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 – 8C
(Syllabi for Biotechnology w/s Genetic Engineering Programme Courses)

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	21BTE207T	Course Name	HUMAN GENETICS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*outline the human genome structure and organization*
CLR-2:	*understanding the patterns of inheritance in humans*
CLR-3:	*appraise karyotype techniques to analyze human chromosomal aberrations*
CLR-4:	*explain the methods used to detect genetic variations in human population and prenatal diagnosis*
CLR-5:	*apply the knowledge of human genetics in real life problems*

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:	*remember the human genome organization and its importance*	2	-	2	-	-	-	-	-	-	-	-	-	1	-	-
CO-2:	*categorize the inheritance patterns and apply in real world human diseases*	-	2	-	3	-	-	-	-	-	-	-	-	2	-	-
CO-3:	*analyze and interpret the chromosomal abnormalities and associated techniques*	-	2	2	-	2	-	-	-	-	-	-	-	-	2	-
CO-4:	*understand the genetic diseases using the genetic testing techniques*	-	-	2	3	2	-	-	-	-	-	-	-	-	2	-
CO-5:	*integrate the knowledge of human genetics to apply in various fields*	-	2	-	2	-	-	-	-	-	-	-	-	-	-	2

Unit-1 - Introduction to Human Genetics and Genome Organization ***9 Hour***

Classical & Modern Genetics - Human chromosome structure and organization - Mitochondrial genome organization - coding and non-coding genes- gene arrangements - regulatory RNAs-epigenetic regulation.

Unit-2 - Understanding of Inheritance in Human ***9 Hour***

Types of inheritance - mendelian inheritance and, deviations of mendelian inheritance - mitochondrial inheritance -Mendelian pedigree patterns & Pedigree analysis, Quantitative traits, Polygenic inheritance, Gene and genotype frequencies

Unit-3 - Chromosomal Abnormalities in Human ***9 Hour***

Numerical chromosome abnormalities and causative mechanisms - Aneuploidy & polyploidy - Structural chromosome abnormalities and causative mechanisms- Mixoploidy, X-inactivation, Mosaicism due to X-inactivation- Karyotyping, Fluorescent in situ hybridization techniques.

Unit-4 - Diagnosis of Genetic Diseases ***9 Hour***

Genetic testing single gene and whole genome- exome sequencing-Genome Wide Association Studies - Biochemical tests and gene expression analyses, Prenatal and neonatal genetic testing.

Unit-5 - Applications of Human Genetics ***9 Hour***

Applications of Human genetics - personalized medicine- pharmacogenetics - forensic analysis - pedigree construction and analysis - genetic counseling - importance of genetic counseling - Ethical & legal implications of human genetics research.

Learning Resources	1. *Human Molecular Genetics, 5th Edition - Tom Strachan & Andrew P Read, A Garland Science Book, CRC Press, 2018*	2 *Human Genetics, 12th edition – Lewis, McGraw hill 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 (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. Fiona D'Souza, Head of Scientific operations, reproductive genetics division,Anderson diagnostics Pvt Ltd, Chennai - 600006, fiona@andersondiagnostics.com*	1. *Dr. Bibhas Kar, Madras Medical Mission, Chennai, Tamilnadu,drbibhaskar65@gmail.com*	1. *Dr. N. ArulJothi, SRMIST*
2. *Dr. Chakshu Chaudhry, MD, DNB, Head Clinical consultant, SUMA Genomics, Bangalore, chakshu.doc@gmail.com*	2. *Dr. Partha P. Majumder, NIBG, Kalyani, West Bengal, ppm1@nibmg.ac.in*	2. *Dr. S. Kiran Kumar, SRMIST*

Course Code	21BTE315T	Course Name	METABOLIC ENGINEERING OF MICROBES	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:	*develop metabolically engineered organisms and products*
CLR-2:	*use tools and methods used for metabolic engineering of microbes*
CLR-3:	*understand regulatory mechanisms in metabolic pathways*
CLR-4:	*apply knowledge on design of a metabolic engineering in practice*
CLR-5:	*analyze metabolic flux in biochemical pathways*

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 regulation of metabolic pathways*	-	2	-	-	-	-	-	-	-	-	-	-	-	2	-
CO-2:	*understand methods used for metabolic engineering*	-	-	-	-	-	-	-	-	-	-	-	-	2	2	-
CO-3:	*devise methods for metabolic engineering*	-	-	3	2	-	-	-	-	-	-	-	-	2	2	-
CO-4:	*apply knowledge on tools and techniques used for metabolic engineering*	-	2	2	-	-	-	-	-	-	-	-	-	2	3	-
CO-5:	*develop value added products from metabolically engineered microbes*	-	-	3	2	-	-	-	-	-	-	-	-	2	3	-

Unit-1 - Overview of Cellular Metabolism	***9 Hour***
Anabolic and catabolic pathways, biomolecule transport processes, primary and secondary metabolite production, cellular energetics, yield coefficient, metabolic pathways and types.	
Unit-2 - Metabolic Regulation	***9 Hour***
Regulatory mechanisms of metabolic pathways – enzyme regulation by feedback and allosteric mechanism, transcriptional and translational control, two component system, global control, branch points and its classification, coupled reactions and its importance.	
Unit-3 - Pathway Manipulations	***9 Hour***
Metabolic engineering for increased production of ethanol, acetone, antibiotics, vitamins, xenobiotic degradation and biopolymer production.	
Unit-4 - Metabolic Engineering Tool Kit	***9 Hour***
Tools and techniques for metabolic engineering – classical mutagenesis, gene deletion using CRISPR, heterologous expression, RNA interference, chromosomal engineering, engineering protein secretory pathway, multifunctional enzyme systems.	
Unit-5 - Applications of Metabolic Engineering	***9 Hour***
Metabolic flux analysis, metabolic pathway flux distribution & calculations, genome scale model of cellular metabolism, cell free metabolic engineering.	

Learning Resources	1. *Stephanopolous, G.N, Nielsen J, Aristidou A A. Metabolic Engineering – principles and methodologies, Academic Press, 1998* 2. *Alper H. S. Systems metabolic engineering – methods and protocols, Humana Press, 2013* 3. *Vijay Singh, Ajay Kumar Singh, Chaitanya Joshi (Ed) Engineering of microbial biosynthetic pathways , Springer, 2019*	4. *Sang Yup Lee, Jens Nielsen, and Gregory Stephanopoulous. Metabolic Engineering - Concepts and applications, Vol 13, Wiley, 2021* 5. *Cortassa. S, Aon M A, Iglesias S A, Aon J C, Lloyd D. An introduction to metabolic and cellular engineering, 2nd edition, World Scientific, 2012.* 6. *Microbial Cell Factories Engineering for production of biomolecules Edited by Vijay Singh, Academic Press, 2021*

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. Selvaraj Vellaisamy, Ph.D Regenix Drugs Limited, Chennai,selvarajv@yahoo.co.in*	1. *Dr. S. Ramalingam, Anna university, Chennai ramabioprocess@annauniv.edu*	1. *Dr. M. Ramya, SRMIST*
2. *Dr. M. Durairaaj , Ph.D Orchid Pharmaceuticals, Chennai.durairaj@orchidpharma.com*	2. *Dr. N. Ayyadurai, CLRI, Adyar, Chennai. ayyadurai@clri.res.in*	2. *Dr. K. N. Rajnish, SRMIST*

Course Code	21BTE316T	Course Name	GENETIC ENGINEERING FOR CROP IMPROVEMENT	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:	*compare, contrast and distinguish the right molecular strategies for crop improvement*
CLR-2:	*understand the factors that control crop productivity*
CLR-3:	*investigate biotic and abiotic stress-plant interactions*
CLR-4:	*explore plant-microbe beneficial interactions*
CLR-5:	*equip with tools to engineer crop value addition*

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 modern genetic tools in crop improvement*	-	-	-	-	3	-	-	-	-	-	-	2	2	3	-
CO-2:	*analyze plant response to abiotic and biotic stress*	-	2	-	-	-	-	-	-	-	-	-	-	2	3	-
CO-3:	*develop strategies for plants to tolerate abiotic stress*	-	-	3	-	3	-	-	-	-	-	-	-	2	3	-
CO-4:	*engineer genetic approaches to tolerate biotic stress*	-	-	3	-	3	-	-	-	-	-	-	-	2	3	-
CO-5:	*plan strategies for bio-fortification and value addition*	-	2	3	-	3	-	-	-	-	-	-	-	-	3	-

Unit-1 - Organization and Expression of Plant Genes ***9 Hour***

Gene structure and expression, regulation of gene expression, plant promoters, terminators, reporters, selectable markers, marker-free transgenics, regulation of GMO.

Unit-2 - Tool Box for Engineering Crop Improvement ***9 Hour***

Mutational breeding, genomics assisted breeding, marker assisted backcross breeding, transgenic technology, gain of function and loss of function- genetic screens, RNAi, CRISPR, ZFN, and TALEN.

Unit-3 - Genetic Engineering for Biotic Stress Tolerance ***9 Hour***

Disease tolerance - intervention based on pathogen recognition and effectors, modification of defense signaling and regulation, targeting susceptible genes, dominant plant resistance genes, antimicrobial peptides. Genetic engineering of plants for insect resistance- cry genes for insect resistance, insect resistance through VIP genes, insect resistance through lectins, insect resistance through fusion proteins.

Unit-4 - Genetic Engineering for Abiotic Stress and Herbicide Tolerance ***9 Hour***

Overexpression of genes for transcriptional regulation, overexpression of genes for osmo-protectants, engineering of ion transport, overexpression of genes for stress signaling, quenching of reactive oxygen species. Herbicide tolerance – PSII herbicide, herbicides affecting biosynthesis of amino acids, glyphosate tolerance.

Unit-5 - Genetic Engineering for Value Addition and Fortification ***9 Hour***

Engineering male sterility in crop plants. Biofortification - vitamins, ascorbic acid, and tocopherols. Genetic engineering to reduce antinutritional traits – saponins and phytates.

Learning Resources	1. *S. Mohan Jain and D.S. Brar Molecular Techniques in Crop Improvement 2nd edition. 2010 Springer. ISBN 978-90-481-2966-9 e-ISBN 978-90-481-2967-6*	2. *Khalid Rehman Hakeem and Parvaiz Ahmad Munir Ozturk. 2013. Springer. Crop Improvement New Approaches and Modern Techniques. ISBN 978-1-4614-7027-4 ISBN 978-1-4614-7028-1*

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. Florida Tilton, Biozone Research Technologies Pvt, Ltd, Chennai (floridatilton@gmail.com*	1. *Dr. Ravindran, TNAU, Coimbatore, TN – (sivakasiravi@yahoo.com)*	1. *Dr. D. Rex Arunraj, SRM IST*
2. *Dr. N. Ayyadurai CLRI, Adyar, ayyadurai@clri.res.in*	2. *Dr. Gopalakrishnan, IARI New Delhi – (krish.icar@gmail.com)*	2. *Dr. Swapnageethanjali, SRM IST*

Course Code	21BTE317T	Course Name	MOLECULAR BIOLOGY OF INFECTIOUS DISEASES	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:	*state the basics of infectious diseases*
CLR-2:	*discuss molecular pathogenesis of bacterial diseases*
CLR-3:	*understand the molecular pathogenesis of viral diseases*
CLR-4:	*discuss the molecular pathogenesis of parasitic diseases*
CLR-5:	*illustrate the evasion mechanism of 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:	*understand the basics of the molecular pathology of various infectious diseases*	-	*2*	-	-	-	-	*2*	-	-	-	-	-	-	*2*	-
CO-2:	*investigate the molecular pathogenesis of bacterial pathogens*	-	-	-	-	-	-	*2*	-	-	-	-	-	*2*	*2*	-
CO-3:	*discuss the molecular pathogenesis of viral pathogens*	-	-	*3*	*2*	-	-	-	-	-	-	-	-	*2*	*2*	-
CO-4:	*examine the molecular pathogenesis of parasitic diseases*	-	*2*	*2*	-	-	-	-	-	-	-	-	-	*2*	*3*	-
CO-5:	*discuss the immunological surveillance mechanism of pathogens*	-	-	*3*	*2*	-	-	-	-	-	-	-	-	*2*	*3*	-

Unit-1 - Introduction to Infectious Diseases and Virulence Factors ***9 Hour***

Historical perspective of infectious diseases, disease outbreaks, microbial toxins, types of microbial toxins, toxin assays, toxin genes, waterborne pathogens, air-borne pathogens, soil-borne pathogens, pathogens transmitted via animals, mode of entry of pathogens, initiation of diseases, general disease symptoms – external, disease symptoms – internal, virulence factors – cell-bound, virulence factors – secreted, virulence-associated genes, plasmid-borne virulence-associated genes.

Unit-2 - Molecular Pathogenesis of Bacterial Diseases ***9 Hour***

Molecular pathogenesis of Vibrio cholerae-Genomic structure, serogroups, cholera toxin-Helicobacter pylori-CagA, VacA, Surface colonization, gastric cancer-Salmonella typhi-Distinctive virulence factors, serovars, typhoid toxin, Escherichia coli-pathotypes- toxin genes-Haemophilus influenzae-molecular determinants of pathogenicity-Neisseria gonorrhoeae - Surface structures. Tissue colonization, iron acquisition, Orb, IgA protease- Listeria monocytogenes-Molecular mechanisms for entry and spread, regulation of virulence genes.

Unit-3 - Molecular Pathogenesis of Viral Diseases ***9 Hour***

HIV-Genome structure, retroviral reverse transcriptase, transcription and gene regulation- Hepatitis virus- Serotypes, Genome structure, genes and transcriptional units Influenza virus-segmented genome replication, antigenic shift, antigenic drift-Polio virus- Serovars, Determinants of PV neurovirulence- Rabies virus-molecular, structural, and cellular aspects of RABV transcription and replication-Coronavirus - Genome structure and transcription, cytokine release syndrome.

Unit-4 - Molecular Pathogenesis of Parasitic Diseases ***9 Hour***

Molecular parasitology of Malaria - Trypanosomiasis- trypanosome gene expression and its regulation- Leishmaniasis Invasive/evasive determinants, Genomic organization, regulation of gene expression- Amoebiasis - Gene organization, Molecular determinants-Toxoplasmosis-Genetics and genome organization of toxoplasma gondii Criptosporidiosis-virulence factors, genome structure, gene expression and regulation.

Unit-5 - Evasion Mechanism	***9 Hour***
Hide from immune surveillance, microbe escape mechanism, antibiotic resistance mechanism, multiple drug resistance, evasion of phagocytosis, evasion mechanism of phagocytosis, antigen hypervariability, antigenic shift and drift, secreted modulators, surface modulators, interaction with toll-like receptors, interference with cytokines, complement pathway inhibition, defense against the competition, interfering with cell signaling.	

Learning Resources		
	1 Peter Williams, Julian Ketley & George Salmond, "Methods in Microbiology: Bacterial Pathogenesis, Vol. 27", Academic Press, 1998.	*3 Dimmock NJ, Easton AJ, Leppard KN. Introduction to modern virology. John Wiley & Sons; 2015 Dec 28.*
	2 Wilson BA, Winkler M, Ho BT. Bacterial pathogenesis: a molecular approach. John Wiley & Sons; 2020.	*4 Walochnik J, Duchêne M, editors. Molecular parasitology: protozoan parasites and their molecules. Springer; 2016.*

Learning Assessment

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

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. Dr. Rajeev Kumar Sukumaran, NIIST, Trivandrum	*1 Microbiology, Bharathidasan University, Tiruchirappalli*	*1 Dr. M.Ramya, SRMIST*
2 Dr.Ayyadurai , Scientist, CLRI , Chennai	*2 Mohammed Jaabir, Associate Professor, National college ,*	

Course Code	21BTE318T	Course Name	MOLECULAR DIAGNOSTICS	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:	*understanding hybridization based methods for diagnosis of genetic diseases*
CLR-2:	*state PCR based diagnosis*
CLR-3:	*discuss diagnosis by DNA Sequencing*
CLR-4:	*explain about nucleic acid based diagnosis of infectious diseases*
CLR-5:	*illustrate immunological diagnosis of infectious diseases*

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 hybridization based methods for diagnosis of genetic diseases*	*2*	*2*	*-*	*2*	*2*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*2*	*2*
CO-2:	*understand PCR based diagnosis*	*2*	*2*	*-*	*2*	*3*	*-*	*-*	*-*	*-*	*-*	*-*	*2*	*-*	*3*	*2*
CO-3:	*apply diagnostic method by DNA Sequencing*	*-*	*3*	*-*	*3*	*3*	*-*	*-*	*-*	*-*	*-*	*-*	*3*	*-*	*3*	*3*
CO-4:	*analyze nucleic acid based diagnosis of infectious diseases*	*-*	*3*	*-*	*3*	*2*	*-*	*-*	*-*	*-*	*-*	*-*	*3*	*-*	*3*	*3*
CO-5:	*illustrate Immunological diagnosis of infectious diseases*	*2*	*3*	*-*	*2*	*2*	*-*	*-*	*-*	*-*	*-*	*-*	*2*	*-*	*2*	*2*

Unit-1 - DNA Hybridization in Molecular Diagnosis — ***9 Hour***

FISH, Types of FISH, Interphase FISH, Metaphase FISH, Multicolor FISH, Application and Limitations of FISH. Principles of genomic hybridization, Comparative genomic hybridization. Diagnostics based on DNA chips and Micro-arrays

Case study*: Diagnosis of Down syndrome, Digeorge syndrome, Childhood leukemia.*

Unit-2 - PCR Based Diagnostics — ***9 Hour***

End-point PCR,ARMS PCR, Allele specific PCR, Restriction fragment length polymorphism (RFLP), Mutation detection using RFLP, Multiplex PCR, LAMP PCR, Multiplex ligation probe dependent amplification (MLPA), Real time PCR, High resolution melting curve analysis

Case study: *Diagnosis of Sickle cell anemia, Duchenne muscular dystrophy*

Unit-3 - DNA Sequencing in Molecular Diagnosis — ***9 Hour***

Basics of DNA sequencing, Mutation detection by sequencing, Genome wide association studies, Application in Health care, Next generation sequencing, Clinical exome sequencing, Linkage analysis, Methods for DNA Methylation analysis, MALDI-TOF for mutation analysis

Case study*: Molecular aspects and diagnosis of Marfan syndrome, Cystic fibrosis, diabetes,*

Unit-4 - Diagnosis of Microbial Infection — ***9 Hour***

Ribotyping, Pulse Field Gel Electrophoresis, Multiplex PCR for virulence factor detection, Recombinase polymerase amplification (RPA) assay, Sequencing for multidrug resistant markers, DNA chips and its use in mutation screening in virulence genes

Case study*: MRSA, Vibrio cholerae, Acinetobacter boumannii*

Unit-5 - Immunological Methods of Diagnosis	***9 Hour***
Agglutination test, ELISA and types of ELISA, Immunofluorescence, Western blotting, Protein diagnostics by proximity ligation, 2DHPLC	
Case study: *HIV detection, Tuberculosis, Flu virus, Dengue, chikungunya*	

Learning Resources		
	1. *3rd edition George P. Patrinos, Molecular Diagnostics Academic Press 2017* 2. *William B. Coleman and Gregory J. Tsongalis, Diagnostic Molecular Pathology A guide to applied Molecular testing Academic Press 2016*	3. *Dr. Michal Janitz, Next Generation Genome Sequencing: Towards Personalized Medicine Wiley-VCH Verlag GmbH & Co. KGaA 2018* 4. *Robert Hnosko, ELISA Methods and Protocol Humana New York, NY, 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. Satheesh K. Sainathan, Study Director, Phenotypic Services, Eurofins Discovery, St Charles, Missouri, USA, sksainathan@gmail.com*	1. *Dr. Yuvaraj Sambandam, Assistant Professor, Surgery, Transplant Surgery Division, North western University, USA, syuvarajj@gmail.com*	1. *S. Iyappan, SRMIST*
2. *Dr. Subramanian Senthivinayagam, Team Leader, Invivotek, Genesis Drug Discovery and Development, Greater Philadelphia, USA,* subbi100@gmail.com	2. *Dr. A. Muralidharan Anbalagan, Assistant Professor, Tulane University, USA, manbalag@tulane.edu*	2. *R. Satish, SRMIST*

Course Code	21BTE420T	Course Name	GENE THERAPY	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:	*provide basic knowledge on gene therapy and its importance*
CLR-2:	*build up an interest to learn about the different types of gene therapy*
CLR-3:	*develop awareness about the different methods of gene delivery and provide knowledge on vectors*
CLR-4:	*initiate interest on latest techniques in genome editing and understand its applications*
CLR-5:	*develop interest on applications and uses of gene therapy in treatment of diseases*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	Program Outcomes (PO)												Program Specific Outcomes		
		1 Engineering Knowledge	2 Problem Analysis	3 Design/development of solutions	4 Conduct investigations of complex problems	5 Modern Tool Usage	6 The engineer and society	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*recall various methods of gene therapy in treating diseases*	-	-	2	-	2	-	-	-	-	-	-	2	2	-	-
CO-2:	*illustrate knowledge on different types of gene therapy and its applications*	2	-	-	2	-	-	-	3	-	-	-	-	2	-	-
CO-3:	*apply knowledge on construction of viral vectors and usage of non-viral vectors to correct the genetic defect*	3	-	-	3	-	-	-	-	-	-	-	2	-	-	2
CO-4:	*analyze molecular aspects involved in genome editing in gene therapy*	3	-	-	-	2	-	-	2	-	-	-	-	2	-	-
CO-5:	*evaluate treatment of diseases addressed by gene therapy clinical trials*	-	-	-	2	-	-	-	3	-	-	-	-	-	1	-

Unit-1 - Introduction to Gene Therapy ***9 Hour***

Genes as drugs in Gene Therapy-History of Gene Therapy- Types of gene therapy- Somatic and Germline- Ex vivo and In vivo gene therapy- Nucleic acid-based gene therapy (Antisense DNA and RNA, Ribozymes, RNA decoys)-Vectors for gene therapy-viral and non-viral, Diseases with dominant heredity, Diseases with recessive heredity, Ex vivo gene therapy with case study-SCID and Adrenoleukodystrophy- In vivo gene therapy with case study- Cystic fibrosis and Inherited Retinal Disorders- Ethical problems and social problems in gene therapy.

Unit-2 - Types of Gene Therapy ***9 Hour***

Embryo somatic gene therapy - Reproductive cloning and Therapeutic cloning-Prenatal/ fetal gene therapy – Concept, methods and case study –Tay Sach's disease- Postnatal somatic gene therapy- Genetic Screening- Preimplantation genetic diagnosis-History, Indications, applications, Techniques and ethical issues-Germline gene therapy-Suicide gene therapy – Secretion gene therapy-Immunotherapy-Gene therapy for infectious diseases-Target pathogens for antimicrobial gene therapy-Examples of clinical trials for infectious diseases

Unit-3 - Vectors in Gene Therapy ***9 Hour***

Cellular barriers to gene therapy-Direct Inoculation of DNAs & RNAs, Non-viral methods-Physical and Chemical methods-Viral Vectors-Retroviral vectors-Structure, genome, vector construction, Mechanism of action, advantages and disadvantages- Adenoviral vectors- Structure, genome, vector construction, mechanism of action, advantages and disadvantages, Adeno associated viral vectors- Structure, genome, vector construction, mechanism of action, advantages and disadvantages, Herpes simplex viral vectors – Structure, genome, vector construction, mechanism of action, advantages and disadvantages-Hybrid vectors.

Unit-4 - Genome Editing in Gene Therapy ***9 Hour***

Genome editing-Gene Targeting, Genome editing Processes-Double strand break repair, Engineered Nucleases-Meganucleases-ZNFs as gene editing tools- Introduction, mechanism and applications-TALENs as gene editing tools- Introduction, mechanism and applications- CRISPR/Cas9 as gene editing tools- Introduction, mechanism and applications- Precision and efficiency of engineered nucleases, Multiplex automated Genome engineering, Types of therapeutic genome modifications- Non homologous end joining – Mechanism, gene knockout procedure- Homology directed repair – Mechanism and gene correction/addition procedure, Applications of Genome editing, Prospects and limitations of Genome editing.

Unit-5 - Applications in Gene Therapy	***9 Hour***
Stem cells in gene therapy-gene therapy of hematopoietic stem cells, major applications, procedures of gene transfer into Hematopoietic Stem Cells, treatment of genetic diseases-Gene therapy of cancer- using suicide genes, Immunotherapy of Cancer-Gene therapy of neurodegenerative disorders- Alzheimer's Disease, Parkinson's Disease, Huntington's Disease, Spinal Muscular Dystrophy- Gene therapy of eye diseases- Retinal Photo transduction and the Visual Cycle, Congenital Retinal degenerations, Retinal Neovascularization and Retinoblastoma, Gene therapy of cardiovascular diseases - Heart Failure, Therapeutic Angiogenesis-Gene therapy for bone regeneration- Gene therapy of HIV infection - Natural History of HIV-1 Infection, Gene Therapy of HIV Infection by Intracellular Immunization, Therapy of HIV Infection by Immunotherapy, Recent advances in gene therapy.	

Learning Resources	
1. *Nicholas R. Lemoine, David N. Cooper, "Gene Therapy", Garland Science, 2020* 2. *Mauro Giacca, "Gene Therapy", Springer Milan, 2014.* 3. *Clévio Nóbrega, Liliana Mendonça, Carlos A. Matos, "A Handbook of Gene and Cell Therapy", Springer Cham, 2020.*	4. *Roland W. Herzog, "A Guide to Human Gene Therapy",World Scientific Publishing Co Pvt. Ltd. 2010* 5. *David Benjamin Turitz Cox et al "Therapeutic genome editing: prospects and challenges" Nature Medicine, Vol 21(2): 121- 131, 2015.* 6. *Christopher W Peterson and Hans-Peter Kiem, "Cell and Gene Therapy for HIV Cure" current topics in microbiology and immunology, Vol 417:211-248, 2018.*

Learning Assessment

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

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Ms. Krutika Rajkumar, Life Cell, Senior Manager Corporate Communications, krutika.r@lifecell.in*	1. *Dr. Sachin Kumar, Department of Biosciences and Bioengineering, Indian Institute of Technology Guwahati, Guwahati 781039, Assam, India. sachinku@iitg.ac.in*	1. *Dr. Devi. A, SRMIST*
2. *Dr.Sudha Warrier, Associate Professor, Manipal University, Manipal school of Regenerative Medicine, sudha.warrier@manipal.edu*	2. *Dr. B.S.Lakshmi, Associate Professor, Anna University, lakshmibs@annauniv.edu*	2. *Dr. Swapna Geetanjali A, SRMIST*

Course Code	21BTE421T	Course Name	FUNCTIONAL 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, organization and function across life*
CLR-2:	*analyze about the comparative genomics of organelles and nuclear genomes across life*
CLR-3:	*apply different classical methods to study gene expression and whole transcriptome*
CLR-4:	*compare various NGS techniques to study genome, exome, and transcriptomes*
CLR-5:	*infer the basics of metabolic pathways, transcription factors and genome editing*

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 basics of genome organization across life and study of gene function*	*2*	-	-	-	-	-	-	-	-	-	-	-	-	-	*2*
CO-2:	*apply organelle and nuclear genomes across life*	*2*	*2*	-	*2*	-	-	-	-	-	-	-	-	-	*2*	*2*
CO-3:	*use transcriptome and classical methods to study gene expression*	*2*	*3*	-	*2*	*2*	-	-	-	-	-	-	-	-	*3*	*2*
CO-4:	*compare traditional and Next Generation Sequencing (NGS)platforms for the study of genome, exome and transcriptome*	*3*	*3*	-	*2*	*2*	-	-	-	-	-	-	-	-	*3*	*2*
CO-5:	*summarize genes for metabolic pathways, transcription factors, genome editing*	*2*	*3*	-	*2*	-	-	-	-	-	-	-	-	*2*	*3*	*2*

Unit-1 - Genomic Concepts	***9 Hour***
Genome organization in Eukaryotes - Genetic elements and their organization in Eukaryotes - Genetic elements and their organization in prokaryotes - Forward and reverse genetics - Methods in Forward and reverse genetics - Current methods in Forward and reverse genetics	
Unit-2 - Comparative Genomics	***9 Hour***
Genome size - gene content - Gene order - Homology - Comparative genomics of bacteria - Pangenome-metagenomics - Microbiome - Horizontal gene transfer - Methods to study organelle genomes - Comparative genomics of planned genomes - Comparative genomics of nuclear genomes - Comparison of plant and animal genomes	
Unit-3 –Transcriptomics	***9 Hour***
Transcriptome from Eukaryotes and Prokaryotes - Gene expression studies with mRNA and other RNAs - Classical methods to study gene expression - Northern hybridization - Differential Display PCR - Serial Analysis of Gene Expression (SAGE) - Reverse transcriptase PCR (RT-PCR) to study gene expression - Quantitative PCR (real time) to study gene expression - Methodology of RT-PCR, and real time-PCR - Study of Gene expression using Microarray - Principle and Methodology of Microarray - Correlation of mRNA and protein abundance.	
Unit-4 - DNA Sequencing	***9 Hour***
Sanger method of DNA Sequencing - Next Generation Sequencing (NGS) - Principle and methodology of NGS Platforms - Third Generation Sequencing methods - Comparison of high-throughput sequencing methods and applications - Genome sequencing and assembly - Gene Prediction - High-throughput RNA sequencing - RNA sequencing to study genome wide gene expression - Differential gene expression analysis with RNAseq - Small RNA sequencing - Targeted sequencing - Exome sequencing - Amplicon sequencing.	

Unit-5 - Study of Gene functions	***9 Hour***
Metabolic pathways - KEGG - Signalling cascades controlled by Transcription factors - Genome editing - Targeted genome Editing - Tools for genome editing - CRISPR/cas9 genome editing - Genetic variations and diseases - Tools to study mendelian diseases - Genomics of monogenic disorders - Genomics of polygenic disorders - Genomics in Diagnostics - Population and Evolutionary genetics - Applications of functional genomics in agriculture - healthcare and prokaryotes.	

Learning Resources	1. *Pevsner. J., "Bioinformatics and Functional Genomics", 3rd edition, Wiley-Blackwell. 2015.* 2. *Mount. D, "Bioinformatics: Sequence and Genome Analysis", 2nd Edition, Cold Spring Harbor Laboratory Press, New York. 2004*	3. *Primrose. S.B., Twayman. R.M., "Principles of Gene Manipulation and Genomics" 7th edition, Blackwell publishing. 2006.*

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. S. Mahalingam,Indian Institute of Technology Madras, Chennaimahalingam@iitm.ac.in*	1. *Dr. Habeeb. S. K. M, SRM*
2. *Dr. N. Mathan, Allianz Biosciences (P) Ltd, Puducherrynm@abpl.co.in*	2. *Dr. M. Raveendran,Tamil Nadu Agricultural University, Coimbatore.raveendrantnau@gmail.com*	2 *Dr. R. Satish, SRMIST*

Course Code	21BTE422T	Course Name	GENOME EDITING	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*describe the basics of genome editing nucleases*
CLR-2:	*design constructs for targeted genome modifications using genome-editing nucleases*
CLR-3:	*develop strategies to use genome editing nucleases*
CLR-4:	*apply gene editing nucleases in the treatment of human diseases*
CLR-5:	*analyze legal and bioethical issues of genome edited 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:	*understand the mechanism by which programmable nucleases make targeted engineering in the genome*	-	-	2	-	2	2	-	-	-	-	-	-	2	3	-
CO-2:	*design guide RNAs and CRISPR/Cas editing vectors for targeted genome engineering*	2	-	-	-	3	-	-	-	-	-	-	-	-	3	-
CO-3:	*use targeted genome editing method in various model organisms*	-	-	2	2	2	-	-	-	-	-	-	-	2	-	-
CO-4:	*apply targeted genome editing method to treat human diseases*	-	-	3	-	2	2	-	-	-	-	-	-	2	3	-
CO-5:	*analyze biosafety issues and regulatory concerns of genome edited organisms*	-	2	-	-	-	-	2	3	-	-	-	-	-	3	-

Unit-1 - Introduction to Genome Editing	***9 Hour***
Targeted genome engineering-Double Strand Breaks- Recombination; Homologous Recombination and Non-Homologous End Joining- homology directed repair-Biology of endonucleases (Zinc Finger nucleases, TALENs and CRISPR/Cas), Base editors-Advantages and disadvantages of Zinc finger nucleases, TALENs, CRISPR/Cas-On and Off target effects of genome editing nucleases	
Unit-2 - Design and Delivery of Gene Editing Nucleases	***9 Hour***
Guide RNA design-Different types of Cas proteins-Vectors for genome editing- Delivery of viral vectors for genome editing-Base editing, T7E1-Bioinformatic tools of genome editing; PROGNOS, CRISPR-P, CHOPCHOP, CRISPRz, TIDE analysis-Base editing-designer and analyser-NGS based off-target identifications	
Unit-3 - Genome Editing in Model Organisms	***9 Hour***
E. coli-Drosophila-Zebrafish-Mouse and Rat-Arabidopsis and rice-Nematode-Livestock-Human cell lines-Human induced pluripotent stem cells	
Unit-4 - Application of Genome Editing in Treating Human Diseases	***9 Hour***
Cancer-AIDS-Blood Disorders-Ophthalmological Diseases-Cystic fibrosis-COVID-19-Neurological diseases	
Unit-5 - Legal and Bioethical Issues of Genome Editing	***9 Hour***
Inventors of genome editing nucleases-Patents related to genome editing nucleases-Challenges and safety of personalized medicine-The future of CRISPR /cas technology-Ethical concerns of human germ cell gene editing-Regulation of genome edited agricultural plants	

Learning Resources	
	1. *Appasani K "Genome Editing and Engineering: From TALENs, ZFNs and CRISPRs to Molecular Surgery", Cambridge University Press, 2018*
	2. *Tsan S "Precision Medicine, CRISPR, and Genome Engineering Moving from Association to Biology and Therapeutics", Springer. 2017*
	3. *Zhara K, Mishra R, Joshi R "Genome Editing Technologies for Crop Improvement", Springer.2022*
	4. *Sarmah, BK and Borah BK "Genome Engineering for Crop Improvement", Springer. 2021*
	5. *Jeganath D et al. CRISPR for Crop Improvement: An Update Review, Frontiers in Plant Science. 2018*

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

Course Designers		
Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. M. Saravana Kumar, Rasi Seeds, Tamilnadu msk@rasiseeds.com*	1. *Dr. K.R. Sivaprakash, IGIB, New Delhi sivaprakash.ramalingam@gmail.com,*	1. *Dr. S. Kiran Kumar, SRM IST*
2. *Dr. MS Vinoth, Advanta US Inc, USA vinodms@gmail.com*	2. *Dr. C. Appunu, SBI, Coimbatore cappunu@gmail.com,*	2. *Dr. G. Ganesan, SRM IST*

Course Code	21BTE423T	Course Name	GENES & ANIMAL DEVELOPMENT	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:	*categorize the mechanisms of cell-to-cell interactions*
CLR-2:	*assemble genetic concepts behind sex determination and body patterning*
CLR-3:	*summarize the role of various genetic pathways in neural tube development*
CLR-4:	*understand the genetic basis of somite and kidney development*
CLR-5:	*classify the genetic mechanisms involved in limb and digestive organs development*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1 Engineering Knowledge	2 Problem Analysis	3 Design/development of solutions	4 Conduct investigations of complex problems	5 Modern Tool Usage	6 The engineer and society	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*explain the mechanisms of cell communication in the context of development*	-	*2*	*3*	-	*2*	-	-	-	-	-	-	-	-	-	*2*
CO-2:	*appraise the genetics behind sex determination and body axes specification*	-	*2*	*3*	*2*	-	-	-	-	-	-	-	-	-	*2*	*2*
CO-3:	*discuss the genetic basis of neurogenesis*	-	*3*	-	*2*	*2*	-	-	-	-	-	-	-	-	*3*	*2*
CO-4:	*relate the role of genetic factors on development of mesoderm organs*	-	*3*	-	*2*	*2*	-	-	-	-	-	-	-	-	*3*	*2*
CO-5:	*interpret the genetics behind limb development and gut tube formation*	-	*3*	*2*	*2*	-	-	-	-	-	-	-	-	*2*	*3*	*2*

Unit-1 - Cell-to-Cell Communication — ***9 Hour***

Differential cell affinity - Cadherins and cell adhesion - ECM as a source of developmental signals – Integrins - Epithelial-mesenchymal transition in development - Cell signaling - Induction and Competence - Epithelial-mesenchymal interactions - Inducer molecules - Morphogen gradients - Signal transduction cascades - FGF and RTK pathway - Paracrine factors - The Wnt family.

Unit-2 - Genetics of Sex Determination and Body Axes Specification — ***9 Hour***

Bipotential gonads - Role of Wnt4 and R-spondin-1 in ovary development - Role of Sry and Sox9 in testis determination - Sex determination in Drosophila - Role of Sex-lethal and Doublesex genes - Genetics of Drosophila body patterning - Maternal gradients -AP axis and DV axis specification - Gap genes - Pair-rule genes - Segment polarity genes - The Homeotic selector genes.

Unit-3 - Genetics of Neural Tube Formation — ***9 Hour***

Ectoderm specification - Primary neurulation - Patterning of the CNS, Role of Shh, RA and BMP signaling - Neural crest cell migration – Delamination - Collective migration - Growth cones and axon pathfinding - Axon guidance - Ephrins and semaphorins - Local and long-range guidance molecules.

Unit-4 - Genetics of Mesoderm Diversification — ***9 Hour***

Specification of paraxial mesoderm - Colinearity of Hox genes to determine AP axis identity – Somitogenesis - The clock-wavefront model - Sclerotome development - Dermomyotome development - Role of Pax8 and Lim1 in specification of intermediate mesoderm - Reciprocal interactions of developing kidney tissues.

Unit-5 - Development of Endodermal Organs — ***9 Hour***

The limb bud - Role of Hox genes - Specification of limb fields - Apical ectodermal ridge - Role of Shh signaling in digit specification - Specification of endoderm - Development of gut tissue and the digestive tube - Development of liver, pancreas and gall bladder - Development of respiratory tube.

Learning Resources	1. *Developmental Biology (2020): Scott F. Gilbert and Michael J.F. Barresi, Twelfth Edition, Oxford University Press, Inc.* 2. *Essential Developmental Biology (2012): J.M.W. Slack, Third Edition,Wiley-Blackwell Publishers*	3. *Principles of Development (2015): Lewis Wolpert, Cheryll Tickle and Alfonso Arias, Fifth Edition, Oxford Publishers, Inc.* 4. *Principles of Developmental Genetics (2014) S.A. Moody (Ed.) Second Edition, Academic Press*

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%*	*-*	*10%*	*-*	*15%*	*-*
Level 2	*Understand*	*25%*	*-*	*15%*	*-*	*25%*	*-*
Level 3	*Apply*	*30%*	*-*	*30%*	*-*	*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. K. Subramaniam,Indian Institute of Technology Madras, Chennai,subbu@iitm.ac.in*	1. *Dr. S. Kirankumar, SRMIST*
2 *Dr. N. Mathan, Allianz Biosciences (P) Ltd, Puducherry nm@abpl.co.in*	2 *Dr. Jonaki Sen,Indian Institute of Technology, Kanpur jonaki@iitk.ac.in*	2. *Dr. A. Devi, SRMIST*

Course Code	21BTE424T	Course Name	GENETICS OF CANCER	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:	*obtain knowledge on Biology and Genetics of Cancer*
CLR-2:	*identify the major steps in the metastatic process*
CLR-3:	*comprehend the molecular signaling mechanisms involved in Cancer*
CLR-4:	*evaluate the mechanisms of cell cycle control and cell death*
CLR-5:	*identify novel drugs and targets for cancer treatment*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*understand the factors, types and hallmarks of cancer*	-	-	-	-	*2*	-	*3*	-	-	-	-	*3*	-	-	-
CO-2:	*recognize genetic changes leading to tumor development, invasion, and metastasis*	-	-	*3*	*2*	-	-	*2*	-	-	-	-	-	-	-	*3*
CO-3:	*use epigenetics for cancer prevention and treatment*	-	-	-	-	-	-	-	*3*	-	-	*2*	*2*	-	-	-
CO-4:	*apply the knowledge about cell cycle and cell death mechanism for cancer control*	-	-	*2*	-	-	-	*3*	-	*2*	-	-	-	-	-	*2*
CO-5:	*evaluate the gene targets for cancer treatment*	-	-	-	-	-	*1*	-	*2*	-	-	-	*3*	-	-	-

Unit-1 - Basics of Cancer	***9 Hour***
Introduction and Classification of Cancer (Benign and Malignant), Types of cancer (Carcinoma, Sarcoma, Blood cancers-Leukemia and lymphoma, Melanoma, Brain and Spinal tumors) Factors causing cancer- Physical, Chemical and Biological (bacteria, virus, protozoa), Hallmarks of cancer, Cancer detection - biopsy, ctDNA, Circulating Tumor Cells.	
Unit-2 - Cancer Metastasis	***9 Hour***
Tumor suppressor Genes, Oncogenes, Dark matter of Cancer Genome- aberrations in regulatory elements, untranslated regions, splice sites, non- coding RNAs in cancer, Genes involved in Metastasis, Steps involved in metastasis - Intravasation, Epithelial mesenchymal transition Extravasation, Mesenchymal epithelial transition, Metastasis suppressor genes (self-study), Role of Angiogenesis and its inhibitors.	
Unit-3 - Epigenetics and Signaling Pathways	***9 Hour***
Epigenetics and Cancer, DNA methylation alterations, histone and RNA modifications, and nucleosome remodeling, Epigenetic targets for cancer treatment and their mechanism of action (self-study), Role of Hormones and cancer - ER, PR, prolactin, Androgen, and thyroid hormones, Signaling pathways involved in cancer, Growth factors and cancer.	
Unit-4 - Cell Cycle and Cell Death Mechanisms	***9 Hour***
Genes involved in Cell cycle - Cyclins and CDKs, Cell cycle-targeted therapeutic agents (self-study), Cell death mechanisms-Apoptosis (Intrinsic and Extrinsic), Autophagy, Cross talk between apoptosis and autophagy, Genes involved in DNA repair and Aging, Inflammation and Cancer- Colitis associated cancer.	
Unit-5 - Cancer Therapy and Resistance	***9 Hour***
Genes involved in Chemoprevention and Chemotherapy, Targets of Immunotherapy, Gene Therapy and Hormone Therapy, Mechanism of action of Radiation Therapy, Cancer Stem Cell Targeted therapy, Personalized Medicine (self-study). Genes involved in Chemotherapy and radiation therapy Resistance. Advances in Oncology, Alternative medicine treatment options for Cancer	

Learning Resources		
	1. *Bunz F. "Principles of Cancer Genetics", Springer Science, 3rd Edition (2022).*	3. *Oxford Textbook of Cancer Biology, by Pezzella Et Al, Oxford UP, 2019*
	2. *Weinberg R. "The Biology of Cancer", Garland, Second Edition (2013).*	4. *Treatment of Cancer, Edited By Pat Price, Karol Sikora, by CRC Press Year 2021*

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. Dharmalingam Subramaniam, Scientist II at Attentive Science, Stilwell, Kansas, United States, ksdlingam@yahoo.com*	1. *Dr. A. Muralidharan Anbalagan, Assistant Professor, Tulane University, United States, manbalag@tulane.edu*	1. *Dr. R. Satish, SRMIST*
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