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 – 8D
(Syllabi for Biotechnology (Computational Biology) Programme Courses)

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

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

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	21BTE208T	Course Name	SEQUENCE ANALYSIS AND MOLECULAR PHYLOGENY	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:	*Summarize the biological databases and methods of sequence alignment.*
CLR-2:	*Analyze sequence patterns and profiles.*
CLR-3:	*Apply the concept of the evolutionary tree.*
CLR-4:	*Understand the various methods of phylogenetic tree construction.*
CLR-5:	*Interpret the application of Biomolecular sequence analysis and tools.*

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 types of biological databases and alignment techniques*	*2*	*-*		*3*	*2*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*2*	*-*	*2*
CO-2:	*Infer the different kinds of sequence patterns and profiles*	*2*	*3*	*-*	*-*	*3*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*2*	*-*	*2*
CO-3:	*Explore the phylogenetic relationship between species*	*3*	*3*	*-*	*2*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*2*	*2*	*-*	*2*
CO-4:	*Formulate an approach to analyze phylogenetic inference and methods*	*2*	*3*	*-*	*2*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*2*	*2*
CO-5:	*Understand and implement biomolecular sequence analysis and tools.*	*2*	*-*	*-*	*2*	*3*	*-*	*-*	*-*	*-*	*-*	*-*	*2*	*-*	*2*	*2*

Unit-I: Biological Databases	***9 hour***
Biological databases - Classification: Primary and secondary databases - NCBI, EMBL and DDBJ - PIR: UniProtKB - Structure database: PDB, SCOP and CATH - Specialized database- KEGG, TCGA, PUBCHEM, Bibliographic database- File formats.	
Unit-II: Sequence Alignment, Patterns and Profiles	***9 hours***
Sequence alignment classification: Pairwise alignment and Multiple sequence alignment (MSA) -Scoring matrices Illustration – PAM and BLOSUM - Needleman Wunsch algorithm - Smith-Waterman algorithm – Database searching algorithm- BLAST - Methods and Tools for MSA - Progressive alignment - Domain & Motif - Family – Superfamily-Profiles-Patterns.	
Unit-III: Concept of Evolutionary Tree	***9 hours***
Terminology of phylogenetics, definition of Dendrogram, Cladograms, & Phylograms, Types of phylogenetic trees (rooted vs. unrooted trees), gene tree & Species tree, Newick format of tree representation, True tree & Inferred tree. Phylogenetic Inference, Distance methods – Fitch Margoiasch, UPGMA, WPGMA, Neighbor-Joining method, Character-based method - Maximum Parsimony methods, Maximum Likelihood method.	
Unit-IV: Phylogenetic Inference – Evaluation methods	***9 hours***
Bootstrapping, Randomized and jack-knifing methods- Molecular Clock- Rate heterogeneity- LBA problem- Phylogenomics- Supertree & Super matrix method-Phylogenetic analysis software: PHYLIP, MEGA, PhyML, and MrBayes.	
Unit-V: Biomolecular Sequence Analysis and Tools	***9 hour***

Gene prediction in prokaryotes and eukaryotes-ORF finder- primer design- secondary structure prediction of RNA and proteins - Chou Fasman - GOR - TMHMM, Promoter and regulatory element prediction - RNA structure prediction.

Learning Resources	1. *David W. Mount Bioinformatics: Sequence and Genome Analysis Cold Spring Harbor Laboratory Press, 2004* 2. *Lesk, Arthur. Introduction to bioinformatics. Oxford University Press, 2019.*	3. *Molecular Evolution and Phylogenetics Masatoshi Nei and Sudhir Kumar, Oxford University Press,2000.* 4. *Dandekar, Thomas, and Meik Kunz. Bioinformatics: An Introductory Textbook. Springer Nature, 2023.*

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%*	-	*25%*	-	*25%*	-
Level 3	*Apply*	*30%*	-	*30%*	-	*30%*	-
Level 4	*Analyze*	*20%*	-	*20%*	-	*20%*	-
Level 5	*Evaluate*	*10%*	-	*10%*	-	*10%*	-
Level 6	*Create*	-	-	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *P. V. Prasad, Founder, Helix Biosciences*	1. *Dr.Sanjeev Kumar Singh, Department of Bioinformatics, Alagappa University, Tamil Nadu, India. sanjeevslab@gmail.com*	1. *Dr. S. K. M. Habeeb, SRMIST*
2. *Mr. Sudheendra Rao, Director, DataLore Labs, Bengaluru*	2. *Dr. K. Sekar, Department of Computational and Data Sciences, Indian Institute of Science, Bangalore, India. Sekar@iisc.ac.in*	2. *Dr. S. Shobana, SRMIST*

Course Code	21BTE319T	Course Name	ADVANCED GENOMICS	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 Genome structure*
CLR-2:	*Summarize the DNA sequencing methods*
CLR-3:	*Create an interest about approaches of studying genomics*
CLR-4:	*Demonstrate the methods used for performing genome annotation*
CLR-5:	*Apply genomics 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 knowledge about genome structure and human genome project*	-	2	2	-	2	-	-	-	-	-	-	-	-	-	2
CO-2:	*Discuss about different DNA sequencing methods*	3	3	-	-	2	-	-	-	-	-	-	-	-	-	2
CO-3:	*Outline the different approaches involved in studying genomics and transcriptomics*	-	2	-	2	-	3	-	-	-	-	-	-	2	-	-
CO-4:	*Demonstrate applicability of methods involved in gene prediction and genome annotation*	2	-	-	-	2	2	-	-	-	-	-	-	-	-	3
CO-5:	*Explain various applications of genomics in different fields*	2	2	-	-	2	-	-	-	-	-	-	-	-	-	3

Unit-I: Genome Organization and Structure	***9 Hour***
Organization of nuclear DNA in eukaryotes; Genome structure – Genome sizes – Genome sequence complexity – Human genome project - Goals and outcomes of human genome project - Human reference genome - significance of other genome projects - Genome assembly	
Unit-II: DNA Sequencing Strategies	***9 Hour***
History and Evolution of DNA sequencing strategies; Principles, methods, advantages, disadvantages and comparison of Sanger sequencing, Illumina sequencing, Ion Torrent sequencing, PacBio sequencing, Nanopore sequencing	
Unit-III: Genomic Approaches	***9 Hour***
Principles, methods, advantages, disadvantages and applications - Whole genome sequencing – whole transcriptome sequencing – Small RNA sequencing – ChipSeq – Exome Sequencing – Amplicon sequencing – Metagenomics – Single Cell Genomics - Microarray	
Unit-IV: Genome Annotation	***9 Hour***
Bioinformatics tools for genome annotation - Detecting open reading frames – principles, methods and tools for gene prediction; Homology based approach to find genes – Non-coding RNA, Extra coding DNA, function identification of new gene, fusion genes, gene ontology, non-homology-based approach to find genes- genome annotation tools - Introduction to Bioconductor	
Unit-V: Applications of Genomics	***9 Hour***
Case studies depicting applications in Pharmacogenomics and Personalized Medicine – GWAS, MWAS and mGWAS Studies in agriculture– Single-Cell RNA sequencing application - Application of NGS in Human diseases: Cancer and neurodegenerative diseases.	

Learning Resources	1. *Sandy B. Primrose and Richard Twyman, Principles of Genome Analysis and Genomics, 3rd Edition, Wiley, 2009.* 2. *Stuart M. Brown, Next-Generation DNA Sequencing Informatics, 2nd Edition, Cold Spring Harbor Laboratory Press, New York. 2015* 3. *David W. Mount., "Bioinformatics: Sequence and Genome Analysis", 2nd Edition, Cold Spring Harbor Laboratory Press, New York. 2004*	4. *Shademan B, Biray Avci C, Nikanfar M, Nourazarian A. Application of Next-Generation Sequencing in Neurodegenerative Diseases: Opportunities and Challenges. Neuromolecular Med. 2021 Jun;23(2):225-235.* 5. *Wang Y, et al. GWAS, MWAS and mGWAS provide insights into precision agriculture based on genotype-dependent microbial effects in foxtail millet. Nat Commun. 2022 Oct 7;13(1):5913.*

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%*	-	*25%*	-	*25%*	-
Level 3	*Apply*	*30%*	-	*30%*	-	*30%*	-
Level 4	*Analyze*	*20%*	-	*20%*	-	*20%*	-
Level 5	*Evaluate*	*10%*	-	*10%*	-	*10%*	-
Level 6	*Create*	-	-	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Dr. V.L.Ramprasad, MedGenome Labs Ltd, Bengaluru, ramprasadv@medgenome.com*	1. *Dr. Ranjith Kumavath, Pondicherry University, Pondicherry, rnkumavath@gmail.com*	1. *Dr.S. K. M. Habeeb, SRMIST*
2. *Dr. Sanjay Singh, Eurofins Genomics India Pvt Ltd., Bengaluru, sanjay.singh@xoin.eurofinasia.com*	2. *Dr. S. Mahalingam, Indian Institute of Technology Madras, Chennai, mahalingam@iitm.ac.in*	2. *Dr. R. Satish, SRMIST*

Course Code	21BTE320T	Course Name	ALGORITHMS IN COMPUTATIONAL 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:	*understand the background of algorithms in computational biology*
CLR-2:	*acquire knowledge on sequence alignment*
CLR-3:	*analyze genomic data to perform regulatory motif analysis*
CLR-4:	*evaluate high throughput data analysis approaches*
CLR-5:	*apply graph theory for network analysis*

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:	*summarize the need to study bioinformatics algorithms*	*3*	*2*	*1*	-	-	-	-	-	-	-	-	-	-	-	*2*
CO-2:	*implement various sequence alignment algorithms*	*3*	*3*	*3*	-	-	-	-	-	-	-	-	-	*2*	-	*2*
CO-3:	*perform genome assembly and regulatory motifs*	*3*	*3*	*2*	-	-	-	-	-	-	-	-	-	*2*	-	*2*
CO-4:	*analyze high throughput data analysis*	-	*3*	*3*	*2*	-	-	-	-	-	-	-	-	*2*	-	*2*
CO-5:	*integrate biological interaction with network analysis*	-	*3*	*3*	-	*3-*	-	-	-	-	-	-	-	-	*2*	*2*

Unit-I: Introduction to Algorithms	***9 Hour***
Background - algorithms – complexity - brute force, recursive techniques - molecular biology primer - different data types - anecdotes of algorithms and data structures - breakthroughs - Probability - Descriptive statistics - Hypothesis testing - Heuristics algorithm	
Unit-II: Sequence Alignment Algorithms	***9 Hour***
Dynamic programming -Sequence alignment methods - sequence database search - suffix trees - space efficient alignment using divide & conquer - addressing challenges with pseudoknots, Principal component analysis- Poisson distribution - Regression analysis- Hidden Markov Model - Neural networks.	
Unit-III: Genome Assembly and Regulatory Motif	***9 Hour***
Genome assembly - Overlap layout consensus - Burrow wheeler and De Bruijn graph assembly - greedy algorithm types - for shortest common superstring - Regulatory motif discovery - brute force - greedy algorithms - the Pattern branching algorithm - Genetic Algorithm - Bayesian statistics.	
Unit-IV: High-Throughput Data Analysis	***9 Hour***
Analysis of bulk and single cell expression - data normalization - dimension reduction – K-means clustering – bi-clustering - BiMax, a divide and conquer algorithm - differential expression analysis - pseudo time analysis using minimum spanning tree - Bootstrapping - Survival analysis.	
Unit-V: Network Analysis Algorithm	***9 Hour***
Network analysis: clique finding - regulatory networks - co-expression networks – Scale free networks – Small world network – Density based clustering – Tools for network analysis – Mcode algorithm - shortest path algorithm.	

Learning Resources	1. *Pevzner, P., Compeau, P. Bioinformatics Algorithms: An Active Learning Approach. United States: Active Learning Publishers, 2018.* 2. *Gusfield, D. Algorithms on Strings, Trees, and Sequences: Computer Science and Computational Biology. United States: Cambridge University Press, 1997*	*3.Baum, J. O., Zvelebil, M., Zvelebil, M. J. Understanding Bioinformatics. United Kingdom: Garland Science, 2008*

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%*	-	*25%*	-	*25%*	-
Level 3	*Apply*	*30%*	-	*30%*	-	*30%*	-
Level 4	*Analyze*	*20%*	-	*20%*	-	*20%*	-
Level 5	*Evaluate*	*10%*	-	*10%*	-	*10%*	-
Level 6	*Create*	-	-	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. V.L.Ramprasad, MedGenome Labs Ltd, Bengaluru. ramprasadv@medgenome.com	*1. Dr Shandar Ahamad, Jawaharlal Nehru University, New Delhi. shandar@jnu.ac.in*	*1. Dr. T..Anand, SRMIST*
2. Dr. N. Mathan, Allianz Biosciences (P) Ltd, Puducherry. nm@abpl.co.in	*2. Dr. Michael Gromiha,Indian Institute of Technology Madras, Chennai. gromiha@iitm.ac.in*	*2. Dr. V. Sivaramakrishnan, SRMIST*

Course Code	21BTE321T	Course Name	PYTHON FOR BIOINFORMATICS	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 basic of python coding*
CLR-2:	*Summarize about Python libraries for data analysis*
CLR-3:	*Exercise biopython modules to analzye the biological sequence*
CLR-4:	*Analyze sequence annotation objects*
CLR-5:	*Implement python in molecular biology*

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:	*Learn the basics of Python coding necessary for biological problem analysis*	*2*	*2*		-	-	-	-	-	-	-	-	*2*	-	-	*2*
CO-2:	*Discuss the application of Numpy, Pandas and Matplotlib*	*2*	-	*2*	*2*	-	-	-	-	-	-	-	-	-	-	*2*
CO-3:	*Apply python for genomic data analysis*	*2*	*2*	*2*	*2*	-	-	-	-	-	-	-	-	-	-	*2*
CO-4:	*Demonstrate how to use python coding to annotate the sequence objects*	*2*	*2*	*2*	*2*	-	-	-	-	-	-	-	-	-	-	*2*
CO-5:	*Application of Bio-python coding practices for biological sciences*	*3*	*3*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	*3*

Unit-I: Basics of Python Programming	***9 Hour***
Introduction to python- Keywords and identifiers - Datatypes - Operators - Python statements - if - Elif and Else For and while loop - Python functions: Built in and user defined Functions - Lists and Tuple.	
Unit-II: Python for Data Analysis	***9 Hour***
Introduction to Python library for data analysis - Numpy-Arrays - Indexing and selection - Operation - Exercise - Pandas - Series - DataFrames - Conditional filtering	
Unit-III: Python for Sequence Objects	***9 Hour***
Biopython - working with Python for Genomic data analysis - String operators - Indexing and slicing biological sequences - Sequences as objects: Seq object into strings, -Comparing sequence objects: Unknown sequence contents, partially defined sequence contents-Mutableseq Objects	
Unit-IV: Python for Sequence Annotation Objects	***9 Hour***
Sequence annotation objects: Sequence record objects from FASTA and Genbank-Sequence feature objects-Parsing FASTA Sequence format - Parsing Genbank sequence file format. Parsing or reading sequence alignments: Multiple and pairwise sequence alignment	
Unit-V: Application of Python Modules in Molecular Biology	***9 Hour***
Introduction to Biopython library-Python code-Identify the GC Content-Counting nucleotides-coding nucleotide sequences-reverse complements-Transcription-Translation -Translation table	

Learning Resources	1. *Jitendra Kumar Verma, Prashant Johri, Sudip Paul. Application of Machine learning., Springer Singapore, 2020* 2. *Dheepak Khemani. A First course in Artificial Intelligence., McGraw Hill Education Pvt Ltd., 2014*	*3. Online Sources: https://wiki.python.org/moin/BeginnersGuide/Programmers.* *4. http://biopython.org/DIST/docs/tutorial/Tutorial-1.48.pdf*

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*	*20%*	-	*25%*	-	*20%*	-
Level 5	*Evaluate*	*10%*	-	*10%*	-	*10%*	-
Level 6	*Create*	-	-	*5%*	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Dr. C. Ramakrishnan, Principal Scientist, Molecular Design Division Aroniter Co., Seoul, South Korea ramakrishnan@arontier.co*	*1. Dr Shandar Ahamad, Jawaharlal Nehru University, New Delhi. shandar@jnu.ac.in*	*1. Dr.Thirumurthy Madhavan, SRMIST*
2. *Mr. Sudheendra Rao, Director, DataLore Labs, Bengaluru*	*2. Dr. Balachandran Manavalan, Department of Integrative Biotechnology, College of Biotechnology and Bioengineering, Sungkyunkwan University, Suwon 16419, Gyeonggi-do, Republic of Korea, bala2022@skku.edu*	*2. Dr. Habeeb. S. K. M, SRMIST*

Course Code	21BTE322T	Course Name	DATA SCIENCES IN 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:	*summarize the biological file formats*
CLR-2:	*acquire knowledge about different data analysis tools*
CLR-3:	*perform data analysis using mathematical and statistical approaches*
CLR-4:	*analyzing the graphical data*
CLR-5:	*integration of data science in biology*

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 need for biological data formats*	*3*	*2*	-	-	-	-	-	-	-	-	-	-	*2*	-	-
CO-2:	*outline the various data analysis tools in biological sciences*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	*2*	-	-
CO-3:	*apply the big data analysis approach to biological data*	-	-	*2*	-	*3*	-	-	-	-	-	-	-	*2*	-	-
CO-4:	*analyze biological data using graph theory*	-	-	*2*	*3*	-	-	-	-	-	-	-	-	-	-	*2*
CO-5:	*application of data science in biology*	*3*	-	-	*2*	-	-	-	-	-	-	-	-	-	-	*2*

Unit-I: Data Formats in Biological Science	***9 hours***
Databases and file formats: GenBank, VCF, BED, SRA, FASTA, and Fastq - Mapping data formats: SAM - BAM and CRAM – General Feature Format/General Transfer Format for Genes, DNA, RNA, and Protein sequences – Binary Base Call format - Protein structure file formats: PDB, PSF and mmCIF - small molecule file formats: SMILES, MOL2, SDF and MultiMOL2.	
Unit II: Data Analysis Tools for Biologists	***9 hours***
Gene Database tools: Ensemble, GeneCards, and UCSC Genome browser - Protein Analysis Tools: UniProt, Expasy, InterProscan, Motif prediction and ProFunc - Protein Visualization Tools: Rasmol, and Chimera - Structure Prediction Tools: SwissPDB, Alpha fold, iTasser, and PDBeMotif - Pathway Database: KEGG-GeneMania-STRING- Biogrid.	
Unit-III: Overview of Big Data	***9 hours***
Big Data and its relevance in biological science – Its Characteristics: OMICS and Cancer Research - Sources and generation of Big Data in biological science: High throughput techniques - Challenges and opportunities in analyzing Big Data.	
Unit-IV: Data Mining and Statistical Analysis	***9 hours***
Introduction to data mining and visualization in biological science - Data preprocessing and cleaning techniques for biological data: KNIME, GALAXY, Open Refine - Statistical analysis of biological data: Regression, Clustering, Classification, and Resampling analysis - Machine learning algorithms for analyzing OMICS data: SVM, RF, ANN and Deep Learning	
Unit-V: Data visualization and Applications	***9 hour***
Data visualization - techniques and tools: MiBiOmics and Graph Bio – Application: Machine learning principles for Biomarker determination – Machine learning approaches for Drug discovery- Predictive modeling for disease diagnosis - Immune engineering: Epitope prediction and Network analysis for understanding signaling pathways involved in immunology – Neurosciences: Image processing analysis using machine learning approaches.	

Learning Resources	1. *Cathy O'Neil and Rachel Schutt. Doing Data Science, Straight Talk From The Frontline. O'Reilly. 2014.* 2. *Jure Leskovek, Anand Rajaraman and Jeffrey Ullman. Mining of Massive Datasets. v2.1, Cambridge University Press. 2014.*	*3 Kevin P. Murphy. Machine Learning: A Probabilistic Perspective. ISBN 0262018020. 2013.* *4. Mohammed J. Zaki and Wagner Miera Jr. Data Mining and Analysis: Fundamental Concepts and Algorithms. Cambridge University Press. 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*	*20%*	-	*25%*	-	*20%*	-
Level 5	*Evaluate*	*10%*	-	*10%*	-	*10%*	-
Level 6	*Create*	-	-	*5%*	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Dr. C. Ramakrishnan, Principal Scientist, Molecular Design Division Aroniter Co., Seoul, South Korea ramakrishnan@arontier.co*	1. *Dr. Sanjeev Kumar Singh, Department of Bioinformatics, Alagappa University, sanjeevslab@gmail.com*	*1. Dr. V. Sivaramakrishnan, SRM IST*
2. Mr. Sudheendra Rao, Director, DataLore Labs, Bengaluru	*2. Dr. P. Gautam, Department of Biotechnology, Anna University, Tamil Nadu, India. pgautam@annauniv.edu*	*2. Dr. S.K.M. Habeeb, SRM IST*

Course Code	21BTE425T	Course Name	R PROGRAMMING FOR BIOLOGISTS	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:	*generate knowledge about the fundamentals of R programming*
CLR-2:	*provide a detailed understanding of statistical approaches in R*
CLR-3:	*create awareness on bioconductor packages for whole genome related analysis*
CLR-4:	*initiate interest to utilize different bioconductor packages for exome and variant analysis*
CLR-5:	*understand the importance of transcriptomics and pathway based packages*

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 knowledge about the fundamentals of R programming*	-	*2*	*2*	-	*2*	-	-	-	-	-	-	-	*2*	-	*2*
CO-2:	*discuss about the importance of R in statistics and biological sciences*	*3*	*3*	-	-	*2*	-	-	-	-	-	-	-	-	*2*	*2*
CO-3:	*outline the significance of bioconductor packages for whole genome analysis*	-	*2*	-	*2*	*3*	-	-	-	-	-	-	*2*	-	-	-
CO-4:	*demonstrate the applicability of bioconductor packages to do exome research*	*2*	*3*	-	-	*3*	-	-	-	-	-	-	-	-	*3*	*3*
CO-5:	*develop a rationale for using gene expression and pathway based packages*	*2*	*3*	-	-	*3*	-	-	-	-	-	-	-	-	*2*	*2*

Unit-1 : Fundamentals of R	***9 Hours***
Introduction to R – Installation and R-Studio - Datatypes & Data structures– scalars, vectors, matrices, data frames, lists, array, factors and tables; Loops and Conditionals; Operators - arithmetic, relational, logical; Strings, Input/Output (I/O) - Introduction to basic statistical functions and packages	
Unit-2 : Statistics in R	***9 Hours***
Statistics in R - mean, median, mode, standard deviation, functions and strings - concepts of statistical significance - F-test, t-test, Anova - one- and two-way, Chi square test - Linear algebra, correlation, regression. PCA, Data Visualization – charts & types – ggplot2 - heatmaps, correlogram	
Unit-3: Bioconductor and Genome Analysis	***9 Hours***
Introduction to Bioconductor – Installation – CRAN vs Bioconductor– BiocManager – Discovering and Installing packages - string manipulation, BioStrings - Genome annotation - features - databases, bioconductor packages - read alignment: - Genome Annotation: BSGenome – Genomic Features – RSAM Tools – Genomic Alignments - Rsubread, Orthology. eg.db – Gene Ontology database	
Unit-4 : Exome Analysis	***9 Hours***
Exome - significance of exome data analysis - SNP - SNV - Packages - Gwascat, VariantAnnotation, SeqVarTools, StructuralVariantAnnotation, RAREsim, XNAString, VariantFiltering - heatmap - pharmacogenomics: PharmacoGx, drugTargetInteractions	
Unit-5: Transcriptome and Pathway Analysis	***9 Hours***
Transcriptomics - features - tools: dada2 - easyRNASeq, Differential expression: Limma, edgeR, RNASeqR, deseq2, DNAfusion, pathwayPCA, Co-expression profile: GeneGeneInteR, gCrisprTools, Enrichment analysis: EGSEA - DEScan2 - GSVA - pathview	

Learning Resources	1. *Dylan Z. Childs & Andrew P Beckerman. Second Edition, OUP Oxford. 2017* 2. *Dan MacLean. R Bioinformatics Cookbook. First Edition, Packt Publishing Ltd. 2019*	3. *Matloff N. "The art of R programming: A tour of statistical software design". No Starch Press; 2011* 4. *https://bioconductor.github.io/BiocWorkshops/r-and-bioconductor-for-everyone-an-introduction.html*

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*	*25%*	-	*25%*	-	*25%*	-
Level 4	*Analyze*	*25%*	-	*30%*	-	*25%*	-
Level 5	*Evaluate*	*10%*	-	*10%*	-	*10%*	-
Level 6	*Create*	-	-	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Dr. C. Ramakrishnan, Principal Scientist, Molecular Design Division, Aroniter Co., Seoul, South Korea, ramakrishnan@arontier.co*	1. *Dr Shandar Ahamad, Jawaharlal Nehru University, New Delhi.shandar@jnu.ac.in*	1. *Dr. S. K. M. Habeeb, SRMIST*
2. *Mr. Sudheendra Rao, Director, DataLore Labs, Bengaluru*	2. *Dr. Michael Gromiha, Indian Institute of Technology Madrasgromiha@iitm.ac.in*	2. *Dr. T. Anand, SRMIST*

Course Code	21BTE426T	Course Name	SYSTEMS BIOLOGY - MODELING 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:	*understand importance of modelling biological systems*
CLR-2:	*acquire knowledge on fundamental principles that govern biological system modelling*
CLR-3:	*create insights on complex biological systems modelling and its challenges*
CLR-4:	*design biological circuits and automating circuit design*
CLR-5:	*apply design principles in synthetic biology*

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:	*review the basic principles involved in modelling biological systems*	*3*	*2*	*1*	-	-	-	-	-	-	-	-	-	-	-	*2*
CO-2:	*discuss knowledge on basic biological process that can be modelled and simulated*	*3*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	-	*2*
CO-3:	*design and simulation of biological process like cellular signalling*	*3*	*3*	*2*	-	-	-	-	-	-	-	-	-	-	-	*2*
CO-4:	*evaluate biological circuits and provide insight on automating circuit design*	-	*3*	*3*	*2*	-	-	-	-	-	-	-	-	-	-	*2*
CO-5:	*apply the synthetic biology in real world*	-	*3*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	*2*

Unit-I: Systems Biology Introduction	***9 Hour***
Principles of Systems Biology, Reductionist Vs Holism approach - Challenges in modelling biological systems - The practice of modelling - Building the model - Simulating the biological model - Troubleshooting biological models - Graph theory and biological networks	
Unit-II: Standard Models and approaches	***9 Hour***
Kinetic laws for modelling Biochemical reactions - Mass-action kinetic models - Modelling enzyme kinetics - Co-operativity: Hill kinetics - Biochemical systems theory - Discrete dynamic models: Boolean networks - Flux balance analysis approach - Metabolic control analysis - Perturbation of metabolic networks - Metabolic engineering - Drug target identification - Scope of genome scale metabolic models.	
Unit-III: Simulation of Signaling Pathways	***9 Hour***
Introduction, structure, and functions of signalling mechanisms - Signalling paradigm – Receptor Ligand Interaction - Selected biological process: Glycolysis as a model - G protein model - MAP kinase cascade - Signalling: Simple motifs - Feedback mechanisms.	
Unit-IV: Modelling Biological Process	***9 Hour***
Biological oscillation - Glycolytic oscillation: Coupling of oscillator - Cell cycle modelling - Models of budding yeast cell cycle - Ageing model - Evolution and self-organization - Boolean network models - Prediction of biological systems from optimality principles - Modelling tools.	
Unit-V: Synthetic Biology	***9 Hour***

Designing Biological circuits - The biobricks - Classic circuit design experiment - Designing an oscillator: the repressilator - Systems-theoretic approaches - Automating circuit design - Toggle switch - Designing modules - Exploring the design space - Automating circuit design - Concepts of redundancy, modularity, exaptation, robustness - Adelman's classic experiment - DNA data storage - The E-cell project.

Learning Resources	1. *Raman K. An Introduction to Computational Systems Biology: Systems-Level Modelling of Cellular Networks. Chapman and Hall/CRC; 2021.* 2. *Wierling, C., Kowald, A., Liebermeister, W., Klipp, E. Systems Biology: A Textbook., Wiley, Germany, 2016*	*3.Marchetti, L., Thanh, V. H., Priami, C. Simulation Algorithms for Computational Systems Biology. Germany: Springer International Publishing., Germany, 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. V.L.Ramprasad, MedGenome Labs Ltd, Bengaluru ramprasadv@medgenome.com*	1. *Dr Shandar Ahamad, Jawaharlal Nehru University, New Delhi.shandar@jnu.ac.in*	1. *Dr. T..Anand, SRM IST*
2. *Dr. N. Mathan, Allianz Biosciences (P) Ltd, Puducherry nm@abpl.co.in*	2. *Dr. Michael Gromiha,Indian Institute of Technology Madras, Chennai. gromiha@iitm.ac.in*	2. *Dr. Sivaramakrishnan, SRMIST*

Course Code	21BTE427T	Course Name	COMPUTATIONAL APPROACHES IN DRUG DISCOVERY	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 the knowledge to manipulate the chemical structures of 2D and 3D*
CLR-2:	*gain knowledge in basics of protein chemistry and functions*
CLR-3:	*understand the drug discovery process and computational approaches*
CLR-4:	*obtaining to information to generate various computational models*
CLR-5:	*applications of 3D-QSAR in Drug design*

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:	*apply the computational approaches to generate 2D and 3D chemical structures*	*1*	-	*1*	-	*1*	-	-	-	-	-	-	-	-	-	*1*
CO-2:	*learn the basics of Protein world to design drug molecules*	*2*	-	*2*	-	-	-	-	-	-	-	-	*2*	-	-	*2*
CO-3:	*understand the process of drug discovery process and computational approaches*	*2*	*2*	*2*	-	-	-	-	-	-	-	-	-	-	-	*2*
CO-4:	*apply knowledge on computational models and learn best approaches for drug design*	*3*	*2*	-	-		-	-	-	-	-	-	-	-	-	*2*
CO-5:	*apply 3D-QSAR in Drug design*	*2*	*2*	-	-	*2*	-	-	-	-	-	-	-	-	-	*2*

Unit-I: Representation and Manipulation of Chemical Structures	***9 Hour***
2D Chemical Structures- Chemical notations, Graph theory, Connection table, Morgan algorithms Structure and substructure searching, 3D Chemical Structures- Experimental 3D Databases-Conformational search and analysis: Systematic and random search analysis -Molecular descriptors- Calculation of physical and Chemical Data: Empirical approaches to the calculation properties-Molecular mechanics: DFT-Molecular Dynamics Simulation	
Unit-II: Protein Modeling	***9 Hour***
Amino acids, Protein structure and conformational properties, Determination and validation of protein 3D structures-Ramachandran Plot, Protein structure database, Enzyme mechanisms, protein secondary and tertiary structure prediction methods: Homology and ab initio methods	
Unit-III: Drug Design and Development	***9 Hour***
Drug Discovery Process-Target Identification-Lead Identification- Lead optimization-Identification of active part-Pharmacophore-functional group modification-Introduction to drug discovery process and computational approaches-Drug-Likeness and Compound Filters	
Unit-IV: Computational Models	***9 Hour***
Virtual Screening-Structure based virtual screening-Protein–Ligand Docking: Searching algorithms, Scoring function, applications-Pharmacophore concept of Bioisosterism:3D-Pharmacophore, Model generation, Lead hoping- Ligand based pharmacophore search, structure based pharmacophore search	
Unit-V: 3D-QSAR in Drug Design	***9 Hour***
Introduction of Deriving a Quantitative Structure Activity Relationship (QSAR) Equation: Simple and Multiple Linear Regression-Designing a QSAR Experiment: Selection of Descriptors, Experimental Design, Indicator variables, Molecular field analysis-Partial Least Squares-cross validation-Evaluation of QSAR models	

Learning Resources	1. *Andrew Leach. Molecular Modelling: Principles & Applications, Second edition, Pearson, 2013* 2. *Hugo Kubinyi. 3D-QSAR in Drug design, Volume-3, Kluwer Academic Publishers, UK, 1998*	3. *John Gasteiger & Thomas Engel. Chemoinformatics, Wiley-VCH, 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*	*25%*	-	*25%*	-	*25%*	-
Level 4	*Analyze*	*25%*	-	*30%*	-	*25%*	-
Level 5	*Evaluate*	*10%*	-	*10%*	-	*10%*	-
Level 6	*Create*	-	-	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Dr. C. Ramakrishnan, Principal Scientist, Molecular Design Division Aroniter Co., Seoul, South Korea. ramakrishnan@arontier.co*	1. *Dr Shandar Ahamad, Jawaharlal Nehru University, New Delhi. shandar@jnu.ac.in*	1. *Dr. Thirumurthy Madhavan, SRMIST*
2. *Mr. Sudheendra Rao, Director, DataLore Labs, Bengaluru.*	2. *Dr. Balachandran Manavalan, Assistant Professor, Department of Integrative Biotechnology, Sungkyunkwan University, Suwon 16419, Gyeonggi-do, Republic of Korea bala2022@skku.edu*	2. *Dr. Habeeb. S. K. M, SRMIST*

Course Code	21BTE428T	Course Name	MACHINE LEARNING IN BIOLOGICAL SCIENCES	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 various ML environment*
CLR-2:	*acquire the basis of python coding*
CLR-3:	*provide the knowledge about ML libraries*
CLR-4:	*manipulate Data of various ML algorithms*
CLR-5:	*learn ML algorithms and their application in biological dataset*

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:	*implement ML environment using python librarires*	2	-	2	-	2	-	-	-	-	-	-	-	-	-	2
CO-2:	*learn the basics of Python coding necessary for ML*	2	-	2	-	2	-	-	-	-	-	-	-	-	-	2
CO-3:	*discuss the application of Numpy, Pandas and Matplotlib*	2	2	-	-	2	-	-	-	-	-	-	-	-	-	2
CO-4:	*learn how to use Scikit-learn to apply powerful machine learning algorithms*	2	-	-	2	2	-	-	-	-	-	-	-	-	-	2
CO-5:	*apply knowledge on ML models and learn best practices for biological dataset*	2	-	-	2	2	-	-	-	-	-	-	-	-	-	2

Unit-I: Introduction of basic concepts and various ML environment	***9 Hour***
Machine learning pathway overview-Types of ML Algorithms: Supervised and Unsupervised learning - classification-regression-clustering-Dimensionality reduction-Model selection-Preprocessing-Feature engineering and data Preparation: Dealing with outliers, missing data	
Unit-II: Python for ML	***9 Hour***
Introduction to Python: Installation of python software-Google Collab tool-Jupyter notebook-Basics of python programming, Variables -Identifies, Reserved word list, Arithmetic operators, Objects, Comparison operators, Logical operators- Functions-arguments-modules-String operators-List	
Unit-III: Numpy, Pandas and Matplot for ML	***9 Hour***
Numpy: Arrays, Indexing and selection, Operation, Exercise-Pandas-Series-Data Frames: Conditional filtering, Exercise-Matplotlib: basics, figure parameters, Exercise	
Unit-IV: ML Algorithms	***9 Hour***
Supervised learning algorithm: Support Vector Machine (SVM): Theory and intuition, SVM with Scikit, SVM Model generation- Random Forest (RF) algorithms: Theory and intuition, RF with Scikit, RF model generation -Unsupervised learning algorithm: K means clustering overview, theory, and coding - Cross-validation	
Unit-V: Application of ML Algorithms and Model Implementation in Biological Dataset	***9 Hour***
Case study: Introduction to various Biological Dataset construction-Data preparation, data preprocessing, dataset distributions, cross validation Test and Training split, implementation of cross validation Leave One Out (LOO), 10 fold cross validation, 5 fold cross validation, ML model performance-External validation	

Learning Resources	*1. Inamuddin, Jorddy N. Cruz, Moamen Salah El-Deen Refat, Tariq A. Altalhi. Drug design using Machine learning, Wiley, 2022* *2. Alexander Heifetz. Artificial Intelligence in Drug design, Springer USA, 2021*	*3. Jitendra Kumar Verma, Prashant Johri, Sudip Paul. Application of Machine learning, Springer Singapore, 2020*

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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*	-	-	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

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

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