ACADEMIC CURRICULA

POST GRADUATE DEGREE PROGRAMMES

Master of Technology

(Choice Based Flexible Credit System)

Regulations 2021

Volume – 22
Syllabi for School of Bioengineering Programme

Professional Core and Elective Courses

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

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

Kattankulathur, Chengalpattu District 603203, Tamil Nadu, India

ACADEMIC CURRICULA

Genetic Engineering

Professional Core Courses

Regulations 2021

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

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

Kattankulathur, Chengalpattu District 603203, Tamil Nadu, India

Course Code	21GEC501J	Course Name	MOLECULAR TECHNIQUES	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	*Genetic Engineering*	**Data Book / Codes / Standards**	*Nil*		

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*understand the principles of DNA analytical techniques*
CLR-2:	*knowledge on RNA based techniques*
CLR-3:	*discuss various protein analytical methods*
CLR-4:	*restate various sequencing technologies*
CLR-5:	*explain the basic and advanced methods to analyse secondary metabolites*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	***2***	***3***
CO-1:	*design primers and perform PCR*	*3*		*2*
CO-2:	*perform qualitative and quantitative analysis of RNA*	*3*	*2*	*3*
CO-3:	*investigate and characterize proteins*			*2*
CO-4:	*analyze DNA sequence using various sequencing strategies*	*2*		
CO-5:	*experiment and interpret secondary metabolites*	*2*	*2*	

Module-1 - DNA Techniques	***15 Hour***
Methods of DNA analysis - Principle, method and application: Polymerase Chain Reaction (PCR), inverse PCR, multiplex-PCR, Amplification-Refractory Mutation System (ARMS) PCR, Loop-mediated isothermal amplification (LAMP), Targeting induced local lesion in genomes (TILLING), Thermal asymmetric interlaced (Tail) PCR, PCR-RFLP (Restriction Fragment Length Polymorphism), Bisulphite PCR, nested PCR, and digital PCR. Principle, method, and application of site-directed mutagenesis ***Practice:*** *1. Isolation of DNA* *2. ARMS-PCR* *3. LAMP*	
Module -2 - RNA Techniques	***15 Hour***

Principle, method, and application: Reverse Transcription PCR, semi-quantitative PCR, Quantitative PCR, 5'-rapid amplification of cDNA ends, 3'-rapid amplification of cDNA ends, and Differential Display Reverse Transcription PCR. Principle, method, and application of in vitro transcription ***Practice:*** *1. Random amplified Polymorphic DNA* *2. Restriction Fragment Length Polymorphism* *3. Bacterial identification using 16srDNA*
Module -3 - Protein Techniques ***15 Hour***
Principle, method, and application: denaturing and non-denaturing Polyacrylamide gel electrophoresis, 2D electrophoresis – 2D-Difference in Gel Electrophoresis, Western blotting– far western, peptide fingerprinting, affinity purification - His-tag purification, GST-tag purification, Enzyme-Linked Immunosorbent assay, Radioimmunoassay, Chromosome Immunoprecipitation, Electrophoretic Mobility Shift Assay, Pull-down assay, Co-localization using fluorescent tags ***Practice:*** *1. In vitro transcription assay* *2. Quantification of protein using Bradford method*
Module -4 - Hybridization and Sequencing Techniques ***15 Hour***
Probes - Types of probes, types of labels, methods of labeling, methods of detection, Southern hybridization - Restriction Fragment Length Polymorphism, Dot Blot hybridization, Northern Blotting, In situ hybridization, Fluorescent in situ hybridization, DNA sequencing by Sanger, Maxam-Gilbert, Next-generation sequencing – Illumina, ion-torrent, nanopore sequencing, third generation sequencing ***Practice:*** *1. SDS-Polyacrylamide Gel Electrophoresis* *2. PCR-RFLP*
Module -5 -Bio-Analytical and High Through-put Techniques ***15 Hour***
Principle, method, and application: High-performance thin layer chromatography, High-Performance liquid chromatography, Gas chromatography, Mass spectrometry, Nuclear Magnetic Resonance, Fourier-transformed infrared spectroscopy, Matrix-Assisted Laser Desorption/ionization-Time of Flight, Fluorescent imaging, confocal imaging, cryogenic Electron Microscopy, Flow cytometry, High content screening – automated microscopy, High through-put screening – cell based assays, target based assays, reporter based assays, label free assays, microfluidic screening. ***Practice:*** *1. LC-MS analysis of protein/metabolite* *2. Reporter Gene based assays*

Learning Resources	*1. Frederick M. Ausubel, Roger Brent, Robert E. Kingston, David D. More, Seidman J. G., John A. Smith and Kevin Struhl, "Curent Protocols in Molecular Biology", John Wiley& Son, Inc.*	*2. Daniel C. Liebler "Introduction to Proteomics", Humana Press.*

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

Course Designers		
Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. Dr. Florida Tilton Managing Director, Biozone Research Technologies	*1. Dr. Subramanian Sankaranarayanan Associate Professor, IIT Gandhinagar*	*1. Dr. D. Rex Arunraj, SRMIST*
2. Dr. Aneesh, Head, Centre for Genomics Medicine NIMS Hospital, Trivandrum	*2. Prof. Gopalakrishnan Professor, IARI, New Delhi*	*2. Dr. Usha B , SRMIST*

Course Code	21GEC502T	Course Name	MOLECULAR BIOLOGY OF GENE	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	*Genetic Engineering*	**Data Book / Codes / Standards**	*Nil*		

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*gain knowledge on genes and their structure*
CLR-2:	*obtain knowledge replication of DNA*
CLR-3:	*learn the process of DNA transcription into RNA*
CLR-4:	*gain knowledge on protein translation*
CLR-5:	*learn post-translational modification of proteins*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	***2***	***3***
CO-1:	*explain the structure of genes*	*3*	*3*	*2*
CO-2:	*describe how DNA is replicated in prokaryotes and eukaryotes*	*3*	*3*	*2*
CO-3:	*interpret how DNA is transcribed in prokaryotes and eukaryotes*	*3*	*3*	*2*
CO-4:	*compare and contrast process of translation in prokaryotes and eukaryotes*	*3*	*3*	*2*
CO-5:	*investigate the process of post-translational modification of proteins*	*3*	*3*	*2*

Module -1 - Structure of Gene	***9 Hour***
Structure of DNA and RNA. Organization of chromosomes. Genes, alleles, and locus. Genes in DNA and RNA. Genome, genome size and non-coding DNA, Central dogma of life.	
Module -2 - Replication of DNA	***9 Hour***
Replication of small circular genomes and large linear chromosomes. Enzymes and proteins required for replication, chromosome remodeling for replication, leading and lagging strand synthesis for replication. Rolling circle replication of phage DNA, errors during replication, proofreading and DNA repair.	
Module -3 - Transcription of DNA	***9 Hour***
Promoters, RNA polymerases, and transcription factors. Transcription in E.coli. Transcription in eukaryotes. mRNA maturation and stability, alternative splicing, and RNA export to the cytoplasm	
Module -4 - Translation of RNA	***9 Hour***
Genetic code in DNA and RNA. Features of genetic code. Codons use frequency and its implication in genetic engineering. Components of translation. Translation in prokaryotes and eukaryotes; Protein degradation by ubiquitin-proteasome pathway and lysosomal proteolysis.	
Module -5 - Recombination of DNA	***9 Hour***
Models of homologous recombination, proteins involved in homologous recombination, homologous recombination in eukaryotes, site specific recombination, molecular biology of transposition	

Learning Resources	1. *James D Watson, Molecular Biology of Gene, Pearson Publisher, 2017*	2. *Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick, Lewin's Genes XII, Jones & Bartlett Publishers, 2017*

Learning Assessment

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

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. Dr. V. Ramprasad, CEO, MedGenome, Bengaluru. ramprasadv@medgenome.com	*1. Dr. Latha Rangan, Indian Institute of Technology Guwahati. lrangan@iitg.ac.in*	*1. Dr. M. Parani, SRMIST*

Course Code	21GEC503J	Course Name	MOLECULAR CLONING	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	*Genetic Engineering*	**Data Book / Codes / Standards**	*Nil*		

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*summarize DNA manipulating enzymes*
CLR-2:	*illustrate use of various cloning and expression vectors*
CLR-3:	*explain the process of gene cloning strategies*
CLR-4:	*create knowledge on DNA library and screening*
CLR-5:	*construct expression vector for recombinant protein purification*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	**2**	**3**
CO-1:	*describe restriction enzymes and polymerases*	*3*	*3*	*2*
CO-2:	*use plasmids and vectors for gene cloning*	*3*	*3*	*2*
CO-3:	*compare various cloning strategies*	*3*	*3*	*2*
CO-4:	*explain DNA libraries and their uses*	*3*	*3*	*2*
CO-5:	*explain recombinant protein purification methods*	*3*	*3*	*2*

Module -1 - DNA Manipulating Enzymes	***15 Hour***
DNA manipulating enzymes- Restriction enzymes, types, DNA modifying enzymes, Terminal transferases, Alkaline phosphatases, Polynucleotide kinase, Methylases; DNA dependent DNA polymerases, DNA dependent RNA polymerases, RNA dependent DNA polymerases, Exo and endonucleases, DNA ligases and RNA ligases. ***Practice:*** *1. Plasmid DNA isolation for cloning* *2. PCR amplification of the insert* *3. Agarose gel electrophoresis of vector and insert*	
Module -2 - Vectors for Cloning	***15 Hour***
E. coli vectors: pBR322, pUC18/19, BAC, cosmids, Lambda and M13 phage vectors and expression vectors. Yeast vectors. Plant binary vectors for transformation. Animal vectors for transfection ***Practice:*** *1. Restriction digestion of Vector and Insert DNAs* *2. Gel purification of Vector and Insert DNA* *3. Qualitative and Quantitative analysis of purified DNA*	
Module -3 - Gene Cloning Strategies	***15 Hour***

Cloning using restriction enzymes: Cohesive end cloning and blunt end cloning. Cloning using linkers and adaptors. TA cloning and TOPO cloning. Restriction free cloning and ligation independent cloning. ***Practice:*** *1. Vector-Insert ligation* *2. Competent cell preparation*
Module -4 - DNA Library ***15 Hour***
Genomic DNA Library: Genomic DNA fragmentation, size fractionation, choice of vectors and size of library. cDNA Library: RNA isolation, mRNA purification, cDNA synthesis and cloning. Screening strategies of DNA libraries: Functional screening, probe-based screening and immunoscreening. ***Practice:*** *1. Transformation of ligated sample and selection* *2. Colony PCR for recombinant selection*
Module -5 - Gene Cloning and Expression ***15 Hour***
Expression vectors: Characteristics of expression vectors, cloning with fusion tags: His tags, GST tags, CBD and MBD tags. Expression and purification of recombinant protein. Codon bias and optimization. ***Practice:*** *1. Recombinant protein expression* *2. SDS-PAGE analysis of recombinant protein*

Learning Resources	1. *Principles of Gene Manipulation and Genomics, 7th Edition, S.B. Primrose and R.M. Twyman, Black well publishing, 2006*	2. *Current Protocols in Molecular Biology, Frederick M. Ausubel, Roger Brent, Robert E. Kingston, David D. Moore, J.G. Seidman, John A. Smith,Kevin Struhl (eds.), John Wiley & Sons, Inc*

Learning Assessment

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

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Dr. Ramanathan Vai* *Head, Genomics at Metahelix Lifesciences, Bengaluru*	1. *Dr. N. Ayyadurai* *Senior Scientist, CLRI, Chennai*	1. *Dr. S. Iyappan, SRMIST*
2. *Dr. Shankar. S* *Principal Scientist, Adenovirus Therapeutics, Ltd*	2. *Dr.Vikas Jain* *Associate Professor, IISER, Bhopal*	2. *Dr. Rex Arunraj D, SRMIST*

Course Code	21GEC504J	Course Name	GENOMICS: METHODS AND ANALYSIS	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	*Genetic Engineering*	**Data Book / Codes / Standards**		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*summarize the principles and resources for genomic data analysis*
CLR-2:	*interpret the different approaches for sequence quality assessment*
CLR-3:	*analyse the quality of the assembled transcriptome and the normalization*
CLR-4:	*predict the genes of significance based on differential gene expression*
CLR-5:	*simulate genomic and exomic data for variants prediction*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	***2***	***3***
CO-1:	*explain concepts and databases for sequence analysis*	*2*	-	-
CO-2:	*demonstrate the different methods to perform data QC and file formats*	*2*	-	-
CO-3:	*differentiate between de novo and reference assembly approaches in transcriptomics*	*3*	*2*	*3*
CO-4:	*estimate the change in the expression pattern among genes*	*3*	*2*	*2*
CO-5:	*integrate methods and tools for WES and WGS analysis*	*2*	*2*	*2*

Module -1 - Concepts and Resources	***15 Hour***
Databases: Nucleotide and Protein Sequence Databases, NCBI Sequence Read Archive, TCGA, KEGG, RNA Central, Uniprot and InterPro; Sequence Analysis: Basics of Pairwise, Global and Local Alignment, BLAST and its types, Identity, Similarity, Homology, Orthologs, Paralogs, Xenologs; Multiple Sequence Alignment: Motifs, Domains, Family and Superfamily – Phylogeny tree construction and validation. ***Practice:*** *1. Data retrieval, pairwise sequence alignment and BLAST, 2. Multiple sequence alignment and Phylogenetic tree construction*	
Module-2 - Sequencing Data QC	***15 Hour***
Introduction to Linux and Galaxy; File Formats: FASTA, FASTQ, BCL, SAM and BAM; Characteristics of a NGS library – adapters, indexes; Single-end and Paired-end sequencing, Phred Score Calculation and its interpretation, Adapter trimming, FastQC and MultiQC. Visualization tools. ***Practice:*** *1. Linux commands and Galaxy, 2. File formats conversion, 3. SRA data mining and Assessment of sequence data quality*	
Module -3 - Transcriptomic Data Analysis	***15 Hour***
Introduction- RNASeq, Assembly: Reference and De novo, N50, N90, Bowtie2; Contigs, Transcripts and Isoforms; Completeness of De novo assembly: BUSCO, Bowtie, Indexes for Reference mapping, HISAT2, Normalization: RPKM, FPKM, TPM; Pipelines for RNA-Seq ***Practice:*** *1. De novo assembly and assessment of the transcriptome, 2. Reference assembly, 3. Feature counts and Normalization*	
Module -4 - Differential Gene Expression and Annotation	***15 Hour***
Introduction- Differential Gene Expression: Foldchange, logFC, Heatmap, Time Course analysis of DEGs, DESeq2, EdgeR; Functional Annotation: BLAST, Blast2GO, Gene Ontology, Geneset Enrichment Analysis, Principal Component Analysis, Gene-Gene network, Fusion Genes; Case studies.	

Practice: *1. Differential expression of genes, 2. Functional Annotation and Gene Ontology, 3. Cytoscape*	
Module -5 - Whole Genome Sequencing and Whole Exome Sequencing	***15 Hour***
Introduction - WGS and WES, Targeted and Amplicon Sequencing, Coverage and Depth of Sequencing, Indels, Variant Calling – SNV, SNP, variant call format (VCF); Alignment, Copy number variation, Genome resequencing, COSMIC, OMIM, GATK, AnnoVar, Personalized Medicine; Pipelines for WES and WGS. Case studies.	
Practice: *1. Identification of SNP using GATK, 2. Annotation of SNPs using COSMIC*	

Learning Resources	*1. David W. Mount. Bioinformatics: Sequence and Genome Analysis, 2nd Edition, Cold Spring Harbor Laboratory Press, USA. 2004* *2. Hamid D Ismail. Bioinformatics A Practical Guide to Next Generation Sequencing Data Analysis, CRC Press. 2023.* *3. Ju Han Kim. Genome Data Analysis: Learning Materials in Biosciences, Springer Nature Singapore Pte Ltd. 2019.*	*4. Filippo Geraci, Indrajit Saha, Monica Bianchini. RNA-Seq Analysis: Methods, Applications and Challenges, Frontiers Media SA, 2020.* *5. Peter N. Robinson, Rosario Michael Piro & Marten Jager. Computational Exome and Genome Analysis, 1st Edition, Chapman and Hall/CRC, 2017* *6. https://en.wikibooks.org/wiki/Next_Generation_Sequencing_(NGS)/Print_version*

Learning Assessment

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

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. Dr. Arpita Ghosh, Eurofins Genomic India Pvt. Ltd, Bengaluru, arpita.Ghosh@xoin.eurofinsasia.com	*1. Prof. V. Umashankar, ICMR-NIE Chennai, umashankar.v@icmr.gov.in*	*1. Dr. Habeeb. S. K. M, SRMIST*
2. Dr. Sanjay Singh, Eurofins Genomic India Pvt. Ltd, Bengaluru, sanjay.singh@xoin.eurofinsasia.com	*2. Prof. Saharuddin Bin Mohammad, University of Malaya, Kuala Lumpur, saharuddin@um.edu.my*	*2. Dr. T. Anand, SRMIST*

Course Code	21GEC505J	Course Name	REGULATION OF GENE EXPRESSION	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	*Genetic Engineering*	**Data Book / Codes / Standards**		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*summarize various factors influencing gene expression.*
CLR-2:	*illustrate transcriptional level control mechanisms in gene expression.*
CLR-3:	*explain post-translational regulation of gene expression*
CLR-4:	*analyze epigenetic mechanisms regulating gene expression.*
CLR-5:	*develop skills in quantifying gene expression and modifications*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	***2***	***3***
CO-1:	*identify various regulatory elements influencing gene expression.*	3	2	3
CO-2:	*develop skills in quantifying gene expression.*	3	2	-
CO-3:	*demonstrate proficiency in utilizing antisense RNA.*	-	3	2
CO-4:	*analyze the effects of protein modifications.*	2	3	-
CO-5:	*apply principles of epigenetic regulation to control gene expression.*	3	-	2

Module -1 - Control of Gene Expression	***15 Hour***
Fine structure of gene; Structural elements controlling gene expression- promoters, enhancers, and silencers; General and Inducible transcription factors; Transcriptional regulation in prokaryotes-Lactose operon, tryptophan operon, arabinose operon and galactose operon; Translational regulation in prokaryotes. ***Practice:*** *1. Isolation of RNA* *2. Qualitative and Quantitative analysis of RNA using Agarose gel electrophoresis and Nanodrop spectrophotometer*	
Module -2 - Transcriptional and Post-Transcriptional Control of Gene Expression	***15 Hour***
Riboswitches and types; Control of gene expression using riboswitches; Regulation of gene expression by non-coding RNAs; X chromosome inactivation-Dosage compensation; Bacteriophage lambda genome; Control of lytic and lysogenic life cycle of lambda phage; Control of yeast HO gene using two repressors; Combinatorial control of yeast mating type genes. ***Practice:*** *1. DNase treatment and RNA purification* *2. Primer designing and first-strand cDNA synthesis*	
Module -3 - Translational and Post-Translational Control of Gene Expression	***15 Hour***
Protein folding; Molecular chaperons-Heat shock factors; Post-translational modifications of proteins-prenylation, palmitoylation, myristoylation, glycosylation, phosphorylation, ubiquitination, SUMOylation; mechanism in protein packaging.	

Practice: *1. Semiquantitative-Reverse Transcription PCR* *2. Quantitative gene expression analysis using qRT-PCR*
Module -4 - Epigenetic Control of Gene Expression ***15 Hour***
Histone modifications; Effect of histone modification on gene expression; Histone acetylation, methylation; Histone code hypothesis; Chromatin remodellers in eukaryotes; Chip-Seq; Regulators of homeotic genes- PcG and TrxG proteins; Role of polycomb group of proteins; Genomic imprinting- DNA methylation, Patterns of DNA methylation; Effects of DNA methylation on transcription; Imprinting control regions. ***Practice:*** *1. Methylation-specific PCR* *2. DNA cytosine methylation analysis by bisulfite sequencing*
Module -5 - Gene expression Analysis Methods ***15 Hour***
Analysis of regulatory elements using reporter genes; Protein-DNA/protein interaction-Yeast one-hybrid assay, EMSA, Yeast two-hybrid assay; post-transcriptional modification- Real-Time PCR, small RNA transcriptomics, mRNA stability assay; post-translational modifications of proteins-Western blotting, immunofluorescence assay; Epigenetic modification-Chromatin immunoprecipitation assay, Bisulfite sequencing. ***Practice:*** *1. IPTG induction protein expression and analysis* *2. Electrophoretic Mobility Shift Assay (EMSA)*

Learning Resources	*1. Molecular Biology of the gene by Watson J D, Bake T A, Bell SP, Gann A, Lewine M, Losick R 2014* *2. Epigenetic Gene Expression and Regulation by Huang S, Litt M D, and Blackey C A, 2015* *3. Molecular Cloning – A Laboratory Manual by Michael Green and Joseph Sambrook, CSHL Press, 4th edition, 2014*	*4. Mechanisms of Gene Regulation: How Science Works by Carsten Carlberg, Ferdinand Molnár, Springer Internation Publishing, 2020* *5. Laboratory Manual*

Learning Assessment

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

Course Designers

Experts from Industry	*Experts from Higher Technical Institutions*	*Internal Experts*
1. *Dr. Ramanathan Vai Head, Genomics at Metahelix Lifesciences, Bengaluru*	1. *Dr. P.V. Shivaprasad, Group leader, NCBS Bengaluru*	1. *Dr. G. Ganesan, SRMIST*
2. Dr. P. Sadasivam Scientist, Du Pont Industrial biosciences, Hyderabad	*2. Dr. Sivaprakash Ramalingam, Scientist, IGIB, New Delhi*	*2. Dr. S. Iyyappan , SRMIST*

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Genetic Engineering

Professional Elective Courses

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Kattankulathur, Chengalpattu District 603203, Tamil Nadu, India

Course Code	21GEE501T	Course Name	HUMAN PHYSIOLOGY	Course Category	E	PROFESSIONAL ELCTIVE	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*generate knowledge in architecture of biological membrane and cellular processes involved in physiology*
CLR-2:	*provide an understanding about the basic functions of cardiovascular and respiratory systems*
CLR-3:	*enable the students to understand the digestion of macromolecules*
CLR-4:	*create an understanding about the neuromuscular systems that controls and maintains homeostasis*
CLR-5:	*initiate the students to understand the role of reproductive organs in gametogenesis*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	***2***	***3***
CO-1:	*recall the structural organization of cell membrane and transport of molecules across the membrane*	3	2	-
CO-2:	*describe the cardiac events that helps in effective functioning of heart and exchange of gases between the lungs and tissues*	3	3	-
CO-3:	*explain the gastrointestinal secretions and their role in digestion and absorption*	-	-	3
CO-4:	*summarize the nerve impulse conduction and muscular contraction*	2	2	-
CO-5:	*integrate the process of gametogenesis and the role of hormones involved in the reproductive system.*	2	2	-

Module -1 - Cellular Physiology	***9 Hour***
Structural organization of cell, Transport function of cell membrane- Cross membrane movement of small and large molecules; Membrane shuttles - Endocytosis and Exocytosis.	
Module -2 - Cardiovascular and Respiratory System	***9 Hour***
Cardiovascular system –Working mechanism of heart, Electrocardiogram, Blood pressure, Cardiovascular pathways, Cardiac output and Cardiac cycle events. Cellular respiration-, Partial pressure of gaseous molecules, Effect of pO2 on Hb saturation, Gaseous transport – Exchange of O_2 and CO_2 between alveolar sac and tissues.	
Module -3 - Digestive System and Gastrointestinal Disorders	***9 Hour***
Overview of digestive system - Major and minor accessory organs of digestive system. Role of gastrointestinal enzymes in digestion and absorption of carbohydrates, proteins and fats. Physiology of gastrointestinal disorders	
Module -4 - Neuronal Biology and Muscular System	***9 Hour***
Neuronal structure, types of neurons, glial cells; Synapses – Chemical and electrical synapse; Mechanism of nerve impulse transmission with G protein coupled receptor; Neurotransmitters - Types of neurotransmitters, its synthesis and secretions. Muscular system – Role of contractile proteins in muscular contraction and relaxation Sources of ATP in muscle metabolism.	
Module -5 - Excretory System and Reproductive Biology	***9 Hour***
Overview of Urinary system, role of nephrons in urine formation; Countercurrent multiplier system in excretion; Role of Renin Angiotensin -Aldosterone regulation of kidney function. Reproductive system- Spermatogenesis, Oogenesis, Menstrual cycle, Maternal changes during pregnancy and lactation.	

Learning Resources	*1. Sembulingam P., Sembulingam K,"Essentials of Medical Physiology" , Jaypee Publications, 6th Edition. 2010.* *2. Jain A.K. "Textbook of Physiology", Avichal Publishing Company, 4th Edition, 2009.*	*3. Guyton A.C. and Hall J.E., "Medical Physiology", Saunders Publications, 11thEdition, 2005* *4. Muthayya, N.M., "Human Physiology", 4th edition, Jaypee Publications, 2010.*

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

Course Designers		
Experts from Industry	*Experts from Higher Technical Institutions*	*Internal Experts*
1. Dr. V. Ganesan, Managing Director, Acme Progen Biotech (India) Pvt. Ltd, Salem *Astarich16@gmail.com*	*1. Dr. Jayanthi* *Assistant Professor, Dept of Environmental Sciences, Periyar University, Salem*	*1. Dr. J. Megala, SRMIST*
2. Dr. S. Ramamoorthy, CEO,Palamur Biosciences PVT Ltd, Hyderabad *ram.murthy@palamurbio.com.*	*2. Dr. S. Ananthi* *Scientist, Dept.of Preventive Oncology, Cancer Institue, Chennai*	*2. Dr. Sivaramakrishnan, , SRMIST*

Course Code	21GEE502T	Course Name	MOLECULAR IMMUNOLOGY	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*obtain knowledge of the principles of immune responses*
CLR-2:	*analyze the molecular mechanisms of immune response*
CLR-3:	*discuss about antigen and antibody*
CLR-4:	*illustrate various immunodeficiency diseases and vaccine development*
CLR-5:	*state an overview of emerging topics in immunology*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	***2***	***3***
CO-1:	*recall about basic concepts of immunology*	-	2	-
CO-2:	*describe antibody structure and diversity*	-	2	-
CO-3:	*analyse recent developments in antigen-antibody interactions*	3	-	2
CO-4:	*discuss concepts in immunopathology and immunotherapy*	3	2	2
CO-5:	*apply emerging concepts in immunology*	3	2	2

Module -1 - Overview to Immunology	***9 Hour***
Basic concepts and principles of immunology; Cells and organs of the immune system; Adaptive immunity; Major histocompatibility complex (MHC); Antigen presentation system and Innate Immune Responses – PRRs – TLRs – RLRs and NLRs	
Module -2 - Molecular Mechanisms of Immune Responses	***9 Hour***
B cell development and activation; T cell development and activation; T cell receptor structure and function; T cell subsets and differentiation; Cell-mediated cytotoxicity and apoptosis; Chemokines and adhesion molecules in cell migration and homing to lymphoid organs.	
Module -3 - Antigens and Antibodies	***9 Hour***
Antigens- chemical and molecular nature; Haptens; Adjuvants; Antibodies- structure and functions of antibodies; Immunoglobulin gene rearrangement and diversity; Genetic control of antibody production; Isotype, Allotypes; Idiotypes; Antigen-antibody reactions and their significance in diagnosis; Immunotoxic chimeric antibodies and abzymes.	
Module -4 - Immunopathology and Immunotherapy	***9 Hour***
Monoclonal and polyclonal antibody production- principles and applications; Hypersensitivity and allergy; Autoimmunity and autoimmune diseases; Immunodeficiency and immunodeficiency diseases; Transplantation and graft rejection; Tumor immunology and cancer immunotherapy; Infectious diseases and vaccine development.	
Module -5 - Emerging Topics in Molecular Immunology	***9 Hour***
Immunogenomics and immunoproteomics; Immunoinformatics and computational immunology; Epigenetics and chromatin remodeling in immune cells; Microbiome and mucosal immunology; Nanovaccines and nanotheranostics in immunology.	

Learning Resources	*1. Abul K. Abbas Andrew H. Lichtman & Shiv Pillai, "Cellular and Molecular Immunology" 10th Edition. 2021* *2. Judith A. Owen, Jenni Punt and Sharon Stranford, "Kuby Immunology", W.H. Freeman and Company, 7th Edition, 2014.* *3. Sudha Gangal and Shubhangi Sontakke, "Textbook of basic and clinical immunology," Universities Press, 2013.*	*4. Bruce Alberts. Molecular Biology of the Cell, 5th Edition. 2017* *5. Roitt's Essential Immunology. 13th ed. P. Delves, et al., ed., Blackwell Publishing, 2017.*

Learning Assessment

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

Course Designers

Experts from Industry	*Experts from Higher Technical Institutions*	*Internal Experts*
1. Dr. C. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com	*1. Prof. K Subramaniam, IITM, Chennai, subbu@iitm.ac.in*	*1. Dr. M. Ramya, 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. Sivaramakrishnan, SRMIST*

Course Code	21GEE503J	Course Name	CANCER GENETICS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	0	2	3

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

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*obtain knowledge on biology and genetics of cancer*
CLR-2:	*comprehend the molecular signalling mechanisms involved in cancer*
CLR-3:	*study the types of cancer therapy*
CLR-4:	*evaluate the mechanisms of resistance*
CLR-5:	*identify novel drugs and targets for cancer treatment*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	***2***	***3***
CO-1:	*define various factors involved in cancer progression and metastasis*	3	2	2
CO-2:	*analyze the mechanism of the spread of cancer*	3	3	2
CO-3:	*demonstrate the role of genetic and epigenetic factors in cancer*	3	2	2
CO-4:	*compile signaling pathways activated during carcinogenesis*	3	3	2
CO-5:	*propose the challenges and limitations in cancer therapies*	3	3	2

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Module - 1 - Classification and Causes of Cancer	***12 Hour***
Introduction to Cancer - Epidemiology of cancer; Global and Indian Scenario of Cancer; Types of Cancer; Causes of Cancer – Physical agents, Chemical agents, Genetic factors, Lifestyle influence, Bacterial, protozoan and viral causes of cancer; Cancer Prevention Strategies ***Practice:*** *1. MTT assay* *2. Colony Formation Assay*	
Module - 2 - Hallmarks of Cancer	***12 Hour***
Oncogenes and Tumor Suppressor genes; Cell cycle and Cancer; Programmed cell death, Metastasis – Steps and Genes involved in metastasis; Tumor recurrence, immune evasion; drug/radio -resistance; Cancer stem cells; tumor angiogenesis and Anti-angiogenic chemotherapeutics ***Practice:*** *1. Migration Assay* *2. CAM assay*	
Module - 3 - Aging and Epigenetics in Cancer	***12 Hour***
Genetic alterations in cancer- Mutation-p53, kRas, Translocation-Bcr/Abl, DNA repair mechanisms- MLH and MMR in cancer, Epigenetics- DNA methylation in promoter regions of tumor suppressor gene - p53, Histone modifications in cancer, Noncoding RNAs in Cancer-OncomiRs and Tumor suppressor miRNAs, Cellular senescence, aging and cancer. ***Practice:*** *1. Cell Viability – Trypan blue/ Fluorescein diacetate assay* *2. COMET assay*	
Module – 4 - Cancer Cell Signaling Pathways	***12Hour***
Basic elements and concepts of signaling, G-Protein Coupled Receptors in Cancer, Hormone signaling in Cancer-Estrogen receptor, Growth factor signaling - EGFR and cancer, Inflammation and cancer-Colitis associated cancer, Cancer stem cell self renewal signaling pathways-Hedgehog, Wnt and Notch signaling.	

Practice: *1. Anchorage independent assay* *2.Colonospheroid assay*	
Module - 5 - Cancer Therapy	***12 Hour***
Types of Cancer treatment – Radiation therapy; Chemotherapy-, Immunotherapy, Gene Therapy-Suicide Gene Therapy and oncolytic virus; Hormone Therapy-Aromatase inhibitors, Targeted Therapy, Cancer Stem Cell Therapy-Vismodegib ***Practice****: 1. PI/Annexin V – Flow cytometry* *2. Immunocytochemistry-cMYC*	

Learning Resources	*1. Bunz F. "Principles of Cancer Genetics", Springer Science, Second Edition (2016).* *2. Weinberg R. "The Biology of Cancer", Garland, Second Edition (2013).*	*3. Ramalingam S, "Cancer Genes" Bentham Books, (2023)*

Learning Assessment

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

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. Dr. Durairaj Director & Head - Biotechnology at Orchid Pharma Ltd	*1. Dr. Rajasingh Johnson* *Associate Professor, University of Tennessee, USA*	*1. Dr. R. Satish, SRMIST*
2. Dr. Satheesh K. Sainathan *Study Director, Biomarker and Phenotypic services at Eurofins Discovery at Eurofins Discovery, Chesterfield, Missouri, USA*	*2. Dr. A. Muralidharan* *Assistant Professor, University of Tulane, USA*	*2. Dr. N.S. Raja, SRMIST*

Course Code	21GEE504J	Course Name	PLANT GENETIC ENGINEERING	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	0	2	3

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

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*understand the methods of plant tissue culture*
CLR-2:	*mass propagation of plants through tissue culture methods*
CLR-3:	*reproduce the production of transgenic plants through various methods*
CLR-4:	*demonstrate the applications of genetically modified crops in various fields*
CLR-5:	*recall the legal issues concerned with cultivation and commercialization of transgenic plants*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	***2***	***3***
CO-1:	*classify the different plant tissue culture methods*	-	-	-
CO-2:	*recall the strategies and tools used for creating transgenic crops*	3	-	-
CO-3:	*perform site directed genome editing in plants*	3	2	3
CO-4:	*apply different methods for creating genetically modified crops*	3	2	3
CO-5:	*create and commercialize genetically modified crops*	3	2	3

Module -1 - Plant Tissue Culture Methods and Applications ***12 Hours***

History; Tissue culture lab organization; Types of media and preparation; Sterilization methods; Plant hormones; Direct and indirect organogenesis; Micropropagation; Anther culture; Embryo culture; Somatic embryogenesis; Protoplast isolation and fusion; Callus and Suspension cell culture; Somaclonal variation.

Practice: *1. Preparation of tissue culture media*
2. Aseptic germination of seeds
3. Callus culture and meristem culture

Module -2 - Methods of Plant Transformation ***12 Hours***

Biology of Agrobacterium tumefaciens; Binary vectors; Agrobacterium mediated plant transformation; Selection and molecular characterization of transgenic crops; Particle bombardment; Promoters and its types; Selection and screening markers; Marker free transgenics.

Practice: *1. Biolistic gene gun*
2. Transformation of binary vector into Agrobacterium tumefaciens

Module -3 - Site Directed Genome Editing in Plants ***12 Hours***

Mechanisms of gene editing -Zinc finger nucleases, TALENS; CRISPR-Cas9; orthologs of Cas9, Vectors of CRISPR construct, Components of SgRNA, Designing and cloning of SgRNA for plant transformation; Protoplast transformation for quick CRISPR confirmation, Confirmation of mutagenesis by Sanger sequencing.

Practice: *1. Screening of recombinant colonies by colony PCR*
2. Agrobacterium mediated plant transformation

Module -4-: Transgenic Plants and Gene Edited Plants ***12 Hours***

Transgenic plants- Bt cotton, Round-up ready soybean, Blue rose, Golden rice, Pharmaceutical drugs and vaccines in plants; Gene edited plants- Semi-dwarf (sd1) mutant rice, Zea mays with reduced phytic acid content, Mushroom with reduced oxidation; Gene containment.

Practice: *1. GUS Assay* *2. sgRNA design for CRISPR-Cas9 mediated gene editing*
Module -5 - Regulation of GM Crops in India ***12 Hours***
Biosafety and Safety assessment of GE plants in India and the world, Competent authorities and committees in India; Quarantine involved in import and export of GE crops, Recombinant DNA safety guidelines, Institutional biosafety committee guidelines ***Practice:*** *1. In-planta transformation (infiltration in tobacco leaves)* *2. Microscopic examination of GUS in transgenic cells*

Learning Resources	*1. Razdan. M.K., "Introduction to plant tissue culture" second edition, Science Publishers, 2003.* *2. Slater. A., Scott. N.W., Fowler. M.R., "Plant biotechnology-the genetic manipulation of plants", Third edition, Oxford University Press, 2008.* *3. Gelvin. S., Agrobacterium-mediated plant transformation: the biology behind the "gene-jockeying" tool. Microbiol. Mol. Biol. Rev., 67, 16–37, 2003.*	*4. Voytas. D.F., Gao. C., Precision genome engineering and Agriculture: opportunities and regulatory challenges. Plos One. 12, e1001877, 2014.* *5. Laboratory Manual*

Learning Assessment

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

Course Designers

Experts from Industry	*Experts from Higher Technical Institutions*	*Internal Experts*
Dr. P. Sadasivam *Scientist, Du Pont Industrial biosciences, Hyderabad*	*Dr. Sivaprakash Ramalingam* *Scientist, IGIB, New Delhi*	*Dr. B. Usha, SRMIST*
Dr. M. Harikrishnan *Scientist, Pondicherry Biotech Pvt. Ltd, Pondicherry.*	*Prof. Raveendran* *Professor, TNAU, TamilNadu*	*Dr. M. Parani, SRMIST*

Course Code	21GEE505T	Course Name	MOLECULAR PATHOGENESIS OF INFECTIOUS DISEASES	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*understand important concepts in molecular pathology*
CLR-2:	*obtain knowledge on host defense mechanisms against pathogens*
CLR-3:	*learn the pathogenesis of infectious diseases*
CLR-4:	*discuss the different methods for disease diagnosis*
CLR-5:	*learn about evasion strategies of pathogens*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	***2***	***3***
CO-1:	*explain the process of establishment of infection*		2	2
CO-2:	*describe how host responds to infection*	*3*	*3*	*2*
CO-3:	*analyse the expression of virulence factors*	*2*	*3*	*2*
CO-4:	*investigate the mechanisms of virulence gene expression*	*3*	*3*	*2*
CO-5:	*develop tools and techniques for diagnosis of diseases*	*3*	*3*	*2*

Module 1 - Infectious Agents and Disease Development	***9 Hour***
Emerging infectious diseases and outbreaks, categories of infectious agents, Koch postulates and molecular aspects, pathogens and mode of entry, host pathogen interaction and disease development, virulence factors and types, host defense against infection	
Module 2 - Mechanisms of Genetic Modification	***9 Hour***
Virulence factors in pathogens, Virulence gene mutations and types, modes of virulence gene transfer, antigenic and phase variation, pathogenicity islands and properties, genome rearrangements and pathogen evolution	
Module 3 - Virulence Factor Identification	***9 Hour***
Tissue culture models, plaque assay, cell to cell spread assay, Molecular approaches – gene cloning and PCR, measuring virulence using reporter assay, profiling virulence gene expression using transcriptomics and proteomics	
Module 4 - Mechanisms of Virulence Gene Regulation	***9 Hour***
Modes of gene regulation pathogens, Transcriptional activators and repressors, two component regulatory networks, quorum sensing mechanisms in Gram-positive and Gram-negative bacteria, environmental control on virulence gene expression, virulence gene expression for toxin production and biofilm formation	
Module 5 - Molecular Diagnostic Approaches for Infectious Diseases	***9 Hour***
Nucleic acid-based typing, aptamer-based detection, PCR-based diagnostic approaches, biomarker discovery using transcriptomics and proteomics approaches, Point -of-care testing, infectious disease surveillance approaches and biosecurity	

Learning Resources	1. *Brena Wilson, Abigail Syers, Malcom Winkler – Bacterial pathogenesis – a molecular approach, ASM Press, 2019*	2. *Anderson DG, Sarah S, Deborah Allen – Nesters Microbiology – A human Perspective, McGraw Hill, 2022*

Learning Assessment

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

Course Designers

Experts from Industry	*Experts from Higher Technical Institutions*	*Internal Experts*
1. *Dr. B. Winston Umakanth, Director, Quality Control, Inventprise, USA*	1. *Dr. Nivedita Gupta, Scientist F & Head, ICMR - NICED, Kolkata*	1. *Dr. K.N.Rajnish, SRMIST*
2. *Dr. Sivakumar Selvaraj, Medall Diagnostics, Chennai*	2. *Dr. Sibnarayanan Dutta,, Scientist, DRDO, Tezpur, Assam*	2. *Dr. S. Shobana, SRMIST*

Course Code	21GEE506T	Course Name	GENETIC ENGINEERING FOR INDUSTRIAL APPLICATIONS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*know the basic genetic modification tools to improve the productivity*
CLR-2:	*understand the various process used for primary metabolite production*
CLR-3:	*recognize the several methods involved in the formation of secondary metabolites.*
CLR-4:	*explore the application of genetic engineering in bioenergy and bioremediation*
CLR-5:	*develop interest on biopharmaceuticals through genetic engineering*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	***2***	***3***
CO-1:	*identify the fundamental genetic modification techniques for enhancing productivity.*	3	-	-
CO-2:	*describe the diverse procedures employed in primary metabolite synthesis.*	2	2	-
CO-3:	*distinguish the different methodologies utilized in the production of secondary metabolites.*	-	2	3
CO-4:	*investigate the utilization of genetic engineering in bioenergy and bioremediation.*	2	-	2
CO-5:	*design genetic engineering method to produce biopharmaceuticals*	2	2	3

Module -1 Genetic Modification to Enhance the Production	***9 Hour***
Modification of strains: Random and site-directed mutagenesis, Genome shuffling, Gene integration, and gene knockout methods, Transposons mediated mutagenesis, CRISPR technology; Selection of genetically modified organism: Selectable and counter selectable markers, Allelic exchange and counter selection, Marker free selection.	
Module -2 Production of Primary Metabolites	***9 Hour***
Enhancing the primary Metabolites production through GMOs: Volatile fatty acids, organic acids, amino acids, vitamins, biopolymer and enzyme	
Module -3 Production of Secondary Metabolites	***9 Hour***
Production processes for various classes of secondary metabolites: Biopigments, Metabolic engineering of plants for the production of flavonoids, carotenoids; Bioengineering of Microalgae for the production of antibiotics	
Module -4 - Biofuel and Bioremediation	***9 Hour***
Biofuel intermediate-C4 and C6 intermediate for biofuel production, Fourth-generation biofuels: Bioethanol and biobutanol production through GMO; Biohydrogen production; Genetically engineered microorganisms for environmental remediation: Biodegradation of oil spills, xenobiotics degradation	
Module -5 - Biopharmaceutical	***9 Hour***
Heterologous expression of therapeutic protein, Production of therapeutic protein production: Insulin, Monoclonal Antibodies (mAbs), Interferons, Vaccines, Human growth hormones, Challenges in recombinant therapeutic protein production.	

Learning Resources	1. *Stephanopoulos G.N and Aristidou A.A. "Metabolic Engineering – Principles and Methodologies", Jens Nielsen Academic Press, First Edition (1998).* 2. *Dien S.V. "Metabolic Engineering for Bioprocess Commercialization", Springer, First Edition (2016).*	3. *Wim Soetaert and Eric J Vandamme "Industrial Biotechnology" , Wiley-VCH (2010)* 4. *Christoph Wittmann, James C.Liao, Industrial Biotechnology: Products and process, Wiley (2016)*

Learning Assessment

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

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. Shankar. S, Principal Scientist, Adnivirus therapeutics, Ltd*	*1.Dr. Debasish Das, IIT Guwahati*	*1.Dr. P. Rathinasabapathi SRMIST*
2. *Dr.DuraiRaj, Orchid Pharma*	*2. Dr. S. Ramalingam, ,Anna University, hennai rama@bioprocess.edu*	*2 Dr. N Selvarajan, SRMIST,*

Course Code	21GEE507T	Course Name	HUMAN GENETICS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*obtain knowledge on classical genetics and genotypes.*
CLR-2:	*comprehend the concepts of inheritance and associated complications in human*
CLR-3:	*study the regulation of gene expression in humans*
CLR-4:	*evaluate the human chromosomal abnormalities*
CLR-5:	*identify the human disease gene for screening using different methods*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	***2***	***3***
CO-1:	*understanding classical and modern genetics*	*3*	*-*	*-*
CO-2:	*analyse the organization of the nuclear and mitochondrial genomes*	*-*	*3*	*-*
CO-3:	*define the role of human chromosome aberrations in disease burden*	*-*	*1*	*1*
CO-4:	*demonstrate the association of genomic variation in complex phenotypes*	*-*	*1*	*2*
CO-5:	*plan the genetic diagnosis, and assess the problems and limitations associated with diagnosis*	*3*	*2*	

Module -1 - Classical and Modern Genetics	***9 Hour***
Mendelian monogenic inheritance, Pedigree analysis, Autosomal linked inheritance, Sex-linked inheritance, Non-Mendelian inheritance, incomplete dominance, Co-dominance, Uniparental disomy, Penetrance, non-penetrance, Expressivity, Mitochondrial inheritance, Late-onset diseases, Anticipation, Imprinting, Heterogeneity, Consanguinity, Phenocopy, pleiotropy, Mosaicism, Quantitative traits of polygenic inheritance, Gene and Genotype frequencies	
Module -2 - Genome Organization	***9 Hour***
Human chromosomes - structure and organization; Mitochondrial genome- structure and organization- Limited autonomy; Genes - Protein coding, RNA genes, Micrornas, Overlapping genes; Gene arrangements - Genes-within-genes Non-coding DNA, Satellite DNA, Transposons; control of gene expression - Locus heterogeneity, Clinical heterogeneity Epigenetics	
Module -3 - Chromosomal Abnormalities and Detection Methods	***9 Hour***
Numerical chromosome abnormalities, Autosomal abnormalities, Sex chromosomal abnormalities, Sex chromosomal abnormalities, X-inactivation, Mixoploidy, Mosaicism, Chimerism, Polyploidy, Diandric and Digynic, Human reproductive disorders, Comparative genomic hybridization, Microarray, Karyotyping, FISH technique, Chromosome painting, Introduction to the international system of human cytogenetic nomenclature (ISCN)	
Module -4 - Understanding Genetic Variations	***9 Hour***
Human Genome Project; Human Genome Variation Society (HGVN) - nomenclature of human mutations; Pathogenic variations in the human genome, Functional classification of mutations, Segregation analysis, Linkage analysis, Linkage disequilibrium, Association studies GWAS	
Module - 5 - Genetic Testing and Applications	***9 Hour***
Genomics approaches, Whole genome approaches - Applications and limitations of Whole genome, Whole exome, targeted, clinical exomes, Applications and limitations, Transcriptome strategies, Candidate gene testing, Pre and post-natal Diagnosis, Pharmacogenomics, Personalized medicine, and Genetic counseling	

Learning Resources	1.	*Tom Strachan, Andrew Read " Human Molecular Genetics".5th Edition2019*	3.	*Arsham M.S and Barch M.J. "The AGT Cytogenetics Laboratory Manual" Wiley- Blackwell", New Jersey, USA, Fourth Edition (2017).*
	2.	*Gardner A and Davies T. "Human Genetics" Viva Books, Second Edition (2012).*		

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

Course Designers		
Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. Dr. Kalpana Gowrishankar, KKCTH, Chennai, gskalpana@yahoo.com	*1. Prof. Solomon F.D. Paul ,SRIHER, paul@sriramachandra.edu.in*	*1. Dr. KN. ArulJothi , SRMIST*
2. Dr. Fiona D'Souza, Anderson Diagnostics Labs, Chennai, fiona@andersondiagnostics.com	*2. Dr. Aravindhan Vivekanandhan, Dr ALM PG IBMS, University of Madras, cvaravindhan@gmail.com*	*2. Dr. B. Usha,SRMIST*

Course Code	21GEE508T	Course Name	FUNCTIONAL GENOMICS IN THE MODERN ERA	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*understand the various approaches to functional genomic studies*
CLR-2:	*provide knowledge on gene expression tools*
CLR-3:	*summarize the features of NGS platforms*
CLR-4:	*recall the tools to investigate functional proteins*
CLR-5:	*predict co-expression networks and interactomes*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	***2***	***3***
CO-1:	*Illustrate the principles of forward and reverse genetics*	3		
CO-2:	*experiment with the tools of gene expression studies*			3
CO-3:	*apply NGS platforms for high-throughput sequencing*	2		2
CO-4:	*investigate and characterize proteins*			2
CO-5:	*draw co-expression networks and interactomes*	2		

Module -1 - Approaches to Functional Genomics	***9 Hour***
Forward genetics - Methods in Forward genetics - Mutational Breeding - Linkage and Association Mapping - Insertion Mutagenesis, Reverse Genetics - Methods in Reverse genetics – RNAi – Antisense - Over-expression - Site directed mutagenesis – TILLING - Knock-outs - Genetic screens	
Module -2 - Analysis of Gene Expression	***9 Hour***
Differential display PCR, Microarray- analysis of differential gene expression, Serial analysis of gene expression, Northern hybridization, Subtractive hybridization, small non-coding RNA analytical tools, non-coding RNA in gene regulation.	
Module -3 - High-throughput Expression Analysis Platforms	***9 Hour***
Next generation sequencing – Illumina – ion torrent, whole genome sequencing, transcriptome sequencing, exome sequencing, targeted sequencing. small RNA sequencing, Metagenome analysis, Steps in differential expression of genes analysis.	
Module -4 – Proteomics	***6 Hour***
Approaches to proteomics – top-down and bottom-up approach, differential proteomics – gel based – non-gel based - reverse phase protein array, protein-protein interaction – yeast two hybrid system	
Module -5 - Co-expression Networks	***9 Hour***
Methods of constructing co-expression networks, network analysis. Protein interactomes, approaches to map individual protein interactions, large scale mapping interactomes – Machine learning based approaches for gene regulatory networks and protein interactomes	

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

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

Course Designers		
Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. Dr. Florida Tilton, Managing Director, Biozone Research Technologies	*1. Dr. Subramanian Sankaranarayanan, Associate Professor, IIT Gandhinagar*	*1. Dr. D. Rex Arunraj, SRMIST*
Dr. Aneesh nair, Head-Centre for Genomic Medicine, NIMS Hospital, Trivandrum	*2. Prof. Gopalakrishnan Professor, IARI, New Delhi*	*2. Dr. Sathish R, SRMIST*

Course Code	21GEE601T	Course Name	MODERN BIOTECHNOLOGY OF CROP IMPROVEMENT	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*understand the genetic approaches for crop improvement*
CLR-2:	*utilise genomics for crop improvement*
CLR-3:	*deduce the gene editing approach for crop improvement*
CLR-4:	*understand the approaches for biotic and abiotic tolerance*
CLR-5:	*focus on the modern approaches for crop yield and biofortification*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	***2***	***3***
CO-1:	*understand the modern genetic approaches for crop improvement*	-	2	-
CO-2:	*correlate the genomics assisted biotechnology tools for crop improvement*	3	2	3
CO-3:	*perform gene editing in plants for crop improvement*	3	2	3
CO-4:	*reproduce different methods for developing biotic and abiotic tolerance crops*	3	2	3
CO-5:	*prioritize modern biotechnological approaches for crop yield and biofortification*	3	2	3

Module -1 - Modern Genetic Approaches for Crop Improvement	***9 Hour***
Classical breeding; Modern crop breeding- Marker assisted breeding -Marker assisted selection by QTL Mapping, GWAS and genomic selection; Reverse genetics approach; Forward genetics approach; Mutational Breeding	
Module -2 - Genomics Assisted Biotechnology for Crop Improvement	***9 Hour***
Genomics: Genomics assisted backcrossing; Gene expression analysis approaches-Transcriptomics-Methods and applications, RNA-Seq; Phenomics-Plant Phenotyping for crop improvement -High throughput plant phenotyping (HTPP)-HTPP types	
Module -3 - Gene Editing for Crop Improvement	***9 Hour***
Transgenesis and genome editing by CRISPR/Cas9 system; DNA-free editing and nanotechnology; CRISPR/Cas9 mediated gene editing for crop improvement-increasing crop yield, crop quality improvement focused on the physical appearance, edible quality, fruit texture and nutritional value	
Module -4 - Modern Approaches for Abiotic and Biotic Tolerance	***9 Hour***
Abiotic tolerance- climate resilient crops; drought tolerance, heat tolerance; Biotic tolerance-herbicide, bacterial, fungal and viral tolerance-Methods and approaches.	
Module -5 - Modern Approaches for Crop Yield and Biofortification	***9 Hour***
Nitrogen use efficiency; Water use efficiency; Biofortification in cereal and pulse crops-approaches and challenges; Low phytate crops	

Learning Resources	1. *Hakeem. K.R., Ahmad. P., Ozturk. M., "Crop Improvement New Approaches and Modern Techniques", Springer, Boston, 2013.* 2. *Kumar. P., Thakur. A. K., "Crop Improvement: Biotechnological approaches", First edition, CRC Press, Boca Raton, 2021.* 3. *Slater. A., Scott. N.W., Fowler. M.R., "Plant biotechnology-the genetic manipulation of plants", Third edition, Oxford University Press, 2008.*	4. *Wang. J.Y., Doudna. J.A., CRISPR technology: A decade of genome editing is only the beginning. Science., 379 (6629), 2023.* 5. *Benavente, E.; Giménez, E. Modern Approaches for the Genetic Improvement of Rice, Wheat and Maize for Abiotic Constraints-Related Traits: A Comparative Overview. Agronomy., 11, 376, 2021.*

Learning Assessment

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

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. Dr. P. Sadasivam *Scientist, Du Pont Industrial biosciences, Hyderabad*	*1. Dr. Sivaprakash Ramalingam* *Scientist, IGIB, NewDelhi*	*1. Dr. Rex Arunraj, SRMIST*
2. Dr. Florida Tilton *MD, Biozone research technologies Pvt ltd, Chennai.*	*2. Prof. Raveendran* *Professor, TNAU, TamilNadu*	*2. Dr. A.Swapna Geetanjali, SRMIST*

Course Code	21GEE602T	Course Name	NEUROGENETICS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*describe the biology of nervous system*
CLR-2:	*explain the process of neurulation and brain development*
CLR-3:	*list neurotransmitter types and synaptic transmission processes*
CLR-4:	*discuss the biology of sensory systems*
CLR-5:	*summarize the genetics of neurodegenerative disorders*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	***2***	***3***
CO-1:	*visualize the biology of neurons and glia*	-	2	-
CO-2:	*appraise neurulation and brain formation mechanisms*	-	2	-
CO-3:	*analyse the biology of neurotransmission*	3	-	-
CO-4:	*compare the molecular mechanisms behind sensory systems*	3	2	2
CO-5:	*integrate the genetic basis of various neuronal disorders*	3	2	2

Module -1 - Biology of Nervous System	***9 Hour***
Anatomy of nervous system; Functions of nervous system; CNS; Brain and behaviour; PNS; Spinal cord; Neuron; Soma, neuronal membrane, axon and dendrites; Glial cells; Neural circuitry; Electrical properties of neuron; Action potential	
Module -2:- Neurulation and Brain Formation	***9 Hour***
Neural plate; Neurulation; Role of Shh and BMP signaling in neural tube patterning; Forebrain regionalisation; Functions of midbrain and hindbrain; Cerebral cortex, Cortical neurons; Hippocampus, Amygdala; Limbic lobe; Emotion and memory	
Module -3 - Biology of Neurotransmission	***9 Hour***
Synaptic transmission; Electrical synapses; Chemical synapses; Role of neurotransmitters; Postsynaptic receptors; Role of ion channels; Excitatory synaptic transmission; Inhibitory synaptic transmission; Motor neurons; Acetylcholine receptor channels; Key criteria for neurotransmitters; Types of neurotransmitters	
Module -4 - Sensory Systems	***9 Hour***
Somatosensory system; Dorsal root ganglia; Primary sensory neurons; Mechanoreceptors; Touch response; Proprioceptors; Nociceptors; Thermal receptors; Olfactory receptors; Visual perception; Visual cortex; Addictive drugs; Short-term and long-term memory	
Module -5 - Biology of Neurodegenerative Diseases	***9 Hour***
Cognitive abnormalities in autism; Fragile X syndrome; Alzheimer's disease; Down syndrome; Epilepsy; Genetic basis of Huntington's disease; Genetic basis of Parkinson's disease; Unipolar depression; bipolar disorder; Anxiety; Working memory; Ageing brain and cognitive decline	

Learning Resources	*1. Principles of Neural Science (2012): Kandel, E.R. et al. (Eds.), Fifth Edition, McGraw Hill Education, 1760pp.*	*2. Neuroscience: Exploring the brain (2015): Bear, M.F., Connors, B. and M. Paradiso, Fourth Edition, Lippincott Williams and Wilkins Inc., 1008 pp.*

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

Course Designers		
Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. Dr. C. N. Ramchand, Ph.D., Saksin Life sciences Pvt Ltd, Chennai	*1. Dr. K. Subramaniam, Ph.D., Professor, IIT Madras, Chennai*	*1. Dr. S. Kirankumar, SRMIST*
2. Dr. Karthik Periyasamy, Ph.D., Aurobindo Pharma Limited, Hyderabad	*2. Dr. R. Venkatesh, M.B.B.S., M.S., M.Ch., Professor, Coimbatore Medical College, Coimbatore*	*2. Dr. Devi A, SRMIST*

Course Code	21GEE603T	Course Name	STEM CELL BIOLOGY	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*generate knowledge about stem cells and their characteristics*
CLR-2:	*provide knowledge on embryonic stem cells and stem cell niche*
CLR-3:	*create an interest about adult stem cells and their properties*
CLR-4:	*initiate interest on the role of signaling pathways and epigenetics in stem cell fate*
CLR-5:	*understand the applications of stem cells in tissue engineering and treatment of human diseases*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	***2***	***3***
CO-1:	*recall knowledge about stem cells and their characteristics*	-	2	-
CO-2:	*discuss concepts in embryonic stem cells and stem cell niche*	2	2	-
CO-3:	*understand about adult stem cells and their properties*	2	2	-
CO-4:	*analyze the role of signaling pathways and epigenetics in stem cell fate*	2	-	2
CO-5:	*apply knowledge on stem cells in tissue engineering and treatment of human diseases*	2	2	3

Module -1 - Basics of Stem Cells	***9 Hour***
Origin of Stem Cells; Early development and embryogenesis; Stem Cell Properties; Symmetric and Asymmetric division; Classification of Stem Cells – Totipotent, pluripotent, multipotent; Types of Stem Cells - Embryonic Stem Cells, Adult Stem Cells, iPSCs, Cancer Stem Cells; Similarities and differences between embryonic and adult stem cells; Stem Cells and Regeneration	
Module -2 - Embryonic Stem Cells	***9 Hour***
Ethical issues involved in hESCs; Mouse embryo derived cells (mESCs) - Embryonic Carcinoma Cells, Embryonic Stem Cells, Embryonic Germ Cells, Trophoblast Stem Cells, Nuclear transfer embryonic stem cells; Comparison of various mESCs; Primate ESCs - Similarities and differences between primate and mouse ESCs; Naïve ESCs, Primed ESCs; Lab tests for identification of ESCs; Isolation techniques for human ESCs; Stem Cell Niches - Drosophila testis and ovary, Human intestinal epithelium, Hematopoietic cells	
Module -3 - Adult Stem Cells	***9 Hour***
Properties of adult stem cells (ASCs); Sources of ASCs; Lab tests for ASCs; Mesenchymal stem cells, hematopoietic stem cells, neural stem cells, germinal stem cells -Steven's experiment; Fusion and Trans differentiation; Cancer Stem Cells; Reprogramming of iPSCs-methods of producing of iPSCs; Somatic cell nuclear transfer; Molecular mechanisms in cloning; Stem cells and aging	
Module -4 - Stem Cell Signaling and Regulation	***9 Hour***
ESCs pluripotency and signaling - JAK-STAT pathway; Hematopoietic signaling pathways – Positive and Negative Regulators; Epigenetic control in pluripotent stem cells, Epigenetic regulation in progenitor and adult stem cells	
Module -5 - Applications of Stem Cells	***9 Hour***
Tissue Engineering and Biomaterial Scaffolds for Stem Cells; Stem Cell Therapies - Parkinson's disease, Burns, Spinal cord injury, Heart diseases, Diabetes, Auto Immune Diseases; Stem Cells in Cancer Therapy; Recent developments in stem cell research	

Learning Resources	1. *Sell S. "Stem Cells Handbook", Humana Press, Second Edition (2004).* 2. *Stem Cell Information, "National Institutes of Health", Stem Cell Primer (2009).* 3. *Lanza R and Atala A. "Essentials of Stem Cell Biology", Academic Press, Third Edition (2014).* 4. *https://www.stembook.org/chapters.* 5. *Bendall S.C, Stewart M.H and Bhatia M (2008) Human Embryonic Stem Cells: Lessons from Stem Cell Niches in Vivo, Regenerative Medicine, 3: 365-376.* 6. *Jopling C, Boue S, Carlos J and Belmonte I (2011) Dedifferentiation, Transdifferentiation and Reprogramming: Three Routes to Regeneration, Nature Reviews. Molecular Cell Biology, 12: 79-89.* 7. *Zech N (2005) Plasticity of Stem Cells: Cell-Fusion versus Trans Differentiation, Journal of Reproduktionsmed Endokrinol, 2: 239-245.*	8. *Ma D.K, Bonaguidi M.A and Ming G.L (2009) So. Adult Neural Stem Cells in the Mammalian Central Nervous System, Cell Research, 19: 672-682.* 9. *Takahashi K and Yamanaka S (2006) Induction of Pluripotent Stem Cells From Mouse Embryonic and Adult Fibroblast Cultures by Defined Factors, Cell, 126: 663-76.* 10. *Huang G, Ye S, Zhou X, Liu D and Ying Q.L (2015) Molecular Basis of Embryonic Stem Cell Self-Renewal: From Signaling Pathways to Pluripotency.* 11. *Zhang CL, Huang T, Wu BL, He WX, Liu D. Stem cells in cancer therapy: Opportunities and challenges. Oncotarget. 2017;8(43):75756-75766. doi:10.18632/oncotarget.20798* 12. *Ahmed ASI, Sheng MH, Wasnik S, Baylink DJ, Lau K-HW. Effect of aging on stem cells. World J Exp Med. 2017;7(1):1. doi:10.5493/wjem.v7.i1.1*

Learning Assessment

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

Course Designers

Experts from Industry	*Experts from Higher Technical Institutions*	*Internal Experts*
Dr. Indumathi Mariappan *Research Scientist, Center for Ocular Regeneration (CORE)* *Prof. Brien Holden Eye Research Center (BHERC), L.V. Prasad Eye Institute* *indumathi@lvpei.org*	*Dr Halagowdar Devaraj, Univ of Madras, hdrajum@yahoo.com*	*Dr. Devi A, SRMIST*
Dr. Bhavana Muralidharan *Principal Investigator, Institute for Stem Cell Biology and Regenerative Medicine (InStem), Bengaluru* *bhavanam@instem.res.in*	*Dr Sudha Warrier, Principal, SRIHER, Chennai* *sudha.warrier@gmail.com*	*Dr. Satish. R, SRMIST*

Course Code	21GEE604T	Course Name	GENETICS OF DISEASES AND DISORDERS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*understand about genetic factors behind diseases*
CLR-2:	*gain knowledge on autosomal and allosomal disorders*
CLR-3:	*summarize about chromosomal and multifactorial disorders*
CLR-4:	*explain about mitochondrial and metabolic disorders*
CLR-5:	*understand about congenital and connective tissue disorders*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	***2***	***3***
CO-1:	*describe about the genetic factors responsible for different type of heritable diseases*	-	2	-
CO-2:	*recall about the genetics and treatment options of diseases related to autosomal and allosomal disorders*	3	2	-
CO-3:	*explain about the genetics and treatment options for chromosomal and multifactorial disorders.*	-	-	3
CO-4:	*discuss about the genetics and treatment options for mitochondrial and metabolic disorders*	2	-	2
CO-5:	*assess about the genetics and treatment options for congenital and connective tissue disorders*	2	2	3

Module -1 - Introduction to Genetic Disorders	***9 Hour***
Introduction to genetic versus non-genetic diseases; Importance of the genetics of heritable diseases; Dominance, recessive and co-dominance; Autosomal and sex-linked, multifactorial and polygenic (complex) disorders	
Module -2 - Autosomal and Allosomal Genetic Disorders	***9 Hour***
Autosomal Dominant Disorders-Huntington's disease and Marfan Syndrome; Autosomal Recessive Disorders – Cystic Fibrosis and Sickle Cell Anemia; X-Linked Disorders- Duchenne Muscular Dystrophy, Rett Syndrome, Hemophilia; Y-linked Disorders- Infertility	
Module -3 - Chromosomal and Multifactorial Disorders	***9 Hour***
Turner's syndrome, Down syndrome, Klinefelter's syndrome, Prader-Willi syndrome, Angelman syndrome, Williams syndrome, Edward's syndrome, Patau syndrome, Cri-du-chat syndrome. XYY Syndrome, X-Trisomy; Multifactorial Disorders- Type 2 diabetes, Heart disease, Cancer, and Psychiatric disorders like schizophrenia and bipolar disorder	
Module -4 - Mitochondrial and Metabolic Disorders	***9 Hour***
Mitochondrial diseases - Leber's hereditary optic neuropathy, mitochondrial myopathy, and mitochondrial encephalopathy, lactic acidosis, and stroke-like episodes (MELAS syndrome); Metabolic Disorders - Phenylketonuria (PKU), maple syrup urine disease (MSUD), Gaucher disease, and lysosomal storage disorders	
Module -5 - Congenital Anomalies and Connective Tissue Disorders	***9 Hour***
Structural Congenital Anomalies - Cleft lip and Palate, neural tube defects (e.g., spina bifida);, Functional Congenital Anomalies - Adrenal Hyperplasia, Congenital hearing loss; Environmental Teratogens-Fetal hydantoin syndrome ; Connective Tissue Disorders - Ehlers-Danlos syndrome, Osteogenesis Imperfecta, and Cutis laxa	

Learning Resources	1. *Genes and Diseases, NCBI Bookselfhttp://www.ncbi.nlm.nih.gov/books/bookres.fcgi/gnd/tocstatic.html* 2. *Tom S., and Andrew P. R., "Human Molecular Genetics", 2nd Edition NewYork ; Willy: Liss, 1999*	3. *Pagon R.A. et al.,"GeneReviews™ [Internet]".Seattle (WA): University of Washington, Seattle; 1993- 2016. Available from:http://www.ncbi.nlm.nih.gov/books/NBK1116/* 4. *Puiu, M. (Ed.). (2013). Genetic Disorders. InTech. doi: 10.5772/46039*

Learning Assessment

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

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. Dr. S. Ezhilarasi,Paediatric Haematoncologist Metha Multispeciality Hospital, Chennai	*1. Dr. B. Anandan, University of Madras, anandan@unom.ac.in*	*1. Dr. Devi A, SRMIST*
2. Dr. Shruti Bajaj , MD Pediatrics, Fellowship in Clinical Genetics (MUHS, KEMHospital , Mumbai	*2. Dr K Thangaraj, CCMB, Hyderabad thangs@ccmb.res.in*	*2. Dr. Kirankumar S, SRMIST*

Course Code	21GEE605J	Course Name	DEVELOPMENTAL GENETICS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	0	2	3

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

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*describe the animal embryogenesis concepts*
CLR-2:	*summarize the importance of cell specification and cell-cell interactions*
CLR-3:	*explain the fruit fly and zebrafish development processes*
CLR-4:	*discuss the processes in neurulation, somitogenesis, kidney development and gut formation*
CLR-5:	*list the mechanisms in animal tissue regeneration*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	**2**	**3**
CO-1:	*differentiate between various cell signaling mechanisms*	-	2	-
CO-2:	*classify the key processes in fruit fly and zebrafish embryogenesis*	3	-	-
CO-3:	*analyse the molecular basis of neurulation and somitogenesis*	3	2	3
CO-4:	*compare the genetic basis of kidney and digestive tract development*	3	3	3
CO-5:	*integrate the different types of regeneration*	3	3	3

Module -1 - Basic Concepts in Animal Development ***12 Hour***

History; Epigenesis; Karl von Baer's principles; Embryonic homologies; Cell specification and types; Cell determination; Cell-Cell interaction; Cadherins and cell adhesion; Induction and Competence; Germ layers; Paracrine factors; Notch signaling and cell fate identity; Role of FGF signaling in Drosophila trachea formation; insect metamorphosis

Practice: *1. Drosophila culturing techniques*
2. Stages of Drosophila larval development
3. Observation and analysis of Drosophila white eye mutant

Module -2 - Drosophila Development ***12 Hour***

Morphogen gradients; Drosophila – life cycle; fertilisation, cleavage and gastrulation; Role of maternal factors; Anterior-posterior axis formation in Drosophila; Dorso-ventral axis specification; Segmentation genes: Gap genes, Pair-rule genes, Segment polarity genes; Homeotic genes

Practice: *1. Observation and analysis of Drosophila vestigial wings mutant*
2. Observation and analysis of Drosophila Bar eye mutant
3. Observation and analysis of Drosophila ebony body mutant

Module -3 - Zebrafish Development and Formation of Ectodermal Structures ***12 Hour***

Zebrafish – fertilization, cleavage & gastrulation; Body axes specification; Vertebrate neurulation; Formation of neural tube; Patterning in the neural tube; Tissues and cells of the CNS; Neurogenesis; Development of epidermis

Practice: *1. Dissection of brain from Drosophila larvae*
2. Culture, maintenance and breeding methods for zebrafish

Module -4 : Specification and Development of Mesodermal Structures ***12 Hour***

Paraxial mesoderm specification; Somitogenesis; The clock and wavefront model; Role of Hox genes in axial identity; Intermediate mesoderm specification; Kidney tissue development; Formation of kidney; Lateral plate mesoderm; Specification of heart tissue; Development of heart ***Practice:*** *1. Anaesthetizing protocol for larval and adult zebrafish* *2. Stages of zebrafish embryonic and larval stages*
Module -5: Overview on endodermal organ Development and Tissue Regeneration ***12 Hour***
Specification of gut tissue; Development of liver, pancreas and gall bladder; Origin of respiratory tube; Development of respiratory tube; Epimorphic regeneration in Salamander; Morphallactic regeneration in hydra; Regeneration in mammalian liver ***Practice:*** *1. Staining of bone and cartilage tissue in zebrafish* *2.Measurement of heartbeat in zebrafish larvae*

Learning Resources	1. *Developmental Biology (2016): Scott F. Gilbert and Michael J.F. Barresi, Eleventh Edition, Oxford University Press, Inc.* 2. *Essential Developmental Biology (2012): J.M.W. Slack, Third Edition, Wiley-Blackwell Publishers* 3. *Principles of Development (2015): Lewis Wolpert, Cheryll Tickle and Alfonso Arias, Fifth Edition, Oxford Publishers, Inc.*	4. *The zebrafish book: A guide for the laboratory use of zebrafish (2007): Westerfiled, M., Fifth Edition, University of Oregon Press.* 5. *Drosophila: A laboratory handbook (1989): Ashburner, M., First Edition, Cold Spring Harbor Laboratory Press.*

Learning Assessment

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

Course Designers		
Experts from Industry	*Experts from Higher Technical Institutions*	*Internal Experts*
1. Dr. Krutika Rajkumar, Ph.D., Life Cell International, Chennai	*1. Dr. K. Subramaniam, Ph.D., Professor, IIT Madras, Chennai*	*1. Dr. S. Kirankumar, SRMIST*
2. Dr. James Bhaskar, Ph.D., ITC, Bengaluru	*2. Dr. Richa Arya, Ph.D., Assistant Professor, BHU, Varanasi*	*2. Dr. Devi A, SRMIST*

Course Code	21GEE606T	Course Name	GENETIC COUNSELLING	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*define the principles of genetic counselling*
CLR-2:	*assess psychological aspects of patients in genetic counselling*
CLR-3:	*explain about strategies involved in genetic counselling*
CLR-4:	*demonstrate the genetic counselling process using case studies*
CLR-5:	*understand the ethical and legal implications of genetic counselling*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	***2***	***3***
CO-1:	*recall knowledge about human genetics and inheritance*	3	-	2
CO-2:	*integrate knowledge of psychological aspects of patients and genetic counsellors*	-	-	2
CO-3:	*discover the strategies involved in genetic counselling*	2	-	-
CO-4:	*evaluate various cases of genetic diseases*	2	-	3
CO-5:	*create knowledge on ethical legal implications surrounding genetic counselling*	-	2	2

Unit-1 - introduction and Essential Components of Genetic Counselling	***9 Hour***
Historical overview, definition, models of genetic counselling, components of genetic counselling interaction, providers of genetic counselling, professional and educational landmarks in Genetic counselling, Interpretation of genetic case - pedigree analysis, consent form, family history, risk assessment, verbal and non-verbal communication, psychological aspects of patient- case documentation	
Unit-2 - Psychological aspects of Genetic Counselling	***9 Hour***
The psychological processes underlying genetic counseling - understanding the individual difference in genetic counseling using attachment theory; The role and skills of the counselor and ideas from psychotherapy; the nature of the disorder influencing the consultation; psychological effects on the counselor, the interview and non-directiveness in genetic counseling	
Unit-3 - Strategies of Genetic Counseling	***9 Hour***
Strategies for genetic counselling- characteristics and systems of family, comparison of family therapy – medical therapy, structuring the genetic counseling session, Patient Factors: Resistance, Coping, Affect, and Styles	
Unit-4 - Case studies in Genetic Counseling	***9 Hour***
Genetic counseling for specific diseases- Case study for genetic counseling: Huntington's disease; Beta Thalassemia, Cystic fibrosis, Fragile X syndrome, Duchenne muscular dystrophy, Down syndrome, Leukemia, Breast cancer, male and female infertility, Autism	
Unit-5 - Genetic testing and Ethical and Legal Implications in Genetic Counseling	***9 Hour***
Criteria for Genetic testing; Tests for genetic disorders - physical, chemical and genetic tests; risks and limitations of genetic testing; Regulatory affairs of genetic testing; Ethics and legal issues of genetic testing - Genetics and Patent Law	

Learning Resources	*1. Wendy R. Uhlmann, Jane L. Schuette, Beverly Yashar, "A Guide to Genetic Counselling", 2nd Edition, Wiley-Blackwell, 2009.* *2. Bonnie S. LeRoy, Patricia M. Veach, Dianne M. Bartels "Genetic Counselling Practice: Advanced Concepts and Skills". Wiley-Blackwell, 2010* *3. Christine Evans and Barbara Bowles Biesecker, "Genetic Counselling A Psychological Conversation", Cambridge University press, 2006*	*4. Patricia McCarthy Veach, Bonnie S. LeRoy, Dianne M. Bartels "Facilitating the Genetic Counselling Process: A Practice Manual", Springer, 2003* *5. Peter S. Harper "Practical Genetic Counselling" 7th Edition. Taylor & Francis group, 2011* *6. Janice l. Berliner, Ethical Dilemmas in Genetics and Genetic Counselling, Oxford press, 2015*

Learning Assessment

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

Course Designers

Experts from Industry	*Experts from Higher Technical Institutions*	*Internal Experts*
1. Dr. Janani Dakshina Moorthy, GeneAura Pvt Ltd, Chennai, janani@geneaura.com	*1. Dr. Madhavilatha, Scientis, Medgenome labs, Bangalore, madhavi@medgenome.com*	*1. Dr. N. Aruljothi SRMIST*
2. Dr. Finoa D'souza, Anderson Diagnostics, Chennai, fiano@andersondiagnostics.com	*2. Dr. Uma Maheswari MBBS. DGO, Tagore Medical College, Chennai Leeuma6@gmail.com*	*2. Dr. R. Satish, SRMIST*

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