ACADEMIC CURRICULA

Professional Core Courses

BIOTECHNOLOGY

Regulations - 2018

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

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

Kattankulathur, Kancheepuram, Tamil Nadu, India

Course Code	18BTC101J	Course Name	BIOCHEMISTRY	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:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Interpret the various aspects of biological macromolecules			
CLR-2 :	Interrelate between metabolism of biomolecules and the enzymes involved			
CLR-3 :	Comprehend principles behind estimation and analysis of biomolecules in the body fluids			
CLR-4 :	Evaluate the role of biochemistry in various biological processes and the role of biochemistryin making them economical			
CLR-5 :	Assess the metabolic diseases and disorders related to biomolecules			
CLR-6 :	Evaluate the basics of practical biochemistry and have an understanding on biomolecules			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	Discuss in details the structures and reactions of biomolecules (proteins, lipids, nucleic acids, and carbohydrates)	1	80	70	L	-	-	H	H	-	-	-	H	H	-	H	H	H	H
CLO-2 :	Describethe synthesis of biomolecules and their role in metabolic pathways along with their regulation	1	80	70	-	L	-	H	H	-	-	-	H	H	-	H	H	H	H
CLO-3 :	Demonstrate an understanding of the metabolic pathways - the energy-yielding andenergy-requiring reactions in life	2	80	70	-	H	-	H	H	-	-	-	H	H	-	H	H	H	H
CLO-4 :	Describe how these biochemical processes are not isolated but tightly integrated, with specific control sites and key junctions	2	80	70	-	L	-	H	H	-	-	-	H	H	-	H	H	H	H
CLO-5 :	Demonstratethe role of biomolecules in metabolic diseases and disorders	2	80	70	-	H	-	H	H	-	-	-	H	H	-	H	H	H	H
CLO-6 :	Explain the importance of laboratory safety and standard operating procedures of lab equipment	1	80	70	-	H	-	H	H	-	-	-	H	H	-	H	H	H	H

Duration (hour)		15	15	15	15	15
S-1	SLO-1	History of Biochemistry, Chemical bonds	Introduction to metabolism	Introduction to amino acid metabolism	Introduction of Fatty acids metabolism	Metabolic relationships among the major human organs
	SLO-2	pH and Buffers	Carbohydrate metabolism	Transamination	Hormones role in the release of fatty Acids from adipose tissue	Introduction –Bioenergetics
S-2	SLO-1	Introduction and classification of carbohydrates	Glycolysis - Introduction	Deamination	Fatty acid oxidation - Introduction	High energy compounds
	SLO-2	Monosaccharaides – structure and function	Role of enzymes in glycolysis	Metabolism of ammonia	Oxidation	ATP synthesis
S-3	SLO-1	Disaccharides– structure and function	Pyruvate metabolism	Urea cycle	Energetics of fatty acid oxidation	Electron transport chain (ETC)
	SLO-2	Polysaccharides – structure and function	Regulation of glycolysis	Importance of urea cycle	Ketone bodies	Biological oxidation
S 4-5	SLO-1	Lab 1 - Introduction to commonly used instruments and laboratory safety	Lab 4 - Qualitative analysis of Disaccharides in food samples	Lab 7 - Estimate blood glucose, compare normal and diabetes mellitus samples	Lab 10: Repeat/Revision of experiments	Lab 13 - Quantitative analysis of proteins (Lowry's method)
	SLO-2					
S-6	SLO-1	Introduction and classification of amino acids	Citric acid cycle - Introduction	Biosynthesis of amino acids	Ketogenesis	Electron Carriers
	SLO-2	Introduction and classification of proteins	Regulation of Citric acid cycle	Tyrosine synthesis	Biosynthesis of fatty acids	Overview of pathway in the mitochondrial ETC
S-7	SLO-1	Primary Structure of proteins	Gluconeogenesis and energetics	Phenylalanine synthesis	Regulation of fatty acid synthesis	Various complexes in the mitochondrial ETC

	SLO-2	*Secondary, Tertiary and Quaternary structure of proteins*	*Cori and Glucose-alanine cycle*	*Tryptophan synthesis*	*Eicosanoids and cholesterol biosynthesis*	*Chemiosmotic theory*
S-8	SLO-1	*Functions and biotechnological applications of proteins*	*Glycogen metabolism*	*Molecules derived from amino acids*	*Lipoproteins*	*Oxidative Phosphorylation*
	SLO-2	*Biological important peptides Enzymes – structure and function*	*Hormones regulate muscle use of glycogen*	*Neurotransmitters*	*Disorders of Lipid metabolism*	*Inhibitors of oxidative phosphorylation*
S 9-10	SLO-1 SLO-2	*Lab 2 - Preparation and measurement of pH of standard buffers*	*Lab 5 - Qualitative analysis of Polysaccharides in food samples*	*Lab 8 - Acid hydrolysis and action of salivary amylase on starch*	*Lab 11 - Separation of amino acids on Thin Layer Chromatography*	*Lab 14 - Quantitative estimation of serum cholesterol*
S-11	SLO-1	*Enzyme kinetics*	*Various bioproducts produced from carbohydrate metabolism*	*Biosynthesis of lignin, tannin, and auxin*	*Biosynthesis of Pyrimidines*	*Glycerol phosphate Shuttle*
	SLO-2	*Industrial application of enzymes*	*Disorders of carbohydrate metabolism*	*Regulation of amino acid synthesis*	*Biosynthesis of Purine*	*Malate aspartate Shuttle*
S-12	SLO-1	*Introduction to Nucleic acids – DNA and RNA*	*Diabetes Mellitus – Types and diagnosis*	*Disorders of tyrosine metabolism*	*Degradation of purine and pyrimidines nucleotides*	*Photosynthesis*
	SLO-2	*Classification of lipids*	*Biochemical aspects of Diabetes mellitus*	*Disorders of phenyl alanine metabolism*	*Disorders of purine metabolism*	*Light and dark reactions*
S-13	SLO-1	*Classification of fatty acids*	*Oral medications of Diabetes mellitus*	*Disorders of heme metabolism*	*Disorders of pyrimidine metabolism*	*Carbon Dioxide Fixation: Calvin-Benson Cycle*
	SLO-2	*Cholesterol and cell membranes*	*Hyperglycemia and diabetic nephropathy*	*Medically important peptides and amino acid derivatives*	*Deoxyribonucleotide Biosynthesis*	*Regulation of Carbon Dioxide Fixation*
S 14-15	SLO-1 SLO-2	*Lab 3 - Qualitative analysis of Monosaccharide in food samples*	*Lab 6 - Qualitative analysis of lipids (triglycerides, cholesterol, phospholipids)*	*Lab 9 - Estimation of enzyme kinetic parameters*	*Lab 12 - Enzymatic hydrolysis of glycogen by α and β amylase*	*Lab 15 - Quantitative analysis of urea in serum*

Learning Resources	1. *U. Satyanarayana, U. Chakrapani, Biochemistry, 4th ed., Elsevier India, 2013* 2. *David L. Nelson, Michael M. Cox, Lehninger Principles of Biochemistry, 7th ed., W.H. Freemen & Co., 2017*	3. *Jeremy M. Berg, John L. Tymoczko, Gregory J. Gatto, Lubert Stryer, Biochemistry, 8thed., 2015* 4. *Donald Voet, Judith G. Voet, Charlotte W. Pratt, Fundamentals of Biochemistry: Life at the Molecular Level", 5th ed., John Wiley & Sons Inc., 2016*

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
Level 2	Apply Analyze	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
Level 3	Evaluate Create	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1 Dr. P. Bala Kumaran, Proklean Technologies (P) Limited, Chennai, genbalu86@gmail.com	*1.Prof. K Subramaniam, IITM, Chennai, subbu@iitm.ac.in*	*1. Dr. S. ThyagaRajan, SRMIST*
2. Dr. Karthik Periyasamy, Aurobindo Pharma Limited, Hyderabad karthikmpk@gmail.com	*2.Prof. R. B. Narayanan, SVCE, Chennai, rbn@svce.ac.in*	*2. Dr. V. Vinoth Kumar SRMIST*

Course Code	18BTC102J	Course Name	CELL BIOLOGY	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:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	State the basic concepts and understanding of cell structure and function			
CLR-2 :	Analyze the different strategies of organization of organelles			
CLR-3 :	Restate the concepts of structural and functional orientation in eukaryotes			
CLR-4 :	Create a platform to study the molecular mechanism of cellular transport			
CLR-5 :	Relate the applications of various receptors and their role in diseases			
CLR-6 :	Analyze the concept of cell signaling and their role in diseases			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	Discuss on the basic concepts of cell biology	2	80	70	M	M	-	H	-	-	-	H	-	-	-	-	H	H	H
CLO-2 :	Plan on designing and conducting experiments involving cell structures and functions	2	85	75	M	M	H	H	-	-	-	H	H	-	-	-	H	H	H
CLO-3 :	Recognize the basis of cell structure and its function in development and cell death	2	75	80	M	M	H	H	H	-	-	H	H	-	-	-	H	H	H
CLO-4 :	Describe the steps involved in cell-cell signaling in mammalian cell systems	2	85	80	M	M	H	H	H	H	H	H	H	-	-	-	H	H	H
CLO-5 :	Devise examples and advances in the different areas of diagnostic and therapeutic applications of cells	3	85	80	M	M	H	H	H	M	H	H	H	-	-	-	H	H	H
CLO-6 :	Design the experiments using routine and specialized cells to study cell proliferation, mitosis spread and karyotyping	3	80	75	M	M	H	H	H	M	H	H	H	-	-	-	H	H	H

Duration (hour)		15	15	15	15	15
S-1	SLO-1	Introduction to cell biology	Cell structure and function: Nucleus	Cytoskeleton	Principles of cell signaling	Cancer
	SLO-2	Origin and history of life	Internal organization of Nucleus	Types and function	Models of cell signaling	Introduction to cancer
S-2	SLO-1	Evolution of cell	Endoplasmic reticulum	Microfilaments	Intracellular signal transduction	Stages of cancer
	SLO-2	Evolution of metabolism	Protein folding and processing in ER	Intermediate filaments	Pathways in signal transduction	Types of cancer
S-3	SLO-1	Origin of prokaryotes	Lipid synthesis in SER	Microtubules	Function of cell surface receptors	Development of cancer
	SLO-2	Endosymbiosis	Export of proteins and lipids from ER	Re-organization of microtubules during mitosis	GPCR pathway	Hallmarks of cancer
S 4-5	SLO-1	Lab 1: Cell Morphology: Microscopic observation of eukaryotic cells	Lab 4: Cell Organelles: Nuclear staining of cells	Lab 7: Cell Proliferation: Mitotic index determination	Lab 10: Repeat/Revision of experiments	Lab 13: Cell differentiation: L6 myoblasts to L6 myotubes
	SLO-2					
S-6	SLO-1	Origin of eukaryotes	Golgi apparatus	Transport of molecules in cell	cAMP pathway	Oncogenes and tumor suppressor genes
	SLO-2	Differences between Prokaryotes & Eukaryotes	Protein sorting from Golgi	Passive diffusion	Receptor tyrosine kinase pathway	Targeted drug therapy
S-7	SLO-1	Development of multicellular organisms: Yeast, Amoeba & Volvox	Lysosomes	Active diffusion	MAPK pathway	Epithelial cell cancer
	SLO-2	Plant cells & Animal cells	Phagocytosis and autophagy	Ion channels	Cell division	Oral cancer
S-8	SLO-1	Cells as experimental models	Bioenergetics	Endocytosis	Cell cycle	Lung cancer
	SLO-2	Tools of cell biology	Metabolism	Phagocytosis	Mitosis and stages	Breast cancer

S 9-10	SLO-1	*Lab 2: Cell development: Embryogenesis in fruit fly and Zebrafish*	*Lab 5: Osmosis: Stomatal opening and closing*	*Lab 8: Karyotyping: G banding*	*Lab 11: Cell division: Mitotic cell division in onion root tip*	*Lab 14: Heterochromatin: Polytene chromosomes*
	SLO-2					
S-11	SLO-1	*Molecular composition of cell*	*Mitochondria- structure and function*	*Cell-cell interactions*	*Meiosis*	*Classification of breast cancer*
	SLO-2	*Biosynthesis of cellular constituents*	*Genetic system of mitochondria*	*Cell junctions*	*Programmed cell death:Necrosis and apoptosis*	*Treatment of breast cancer*
S-12	SLO-1	*Enzymes as biocatalysts*	*Chemiosmotic coupling*	*Adhesion junctions*	*Intrinsic and extrinsic pathway*	*Neurodegenerative diseases*
	SLO-2	*Central role of Enzymes*	*Chloroplasts*	*Tight junctions*	*Cell differentiation*	*Dementia*
S-13	SLO-1	*Cell membrane*	*Photosynthesis*	*Gap Junctions*	*Stem cells adult and embryonic*	*Alzheimer's disease*
	SLO-2	*Glycocalyx*	*Peroxisomes*	*Plasmodesmata*	*Therapeutic applications of stem cells*	*Diagnosis and treatment*
S 14-15	SLO-1	*Lab 3: Chromosome preparation: Metaphase spread preparation*	*Lab 6: Cellular fractionation: chloroplast*	*Lab 9: Cell viability: Determination of cell viability using typhan blue dye exclusion*	*Lab 12: Cell division: Meiosis in grass hopper*	*Lab 15: Histology: Sectioning of tissues using microtome and staining*
	SLO-2					

Learning Resources	1. *Channarayappa, Cell biology, Universities Press, 2010* 2. *Rastogi, S.C, Cell Biology, New Age International publishers, 2005*	3. *ThyagaRajan et al., Biology for Engineers, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2012* 4. *Ajoy Paul, Text book of cell and molecular biology, 2nd ed., Books & Allied (P) Ltd., 2009*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Understand										
Level 2	Apply	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
	Analyze										
Level 3	Evaluate	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

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. ThyagaRajan, SRMIST*
2. Dr. Karthik Periyasamy, Aurobindo Pharma Limited, Hyderabad, karthikmpk@gmail.com	*2. Prof. R. B. Narayanan, SVCE, Chennai, rbn@svce.ac.in*	*2. Dr. S. Sujatha, SRMIST*

Course Code	18BTC103J	Course Name	MICROBIOLOGY	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:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Illustrate the fundamentals of Microbiology and different types of microorganisms and their characteristics			
CLR-2 :	Demonstrate the fine structure of bacteria, their functions, growth and cultivation of microorganisms			
CLR-3 :	Illustrate various infectious diseases and their mode of actions			
CLR-4 :	Demonstrate the host-microbe interactions			
CLR-5 :	Illustrate the various applications of microorganisms in various fields			
CLR-6 :	Analyze the importance of Microbiology in various field applications			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	Illustrate the roles and characteristics of microorganisms	2	80	70	-	H	-	-	-	-		-	H	-	-	-	H	H	H
CLO-2 :	Identify growth of microorganisms, its impact in environment, applications of advanced microscopical techniques	2	85	75	-	H	H	-	-	-	H	-		-	-	-	H	H	H
CLO-3 :	Explain the role of microbes in public health and antimicrobial agents	2	75	80	H	-	H	M	H	-	H	-	H	-	H	-	H	H	H
CLO-4 :	Discuss various interactions of microbes with various microbes, animals and plants	2	85	80	H	-	H		H	-	M	-	H	-	H	-	H	H	H
CLO-5 :	Explain the applications of microbes and their products in various field	3	85	80	H	H	H	H	H	-	M	-	H	-	H	-	H	H	H
CLO-6 :	Illustrate the fundamental and applied Microbiology	2	80	75	H	H	H	H	H	-	M	-	H	-	H	-	H	H	H

Duration (hour)		15	15	15	15	15
S-1	SLO-1	Introduction to Microbiology	Nutritional requirements of bacteria	Fungi-Importance of fungi in various field applications	Microbial infections, transmission, and their mode of action	Introduction to Applied Microbiology
	SLO-2	Prokaryotes and Eukaryotes	Nutritional types of bacterium	Morphology of fungi	Sources of infection	Beneficial microbes and Microbial metabolites-overview
S-2	SLO-1	Basics of microbial existence- History of Microbiology	Physical nutrients requirement of the bacteria	Structural characteristics and ecological association of fungi	Portals of entry and Exit of microbes.	Microbial applications in Biotechnological field
	SLO-2	Characterization of microorganisms	Chemical nutrients requirement of the bacteria	Classification of fungi	Epidemiological terminologies-Infectious diseases caused by Vibrio cholerae	Microbial enzymes in various biotechnological applications
S-3	SLO-1	Classification and nomenclature of microorganisms	Types of culture media; Factors influencing bacterial growth	Sexual and Asexual Reproduction of fungi	Vibrio cholera-Mode of action	Microbial secondary metabolites-antibiotics
	SLO-2	Microscopic examination ofmicroorganisms Light Microscopy-Bright field; Dark field	Microbial growth phases	Cultivation of fungi	Vibrio cholera-Treatment	Microbial applications in agricultural field
S 4-5	SLO-1	Lab 1: Aseptic techniques and Media preparation (Both liquid and solid)	Lab 4: Staining Techniques (Simple staining, Gram staining, spore staining)	Lab 7: Enzyme based biochemical characterizations-Catalase test	Lab 10: Repeat/Revision of experiments	Lab 13: Antibiotic sensitivity test-Kirby-Bauer assay
	SLO-2					
S-6	SLO-1	Phase contrast; Fluorescent Microscopy	Types of bacterial culturing/fermentations with respect to growth phases	Preservation techniques of fungi	Sexually Transmitted diseases	Microbial applications in agricultural field
	SLO-2	Differential and specific staining methods	Microbial growth curve and kinetics	Fungal toxins	Acquired Immuno Deficiency syndrome (AIDS)	Advancements in agricultural field

S-7	SLO-1	*Electron Microscopy techniques: Scanning and Transmission Electron Microscopy*	*Different methods of quantitative bacterial growth-Direct method*	*Bacterial viruses-Bacteriophages*	*HIV-Replication; Opportunistic Infections associated with AIDS; Treatment*	*Biocontrol agents-Biofertilizer*
	SLO-2	*Sample preparation techniques for SEM and TEM*	*Different methods of quantitative bacterial growth-Indirect method*	*Types of bacteriophages and their General characteristics*	*Fungal diseases*	*Microbial applications in Pharmaceutical field*
S-8	SLO-1	*Advanced Microscopic techniques-Confocal Microscopy*	*Utilization of energy in non-biosynthetic processes- Energy utilization-Bacterial motility*	*Morphology and structure of bacteriophages*	*Antibacterial agents-classification*	*Microbial applications in Environmental field*
	SLO-2	*Scanning Probe Microscopy-Scanning Tunneling*	*Bacterial nutrient uptake mechanisms-Simple Diffusion, Active Transport, Group Translocation*	*Replication-Viruses of bacteria*	*Mode of actions of antibiotics*	*Microbes in the pollution removal and bioplastic syntheis*
S 9-10	SLO-1 SLO-2	*Lab 2: Isolation and enumeration of microorganisms from given sample*	*Lab 5: Motility test by Hanging drop method*	*Lab 8: Enzyme based biochemical characterizations-oxidase test*	*Lab 11: Triple sugar Iron agar test-H2S production*	*Lab 14: Identification of bacteria using 16s-rRNA sequencing*
S-11	SLO-1	*Scanning Probe Microscopy - Atomic Force Microscopy*	*Bioenergetics- utilization of energy in biosynthetic processes*	*Animal viruses-Classification*	*Multidrug resistance in bacterial pathogens-MDROs, MRSA, VRE*	*Control of Microorganisms-Physical, chemical and biological methods*
	SLO-2	*Morphology and fine structure of Bacteria*	*Biosynthesis of small molecules-synthesis of amino acids*	*Animal virus- Replication*	*Mechanisms of antibiotic resistance*	*Host-microbe interactions: Microbe-Microbe interaction*
S-12	SLO-1	*Size, Shape, And Arrangement of Bacterial Cells*	*Biosynthesis of macromolecules-synthesis of peptidoglycan*	*Viruses of cancer*	*Antifungal agents*	*Host-microbe interactions: Plant-microbe interaction*
	SLO-2	*External structure of bacteria*	*Synthesis of organic cell material in chemoautotrophic bacteria*	*Viroids and Prions*	*Mode of action of antiviral agents*	*Host-microbe interactions: Animal-microbe interaction*
S-13	SLO-1	*Cell organization*	*Bioenergetics of microbial metabolism*	*Plant viruses-Classification*	*Antiviral agents*	*Normal/indigenous flora and opportunistic flora of human body*
	SLO-2	*Internal structures of bacteria*	*Aerobic respiration and Anaerobic bioenergetics*	*Replication of plant viruses*	*Mode of action of antiviral agents*	*Probiotics and Prebiotics*
S 14-15	SLO-1 SLO-2	*Lab 3: Purification and preservation techniques of bacterial cultures*	*Lab 6: Biochemical Characterization of Bacteria–IMViC test*	*Lab 9: Enzyme based biochemical characterizations-Urease test*	*Lab 12: Casein and Starch Hydrolysis*	*Lab 15: Differentiation of live and dead cells using fluorescence Microscopy*

Learning Resources	1. *Pelczar et al., Microbiology, 7th ed., Mc Graw Hill, 2011* 2. *Madigan et al., Brock Biology of microorganisms, 12th ed., Prentice Hall,2008* 3. *Davis et al., Microbiology, 6th ed., Lippincott Williams and Wilkins, 2010*	4. *Prescott et al., Microbiology, 11th ed., Mc Graw Hill, 2011* 5. *Brooks et al., Medical Microbiology, 26th ed., Lange Med. 2012*

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
Level 2	Apply Analyze	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
Level 3	Evaluate Create	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

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. A. Gnanamani, CSIR-Central Leather Research Institute, agmani_2000@yahoomail.com*	*1. Dr. K. Ramani, SRMIST*
2.Dr. D. Gunaseelan, BIOCON Ltd., guna.sachin@gmail.com	*2. Dr. Anbumani Sadasivam, CSIR-Indian Institute of Toxicology Research,anbumani@iitr.res.in*	*2. Dr. R. Muthukumar, SRMIST*

Course Code	18BTC104T	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	18BTC105J
Course Offering Department	Biotechnology	Data Book / Codes/Standards		Nil	

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Analyze the pattern of inheritance of genes in eukaryotes			
CLR-2 :	Use two and three factor cross in mapping of genes			
CLR-3 :	Use Karyotype in detecting mutation			
CLR-4 :	Apply different methods for mapping of genes in bacteria.			
CLR-5 :	Analyze genetic variations in a population.			
CLR-6 :	Analyze genetic variation and inheritance in living organisms.			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1 :	Describe the fundamental Laws of Genetics and interaction of genes	1	80	80	H	H	H	H	-	M	L	H	H	H	H	H	H	H	H
CLO-2 :	Explain the concepts and experiments in the preparation of linkage map	2	85	75	H	H	H	H	-	-	M	H	H	H	H	H	H	H	H
CLO-3 :	Recognize the pattern of genetic disorders	2	75	80	M	H	M	H	M	M	-	M	H	H	H	H	H	H	H
CLO-4 :	Discuss the different methods in the construction of linkage map in bacteria	2	85	80	H	H	H	H	-	-	H	L	H	H	H	H	H	H	H
CLO-5 :	Analyze genes in the population	3	85	75	H	H	H	H	-	M	H	H	H	L	H	H	H	H	H
CLO-6 :	Explain the basic concepts and principles of nucleic acids in prokaryotic and eukaryotic organisms	2	80	80	H	H	H	H	L	M	M	M	H	H	H	H	H	H	H

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Mendel's Experiments	Chromosome structure	Mutation	Bacterial genetics	Population genetics
	SLO-2	Law of segregation	Chromosome organization	Classification of mutation	Mechanisms of recombination	Allele frequency
S-2	SLO-1	Law of independent assortment	Giant chromosomes- polytene chromosome	Structural chromosomal aberration	Transformation in bacteria	Calculation of allele frequency in a population
	SLO-2	Problems in Mendelein inheritance	Lampbrush chromosome	Types of structural aberration	Mapping by transformation	Solving Problems
S-3	SLO-1	Allelic interaction	Linkage	Numerical chromosomal aberration - Aneuploidy	Recombination by generalized transduction	Calculation of genotype frequency in a population
	SLO-2	Lethal genes	Arrangement and types of linkage	Euploidy	Mapping by generalized transduction	Hardy-Weinberg equilibrium
S-4	SLO-1	Non-allelic interaction	Crossing over	Non-disjunction	Specialized transduction by lambda phage	Applications of Hardy Weinberg equilibrium
	SLO-2	Epistatis	Frequency of recombination	Aneuploids in humans	Mapping by specialized transduction	Solving Problems
S-5	SLO-1	Duplicate genes	Cytological basis of crossing over	Mosaics	Conjugation	Changes in allele frequency
	SLO-2	Complementary and inhibitory genes	Stern's experiment	Position effect	Recombination by conjugation	Changes in allele frequency by mutation
S-6	SLO-1	Multiple allelism -ABO	Mapping by two factor cross	Chromosome preparation from leukocyte culture	Interrupted mating analysis	Changes in allele frequency by migration
	SLO-2	Rh factor in Humans	Solving Problems	Chromosome preparation from bone marrow	Mapping by conjugation	Migration dynamics
S-7	SLO-1	Cytoplasmic inheritance	Mapping by three factor cross	Chromosome preparation from amniotic fluid and chorionic villi	Preparation of linkage maps in bacteria	Changes in allele frequency by selection

	SLO-2	*Pedigree analysis - Solving Problems*	*Solving Problems*	*Banding technique*	*Solving Problems*	*Selection dynamics*
S-8	SLO-1	*Mechanisms of sex determination*	*Combining of map segments*	*Karyotype preparation and analysis*	*Merozygote analysis*	*Random genetic drift*
	SLO-2	*Sex linked inheritance*	*Preparation of linkage map*	*Prenatal diagnosis*	*Fine structure mapping*	*Dynamics of random genetic drift*
S-9	SLO-1	*Epigenetics - reprogramming*	*Somatic cell hybridization*	*Fluorescent in situ hybridization*	*Solving Problems*	*Genetic equilibrium*
	SLO-2	*X-inactivation*	*HAT selection procedure*	*Comparative Genomic hybridization*	*Solving Problems*	*Solving Problems*

Learning Resources	1. *Gardner, Simmons, Sunstad, Principles of Genetics, 8th ed., John Wiley and Sons, Inc., 2006*	2. *Monroe W. Strickberger, Genetics, 3rd ed., PHI Learning, 2008*

Learning Assessment												
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

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, Aurobindo Pharma Limited, Hyderabad, karthikmpk@gmail.com	*2. Prof. R. B. Narayanan, SVCE, Chennai, rbn@svce.ac.in*	*2. Dr. K. T. Ramyadevi, SRMIST*

Course Code	18BTC105J	Course Name	MOLECULAR BIOLOGY	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	18BTC104T	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:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Illustrate the chemistry of polynucleotides			
CLR-2 :	Demonstrate the mode of DNA replication			
CLR-3 :	Demonstrate transcription and the processing of RNA			
CLR-4 :	Demonstrate protein synthesis and modification in regulation of cellular activities			
CLR-5 :	Illustrate the various regulatory elements that control gene expression at the transcriptional level			
CLR-6 :	Analyze the chemical and molecular processes that occur in the cells			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1 :	Discuss on the basic concepts and principles of nucleic acids from the perspective of engineers	2	80	70	-	H	-	-	-	-	-	-	H	-	-	-	H	H	H
CLO-2 :	Illustrate the mechanism involved in the duplication of hereditary material.	2	85	75	-	H	H	-	-	-	H	-		-	-	-	H	H	H
CLO-3 :	Illustrate the mechanism and role of the nucleic acids in gene expression.	2	75	80	H	-	H	M	H	-	H	-	H	-	H	-	H	H	H
CLO-4 :	Discuss the structure and machinery of nucleic acids responsible for cell functioning.	2	85	80	H	-	H		H	-	M	-	H	-	H	-	H	H	H
CLO-5 :	Explain the regulation of gene expression under anabolic and catabolic conditions.	3	85	80	H	H	H	H	H	-	M	-	H	-	H	-	H	H	H
CLO-6 :	Explain the role of biological macromolecules which are essential to life.	2	80	75	H	H	H	H	H	-	M	-	H	-	H	-	H	H	H

Duration (hour)		15	15	15	15	15
S-1	SLO-1	Scope and history	Basic rules for replication	RNA polymerases in prokaryotic and eukaryotic cells	Genetic code	Gene regulation
	SLO-2	Proof for DNA as the genetic material	Chemistry of DNA synthesis	Types and function of RNA polymerases	wobble hypothesis	Principles of gene regulation
S-2	SLO-1	Proof for semi conservative replication	Semi discontinuous replication	Structure and function of the promoters	Translation in prokaryotic cells	Transcriptional gene regulation
	SLO-2	DNA constituents	Pulse chase and pulse labeling experiment	Fine structure of prokaryotic and eukaryotic genes	Initiation of translation	Post transcriptional gene regulation
S-3	SLO-1	Nucleoside and Nucleotide	Enzymes involved in replication	Transcription of RNA in prokaryotes - initiation	Elongation of translation	Activators
	SLO-2	Structure of DNA	Types and functions of DNA polymerases in prokaryotic and eukaryotic replication	Elongation and termination	Translocation	Co-activators
S 4-5	SLO-1	Lab 1: Isolation of genomic DNA from bacteria	Lab 4: Plasmid DNA isolation	Lab 7: Polyacrylamide gel electrophoresis of DNA	Lab 10: Repeat/Revision of experiments	Lab 13: Ligation of digested DNA
	SLO-2					
S-6	SLO-1	Base pairing and base stacking	Proof reading activity	Transcription in eukaryotes	Termination of translation	Suppressors – Co-suppressors
	SLO-2	Models of DNA	5'-3' exonuclease activity and Topoisomerase activity	Structure of promoters in mRNA, rRNA, and tRNA genes	Ribosome recycling	Moderators, Silencers and Enhancers
S-7	SLO-1	Double helix	Events in the replication fork	Transcription of mRNA	Translation in eukaryotic cells	Operons
	SLO-2	Features of Watson and crick model	Telomeric DNA replication	Steps in transcription by RNA polymerase II	Polyribosome	Positive and negative regulation
S-8	SLO-1	Major and minor groove	Models of DNA replication – Bidirectional replication	Transcription of tRNA by RNA polymerase III	Post translational modifications	Lac Operon

	SLO-2	*Forms of DNA - A, B, Z*	*Plasmid replication-theta model*	*Transcription of rRNA by RNA polymerase I*	*Protein folding*	*Regulation of Lac operon by glucose*
S 9-10	SLO-1	*Lab 2: Qualitative analyses of genomic DNA*	*Lab 5: Qualitative analyses of plasmid DNA*	*Lab 8: Isolation of RNA*	*Lab 11: Restriction digestion of Plasmid DNA*	*Lab 14: Effect of UV rays in the bacterial cell growth*
	SLO-2					
S-11	SLO-1	*Structure and function of RNAs– mRNA, rRNA and tRNA*	*Strand displacement model*	*Processing of tRNA*	*Protein sorting and targeting*	*Trp Operon*
	SLO-2	*Secondary structures in RNA*	*Rolling circle model*	*Processing of rRNA*	*Types of Protein targeting*	*Control of Trp operon by Attenuator*
S-12	SLO-1	*DNA Topology*	*Bidirectional replication*	*Post transcriptional processing of mRNAs – 5'capping*	*Principles of protein sorting and targeting into mitochondria*	*Ara Operon*
	SLO-2	*Supercoiling – Twist - Writhe*	*Unidirectional replication*	*Polyadenylation*	*Principles of protein sorting and targeting into endoplasmic reticulum*	*Regulation of Ara operon*
S-13	SLO-1	*Linking number*	*DNA repair: Nucleotide excision and Mismatch repair*	*Splicing (including different types)*	*Principles of protein sorting and targeting into nucleus*	*Gal Operon*
	SLO-2	*Change in linking number*	*Photo-reactivation, Recombination repair and SOS repair*	*Alternative splicing*	*Principles of protein sorting and targeting into chloroplast*	*Regulation of Gal operon*
S 14-15	SLO-1	*Lab 3: Quantitative analyses of genomic DNA*	*Lab 6: Quantitative analyses of plasmid DNA*	*Lab 9: Qualitative and quantitative analyses of RNA*	*Lab 12: Restriction digestion of genomic DNA*	*Lab 15: Polymerase Chain Reaction*
	SLO-2					

Learning Resources	1. *James D Watson, Molecular Biology of Gene, Pearson Education, 2017* 2. *Robert Weaver, Molecular Biology, McGraw-Hill, 2011*	3. *Benjamin Lewin, Genes IX, Benjamin Cummings, 2007* 4. *G.M. Malacinski, David Friefelder, Essentials of Molecular Biology, 4th ed., Narosa Publishers 2008*

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Understand										
Level 2	Apply	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
	Analyze										
Level 3	Evaluate	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

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. A. Gnanamani, CSIR-Central Leather Research Institute, agmani_2000@yahoomail.com*	*1. Dr. K. Ramani, SRMIST*
2. Dr. D. Gunaseelan, BIOCON Ltd., guna.sachin@gmail.com	*2. Dr. Anbumani Sadasivam, CSIR-Indian Institute of Toxicology Research,anbumani@iitr.res.in*	*2. Dr. R. Muthukumar, SRMIST*

Course Code	18BTC106J	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:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Examine the science of immunology and a detailed study of various types of immune cells			
CLR-2 :	Distinguish immune systems produced molecules and their classification, structure and function			
CLR-3 :	Choose methods used in immunology, particularly the use of specific antibody in bio-molecular applications			
CLR-4 :	Evaluate knowledge about immune system, their cells, its interaction and how they fight against infectious diseases			
CLR-5 :	Analyze the dysregulation of immune system functioning and ways to strengthen immune system			
CLR-6 :	Evaluate the knowledge about how human body is designed and protected to fight against various pathogens			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)													
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	Describe the immune system and their structure and classification	1	80	70	M	-	H	H	L	L	L	H	-	H	M	H	M	H	H
CLO-2 :	Discuss about genetic control of antibody production, cellular immunology	2	80	70	M	M	-	H	H	M	H	H	-	H	M	H	M	H	H
CLO-3 :	Explain various methods to assess immune function, their application and interpretation of the results	2	80	70	M	M	L	H	H	-	-	H	M	H	M	H	H	H	H
CLO-4 :	Describe the role of the immune molecules in infectious diseases, autoimmunity, and cancer will be discussed	2	80	70	-	-	-	H	H	M	H	H	M	H	M	L	H	H	H
CLO-5 :	Discuss about hypersensitive immune reaction, vaccination and cancer immunology	2	80	70	M	M	-	H	H	-	H	H	M	H	H	M	H	H	H
CLO-6 :	Describe how immune cells, organ and processes function to protect human body against infective agents and cancer cells.	2	80	70	M	L	M	H	H	M	M	H	M	H	H	M	H	H	H

Duration (hour)		15	15	15	15	15
S-1	SLO-1	Overview of the immune system	Immunoglobulin structure	Isolation of immune cells from Human and animals	Major histo-compatibility Complex(MHC)	Hypersensitive reactions
	SLO-2	Development and differentiation of the hematopoietic stem cells	Immunoglobulin types and function	Antigen- antibody interaction	MHC – types and function	Type I and Type II reaction
S-2	SLO-1	Myeloid and Lymphoid lineage	Antibodies biological and functional properties	antibody affinity and avidity	MHC Class I	Type III and Type IV reaction
	SLO-2	Lymphatic system	Proteolytic digestion of antibodies	Hemaagglutination reaction	MHC Class II	Immune responses to infectious diseases introduction
S-3	SLO-1	Lymphoid organs - types	Monoclonal antibodies production	Coombs test – direct and indirect	antigen processing and presentations – Endogenous and Exogenous	Viral disease-HIV infection
	SLO-2	Innate lymphoid cells	Monoclonal antibodies applications	precipitation reaction	Diversity of MHC molecules	Bacterial disease-Tuberculosis
S 4-5	SLO-1	Lab 1:Laboratory safety principles and Blood grouping	Lab 4: Antigen – Antibody reaction I – Widal test	Lab 7: Ouchterlony gel diffusion	Lab 10: Active immunodiffusion – II – Counter Current Immunoelectrophoresis	Lab 13: Enzyme linked Immunosorbent assay (ELISA) – DOT
	SLO-2					
S-6	SLO-1	Agglutination principle, blood group types Rhesus group types	Widal test - slide method and test tube method	Single radial immunodiffusion (SRID)	Antigen – Antibody interaction	Types of ELISA, Direct vs Indirect ELISA, Dot ELISA Sandwich ELISA
	SLO-2	incompatible blood transfusion and hemolytic disease	B Cell differentiation	titer value, zone of equivalence Quantitative Immuno assays	Standard and test antigen Rocket Immunoelectrophoresis	Parasitic disease-Malaria
S-7	SLO-1	Receptors of Innate Immune system	B cell receptor structure and B cell signal transduction	passive Immunodiffusion	Biology of T lymphocyte	Evading Mechanisms of pathogens

	SLO-2	*Types of Immune cells, Innate Immunity*	*Antibody diversity*	*Precipitation reaction*	*T cell receptors and interaction with MHC*	*Vaccine history and principle*
S-8	SLO-1	*Anatomical and Physiological barriers*	*Light chain synthesis*	*Active Immunodiffusion – Rocket immunoelectrophoresis*	*T-cell maturation*	*Active and passive Immunization*
	SLO-2	*Acquired Immunity, clonal selection theory*	*Heavy chain synthesis Cytokine receptor structure*	*SDS-PAGE and Western blot*	*T-cell activation and differentiation*	*DNA vaccine, Edible vaccine and Adjuvants*
S 9-10	SLO-1	*Lab 2: Total Leukocyte count*	*Lab 5: Antigen – Antibody reaction II -rapid plasma reagin (RPR) test*	*Lab 8: Repeat/Revision of experiments*	*Lab 11: Immunoprecipitation*	*Lab 14: Enzyme linked Immunosorbent assay (ELISA) – Plate*
	SLO-2					
S-11	SLO-1	*Types of blood cells Leukocyte counting*	*Flocculation reaction Rapid Plasma Reagin (RPR) test*	*Quantitative Immuno assays - Radio-immunoassay*	*Thymic selection – Positive and negative selection*	*Tumor Immunology introduction*
	SLO-2	*Comparative immunity - Plant Immune system*	*Cytokine types and function*	*Precipitation reaction, Immunoprecipitation*	*T-cell activation and cytokine secretion*	*Evidence for Tumor Immunity*
S-12	SLO-1	*Vertebrate and Invertebrate Immune system*	*Role of cytokines in diseases*	*Immunofluorescence – Direct and indirect*	*Result interpretation Counter current immuno electrophoresis*	*Tumor immuno therapy*
	SLO-2	*Immunogens, Antigens and Haptens*	*Complement system*	*Immunohistochemistry*	*Cytokine control of TH1 and TH2 CD4+*	*Autoimmunity introduction*
S-13	SLO-1	*Requirements for immunogenicity; major classes of antigens*	*Regulation of complement pathway*	*flow cytometry, ELISA and types*	*Function of CD8+ T cells, T Regulatory cells*	*Genetic Basis of Autoimmunity*
	SLO-2	*antigen recognition by T and B lymphocytes*	*Role of complement proteins in diseases*	*Cell culture and experimental models, analysis of gene expression*	*T-cell and B-cell cooperation, Pathways of Activation*	*Classification of auto-immunity*
S 14-15	SLO-1	*Lab 3: Differential Leukocyte count*	*Lab 6: Single radial immunodiffusion (SRID)*	*Lab 9: Active Immunodiffusion I - Rocket Immunoelectrophoresis*	*Lab 12: SDS-PAGE*	*Lab 15: Western blotting*
	SLO-2					

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 (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Understand										
Level 2	Apply	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
	Analyze										
Level 3	Evaluate	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

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. Thyagarajan, SRMIST*
2. Dr. Karthik Periyasamy, Aurobindo Pharma Limited, Hyderabad, karthikmpk@gmail.com	*2. Prof. K Subramaniam, IITM, Chennai, subbu@iitm.ac.in*	*2. Dr. S. Nageswaran, SRMIST*

Course Code	18BTC107J	Course Name	BIOPROCESS PRINCIPLES	Course Category	C	*Professional Core*	L	T	P	C
							3	0	2	4

Pre-requisite Courses	*18BTC103J*	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:*	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	*Select the proper design offermenters and the fermentation process*			
CLR-2 :	*Examine the process of media formulation and sterilization kinetics*			
CLR-3 :	*Assess the metabolic stoichiometry and energetics of the biochemical process*			
CLR-4 :	*Manage the various modes of operating and designing a bioreactor*			
CLR-5 :	*Interpret the microbial growth and kinetics during formation of products*			
CLR-6 :	*Analyze the basic principles of bioprocess engineering and the working of living cells*			

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning			Program Learning Outcomes (PLO)													
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1 :	*Explain the various aspects of fermenter and types of fermentation process*	*2*	*80*	*70*	*H*	*L*	*H*	*H*	*L*	*-*	*H*	*-*	*H*	*H*	*-*	*H*	*H*	*H*	*H*
CLO-2 :	*Practice the components of media and its prerequisites to produce bioproducts*	*3*	*80*	*70*	*H*	*M*	*H*	*H*	*L*	*-*	*H*	*-*	*H*	*H*	*-*	*H*	*H*	*H*	*H*
CLO-3 :	*Interpret the stoichiometry and energetics of product formation mediated by cell growth*	*3*	*80*	*70*	*H*	*H*	*H*	*H*	*L*	*-*	*H*	*-*	*H*	*H*	*-*	*H*	*H*	*H*	*H*
CLO-4 :	*Analyze and interpret key elements of the fermentation data to operate the bioreactor accordingly*	*2*	*80*	*70*	*H*	*M*	*H*	*H*	*M*	*-*	*H*	*-*	*H*	*H*	*-*	*H*	*H*	*H*	*H*
CLO-5 :	*Apply various models to understand the kinetics and mechanism of microbial growth*	*3*	*80*	*70*	*H*	*H*	*H*	*H*	*H*	*-*	*H*	*-*	*H*	*H*	*-*	*H*	*H*	*H*	*H*
CLO-6 :	*Employ fermentation skills to synthesize value added bioproducts*	*3*	*80*	*70*	*H*	*H*	*H*	*H*	*H*	*-*	*H*	*-*	*H*	*H*	*-*	*H*	*H*	*H*	*H*

Duration (hour)		15	15	15	15	15
S-1	SLO-1	*Outline of an integrated bioprocess*	*Criteria for a good medium*	*Stoichiometric of cell growth*	*Types of bioreactor*	*Mathematical models*
	SLO-2	*Upstream and downstream bioprocess*	*Types of media*	*Stoichiometric of product formation*	*Strategies for choosing a bioreactor*	*Mathematical Models - Classification*
S-2	SLO-1	*Process flow sheets of primary metabolite production*	*Various commercial media for microbial biotechnology*	*Elemental balance, degree of reduction*	*Modes of operation of bioreactor*	*Model formulation*
	SLO-2	*Process flow sheets of secondary metabolite production*	*Medium formulation – Carbon and Nitrogen source*	*Substrate and biomass*	*Batch operation – Theory*	*Unstructured, Nonsegregated models*
S-3	SLO-1	*Types of fermentation*	*Medium formulation – Growth factor and inducers*	*Electron balance*	*Growth kinetics of batch culture*	*Monod model*
	SLO-2	*Fermented products*	*Natural and synthetic media*	*Yield coefficient of biomass and product formation*	*Solving problem in growth kinetics*	*Blackman, tessier, moser and contois models*
S 4-5	SLO-1	*Lab 1 - Types of fermentation*	*Lab 4 - Medium formulation to maximize the biomass production*	*Lab 7 - Batch growth kinetics - Evaluation of doubling time*	*Lab 10: Repeat/Revision of experiments*	*Lab 13 - Quantification of biomass, ethanol and glucose*
	SLO-2					
S-6	SLO-1	*Fermenter – Various components*	*Animal culture media*	*Maintenance coefficients*	*Batch reactor – Logistic equations*	*Monod model modified for substrate inhibition*
	SLO-2	*Fermenter design*	*Plant culture media*	*Determination of stoichiometric coefficients*	*Performance equation of a batch reactor*	*Modified Monod models*
S-7	SLO-1	*Standard geometry of stirred tank bioreactor (STR)*	*Design of experiments*	*Solving problem in stoichiometric coefficients*	*Solving problem related to batch reactor*	*Unstructured Batch Growth Models*
	SLO-2	*Basic features of STR – Agitation*	*Plackett - Burman design (PBD)*	*Solving problem in stoichiometric*	*Fed-batch operation – theory*	*Product Formation Kinetics*

				coefficients		
S-8	SLO-1	Basic features of STR – Aeration	Response surface methodology (RSM)	Energetic analysis of microbial growth and product formation	Performance equation of a fed- batch reactor	Structured kinetics Model
	SLO-2	Basic features of STR – Miscellaneous items	Artificial neural network (ANN)	Oxygen transfer in aerobic culture	Solving problem related to fed-batch reactor	Structured product formation kinetic modeling
S 9-10	SLO-1	Lab 2 - Bioreactor operation (demonstration)	Lab 5 - Screening of process parameters for bacterial biomass production by PBD	Lab 8 - Batch growth kinetics - Evaluation of specific growth rate	Lab 11 - Preparation of immobilized cells/enzyme	Lab 14 - Production of ethanol by Saccharomyces cerevisae
	SLO-2					
S-11	SLO-1	Summary of conventional bioreactor systems	Sterilization	Oxygen transfer in aerobic culture – problem	Continuous operation - Theory	Compartment model
	SLO-2	Summary of novel bioreactor systems	Kinetics of thermal death of microorganism	Determination of yield coefficients	Chemostat and Turbidostat	Williams two compartment model
S-12	SLO-1	Monitor and Control of physical parameters	Solving problem in sterilization kinetics	Solving problem in yield coefficients	Performance equation of a continuous reactor	Ramakrishna Model
	SLO-2	Monitor and Control of chemical parameters	Types of sterilization - batch	Solving problem in yield coefficients	Dopt – Significance	Product formation models
S-13	SLO-1	Monitor and Control of biological parameters	Types of sterilization - Continuous	Heat evolution in aerobic culture	Solving problem related to Dopt	Luedeking-piret Model
	SLO-2	Summary of Monitor and Control of fermentation parameters	Air sterilization	Analyze thermodynamic efficiency of cell growth	Stability analysis of bioreactor	Growth and non-growth associated kinetics
S 14-15	SLO-1	Lab 3 - Real-time monitoring of process (pH, temp etc.) parameters in bioreactor	Lab 6 - Media Sterilization	Lab 9 - Batch growth kinetics - Evaluation of yield coefficient	Lab 12 - Comparison of free and immobilized enzyme/cells kinetics	Lab 15 - Evaluation of ethanol yield and productivity by S. cerevisae
	SLO-2					

Learning Resources	1. Hall, Stephen J., Stanbury, Peter F., Whitaker, Allan, Principles of Fermentation Technology, 3rd ed., Butterworth– Heinemann, 2017 2. Pauline M. Doran, Bioprocess Engineering Principles, 2nd ed., Academic press, 2012	3. Carl-Fredrik Mandenius, Bioreactors: design, operation and novel applications, 1sted., Wiley-VCH Verlag GmbH & Co, 2016

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	20%	15%	15%	15%	15%	15%	15%	15%	15%
	Understand										
Level 2	Apply	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
	Analyze										
Level 3	Evaluate	10%	10%	15%	15%	15%	15%	15%	15%	15%	15%
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. P. BalaKumaran, Proklean Technologies (P) Limited, Chennai,genbalu86@gmail.com	1. Prof. K Subramaniam, IITM, Chennai, subbu@iitm.ac.in	1. Dr. M. VenkateshPrabhu,SRMIST
2. Dr. Karthik Periyasamy, Aurobindo Pharma Limited, Hyderabad, karthikmpk@gmail.com	2. Prof. R. B. Narayanan, SVCE, Chennai, rbn@svce.ac.in	2. Dr. V. Vinoth Kumar, SRMIST

Course Code	18BTC108J	Course Name	PLANT BIOTECHNOLOGY	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	18BTC103J	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Biotechnology	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Illustrate the genome organization in plants and its regulations
CLR-2 :	Employ the different methods for the development of transgenic plants
CLR-3 :	Use the plants as production systems by altering the plant hormones for growth and developments
CLR-4 :	Interpret the mechanisms for plant to cope up for biotic and abiotic stresses
CLR-5 :	Apply the classical and modern plant breeding techniques for crop improvements
CLR-6 :	Use the knowledge to increase plant production and protection through biotechnological approaches

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1 Level of Thinking (Bloom)	Learning 2 Expected Proficiency (%)	Learning 3 Expected Attainment (%)	PLO 1 Engineering Knowledge	PLO 2 Problem Analysis	PLO 3 Design & Development	PLO 4 Analysis, Design, Research	PLO 5 Modern Tool Usage	PLO 6 Society & Culture	PLO 7 Environment & Sustainability	PLO 8 Ethics	PLO 9 Individual & Team Work	PLO 10 Communication	PLO 11 Project Mgt. & Finance	PLO 12 Life Long Learning	PLO 13 PSO - 1	PLO 14 PSO - 2	PLO 15 PSO – 3
CLO-1 :	Discuss on the basics of plant genomes organizations and expressions	2	80	70	-	H	-	H	-	-	-	-	H	-	-	-	H	H	H
CLO-2 :	Demonstrate the various methods of genetic manipulations in plants	2	85	75	H	H	H	H	H	-	H	H	H	-	H	-	H	H	H
CLO-3 :	Illustrate the mechanism and role of plant tissue culture for mass multiplications	2	75	80	H	H	H	H	H	-	H	-	H	-	H	-	H	H	H
CLO-4 :	Discuss the molecular aspects of plant adaptability to various stresses	2	85	80	H	M	H	M	-	-	M	-	H	-	H	-	H	H	H
CLO-5 :	Explain the significance of plant breeding and genetic manipulations of plants for economic importance	3	85	80	H	H	H	H	H	-	M	H	H	-	H	-	H	H	H
CLO-6 :	Explain the basic concepts and to use the plant biotechnology techniques for crop improvements	2	80	75	H	H	H	H	H	-	H	H	H	-	H	-	H	H	H

Duration (hour)		15	15	15	15	15
S-1	SLO-1	Introduction and scope of plant molecular biology	Agrobacterium mediated gene transfer	Plant Tissue culture	Plant stresses	Introduction to crop improvement
	SLO-2	DNA, Chromatin, and Chromosome structure	The biology of Agrobacterium	Plasticity and totipotency of plant cells	Biotic stress	The distant past - Crop plant domestication and beyond
S-2	SLO-1	Chloroplast genome	Vector for plant transformations	The culture environment	Plant – pathogen interactions	The recent past -
	SLO-2	Genome Structure, evolution, expression, gene regulations	Ti plasmid	Physical and chemical factors	Prokaryotes, fungi and viruses	Hybrid seed production
S-3	SLO-1	Mitochondrial genome	t-DNA transfer and integration	Plant growth hormones	Disease resistance	Importance of green revolution
	SLO-2	Genome Structure, evolution, expression, gene regulations	transformation in plant with an example of Arabidopsis thaliana	Culture types	Natural disease resistance in plants	The (First) Green Revolution
S 4-5	SLO-1	Lab 1: Isolation of genomic DNA from plant	Lab 4: Isolation and recombinant preparation of Ti plasmid	Lab 7: Preparation of plant tissue culture media	Lab 10: Repeat/Revision of experiments	Lab 13: Protoplast –Isolation, electro-fusion and regeneration
	SLO-2	tissues				
S-6	SLO-1	Nuclear genome	Direct gene transfer methods	Production of secondary metabolites	Biotechnological approach	Breeding technologies
	SLO-2	Genome size and organization	Advantages and disadvantages	Carbohydrates	Over expression of PR-proteins	Advances in breeding technologies
S-7	SLO-1	Introduction to gene and expression	Vectors	Metabolic engineering	Herbs as biotic stress factors	Practicing Now and
	SLO-2	Regulation of gene expressions	Optimization and binary vectors	Lipids	Types of herbicides	into the future
S-8	SLO-1	Gene transcription	Alternative markers and reporter genes	Molecular farming	Transgenic approach for improving	Applications of breeding

					tolerance to herbicide	
	SLO-2	*Organellar Self-Splicing Introns and Horizontal DNA transfer*	*Effect of selectable marker system to environment*	*Proteins*	*Plant based detoxification*	*Breeding for improved human health*
S 9-10	SLO-1	*Lab 2: Extraction of total RNA from plant tissues*	*Lab 5: Agrobacterium mediated gene transformation in Arabidopsis thaliana*	*Lab 8: Direct organogenesis of plants*	*Lab 11: Enhanced production of secondary metabolites in suspension cultures by using elicitors*	*Lab 14: Haploid productions/ Somatic embryogenesis*
	SLO-2					
S-11	SLO-1	*RNA modification*	*The genetic manipulation of pest resistance crop plants*	*Emerging applications*	*Abiotic stresses - nature*	*Breeding*
	SLO-2	*Post Transcriptional Gene Silencing (PTGS)*	*Bacillus thuringiensis (Bt) approach*	*Producing fine chemicals*	*Plant responses*	*For drought tolerance*
S-12	SLO-1	*Micro RNA*	*The use of Bt as a biopesticide*	*Plant derived compounds*	*The nature of water deficit stress*	*Innovations*
	SLO-2	*Production and interfering with gene for silencing*	*Bt-based genetic modification of plants*	*As a drugs*	*Various approaches for tolerance*	*In agriculture*
S-13	SLO-1	*DNA instability*	*Development of pest resistant crops*	*Current demand from plants*	*Salt stress*	*Revolutions*
	SLO-2	*Transposable Elements in plants*	*Clean gene technology – Copy nature strategy*	*Alternative fuels*	*Cold and heat stress*	*The Second Green Revolution*
S 14-15	SLO-1	*Lab 3: Qualitative and Quantitative analysis of nucleic acids from plant tissues*	*Lab 6: Demonstration of electroporation method of gene transformation in plants*	*Lab 9: Callus induction and indirect organogenesis*	*Lab 12: Quantification of stress induced secondary metabolites using HPLC*	*Lab 15: Quantification of t-DNA expressions from plants*
	SLO-2					

Learning Resources	1. *Slater. A, Scott.N.W, Fowler,M.R, Plant Biotechnology - The genetic manipulation of plants, Oxford University Press 2008* 2. *C Neil Stewart Jr. Plant Biotechnology and Genetics, John Wiley & Sons, Inc., New Jersey 2008*	3. *Carole L. Bassett, Regulation of gene expression in plants - The role of transcript structure and processing. Springer, 1st ed., 2007* 4. *Murray.D.R, Advanced methods in plant breeding and biotechnology, CAB International 1998*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Understand										
Level 2	Apply	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
	Analyze										
Level 3	Evaluate	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Senthil, EID Parry, Chennai, *parrynutraceuticals@parry.murugappa.com*	*1. Prof. Usha Vijayraghavan. IISc, Bangalore, uvr@mcbl.iisc.ernet.in*	*1. Dr. Sarada, SRMIST*
1. Dr. C. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com	*2. Prof. K Subramaniam, IITM, Chennai, subbu@iitm.ac.in*	*2. Dr. Pachaiappan, SRMIST*

ACADEMIC CURRICULA

Professional Core Courses

BIOTECHNOLOGY

Regulations - 2018

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

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

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

Kattankulathur, Kancheepuram, Tamil Nadu, India

Course Code	18BTC201J	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:*	Learning			Program Learning Outcomes (PLO)														
CLR-1 :	*Discuss the basic concepts and principles of utilization of different expression vectors for cloning from the perspective of engineers*	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-2 :	*Demonstrate the different strategies of gene cloning and construction of genomic and cDNA libraries*	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLR-3 :	*Analyse the concepts of structural and functional genomics*																		
CLR-4 :	*Apply advanced cutting-edge technologies*																		
CLR-5 :	*Assess the applications of recombinant DNA technology in animals, plants and microbial organisms*																		
CLR-6 :	*Prepare engineering students to develop the strategies on altering gene expression in vitro and in vivo*																		
Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*																		
CLO-1 :	*Explain the foundations of modern biotechnology*	*1*	*80*	*70*		*L*	*M*	*L*	*M*				*H*			*H*	*H*	*H*	*H*
CLO-2 :	*Design and conduct experiments involving genetic manipulation.*	*2*	*85*	*75*	*H*	*H*	*H*	*H*	*H*				*H*		*H*	*H*	*H*	*H*	*H*
CLO-3 :	*Use versatile techniques in recombinant DNA technology.*	*2*	*75*	*80*	*H*	*M*	*H*	*H*	*H*				*H*		*H*	*H*	*H*	*H*	*H*
CLO-4 :	*Describe the steps involved in the production of biopharmaceuticals in microbial and mammalian cell systems.*	*2*	*85*	*80*	*H*	*H*	*H*	*H*	*H*		*M*		*H*		*H*	*H*	*H*	*H*	*H*
CLO-5 :	*Apply modern biotechnology in the different areas like medicine, microbes, environment and agriculture.*	*2*	*80*	*80*	*H*	*M*	*H*	*H*	*H*	*L*	*H*		*H*		*H*	*H*	*H*	*H*	*H*
CLO-6 :	*Design the cloning experiments using routine and specialized vectors for such applications as plant transformation, protein expression and genomic DNA library construction etc.*	*2*	*80*	*75*	*H*	*H*	*H*	*H*	*H*		*M*		*H*		*H*	*H*	*H*	*H*	*H*

Duration (hour)		15	15	15	15	15
S-1	SLO-1	*Overview of cloning*	*DNA Library*	*DNA sequencing*	*Analysis of gene expression*	*Applications of cloning*
	SLO-2	*DNA cloning vectors*	*Preparation of DNA Libraries*	*Principles of DNA sequencing*	*Transcription and translation*	*Medical applications*
S-2	SLO-1	*Cell based DNA cloning*	*Genomic DNA library*	*Sanger's Dideoxy sequencing method*	*Post transcriptional and post translational regulations*	*Human and genetic diseases*
	SLO-2	*Cell free DNA cloning*	*Overlapping and non-overlapping DNA fragments*	*Automated DNA sequencing*	*Methods for protein expression*	*DNA vaccines*
S-3	SLO-1	*Plasmid vectors – pBR322*	*Choice of vectors*	*Next generation sequencing*	*Analysis of gene function*	*Gene therapy*
	SLO-2	*pUC vector*	*Evaluation of genomic DNA library*	*Genome sequencing*	*Factors influencing gene expression*	*Study of gene function in vivo*
S 4-5	SLO-1	*Lab 1: Restriction enzyme digestion of genomic DNA*	*Lab 4: Alkaline Phosphatase treatment for cloning*	*Lab 7: Transformation of recombinant vector in to E.Coli*	*Lab 10: Repeat/Revision of experiments*	*Lab 13: Qualitative and quantitative analyses of RNA*
	SLO-2					
S-6	SLO-1	*Phage vectors – Lambda insertion*	*cDNA library*	*Emulsion PCR*	*Manipulation of gene expression*	*Embryonic stem cells*
	SLO-2	*Lambda Replacement vector*	*Purification and separation of mRNA*	*Bridge PCR*	*Transcriptomics - Non-coding RNA*	*Applications in Embryonic stem cells*
S-7	SLO-1	*Cosmids*	*cDNA synthesis*	*RNA sequencing*	*Small RNAs, siRNAs*	*Transgenics*
	SLO-2	*M13 vector*	*cDNA library construction*	*Applications of NGS*	*MicroRNAs, lncRNA*	*Methods of producing transgenic mice*
S-8	SLO-1	*Phagemid*	*Evaluation of cDNA library*	*Labeling of nucleic acids*	*Expression in prokaryotic host cells*	*Over-expression*
	SLO-2	*pBluescript*	*Screening libraries*	*Random priming*	*Purification of expressed protein*	*Gene knock-in*
S	SLO-1			*Lab 8: Screening- Blue white selection*		*Lab 14: cDNA synthesis*

Duration (hour)		15	15	15	15	15
9-10	SLO-2	*Lab 2: Restriction enzyme digestion of Vector*	*Lab 5: Preparation of rDNA- Ligation of DNA fragment with cloning vector*		*Lab 11: Expression in eukaryotic host cells*	
S-11	SLO-1	*Yeast vectors*	*Polymerase chain reaction (PCR)*	*Nick translation and End labeling*	*Expression in eukaryotic host cells*	*Gene knock-out*
	SLO-2	*Types of yeast vector*	*Semi quantitative PCR*	*RNA labeling*	*Mammalian expression vectors*	*Conditional knock-out*
S-12	SLO-1	*YAC*	*RNA-PCR*	*Non-isotopic labeling*	*Mutagenesis*	*Genome editing*
	SLO-2	*Expression vectors*	*Real time PCR*	*Structural genomics*	*in vitro mutagenesis*	*CRISPER-Cas9*
S-13	SLO-1	*Restriction enzymes*	*Types of qRT-PCR*	*comparative genomics*	*Site directed mutagenesis*	*Guide RNA*
	SLO-2	*Linker and homopolymer tailing*	*Applications of PCR*	*Microarray*	*Methods for site directed mutagenesis*	*Gene inactivation*
S 14-15	SLO-1	*Lab 3: Purification of digested DNA by column purification*	*Lab 6: Preparation of Competent cell*	*Lab 9: Identification of recombinants-isolation of rDNA*	*Lab 12: RNA isolation*	*Lab 15: Quantitative PCR (Real time PCR)*
	SLO-2					

Learning Resources		
	1. *Jeremy W. Dale and Malcolm von Schantz, "From Genes to Genomes," John Willey and Sons Publications, 2002* 2. *Sandy-b-primrose, "Principles of Gene Manipulation and Genomics" Seventh Edition, 2012*	3. *S. B. Primrose and R. M. Twyman, "Principles of Gene Manipulation and Genomics"7th Edition,Wiley-Blackwell, 2006*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Understand										
Level 2	Apply	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
	Analyze										
Level 3	Evaluate	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

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. N.Selvamurugan, SRMIST*
2. *Dr. Karthik Periyasamy, Scientist I, Aurozymes Unit, Aurobindo Pharma Limited, Hyderabad, karthikmpk@gmail.com*	2. *Prof. R. B. Narayanan, SVCE, Chennai, rbn@svce.ac.in*	2. *Dr. S.Barathi, SRMIST*

Course Code	18BTC202J	Course Name	BIOPROCESS ENGINEERING	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 :	*Demonstrate the various operational modes of bioreactor*
CLR-2 :	*Illustrate about the various transport phenomena in bioprocess systems.*
CLR-3 :	*Demonstrate the monitoring and control of various process parameters in bioreactors.*
CLR-4 :	*Analyze the design and operation of various industrially important bioreactor*
CLR-5 :	*Illustrate the various mathematical models of biological systems*
CLR-6 :	*Illustrate the transformation of bioprocess engineering approaches from laboratory scale to commercial scale*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	*Analyze the various operations of the bioreactor and evaluating its performance.*	2	80	70	H	H	H	H			H		H		H	H	H	H	H
CLO-2 :	*Discuss the fundamental knowledge on mechanisms of oxygen transfer in biological systems.*	2	85	75	H	H	H	H			H		H		H	H	H	H	H
CLO-3 :	*Illustrate the procedures adopted for monitoring and control of process parameters in bioreactors.*	2	75	80	H	H	H	M			H		H		H	H	H	H	H
CLO-4 :	*Discuss on the design and operation of bioreactors for the cultivation of microbial, plant and animal cell cultures.*	2	85	80	H	H	H	H			M		H		H	H	H	H	H
CLO-5 :	*Explain the applicability of modeling preliminaries and software packages in bioprocess.*	3	85	80	H	H	H	H	H		M		H		H	H	H	H	H
CLO-6 :	*Explain the engineering approaches for successful commercialization of bioprocess operations.*	2	80	75	H	H	H	H	H		M		H		H	H	H	H	H

Duration (hour)		15	15	15	15	15
S-1	SLO-1	*Introduction to ideal reactors*	*Molecular Diffusion*	*Bioreactor Instrumentation and Control*	*Bioreactor configurations for production of metabolites from microbial sources*	*Introduction to mathematical modeling of biological systems*
	SLO-2	*Ideal reactor types*	*Role of Diffusion in Bioprocessing*	*Monitoring of biochemical parameters*	*Stirred tank reactor*	*Approaches to modelling cell growth*
S-2	SLO-1	*Ideal batch reactor - basics*	*Convective Mass Transfer*	*Instrumentation for Measurements of Active Fermentation*	*Packed bed reactor*	*A Model of Cell Growth Dynamics*
	SLO-2	*Performance equation: Ideal batch reactor*	*Oxygen Uptake in Cell Cultures*	*pH, temperature, and DO*	*Fluidized bed reactor*	*Sigle cell model*
S-3	SLO-1	*Ideal continuous reactor - basics*	*Oxygen Transfer in Fermenters*	*Chemical composition and exhaust gas analysis*	*Air lift loop reactor*	*Yeast model*
	SLO-2	*Performance equation: Ideal continuous reactor*	*Measuring Dissolved-Oxygen Concentrations*	*Water purity, pressure and mass*	*Case studies*	*Simulation software packages*
S 4-5	SLO-1	*Lab 1: Batch operation*	*Lab 4: Estimation of K_La by sulphite oxidation method*	*Lab 7: Enzyme Production - Medium optimization by RSM*	*Lab 10: Repeat/Revision of experiments*	*Lab 13: Analysis of various growth kinetic parameters of batch fermentation using Berkley Madonna software*
	SLO-2					
S-6	SLO-1	*Ideal plug flow reactor - basics*	*Estimating Oxygen Solubility*	*Mass flow rate, volumetric flow rate and broth level*	*Bioreactor configurations for production of metabolites from plant sources*	*Berkley Madonna software*
	SLO-2	*Performance equation: Ideal plug flow reactor*	*Mass-Transfer Correlations*	*Methods for on-line and off-line biomass estimation*	*Different types of bioreactors for plant cells, tissues and organs*	*Continuous fermentation process*
S-7	SLO-1	*Reasons for non-ideality in bioreactors*	*Measurement of K_La*	*On-line analysis of other chemical factors*	*Light Introducing Bioreactors*	*Fed batch fermentation process*

Duration (hour)		15	15	15	15	15
	SLO-2	*Measurement of non-ideality in bioreactors*	*Oxygen-Balance Method and Dynamic Method*	*State and parameter estimation techniques for biochemical process*	*Rotating Drum Bioreactor*	*MATLAB - Basics*
S-8	SLO-1	*Residence Time Distribution - Studies*	*Power correlation analysis for KLa*	*Control system in bioreactor*	*Balloon-type bubble bioreactors*	*Input and Output in MATLAB*
	SLO-2	*Non-ideal bioreactors*	*Oxygen Transfer in Large Vessels*	*Regulatory and multivariable control*	*Scale-up*	*Curve fitting tool*
S 9-10	SLO-1	*Lab 2: Fed batch operation*	*Lab 5: KLa determination by dynamic gassing method*	*Lab 8: Repeat/Revision of experiments*	*Lab 11: Wine production*	*Lab 14: Estimation of bacterial growth kinetic parameter using Curve Fitting tool in MATLAB*
	SLO-2					
S-11	SLO-1	*Axial Dispersion*	*Regime analysis of bioprocess*	*Computer-based data acquisition*	*Bioreactor configurations for production of metabolites from animal sources*	*Running simulation in MATLAB*
	SLO-2	*Dispersion Model*	*Mechanism of mixing in bioreactors*	*Artificial intelligence for the control of bioreactor systems*	*Cell culture - basics*	*Running simulation in SIMULINK*
S-12	SLO-1	*Application of dispersion model in design of continuous sterilizers*	*Scale-up of bioreactors*	*Application of Computer Control and Sensing Technologies for bioreactor systems*	*Hollow fire reactors*	*Dynamic simulation studies*
	SLO-2	*Tanks-in-Series Model*	*Scale-up of bioreactors based on power consumption – Gassed*	*Flow injection analysis – Introduction*	*Perfusion culture systems*	*Process Flow sheeting*
S-13	SLO-1	*Conversion from Tanks-in-Series Model*	*Scale-up of bioreactors based on power consumption – Ungassed*	*Various transport system - FIA*	*Sedimentation column perfusion systems*	*Examples of various primary metabolites process flow diagram*
	SLO-2	*Summary - Types of models for non-ideal (real) reactors*	*Scale-up of bioreactors based on oxygen transfer*	*FIA applications*	*Bioreactor strategies for maximizing product formation*	*Examples of various secondary metabolites process flow diagram*
S 14-15	SLO-1	*Lab 3: Sterilization kinetics*	*Lab 6: KLa determination by power correlation analysis*	*Lab 9: Monitoring of process and kinetics parameters in enzyme production – Shake flask studies*	*Lab 12: Prediction of flow behavior in fermentation broth*	*Lab 15: Repeat/Revision of experiments*
	SLO-2					

Learning Resources		
	1. *Kargi. F., Shuler. M.L., "Bioprocess Engineering: Basic Concepts", 3rd Edition. Prentice Hall, 2017.*	*4. Scott F.H., "Elements of Chemical Reaction Engineering", 5th Edition, Pearson Education, Inc., 2015.*
	2. *Doran. P. M., "Bioprocess Engineering Principles", Academic press, 2012*	*5. Burstein L., "Matlab® in Bioscience and Biotechnology, Woodhead Publishing, 2011*
	3. Najafpour G., "Biochemical Engineering and Biotechnology", 2nd Edition, Elsevier Science, 2015	*6. Schügerl K., Bellgardt K.-H., Bioreaction Engineering: Modeling and Control, Springer, 2000.*

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Understand										
Level 2	Apply	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
	Analyze										
Level 3	Evaluate	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. P. BalaKumaran, Proklean Technologies (P) Limited, Chennai, genbalu86@gmail.com	*1. Prof. K Subramaniam, IITM, Chennai, subbu@iitm.ac.in*	*1. Dr. V. Vinoth Kumar, SRMIST*
2. Dr. Karthik Periyasamy, Aurobindo Pharma Limited, Hyderabad, karthikmpk@gmail.com	*2. Prof. R. B. Narayanan, SVCE, Chennai, rbn@svce.ac.in*	*2. Dr. M. Venkatesh Prabhu, SRMIST*

Course Code	18BTC203J	Course Name	ANIMAL BIOTECHNOLOGY	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:*	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	*Understand animal breeding,controlling characters and disorders*			
CLR-2 :	*Develop an understanding about transgenic animals*			
CLR-3 :	*Inculcate the understanding of cell culture technique and production of valuable products from them*			
CLR-4 :	*Emphasize on animal health thereby improving livestock production*			
CLR-5 :	*Develop an understanding of alteration of animal body biological system*			
CLR-6 :	*provide a basic understanding of animal biotechnology*			

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	*Impart theoretical knowledge on breeding, Characteristics of animals and biological markers for genetic diseases*	*2*	*80*	*70*		*H*							*H*			*M*	*H*	*H*	*H*
CLO-2 :	*Acquire knowledge on Embryo transfer, fertilization methods and transgenic animals*	*2*	*85*	*75*		*H*	*H*				*H*	*M*				*M*	*H*	*H*	*H*
CLO-3 :	*Illustrate on various cell culture techniques and their applications*	*2*	*85*	*80*	*H*		*H*	*M*	*H*		*H*	*H*	*H*		*H*	*H*	*H*	*H*	*H*
CLO-4 :	*Explain on microbial infections of animal thereby rendering prophylaxis*	*2*	*85*	*80*	*H*		*H*		*H*		*M*		*H*		*H*		*H*	*H*	*H*
CLO-5 :	*Gain knowledge about improvement of animals to increase the yield and quality of animal products*	*3*	*85*	*80*	*H*	*H*	*H*	*H*	*H*		*M*		*H*		*H*		*H*	*H*	*H*
CLO-6 :	*Assess the knowledge on animal biotechnology for its applications*	*2*	*80*	*75*	*H*	*H*	*H*	*H*	*H*		*M*		*H*		*H*		*H*	*H*	*H*

Duration (hour)		15	15	15	15	15
S-1	SLO-1	*Breed*	*Artificial insemination*	*Principles of sterile techniques and cell propagation*	*Vaccines for animal health*	*Use of biotechnology in livestock production*
	SLO-2	*Species*	*Super ovulation*	*Primary cell culture*	*Diseases in cattle:*	*Effects of Growth hormone*
S-2	SLO-1	*Different types of breeding: Pros & Cons*	*In vitro fertilization*	*secondary cell culture*	*Bacterial disease- symptoms and prevention*	*Manipulation of Growth hormone*
	SLO-2	*Inbreeding, Outbreeding*	*Embryo transfer*	*continuous cell lines*	*Viral disease -symptoms and prevention*	*Somatotropic hormone*
S-3	SLO-1	*Types of cross breeding*	*Embryo sexing*	*suspension cultures*	*Parasitic disease -symptoms and prevention*	*Recombinant Bovine Growth Hormone*
	SLO-2	*Up grading*	*Splitting and quality analysis of embryo*	*Chemically defined and serum free media for cell culture*	*Diseases in sheep & goat:*	*Thyroid hormone*
S 4-5	SLO-1	*Lab 1: Sterilization techniques for animal cell culture*	*Lab 4: Isolation and culture of Hepatocytes*	*Lab 7: Cell passaging*	*Lab 10: Mitochondrial staining by Rhodamine 123*	*Lab 13: Cytotoxicity-LDH assay*
	SLO-2					
S-6	SLO-1	*ChoosingTraits in farm animals*	*Pregnancy diagnosis*	*Scaling up of monolayer culture*	*Bacterial disease- symptoms and prevention*	*Probiotics as growth promoters:*
	SLO-2	*Quantitative trait loci*	*Cryopreservation of embryo*	*Scaling up of suspension culture*	*Viral disease -symptoms and prevention*	*Ideal characteristics*
S-7	SLO-1	*Marker assisted selection*	*Vitrification*	*Contamination: sources, types and eradication*	*Parasitic disease -symptoms and prevention*	*Mode of action of probiotics*
	SLO-2	*Single locus marker- RFLP*	*Slow programmed freezing*	*Preservation of animal cells*	*Introduction to animal vaccination*	*uses of probiotics*

Duration (hour)		15	15	15	15	15
S-8	SLO-1	*Multilocus marker- AFLP, SSR*	*Cloning for conservation of endangered species- Pros & Cons*	*characterization of animal cells*	*Vaccine production using animal cells*	*Manipulation of lactation*
	SLO-2	*RAPD in farm animals*	*Gene transfer techniques*	*Species identification*	*Live vaccines*	*Mammogenesis*
S 9-10	SLO-1	*Lab 2: Preparation of cell culture media*	*Lab 5: Cell counting and Viability*	*Lab 8: Cryopreservation of cells*	*Lab 11: Nuclear staining by Propidium iodide*	*Lab 14: Culture and differentiation of L6 cells*
	SLO-2					
S-11	SLO-1	*DNA Finger printing in animals*	*Transgenic animals – importance & methods of producing it*	*Organotypic culture*	*killed vaccines*	*Lactogenesis*
	SLO-2	*Applications of molecular markers*	*Transgenic mice*	*Types of organ culture*	*Conjugate vaccines*	*Galactopoiesis*
S-12	SLO-1	*Chromosomal aberrations*	*Transgenic fish*	*Application of animal cell culture*	*Anti Idiotypic vaccines*	*Manipulation of rumen microbial digestive system*
	SLO-2	*Genetic disorders: Cattle*	*Molecular farming*	*Cell cytotoxicity and viability assays*	*Subunit vaccines*	*Methods for manipulation*
S-13	SLO-1	*Sheep & Goat*	*Expression of therapeutic proteins*	*Cell culture as source of therapeutic products*	*Recombinant vaccines*	*Manipulation of wool growth*
	SLO-2	*Horse*	*Animal as a bioreactor*	*Tissue plasminogen activator*	*DNA vaccines*	*Factors affecting wool quality in sheep*
S 14-15	SLO-1	*Lab 3: Isolation and culture of Splenocytes*	*Lab 6: Primary culture using Chick embryo*	*Lab 9: Revival of Cryopreserved cells*	*Lab 12: Cell viability assay using MTT*	*Lab 15: Determination of glucose assay by GOD-POD method*
	SLO-2					

Learning Resources	
1. *Animal Biotechnology: Recent concepts and developments - P.Ramadas, MJP Publications, 2015.*	**3.** *Culture of animal cells; a manual of basic technique - R.Ian Freshney, Vth edition, Wiley publications, 2006.*
2. *Animal Biotechnology – M.M.Ranga, IIIrd edition, 2007*	**4.** *Textbook of Animal Biotechnology – P.Ramadas & S.Meerarani, IInd edition, 2002.*

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Understand										
Level 2	Apply	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
	Analyze										
Level 3	Evaluate	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

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 I, Aurozymes Unit, Aurobindo Pharma Limited, Hyderabad, karthikmpk@gmail.com*	2. *Prof. R. B. Narayanan, SVCE, Chennai, rbn@svce.ac.in*	2. *Dr. S.Subhashini, SRMIST*

Course Code	18BTC204T	Course Name	PROTEIN ENGINEERING AND PROTEOMICS	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:*	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLR-1 :	*Distinguish the organizational levels of protein structure.*																		
CLR-2 :	*Appraise the structure-function correlation in selected proteins.*																		
CLR-3 :	*Interpret the structural basis of catalytic mechanism of proteolytic enzymes.*																		
CLR-4 :	*Construct 3D structure of protein from amino acid sequence.*																		
CLR-5 :	*Discuss on the experimetal techniques available for protein structure characterization.*																		
CLR-6 :	*Express the structural similarities existing at basal level in a group of proteins with similar functions*																		
Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*																		
CLO-1 :	*Interpret the properties of protein based on the sequence*	*1*	*80*	*80*	*H*	*H*	*H*	*H*		*M*	*L*	*H*	*H*	*H*	*H*	*H*	*H*	*H*	*H*
CLO-2 :	*Recognize the 3D orientation of proteins and its correlation to the function oft the protein*	*2*	*85*	*75*	*H*	*H*	*H*	*H*			*M*	*H*	*H*	*H*	*H*	*H*	*H*	*H*	*H*
CLO-3 :	*Design mutated proteins to obtain proteins with desired function*	*2*	*75*	*80*	*M*	*H*	*M*	*H*	*M*	*M*		*M*	*H*	*H*	*H*	*H*	*H*	*H*	*H*
CLO-4 :	*Restate the biological significance of select group of proteins*	*2*	*85*	*80*	*H*	*H*	*H*	*H*			*H*	*L*	*H*	*H*	*H*	*H*	*H*	*H*	*H*
CLO-5 :	*Explain the basics of available experimental techniqes for resolving protein structure*	*3*	*85*	*75*	*H*	*H*	*H*	*H*		*M*	*H*	*H*	*H*	*L*	*H*	*H*	*H*	*H*	*H*
CLO-6 :	*Devise strategies for prediction, modification and design novel proteins*	*2*	*80*	*80*	*H*	*H*	*H*	*H*	*L*	*M*	*M*	*M*	*H*	*H*	*H*	*H*	*H*	*H*	*H*

Duration (hour)		9	9	9	9	9
S-1	SLO-1	*Structure of amino acids*	*Role of Transcription factors in gene expression*	*Types and uses of proteases*	*Difficulties in generating crystals of Protein*	*Introduction to proteomics*
	SLO-2	*Properties of amino acids*	*Significance of TATA-box binding proteins (TBP)*	*Mechanism of action of serine proteases*	*Methods of generating crystals*	*Difference between functional genomics and proteomics*
S-2	SLO-1	*Role of Glycine and Proline in structure determination*	*Structural elucidation of TBP*	*Significance of Catalytic triad in serine proteases*	*Braggs law*	*Importance of sequencing of prtoein*
	SLO-2	*Ramachandran plot and its significance.*	*Nature of interaction between TBP and DNA*	*Importance of oxyanion hole for the catalytic activity*	*Instrumentation setup for diffraction studies*	*Edmund sequencing method*
S-3	SLO-1	*Interactions that stabilize secondary structures*	*Structural elucidation of p53*	*Specificity of Trypsin towards cleavage of lysine and arginine amino acid bonds*	*Phase determination*	*Array based proteomics*
	SLO-2	*Structural features of alpha helix*	*Nature of interaction between p53 and DNA*	*Specificity of Chymotrypsin and subtilisin*	*Role of Fourier transformation to overcome phase problem*	*Two hybrid system*
S-4	SLO-1	*Types of alpha helices*	*Effect of mutations in the DNA binding domain of p53*	*Domains of Immunoglobulin*	*Multi-wavelength Anomalous Diffraction experiments*	*2D gel electrophoresis*
	SLO-2	*Parallel beta-strand structure*	*Effects of mutations in the oligomerization and Nuclear localization region*	*Class-switching in Immunoglobulins*	*Recent advances in diffraction studies*	*Advantages and limitations of 2D gel electrophoresis*
S-5	SLO-1	*Anti-parallel beta-strand structure*	*Structural elucidation of leucine zipper*	*Immunoglobulin fold*	*NMR principle*	*Mass Spectrometry - Principle*
	SLO-2	*Beta turns, loops and other secondary structures*	*Interaction of leucine zipper and DNA*	*Secondary structures in hyper-variable loop region*	*Instrumentation in NMR*	*Instrumental setup in MS*

Duration (hour)		9	9	9	9	9
S-6	SLO-1	*Super-secondary structures*	*Structure-function correlation in actin*	*Structural orientation in antigen binding site*	*NOE & NOE-COSY*	*Ionisation by MALDI*
	SLO-2	*Difference between motiffs & domains*	*Structure-function correlation in myosin*	*Nature of interaction between antigen and antibody*	*Coupling constants*	*Ionisation by ESI & EI*
S-7	SLO-1	*Types of motiffs*	*Role of ATP in muscular contraction*	*Significance of CDR3 loop in antibody*	*Chemical Shifts*	*Time of Flight concept & peptide mass fingerprinting*
	SLO-2	*Types of domains*	*Structural elucidation of GPCR*	*Mechanism of activation of T-Cell*	*Dipolar Coupling constants*	*Tandem MS and MS/MS*
S-8	SLO-1	*Monomeric and polymeric proteins*	*Types of GPCR*	*Prediction of 3D structure from amino acid sequence*	*Isothermal Titration Calorimetry (ITC) Principle*	*SALSA algorithm*
	SLO-2	*hydrophobic collapse & theories of folding*	*Mechanism of activation of GPCR*	*Homology modelling and threading*	*Instrumentation of ITC*	*De novo algorithms*
S-9	SLO-1	*Levinthal paradox*	*Structural elucidation of Tyrosine kinase receptor*	*Enhancing binding affinity of T4 lysozyme*	*Determination enthalpy, entropy and free energy*	*Revision of entire units*
	SLO-2	*Role of chaperons and heat shock proteins*	*Interactions that activate Tyrosine kinase receptor*	*Enhancing stability in T4 lysozyme*	*Prediction of binding energy and multiple binding sites by ITC*	*Revision of entire units*

Learning Resources	1. *Brandon.C, Tooze.J, "Introduction to Protein Structure", 2nd Edition - Garland Publishing, Taylor & Francis group, 1999.* 2. *Twyman. R. M, "Principles of Proteomics", Garland Scientific Publishers, 2004.*	3. *Chatwal. G. R, "Instrumental methods of Chemical Analysis", Himalaya Publishing House, 5th Edition, 2011.*

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%) #			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Understand										
Level 2	Apply	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
	Analyze										
Level 3	Evaluate	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

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2. *Dr. Karthik Periyasamy, Aurobindo Pharma Limited, Hyderabad, karthikmpk@gmail.com*	2. *Prof. R. B. Narayanan, SVCE, Chennai, rbn@svce.ac.in*	2. *Dr. Vasantha Rekha, SRMIST*

Course Code	18BTC301J	Course Name	BIOSEPARATION 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:*	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
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*																		
CLR-6:	*Familiarize with separation, isolation, purification, polishing and formulation techniques*																		
Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*																		
CLO-1:	*Categories the products into various sectors*	*H*	*80*	*70*	*H*	*H*	*H*	*H*	*L*				*H*	*H*	*H*	*H*	*H*	*H*	*H*
CLO-2:	*Identify the unit operation for separation*	*H*	*90*	*80*	*H*	*H*	*H*	*H*	*L*				*H*	*H*	*H*	*H*	*H*	*H*	*H*
CLO-3:	*Adapt the best methods of isolation of products*	*H*	*80*	*80*	*H*	*H*	*H*	*H*	*L*				*H*	*H*	*H*	*H*	*H*	*H*	*H*
CLO-4:	*Identify the sophisticated equipment for purification*	*H*	*80*	*80*	*H*	*H*	*H*	*H*	*L*				*H*	*H*	*H*	*H*	*H*	*H*	*H*
CLO-5:	*Know the polishing and formulation of the products*	*H*	*80*	*90*	*H*	*H*	*H*	*H*	*L*				*H*	*H*	*H*	*H*	*H*	*H*	*H*
CLO-6:	*Acquired knowledge in down streaming of Biomaterials*	*H*	*90*	*90*	*H*	*H*	*H*	*H*	*L*				*H*	*H*	*H*	*H*	*H*	*H*	*H*

Duration (hour)		15	15	15	15	15
S-1	SLO-1	*Introduction to Bio- separation process*	*Solid –Liquid Separation*	*Isolation of products*	*Purification of products*	*Product Formulation*
	SLO-2	*Importance of bioseparation in biotechnological processes*	*Biomass and particulate debris separation techniques*	*Adsorption-Chemistry of adsorption*	*Diafiltration*	*Crystallization- Basic concepts*
S-2	SLO-1	*Problems and requirements of bio-product purification*	*Flocculation-Pretreatment of broth*	*Batch Adsorption*	*Electro dialysis*	*Crystallization principles*
	SLO-2	*Different sectors of products in biotechnology*	*The electric double layer*	*Problems*	*Isoelectric focusing*	*Batch crystallizers*
S-3	SLO-1	*Engineering analysis in Bio separation- Stages of Bio separation*	*Forces Between Particles and Flocculation by Electrolytes*	*Continuous stirred tank adsorption*	*Electrophoretic separation of protein*	*Continuous crystallizers*
	SLO-2	*Basic principles of Engineering analysis*	*The Schulze–Hardy Rule Flocculation Rate Polymeric Flocculants*	*Fixed bed adsorption*	*Solving Problems*	*Solving Problems*
S-4-5	SLO-1	*Lab1. Cell disruption by Sonication*	*Lab 4. Separation of cells by Flocculation*	*Lab 7. Extraction of protein by aqueous two phase extraction*	*Lab 10. Detection and Estimation of Ethanol by Gas Chromatography*	*Lab 13. Crystallization of bioproducts*
	SLO-2					
S-6	SLO-1	*Process and product quality*	*Sedimentation Principles*	*Extraction*	*Chromatography principles*	*Crystallizer design*
	SLO-2	*Criteria for process development*	*Sedimentation Methods and coefficients*	*Chemistry of Extraction*	*Instruments and practice*	*Scale-up*
S-7	SLO-1	*Process Economics and Cost analysis*	*Centrifugation*	*Batch Extraction*	*Normal phase chromatography*	*Drying- principles*
	SLO-2	*Solving Problems*	*Tubular centrifuge*	*staged Extraction*	*Reversed phase chromatography,*	*Adiabatic and Conduction drying*
S-8	SLO-1	*Chemical and application range of Bioproducts*	*Disk Centrifuge*	*Differential Extraction- aqueous two phase.*	*Ion exchange chromatography*	*Dryer description and operations-Vacuum shelf dryer*

Duration (hour)		15	15	15	15	15
	SLO-2	*Sectors of Products*	*Ultra Centrifuge*	*Three phase Extraction Super critical Extraction*	*Gel permeation chromatography*	*Batch Vacuum rotary dryer*
S 9-10	SLO-1	*Lab 2. Cell disruption by Enzymatic method*	*Lab 5. Cell separation by Batch Filtration*	*Lab 8. Protein separation by Ultra filtration*	*Lab 11. Protein separation by column chromatography*	*Lab 14. Freeze drying of Biomaterial*
	SLO-2					
S-11	SLO-1	*Cell disruption methods for intracellular products*	*Filtration*	*Precipitation*	*Bio affinity chromatography*	*Freeze dryer*
	SLO-2	*Physical Cell Disruption*	*Filter Media and Equipment's*	*Precipitation by salt, Non solvents and large scale precipitation*	*Hydrophobic interaction chromatography*	*Spray dryer*
S-12	SLO-1	*Chemical and Enzymatic cell disruption*	*Theory of filtration*	*Cross flow filtration*	*Chiral chromatography*	*Conduction drying*
	SLO-2	*Solving Problems*	*Batch Filtration*	*Micro and Ultra filtration*	*Analysis of purity*	*Problems*
S-13	SLO-1	*Mechanical Cell Disruption*	*Continuous Rotary filters*	*Design of Ultra filtration*	*Scale-up in chromatography*	*Adiabatic drying*
	SLO-2	*Solving Problems*	*Solving Problems*	*Solving Problems*	*Solving Problems*	*Solving Problems*
S14-15	SLO-1	*Lab 3. Cell disruption by High pressure Homogenizer*	*Lab 6. Cell separation by Centrifugation*	*Lab 9. Protein Concentration by salting out method*	*Lab 12. Protein separation by Gel Electrophoresis*	*Lab 15. Drying of Bioproducts*
	SLO-2					

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*

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Understand										
Level 2	Apply	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
	Analyze										
Level 3	Evaluate	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Dr. P. BalaKumaran, Proklean Technologies (P) Limited, Chennai, genbalu86@gmail.com*	1. *Prof. K Subramaniam, IITM, Chennai, subbu@iitm.ac.in*	1. *Dr.M.Venkatesh Prabhu SRM IST*
2. *Dr. Karthik Periyasamy, Aurobindo Pharma Limited, Hyderabad, karthikmpk@gmail.com*	2. *Prof. R. B. Narayanan, SVCE, Chennai, rbn@svce.ac.in*	2. *Dr. Y.Ravichandran SRM IST*

Course Code	18BTC350T	Course Name	COMPREHENSION	Course Category	C	Professional Core	L	T	P	C
							0	1	0	1

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:*	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	*Acquire skills to develop knowledge in biochemical principles*			
CLR-2 :	*Acquire skills to solve real world problems in medical biotechnology*			
CLR-3 :	*Acquire skills in gene manipulation and recombinant DNA technology*			
CLR-4 :	*Acquire skills in enzyme technology and bioremeddiation*			
CLR-5 :	*Acquire skills in bioseparation technology*			
CLR-6 :	*Acquire skills to solve real world problems in the broad domain of biotechnology*			

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning			Program Learning Outcomes (PLO)													
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design,	Modern Tool Usage	Society & Culture	Environment &	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1 :	*Practice and gain confidence and competence to solve problems in biochemical principles*	*3*	*85*	*80*	*H*	*H*	*H*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*M*	*L*	*M*
CLO-2 :	*Practice and gain confidence and competence to solve problems in medical biotechnology*	*3*	*85*	*80*	*H*	*H*	*M*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*M*	*M*	*M*
CLO-3 :	*Practice and gain confidence and competence to solve problems in gene manipulation and recombinant DNA technology*	*3*	*85*	*80*	*H*	*H*	*M*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*M*	*L*	*M*
CLO-4 :	*Practice and gain confidence and competence to solve problems in enzyme technology and bioremeddiation*	*3*	*85*	*80*	*H*	*H*	*M*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*M*	*M*	*M*
CLO-5 :	*Practice and gain confidence and competence to solve problems in bioseparation technology*	*3*	*85*	*80*	*H*	*H*	*H*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*M*	*L*	*M*
CLO-6 :	*Practice and gain confidence, competence to solve problems in the domain of biotechnology and competitive examinations in biotechnology*	*3*	*85*	*80*	*H*	*H*	*M*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*M*	*M*	*M*

Duration (hour)		3	3	3	3	3
S-1	SLO-1	*Tutorial on biochemistry*	*Tutorial on genetics and gene mainpulation*	*Tutorial on microbiology*	*Tutorial on bioprocess technology*	*Tutorial on bioinformatics*
	SLO-2	*Problem Solving*	*Problem Solving*	*Problem Solving*	*Problem Solving*	*Problem Solving*
S-2	SLO-1	*Tutorial on cell biology and molecular biology*	*Tutorial on immunology*	*Tutorial on plant biotechnology*	*Tutorial on medical biotechnology*	*Problem environmental biotechnology*
	SLO-2	*Problem Solving*	*Problem Solving*	*Problem Solving*	*Problem Solving*	*Problem Solving*
S-3	SLO-1	*Tutorial on bioseparation technology*	*Tutorial on pharmaceutical biotechnology*	*Tutorial on animal biotechnology*	*Tutorial on protein engineering*	*Tutorial on fermentation technology*
	SLO-2	*Problem Solving*	*Problem Solving*	*Problem Solving*	*Problem Solving*	*Problem Solving*

Learning Resources	*1. Pranav Kumar and Usha Mina,Life Sciences, Fundamentals and Practice, Pathfinder Publication, 2016*

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (100% weightage)								Final Examination	
		CLA – 1 (20%)		CLA – 2 (30%)		CLA – 3 (30%)		CLA – 4 (20%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	-	*40%*	-	*30%*	-	*30%*	-	*30%*	-	-
	Understand										
Level 2	Apply	-	*40%*	-	*40%*	-	*40%*	-	*40%*	-	-
	Analyze										
Level 3	Evaluate	-	*20%*	-	*30%*	-	*30%*	-	*30%*	-	-
	Create										
	Total	100 %		100 %		100 %		100 %		-	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

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.Vinoth Kumar, SRMIST*
2. Dr. Karthik Periyasamy, Aurobindo Pharma Limited, Hyderabad, karthikmpk@gmail.com	*2. Prof. R. B. Narayanan, SVCE, Chennai, rbn@svce.ac.in*	*2.Dr.Samuel Jacob, SRMIST*