	-	-	-	*3*	*3*	-
CO-4:	*provide knowledge about improvement of animals to increase the yield and quality of animal products*	*3*	-	-	*3*	-	-	-	-	-	-	-	-	*3*	*3*	-
CO-5:	*familiarize the students about livestock improvement using molecular pharming*	*3*	-	-	*2*	-	-	-	-	-	-	-	-	-	*3*	*3*

Unit-1 - Animal Improvement for Desired Traits and Animal Health	***9 Hour***
Breeding, different types of breeding; Marker assisted Selection - Gene mapping and identification of genes of economic importance in farm animals; Animal Health: Common viral, bacterial and parasitic diseases affecting animals; Vaccines for animal health; Developing diagnostic kits for animal diseases	
Unit-2 - Embryo Transfer and Animal Propagation	***9 Hour***
Assisted reproductive techniques in animals: Artificial insemination; In vitro fertilization- Superovulation, MOET,Embryo transfer,– Pregnancy diagnosis – Sexing of embryos, Embryo splitting; Cryopreservation of embryo; Cloning for conservation of endangered species; Stem cell technology & its applications	
Unit-3 - Animal Cell Culture	***9 Hour***
Principles of sterile techniques and cell propagation – Primary cell culture, secondary cell culture, continuous cell lines, suspension cultures; Chemically defined and serum free media for cell culture; Preservation and characterization of animal cells; Scaling up of animal cell culture; organ culture; 3D printing; Application of animal cell culture in vitro testing of drugs; Cell culture as source of therapeutic protein production	
Unit-4 - Biotechnology in Livestock Production	***9 Hour***
Manipulation of Growth hormone – somatotropic hormone – Thyroid hormone; Probiotics as growth promoters, Mode of action & uses of probiotics ; Manipulation of lactation – Lactogenesis – galactopoiesis ; Manipulation of rumen microbial digestive system; Manipulation of wool growth	
Unit-5 - Transgenesis and Molecular Pharming	***9 Hour***
Trangenesis, Gene editing using CRISPR Cas9, Transgenic animals, Methods of producing transgenic animals, knockin, knock out, mutation models; Transgenic animals as models for human diseases; Transgenic animals in livestock improvement- Therapeutic protein expression using transgenic animals, Animal as bioreactors; Ethical issues in animal biotechnology, 3R's and alternative for animal models - In vitro testing & insilico modeling	

Learning Resources	1. *Animal Biotechnology: Recent concepts and developments - P.Ramadas, MJP Publications, 2015.* 2. *Animal Breeding and Genetics; Aggrey, S.E.; Rekaya, R. Spangler, M.L., Ed.; Springer: New York, NY, USA, 2022.*	3. *Animal Biotechnology – M.M.Ranga, 3rd edition, 2007.* 4. *Culture of Animal cells; a manual of basic technique - R.Ian Freshney, 4th edition, Wiley publications, 2006.* 5. *Textbook of Animal Biotechnology – P.Ramadas & S.Meerarani, 2nd edition, 2002.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	*-*	*15%*	*-*	*15%*	*-*
Level 2	*Understand*	*25%*	*-*	*20%*	*-*	*25%*	*-*
Level 3	*Apply*	*30%*	*-*	*25%*	*-*	*30%*	*-*
Level 4	*Analyze*	*30%*	*-*	*25%*	*-*	*30%*	*-*
Level 5	*Evaluate*	*-*	*-*	*10%*	*-*	*-*	*-*
Level 6	*Create*	*-*	*-*	*5%*	*-*	*-*	*-*
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. G. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com*	1. *Prof. K Subramaniam, IITM, Chennai, subbu@iitm.ac.in*	1. *Dr.S.Sujatha, SRMIST*
2. *Dr. Karthik Periyasamy, Scientist, Biocon, karthik.periyasamy@biocon.com*	2. *Prof. R. B. Narayanan, Anna University, Chennai arbeen09@gmail.com*	2. *Dr.K.Venkatesan, SRMIST*

Course Code	21BTC305L	Course Name	ANIMAL BIOTECHNOLOGY LABORATORY	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							0	0	4	2

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Biotechnology*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*provide the basics of cell culture media and primary cell culture*
CLR-2:	*understand the rationale of sub culturing of cells and maintaining it*
CLR-3:	*analyzing the cellular content using specific staining methods*
CLR-4:	*distinguish between cell viability and cell cytotoxicity*
CLR-5:	*comprehend the applications of animal cell culture*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1 Engineering Knowledge	2 Problem Analysis	3 Design/development of solutions	4 Conduct investigations of complex problems	5 Modern Tool Usage	6 The engineer and society	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*develop hands on training in primary cell culture techniques*	-	*2*	*3*	-	-	-	-	-	-	-	-	-	-	*3*	-
CO-2:	*gain proficiency in culturing and maintaining cell lines*	-	-	*3*	*2*	-	-	-	-	-	-	-	-	-	-	*3*
CO-3:	*acquire skills to perform fluorescent staining procedures to visualize cellular content*	-	*3*	*3*	-	-	-	-	-	-	-	-	-	-	*3*	-
CO-4:	*critique the toxicity of drugs invitro*	-	-	*3*	*3*	-	-	-	-	-	-	-	-	*2*	*3*	-
CO-5:	*utilize cell culture techniques in emerging fields of animal biotechnology*	-	-	-	*3*	*2*	-	-	-	-	-	-	-	-	-	*3*

Unit-1 - Media Preparation and Primary Cell Culture — ***12 Hour***

Practice:

1. Preparation & Sterilization of media for animal cell culture
2. Isolation of Hepatocytes and checking its viability
3. Isolation and culturing fibroblasts from chick embryo

Unit-2 - Cell Culture and Maintenance — ***12 Hour***

Practice:

1. Cell passaging
2. Cryopreservation of cells
3. Revival of Cryopreserved cells.

Unit-3 - Rapid Staining Procedures for Analysis of Cellular Content using Specific Fluorochromes — ***12 Hour***

Practice:

1. Mitochondrial & Nuclear staining using fluorochromes
2. Detection of apoptosis using Annexin V
3. Detection of mycoplasmal contamination by Hoechst staining

Unit-4 - Cell Viability and Cell Cytotoxicity Assays	***12 Hour***
Practice: *1. Determination of Cell viability by MTT assay* *2. Assessment of Cytotoxicity by LDH assay* *3. Clonogenic assay*	
Unit-5 - Applications of Cell Culture	***12 Hour***
Practice: *1. Determination of glucose uptake by the cells using 2NBDG method* *2. Demonstration on sorting of cells by flow cytometry* *3. Mammalian cell transfection using lipofectamine*	

Learning Resources	*1. Capes-Davis & Ian Freshney " Freshney's Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications", 8th Edition, ISBN: 978-1-119-51304-9, 2021 Wiley-Blackwell*	*2. ATCC Animal Cell culture guide*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Final Examination (0% weightage)	
		CLA-1 Average of first cycle experiments (30%)		CLA-2 Average of second cycle experiments (30%)		Practical Examination (40% weightage)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	-	15%	-	15%	-	15%	-	-
Level 2	Understand	-	20%	-	20%	-	20%	-	-
Level 3	Apply	-	25%	-	25%	-	25%	-	-
Level 4	Analyze	-	25%	-	25%	-	25%	-	-
Level 5	Evaluate	-	10%	-	10%	-	10%	-	-
Level 6	Create	-	5%	-	5%	-	5%	-	-
	Total	100 %		100 %		100 %		-	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. G. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com	*1. Prof. K Subramaniam, IITM, Chennai, subbu@iitm.ac.in*	*1. Dr.S.Sujatha, SRMIST*
2. Dr. Karthik Periyasamy, Scientist, Biocon, karthik.periyasamy@biocon.com	*2. Prof. R. B. Narayanan, Anna University, Chennai arbeen09@gmail.com*	*2. Dr.K.Venkatesan, SRMIST*

Course Code	21BTC306T	Course Name	PLANT BIOTECHNOLOGY	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Biotechnology*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*understand the genome organization and gene expression in plants*
CLR-2:	*exercise the plants as production systems by altering the plant hormones for growth and development*
CLR-3:	*employ different methods for the development of transgenic plants*
CLR-4:	*interpret the mechanisms for the plant to cope with biotic and abiotic stresses*
CLR-5:	*apply the classical and modern plant breeding techniques for crop improvements*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*discuss the structure, organization of plant genomes and gene regulation*	*3*	-	*3*	-	-	-	*3*	-	-	-	-	-	-	*2*	-
CO-2:	*demonstrate the mechanism and role of plant tissue culture for mass multiplications*	*3*	*2*	*3*	-	-	-	-	-	-	-	-	-	-	*3*	-
CO-3:	*establish the various methods of genetic manipulation in plants*	*3*	*2*	-		*3*	-	-	-	-	-	-	-	-	*3*	-
CO-4:	*discuss the molecular aspects of plant adaptability to various stresses*	*3*	-	*2*	-	-	-	*3*	-	-	-	-	-	-	-	*3*
CO-5:	*apply the significance of plant breeding and genetic manipulations of plants for economic importance*	*3*	-	-	-	*3*	-	*3*	-	-	-	-	-	-	*3*	-

Unit-1 - Plant Genomes: the Organization and Expression of Genes — ***9 Hour***

Plant DNA, chromatin, chromosome structure. Nuclear genome, genome size, and organization. Chloroplast and mitochondrial - Genome structure, evolution, expression, and gene regulations. Eukaryotic gene expressions and its regulation - Transcription and translation levels: Organellar self-splicing, introns, and horizontal DNA transfer, RNA modification, post-transcriptional gene silencing (PTGS), Micro RNA - Production and interfering with the gene for silencing, DNA instability, Transposable elements in plants.

Unit-2 -Techniques for in Vitro Propagation of Plants — ***9 Hour***

Introduction to plant tissue culture. Plasticity and totipotency of plant cells. The culture environment - physical and chemical factors. Plant growth hormones - classes and their roles. Stages of plant tissue culture. Culture types. Cybrids production, haploid production. Production of secondary metabolites.

Unit-3 - Tools and Techniques for Transgenic Plant Development — ***9 Hour***

Introduction to Agrobacterium-mediated gene transfer and Biology. Ti-plasmid-process of T-DNA transfer and integration, transformation in the plant.Direct gene transfer methods - advantages and disadvantages. Basic features of vectors, optimization, and binary vectors. Alternative markers and reporter genes. The genetic manipulation of pest resistance crop plants, and Clean gene technology.

Unit-4 - Biotic and Abiotic Stresses of Plants — ***9 Hour***

Plant stresses - Biotic stress: Plant–pathogen interactions, prokaryotes, fungi, and viruses. Disease resistance, natural disease resistance in plants. Biotechnological approach - Overexpression of PR-proteins. Herbs as biotic stress factors. Abiotic stresses: Natural and plant responses - The nature of water deficit stress. Various approaches for tolerance - salt, cold, and heat stress - Molecular mechanisms.

Unit-5 - Genetic Improvements in Agriculture — ***9 Hour***

Introduction to crop improvement, crop plant domestication, and beyond. Breeding technologies: Advances in breeding technologies - Modern molecular plant breeding - Transgenic plants. Emerging technologies circumvent some concerns about transgenics. Applications of breeding. The second green revolution. Metabolic engineering: Molecular farming of carbohydrates, lipids, and protein. Producing fine chemicals, Plant-derived compounds as drugs. Current demand - the plants as alternative fuels

Learning Resources	1. *Slater. A, Scott.N.W and Fowler,M.R, "Plant Biotechnology - The genetic manipulation of plants", Oxford University Press 2008* 2. *Agnès Ricroch, Surinder Chopra, Marcel Kuntz. - Plant Biotechnology (2021). Springer Nature Switzerland AG 2021 Publisher. ISBN: 978-3-030-68344-3. Published: 31 August 2021. https://doi.org/10.1007/978-3-030-68345-0. 2nd Edition.*	3. *C Neil Stewart Jr. "Plant Biotechnology and Genetics: Principles, Techniques, and Applications (2016)"- John Wiley & Sons, Inc., New Jersey ISBN: 978-1-118-82012. 2nd Edition.* 4. *Malik Zainul Abdin, Usha Kiran, Kamaluddin, Athar Ali. - Plant Biotechnology: Principles and Applications (2017). Springer Publisher, Singapore. ISBN: 978-981-10-2959-2 Published: 17 March 2017. https://doi.org/10.1007/978-981-10-2961-5.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life Long Learning CLA-2 – (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	*-*	*15%*	*-*	*15%*	*-*
Level 2	*Understand*	*25%*	*-*	*20%*	*-*	*25%*	*-*
Level 3	*Apply*	*30%*	*-*	*25%*	*-*	*30%*	*-*
Level 4	*Analyze*	*30%*	*-*	*25%*	*-*	*30%*	*-*
Level 5	*Evaluate*	*-*	*-*	*10%*	*-*	*-*	*-*
Level 6	*Create*	*-*	*-*	*5%*	*-*	*-*	*-*
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. G. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com*	1. *Prof. K Subramaniam, IITM, Chennai, suubu@iitm.ac.in*	1. *R. Pachaiappan, SRMIST*
2. *Dr. Karthik Periyasamy, Scientist, Biocon, karthik.periyasamy@biocon.com*	2. *Prof. R. B. Narayanan, Anna University, Chennai arbeen09@gmail.com*	2. *S. Rupachandra, SRMIST*

Course Code	21BTC401L	Course Name	PLANT BIOTECHNOLOGY LABORATORY	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							0	0	4	2

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Biotechnology*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*relate the growth and development of natural and in vitro growth of plants for production systems*
CLR-2:	*comprehend the methods of nucleic acids isolation from plants*
CLR-3:	*apply various gene transfer methods in plants*
CLR-4:	*employ different steps for the production of plant secondary metabolites*
CLR-5:	*apply the classical techniques for crop improvement*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*develop in vitro plants for mass multiplication*	*3*	*2*	*3*	-	-	-	-	-	-	-	-	-	*3*	-	-
CO-2:	*contrast the different techniques for the isolation of nucleic acids for cloning and quantification of gene expression*	*2*	*3*	*2*	-	-	-	-	-	-	-	-	-	-	*3*	-
CO-3:	*demonstrate the different steps for gene transfer methods and verify the transgene in plants*	*3*	-	-	*3*	*2*	-	-	-	-	-	-	-	*3*	-	-
CO-4:	*establish the cells for the production of bioactive plant secondary metabolites and methods for isolation and detection*	*3*	*2*	-	-	-	-	-	-	-	-	-	-	*2*	*3*	-
CO-5:	*design the methods for the production of best traits and apply the plant pathology for crime investigation*	*3*	*2*	-	*3*	-	-	-	-	-	-	-	-	-	*3*	-

Unit-1 - Techniques for in Vitro Propagation of Plants	***12 Hour***
Practice:	
1. Preparation of plant tissue culture media - Murashige and Skoog's (MS) medium	
2. Plant tissue culture - Direct and Indirect Organogenesis	
Unit-2 - Plant Genomic DNA and RNA Isolation Techniques	***12 Hour***
Practice:	
1. Isolation of plant genomic DNA - Salk line & CTAB methods - Qualitative and quantitative analysis of DNA	
2. Extraction of total RNA from plant tissues using Trizol reagent - Qualitative and quantitative analysis of RNA	
Unit-3 - Techniques for Transgenic Plant Development	***12 Hour***
Practice:	
1. Transform the binary vector (pCAMBIA 1301) to Agrobacterium tumefaciens	
2. Screening of Agrobacterium colonies for confirming transformation of pCAMBIA 1301 by colony PCR and Agrobacterium - Mediated gene transformation by Co-cultivation of plant leaf discs	
3. Screening of transgenic plant tissues - GUS Reporter assay	

Unit-4 - Plant Secondary Metabolites - Production, Isolation and Detection	***12 Hour***
Practice: *1. Development of Cell suspension culture for the production of secondary metabolites* *2. Extraction and detection of plant secondary metabolites extract - Flavonoid - quercetin from onion dried peels and alkaloid - caffeine from Camellia sinensis - Tea / Detection by TLC and HPLC*	
Unit-5 - Applications of in Vitro Propagation & Plant Pathology	***12 Hour***
Practice: *1. Cybrids production through protoplast fusion* *2. Somatic embryogenesis through endosperm culture* *3. Crime scene investigation*	

Learning Resources	1. *Plant Biotechnology Practical Manual - 2023.* 2. *C Neil Stewart Jr. "Plant Biotechnology and Genetics: Principles, Techniques, and Applications (2016)"- John Wiley & Sons, Inc., New Jersey ISBN: 978-1-118-82012. 2nd Edition* 3. *Maheshwari, S.C. (1990). Tissue Culture, Molecular Biology and Plant Biotechnology — A Historical Overview. In: Sangwan, R.S., Sangwan-Norreel, B.S. (eds) The Impact of Biotechnology on Agriculture..Current Plant Science and Biotechnology in Agriculture, vol 8. Springer, Dordrecht. https://doi.org/10.1007/978-94-009-0587-0_1*	4. *Çelik, Ö. (2018). Introductory Chapter: New Age Molecular Techniques in Plant Science. In (Ed.), New Visions in Plant Science. IntechOpen. https://doi.org/10.5772/intechopen.79360.* 5. *Methods in Plant Molecular Biology and Biotechnology by Bernard R. Glick. Published November 29, 2017, by CRC Press. ISBN 9780367412128*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Final Examination (0% weightage)	
		CLA-1 Average of first cycle experiments (30%)		CLA-2 Average of second cycle experiments (30%)		Practical Examination (40% weightage)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	*Remember*	-	*15%*	-	*15%*	-	*15%*	-	-
Level 2	*Understand*	-	*20%*	-	*20%*	-	*20%*	-	-
Level 3	*Apply*	-	*25%*	-	*25%*	-	*25%*	-	-
Level 4	*Analyze*	-	*25%*	-	*25%*	-	*25%*	-	-
Level 5	*Evaluate*	-	*10%*	-	*10%*	-	*10%*	-	-
Level 6	*Create*	-	*5%*	-	*5%*	-	*5%*	-	-
	Total	*100 %*		*100 %*		*100 %*		-	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Dr. G. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com*	1. *Prof. K Subramaniam, IITM, Chennai, suubu@iitm.ac.in*	1. *R. Pachaiappan, SRMIST*
2. *Dr. Karthik Periyasamy, Scientist, Biocon, karthik.periyasamy@biocon.com*	2. *Prof. R. B. Narayanan, Anna University, Chennai arbeen09@gmail.com*	2. *S. Rupachandra, SRMIST*

Course Code	21BTC402J	Course Name	BIO SEPARATION TECHNOLOGY	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							3	0	2	4

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Biotechnology*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*know the importance of bio separation and its recovery economically*
CLR-2:	*learn the separation of product from solid –liquid phase*
CLR-3:	*know the techniques of isolation of bio-products*
CLR-4:	*learn the methods of purification of products*
CLR-5:	*learn the methods of polishing and formulation of products for packaging*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*categories the products into various sectors*	*1*	*2*	*1*	-	-	-	-	-	-	-	-	-	*1*	*2*	*1*
CO-2:	*identify the unit operation for separation*	*2*	*3*	*1*	-	-	-	-	-	-	-	-	-	*2*	*2*	*1*
CO-3:	*adapt the best methods of isolation of products*	*2*	*2*	*2*	-	-	-	-	-	-	-	-	-	*2*	*2*	*1*
CO-4:	*identify the sophisticated equipment for purification*	*2*	*3*	*2*	-	-	-	-	-	-	-	-	-	*2*	*2*	*2*
CO-5:	*know the polishing and formulation of the products*	*2*	*2*	*2*	-	-	-	-	-	-	-	-	-	*2*	*2*	*2*

Unit-1 - Bioproducts Classification and Disruption Techniques ***15 Hour***

Classification of Bioproducts, Engineering Analysis, Analytical methods, Cell disruption Methods- Physical, Chemical, Mechanical and Biological methods.

Practice:

Cell disruption Techniques

1. Cell disruption by Sonication, 2. Cell disruption by High Pressure Homogenisation, 3. Chemical and Enzymatic method of cell disruption

Unit-2 - Separation of Insolubles ***15 Hour***

Electrical Double layers, Schulze–Hardy Rule, Flocculation Rate, Polymeric Flocculants, Sedimentation-Principles, Methods and Coefficients, Filtration Principles and Theory, Conventional Filtration- Filtration Equipments and Media, Scaleup and Design of Filtration Systems ,Cross flow filtration- Microfiltration, Centrifuges, Scaleup of Centrifugations.

Practice:

Recovery Methods

1. Cell separation by Flocculation, 2. Cell separation by Batch filtration, 3. Cell separation by Microfiltration, 4. Cell separation by Centrifugation

Unit-3 - Concentration of Solubles ***15 Hour***

Extraction-Batch,Staged,Differential Extraction,Aqueous two phase Extraction, Supercritical Extraction, Batch Adsorption, Adsorption in CSTR and Fixed Bed, Precipitation-Different methods of precipitation, Ultrafiltration, Dialysis and Electrodialysis.

Practice:

Protein Concentration Methods

1. Protein concentration by Precipitation methods, 2. Protein concentration by Ultrafiltration, 3. Protein Concentration by Aqueous two-phase extraction

Unit-4 - Protein Purification	***15 Hour***
Chromatography Column Dynamics, Plate Models, Chromatography Column Mass Balance with Negligible Dispersion, Dispersion Effects in Chromatography, Gradients and Modifiers, Adsorbent Types, Particle Size and Pressure Drop in Fixed Beds, Equipment, Scaleup. ***Practice:*** *Purification of Protein* *1. Protein purification by gel column chromatography* *2. Protein purification by ion exchange chromatography*	
Unit-5 - Polishing	***15 Hour***
Crystallization Principles, Batch Crystallizers, Process Crystallization of Proteins, Crystallizer Scaleup and Design, Drying Principles, Dryer Description and Operation, Scaleup and Design of Drying Systems, Case studies. ***Practice:*** *Polishing of Biomaterial* *1. Crystallization Techniques* *2. Freeze drying of biomaterials*	

Learning Resources	1. *Harrison. R.G., Todd. P., Rudge S.R, Petrides. D.P, "Bioseparation Science and Engineering" Oxford University press, 2003.* 2. *Belter. P.A., Cussler, E., "Bioseparations", Wiley, 1985.*	3. *Nooralabettu Krishna Prasad, "Downstream Process Technology: A New Horizon In Biotechnology", PHI Learning Private Limited 2013* 4. *Mihir K Purkait; Randeep Sing,"Membrane Technology in separation science, CRC Press Taylor & Francis Group, 2018*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (45%)		*CLA-2-Practice (15%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	-	-	*15%*	*15%*	-
Level 2	*Understand*	*25%*	-	-	*20%*	*25%*	-
Level 3	*Apply*	*30%*	-	-	*25%*	*30%*	-
Level 4	*Analyze*	*30%*	-	-	*25%*	*30%*	-
Level 5	*Evaluate*	-	-	-	*10%*	-	-
Level 6	*Create*	-	-	-	*5%*	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. G. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com*	1. *Dr.S.Senthil Kumar, IITG, senthilkumar@iitg.ac.in*	1. *Dr.M.Venkatesh Prabhu, SRMIST*
2. *Dr. Karthik Periyasamy, Scientist, Biocon, karthik.periyasamy@biocon.com*	2. *Dr.N.Selvaraj, IITG, selva@iitg.ac.in*	2. *Dr.P.Radha, SRMIST*

ACADEMIC CURRICULA

Non-Credit Course

Regulations 2021

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu, India

Course Code	21BTM191T	Course Name	BIOETHICS AND IPR	Course Category	M	NON CREDIT	L	T	P	C
							1	0	0	0

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Biotechnology*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*realize the need for ethical values in Biotechnology Research*
CLR-2:	*understand the risks associated with biotechnology Research*
CLR-3:	*know the type and extent of damage that could be caused to the environment*
CLR-4:	*understand the ethical and moral values to be inculcated in ethical decision making*
CLR-5:	*know the requirements for containment of risk group organisms*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*define Principles of Bioethics and aspects related to IP protection*	-	*3*	*3*	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	*elaborate the ethical issues and safety precautions in biotechnology research*	-	*3*	*2*	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	*explain concepts pertaining to exercising personal and environmental safety*	-	*2*	-	-	*3*	-	-	-	-	-	-	-	-	-	-
CO-4:	*examine case studies and ethical decisions in healthcare research*	-	*2*	*3*	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	*discriminate different biosafety levels and different forms of IP*	-	*2*	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Basic Principles of Bioethics	***3 Hour***
Ethics and Bioethics, Ethical Theories, Use of animals in research and Ethical issues in Clinical Trials, Ethical issues in Stem Cell Research, Ethical Issues in In vitro Fertilization	
Unit-2 - Global Health Ethics	***3 Hour***
Health Systems and Institutions, Synaptogenesis and development of sensory-motor system, Ethical issues in Organ transplantation, Biobanking, Ethical issues in Regenerative Medicine, Religious and Cultural Perspectives in Bioethics	
Unit-3 - Biosafety Regulations	***3 Hour***
Transgenic Research and Field Trials, Roles of various regulatory bodies, Biosafety Rules for GMOs, Biodiversity and Environment conservation, CBD and Cartagena Protocol	
Unit-4 - Forms of IPR	***3 Hour***
Designs, Copyrights and Geographical indications, Novelty and Utility, Patentable subjects and protection in biotechnology, Biodiversity	
Unit-5 - Patens	***3 Hour***
Basic principles and general requirements of patent law Patents and methods of application of patents-Legal implications, Objectives of the patent system, TRIPs-GATT-International conventions, Patent Cooperation Treaty, Plant variety protection and farmer rights, other forms of IP	

Learning Resources	1. *Singer and Viens (Eds.) Bioethics – Cambridge University Press, Cambridge,2008*	2. *The Indian Patent Act and Rules, 2015, GoI, India.*

Learning Assessment							
	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	-	*15%*	-	*15%*	-
Level 2	*Understand*	*25%*	-	*20%*	-	*25%*	-
Level 3	*Apply*	*30%*	-	*25%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*25%*	-	*30%*	-
Level 5	*Evaluate*	-	-	*10%*	-	-	-
Level 6	*Create*	-	-	*5%*	-	-	-
	Total	*100 %*		*100 %*		*100%*	

Course Designers		
Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. G. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com*	1. *Prof. K Subramaniam, IITM, Chennai, subbu@iitm.ac.in*	1. *Dr. DVL Saradha, SRMIST*
2. *Dr. Karthik Periyasamy, Scientist, Biocon, karthik.periyasamy@biocon.com*	2. *Prof. R. B Narayanan Anna University, Chennai,arbeen09@gmail.com*	2. *Dr Lilly M Saleena. SRMIST*

ACADEMIC CURRICULA

UNDERGRADUATE/ INTEGRATED POST GRADUATE DEGREE PROGRAMMES

(With exit option of Diploma)

(Choice Based Flexible Credit System)

Regulations 2021

Volume – 8A
(Syllabi for Biotechnology Programming Courses)

SRM
INSTITUTE OF SCIENCE & TECHNOLOGY
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SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

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Kattankulathur, Chengalpattu District 603203, Tamil Nadu, India

ACADEMIC CURRICULA

Professional Elective Courses

Regulations 2021

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu, India

Course Code	21BTE201T	Course Name	DEVELOPMENTAL BIOLOGY	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Biotechnology*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*discuss the basic concepts of developmental patterning and organization*
CLR-2:	*compare the early embryonic development events across species*
CLR-3:	*demonstrate the metamorphosis and organogenesis*
CLR-4:	*describe the influence of external environment on developmental process*
CLR-5:	*study various developmental defects*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*understand the key aspects of developmental biology*	*2*	*2*	-	-	-	-	-	-	-	-	-	-	*2*	-	*2*
CO-2:	*develop the concepts and experiments in the early development, cleavage and axis formation*	-	*2*	*3*	-	-	-	-	-	-	-	-	-	*3*	-	*2*
CO-3:	*illustrate the roles of signaling pathways during the organogenesis*	-	*3*	*3*	-	-	-	-	-	-	-	-	-	*3*	-	*2*
CO-4:	*illustrate the fertilization and developmental events in plants*	-	*3*	*3*	-	-	-	-	-	-	-	-	-	*3*	-	*3*
CO-5:	*integrate modern biotechnology in the developmental process*	-	*3*	*3*	-	-	-	-	-	-	-	-	-	*3*	-	*3*

Unit-1 - Principles of Developmental Biology	***9 Hour***
Introduction to Developmental Biology, Life cycles and the evolution of developmental patterns, Principles of experimental embryology, Genes and development- Techniques and ethical issues, Differential gene expression, Cell-cell communication in development	
Unit-2 - Early Embryonic Development	***9 Hour***
Fertilization, Early development in selected invertebrates, The genetics of axis specification in Drosophila, Early development and axis formation in amphibians, The early development of vertebrates- Fish, birds, and mammals	
Unit-3 - Later Embryonic Development	***9 Hour***
The central nervous system and the epidermis, Neural crest cells and axonal specificity, Paraxial and intermediate mesoderm, Lateral plate mesoderm and endoderm, Development of the tetrapod limb, Sex determination, Metamorphosis, regeneration, and aging, Germ cell	
Unit-4 - Ramifications of Developmental Biology	***9 Hour***
Development of Plants, Environmental regulation of animal development, Developmental mechanisms of evolutionary change	
Unit-5 - Developmental Defects	***9 Hour***
Birth defects associated with Pharyngeal arches, Neural tube, Nervous system, Cardiovascular system, Skeletal system, Immune-system, Limbs, Respiratory system, Circulatory system and Excretory system	

Learning Resources	1. *Scott F. Gilbert, Michael J. F. Barresi. Developmental Biology, Sinauer Associates-Oxford University Press; 12 edition, 2020* 2. *JMW Slack Essentials of Developmental Biology 3rd Edition Wiley-Blackwell. 2013*	3. *Before we are born. Essentials of Embryology and Birth Defects; Keith L. Moore, T.V.N. Persaud, Mark G. Torcha; 10th Edition; 2019; Philadelphia, Elsevier*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	-	*15%*	-	*15%*	-
Level 2	*Understand*	*25%*	-	*20%*	-	*25%*	-
Level 3	*Apply*	*30%*	-	*25%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*25%*	-	*30%*	-
Level 5	*Evaluate*	-	-	*10%*	-	-	-
Level 6	*Create*	-	-	*5%*	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. G. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com*	1. *Prof. K Subramaniam, IITM, Chennai, subbu@iitm.ac.in*	1. *Dr. Harinarayana Ankamreddy, SRMIST*
2. *Dr. Karthik Periyasamy, Scientist, Biocon, karthik.periyasamy@biocon.com*	2. *Prof. R. B Narayanan Anna University, Chennai, arbeen09@gmail.com*	2. *Dr.R.Vasantharekha, SRMIST*

Course Code	21BTE301T	Course Name	DISEASES MODELS AND MECHANISM	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Biotechnology*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*gain fundamental knowledge about the existing diseases and their pathologies*
CLR-2:	*understanding the molecular mechanism of varied metabolic and cardiovascular diseases*
CLR-3:	*mechanistic insights into various neurological disorders, and pathways associated with it*
CLR-4:	*understand the commonly used model systems and their pros and cons*
CLR-5:	*gain more information on advanced disease model systems and their advantages and disadvantages*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*relate various diseases and pathologies*	-	*2*	*2*	-	-	-	-	-	-	-	-	-	*2*	-	*3*
CO-2:	*demonstrates multiple metabolic and cardiovascular diseases*	*2*	*2*	*3*	-	-	-	-	-	-	-	-	-	*2*	-	*3*
CO-3:	*discuss the varied neurological diseases and their mechanism*	*2*	*3*	*3*	*3*	-	-	-	-	-	-	-	-	*3*	-	*3*
CO-4:	*analyze the widely studied disease model systems*	*3*	*3*	*3*	*3*	-	-	-	-	-	-	-	-	*3*	-	*3*
CO-5:	*explain the modern engineered disease model systems*	*3*	*3*	*3*	*3*	-	-	-	-	-	-	-	-	*3*	-	*3*

Unit-1 - Introduction to Pathology and Disease	***9 Hour***
General pathophysiology- Pathophysiological mechanisms of acute and chronic injury, necrosis/apoptosis & tissue repair (the healing process). Overview of physical diseases, mental diseases, infectious diseases, non-infectious diseases, inherited diseases, degenerative diseases, social diseases, and self-inflicted diseases. Categories of infectious agents, mechanisms, and pathogenesis of infectious diseases, viz tuberculosis, malaria, influenza, and HIV/AIDS.	
Unit-2 - Metabolic and Cardiovascular Disease	***9 Hour***
The origin of metabolic diseases, Disorders of Amino acid metabolism, Carbohydrate metabolism, Lipid metabolism, Mitochondrial disorders, Lysosomal storage disorders, Peroxisomal disorders, Purine and Pyrimidine disorders, and Porphyrias. Hyperlipidemia, Atherosclerosis, Coronary artery disease, Hypertension, Heart failure, Thromboses, and stroke. Compare and contrast Diabetes vs Atherosclerosis	
Unit-3 - Neurological Diseases and their Mechanism	***9 Hour***
Alzheimer's, Parkinson's, Amyotrophic Lateral Sclerosis, Huntington, Creutzfeldt Jakob Disease, Spinal muscular atrophy, Multiple Sclerosis, Epilepsy, and Seizures. Diseases of the peripheral nervous system. Compare and contrast peripheral to central nervous system disorders (Charcot Marie Tooth vs Alzheimer's).	
Unit-4 - Widely Studied Disease Model Systems	***9 Hour***
2D Cell Culture, Yeast, C. elegans, D. melanogaster, Zebrafish, Xenopus mouse, and Primate model systems for various diseases.	
Unit-5 - Advanced Disease Model Systems	***9 Hour***
3D Primary Cell Cultures, the evolution of organoids, cerebral organoids, Intestinal organoids, organoids in cancer research, Somatic cell-derived organoids, other applications of organoids in designing personalized medicine, and Organs on a chip.	

Learning Resources	1. *The Nature of Disease-Pathology for the Health Professions, Author: McConnell, Publisher: Lippincott Williams & Wilkins, second edition, 2014 ISBN-10 : 9781609133696 ISBN-13 : 978-1609133696* 2. *Robbins & Cotran Pathologic Basis of Disease (Robbins Pathology) ninth edition 2014, Kumar MBBS MD FRCPath, Abbas MBBS, Aster MD Ph.D., Jon C. ISBN-13: 978-1455726134 / ISBN-10: 1455726133*	3. *Lippincott's Illustrated Reviews: Microbiology, Second 2014 Edition. Richard A Harvey Ph.D., Cynthia N Cornelissen Ph.D. ISBN/ISSN: 9781608317332* 4. *Park's Textbook of Preventive and Social Medicine, Banarsidas Bhanot Publishers Edition: 2021 ISBN: 9789382219163*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	*-*	*15%*	*-*	*15%*	*-*
Level 2	*Understand*	*25%*	*-*	*20%*	*-*	*25%*	*-*
Level 3	*Apply*	*30%*	*-*	*25%*	*-*	*30%*	*-*
Level 4	*Analyze*	*30%*	*-*	*25%*	*-*	*30%*	*-*
Level 5	*Evaluate*	*-*	*-*	*10%*	*-*	*-*	*-*
Level 6	*Create*	*-*	*-*	*5%*	*-*	*-*	*-*
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. Giridharan Appaswamy, Lifecell International (P) Limited, Chennai, giridharan.a@lifecell.in*	1. *Prof. Karunagaran D, IITM, Chennai, karuna@iitm.ac.in*	1. *Dr.Bibin SRMIST*
2. *Dr. Karthik Periyasamy, Scientist, Biocon, karthik.periyasamy@biocon.com*	2. *Dr. Sib Sankar Roy, CSIR-IICB, Kolkatta, sibsankar@iicb.res.in*	2. *Dr. K.M Ramkumar SRMIST*

Course Code	21BTE302T	Course Name	METABOLIC DISORDERS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Biotechnology*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*discuss the basic principles of metabolic regulation*
CLR-2:	*demonstrate the importance of genetics in medicine and in metabolic diseases*
CLR-3:	*analyze the influence of regulatory enzymes in various metabolic disorders*
CLR-4:	*understand the common genetic diseases in our society and the reason for it*
CLR-5:	*know how to prevent and treat metabolic disorders*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*explain the basic principles of metabolic disorders*	-	2	2	-	-	-	-	-	-	-	-	-	3	-	3
CO-2:	*examine and solve the metabolic problems of specific nutrients*	-	3	3	-	-	-	-	-	-	-	-	-	3	-	3
CO-3:	*dissect the knowledge in metabolic control*	-	2	2	3	-	-	-	-	-	-	-	-	3	-	3
CO-4:	*comprehend the importance of genetics in medicine and in metabolic diseases*	-	3	-	2	-	-	-	-	-	-	-	-	2	-	3
CO-5:	*evaluate how genetic diseases are common in our society and the reason for it*	-	2	-	2	-	-	-	-	-	-	-	-	2	-	3

Unit-1 - Introduction to Metabolic Disorders ***9 Hour***

Principles of metabolic regulation- Garrod's hypothesis, Regulation of enzyme activity Covalent modifications and reversible modifications, phosphorylation, dephosphorylation, adenylation and disulphide reduction, Overview of inherited metabolic disorders

Unit-2 - Disorders of Carbohydrate Metabolism ***9 Hour***

Pathways of carbohydrate metabolism and their physiological significance, Regulation of carbohydrate metabolism, Allosteric and hormonal mechanisms, Metabolic interrelationships among various tissues, Congenital disorders of Glycosylation, Galactosaemia, Fructosaemia, Lactose intolerance, Glycogen storage diseases, glucose homeostasis and diabetes mellitus

Unit-3 - Disorders of Nitrogen Metabolism ***9 Hour***

Disorders of amino acids metabolism- Phenylketonuria, tyrosinemia, homocystinuria, maple syrup urine disease, Argininemia, Tyrosinemia, Alkaptonuria, Albinism, Amino acid transport disorders: Cystinuria, Dicarboxylic aminoaciduria, Hartnup disease, Inborn error of purine metabolism, Adenylosuccinate lyase deficiency, adenosine monophosphate deaminase deficiency, Nucleotide salvage - Lesch-Nyhan syndrome, Adenine phosphoribosyl transferase deficiency, Xanthinuria – Pyrimidine metabolism, Inborn error of pyrimidine metabolism: Oroticaciduria, Miller syndrome, Dihydropyrimidine dehydrogenase deficiency

Unit-4 - Disorders of Lipid and Lipoprotein Metabolism ***9 Hour***

Inborn error of lipid metabolism, Hyperlipidemia, Hypercholesterolemia and its associated disorders, Hypolipoproteinemia, Tangier disease, Lipodystrophy, Lipid storage disorders: Fatty-acid metabolism disorders, biotinidase deficiency, malonicaciduria, Sjögren–Larsson syndrome

Unit-5 - Micronutrients and Metabolic Diseases ***9 Hour***

Disorders of vitamins, Disorders of coenzymes, Disorders of cofactors, Biotinidase deficiency, Holocarboxylase synthetase deficiency, Pantothenate kinase-associated neurodegeneration, Methylmalonic academia, Glutaric aciduria, Al Aqeel-Sewairi syndrome – multicentric osteolysis, nodulosis, arthropathy (MONA) – MMP-2 deficiency

Learning Resources	1. John Fernandes, Jean-Marie Saudubray, Georges van den Berghe 2. John H. Walter. Inborn Metabolic Diseases: Diagnosis and Treatment. 3. Fourth, Revised Edition, Springer press, 2006	4. Robert K. Murray, Darryl K. Granner, Peter A. Mayes, Harper's Illustrated Biochemistry 30th Edition, 2003 5. Enid Gilbert-Barness, Lewis A. Barness, Philip M. Farrell." Metabolic Diseases: Foundations of Clinical Management, Genetics, and Pathology", IOS Press BV, Netherlands, Second Edition, 2017

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Giridharan Appaswamy, Lifecell International (P) Limited, Chennai, giridharan.a@lifecell.in	1. Prof. Karunagaran D, IITM, Chennai, karuna@iitm.ac.in	1. Dr. K.M. Ramkumar, SRMIST
2. Dr. Karthik Periyasamy, Scientist, Biocon, karthik.periyasamy@biocon.com	2. Dr. Sib Sankar Roy, CSIR-IICB, Kolkatta, sibsankar@iicb.res.in	2. Dr. Koustav Sarkar, SRMIST

Course Code	21BTE401T	Course Name	CELLULAR AND MOLECULAR NEUROSCIENCE	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Biotechnology*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*recall the brain function from its organization*
CLR-2:	*discuss the genetic variations in brain development and behavior*
CLR-3:	*recall the synaptic dysfunctions and drug treatment*
CLR-4:	*explain different methods for studying neuro-immune functions*
CLR-5:	*describe the cortical structures pertaining to behavior*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	Program Outcomes (PO)												Program Specific Outcomes		
		1 Engineering Knowledge	2 Problem Analysis	3 Design/development of solutions	4 Conduct investigations of complex problems	5 Modern Tool Usage	6 The engineer and society	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*explain the fundamental organization of the brain and its functions*	*2*	*3*	*3*	-	-	-	-	-	-	-	-	-	*3*	-	*2*
CO-2:	*describe the role of genes in brain development and functions*	*2*	*3*	*2*	-	-	-	-	-	-	-	-	-	*3*	-	*2*
CO-3:	*enhances the knowledge about the neuropathological disorders and treatment options*	*3*	*2*	-	-	*3*	-	-	-	-	-	-	-	*3*	-	*3*
CO-4:	*evaluate the different methods in the neuroendocrine and immune interactions*	*3*	*2*	*3*	-	-	-	-	-	-	-	-	-	*3*	-	*3*
CO-5:	*outline the anatomical relation with behavior*	*3*	*2*	-	-	-	-	-	-	-	-	-	-	*3*	-	*3*

Unit-1 - Organization of Nervous System	***9 Hour***
Development of the nervous system- Molecular basis of neural induction- Initial differentiation of neurons and glia- Cellular Components of the Nervous system- Neurons and Glia- Organization of nerves- Presynaptic terminals- Neural Circuits- Myotactic reflex- Organization of the Nervous system- Divisions of nervous system- Central nervous system- Peripheral nervous system- Structural and Functional analysis of the Nervous system- Cellular diversity of nervous system- Model organisms in neuroscience	
Unit-2 - Neurotransmission and Synaptic Plasticity	***9 Hour***
Electrical signals- Long-distance transmission of Electrical signals- The ionic basis of resting membrane potential- Voltage-dependent membrane permeability- Ion channels and transporters- Diversity of ion channels- Synaptic transmission-Neurotransmitters and their receptors- Chemical and electrical synapses- Molecular signaling in neurons- Activation of signaling pathways- Second messengers- Nuclear signaling- Synaptic plasticity- Short and long-term synaptic plasticity- Properties of neurotransmitters- Receptors of neurotransmitters- Unconventional neurotransmitters	
Unit-3 - Synaptogenesis and Development of Sensory-Motor System	***9 hour***
Synaptogenesis- Molecular mechanisms involved in synapse formation- Construction and modification of neural circuits- Genetic influence and control on animal behavior- Motor neuron circuits-Motor neuron control by the CNS- Motor units- Motor neurons and functions- Reward and motivation- Visual and Vestibular pathways- Retinal circuitry- Phototransduction- Potential treatment for vision loss- The Corticospinal and Corticobulbar Tracts- Repair and Regeneration in nervous system- Axon Growth after Brain Injury- Rodent brain functional anatomy and behavior- Goat brain dissection	
Unit-4 - Cognition, Pharmacology and Neuro-Immunology	***9 Hour***
Overview of cortical structures- Emotions-Memory- Early theories of emotional brain- Kluver-Bucy syndrome- Brain reward circuitry- Cognition- Learning, Memory consolidation and Priming- Dementia- Anti-psychotic drugs and Neurotoxicity- Neuropharmacology in treating social impairments related to autism- Hypothalamus and endocrine system- Hormones of endocrine system and its regulation- Interactions between neuroendocrine system and immune system- Neural-Immune interactions in the periphery- Nervous-immune system role in health and disease	

Unit-5 - Neuropathology and Therapeutics	***9 Hour***
Diseases and injuries of the nervous system- Autism Spectrum Disorders- Alzheimer's disease- Parkinson's disease- Spinal Cord Injury- Traumatic Brain Injury (TBI)- chronic traumatic encephalopathy- Blood Supply to Brain- Stroke and Transient Ischemic Attack- Acute stroke treatment- Prevention of stroke- Hypoxia/Ischemia in mammalian brain- Therapeutics in Neurodevelopmental disorders-GPCR signaling- Novel therapeutic drugs in Alzheimer's disease- Prevention and treatment- Synaptic perspective in neuronal health and disease	

Learning Resources	1. *Dale Purves, George J. Augustine, David Fitzpatrick, William C. Hall, Anthony-Samuel LaMantia, Leonard E. White, "Neuroscience," Sinauer Associates, Inc., 6th Edition, 2017.*	2. *Eric R. Kandel, James H. Schwartz, Thomas M. Jessell, "Principles of Neural Science," McGraw-Hill, 5th Edition, 2012.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	-	*15%*	-	*15%*	-
Level 2	*Understand*	*25%*	-	*20%*	-	*25%*	-
Level 3	*Apply*	*30%*	-	*25%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*25%*	-	*30%*	-
Level 5	*Evaluate*	-	-	*10%*	-	-	-
Level 6	*Create*	-	-	*5%*	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. G. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com*	1. *Prof. K Subramaniam, IITM, Chennai, subbu@iitm.ac.in*	1. *Dr. Anil Annamneedi, SRMIST*
2. *Dr. Karthik Periyasamy, Scientist, Biocon, karthik.periyasamy@biocon.com*	2. *Prof. R. B Narayanan Anna University, Chennai,arbeen09@gmail.com*	2. *Dr. R. Vasantherekha, SRMIST*

Course Code	21BTE402T	Course Name	CANCER BIOLOGY AND THERAPEUTICS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Biotechnology*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*describe protooncogene and oncogenes, risk factors in tumor progression*
CLR-2:	*discuss epigenetics, DNA damage and repair in cancer*
CLR-3:	*recall the molecular signaling mechanisms in cancer*
CLR-4:	*describe the role of stem cells in cancer treatment and metastasis*
CLR-5:	*analyze the role of advanced cancer therapeutics and alkaloids in cancer treatment*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*describe the role of diet in different forms of cancer*	-	-	-	-	-	-	3	2	-	-	-	-	-	2	2
CO-2:	*determine the fundamental assays in hazard identification*	-	2	2	3	-	-	-	-	-	-	-	-	-	2	2
CO-3:	*explain the role of signaling pathway mediated cancer initiation*	-	2	-	-	2	-	-	-	-	-	-	-	-	2	-
CO-4:	*explain the role of cancer stem cell signaling pathway and angiogenesis*	-	2	-	-	2	-	-	-	-	-	-	-	-	-	2
CO-5:	*determine the concepts of cancer detection and therapy*	-	-	2	-	2	-	-	-	-	-	-	-	-	-	2

Unit-1 - Concept of Cancer Biology ***9 Hour***

Basic concepts of cancer - Oncogenes and tumor suppressor genes; Risk factors, Pathogenesis, treatment and future prospects; The cell cycle - cyclin and cyclin dependent kinases; Mechanisms of CdK regulation; Tumor suppressor genes - Knudson's two-hit hypothesis; P53 and pRb control of cell cycle; Molecular pathways of p53; Role of myc oncoprotein in regulating pRb; pRb's role in cancer; Different forms of cancer; Diet and cancer

Unit-2 - DNA Damage and Epigenetics of Cancer ***9 Hour***

DNA structure and stability -Spontaneous DNA damage; DNA repair pathways - Clinical applications of DNA repair biomarkers; Epigenetics and its implication on cancer; Carcinogenesis -Types and mechanism of carcinogens - Carcinogen metabolism; Biotransformation and cancer risk
Cancer prevention and hazard identification assays

Unit-3 - Molecular Signaling of Cancer and Cell Death ***9 Hour***

Signal transduction -Growth factors and receptors; EGF growth factor receptor signaling - Ras activation; Activation of MAPK pathways; NF-KB signaling pathway, JAK/STAT signaling and cancer immuno oncology - Immune system; Effector mechanisms in cancer immunity, Wnt signaling and its Implications in cancer therapy; Apoptosis - Intrinsic and Extrinsic pathways; cell death and cancer

Unit-4 - Cancer Stem Cells and Angiogenesis ***9 Hour***

Stem cells and cancer - Self- renewal and its molecular mechanisms; Hedgehog signaling pathway; polycomb group proteins; tumor micro environment in cancer; Invasion and metastasis - Cell adhesion molecules; Angiogenesis -Tumor angiogenesis and neovasculature - VEGF signal transduction; Angiogenic inhibitors -Vascular targets

Unit-5 - Basic Therapeutics and Screening of Cancer ***9 Hour***

Cancer therapy and detection; Modalities of treatment; Nuclear medicine; Chemotherapeutic agents – Types of chemotherapeutic agent; plant based cancer therapeutics; Immunotherapy; cancer prevention and early detection - Screening techniques and diagnostic tests Imaging and cancer - X-Ray CT, MRI, radio imaging and optical imaging; contrast agents in cancer molecular imaging

Learning Resources	1. *Lauren Pecorino, Molecular Biology of Cancer: Mechanisms, Targets, and Therapeutics, Oxford University Press; 4th edition, 2016*	2. *John Mendelsohn, Peter M. Howley, Mark A. Israel, Joe W. Gray, Craig B. Thompson. The Molecular Basis of Cancer, Saunders; 4 edition, 2014*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	*-*	*15%*	*-*	*15%*	*-*
Level 2	*Understand*	*25%*	*-*	*20%*	*-*	*25%*	*-*
Level 3	*Apply*	*30%*	*-*	*25%*	*-*	*30%*	*-*
Level 4	*Analyze*	*30%*	*-*	*25%*	*-*	*30%*	*-*
Level 5	*Evaluate*	*-*	*-*	*10%*	*-*	*-*	*-*
Level 6	*Create*	*-*	*-*	*5%*	*-*	*-*	*-*
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. G. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com*	1. *Prof. K Subramaniam, IITM, Chennai, subbu@iitm.ac.in*	1. *Dr.S.Nageswaran, SRMIST*
2. *Dr. Karthik Periyasamy, Scientist, Biocon, karthik.periyasamy@biocon.com*	2. *Prof. Natarajan Bhaskaran, Sri Ramachandra Institute of Higher Education and Research, Chennai, natarajanbhaskaran@sriramachandra.edu.in*	2. *Dr.Koustav Sarkar, SRMIST*

Course Code	21BTE403T	Course Name	PHYSIOLOGY OF STRESS AND ITS MANAGEMENT	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Biotechnology*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*describe the homeostasis, control systems and role of biogenic amines in stress*
CLR-2:	*explain the concepts of epigenetics and hormones in stress response*
CLR-3:	*describe the behavioral response and impact of environmental factors on stress*
CLR-4:	*explain the disorders of stress and the role of occupation hazards in stress*
CLR-5:	*analyze the role of education, caregivers, exercises and meditation in control of stress*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*analyze the role of neuroendocrine and immune system in stress condition*	*2*	*2*	*2*	*2*	-	-	-	-	-	-	-	-	*3*	-	*3*
CO-2:	*summarize the role of central nervous system and neurotransmitters in stress*	*3*	*3*	*3*	*2*	-	-	-	-	-	-	-	-	*3*	-	*3*
CO-3:	*discuss the interactions of behavioral and physiological components in stress*	*3*	*2*	*2*	*3*	-	-	-	-	-	-	-	-	*3*	-	*3*
CO-4:	*compare the various disorders of stress and the neuropsychological tests for stress*	*3*	*3*	*3*	*2*	-	-	-	-	-	-	-	-	*2*	-	*2*
CO-5:	*explain the concepts of diet, exercise and lifestyle in managing stress*	*2*	*2*	-	*2*	-	-	-	-	-	-	-	-	*2*	-	*2*

Unit-1 - Homeostasis and Control System ***9 Hour***

Homeostasis and control systems-HPA Axis and endocrine system; Nervous system and stress disorder-Hippocampus and depression. Parasympathetic system-Flight/fight responses; rest/digest responses. Noradrenergic control of stress-Norepinephrine in stress.

Unit-2 - Neuroendocrinology of Stress ***9 Hour***

Corticotrophin releasing hormone, CRF- family with role in HPA axis, intracellular signaling of stress, external signals of stress, Catecholamines; Neural circuitry of stress, fear and anxiety. Serotonergic systems modulate anxiety. Stress-Hippocampal neurogenesis.

Unit-3 - Psychological and Environmental Stressors ***9 Hour***

Behavioral response to stress, Impairment of response inhibition, lack of motivation, physiological components of stress response, environmental factors- impact of environmental factors on stress, differential exposure and vulnerability of environmental stressors. Physiological stressors, cognition and stress, consequence of stress on cognitive functions

Unit-4 - Disorders of Stress ***9 Hour***

Anxiety disorders, panic disorder, post traumatic syndromes. Psychological concomitants of distress. Chronic stress and fear. Emotional stress, acute and chronic stress models, aging and psychological stress, occupational hazards of stress. Non stress, distress and neuropsychological tests questionnaire for stress analysis.

Unit-5 - Stress Management ***9 Hour***

Awareness about stress management; Value of education in stress condition, relaxation, effective communication. Intervention of caregivers and Institutional care. Meditation model, physical and mental exercises. Eating behavior for healthy lifestyle. Mechanism of stress in abnormal eating behavior. Physical and mental well-being and general principles of stress prevention

Learning Resources	1. *George Fink. Stress: concepts, cognition, emotion and behavior. Handbook in stress. Academic press. First edition. 2016*	2. *George Fink: Stress: Neuroendocrinology and neurobiology, Academic press. First edition.2017.*

Learning Assessment							
	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	-	*15%*	-	*15%*	-
Level 2	*Understand*	*25%*	-	*20%*	-	*25%*	-
Level 3	*Apply*	*30%*	-	*25%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*25%*	-	*30%*	-
Level 5	*Evaluate*	-	-	*10%*	-	-	-
Level 6	*Create*	-	-	*5%*	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers		
Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. C. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com*	1. *Prof. K Subramaniam, IITM, Chennai, subbu@iitm.ac.in*	1. *Dr. R.Vasantharekha, SRMIST*
2. *Dr. Karthik Periyasamy, Scientist, Biocon, karthik.periyasamy@biocon.com*	2. *Prof. R. B Narayanan Anna University, Chennai,arbeen09@gmail.com*	2. *Dr. MK. Jaganathan, SRMIST*

Course Code	21BTE202T	Course Name	PHARMACEUTICAL BIOTECHNOLOGY	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Biotechnology*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*understand the general principles of drug action*
CLR-2:	*demonstrate the parameters that affect the action of drug in human system*
CLR-3:	*relate the different type of adverse drug reactions and drug abuse*
CLR-4:	*explain the mechanism of action, and uses of antibiotics and Oligonucleotide therapeutics*
CLR-5:	*describe the regulation of drugs in Indian Government and its initiatives in promoting Indian System of medicine*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*select appropriate target, drug-like candidates based on desired pharmacokinetic and pharmacodynamics parameters*	-	-	3	2	2	-	-	-	-	-	-	-	2	2	-
CO-2:	*explain the logical usage of drugs and suggest appropriate treatment*	-	3	3	2	-	-	-	-	-	-	-	-	2	2	-
CO-3:	*evaluate the dose of drug to be administered for individuals*	-	3	3	2	-	-	-	-	-	-	-	-	2	2	-
CO-4:	*explains the mechanism and improve their use of antibiotics and oligonucleotides as tools or potential therapeutics*	-	-	3	2	3	-	-	-	-	-	-	-	2	2	2
CO-5:	*explain the significance of laws pertaining to manufacturing, distribution and sale of drugs in India*	-	-	-	-	-	-	2	2	-	-	-	-	-	1	2

Unit-1 - Pharmacokinetics	***9 Hour***
Routes of drug administration, Absorption of Drugs - Passsive transport and facilitated transport, Influence of pH on transport of molecules across membranes, Bioavailability. Distribution and Redistribution of drugs - Tissue storage, placental & brain transport. Biotransformation of drugs and types, Inhibition of drug metabolism, Induction of microsomal enzymes Routes of excretion of drugs - Rate of Clearance and Plasma half-life,	
Unit-2 - Pharmacodynamics	***9 Hour***
Principles of drug action - Mechanism of drug action on receptors, enzymes, ion channels and transporters. Transducer mechanism. Dose-Response Relationship, Therapeutic efficiency, Factors modifying drug action. Pharmacovigilance - Casualty assessment, Side, secondary and toxic effects of drugs, Accidental overdose of drugs and the treatment, Drug Intolerance and Drug allergy, Drug abuse and Treatment	
Unit-3 - Biotechnological Drugs Obtained by Microbial Synthesis.	***9 Hour***
Classification of anti-microbial agents based on chemical structure. Structure, classification, Mechanism of action and uses of beta-lactam, Tetracycline, aminoglycosides and Macrolide antibiotics	
Unit-4 - Oligonucleotide Therapeutics	***9 Hour***
Introduction of oligonucleotide therapeutics and types of oligonucleotide therapeutics, Mechanism, application and limitations of Messenger RNA (mRNA), RNAi, Antisense therapeutics, DNAzymes, Oligonucleotide aptamers. Preparations in advanced phases of clinical trials. Other therapeutic and diagnostic potential of synthetic nucleic acids (drug delivery, aptasensors, etc.)	
Unit-5 - Drug Regulatory System	***9 Hour***
Drug Regulatory body - CDSCO, Hierarchy at CDSCO, Functions of CDSCO, Functions of Central Drug-Inspectors, Functions of State Drug-Inspectors. Ayurvedic Formulary of India - Ayurvedic Dosage Forms, Ayurvedic Pharmacopoeia of India, Ayurvedic, Unani, Siddha drugs undertaken by British commission, Indian Government Initiatives to promote Ayurvedic products, Indian Government Initiatives to promote Unani and Siddha products	

Learning Resources	1 *Laurence Brunton, Bjorn Knollmann, Randa Hilal-Dandan, "Goodman and Gilman's - The Pharmacological Basis of Therapeutics", McGraw-Hill Education, 13th Edition 2018, ISBN: 978-1-25-958473-2,* 2 *Nicolay Ferrari, Rosanne Seguin, "Oligonucleotide-Based Drugs and Therapeutics Preclinical and Clinical Considerations for Development" John Wiley & Sons, 1st Edition 2018*	3 *SK Gupta, Sushma Srivastava, "Textbook of Pharmacovigilance- Ensuring the Safe Use of Medicines", Jaypee Brothers Medical Publisher, 2st Edition 2018* *https://cdsco.gov.in/opencms/opencms/en/Home/*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	-	*15%*	-	*15%*	-
Level 2	*Understand*	*25%*	-	*20%*	-	*25%*	-
Level 3	*Apply*	*30%*	-	*25%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*25%*	-	*30%*	-
Level 5	*Evaluate*	-	-	*10%*	-	-	-
Level 6	*Create*	-	-	*5%*	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. S. Sam Gunasekar, Orchid Chemicals and Pharmaceuticals Ltd., sam@orchidpharma.com*	1. *Prof. K Subramaniyam, IITM, Chennai, suubu@iitm.ac.in*	1. *Dr. M.K. Jaganathan, SRMIST*
2. *Dr. Karthik Periyasamy, Scientist, Biocon, karthik.periyasamy@biocon.com*	2. *Dr. R. B Narayanan Anna University, Chennai, arbeen09@gmail.com*	2. *Dr. Y. Ravichandran,SRMIST*

Course Code	21BTE303T	Course Name	COMPUTATIONAL MOLECUALR BIOLOGY	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Biotechnology*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*analyze the databases in bioinformatics*
CLR-2:	*use sequence alignment to find similar sequences*
CLR-3:	*use alignment to build hierarchical lineages*
CLR-4:	*apply principles of bioinformatics to build tertiary structures of proteins*
CLR-5:	*analyze uses of Python programming in Bioinformatics applications*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*describe the applications of bioinformatics to build databases for universal usage*	*2*	-	-	-	*3*	-	-	-	-	-	-	-	-	-	*3*
CO-2:	*explain the concepts and tools to build alignment between similar sequences of DNA or Protein*	*2*	-	-	-	*3*	-	-	-	-	-	-	-	-	-	*3*
CO-3:	*illustrate the pattern of lineages and evolution*	*2*	*2*	-	-	*3*	-	-	-	-	-	-	-	-	-	*3*
CO-4:	*examine the different methods in the construction of protein structure*	*3*	*2*	-	*2*	*3*	-	-	-	-	-	-	-	-	*2*	*3*
CO-5:	*evaluate the principles of Programming in Python for bioinformatics*	*2*	*2*	-	*2*	*3*	-	-	-	-	-	-	-	-	*2*	*3*

Unit-1 - Molecular Biology Data Storage	***9 Hour***
Bioinformatics significance- Applications of bioinformatics- Internet Protocols. HTML script- Webpage creation- Human genome project-Uses of human genome project- The NCBI data model: Introduction - SEQ-Ids- BIOSEQs and BIOSEQ-SETs- SEQ-ANNOT and SEQ-DESCR- Genbank database- Genbank Flat file- Sequence submission to Genbank- Online and offline tools- Entrez - INSDC- Other databases in NCBI	
Unit-2 - Database Resources in Molecular Biology	***9 Hour***
Introduction on databases & biological databases- Uses of biological databases- Primary sequence databases- Nucleotide- Protein sequence database- Primary structure databases- PDB file format- FASTA , GCG,VFF etc- High Throughput sequencing databases- Secondary databases- secondary sequence databases- Secondary structure databases- SCOP- CATH- Composite protein databases- Metabolic databases- SNP -databases- Whole genome - mendelian disease databases- chemical structure databases- bibliographic databases	
Unit-3 - Sequence Analysis	***9 Hour***
Sequence alignment- Global Pairwise Alignment Algorithm- Solving problems- Local Pairwise Alignment Algorithm- Database searching- BLAST- FASTA- Multiple Sequence Alignmen:- Progressive and Iterative Alignment- Tools for pairwise alignment- tools for multiple sequence alignment- Application of Multiple Sequence Alignment- Databases Of Multiple Alignment- Molecular Phylogeny- Methods of phylogeny- types of trees - Tools for phylogeny- PAM and BLOSUM	
Unit-4 -Protein Structure Analysis	***9 Hour***
Motifs and Patterns prediction, Databases for motif prediction, Databases for patterns and blocks, Secondary Database Searching, Secondary structure prediction, , Tools for secondary , structure prediction, , Specialized secondary structure prediction, Tertiary structure prediction, Comparative modelling, Abinitio modelling, Validation of tertiary structure, tools for homology , modeling , tools for structure validation, Structure visualization tools, Pymol, Chemical structure building tools, file formats for small molecules, file format conversion tools	

Unit-5 - Python Coding in Molecular Analysis	***9 Hour***
Introduction of Python and text editors, String datatype, Tuples datatype, Lists datatype, Flow control: If else, For loop, While loop, Reading and Writing files, Modules in Python, Functions, Regular expressions: Syntax, Regex , examples, Biopython, Advantages of python in bioinformatics, Components of biopython: Alphabet, Seq, Seq object, SeqUtils, Align and clustalw with Biopython, BLAST Running and Processing with Biopython	

Learning Resources	1. *Pevsner, Jonathan. Bioinformatics and Functional Genomics. United Kingdom, Wiley, 2015.* 2. *Andreas D Baxevanis & B F Francis, "Bioinformatics- A practical guide to analysis of Genes & Proteins", John Wiley, 2002* 3. *T K Attwood, D J Parry-Smith," Introduction to Bioinformatics", Pearson Education, 1st Edition, 11th Reprint 2005.*	4. *Jin Xiong , " Essential Bioinformatics", Cambridge University Press, 2006* 5. *Sebastian Bassi, " Python for Bioinformatics", 2nd Edition CRC Press, 2017* 6. *Ramalho, Luciano. Fluent Python: Clear, Concise, and Effective Programming. United States, O'Reilly Media, 2015.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	-	*15%*	-	*15%*	-
Level 2	*Understand*	*25%*	-	*20%*	-	*25%*	-
Level 3	*Apply*	*30%*	-	*25%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*25%*	-	*30%*	-
Level 5	*Evaluate*	-	-	*10%*	-	-	-
Level 6	*Create*	-	-	*5%*	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. C. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com*	1. *Prof. K Subramaniam, IITM, Chennai, subbu@iitm.ac.in*	1. *Dr. Priya Swaminathan, SRMIST*
2. *Dr. Karthik Periyasamy, Scientist, Biocon, karthik.periyasamy@biocon.com*	2. *Prof. R. B. Narayanan, Anna University, Chennai, arbeen09@gmail.com*	2. *Dr. MK Jaganathan, SRMIST*

Course Code	21BTE304T	Course Name	COMPUTER AIDED DRUG DESIGNING	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Biotechnology*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*gain knowledge on basic concepts of drug discovery and drug design processes*
CLR-2:	*explain about the various computational tools in drug discovery*
CLR-3:	*gain knowledge on physicochemical Properties and the techniques involved in QSAR*
CLR-4:	*discuss about the pharmacophore Model*
CLR-5:	*discuss about the quantum mechanics in drug design and De novo ligand synthesis*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*demonstrate an understanding of the steps involved in the drug discovery and design process*	-	*3*	*3*	-	*3*	*2*	-	-	-	-	-	-	-	*3*	*3*
CO-2:	*compare the different computational tools for drug designing and the computer software used in the drug designing*	-	*3*	-	*1*	*3*	-	-	-	-	-	-	-	-	*3*	*3*
CO-3:	*demonstrate the ability to use evidence-based approaches to guide decision making during the drug discovery and development process*	-	*3*	*3*	*3*	*3*	-	-	-	-	-	-	-	-	*3*	*2*
CO-4:	*explain the various methods used in structure-based drug design*	-	*3*	*3*	*3*	*3*	-	-	-	-	-	-	-	-	*3*	*2*
CO-5:	*describe the methods in molecular and quantum mechanics, and De nova ligand synthesis*	-	*3*	*3*	*3*	*3*	-	-	-	-	-	-	-	-	*3*	*3*

Unit-1 -The Drug Discovery Process — ***9 Hour***

The sequence of research activities in the development of new drug, Terminology related to drug testing: "hits," "leads," "drug candidates," "drugs,",Criteria that may be necessary to move a compound series onto the lead development stage, Compound Testing, Phases in clinical trials, Effect of Molecular Structure on Activity ,Effect of Molecular Structure on Bioavailability, Drug Side Effects and Toxicity, The Lipinski rule of fives, Exceptions to the Rules Examples of successful drugs that do not obey the "rules.

Unit-2 - Rational Drug Design — ***9 Hour***

Target Identification: Primary Sequence and Metabolic Pathway, Crystallography and 2D NMR, Homology Models and Protein Folding in target identification, Analysis of Target Mechanism: Kinetics and Crystallography, Automated Crevice Detection, ,Introduction to Molecular Dynamics Simulations, Molecular dynamics in target characterization,, The Structure-Based Design Process,The Drug Design Process for a Known Protein Target: Initial Hits and Compound Refinement, Drug Resistance ,Mechanisms of resistance to the drug, The Drug Design Process for an Unknown Target: The Ligand-Based Design Process, Targets inside cells, Targets within the central nervous system

Unit-3 - Force Field and Molecular Mechanics — ***9 Hour***

Introduction to computational tools in drug discovery, Introduction to Homology Model Building, Importance of sequence similarity in homology modeling, Steps for Building a Homology Model, Homology Model creation, Homology Model validation, Molecular Mechanics,How molecular mechanics are utilized in drug design. Force Fields for Drug, Introduction to Molecular Docking ,Search Algorithms in Molecular Docking, The Docking Process: Preparation of Protein and Ligand, Analysis of docking Results, Docking softwares/tools

Unit-4 - Pharmacophore Models and QSAR Equations — ***9 Hour***

Components of a Pharmacophore Model,, Creating a Pharmacophore Model from the Active Compounds ,Advantages of pharmacophore searching, Creating a Structure based pharmacophore, Searching Compound Databases Reliability of search Results, QSAR Conventional QSAR versus 3D-QSAR,The QSAR Process Descriptors, Automated QSAR Programs ,QSAR versus Other Fitting Methods, The 3D-QSAR Process, Criteria are used to construct conformers,3D-QSAR Software Packages, Advantage and disadvantages of 3D-QSAR Software

Unit-5 - Application Oriented Examples of Drug Design	***9 Hour***
Structure-based De novo Ligand synthesis, Example of De novo Ligand synthesis, Future Developments in Drug Design: Individual Patient Genome Sequencing, Analysis of the Entire Proteome, Drugs Customized for Ethnic Group or Individual Patient, Application of Genetic Manipulation in drug designing, Cloning and Stem Cells in drug design	

Learning Resources	1. *Young, "Computational Drug Design: a Guide for Computational and Medicinal Chemists", Wiley, 2009* 2. *Kristian Stromgaard, Povl Krogsgaard-Larsen, Ulf Madsen,"Textbook of Drug Design and Discovery. . CRC Press, 2022* 3. *Andrew Leach, "Molecular Modeling: Principles and applications," 2nd edition, Pearson Education, 1996.*	4. *Rick NG, "Drugs: From Discovery to Approval," John Wiley & Sons, 2004.* 5. *Paul S Charifson, "Practical Application of Computer-Aided Drug Design," Informa Health Care, 1997* 6. *Dev Bukhsh Singh, Computer-Aided Drug Design. Springer Singapore, 2020.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	*-*	*15%*	*-*	*15%*	*-*
Level 2	*Understand*	*25%*	*-*	*20%*	*-*	*25%*	*-*
Level 3	*Apply*	*30%*	*-*	*25%*	*-*	*30%*	*-*
Level 4	*Analyze*	*30%*	*-*	*25%*	*-*	*30%*	*-*
Level 5	*Evaluate*	*-*	*-*	*10%*	*-*	*-*	*-*
Level 6	*Create*	*-*	*-*	*5%*	*-*	*-*	*-*
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. C. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com*	1. *Prof. K Subramaniam, IITM, Chennai, subbu@iitm.ac.in*	1. *Dr. M K Jaganathan, SRMIST*
2. *Dr. Karthik Periyasamy, Scientist, Biocon, karthik.periyasamy@biocon.com*	2. *Prof. R. B. Narayanan, Anna University, Chennai, arbeen09@gmail.com*	2. *Dr. Priya Swaminathan, SRMIST*

Course Code	21BTE404T	Course Name	MARINE BIOTECHNOLOGY	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Biotechnology*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*learn the knowledge of the living and non-living resources*
CLR-2:	*analyze the pharmacological potency of toxins*
CLR-3:	*apply the biopolymers from various sources*
CLR-4:	*control measures of various marine pollution*
CLR-5:	*understand the commercialization of marine and aquaculture resources*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*describe the economically important marine resources and their wealth*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	*explain the natural toxins and its pharmacological potency*	-	2	2	3	-	-	-	-	-	-	-	-	2	2	2
CO-3:	*distinguish the availability of bioactive compounds*	-	2	2	3	2	-	-	-	-	-	-	-	2	2	2
CO-4:	*value the degradation process for discharged wastes*	-	2	2	3	2	-	-	-	-	-	-	-	-	-	-
CO-5:	*integrate the diseases of cultivable animals and its controlling measures*	-	-	2	2	2	-	-	-	-	-	-	-	2	-	-

Unit-1 - Living and Non-Living Resources	***9 Hour***
Zonation of the sea; motion of the ocean; Living resources - Corals, seaweeds and mangroves. Non-living resources -Oil, gas and salts. Economically important animals - Finfishes, shrimps, crabs, edible oysters and pearl oysters.	
Unit-2 - Natural Toxins and its Potential Pharmacological Uses	***9 Hour***
Marie toxins from animals; sources of toxins; pharmacological potential of toxins- tetrodotoxin, conotoxin and ciguateratoxin.	
Unit-3 - Potential Bioactive Compounds	***9 Hour***
Biopolymers - collagen, gelatin, heparin, chitosan, antioxidants. Polyunsaturated fatty acids - omega 3-fatty acids. Sources of carotenoids.	
Unit-4 - Marine Pollution	***9 Hour***
Oil spillage - fate of spilled oil, methods of degradation. Harmful blooms- blue-green algal blooms, red tides. Pesticide pollution - degradation. Heavy metal pollution - minamata disease. Solid waste pollution - plastic waste and degradation, factors affecting degradation.	
Unit-5 - Finfish and Shellfish Diseases and Aquaculture	***9 Hour***
Finfish diseases; shrimp diseases associated with culture and management; antibiotics used in culture, immunostimulants, diagnostic kits. Water quality management in hatcheries and grow-out ponds.	

Learning Resources	1. *Se-Kwon Kim (Ed.) "Springer Handbook of Marine Biotechnology", (Series) Springer Berlin, Heidelberg, 2015.* 2. *Milton Fingerman and Rachakonda Nagabhushanam, "Recent Advances in Marine Biotechnology (Series) Biomaterials and Bioprocessing", Science Publishers, 2009.* 3. *ProkschandWerner E.G.Muller, "Frontiers in Marine Biotechnology",Horizon Bioscience, 2006.*	4. *Le Gal, Y., Ulber, R, "Marine Biotechnology I: Advances in Biochemical Engineering/Biotechnology", (Series editor: T. Scheper) Springer-Verlag Berlin Heidelberg. Vol. 96, 2005.* 5. *Le Gal, Y., Ulber, R "Marine Biotechnology II: Advances in Biochemical engineering /Biotechnology", (Series editor: T. Scheper) Springer-Verlag Berlin Heidelberg. Vol. 97, 2005.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	*-*	*15%*	*-*	*15%*	*-*
Level 2	*Understand*	*25%*	*-*	*20%*	*-*	*25%*	*-*
Level 3	*Apply*	*30%*	*-*	*25%*	*-*	*30%*	*-*
Level 4	*Analyze*	*30%*	*-*	*25%*	*-*	*30%*	*-*
Level 5	*Evaluate*	*-*	*-*	*10%*	*-*	*-*	*-*
Level 6	*Create*	*-*	*-*	*5%*	*-*	*-*	*-*
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. G. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com*	1. *Prof. K Subramaniam, IITM, Chennai, subbu@iitm.ac.in*	1. *Dr.R.A.Nazeer, SRMIST*
2. *Dr. S. Sam Gunasekar, Orchid Chemicals and Pharmaceutical Ltd., Chennai*	2. *Prof. R. B. Narayanan, Ann University, Chennai, arbeen09@gmail.com*	2. *Dr.R.Jaiganesh, SRMIST*

Course Code	21BTE405T	Course Name	VACCINE BIOTECHNOLOGY	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Biotechnology*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*understand the conventional strategies in vaccine production*
CLR-2:	*develop an understanding in the vaccine production techniques*
CLR-3:	*categorise the types of vaccine*
CLR-4:	*analyze different methods of vaccine delivery*
CLR-5:	*comprehend the guidelines for vaccine management*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*acquire theoretical knowledge on conventional strategies in vaccine production*	-	*3*	-	-	-	-	-	-	-	-	-	*2*	-	*3*	-
CO-2:	*exemplify the students with vaccine production techniques*	-	*3*	*3*	-	-	-	-	-	-	-	-	-	*3*	-	*3*
CO-3:	*distinguish various types of vaccine*	-	*3*	-	*3*	-	-	-	-	-	-	-	-	-	*3*	-
CO-4:	*devise various methods for vaccine delivery*	*3*	-	-	*3*	-	-	-	-	-	-	-	-	-	*3*	*3*
CO-5:	*explicate the guidelines for vaccine production and delivery*	-	-	*3*	-	-	-	-	*2*	-	-	-	-	-	*3*	*3*

Unit-1 - Conventional Strategy and Current Developments In Vaccine ***9 Hour***

History of vaccine development -Conventional strategies for vaccine improvement; Live, attenuated, subunit, peptide and killed vaccines; Types of adjuvants; Current development in vaccines- Next-generation vaccines: Human Immunome project; Human antibodies as vaccines

Unit-2 - Vaccine Design and Development ***9 Hour***

Steps involved in vaccine production; Production techniques-Strain selection, growing the microorganisms in maximum titre; Technology related to monitoring -temperature, sterilization, environment, quality assurance, vaccine efficacy and lot release; Preservation techniques-cryopreservation and freeze drying

Unit-3 -Types, Methods and Applications ***9 Hour***

Types of vaccines- Inactivated toxins, Inactivated whole bacteria or viruses, Live attenuated bacteria or viruses, Subunit vaccines, Polysaccharide vaccines, Conjugate vaccines, Genetic approaches in vaccine development- Recombinant DNA vaccines, Edible vaccines; Recent developments in vaccine - Virus like particles, Nanoparticles in vaccine delivery, Induction of immune responses by nanoparticle based vaccine

Unit-4 - Vaccine Delivery ***9 Hour***

Immunomodulators-Innovative methods of delivering immunogens ; liposomes-role of liposomes in delivering vaccines-Mechanism of liposome formation; Microspheres-Types of microspheres, Preparation methods; ISCOMS-Properties of ISCOM based vaccines, Types, components of ISCOM

Unit-5 - Guidelines for Vaccine Management ***9 Hour***

Regulatory issues- Regulatory bodies, Environmental effects of recombinant vaccines; Disease security and biosecurity principles; OIE guidelines for vaccine seed lot management; OIE guidelines for the method of vaccine production, OIE guidelines for production facility; In process control and batch control-organization and responsibilities, documentation and evaluation of data; Test on final products-Overview, General manufacturing recommendations, Final product release tests

Learning Resources	1. *Ronald W. Ellis, "New Vaccine Technologies", Landes Bioscience, 2001.* 2. *Noel Mowat, "Vaccine manual: The production and quality control of veterinary vaccines for use in developing countries", Daya books, 1999.*	3. *Cheryl Barton, "Advances in Vaccine Technology and Delivery", Espicom Business Intelligence, 2009. Vaccines: Stanley A. Plotkin, Walter A. Orenstein, Paul A. Offit(Elsevier), 6th edition, 2008* 4. *Ibrahim M Shnawa, "Vaccine Technology at A Glance", Boffin Access Limited, UK, 2019.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	-	*15%*	-	*15%*	-
Level 2	*Understand*	*25%*	-	*20%*	-	*25%*	-
Level 3	*Apply*	*30%*	-	*25%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*25%*	-	*30%*	-
Level 5	*Evaluate*	-	-	*10%*	-	-	-
Level 6	*Create*	-	-	*5%*	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. S. Sam Gunasekar, Orchid Chemicals and Pharmaceuticals Ltd., sam@orchidpharma.com*	1. *Prof. K Subramaniyam, IITM, Chennai, suubu@iitm.ac.i*	1. *Dr.S.Sujatha, SRMIST*
2. *Dr. Karthik Periyasamy, Scientist, Biocon, karthik.periyasamy@biocon.com*	2. *Dr. R. B Narayanan Anna University, Chennai, arbeen09@gmail.com*	2. *Dr.Koustav Sarkar, SRMIST*

Course Code	21BTE406T	Course Name	MOLECULAR BASIS OF DRUG ACTION	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Biotechnology*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*impart knowledge of drug targets and methods used in molecular cloning of drug targets*
CLR-2:	*Increase the understanding of how drugs work.*
CLR-3:	*impart knowledge about the molecular aspects of drug targets and their signaling mechanisms*
CLR-4:	*impart knowledge about the structure of different drug targets*
CLR-5:	*explain how an individual's genetic makeup influences their response to therapeutic drugs*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*gain knowledge about drug targets and molecular biology techniques used in pharmacology*	-	-	2	2	3	-	-	-	-	-	-	-	2	2	-
CO-2:	*discuss the molecular pharmacology of receptors, channels, and enzymes*	-	2	2	2	-	-	-	-	-	-	-	-	2	2	-
CO-3:	*classify the different types of receptors, ion channels, and transporters*	-	2	-	2	2	-	-	-	-	-	-	-	2	-	-
CO-4:	*identify the receptors, ion channels, and transporter based on structure*	-	-	2	2	2	-	-	-	-	-	-	-	2	2	-
CO-5:	*investigate how an individual's genetic makeup influences their response to therapeutic drugs*	-	-	2	2	2	-	-	-	-	-	-	-	2	2	-

Unit-1 - Drug Targets and Molecular Cloning of Drug Targets ***9 Hour***

Outline of molecular pharmacology based approaches used to interrogate drug targets, Molecular pharmacology vs traditional pharmacology, Nature of the Drug targets, Future drug targets .Molecular Cloning – from DNA to drug discovery, The relevance of recombinant DNA technology to pharmacology/drug discovery. The 'Cloning' of drug targets: Cloning using peptide sequence(s), construction and screening of a DNA library, Cloning using a specific antibody, a functional assay and Polymerase chain reaction. Reverse pharmacology: Reverse pharmacology illustrated on orphan GPCRs

Unit-2 -G-Protein Coupled Receptor ***9 Hour***

Classification and molecular structure of G-Protein Coupled receptor (GPCR), Mechanism of Activation and Signal transduction pathways - phospholipase C and adenylyl cyclase, Measurement of phospholipase C and adenylyl cyclase activation, Desensitization and down-regulation of GPCR signaling and Role of GPCR phosphorylation in desensitization, Constitutive GPCR activity, Agonist-directed signaling and Allosteric modulators of GPCR function. Pharmacological chaperones for GPCRs , GPCR dimerization- Methods to study GPCR dimerization,

Unit-3 - Ion Channels ***9 Hour***

Classification of ion channels .Voltage-gated ion channels -Structure of Voltage-gated Ca2+ channels, Na+ channels, K+ channels. Voltage-gated ion channels in health and disease and their role in neurotransmission and muscle contraction, Effect of toxin on the Voltage-gated ion channels. Ligand-gated ion channels - Pentameric ligand-gated ion channel family, Nicotinic acetylcholine receptors, 5-HT3 receptor channels and GABAA receptors.

Unit-4 -Transporters ***9 Hour***

Classification of Transporter proteins- Transporter families of pharmacological interest-The major facilitator superfamily (MFS), The neurotransmitter: sodium symporter (NSS) - Structure of Glutamate transporters (Gltph) and Leucine Transporter (LeuTAa), NhaA Na+:H+ antiporter (NhaA) family. The cell penetrating peptides (CPP), ATPase transporters Structure and role in human health and disease, Role of transporters in drug pharmacokinetics and cellular homeostasis

Unit-5 - Pharmacogenomics	***9 Hour***
Types of genetic variation, Methods for detecting genetic polymorphisms-PCR-RFLP analysis and Large-scale SNP analysis. Polymorphisms affecting drug metabolism- Different Scenario how the polymorphisms affecting drug metabolism. Genetic variation in drug transporters. Genetic variation in G protein coupled receptors-Genetic variation within the adrenergic receptor family and role of adrenergic receptor SNP in asthma and cardiovascular function.	

Learning Resources		
	1. *Michael Palmer, Alice Chan, Thorsten Dieckmann, John Honek, "Biochemical Pharmacology", Wiley, 2012.* 2. *Chris Lloyd Mills, Fiona Freeman, Christian Thode, Shiva Sivasubramaniam, John Dickenson, "Molecular pharmacology : from DNA to drug discovery ",Wiley-Blackwell, 2012*	3. *Terry Kenakin, "Pharmacology in drug discovery: understanding drug response", Mica Haley, 2016.* 4. *Rang and Dale, "Pharmacology", Churchill Livingstone, 2007.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	*-*	*15%*	*-*	*15%*	*-*
Level 2	*Understand*	*25%*	*-*	*20%*	*-*	*25%*	*-*
Level 3	*Apply*	*30%*	*-*	*25%*	*-*	*30%*	*-*
Level 4	*Analyze*	*30%*	*-*	*25%*	*-*	*30%*	*-*
Level 5	*Evaluate*	*-*	*-*	*10%*	*-*	*-*	*-*
Level 6	*Create*	*-*	*-*	*5%*	*-*	*-*	*-*
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. G. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com*	1. *Prof. K Subramaniam, IITM, Chennai, subbu@iitm.ac.in*	1. *Dr. M. K. Jaganathan, SRMIST*
2. *Dr. Karthik Periyasamy, Scientist, Biocon, karthik.periyasamy@biocon.com*	2. *Dr. R. B Narayanan Anna University, Chennai,arbeen09@gmail.com*	2. *Dr. Y. Ravichandran,SRMIST*

Course Code	21BTE203T	Course Name	PLANT HORMONES AND SIGNALING	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Biotechnology*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*exemplify how plant hormones contribute to their growth, development, reproduction and stress responses*
CLR-2:	*understand the fundamental properties, tropic movement, and mechanism of action of auxin*
CLR-3:	*interpret the effects of cytokinin, its receptor perception & signaling*
CLR-4:	*study the gibberllins and ethylene receptors and regulation of physiological functions*
CLR-5:	*illustrate the interactions of core signaling for controlling the functions of abscisic acid in plants*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*discuss the major plant hormones and their roles in a plant's life*	*3*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	*3*	-
CO-2:	*describe the history, synthesis, transport, and functions of auxin*	*3*	*2*	*3*	-	-	-	-	-	-	-	-	-	-	*3*	-
CO-3:	*understand the cytokinin biosynthetic pathway and protein kinase cascade for signaling*	*3*	*3*	-	*3*	-	-	-	-	-	-	-	-	-	*3*	-
CO-4:	*interpret the different physiological responses to the environment by hormones gibberellins and ethylene*	*3*	*3*	*2*	-	-	-	-	-	-	-	-	-	-	-	*3*
CO-5:	*explain the ways that ABA affects the development of roots, fruits, and seeds during stresse*	*3*	*3*	-	*3*	-	-	-	-	-	-	-	-	-	*3*	-

Unit-1 - Introduction to Phytohormones ***9 Hour***

Types of phytohormones. Overview of hormone action and signaling. Hormones and vegetative developments in plants: Auxin, cytokinin, strigolactones, gibberellins & brassinosteroids. Hormonal control of reproductive development - Transition to flowering, development of flowers and fruits: Ethylene & abscisic acid. Hormonal responses to abiotic stress: Abscisic acid. Hormonal responses to biotic stress: Jasmonates & Salicylates. Hormonal crosstalk, and in defense.

Unit-2 - Auxin ***9 Hour***

Overview of auxin studies, signaling pathways. Biosynthesis and homeostasis, transport. Polar auxin transport, chemiosmotic model. Auxin moves through efflux and influx carrier proteins, types of carrier proteins - AUX1 / LAX, ABCB family & PIN family, perception – receptors, ABP1, TIR1 and AFP protein family of F-box proteins, signaling - Aux/IAA proteins, auxin-responsive transcription factors. Physiological actions.

Unit-3 - Cytokinins (CK) ***9 Hour***

The discovery of cytokinins - overview, homeostasis, and structure of major CKs. The Agrobacterium tmr gene is a CK biosynthesis gene CYP735A. Formation of active CKs, LONELY GUY overexpression, CK inactivation by conjugation or degradation, cytokinin oxidase, CK acts as a paracrine and a long-distance signal PUP and ENT. CK perception and signaling, a two-component-like system. Downstream of the receptors - Histidine phosphotransfer proteins (HPTs) and response regulators (RRs). CK action in whole-plant processes, Abiotic and biotic stress responses.

Unit-4 - Gibberellins & Ethylene ***9 Hour***

Gibberellins - History and overview. Inhibitor of an inhibitor, synthesis and homeostasis, deactivation & transport, perception and signaling, GID1 encodes a GA receptor, GA-regulated growth repressors, DELLA proteins, GA's roles in whole-plant physiology, Response to salt stress, seed germination, and flowering. Ethylene - A gaseous hormone, triple response, ethylene synthesis, and homeostasis. Burg and Thimann's studies, The Yang cycle. Ethylene response, receptors, and downstream signaling. Ethylene's roles in whole-plant processes.

Unit-5 - Abscisic Acid (ABA)	***9 Hour***
Abscisic acid - Plant processes, biosynthesis and homeostasis - Zeaxanthin epoxidase, NCED, VP14 & CYP707A. Transport - ABA movement perception and signaling - PYR/ RCAR, ABI1 encodes a PP2C protein phosphatase, PP2C binds ABA + receptor & SnRK kinase similarly, calcium-dependent protein kinases, ABA's roles in the control of guard cell turgor, ABA in whole-plant processes - drought stress, surviving extreme desiccation, systemic stress responses.	

Learning Resources		
	1. *Lecture Notes. 2023. The Plant Cell, American Society of Plant Biologist, Oxford University Press.* 2. *Jiayang Li, Chuanyou Li, Steven M. Smith. "Hormone Metabolism and Signaling in Plants" Academic Press, ISBN - 978-0-12-811562-6. (2017).* 3. *Davies, P. J.,"Plant Hormones -Biosynthesis, Signal Transduction,Action", Third Edition,Springer 2011.*	4. *S. L. Kochhar and Sukhbir Kaur Gujral "Plant Physiology Theory and Applications", pp. 468 – 525. DOI: https://doi.org/10.1017/9781108486392.019. Cambridge University Press, (2020).* 5. *Lincoln Taiz and Eduardo Zeiger, "Plant Physiology", Third edition. Panima Publishing Corporation, 2003.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	*-*	*15%*	*-*	*15%*	*-*
Level 2	*Understand*	*25%*	*-*	*20%*	*-*	*25%*	*-*
Level 3	*Apply*	*30%*	*-*	*25%*	*-*	*30%*	*-*
Level 4	*Analyze*	*30%*	*-*	*25%*	*-*	*30%*	*-*
Level 5	*Evaluate*	*-*	*-*	*10%*	*-*	*-*	*-*
Level 6	*Create*	*-*	*-*	*5%*	*-*	*-*	*-*
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. C. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com*	1. *Prof. K Subramaniyam, IITM, Chennai, suubu@iitm.ac.in*	1. *Dr. R. Pachaiappan, SRMIST*
2. *Dr. Karthik Periyasamy, Scientist, Biocon, karthik.periyasamy@biocon.com*	2. *Prof. R. B Narayanan Anna University, Chennai arbeen09@gmail.com*	2. *Dr. DVL. Sarada, SRMIST*

Course Code	21BTE305T	Course Name	EPIGENETICS IN PLANTS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Biotechnology*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*illustrate the epigenetic modifications of DNA and chromatin that affect the activity of genes*
CLR-2:	*understand the post-transcriptional gene silencing and transcriptional gene silencing by small RNAs*
CLR-3:	*interpret the regulation of small RNAs in the plant developmental process through gene expression*
CLR-4:	*understand the mechanism of epigenetic modification through small RNAs*
CLR-5:	*illustrate the methods of studying epigenetic modification in plants*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1 Engineering Knowledge	2 Problem Analysis	3 Design/development of solutions	4 Conduct investigations of complex problems	5 Modern Tool Usage	6 The engineer and society	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*discuss the genome organization complexity and controlled expression of the genes*	*3*	*3*	-	*3*	-	-	-	-	-	-	-	-	-	*3*	-
CO-2:	*demonstrate the various levels of checkpoints for gene expressions by small RNAs*	*3*	*3*	*3*	-	-	-	-	-	-	-	-	-	*3*	-	-
CO-3:	*understand the small RNA contribution to plant developmental patterning*	*3*	*3*	-	*3*	-	-	-	-	-	-	-	-	-	*3*	-
CO-4:	*interpret the different small RNAs to control the gene expressions by regulating different factors*	*3*	*3*	-	*3*	-	-	-	-	-	-	-	-	-	-	*3*
CO-5:	*explain the various techniques for epigenetic modification studies*	*3*	*3*	-	-	*3*	-	-	-	-	-	-	-	-	-	*3*

Unit-1 - Genome Structure, Gene, Expression and Controls	***9 Hour***
Introduction to the structural organization of the genome in plants, genes structure, and expression in prokaryotic and eukaryotic systems. Transcriptional and post-transcriptional regulations. Epigenetic markers - transcriptional silencing, chromatin remodeling, DNA methylation. The structure of histones, interactions between DNA and histone methylation functions, RNA-independent chromatin modification.	
Unit-2 - Overviews of RNAs	***9 Hour***
Types and roles of RNAs, General roles - transgene silencing, and viral resistance. Comparative studies of small RNAs in C. elegans. Types of small RNAs, and RNA polymerases in plants. Biogenesis of small RNAs in plants, regulations of small RNAs.	
Unit-3 - Epigenetic Regulation in Whole-Plant Processes	***9 Hour***
Epigenetic control of transposon, repetitive elements. Epigenetic control of flowering time. Plant Developmental Programs - PRC2-mediated H3K27me3 deposition. Vegetative propagated plant regulations. Epigenetic response to stress - Drought stress - H3K4Me3, heat-induced activation - ONSEN transposon. Epigenetic control of imprinted genes. Epigenome reprogramming. Natural epigenetic variations.	
Unit-4 - Epigenetic Modification by Small RNA	***9 Hour***
Functions of small RNAs - mobility and non-cell-autonomous functions, trans-generational transposon silencing with mobile siRNAs. Gametes and zygotes, miRNA regulation of developmental patterning. Functions of phasiRNAs and tasiRNAs. Small RNAs in biotic interactions and defense. AC/DS elements regulations in maize. Applications of small RNAs in crop improvement.	
Unit-5 -Methods to Study Epigenetics	***9 Hour***
Chromatin immunoprecipitation binding analyses in Arabidopsis. Capture-based analysis of nuclear architecture. Analysis of DNA methylation in plants. Combined Bisulfite Restriction Analysis (COBRA) assay. Cytosine-extension assay and in situ analysis of DNA methylation. Analysis of DNA hydroxymethylation. Colorimetric assay. Analysis of small RNA populations. Profiling transposable elements.	

Learning Resources	1. *Rajewsky, Nikolaus & Jurga, Stefan & Barciszewski, Jan. (2017). Plant Epigenetics. 10.1007/978-3-319-55520-1.* 2. *Williams, M.E. (April 2, 2013). Epigenetics.Teaching Tools in Plant Biology:Lecture Notes. The Plant Cell (online), doi/10.1105/tpc.110.tt0110.* 3. *Williams, M.E. (May 3, 2013). The Small RNA World. Teaching Tools in Plant Biology: Lecture Notes. The Plant Cell (online), doi/10.1105/tpc.110.tt10210*	4. *Kovalchuk, Igor. (2017). Plant Epigenetics: Methods and Protocols. 0.1007/978-1-4899-7708-3.* 5. *Spillane, Charles & McKeown, Peter. (2014). Plant Epigenetics and Epigenomics: Methods and Protocols. 10.1007/978-1-62703-773-0.* 6. *Kovalchuk, Igor & Zemp, Franz. (2010). Plant Epigenetics: Methods and Protocols. 10.1007/978-1-60761-646-7.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	*-*	*15%*	*-*	*15%*	*-*
Level 2	*Understand*	*25%*	*-*	*20%*	*-*	*25%*	*-*
Level 3	*Apply*	*30%*	*-*	*25%*	*-*	*30%*	*-*
Level 4	*Analyze*	*30%*	*-*	*25%*	*-*	*30%*	*-*
Level 5	*Evaluate*	*-*	*-*	*10%*	*-*	*-*	*-*
Level 6	*Create*	*-*	*-*	*5%*	*-*	*-*	*-*
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. C. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com*	1. *Prof. K Subramaniam, IITM, Chennai, subbu@iitm.ac.in*	1. *Dr. R. Pachaiappan, SRMIST*
2. *Dr. Karthik Periyasamy, Scientist, Biocon, karthik.periyasamy@biocon.com*	2. *Prof. R. B. Narayanan, Anna university, Chennai, arbeen09@gmail.com*	2. *Dr. DVL. Sarada, SRMIST*

Course Code	21BTE306T	Course Name	PATHOGENESIS RELATED PROTEINS IN PLANTS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Biotechnology*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*highlight the different types of interactions between plants and pathogens*
CLR-2:	*realize inducibility of microbial resistance*
CLR-3:	*delineate various functions of different classes of PR proteins*
CLR-4:	*introduce concepts related to pest resistance*
CLR-5:	*apprise the applications of PR Proteins for crop improvement*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*explain the molecular mechanisms underlying plant pathogen interactions*	*2*	*2*	*2*	*2*	-	-	-	-	-	-	-	-	*3*	-	*3*
CO-2:	*analyze the induction of PR proteins for host defense*	*3*	*3*	*3*	*2*	-	-	-	-	-	-	-	-	*3*	-	*2*
CO-3:	*categorize the functions of different classes of PR proteins to host resistance*	*3*	*2*	*2*	*3*	-	-	-	-	-	-	-	-	*3*	-	-
CO-4:	*infer the differences between pathogen resistance and pest resistance*	*3*	*3*	*3*	*2*	-	-	-	-	-	-	-	-	*2*	-	*3*
CO-5:	*evaluate the applications of PR Proteins for crop improvement*	*2*	*2*	-	*2*	-	-	-	-	-	-	-	-	*2*	-	*2*

Unit-1 - Plant Pathogen Interactions — ***9 Hour***

Plant Pathology – Basics – Major Classes of Pathogens - Fungi, viruses, bacteria, oomycetes and nematodes – Pathogen -Host- Environment Interactions - The Disease Triangle - Strategies of pathogenicity - biotrophy, necrotrophy, and hemi-biotrophy - Host Responses - Pathogen-triggered & Effector-triggered immunity - Pathogen-recognition receptors – Induction of phytoalexin, reactive oxygen and callose production- Recognition and response to effectors through paired R proteins

Unit-2 - Classes I and II — ***9 Hour***

PRs, and PR like proteins PR - proteins from other organisms & Functions Occurrence, Properties and Functions - PR- 1 Proteins Characterization -Induction - Pathogens /wounds, Salicylic acid, Ethylene and Other hormones, UV light and Developmental Stimuli - PR-1 promoter analysis - PR-2 Proteins – β-1,3-Glucanases Structural classes - Biological Functions of β-1,3-Glucanases – Reproduction and Defense – Induction by Developmental, Hormonal and Biotic stimuli

Unit-3 - Chitinases and Osmotins — ***9 Hour***

Structure of PR- 3, 4, 8, 11 Proteins - Other Related Proteins - Catalytic Mechanisms and Specificities - Structure and Regulation of the Genes - Antifungal Activities and other Physiological Properties - PR-5 - Thaumatin-like proteins - Occurrence, Physico- chemical properties - Biological properties - Taste - Antifungal Activity - Anti-Freeze Properties - TLP Expression - Microbial Infection Osmotic Stress, Abscisic Acid, Ethylene, Salicylate, Methyl Jasmonate other Elicitors -Wounding

Unit-4 - Proteinase Inhibitors, Defensins and Ribosome Inactivating Proteins — ***9 Hour***

Proteinases and Proteinase Inhibitors- Occurrence and Structure- Plant–Microbe and Plant Insect Interactions – Defensins – Structure – Significance of Disulphide Residues- Structure – Activity Relationships- Mechanism of Antimicrobial Action - Ribosome inactivating proteins and – Structure, Function and Engineering

Unit-5 - Molecular Basis of Disease Resistance and Application	***9 Hour***
Signals and Putative Receptors that Activate PR Gene Expression – Activation of PR Genes by Different Stimuli - Reactive oxygen species (ROS), salicylic acid (SA), ethylene, and jasmonates Leucine-rich repeat receptor kinases , LysM receptor proteins - Transcriptional Regulation of PR Gene Expression - W-box, GCC box, MRE-like sequence & G-box - SA-inducible promoter - GCC box-binding proteins - EREBP-1, EREBP-2, EREBP-3, and EREBP-4 – Transgenics – Expression of PR Proteins – Examples in Rice.	

Learning Resources	1. *Agrios, G.N. (2005). Plant Pathology. (Burlington, MA: Elsevier Academic Press).* 2. *Schumann, G.L., andand D'Arcy, C.J. (2010). Essential Plant Pathology. (St. Paul, MN: The American Phytopathological Society).*	3. *Swapan K. Datta and Muthukrishnan, "Pathogenesis –Related Proteins in plants", CRC Press, 1999.* 4. *John A. Lucas "Plant pathology and Plant Pathogens" Fourth Edition Wiley- Blackwell 2020*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	-	*15%*	-	*15%*	-
Level 2	*Understand*	*25%*	-	*20%*	-	*25%*	-
Level 3	*Apply*	*30%*	-	*25%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*25%*	-	*30%*	-
Level 5	*Evaluate*	-	-	*10%*	-	-	-
Level 6	*Create*	-	-	*5%*	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. C. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com*	1. *Prof. K Subramaniam, IITM, Chennai, subbu@iitm.ac.in*	1. *Dr. Sarada, DVL, SRMIST*
2. *Dr. Karthik Periyasamy, Scientist, Biocon, karthik.periyasamy@biocon.com*	2. *Prof. R. B. Narayanan, Anna university, Chennai, arbeen09@gmail.com*	2. *Dr. R. Pachaiappan, SRMIST*

Course Code	21BTE407T	Course Name	FOOD SCIENCE AND NUTRITION	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Biotechnology*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*identify the need for greater and more efficient utilization of the existing food sources*
CLR-2:	*demonstrate nutritional quality and nutritional requirement*
CLR-3:	*solve calculate energy requirements of the body*
CLR-4:	*describe about new trends in nutrition*
CLR-5:	*identify anti nutritional factors in food*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*demonstrate nutritional quality and nutritional requirement*	-	*3*	-	-	-	-	-	-	-	-	-	-	*2*	-	-
CO-2:	*explain about carbohydrate nutrition*	-	*2*	-	-	-	-	-	-	-	-	-	-	*2*	-	-
CO-3:	*describe about protein and fat*	*3*	-	-	-	-	-	-	-	-	-	-	-	*2*	-	-
CO-4:	*identify vitamins minerals and anti-nutritional factors in food*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	*2*	-
CO-5:	*describe about new trends in nutrition*	*3*	-	*3*	-	-	-	-	-	-	-	-	-	*3*	-	-

Unit-1 - Nutritional Requirements and Dietary Standards ***9 Hour***

Food as a source of energy, Essential nutrients, The food pyramid, Food Group System, Balanced diet, malnutrition, obesity and health implications; calorific value of nutrients, calculating energy values from food, Instrumental methods to calculate caloric value of food, Proximate analysis of foods,; BMR and BMI calculation, RDA- Recommended dietary allowances for Indians fixed by ICMR comparison with that of FAO/WHO standards ; Digestion, Absorption and Metabolism of fat , Carbohydrate and protein ; Functions of protein, fat and carbohydrates and their dietary requirements,

Unit-2 - Carbohydrates ***9 Hour***

Sources of Carbohydrates, Classification of Carbohydrates, Polysaccharides –Starch and dietary fibers. Role of dietary fibers in food, Carbohydrate rich food- Cereal and tuber crops, Nutritional significance of carbohydrates, non-glycemic and Glycemic carbohydrates, recommended carbohydrate intake, lactose intolerance; blood glucose regulation, diabetics and nutrition; Artificial sweeteners, Sugar alcohols and its adverse effect on health t

Unit-3 - Protein and Lipid ***9 hour***

Protein- dietary requirements, functions, and deficiency in diet; Sources of Protein and its composition- pulses, meat , milk and egg; single cell protein, Anti nutritional factors in pulses, gluten-free diet; Classification of lipids , Plant Sources of fat/oil, Marine and animal sources of fat/oil ,Nutritional significance of lipids-essential fatty acids and omega 3 fatty acids, Diabetes mellitus – Cardiovascular disease- HDL & LDL cholesterol and triglycerides in blood and diet; Trans fatty acids and health effects,

Unit-4 - Water, Vitamins, Minerals and Anti Nutritional Factors ***9 Hour***

Function and daily intake of water, Sources of vitamins in food, Vitamin deficiency disease, Fat soluble vitamins –A,D,E, and K, Water soluble Vitamins-B-complex vitamins, Anemia –preventing vitamins and Vitamin-C; toxicity due to vitamins, bioavailability of vitamins, reasons for losses of vitamins in foods; Sources of mineral in food, Classification of minerals, Naturally occurring food toxicants in foods- Carcinogens produced during food processing and storage

Unit-5 - Diet Planning, Therapeutic Diet and New Trends in Nutrition	***9 Hour***
Diet planning principles, dietary guidelines, dietary recommendations using the nutritional assessment of individuals and populations, therapeutic die; Estimation of energy requirements for different age group and women at different life stages,- Therapeutic diets – Diabetes mellitus – Cardiovascular disease – Hypertension – Cancer – Obesity and underweight; Nutritional value and health implications of fast food and junk food; Probiotics an prebiotics, Antioxidants , Nutraceuticals, Functional food	

Learning Resources		
	1. *Sunetra Roday. "Food science and nutrition". 2016, Oxford university Press.* 2. *Swaminathan, M. (5th Edition). "Hand Book of food and Nutrition", 2015. The Bangalore Printing and Publishing co. Ltd. Bangalore* 3. *Srilakshmi B 2018 (7th Edition). Food Science. New age International Publishers.*	4. *Spark, Arlene. "Nutrition in Public Health: Principles, Policies, and Practice". CRC Press, 2007.Mann, Jim and Stewart Truswell "Essentials of Human Nutrition". 3rd Edition. Oxford University Press, 2007* 5. *Ahuja, K.J, Nath Prem and K.R.M Swamy Food and Nutrition, 2010.Studium Press Pvt. Ltd.,New Delhi.,*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	*-*	*15%*	*-*	*15%*	*-*
Level 2	*Understand*	*25%*	*-*	*20%*	*-*	*25%*	*-*
Level 3	*Apply*	*30%*	*-*	*25%*	*-*	*30%*	*-*
Level 4	*Analyze*	*30%*	*-*	*25%*	*-*	*30%*	*-*
Level 5	*Evaluate*	*-*	*-*	*10%*	*-*	*-*	*-*
Level 6	*Create*	*-*	*-*	*5%*	*-*	*-*	*-*
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. C. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com*	1. *Prof. K Subramaniam, IITM, Chennai, subbu@iitm.ac.in*	1. *Dr.R.Preetha, SRMIST*
2. *Dr. Karthik Periyasamy, Scientist, Biocon, karthik.periyasamy@biocon.com*	2. *Prof. R. B. Narayanan, Anna university, Chennai, arbeen09@gmail.com*	2. *Dr. S. Subhashini, SRMIST*

Course Code	21BTE408T	Course Name	THERAPEUTIC COMPOUNDS FROM PLANTS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Biotechnology*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*outline the importance of natural compounds of plant origin in health and disease*
CLR-2:	*differentiate between the properties of different classes of phytoconstituents*
CLR-3:	*demonstrate the methods of production of phytoconstituents in vitro*
CLR-4:	*appraise the therapeutic applications of phytoconstituents*
CLR-5:	*outline the concepts of metabolic engineering for production of plants with improved phytoconstituents*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1 Engineering Knowledge	2 Problem Analysis	3 Design/development of solutions	4 Conduct investigations of complex problems	5 Modern Tool Usage	6 The engineer and society	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*recall natural products originating from plants and outline their importance in health and disease*	*2*	*2*	*2*	*2*	*2*	-	-	-	-	-	-	-	*3*	*3*	-
CO-2:	*analyze the differences between structure and function of different classes of phytoconstituents*	*3*	*3*	*3*	*3*	*3*	-	-	-	-	-	-	-	*3*	*3*	-
CO-3:	*make use of in vitro culture techniques for production of phytoconstituents*	*3*	*3*	*3*	*3*	*3*	-	-	-	-	-	-	-	*3*	*3*	-
CO-4:	*infer the role of phytoconstituents in development of medicines for therapeutic applications*	*3*	*3*	*3*	*3*	*3*	-	-	-	-	-	-	-	*3*	*3*	-
CO-5:	*appraise the application of metabolic engineering for production of plants with improved content of phytoconstituent*	*3*	*3*	*3*	*3*	*3*	-	-	-	-	-	-	-	*3*	*3*	-

Unit-1 - Plant Genome Structure and Organization — ***9 Hour***

Plants vs Medicinal Plants, Taxonomy and validation of Herbal Medicine, Traditional Indian Medicine, Traditional knowledge, Ethano botany. quality assurance of herbal medicine, over the counter herbal medicines, plant extracts vs purified compounds, quest for active compounds, modern approaches, screening plants for drugs, plant families associated with drug production, drug discovery by relatedness, phytoconstituents , alkaloids , flavonoids , terpenoids

Unit-2 - Analytical Techniques — ***9 Hour***

Overview of extraction and purification of phytoconstituents extraction techniques , different types , advantages and limitations of extraction techniques analytical techniques – spectrometry , purification, Analytical Techniques – Chromatography , Bioassay Guided Fractionation , Identification , Analytical Techniques –Mass Spectrometry , Standardization , Clinical validation

Unit-3 - Secondary Metabolism — ***9 Hour***

Primary vs Secondary Metabolism, Examples of Major Secondary Metabolic Pathways , The Mevalonate Pathway , Examples , The shikmate pathway , Examples , The phenyl propanoid and the polyketide pathway, Examples , Biosynthesis of alkaloids , Tissue Cultures for production of metabolites , Examples , Organ Cultures for production of metabolites , Examples Hairy Root Cultures as a means for enhanced metabolite production , Manipulation of hairy roots for metabolite production , Production of Gingsenolides , In vitro production – Role of Endophytes , Production of Taxol.

Unit-4 - Therapeutic Applications of Phytoconstituents — ***9 Hour***

Potential drugs available in the market , Mechanism of action , Analgesic action of alkaloid (Morphine), Antihyperglycemic action of alkaloids (Piperene) , Anti-cancer activity of alkaloids (Berberine) , Anticancer activity of Vinca alkaloids , Antibacterial action of alkaloids (ciproflaxicin) , Neurostimulatory effects of alkaloids , Neuroprotective effects of alkaloids , Antiinflammatory mechanism of action of flavonoids , Antimalarial action of Terpenoids (Quinine) , Antimalarial action of Terpenoids (Artemesin) , Terpenoids against Trypaonosomes , Terpenoids against Leishmanias , Ephedra- Use and Misuse , Ginseng – The Panacea

Unit-5 - Metabolic Engineering for Improvement of Phyto Constituents	***9 Hour***
In vitro Synthesis – Advantages and dis advantages Omics, Systems and Semi synthetic methods Metabolic Engineering - High throughput methods to identify genes intermediates and pathways Strategies Host Selection and Pathway reconstitution - Metabolic Engineering for Phytoconstituents production in Yeast- Metabolic Engineering in Plants and Plant Cell Cultures	

Learning Resources	1. *Trease and Evans Pharmacognosy, William Evans, Sixteenth Edition Elsevier 2009* 2. *Phytochemical Methods – A guide to Modern Techniques in Plant Analysis, Harborne Springer 1998*	3. *Fundamentals of Pharmacognosy and Phytotherapy Second Edition Michael Heinrich, Joanne Barnes, Simon Gibbons and Elizabeth M. Williamson, Elsevier 2012* 4. *Textbook of Medicinal and Aromatic Plants, Amritpal Singh Saroya Indian Council of Agricultural Research 2018*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	-	*15%*	-	*15%*	-
Level 2	*Understand*	*25%*	-	*20%*	-	*25%*	-
Level 3	*Apply*	*30%*	-	*25%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*25%*	-	*30%*	-
Level 5	*Evaluate*	-	-	*10%*	-	-	-
Level 6	*Create*	-	-	*5%*	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. C. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com*	1. *Prof. K Subramaniam, IITM, Chennai, subbu@iitm.ac.in*	1. *Dr. Sarada, D.V.L., SRMIST*
2. *Dr. Karthik Periyasamy, Scientist, Biocon, karthik.periyasamy@biocon.com*	2. *Prof. R. B. Narayanan, Anna university, Chennai, arbeen09@gmail.com*	2. *Dr. R. Pachaiappan, SRMIST*

Course Code	21BTE409T	Course Name	FOOD SAFETY AND QUALITY MANAGEMENT	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Biotechnology*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*describe and analyze Food contaminates and adulterants*
CLR-2:	*describe safety limits of food additives and risk assessment*
CLR-3:	*prepare HACCP program to any food industry*
CLR-4:	*employ Food Quality control and Risk analysis tools*
CLR-5:	*apply certification methods for the food industries*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*identify the issues of food safety and quality*	*2*	*2*	*2*	*-*	*-*	*3*	*-*	*2*	*-*	*-*	*-*	*-*	*2*	*-*	*-*
CO-2:	*enhance the knowledge on food additives and Identify safety limits of food additives*	*2*	*-*	*-*	*2*	*-*	*3*	*-*	*2*	*-*	*-*	*-*	*-*	*2*	*-*	*-*
CO-3:	*analyze and practice HACCP and Quality Management Systems*	*-*	*3*	*3*	*3*	*-*	*2*	*-*	*2*	*-*	*-*	*-*	*-*	*-*	*2*	*-*
CO-4:	*analyze Risk assessment and risk management*	*-*	*3*	*-*	*2*	*-*	*2*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*2*	*-*
CO-5:	*explain the concept on monitoring & implementing FSSAI regulations*	*-*	*3*	*3*	*3*	*2*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*3*	*-*	*-*

Unit-1 - Food Contaminates and Adulterants ***9 Hour***

Food contaminants- pesticide residues, chemicals, mycotoxins and microbial contamination. Analytical tools and methods for identification and quantification of contaminant; identification of food borne pathogens; Food adulterants, testing methods for adulterants,

Unit-2 - Food Additives, GMO and Food Labeling ***9 Hour***

Food preservatives-natural , synthetic, FSSAI standards for synthetic preservatives; Synthetic Food colours and flavours, Artificial sweeteners; GM Foods- microbes, plants and animals; GM testing and analysis, Safety evaluation of GM foods and future of GM foods, Food safety regulation on additives and GMO in India; Food Labeling, Label claims, Allergen declaration,

Unit-3 - HACCP and Quality Management Systems ***9 Hour***

HACCP- Principles, Implementation and maintenance, Hazard identification, HACCP case studies, CCP; Quality management system- Bar Chart, Pareto analysis, Fish bone model, Run charts; Scatter plots, Control charts,

Unit-4 - Food Quality Control and Risk Analysis ***9 Hour***

Principles of food safety and quality; Methods for food quality analysis; methods and importance of sampling, Statistical Process and Quality Control; Risk-identification, classification, Food quality issues, Food recall

Unit-5 - Food Safety and Certification ***9 Hour***

Food safety issues; Definition and terminology in QMS; Food Safety and standard Authority of India; Food Safety authority and responsibilities ; FSSAI standards; Indian Laws on food safety regulations; Food Safety licensing and registration; Procedure for FSSAI licensing; Registration, Inspection and enforcement; Food import clearance systems; Role of food testing laboratories; Food safety standards in India; GMP, GHP in food industries; Food safety certification bodies;

Learning Resources	1. *Sunetra Roday, S. 2 nd edition Food Hygiene and Sanitation, 2017, Tata McGraw-Hill Education.* 2. *Virag Gupta,The Food Safety and Standards Act, 2006. 16 th edition 2022 C Commercial Law Publishers (India) Pvt. Ltd.* 3. *Andres Vasconcellos J. 2 nd edition. Quality Assurance for the Food industry – A practical approach. 2005, CRC press.*	4. *Inteaz Alli. 1st edition, Food quality assurance - Principles & practices. 2004, CRC Press. New York.* 5. *Sara Mortimore and Carol Wallace. 3rd edition HACCP - A practical approach.2013, Chapman and Hall, London.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	-	*15%*	-	*15%*	-
Level 2	*Understand*	*25%*	-	*20%*	-	*25%*	-
Level 3	*Apply*	*30%*	-	*25%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*25%*	-	*30%*	-
Level 5	*Evaluate*	-	-	*10%*	-	-	-
Level 6	*Create*	-	-	*5%*	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. Sankaran Jagadeesan, VP, Jasmine Concrete Exports, Chennai sankaran.jagadeesan@jasmineindia.com*	1. *Prof. S. Shanmuga Sundaram, IIFPT, Thanjavur - 613 005 sasu@iifpt.edu.in, sasu.iicpt@gov.in*	1. *Dr.R.Preetha, SRMIST*
2. *Krishnamoorthy, Business Head, Food-India, Chennai*	2. *Prof. G. Sarathchandra, TANUVAS, Chennai 600007. sarathchandra.g@tanuvas.ac.in*	2. *Dr.P.Gurumoorthi, SRMIST*

Course Code	21BTE204T	Course Name	ENZYME ENGINEERING AND TECHNOLOGY	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Biotechnology*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*describe the basics of enzyme mechanism, classification and factors affecting enzyme activity*
CLR-2:	*explore the sequential process of the enzyme purification*
CLR-3:	*evaluate the kinetics of enzyme action, inhibition, and regulation*
CLR-4:	*analyze the various methods of enzyme immobilization and evaluate their kinetic efficiency*
CLR-5:	*deliberate the applications of enzymes in various industries*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*recognize the basic nature of enzyme, classification and their mechanism of working*	*2*	-	*2*	-	*2*	-	-	-	-	-	-	-	*2*	-	-
CO-2:	*formulate the succession of enzyme purification and their characterization*	*2*	*2*	*2*	-	*2*	-	-	-	-	-	-	-	*2*	*2*	*2*
CO-3:	*explain various kinetic mechanisms and regulation of enzyme actions*	*3*	*3*	*2*	*2*	*2*	-	-	-	-	-	-	-	*2*	-	-
CO-4:	*analyze the methods of enzyme immobilization and assess the effectiveness of immobilization*	*2*	*2*	*2*	*2*	*2*	-	-	-	-	-	-	-	*2*	*2-*	-
CO-5:	*explore the extent of enzyme applications in various industries*	*2*	-	*2*	*2*	-	-	-	-	-	-	-	-	-	*2*	*2*

Unit-1 - Introduction to Enzymes ***9 Hour***

Chemical nature of enzymes, Characteristics of enzymes, Enzymes and their actions, Mechanism of enzyme action, Structural components of enzymes, Active site of an enzyme, Cofactors and coenzymes, Enzyme commission classification of enzyme, Enzyme-substrate complex formation models - Lock and Key and Induced fit models, Mechanisms of enzyme catalysis, Factors affecting enzyme activity - pH, Temperature, Substrate, Enzyme and Inhibitor concentration, Thermodynamics and stability

Unit-2 - Production and Purification of Enzymes ***9 Hour***

Sources of industrial enzymes - natural and recombinant, Strategies of isolation and purification of new enzymes, large scale industrial enzyme production - technologies for enzyme production, Recovery and purification methods for enzymes, Monitoring of purification of enzymes, Determination of molecular weight of enzymes, Drying and packing, Modification of enzymes - Engineering tools for enzymes

Unit-3 - Enzyme Kinetics. ***9 Hour***

Basics of enzyme kinetics - Michaelis Menten Kinetics, Significance of Michaelis-Menten kinetics, Evaluation of Michaelis-Menten kinetic parameters -Line weaver Burk plot, Hanes Woolf plot and Eadie Hofstee plot, Turn over number, Catalytic efficiency, Enzyme Inhibitors, Types of enzyme inhibition - Competitive inhibition, Uncompetitive inhibition, Noncompetitive inhibition, Substrate inhibition, Feedback inhibition, Enzyme deactivation model, Allosteric activation and inhibition

Unit-4 - Enzyme Immobilization ***9 Hour***

Enzyme immobilization - Advantages and disadvantages, Methods of enzyme immobilization - Physical and chemical, Carrier-based immobilization, Carrier-free immobilization, Immobilization by using porous support - Mass transfer effects and diffusion limitation, Immobilization by using non-porous support - Mass transfer effects and diffusion limitations, Stabilization of immobilized enzymes in an aqueous environment, Stabilization of immobilized enzymes in the non-aqueous environment, Analyzing the effectiveness factor of immobilized enzymes, Advantages and Limitations of immobilized enzyme systems, Types of immobilized enzyme bioreactors.

Unit-5 - Industrial Applications of Enzymes	***9 Hour***
Applications of enzymes - Food processing, Starch and sucrose industries, Dairy industries, Brewing industries, Beverage industries, Leather industries, Textile industries, Detergent industries, Pulp and paper industries, Chemical and Polymer industries. Analytical and Diagnostic applications of enzymes, Role of enzymes - Pharmaceuticals, Medicine, Agriculture, Environment protection and Biofuels development.	

Learning Resources	1. *Trevor Palmer and Philip L Bonner. "Enzymes: Biochemistry, Biotechnology, Clinical Chemistry," East-West Press, 2004.* 2. *Young Je Yoo · Yan Feng Yong Hwan Kim · Camila Flor J. Yagonia. "Fundamentals of Enzyme Engineering" Springer, 2017.*	3. *Syed Tanveer Ahmed Inamdar. "Biochemical Engineering: Principles and Concepts "Third Edition, PHI Learning Pvt. Ltd., 2012*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	-	*15%*	-	*15%*	-
Level 2	*Understand*	*25%*	-	*20%*	-	*25%*	-
Level 3	*Apply*	*30%*	-	*25%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*25%*	-	*30%*	-
Level 5	*Evaluate*	-	-	*10%*	-	-	-
Level 6	*Create*	-	-	*5%*	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. G. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com*	1. *Prof. K Subramaniam, IITM, Chennai, subbu@iitm.ac.in*	1. *Dr. V.Vinothkumar, SRMIST*
2. *Dr. Karthik Periyasamy, Scientist, Biocon karthik.periyasamy@biocon.com*	2. *Prof. R. B. Narayanan, Anna university, Chennai, arbeen09@gmail.com*	2. *Dr. P. Radha, SRMIST*

Course Code	21BTE307T	Course Name	MEMBRANE SEPARATION TECHNOLOGY	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Biotechnology*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*acquire knowledge on membrane and its types cum application*
CLR-2:	*understand the casting and characterization of membrane*
CLR-3:	*analyze the functions of reverse osmosis, Micro and ultra-filtration membranes*
CLR-4:	*discuss the functions of dialysis and electro dialysis membrane*
CLR-5:	*discuss the membranes as reactor and distillation of alcohol*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	Program Outcomes (PO)												Program Specific Outcomes		
		1 Engineering Knowledge	2 Problem Analysis	3 Design/development of solutions	4 Conduct investigations of complex problems	5 Modern Tool Usage	6 The engineer and society	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*apply membranes for bioprocess industries*	*3*	*3*	*3*	*2*	-	-	-	-	-	-	-	-	*2*	-	-
CO-2:	*demonstrate methods of casting membrane*	*2*	*3*	*3*	*2*	-	-	-	-	-	-	-	-	*2*	*2*	*2*
CO-3:	*utilize the selection of membranes for Micro and Macro molecules separation*	*3*	*3*	*3*	*2*	-	-	-	-	-	-	-	-	*2*	*2*	*2*
CO-4:	*apply membrane for dialysis*	*3*	*3*	*3*	*3*	-	-	-	-	-	-	-	-	*3*	*3*	*3*
CO-5:	*demonstrate membrane for distillation and production*	*3*	*3*	*3*	*3*	-	-	-	-	-	-	-	-	*2*	*2*	*2*

Unit-1 - Membranes Overview and its Industrial Application — ***9 Hour***

Basic principles of Membrane, Separation, Membrane developments, Golden age of membranes, Classification of membrane processes-Pressure driven, Concentration gradient, and Electrical potential, Advantages and disadvantages of membranes, Application in Biotechnology Industries, Micro and macromolecular separation, Chemical and Pharmaceutical Industry, Recovery of salt, acid and bases, Food and dairy Industries, Dairy, Animal Products, Fruits and Vegetables, Electrochemical industries, Effluent treatment plants.

Unit-2 - Membrane Casting, Characterization and Modules — ***9 Hour***

Membrane Types, Materials, Preparation and Characterization Types of Synthetic Membranes- Micro porous Membranes, Asymmetric, thin film, Electrically Charged Inorganic Membrane, Membrane Modules-Plate and frame, Tubular, Spiral wound and Hollow fiber, Typical Flow pattern, Membrane Material Pore Characterization, General Methods of Membrane Manufacture-Phase Inversion Method, Track–etching, Sol-gel Peptization Method, Interfacial Polymerization, Melt pressing, Film Stretching, Film Stretching, Ion Exchange Membrane Preparation

Unit-3 - Reverse Osmosis, Ultra and Microfiltration — ***9 Hour***

Reverse Osmosis, Nano filtration, Ultra filtration, and Microfiltration, Concept of osmosis, Determination of osmotic pressure and thermodynamics of osmosis, Phenomena of Reverse osmosis, Models of Reverse osmosis, Design and operating parameters, Design of Reverse Osmosis module Principles, Transport Mechanism, Mass transfer and Industrial Application of Nano filtration Process Limitation Basic principles of Ultra filtration Types of Ultra filtration Factors affecting Ultra filtration and membrane flux of ultra-filtration, Principles of Microfiltration, Microfiltration Membranes, Mechanism of Transport, Flow characterization, Fouling and applications in Microfiltration, Energy Consideration and Application, Flow characterization, Fouling and applications in Microfiltration, Energy Consideration and Application

Unit-4 - Dialysis and Pervaporation — ***9 Hour***

Dialysis, pervaporation and electro dialysis, Principles of Dialysis, Dialysis membranes, Mass transfer in dialysis, Design of Dialysis membranes Applications and its advantages. Principles, Operation of Pervaporation, Application of Pervaporation, Design of pervaporation modules, Factors affecting pervaporation, Applications. Principles of Electro dialysis, Ion Exchange Membranes Energy Requirements Current utilization and Efficiency, Dialysis, Application, Batch electro- dialysis, Continuous electro- dialysis,

Unit-5 - Membrane Distillation, Membrane Reactors and Chromatography,	***9 Hour***
Membrane distillation, Membrane bioreactors and industrial membranes, Membrane contactors, Principles Advantages and Disadvantages, Applications. Membrane Distillation Mechanism, Membrane recycles bioreactors, Plug flow bioreactors, Perstraction- Flux and separation in Perstraction Membrane Chromatography Design and application, Membranes in Wastewater Treatment Design and Application, Membrane in Desalination, Membrane in in Fuel cells ,Biomedical application of membranes, Blood Oxygenator and Drug Delivery.	

Learning Resources	1. *Kaushik Nath," Membrane Separation Processes", PHI, publication, India, 2012.* 2. *William.K..Wang," Membrane Separations in Biotechnology", Marcel Dekker. INC, New York, 2001* 3. *Scott .K, "Hand Book of Industrial Membranes "Elsevier Publication, 1995.*	4. *Mihir K Purkait; Randeep Sing,"Membrane Technology in separation science, CRC Press Taylor & Francis Group, 2018* 5. *Katarzyna Staszak, Karolina Wieszczycka and Bartosz Tylkowski," Membrane Technologies from Academia to Industries, De Gruyter, 2022*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	*-*	*15%*	*-*	*15%*	*-*
Level 2	*Understand*	*25%*	*-*	*20%*	*-*	*25%*	*-*
Level 3	*Apply*	*30%*	*-*	*25%*	*-*	*30%*	*-*
Level 4	*Analyze*	*30%*	*-*	*25%*	*-*	*30%*	*-*
Level 5	*Evaluate*	*-*	*-*	*10%*	*-*	*-*	*-*
Level 6	*Create*	*-*	*-*	*5%*	*-*	*-*	*-*
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. S. Sam Gunasekar, Orchid Chemicals and Pharmaceuticals Ltd., sam@orchidpharma.com*	1. *Dr.G.Pugazhenthi, IITG, pugal@iitg.ac.in*	1. *Dr.M.Venkatesh Prabhu, SRM IST*
2. *Dr. Karthik Periyasamy, Scientist, Biocon, karthik.periyasamy@biocon.com*	2. *Dr.S.Senthil Kumar, IITG, senthilkumar@iitg.ac.in*	2. *Dr.S.Prabhakar SRMIST*

Course Code	21BTE308T	Course Name	INDUSTRIAL FERMENTATION ENGINEERING	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Biotechnology*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*analyze the fundamental behind the need of aseptic strain development*
CLR-2:	*explore the importance of Isolation and Screening of Industrially Important Microorganisms*
CLR-3:	*decipher an understanding on the production of various primary metabolites from microbial fermentation*
CLR-4:	*comprehend the importance and production of secondary metabolites with commercial significance*
CLR-5:	*apprehend the biochemical transformation in the production of recombinant protein with medical importance*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*accomplish knowledge on improvement of strain development for primary and secondary metabolites*	*2*	*2*	*2*	-	-	-	-	-	-	-	-	-	*3*	-	*3*
CO-2:	*explain the upstream and Downstream fermentation process of organic acids and amino acids*	*2*	*2*	*2*	-	-	-	-	-	-	-	-	-	*3*	-	*2*
CO-3:	*describe the industrial scale methodologies for Antibiotic and microbial enzyme production*	*2*	*2*	*2*	-	-	-	-	-	-	-	-	-	*3*	-	*2*
CO-4:	*understand the enzyme biotransformation bio stratergies and recombinant protein production with commercial and medical importance*	*2*	*2*	*2*	-	-	-	-	-	-	-	-	-	*3*	-	*2*
CO-5:	*apprehend the food fermentation process and its preservatives used for improving the shelf period*	*2*	*2*	*2*	-	-	-	-	-	-	-	-	-	*3*	-	*3*

Unit-1 - Industrial Fermentation Technology	***9 Hour***
Industrial fermentations, Types of fermentation process, Microbial growth metabolism, maintenance, and preservation of microbial starter cultures , Microbial metabolites, Strain development, Aseptic inoculation of plant fermenters, Measuring process variables, Product development, Hazard Analysis and Critical Control Point (HACCP) Program – Good manufacturing Practices(GMP's) and microbiological standards.	
Unit-2 - Production of Primary Metabolites	***9 Hour***
Strategies and methods for production of organic acids fermentation: Citric acid, Lactic acid, Acetic acid, gluconic acid, Amino acids fermentation: L-glutamic acid, L-lysine, L-tryptophan, L-valine, Solvents fermentation: Acetone, Butanol, Ethanol, Vitamins production: Cyanaocobalamin, Riboflavin.	
Unit-3 - Production of Secondary Metabolites	***9 Hour***
Strategies and methods for production of industrial enzyme production - Protease, Lipase, Cellulase, Biopolymers fermentation: Xanthan gum, Polyhydroxyalkanoates, Agrochemicals production –Siderophores, Bacillus thuringenesis Cry protein, Artemisinin, Antibiotic production – Avermectin, Streptomycin, Erythromycin, Nystatin.	
Unit-4 - Production of Biologicals	***9 Hour***
Design and properties of different types of protein drugs, eg. Antibodies, antibody analogues, hormone, Use of different engineering methods to design new / optimized variants. Strategies and methods for production of biologicals, eg. Insulin, Interferon, monoclonal antibody, tumor necrosis factor inhibitor, human granulocyte colony-stimulating factor, Pneumococcal conjugate vaccine.	
Unit-5 - Food and Alcohol Fermentations	***9 Hour***
Probiotics, Fermenting with lactic acid bacteria: pickles, sauerkraut, yogurt, and fresh cheese, Soy-based fermented products, Food preservative fermentation: Nisin, bacteriocins, Food colorants fermentation: Monascus pigments, Carotenoid, Astaxanthin Production, Production of single cell protein, Beverages - Brewing process with microbial communities: Wine, Cider, beer, sourdough, kefir and kombucha	

Learning Resources	1. *Cruger W., Cruger A., Aneja K.R., "Biotechnology: A Textbook of Industrial Microbiology", Medtech Publishing, 3rd edition, 2017.* 2. *Lee Y.K., "Microbial Biotechnology: Principles and Applications", World Scientific Publishing, 3rd edition, 2013.* 3. *Waites M. J., Morgan N.L., Rockey J.S., Higton G., "Industrial Microbiology: An Introduction", Blackwell Science, 2013*	4. *Saran S., Babu V., Chuabey A., "High Value Fermentation Products: Human Health", Scrivener Publishing, 2019* 5. *Stanbury. P.F., Whitaker. A., Hall. S.J., "Principles of Fermentation Technology", 3rd Edition, Butterworth– Heinemann, 2016*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	-	*15%*	-	*15%*	-
Level 2	*Understand*	*25%*	-	*20%*	-	*25%*	-
Level 3	*Apply*	*30%*	-	*25%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*25%*	-	*30%*	-
Level 5	*Evaluate*	-	-	*10%*	-	-	-
Level 6	*Create*	-	-	*5%*	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. S. Sam Gunasekar, Orchid Chemicals and Pharmaceuticals Ltd., sam@orchidpharma.com*	1. *Prof. K Subramaniyam, IITM, Chennai, suubu@iitm.ac.in*	1. *Dr. Vinoth Kumar, SRMIST*
2. *Dr. Karthik Periyasamy, Scientist, Biocon, karthik.periyasamy@biocon.com*	2. *Dr. R. B Narayanan Anna University, Chennai,arbeen09@gmail.com*	2. *Dr. Amala Reddy, SRMIST*

Course Code	21BTE410T	Course Name	BIOREACTOR DESIGN	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Biotechnology*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*teach conservation of mass and energy in the bioreactor system*
CLR-2:	*explain the mechanical aspects of reactor design*
CLR-3:	*demonstrate the scale up in bioreactor*
CLR-4:	*explain the biochemical aspects of reactor design*
CLR-5:	*teach Modeling, CFD and design of novel reactors*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*practice conservation of mass and energy in the bioreactor system*	2	2	2	-	-	-	-	-	-	-	-	-	2	2	-
CO-2:	*explain the mechanical aspects of reactor design*	2	2	2	-	-	-	-	-	-	-	-	-	2	2	2
CO-3:	*discuss the scale up in bioreactor*	2	2	2	-	-	-	-	-	-	-	-	-	2	2	2
CO-4:	*practice the biochemical aspects of reactor design*	2	3	3	2	-	-	-	-	-	-	-	-	2	2	2
CO-5:	*demonstrate Modeling, CFD and design of novel reactors*	2	3	3	2	-	-	-	-	-	-	-	-	2	2	2

Unit-1 - Mass and Energy Balance in Bioreactor ***9 Hour***

Elements in Bioreactor Design, Rate Expression in Biological Systems, Basic Concept of Energy Transfer, Basic Concept of Mass Balance, Classification of Bioreactors, Bioreactors for Animal Cell Cultivation, Bioreactors for Plant Cell Culture, Bioreactors for Immobilized System

Unit-2 - Mechanical Aspects of Bioreactor Design ***9 Hour***

Requirements for Construction of a Bioreactor, Guidelines for Bioreactor Design, Bioreactor Vessels, Agitator Assembly

Unit-3 - Scaleup of Bioreactors and Operation ***9 Hour***

Criteria of Scale-Up, Similarity Criteria, Scale-Up Methods, Generalized Approaches to Scale-Up in Combination of Methods, Common Operations of Bioreactor, Selection, Identification of Other Common Factors Necessary for Smooth Operation of Bioreactors, Spectrum of Basic Bioreactor Operations, Reactor Operation for Immobilized Systems, Operation of Animal Cell Bioreactors, Operation of Bioreactors for Plant Cell Culture, Reactors for Waste Management

Unit-4 - Biochemical Aspects of Reactor Design ***9 Hour***

Batch Bioreactors, Continuous Flow Bioreactors, Plug Flow Tubular Reactor (PFTR), Recycle Bioreactors, Combination of Bioreactors, Semi-Continuous Bioreactors, Input to Kinetic Modeling of Enzyme Reactors

Unit-5 - Reactor Modeling ***9 Hour***

Modeling Principles, Fundamental Laws Used in Process Modeling, First-Order Systems, Second-Order Systems, Complexity of the Model, Case Studies-Design of Packed Bed Bioreactor, Airlift Bioreactors, Hollow Fiber Bioreactor (HFBR), Plant Cell Bioreactor, Design of Bioreactors for Solid State Fermentation (SSF), Mammalian Cell Bioreactor Design, CFD in Bioreactor Design-Modeling approaches, Dimensionality of simulation, Difference between Lagrangian and Eulerian approaches, Fluid Dynamic Modeling, Simulation

Learning Resources	1. B.Atkinson.,"Biochemical Reactors",Pion limited,London,1974 2. Panda.T., "Bioreactors: Analysis and Design", McGraw Hill Education (India) PvLtd ,2011 3. Riet. K.V.,Tramper. J. "Basic Bioreactor Design", 2nd ed.,Marcel Dekker, Inc., New York, 1991	4. Shijie Liu,"Bioprocess Engineering Kinetics, Sustainability, and Reactor Design"Elsevier, 2020. 5. Enes Kadic, Theodore J. Heindel,"An Introduction to Bioreactor Hydrodynamics and gas -liquid mass transfer, John Wiley & Sons, 2014

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. S. Sam Gunasekar, Orchid Chemicals and Pharmaceuticals Ltd., sam@orchidpharma.com	1. Dr.S.Senthil Kumar, IITG, senthilkumar@iitg.ac.in	1. Dr.M.Venkatesh Prabhu, ,SRMIST
2. Dr. Karthik Periyasamy, Scientist, Biocon, karthik.periyasamy@biocon.com	2. Dr.N.Selvaraj, IITG, selva@iitg.ac.in	2. Dr.P.Radha, SRMIST

Course Code	21BTE411T	Course Name	BIOPROCESS MODELLING AND SIMULATION	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Biotechnology*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*describe the importance of models, models for Mass and Energy Balance*
CLR-2:	*explain models of upstream and downstream process*
CLR-3:	*demonstrate the development of Process flow sheet using software*
CLR-4:	*explain MATLAB fundamentals, and application of Numerical Integration in MATLAB*
CLR-5:	*describe modelling and simulation in bioreactors using MATLAB and SIMULINK*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*discuss the importance of models, models for Mass and Energy Balance*	*2*	*2*	*2*	-	-	-	-	-	-	-	-	-	*3*	*2*	-
CO-2:	*demonstrate models for upstream and downstream process*	*2*	*2*	*2*	-	-	-	-	-	-	-	-	-	*3*	*2*	-
CO-3:	*develop process flowsheet using software*	*2*	*2*	*3*	-	-	-	-	-	-	-	-	-	*3*	*2*	*2*
CO-4:	*explain MATLAB fundamentals*	*2*	*2*	*3*	-	-	-	-	-	-	-	-	-	*3*	*2*	*2*
CO-5:	*develop programme for reactors using MATLAB*	*2*	-	*3*	-	-	-	-	-	-	-	-	-	*3*	*2*	*2*

Unit-1 - Modelling Fundamentals and Models of Mass and Energy Balance ***9 Hour***

Models - Introduction, Basic modeling principles, Introduction of mathematical modeling, Uses of mathematical modeling, Classification of modeling techniques, Grouping of models into opposite pairs, Classification based on Mathematical complexity, Classification of models according to scale Fundamental laws – Expression, Energy equations - expression , Continuity equations, Transport equations -expression , Equations of motion, Chemical kinetics

Unit-2 - Models of Upstream and Downstream Process ***9 Hour***

Basic Mathematical Models, Setting up a model, Continuous flow tanks - enclosed vessel, Continuous flow tanks - mixing vessel, Steam jacketed vessel Steam jacketed vessel - open and closed, Batch distillation – basics, Batch distillation model, Bioprocess modeling, Modelling approaches for biomanufacturing, Operations, Types of bioprocess model, Mathematical models of microbial process, Applying mechanistic models in bioprocess development, Model formulation for aerobic cultivation of budding yeast, Parameter identifiable analysis ,Uncertainty analysis, Metabolic flux modelling (MFM),MFM as a tool to analyze the behavior of genetically modified yeast strain

Unit-3 - Process Flow Sheeting and Process Economics using Intelligence Software ***9 Hour***

Introduction to Superpro, Developing a Process Model, Process design, Process Modeling and Simulation, Process flow diagrams, Process flow diagram to produce human insulin, The -Galactosidase Process, The Industrial Wastewater Treatment Process, Procedures and Operations, Resources, Scheduling, Process Properties and Simulation, Economics, Material-Balance Calculations, Material-Balance , Energy-Balance Calculations, Energy-Balance

Unit-4 - MATLAB and Numerical Integration ***9 Hour***

MATLAB - Introduction, MATLAB - basics, MATLAB - Data analysis, Curve fitting - Introduction, Curve fitting using MATLAB - Theory, Curve fitting using MATLAB – examples, Numerical Integration, Numerical Integration Techniques, Trapezoidal Rule, Trapezoidal Rule ,Simpson's Rule, Euler's Method, Runge-Kutta 4th Order Method, Programming with MATLAB, Program design and development

Unit-5 - MATLAB and SIMULINK in Bioreactors	***9 Hour***
Modeling of Batch Culture Using MATLAB – basics, Batch Culture – programme, Modeling of Fed-batch Culture Using MATLAB – basics, Fed-batch Culture – programme, ,Modeling of Continuous Culture Using MATLAB – basics, Continuous Culture – programme, ,Process Simulation, Simulink - Introduction, Simulink - basics, Simulation of gravity flow tank, Simulation of three isothermal CSTR, Simulation by Simulink in Batch Culture, Simulation by Simulink in fed-batch Culture, Simulation by Simulink in continuous Culture	

Learning Resources	1. *Mandenius C., Titchener-Hooker N. J., "Measurement, Monitoring, Modelling and Control of Bioprocesses", Springer Publishers, 2013.* 2. *Burstein L., "Matlab® in Bioscience and Biotechnology, Woodhead Publishing, 2011.* 3. *Luben. W.L., "Process Modelling Simulation and Control for Chemical Engineers", McGrawHill, 1990.* 4. *Franks. R.G.E., "Mathematical Modeling in Chemical Engineering", John Wiley and Sons, Inc., 2004.*	5. *Biquette. W.B., "Process Dynamics- Modeling analysis with simulation", Prentice Hall; 1 edition, 1998.* 6. *Beers. K.J., "Numerical Methods for Chemical Engineering Applications in MATLAB®",Massachusetts Institute of Technology, Cambridge University press. 2007. www.intelligen.com/ SuperPro Designer user guide.* 7. *Ashok Kumar Verma," Process Modelling and Simulation in Chemical, Biochemical and Environmental Engineering" CRC Press, 2015.* 8. *Joseph DiStefano," Dynamic Systems Biology Modeling and Simulation" ,Academic Press, 2013*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	-	*15%*	-	*15%*	-
Level 2	*Understand*	*25%*	-	*20%*	-	*25%*	-
Level 3	*Apply*	*30%*	-	*25%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*25%*	-	*30%*	-
Level 5	*Evaluate*	-	-	*10%*	-	-	-
Level 6	*Create*	-	-	*5%*	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. S. Sam Gunasekar, Orchid Chemicals and Pharmaceuticals Ltd., sam@orchidpharma.com*	1. *Dr.S.Senthil Kumar, IITG, senthilkumar@iitg.ac.in*	1. *Dr.M.Venkatesh Prabhu, ,SRMIST*
2. *Dr. Karthik Periyasamy, Scientist, Biocon, karthik.periyasamy@biocon.com*	2. *Dr.N.Selvaraj, IITG, selva@iitg.ac.in*	2. *Dr.P.Radha, ,SRMIST*

Course Code	21BTE412T	Course Name	BIOPROCESS PLANT DESIGN	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Biotechnology*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*describe the Process Flow Sheeting*
CLR-2:	*explain the Material of Selection for Process design*
CLR-3:	*teach Economic Analysis of Process Industries*
CLR-4:	*describe Optimization of Process Variables*
CLR-5:	*explain the Design of Process equipment*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*execute the Process Flow Sheeting*	*2*	*3*	*2*	*2*	-	-	-	-	-	-	-	-	*2*	-	*2*
CO-2:	*discuss the Material of Selection for Process Design*	*2*	*3*	*2*	*2*	-	-	-	-	-	-	-	-	*2*	-	*2*
CO-3:	*evaluate the Cost involved in the Process Industries*	*2*	*3*	*3*	*2*	-	-	-	-	-	-	-	-	*2*	*2*	-
CO-4:	*optimize the process variables*	*2*	*3*	*3*	*2*	*2*	-	-	-	-	-	-	-	*2*	*2*	-
CO-5:	*execute the Design of Reactors*	*2*	*3*	*3*	*2*	*2*	-	-	-	-	-	-	-	*2*	*2*	-

Unit-1 - Process Flowsheet Development	***9 Hour***
Organization of a Bioprocess Engineering Project, Project Documentation, Codes and Standards, Design Factors, Product Design Flowsheet Presentation, Anatomy of a Manufacturing Process, Selection, Modification, and Improvement of Commercially-Proven Processes, Selection, Modification, and Improvement of Commercially-Proven Processes.	
Unit-2 - Materials of Construction	***9 Hour***
Material Properties, Mechanical Properties, Corrosion Resistance, Selection for Corrosion Resistance, Material Costs, Commonly Used Materials of Construction, Mechanical Design of Piping Systems, Pipe Size Selection	
Unit-3 -Process Economics	***9 Hour***
Capital Cost Estimating, Estimating Revenues and Production Costs, Economic Evaluation of Projects	
Unit-4 – Optimization	***9 Hour***
Optimization in Design-The Design Objective, Optimization of a Single Decision Variable, Optimization of Two or More Decision Variables,	
Unit-5 - Equipment Design	***9 Hour***
Equipment Selection, Specification, and Design, The Design of Thin-Walled Vessels Under Internal Pressure, Reactor Design: General Procedure, Design of Bioreactors, Computer Simulation of Reactors	

Learning Resources	1. *Towler G., Sinnott R., "Chemical Engineering Design - Principles, Practice and Economics of Plant and Process Design, Elsevier, 2007.* 2. *Subhabrata Ray; Gargi Das," Process Equipment and Plant Design",Elsevier, 2020.* 3. *Siddhartha Mukherjee," Process Engineering and Plant Design",CRC Press,2022.*	4. *Jacobs T., Signore A. A., "Good Design Practices for GMP Pharmaceutical Facilities", 2nd edition, Taylor, and Francis, 2017.* 5. *Peters M. S., Timmer Haus. K. D., "Plant Design and Economics for Chemical Engineers", 5th Edition, McGraw-Hill Book Co., 2003*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	-	*15%*	-	*15%*	-
Level 2	*Understand*	*25%*	-	*20%*	-	*25%*	-
Level 3	*Apply*	*30%*	-	*25%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*25%*	-	*30%*	-
Level 5	*Evaluate*	-	-	*10%*	-	-	-
Level 6	*Create*	-	-	*5%*	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. S. Sam Gunasekar, Orchid Chemicals and Pharmaceuticals Ltd., sam@orchidpharma.com*	1. *Dr.S.Senthil Kumar, IITG, senthilkumar@iitg.ac.in*	1. *Dr.M.Venkatesh Prabhu, ,SRMIST*
2. *Dr. Karthik Periyasamy, Scientist, Biocon, karthik.periyasamy@biocon.com*	2. *Dr.N.Selvaraj, IITG, selva@iitg.ac.in*	2. *Dr.P.Radha, ,SRMIST*

Course Code	21BTE205T	Course Name	ENVIRONMENTAL BIOTECHNOLOGY	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Biotechnology*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*create awareness on environmental pollution and the need for advanced technologies for their mitigation*
CLR-2:	*provide the in-depth insights on recent advancements in biological approach for the conversion of various environmental pollutants*
CLR-3:	*understand the microbial degradation pathways and interventions of genetic engineering in emerging contaminates removal*
CLR-4:	*understand various biotechnological contributions to the industries to reduce the environmental pollution*
CLR-5:	*educate the relevant information about recovery of bio- and by-products from industrial wastes and environmental policies*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*discuss the global impact of environmental pollutants and the current scenario of treatment*	-	3	-	-	-	-	2	-	-	-	-	-	2	-	3
CO-2:	*demonstrate biotechnological solutions for the treatment of industrial wastes*	2	-	3	2	-	-	3	-	-	-	-	-	-	2	3
CO-3:	*explain the bioconversion pathways for the degradation of various xenobiotic compounds*	2	2	-	2	-	-	3	-	-	-	-	-	2	-	3
CO-4:	*evaluate the biotechnological interventions on emerging contaminates removal and application of computing technologies for environmental management*	2	2	2	-	-	-	2	-	-	-	-	-	2	-	3
CO-5:	*choose from an array of options to turn waste into economic goods and learn environmental policies*	-	2	2	-	-	-	3	-	-	-	-	-	2	-	3

Unit-1 - Current Scenario of Environmental Pollution and Physicochemical Technologies ***9 Hour***

Environmental pollution Current Scenario-water, air, soil; Perspectives of liquid and solid wastes; Design of wastewater treatment systems- Primary, secondary and tertiary treatments; Physicochemical technologies for the liquid waste management; Coagulation, Flocculation, Sedimentation, Filtration -mechanism-Membrane Technologies: Ultra filtration, Reverse Osmosis ; Adsorption processes-Activated Carbon, Ion Exchange; Advanced oxidation processes; Electrolysis; Desalination for wastewater-Membrane distillation, Forward Osmosis, Pressure Retarded Osmosis; Solid waste management-Effects- Secured Landfill, Bacterial and Vermi composting, incineration/pyrolysis; 4R Principle; Air pollution Management-CO2 sequestration, Odour Control;

Unit-2 - Recent Advances in Biological Treatment of Wastewater ***9 Hour***

Recent trends in Biological wastewater treatment; Conversion processes of the carbonaceous and nitrogenous matters; Effluent standards; Aerobic Suspended-Growth Treatment: Biological Kinetics; activated sludge process and its process modifications, Process design considerations, Cyclic Activated Sludge process; Membrane Bioreactor; Sequencing batch reactor; Fluidized bed reactor. Modeling of Suspended Growth Treatment Processes-CSTR; Activated Sludge Principles; Key Process Control Parameters: Mean Cell Resident Time, Food-to-Microorganism (F/M) ratio, Anaerobic digestion process-Stages; Microbiology of anaerobic digester; Factors influencing anaerobic digestion; Anaerobic Biological treatment technologies: Completely mixed anaerobic digestion process; Upflow Anaerobic sludge blanket (UASB) reactor; Two phase AD process, Anaerobic filter; Tertiary treatment: Nutrients removal-N and P removal; Attached-Growth system: Trickling filters;Rotating biological contractors; Packed bed reactors; Integrated fixed film activated sludge process:

Unit-3 - Emerging Environmental Pollutants and Biodegradation Pathways	***9 Hour***
Xenobiotics and Recalcitrants; Environmental effects of Xenobiotics and recalcitrants; Biodegradation of xenobiotics; Mechanisms of Biodegradation of xenobiotics-Reductive/Oxidative/Hydrolytic; Biotransformation of Aliphatic, Aromatic, polyaromatic and polycyclic aromatic Hydrocarbons; Biotransformation of halogenated hydrocarbons; Case studies-Oil pollution and its effect on the environment; Microbial treatment of oil pollution; Microbial treatment of polychlorinated compounds; Radioactive waste and e-waste management-Recent biotechnological advances; Genetic Engineering in environmental pollution management	
Unit-4 - Computing Technologie Application in Environmental Management	***9 Hour***
Biotechnological interventions in Industrial processing and effluent treatment; Environmental Biocatalysts and Biosurfactants in environmental and industrial applications and emerging contaminants removal; Advantages of immobilized cells and enzymes over free cells and enzymes; Microbial heavy metal removal-mechanisms; Role of biosurfactants, Extracellular polysaccharides, Metallothioniens and siderophores in heavy metal removal; Challenges in lipid rich industrial effluents treatment-Application of immobilized lipase and biosurfactant; Biotechnology in Textile industry and dye removal; Bioelectrochemical technologies for wastewater treatment; Application of IOTs and AI in Environmental pollution monitoring and automization of ETPs and CETPs	
Unit-5 - Industrial Wastes as Resources for Value-Additions and Environmental Policies	***9 Hour***
Value additions from industrial wastes-Circular economy concepts-Leather industry wastes; Slaughterhouse industry; Plastics and microplastics; Bioplastics from industrial resources; Biomining-Microbial metal leaching-methods; Environmental laws and regulations; Environmental Impact Assessment; Role of State and Central Pollution Control Boards and Environmental protection Agency in pollution control; Indian Government schemes for the environmental cleanup- Swachh Bharat Abhiyan	

Learning Resources	1. *Bruce E.Rittmann and Perry L.McCarty, Environmental Biotechnology: Principles and Applications, McGraw Hill.2001.* 2. *Macros Von Sperling, Basic principles of wastewater treatment. IWA Publishing, 2007* 3. *Sergio et al. Sea water reverse osmosis desalination, IWA publishing, 2021* 4. *Bimal C Bhattacharyya, Environmental Biotechnology, Oxford University press, 2007.* 5. *Milton Wainwright, an Introduction to Environmental Biotechnology, Springer, 1999.* 6. *P.Rajendran, P.Gunasekaran, Microbial Bioremediation, MJP Publishers, India, 2006.* 7. *Online NPTEL Course: Environmental Biotechnology*	8. *Ram Chandra, Advances in biodegradation and bioremediation of industrial wastes, CRC Press, Taylor&Francis, 2015.* 9. *Hanes Joachim Joardening, Environmental Biotechnology, Concepts and Applications, 2017.* 10. *Navaneitha Krishnaraj and Sani, Biovalorization of wastes to renewable chemicals and biofuels, Elsevier, 2020* 11. *Rathinam and Sani, Next generation biomanufacturing Technologies, ACS Symposium series, ACS Publications, 2019* 12. *https://onlinecourses.nptel.ac.in/noc21_bt41/preview*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	-	*15%*	-	*15%*	-
Level 2	*Understand*	*25%*	-	*20%*	-	*25%*	-
Level 3	*Apply*	*30%*	-	*25%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*25%*	-	*30%*	-
Level 5	*Evaluate*	-	-	*10%*	-	-	-
Level 6	*Create*	-	-	*5%*	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. S. Sam Gunasekar, Orchid Chemicals and Pharmaceuticals Ltd., sam@orchidpharma.com*	1. *Dr.G.Sekaran. CSIR-, Chennai, ganesansekaran@gmail.com*	1. *Dr. K.Ramani,SRMIST*
2. *Mr. D.K.Rana, Heubach Colour Pvt.Ltd.Gujarat, ankplant@heubach-india.com*	2. *Dr. Kurian Joseph., Anna University, Chennai,ccdm.au@gmail.com*	2. *Dr. W.Richard Thilagaraj, SRMIST*

Course Code	21BTE309T	Course Name	INDUSTRIAL WASTE MANAGEMENT	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Biotechnology*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*identify the relevant information about industrial solid waste reduction and hazardous waste management*
CLR-2:	*demonstrate the state of the art in technology, organizational and legislative developments and practices*
CLR-3:	*adapt the concepts of environmental regulation and inculcate in newly developed treatment technologies*
CLR-4:	*create insights to the waste characterization aspects*
CLR-5:	*identify the applications of best possible conversion technology for industrial sustainability]*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*formulate an insight into the pollution from major industries including the sources and characteristics of pollutants and their impact on climate change*	-	*3*	-	*2*	-	-	*2*	-	-	-	-	-	*3*	-	*2*
CO-2:	*apply the biotechnological solutions for the industrial waste management and resource generation*	*3*	-	*3*	*2*	-	-	-	-	-	-	-	-	-	-	*2*
CO-3:	*analyze the impact of industrial wastes on the environmental compartments (land, water and air) and elucidate the mode of monitoring through recent technological innovations*	*3*	*2*	*2*	-	*2*	-	-	-	-	-	-	-		*2*	*3*
CO-4:	*evaluate the waste and wastewater for its toxicity and design of the treatment plants to attain standard limits prescribed by pollution control board*	-	-	*3*	*2*	*2*	-	*2*	-	-	-	-	-	*2*	-	*2*
CO-5:	*explain the stringent environmental regulations and legal aspects in generation, management, and processing of Industrial wastes*	-	-	-	*2*	-	*2*	*2*	*2*	-	-	-	-	*2*	*3*	-

Unit-1 - Paradigm Shifts in Industrial Development and its Consequences — ***9 Hour***

Evolution of Industries 20th Century to 21st Century for Economic Development - Raw materials from natural resources and synthetic precursors employed in industries - Process flow of industries that use hazardous chemicals and reagents - Xenobiotics and recalcitrants - Environmental impacts - Threat to biodiversity - Climate Change - Mitigation strategies for efficient waste management

Unit-2 - Waste Circular Bio Economy — ***9 Hour***

Industrial Wastes as Resource Generation for Fuel, Chemicals and Value Products - Emphasis on major role of Manufacturing and Process Sectors-Paper and Pulp, Tannery, Poultry industry, Food and Agro-based industries - Hierarchy of Potential Implementation of waste management Strategies - 4R Principles - Landfill and leachate management strategies-Biorefinery concepts-for value additions from wastes-Desalination-Membrane processes (Reverse osmosis, Electrodialysis), Distillation processes (Single/multi stage flash distillation, vapour compression distillation), Low temperature thermal desalination process

Unit-3 - Waste Management 4.0 — ***9 Hour***

An adoption of Industry 4.0 concepts (AI, BigData and Blockchain on sustainable waste management and audits - Role of Environmental (Bio-)sensors in monitoring and assessment - Characteristics of industrial wastewater-COD, BOD and TOC - Solids analysis – TDS, TSS and VSS - Characteristics of industrial wastewater-, TKN, Ammonia, Chloride, Sulfide and Sulfate - Remote monitoring and Human-less/Robotic treatment plant operation

Unit-4 - Management for Hazardous and Health Risk (Pandemic like) related Industrial Wastes and Wastewater — ***9 Hour***

Hazardous waste management; Biomedical waste- Physio chemical treatment - Solidification and incineration – Zero discharge - Secure landfills - Removal of refractory organics-strategies -AOP processes- Primary, Secondary and Tertiary Treatment-Aerobic and Anaerobic Technologies-Role of microorganisms and enzymes - Application of nanotechnology for waste degradation - Bioelectricity production through Microbial fuel cells with hazardous leachate and wastewater

Unit-5 - Regulatory Affairs for Industrial Waste Management in Compliance to Global Scenario	***9 Hour***
Global and Indian Scenario Environmental Management System (EIA), Environmental Impact Assessment (EIA), ISO 14000 Environmental Auditing; Sustainable Development Goals (SDGs) for industrial sustainability, Life Cycle Assessment (LCA), International Organization for Standards (ISO), Green Tribunal Act (GTA) and Occupational Safety and Health Association (OSHA)]	

Learning Resources	1. *Guide for Industrial Waste Management by Environment Protection Agency (EPA), 2022* 2. *Waste Management Practices Municipal, Hazardous, and Industrial, Second Edition By John Pichtel, CRC Press* 3. *Macros Von Sperling, Basic principles of wastewater treatment. IWA Publishing, 2007*	4. *Sergio et al. Sea water reverse osmosis desalination, IWA publishing, 2021* 5. *Sawyer et al. Chemistry for Environmental Engineering and Science, 5th Edition, McGraw-Hill Education Online Resources:* 6. *https://www.udemy.com/course/waste-management-in-industry-4/]*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	-	*15%*	-	*15%*	-
Level 2	*Understand*	*25%*	-	*20%*	-	*25%*	-
Level 3	*Apply*	*30%*	-	*25%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*25%*	-	*30%*	-
Level 5	*Evaluate*	-	-	*10%*	-	-	-
Level 6	*Create*	-	-	*5%*	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. S. Sam Gunasekar, Orchid Chemicals and Pharmaceuticals Ltd., sam@orchidpharma.com*	1. *Dr.G.Sekaran, CSIR, Chennai ganesanskaran@ygmail.com*	1. *Dr.K.Ramani, SRMIST*
2. *Mrs. Aarathi Nandhakumar, Sustainability and Environment Management, JSW Steels, Vijayanagar, Karnataka.*	2. *Dr. Surajbhan Sevda, NIT Warangal, sevdasuraj@nitw.ac.in*	2. *Dr.B.Samuel Jacob, SRMIST*

Course Code	21BTE310T	Course Name	BIOENERGY	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Biotechnology*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*classify the potent biomass resources based generations (1G-4G) for energy production]*
CLR-2:	*ascertain the applications of energy conversion technology]*
CLR-3:	*demonstrate the significance of environmental benefits of bioenergy]*
CLR-4:	*create insights to the concepts of sustainable and green technologies]*
CLR-5:	*analyze the important wastes to energy conversion]*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*formulate the appropriate biofuel production based on available feedstocks]*	-	*3*	-	*2*	-	-	*2*	-	-	-	-	-	*3*	-	*2*
CO-2:	*apply the biotechnological solutions for waste to fuel conversion]*	*3*	-	*3*	*2*	-	-	-	-	-	-	-	-	-	-	*2*
CO-3:	*employ synthetic routes for ease and fast biofuel production]*	*3*	*2*	*2*	-	*2*	-	-	-	-	-	-	-	-	*2*	*3*
CO-4:	*evaluate the substituent possibility of biofuel for conventional use]*	-	-	*3*	*2*	*2*	-	*2*	-	-	-	-	-	*2*	-	*2*
CO-5:	*create novel biofuel formulation to adapt to the National policy towards energy security]*	-	-	-	*2*	-	*2*	*2*	-	-	-	-	-	*2*	*3*	-

Unit-1 - Energy in Past, Present and Future — ***9 Hour***

Non-renewable Resources (Fossil fuel) - Oil-The Black Gold for Global Economic driver and factor of slow down-Alternate and renewable resources (Solar, wind and biomass based)- Consequences of Burning Fossil Fuel- Mitigation of Global Warming- Political Drivers for Biofuel Development- Potential Benefits of Replacing Fossil Fuels with Biofuel, Biomass and Biogas- Circular & Biobased Economy-Is E-vehicles a boon or bane?

Unit-2 - Renewable Carbon from Bioresources: An outlook on Different Generations — ***9 Hour***

Transition of 'Bioenergy' from a mere term 'biomass' to microbial driven energy production-Basics of biomass conversion technology (Resources and Technology perspective)-Factors to be considered as an energy crop- Food Vs Fuel vs. feed- Rationale of biomass power sustainable environment- First, Second, Third and Fourth Generation Biofuel feedstock

Unit-3 - Integrating Bio Energy with Industrial Process with Circular Bio Economy — ***9 Hour***

Agro waste resources – Crop residues and by-products - Waste resources – Industrial (solid and liquid) and MSW - Cradle to grave approach of waste raw materials for bioenergy development- Cradle to grave approach of waste raw materials for bioenergy development- Carbon dioxide sequestration Approaches

Unit-4 - Liquid and Gaseous Bio Fuels — ***9 Hour***

Liquid - Bioethanol Enzymology for conversion of biomass to biofuels – Ligninolytic enzymes (MnP, LiP and laccase)- Hexose and Pentose sugar conversion to ethanol- Bioethanol plant design and its components- Bio refinery demonstration projects of Bioethanol-Biodiesel - Biodiesel from vegetable oils/ non-edible oils - Transesterification process-Oleaginous microorganisms-Algal Biofuel - Algal based technologies for biofuel and value added chemical preparation - Biobutanol - ABE Fermentation for Butanol production - Pyrolysis bio-oil/bio-char -Bio-alkanes and alkenes from waste biomass - Gaseous Biofuel - Bio-synthetic natural gas (SNG)- Biomethanation process- Microbiology of anaerobic digestion- Dimethyl ether (DME)-Biohydrogen- Biological Processes for Hydrogen Production- Dark fermentation and algal based technologies

Unit-5 - New and Alternative Energy Research Projects — ***9 Hour***

Metabolic pathway engineering for fuel biosynthesis- NextGen development for biofuel in India through National Biofuel Policy- Rural participation in Renewable Energy Development- Integrated industrial waste-based energy recovery- Economic, Social and Ecological Impacts of Bioenergy

Learning Resources	1. *Anju Dahiya, Bioenergy: Biomass to Biofuels and Waste to Energy, Second Edition, Elsevier, 2020]* 2. *[Abul Azad, Mohammad Khan, Bioenergy Resources and Technologies, 1st Edition, Elsevier, 2021]*	3. *Online resource: https://onlinecourses.nptel.ac.in/noc19_bt16/preview]*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	*Remember*	15%	-	15%	-	15%	-
Level 2	*Understand*	25%	-	20%	-	25%	-
Level 3	*Apply*	30%	-	25%	-	30%	-
Level 4	*Analyze*	30%	-	25%	-	30%	-
Level 5	*Evaluate*	-	-	10%	-	-	-
Level 6	*Create*	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Mr.Kirti Singh, Camlin Fine Sciences Ltd., New Delhi*	1. *Dr. Rintu Banerjee, IIT Kharagpur, rb@agfe.iitkgp.ernet.in*	1. *Dr.B.Samuel Jacob, SRMIST*
2. *Dr. S. Sam Gunasekar, Orchid Chemicals and Pharmaceuticals Ltd., sam@orchidpharma.com*	2. *Dr. Vinod Kumar, Cranfield University, UK, vinod.kumar@cranfield.ac.uk*	2. *Dr.K.Ramani, SRMIST*

Course Code	21BTE413T	Course Name	METABOLIC ENGINEERING OF MICROORGANISM FOR ENVIRONMENT AND ENERGY	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Biotechnology*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*understand the importance of advanced microbial technologies for the environmental and energy applications*
CLR-2:	*educate the metabolic Engineering of microorganisms and synthetic biology for environment and energy applications*
CLR-3:	*understand the metabolic Engineering of microorganisms for the improved yield of biocatalysts and effectiveness of biodegradation of emerging contaminants*
CLR-4:	*understand the application of Metabolic engineering for advanced biofuels synthesis*
CLR-5:	*educate the future prospects of metabolic engineering in environment and energy*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*discuss various advanced microbial technologies for the environmental and energy applications*	-	*3*	-	-	-	-	*2*	-	-	-	-	-	*2*	-	*3*
CO-2:	*acquire knowledge on metabolic Engineering of microorganisms and synthetic biology for environment and energy applications*	*2*	-	*3*	*2*	-	-	*3*	-	-	-	-	-	-	*2*	*3*
CO-3:	*apply metabolic Engineering to redesign the pathway to improve the yield of biocatalysts and effectiveness of biodegradation of emerging contaminants*	*2*	*2*	-	*2*	-	-	*3*	-	-	-	-	-	*2*	-	*3*
CO-4:	*gain knowledge on application of Metabolic engineering for advanced biofuels synthesis*	*2*	*2*	*2*	-	-	-	*2*	-	-	-	-	-	*2*	-	*3*
CO-5:	*choose from an array of options to design the microbial pathway to degrade pollutants and produce biofuels*	-	*2*	*2*	-	-	-	*3*	-	-	-	-	-	*2*	-	*3*

Unit-1 - Metabolic Engineering Approach in-Methods and Types	***9 Hour***
Introduction to Metabolic Engineering, Basic concepts; Scopes and Applications; Metabolism overview _1 (Cellular Transport processes, Fueling Reactions); Regulation of Metabolic Pathways; Emerging technologies for engineering of metabolic pathways-Strategies and tools; Systems and Synthetic Biology-an overview; Metagenomic approach-Techniques for Culturable and Uncultivable microorganisms	
Unit-2 - Metabolic Engineering in Environmental and Energy Applications	***9 Hour***
Reconstruction of Genome-scale metabolic network; Pathway manipulations by metabolic engineering for environmental applications : Improvements of Biodegradation, Ethanol production; Advanced molecular biological techniques in metabolic engineering of microbes, Analytical tools;	
Unit-3 - Pathway Design for Effective Biodegradation of Emerging Environmental Contaminants	***9 Hour***
Pathway Design- Pathway Design Workflow - Engineering of biodegradation pathways; Engineering of the synthetic metabolic pathway for biodegradation of 1,2,3 trichloropropane and Halogenated hydrocarbons; Biocatalysts engineering for polyethylene terephthalate plastic waste green recycling; Metabolic Engineering for radioactive and e-waste;	
Unit-4 - Metabolic Engineering for Aadvanced Biofuels Synthesis	***9 Hour***
Metabolic engineering for enhancing microbial biosynthesis of advanced biofuels; Genetic and metabolic engineering approaches for improving accessibilities of lignocellulsic biomass-Bioethanol, Biobutanol production; Metabolic engineering in increase of Biohydrogen, Biomethane and Bioethane production and improving of anaerobic digestion process; Metabolic engineering of algae for biodiesel synthesis; Whole crop biorefinery for biofuel and by-products production	

Unit-5 - Case Studies and Future Prospects on Metabolic Engineering	***9 Hour***
Futuristic avenues of metabolic engineering techniques in bioremediation; Case studies-application of systems and synthetic biology and metabolic engineering in environmental management and bioenergy production	

Learning Resources	1. *G N Stephanopoulos, A A Aristidou, J Nielsen, Metabolic Engineering, Principles and Methodologies, 2001, Springer.* 2. *Arindam Kuila and Vinay Sarma, Genetic and metabolic Engineering for improved biofuel production from lignocellulosic biomass, 2020, Elsevier publication.*	3. *Metabolic Pathway design, A Practical Guide; P Carbonell* 4. *Vineet Kumar et al., Metagenomics to bioremediation, 2023, Elsevier publication* 5. *Online sources: NPTEL - Metabolic Engineering https://onlinecourses.nptel.ac.in/noc21_bt18/preview*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	-	*15%*	-	*15%*	-
Level 2	*Understand*	*25%*	-	*20%*	-	*25%*	-
Level 3	*Apply*	*30%*	-	*25%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*25%*	-	*30%*	-
Level 5	*Evaluate*	-	-	*10%*	-	-	-
Level 6	*Create*	-	-	*5%*	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr.Nagarajan, Srinivas Waste Management Services Pvt. Ltd., Chennai.*	1. *Dr.Susmita Dutta, NIT Warangal*	1. *Dr. K.Ramani SRM IST*
2. *Dr. S. Sam Gunasekar, Orchid Chemicals and Pharmaceuticals Ltd., sam@orchidpharma.com*	2. *Dr.T.Rajesh, NEERI, Chennai*	2. *Dr.B.Samuel Jacob, , SRMIST*

Course Code	21BTE414T	Course Name	MICROBIAL DEGRADATION AND BIOREMEDIATION TECHNOLOGY	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Biotechnology*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*create the awareness on the microbial applications in the environmental pollution abatement*
CLR-2:	*give an overview of indigenous microbes on environmental bioremediation*
CLR-3:	*apply the metagenomic approach for the environmental microbial analysis*
CLR-4:	*apply the biomolecules for the environmental applications and biomining processes*
CLR-5:	*demonstrate the application of microbes in industrial emerging pollutants, radioactive wastes, and e-wastes*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*explain the microbial interventions in bioremediation and the importance of bioremediation*	-	3	2	2	-	-	2	-	-	-	-	-	3	-	2
CO-2:	*demonstrate various types of bioremediation techniques and its field implementation strategies*	3	-	3	2	-	-	-	-	-	-	-	-	-	-	2
CO-3:	*apply various bioremediation design in industrial effluents and contaminated sites treatment*	3	2	2	-	2	-	-	-	-	-	-	-	-	2	3
CO-4:	*analyze the metagenomics data to describe the taxonomic make-up and ecological processes of microbial communities from a range of environments*	2	-	3	2	2	-	2	-	-	-	-	-	2	-	2
CO-5:	*evaluate various biomolecules based bioremediation technologies for the bioremediation of polluted environment*	-	-	3	2	-	2	2	-	-	-	-	-	2	3	-

Unit-1 - Anthropogenic Interventions in Biogeochemical Cycles — ***9 Hour***

Pollutants from industries and accidents - Emerging Pollutants - Dyes and Detergents - PAH and Aliphatic hydrocarbons - Ocean oil spills and its consequences - Heavy metals leach in ground water - Antibiotics in wastewater -Volatile organic compounds (VOCs) - E wastes - Microplastics -Radioactive compounds - Classification based on toxicity - Toxicity assessment - Biodiversity impact analysis - Biomagnification - Bioaugumentation - Eutrophication - Acid rain

Unit-2 - Microbial Metabolism of Xenobiotic] — ***9 Hour***

Bioremediation of contaminated environments: 'The Green Option'- Mineralisation and other biotransformation mechanisms - Aerobic and Anaerobic routes - Toxicity tests - Mixed cultures - Enzymes for toxic pollutant remediation - Environmental Factors Affecting Microbial Metabolism of Xenobiotics - Mycoremediation - Bioleaching - Biomining - Metagenomic approach for consolidated bioremediation of pollutants - Screening of candidate microbes through molecular approaches - Cell free bioremediation

Unit-3 - Phytoremediation and Bio-conjugated Material Science for Remediation — ***9 Hour***

Candidate plants for phytoremediation -Mechanism of phytoremediation - Phyto volatilization - phytodegradation - phytoaccumulation - hyper accumulation - Terrestrial and Aquatic plants for remediation - Constructed Wetlands - Hydroponic system based water treatment for removal of organic solids - Nano material for metal recovery and treatment- Nano-sponges - Microbial enhanced oil recovery (MEOR) - Surfactant based pollutant remediation -

Unit-4 - Enhanced Sustainable Remediation Technology for Emerging Pollutants — ***9 Hour***

Biochar-Based Soil and Water Remediation- Biochar for Bioremediation of Toxic Metals - Biochar for Wastewater Treatment - Biosensors - Nanotechnology for micropollutants - Microplastic bioremediation through plastic active enzymes - Black Soldier Fly (a entomological) way to tackle organo-pollutants - Synthetic biology for microbial bioremediation of xenobiotic - Nuclear waste management by microbial interventions- Actinides pollutant removal strategies

Unit-5 - Bioremediation Techniques and Field Studies	***9 Hour***
In situ and ex situ remediation technologies - Soil bioremediation - Bioremediation in sediments (sub-surface) - Bioremediation of aqueous environments contaminated with organic chemicals - Lake and lagoon ecosystems - Marine pollution - Industrial effluents - Environmental Impact Assessment (EIA), Environment Protection Agency (EPA) and Role of Pollution control boards (Central and State) in abatements]	

Learning Resources	1. *Mirza Hasanuzzaman, Majeti Narasimha Vara Prasad, Handbook of Bioremediation Physiological, Molecular and Biotechnological Interventions 1st Edition, Elsevier, 2020* 2. *Vineet Kumar, Muhammad Bilal, Sushil Kumar Shahi, Vinod Garg, Metagenomics to Bioremediation Applications, Cutting Edge Tools, and Future Outlook1st Edition, Elsevier, 2022*	3. *Online sources: NPTEL - Environmental Biotechnology https://archive.nptel.ac.in/courses/102/105/102105088/* 4. *NPTEL - Environmental remediation of Contaminated soils https://archive.nptel.ac.in/courses/105/107/105107181/*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	-	*15%*	-	*15%*	-
Level 2	*Understand*	*25%*	-	*20%*	-	*25%*	-
Level 3	*Apply*	*30%*	-	*25%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*25%*	-	*30%*	-
Level 5	*Evaluate*	-	-	*10%*	-	-	-
Level 6	*Create*	-	-	*5%*	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr.Nagarajan, Srinivas Waste Management Services Pvt. Ltd., Chennai.*	1. *Dr. Rintu Banerjee IIT Kharagpur, rb@agfe.iitkgp.ernet.in*	1. *Dr.B.Samuel Jacob, , SRMIST*
2. *Dr. S. Sam Gunasekar, Orchid Chemicals and Pharmaceuticals Ltd.,sam@orchidpharma.com*	2. *Dr. Vinod Kumar, Cranfield University, UK, vinod.kumar@cranfield.ac.uk*	2. *Dr.K.Ramani, , SRMIST*

Course Code	21BTE415T	Course Name	ENVIRONMENTAL BIOSENSORS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Biotechnology*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*create awareness on biosensors and the need for biosensors in day today life*
CLR-2:	*provide overview of various biomolecules used in biosensors*
CLR-3:	*reflects on the importance of biosensors in healthcare industries*
CLR-4:	*understand on the importance of biosensors in environmental monitoring*
CLR-5:	*educate the advanced state of the art of technology in biosensors*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1 Engineering Knowledge	2 Problem Analysis	3 Design/development of solutions	4 Conduct investigations of complex problems	5 Modern Tool Usage	6 The engineer and society	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*explain the biosensors components and its applications*	*3*	-	*2*	-	*2*	-	*3*	-	-	-	-	-	*3*	-	*2*
CO-2:	*acquire knowledge in biomolecules in biosensors*	-	*2*	*2*	*3*	-	-	-	-	-	-	-	-	-	-	*1*
CO-3:	*evaluate the importance of biosensors in healthcare industries*	-	*3*	*2*	-	*2*	-	-	-	-	-	-	-	-	*2*	*3*
CO-4:	*discuss the importance of biosensors in environmental monitoring*	*3*	*3*	-	*2*	*2*	-	*3*	-	-	-	-	-	*2*	-	*2*
CO-5:	*demonstrate in novel technologies in biosensors*	*3*	-	*2*	-	*2*	-	-	-	-	-	-	-	*2*	*3*	-

Unit-1 - Basic Principle and Instrumentation of Biosensors ***9 Hour***

Introduction to biosensors; Various Types of Biosensors: electrochemical & opticals; acoustic & piezoelectric; Fluorescence & calorimetric; Materials for biosensors: Polymers; Metal Oxides; Photonic Crystals; Nano Materials.

Unit-2 - Biomolecules in Biosensors ***9 Hour***

Bioaffinity Based Sensor- DNA-Based Biosensors, Protein-Based Biosensors, Enzyme-Based Biosensors, Peptide-Based Biosensors, and Antibody-Based Biosensors. Real time applications - Glucose; Cholestrol; Urea; Pregnancy Kit, Pathogens & Detections.

Unit-3 - Biosensors in Healthcare Sectors ***9 Hour***

Biosensors in Health Cares: Biosensors and diabetes management; Biosensors in Cancers management; Biosensor in HIV early diagnosis (ELISA); Biosensors for Influenza Viruses.

Unit-4 - Biosensors in Environmental Monitoring ***9 Hour***

Biosensors in Environmental Monitoring: Water Quality – DO, BOD& COD Sensors; Heavy Metals. Biosensors for AIR Pollutions - Indoor pollutants detection, Gas Leaks Detectors. Biosensors In Agriculture Science - Soil Nutrients and Moisture Detection.

Unit-5 - Microfluidic Devices ***9 Hour***

Bioinspired Molecular Machines; Microfluidic Devices and Analysis; Microfluidics for Disease Diagnosis.

Learning Resources

1. *Modern Techniques in Biosensors Detection Methods and Commercial Aspects, herausgegeben von: Ph.D. Gorachand Dutta, Dr. Arindam Biswas, Prof. Dr. Amlan Chakrabarti, 2021.*
2. *Emerging Biosensor Trends in Organ-on-a-Chip, Mario Rothbauer & Peter Ertl, 2020.*
3. *Smart Biosensor Technology, George Knopf, Amarjeet S. Bassi, 2019.*
4. *Advanced Biosensors for Health Care Applications, Inamuddin, Raju Khan, Ali Mohammad, Abdullah Asiri, and 1st Edition - June 15, 2019.*
5. *Commercial Biosensors and Their Applications, Mustafa Kemal Sezgintürk, Clinical, Food, and Beyond, 1st Edition - June 12, 2020.*

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Level 6	*Create*	-	-	*5%*	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

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1. *Dr. S. Sam Gunasekar,Orchid Chemicals and Pharmaceuticals Ltd., Chennai*	1. *Dr. Dr. V V Raghavendra Sai,IIT Madras, Chennai, vvrsai@iitm.ac.in*	1. *Dr. W. Richard Thilagaraj,SRMIST*
2. *Mr. D.K.Rana, Heubach Colour Pvt.Ltd.Gujarat, ankplant@heubach-india.com*	2. *Dr. Athi N. Naganathan,IIT Madaras , Chennai, athi@iitm.ac.in*	2. *Dr. B.Samuel Jacob, SRMIST*

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

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