

Category Wise Credit Distribution			
Course Sub-category	Subcategory Credits	Category Credits	Learning Hours
Ability Enhancement Courses (AEC)		5	150
University AEC	-		
School AEC	5		
Value Added Courses (VAC)		-	
University VAC	-		
School VAC	-		
Skill Enhancement Courses (SEC)		11	330
School SEC	11		
Department SEC	-		
SEC Elective	-		
Foundation/ Interdisciplinary courses (FIC)		-	
School FIC	-		
Department FIC	-		
Core + Core Elective including Specialization (CC)		51	1530
Core	42		
Core Elective (Inc Specialization)	9		
Minor (MC) + Open Elective (OE)	-		
Research / Design / Internship/ Project (RDIP)		16	480
Internship / Design Project / Startup / NGO	-		
Internship / Research / Thesis	16		
Total		83	2490

Semester Wise Course Credit Distribution Under Various Categories						
Category	Semester					
	I	II	III	IV	Total	%
Ability Enhancement Courses - AEC	-	-	5	-	5	6
Value Added Courses - VAC	-	-	-	-	-	-
Skill Enhancement Courses - SEC	4	7	-	-	11	13
Foundation / Interdisciplinary Courses - FIC	-	-	-	-	-	-
CC / SE / CE / TE / DE / HSS	18	18	15	-	51	61
Minor / Open Elective - OE	-	-	-	-	-	-
(Research/ Design/ Industrial Practice/Project/Thesis/Internship) - RDIP	-	-	2	14	16	19
Grand Total	22	25	22	14	83	100

Note: L-T/D-P/Pr and the class allocation is as follows.

- a) Learning Hours : 30 learning hours are equal to 1 credit.
- b) Lecture/Tutorial : 15 contact hours (60 minutes each) per semester are equal to 1 credit.
- c) Discussion : 30 contact hours (60 minutes each) per semester are equal to 1 credit.
- d) Practical : 30 contact hours (60 minutes each) per semester are equal to 1 credit.
- e) Project : 30 project hours (60 minutes each) per semester are equal to 1 credit.

SEMESTER – I								
S. No	Category	Sub-Category	Course Code	Course Title	L	T/D	P/Pr	C
1	SEC	S SEC		Statistics	3	1	0	4
2	Core	CC		Molecular Biology	3	1	0	4
3	Core	CC		Biophysical and Biochemical Techniques	3	1	0	4
4	Core	CC		Molecular Biology Lab	0	0	4	4
5	Core	CC		Biochemistry and Metabolism	2	1	0	3
6	Elective	CE		Core Elective	2	0	1	3
Semester Total					13	4	5	22

SEMESTER – II								
S. No	Category	Sub-Category	Course Code	Course Title	L	T/D	P/Pr	C
1	SEC	S SEC		Introduction to R and Python	3	0	1	4
2	SEC	S SEC		Research methodology	3	0	0	3
3	Core	CC		RNA Biology	3	1	0	4
4	Core	CC		Bioinformatics	2	1	0	3
5	Core	CC		Genetic Engineering	3	1	0	4
6	Core	CC		Biotechnology Lab	0	0	4	4
7	Core	CC		Microbial biotechnology	2	1	0	3
Semester Total					16	4	5	25

SEMESTER – III								
S. No	Category	Sub-Category	Course Code	Course Title	L	T/D	P/Pr	C
1	AEC	S AEC		Research seminar & Report writing	3	0	0	3
2	AEC	S AEC		Design thinking	2	0	0	2
3	Core	CC		Plant and Animal Biotechnology	3	1	0	4
4	Core	CC		Bioinformatics lab	0	0	2	2
5	Core	CC		Immunology	2	1	0	3
6	Elective	CE		Core Elective 1	2	1	0	3
7	Elective	CE		Core Elective 2	2	1	0	3
8	RDIP	RDIP		Summer Internship	0	0	2	2
Semester Total					14	4	4	22

SEMESTER – IV								
S. No	Category	Sub-Category	Course Code	Course Title	L	T/D	P/Pr	C
1	RDIP	RDIP	BIO 515	Research Degree Project (Academia/Industry)	0	0	14	14
Semester Total					0	0	14	14

Core Elective								
S. No	Category	Sub-Category	Course Code	Course Title	L	T/D	P/Pr	C
1	Elective	CE		Cell Biology	2	1	0	3
2	Elective	CE		Microbiology	2	1	0	3
3	Elective	CE		Programming and Computational Biology	2	1	0	3
4	Elective	CE		Molecular Mechanisms of Diseases	2	1	0	3
5	Elective	CE		Genomics and Proteomics	2	1	0	3
6	Elective	CE		Bionanotechnology	2	1	0	3
7	Elective	CE		Biosafety and IPR	2	1	0	3
8	Elective	CE		A Primer to Neurobiology	2	1	0	3

SEMESTER-I

Outcome 5	2	2	2	1	1	2	-	-	-	-	-	-	-	-	-
Average	2	2	2	1	1	1	-	-	-	-	-	-	-	-	-

Course Unitization Plan Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	UNIT-1 Introduction to Statistics	8		
	Types of data (qualitative vs. quantitative)	2	CO 1	1
	Descriptive statistics (mean, median, variance)	2	CO 1	1,2
	Data visualization (histograms, box plots)	2	CO 2	1,2
	Tutorial	2	CO 2	1
Unit 2	UNIT-2 Probability & Distributions	12		
	Basic probability rules	3	CO 2	2
	Binomial, Poisson, Normal distributions	4	CO 2	2
	Central Limit Theorem.	3	CO 3	2
	Tutorial	2	CO 2, 3	2
Unit 3	UNIT-3 Hypothesis Testing	15		
	Confidence intervals	4	CO 3	1,2,4
	t-tests & chi-square tests	4	CO 3	1,2,4
	Simple analysis of variance (ANOVA)	4	CO 3	3
	Tutorial	3	CO 3	1,2,3
Unit 4	UNIT-4 Regression & Correlation	13		
	The Simple linear regression	3	CO 4	1,2
	Multiple regression (basics)	4	CO 4	1,2
	Pearson/Spearman correlation	3	CO 4	1,2,3
	Tutorial	3	CO 4	1,2,3

Unit 5	UNIT-5 Applied Statistics & Software	12		
	Experimental design	4	CO 5	3,4
	Case studies (biology/environmental science)	4	CO 5	3,4
	Hands-on R/Python/Excel	4	CO 5	3,4

Learning Assessment Theory

Bloom's Level of Cognitive Task	Continuous Learning Assessments --%				End Semester Exam (40 %)
	CLA-1 (15 %)	Mid-1 (20 %)	CLA-2 (15 %)	CLA-3 (10 %)	
Remember	30%	30%	30%	20%	30%
Understand	40%	40%	40%	30%	40%
Apply	30%	30%	30%	50%	30%
Analyse	30%	30%	30%	20%	30%
Evaluate					
Create					
Total	100%	100%	100%	100%	100%

Recommended Resources

1. Moore, D. S. (2020). Statistics: Concepts and Controversies. W.H. Freeman, 10th Edition (2020), ISBN-13: 978-1319393777
2. Openintro Statistics 2019), Diez David M Christopher D Barr and Çetinkaya, 4th Edition (2019), ISBN-13: 978-1943450077
3. Neil J. Salkind. (2017). Statistics for People Who (Think They) Hate Statistics: Using Microsoft Excel, 6th Edition (2017), ISBN-13: 978-1506361161
4. Montgomery, D. C. (2019). Design and Analysis of Experiments. Wiley, 10th Edition (2019), ISBN-13: 978-1119492443

Reference Books

1. Field, A. (2018). Discovering Statistics Using R. Sage. 1st Edition (2018), ISBN-13: 978-1526419521
2. Khan Academy. Probability & Statistics. [Online]

Course Designers

1. Dr. Tapan Kumar Hota, Department of Mathematics.

Molecular Biology

Course Code	BIO 501	Course Category	Core Course (CC)				L	T	P	C
							3	1	0	4
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)						
Course Offering Department	Biological Sciences	Professional / Licensing Standards								

Course Objectives / Course Learning Rationales (CLRs)

1. Understand the chemical foundations, genome organization, and central dogma of molecular biology.
2. Master gene expression, regulation, and the mechanisms of transcription, translation, and DNA replication.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Understand the chemical basis of molecular biology, including nucleic acids, proteins, and genome organization	2	80%	75%
Outcome 2	Grasp gene organization and transcription processes in prokaryotes and eukaryotes.	2	80%	75%
Outcome 3	Learn the mechanisms of translation in prokaryotes and eukaryotes	3	70%	65%
Outcome 4	Understand DNA replication, mutation types, and DNA repair mechanisms	3	70%	65%
Outcome 5	Comprehend the regulation of gene expression, including epigenetic and posttranslational modifications.	4	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

Program Learning Outcomes (PLO)															
CLOs	POs												PSOs		
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	3	3	2	1	3	3	2			2	1	3	2
Outcome 2	3	2	3	3	2	1	2	3	2			2	1	3	2
Outcome 3	3	2	3	3	3	1	3	2	3			3	3	3	2
Outcome 4	3	3	3	3	3	1	3	3	3			3	3	2	2
Outcome 5	3	2	3	3	3	2	2	3	3	2		3	3	3	2
Average	3	2.2	3	3	2.6	1.2	2.6	2.8	2.6	2		2.6	2.2	2.8	2

Course Unitization Plan Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	Chemical basis of Molecular Biology	14		
	Origin of Earth, Molecular evolution, Urey & Miller experiment, origin of biological molecules	2	1	1,2,5
	Reactions in primordial soup, ribose, rNTPs, catalytic activity of RNA, peptide bond formation by RNA, primitive ribosome	2	1	1,2,5
	Building blocks of nucleic acids-DNA and RNA structure, differences	2	1	1-4,
	Building blocks of proteins, pI, Classes of amino acids, peptide bond	2	1	1-4
	Primary, secondary, tertiary and quaternary structures, Ramachandran plot.	2	1	1-4
	Central dogma and exceptions, Genomes of viruses, bacteria and eukaryotes	2	1	1-4
	Major Classes of cellular genes and functions, chromatin organization, nucleosomes.	2	1	1.4
	Chemical basis of Molecular Biology	14		
Unit 2	Gene organization & Transcription	14		
	Gene organization in prokaryotes-Promoters, RNA polymerase, polycistronic mRNA, structure of Model operons (lac & trp)	2	1,2	1-4
	Regulation of lac and trp operons, Biphasic growth curve in presence of 2 substrates	2	1,2	1-4
	Eucaryotic gene organization-promoters, enhancers, RNA polymerases, Transcription factors	2	1,2	1-4
	Mediators, DNA-binding motifs, Basic mechanisms of transcription of rRNA, ribosome biogenesis	2	1,2	1-4
	mRNA gene expression- Transcription, promoters, introns, exons, capping, poly (A) tail	2	1,2	1-4
	Pre-mRNA splicing, exon-intron junctions, splicing factors, transport of Mrna	2	1,2	1,4,5
types of tRNA, structure and function, tRNA transcription, maturation, aminoacyl tRNA synthetases	2	1,2	1,4,5	
Unit 3	Translation	12		
	Genetic code, codon degeneracy, reading frame & ORF, Types of Mutations and their effect on the ORF	2	1,2,3	1-4
	Prokaryotic and eukaryotic ribosome structure, ribosome modifications	2	1,2,3	1-4
	Translation in prokaryotes, polycistronic mRNA, SD sequence, initiation, elongation and termination, termination factors,	2	2,3,4	1-4
	Scanning mechanism of translation, RNA secondary structures in translation, codon bias	2	2,3,4	
	Translation in eukaryotes, Cap & Poly-A, PABP, cap-binding factors, cap-dependent & independent translation, initiation factors	2	2,3,4	1-4

	Translation termination, Translation regulation in virus infection, translation regulation by eIF2 alpha phosphorylation,	2	2,3,4	1-4
Unit 4	DNA Replication & Mutations	10		
	Stahl experiment, semiconservative replication, DNA polymerases-structure and function, Klenow fragment	2	1,4	1,2,4
	Replication bubble, bidirectional replication, enzymes in replication, leading & lagging strands	2	1,4	1-4
	RNA primers, Okazaki fragments, replication errors, proof reading, differences in pro- & eukaryotic replication	2	1,4	1-4
	DNA repair mechanisms, recombination, transposons,	2	1,4	1-4
	Types of Mutations, genetic disorders, Telomeres, telomerase structure, cell growth regulation	2	1,4	1-4
Unit 5	Regulation of gene expression & Student presentations as part of CLA3	10		
	Multiple levels of regulation of gene expression	2	3,4,5	1-4
	Student presentations	2	3,4,5	1-4
	Student presentations	2	3,4,5	1-4
	Student presentations	2	3,4,5	1-4
	Student presentations	2	3,4,5	1-4
Total Contact Hours		60		

Learning Assessment Theory

Bloom's Level of Cognitive Task	Continuous Learning Assessments (50 %)				End Semester Exam (40 %)
	CLA-1 (10 %)	Mid-1 (20 %)	CLA-2 (15 %)	CLA-3 (15 %)	
Remember	40 %	60 %	40 %	30 %	20 %
Understand	60 %	40 %	30 %	40 %	20 %
Apply			30 %	30 %	30 %
Analyse					30%
Evaluate					
Create					
Total	100 %	100 %	100 %	100 %	100 %

Recommended Resources

1. Lewin's Genes XII: Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick Jones and Bartlett Publishers, Inc 12th edition, ISBN: 978-1284104493
2. Molecular Cell Biology: Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Anthony Bretscher, W. H. Freeman; 9th edition, ISBN: 978-1319208523
3. Molecular Biology of the Cell: Bruce Alberts, Rebecca Heald, Alexander Johnson, David Morgan, Martin Raff, Keith Roberts, Peter Walter, WW Norton & Co; 7th edition, ISBN: 978-0393884852
4. Molecular Biology: Nancy L. Craig, Orna Cohen-Fix, Rachel Green, Carol W Greider, Gisela Storz & Cynthia Wolberger: Oxford University press, ISBN 978-0-19-956206-0
5. RNA Worlds: From Life's Origins to Diversity in Gene Regulation: John F, Atkins, Raymond F. Gesteland & Thomas R. Cech: Cold Spring Harbor Laboratory Press, 2010

Course Designers

1. Prof. C. Durga Rao. Professor, Dept. Of Biological Sciences. SRM University – AP.

Biophysical and Biochemical Techniques

Course Code	BIO 503	Course Category	Core Course (CC)			
			L	T	P	C
			3	1	0	4
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)		
Course Offering Department	Biological Sciences	Professional / Licensing Standards				

Course Objectives / Course Learning Rationales (CLRs)

- Gain proficiency in experimental design and execution, including the selection of appropriate biological samples and the isolation of cellular components for detailed analysis.
- Master advanced techniques in spectroscopy, centrifugation, chromatography, electrophoresis, fluorescence, and radio-isotopic methods essential for studying biomolecules and cellular processes.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Understand the selection and analysis of various biological samples and model organisms.	2	75%	70%
Outcome 2	Master the principles and applications of spectroscopy and centrifugation techniques.	3	75%	70%
Outcome 3	Apply various chromatography techniques for the separation and analysis of biological molecules.	3	70%	65%
Outcome 4	Understand and utilize electrophoresis techniques for the analysis of proteins and nucleic acids.	3	70%	65%
Outcome 5	Employ fluorescence and radio-isotopic techniques in biological research and assays.	3	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

Program Learning Outcomes (PLO)															
CLOs	POs												PSOs		
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	3	3	1	1	2	3	2	3		3	3	1	2
Outcome 2	3	3	3	3	3	1	2		1			3	3	2	2
Outcome 3	3	3	3	3	3	1	3		1			2	3	2	2
Outcome 4	3	3	3	3	3	1	3		1			3	3	2	2
Outcome 5	3	3	3	3	3	1	3	2	1	2		3	3	3	3
Average	3	2.8	3	3	2.6	1	2.6	2.5	1.2	2.5		2.8	3	2	2.2

Course Unitization Plan Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	Introduction to Experimental approaches	10		
	Experimental approaches: choice of samples- organism, tissue, biological fluids, cells, and cellular organisms	3	1	1,2
	Whole cell analysis	2	1	1,2
	Isolation of cellular organelles	3	1	1,2
	Choice of model organisms for biological investigations: microorganisms, plants, and animal models.	2	1	1,2
Unit 2	Spectroscopy and centrifugation techniques	15		
	Absorption and emission spectra	2	2	1,2,3
	Beer-Lambert law	2	2	1,2,3
	UV and visible spectrophotometry - principles, instrumentation, and applications in enzyme kinetics	3	2	1,2,3
	Techniques in protein structural determination – CD, NMR, X ray crystallography	5	2	1,2,3
	Centrifugation principles: Basic principles of centrifugation. Differential, density gradient, and equilibrium centrifugation.	3	2	1,2,3
Unit 3	Chromatography	10		
	Chromatography techniques: General principles of chromatography	2	3	2,4,5
	Principles, operational procedure and applications of Paper chromatography, Thin layer chromatography	3	3	2,4,5
	Ion exchange chromatography, Molecular sieve chromatography, Affinity chromatography	2	3	2,4,5
	Gas Liquid chromatography and HPLC	3	3	2,4,5
Unit 4	Electrophoresis Techniques: General principles	10		
	Factors affecting the migration rate - sample, electric field, buffer and supporting medium, Tiselius moving boundary electrophoresis	2	4	4,5
	Native and SDS-PAGE	3	4	4,5
	2D electrophoresis, Blotting techniques	3	4	4,5
	Immunoelectrophoresis, Agarose gel electrophoresis	2	4	4,5
Unit 5	Fluorescence and Radio-isotopic techniques	15		
	Spectrofluorimetry - principles, instrumentation, and applications in vitamin assays (riboflavin and thiamine), enzyme assays, fluorescent probes in the study of protein and membrane structure	5	5	5
	Flame photometry - principles, instrumentation and applications in trace elements (Sodium, potassium analysis).	5	5	5

	Autoradiography and isotope dilution techniques. Applications of radioisotopes in the elucidation of metabolic pathways, clinical scanning and radio dating	5	5	5
Total contact hours		60		

Learning Assessment Theory

Bloom's Level of Cognitive Task	Continuous Learning Assessments (50 %)				End Semester Exam (50 %)
	CLA-1 (15 %)	Mid-1 (25 %)	CLA-2 (25 %)	CLA-3 (15 %)	
Remember	40 %	70 %	30 %	20 %	30 %
Understand	60 %	30 %	30 %	40 %	35 %
Apply			40 %	40 %	35 %
Analyse					
Evaluate					
Create					
Total	100 %	100 %	100 %	100 %	100 %

Recommended Resources

1. Biologist's Guide to Principles and Techniques of Practical Biochemistry: Keith Wilson and Kenneth H. Goulding, Hodder Arnold; 3rd edition, 1986, ISBN: 978-0713129427
2. Practical Biochemistry: Principles and Techniques Keith Wilson and Johnny walker, Cambridge University Press; 5th edition, ISBN: 978-0521799652
3. Introductory Practical Biochemistry: R. Singh and S. K. Sawhney. Narosa Publishing House; 2009, ISBN: 978-8173193026
4. Physical Biochemistry: Applications to Biochemistry and Molecular Biology David Friefelder, W. H. Freeman; 2nd edition, 1982, ISBN: 978-0716714446
5. Instrumental methods of chemical Analysis: Dr. G.R. Chatwal, Sham Anand Himalaya Publishing House; 2012, ISBN: 978-9350515310

Course Designers

1. Dr. Prateek Gupta, Assistant Professor, Department of Biological Sciences. SRM University – AP.

M.Sc. Molecular Biology Lab

Course Code	BIO 504	Course Category	Core Course (CC)	L	T	P	C
				0	0	4	4
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	Biological Sciences	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. Master techniques for buffer preparation, bacterial growth analysis, nucleic acid extraction, and protein quantification.
2. Gain expertise in plasmid isolation, cloning, transformation, recombinant protein expression, and protein analysis.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Preparation of buffers, pH measurement, media preparation and sterilization.	3	80%	75%
Outcome 2	Transformation, plasmid DNA preparation and restriction analysis by agarose gel electrophoresis.	4	70%	65%
Outcome 3	Bacterial lysate preparation and analysis of proteins by SDS PAGE, visualization by Coomassie brilliant blue staining and molecular weight analysis	4	70%	65%
Outcome 4	Recombinant protein expression, purification by affinity chromatography and analysis by SDS-PAGE	4	70%	60%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

Program Learning Outcomes (PLO)															
CLOs	POs												PSOs		
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	3	3	3	2	1	3	3	2			3	3	3
Outcome 2	3	3	3	3	3	3	1	3	3	3			3	3	3
Outcome 3	3	3	3	3	3	3	1	3	4	3			3	3	3
Outcome 4	3	3	3	3	3	3	1	3	4	3			3	3	3
Average	3	2.75	3	3	3	2.75	1	3	3.5	2.75			3	3	3

Course Unitization Plan Lab

Exp No.	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
1	Making buffers, media preparation, pH measurement, and sterilization	5	1	1
2	Transformation and plasmid DNA preparation, concentration measurement at 260 nm	15	2	1
3	Restriction digestion, agarose gel preparation, electrophoresis and Geldoc analysis of the bands	10	3,4	1
4	Growth, Bacterial lysate preparation, estimation of concentration using Bradford reagent, SDS PAGE and Coomassie brilliant blue staining and molecular wt. calculation	20	3,4	1
5	Transformation of BL21(DE3) with expression plasmid, Growth of colonies in LB broth, induction of expression by IPTG, lysate preparation in Urea buffer by sonication concentration determination, Affinity purification using Ni-NTA agarose, SDA-PAGE, Coomassie Blue staining	25	3,4	1

Bloom's Level of Cognitive Task	Continuous Learning Assessments (50%)			End Semester Exam (50 %)
	Experiments (20 %)	Record / Observation Note (10 %)	Viva + Model (20 %)	
Remember	20 %		50 %	50 %
Understand	20 %			
Apply	30 %	100 %	50 %	50 %
Analyse	30 %			
Evaluate				
Create				
Total	100 %	100 %	100 %	100 %

Recommended Resources

1. Molecular cloning: A laboratory Manual by Sambrook, Fritsch and Maniatis, Cold Spring Harbor Laboratory Press, 4th edition, 2014.

Course Designers

1. Prof. C. Durga Rao, Professor, Department of Biological Sciences, SRM University – AP

Biochemistry and Metabolism

Course Code	BIO 505	Course Category	Core Course (CC)				L	T	P	C
							2	1	0	3
Pre-Requisite Course(s)		Co-Requisite Course(s)	Progressive Course(s)							
Course Offering Department	Biological Sciences	Professional / Licensing Standards								

Course Objectives / Course Learning Rationales (CLRs)

1. Provide a comprehensive understanding of the chemical basis of life, including bioenergetics, enzyme kinetics, and major metabolic pathways.
2. Explore the regulation of metabolism and the biochemical basis of inborn errors of metabolism.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Understand the principles of bioenergetics, enzyme kinetics, and the role of water and buffers in biological systems.	2	80%	75%
Outcome 2	Comprehend carbohydrate structures, glycosylation, and metabolic pathways such as glycolysis and the citric acid cycle.	2	80%	75%
Outcome 3	Learn the structure and metabolism of lipids, including fatty acid biosynthesis and the formation of complex lipids.	3	70%	65%
Outcome 4	Master the metabolism of amino acids and nucleic acids, including their synthesis, degradation, and regulation.	3	70%	65%
Outcome 5	Understand the regulation of metabolism and identify various inborn errors of metabolism and related disorders.	3	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

Program Learning Outcomes (PLO)															
CLOs	POs												PSOs		
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	3	3	2	1	3	3	2			2	2	3	2
Outcome 2	3	2	3	3	2	1	2	3	2			2	2	3	2
Outcome 3	3	2	3	3	3	1	3	2	3			3	3	3	3
Outcome 4	3	3	3	3	3	1	3	3	3			3	3	2	3
Outcome 5	3	3	3	3	3	1	2	3	3			3	3	3	3
Average	3	2.4	3	3	2.6	1	2.6	2.8	2.6			2.6	2.6	2.8	2.6

Course Unitization Plan Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	Chemical basis of life	5		
	Water and buffers – biological buffer systems.	1	1	1-4
	Bioenergetics- Laws of thermodynamics and their applications in biological system, oxidation-reduction reactions.	1	1	1-4
	High energy bonds.	1	1	1-4
	Biochemical basis of life.	1	1	1-4
	Enzymes – Classification, and kinetics, coenzymes and cofactors, zymogens, Isoenzymes.	1	1	1-4
Unit 2	Carbohydrate metabolism	10		
	Carbohydrates - mono, di, and polysaccharides	1	2	1-4
	glycosylation of other biomolecules - glycoproteins and glycolipids.	2	2	1-4
	Metabolism of carbohydrates – Glycolysis	2	2	1-4
	Citric acid cycle	2	2	1-4
	HMP pathway	1	2	1-4
	Cori Cycle, and Gluconeogenesis.	2	2	1-4
Unit 3	Lipid metabolism	10		
	Lipids - structure and properties of important members of storage and membrane lipids; lipoproteins.	2	3	1-4
	Fatty acid metabolism: fatty acid biosynthesis	3	3	1-4
	Endogenous synthesis of triacylglycerols	3	3	1-4
	Phospholipids, cerebrosides, gangliosides and cholesterol.	2	3	1-4
Unit 4	Amino-acids and nucleic acid metabolism	10		
	Amino acids – classification and properties	3	4	1-4
	Amino acid metabolism – synthesis and degradation.	2	4	1-4
	Protein classification and turnover	2	4	1-4
	Purine and Pyrimidine biosynthesis and degradation.	3	4	1-4
Unit 5	Inborn errors of metabolism	10		
	Regulation of metabolism	2	2,3,4,5	1-4
	Disorders of metabolism - diabetes mellitus	3	3,5	1-4
	Inborn errors of metabolism: Glycogen storage diseases, phenylketonuria, albinism, Homocystinuria, Maple- syrup urine disease, Gaucher disease, Fabry disease, Lesch-Nyhan syndrome, Gout	5	2,3,4,5	1-4

Total contact hours	45
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Learning Assessment Theory

Bloom's Level of Cognitive Task	Continuous Learning Assessments (50 %)				End Semester Exam (40 %)
	CLA-1 (10 %)	CLA-2 (15 %)	CLA-3 (15 %)	Mid-1 (20 %)	
Remember	30 %	30 %	25 %	20 %	35 %
Understand	40 %	30 %	25 %	20 %	35 %
Apply	30 %	40 %	50 %	60 %	30 %
Analyse					
Evaluate					
Create					
Total	100 %	100 %	100 %	100 %	100 %

Recommended Resources

1. Lewin's Genes XII: Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick Jones and Bartlett Publishers, Inc 12th edition, ISBN: 978-1284104493.
2. Molecular Cell Biology: Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Anthony Bretscher, W. H. Freeman; 9th edition, ISBN: 978-1319208523.
3. Molecular Biology of the Cell: Bruce Alberts, Rebecca Heald, Alexander Johnson, David Morgan, Martin Raff, Keith Roberts, Peter Walter, WW Norton & Co; 7th edition, ISBN: 978-0393884852.
4. Molecular Biology: Nancy L. Craig, Orna Cohen-Fix, Rachel Green, Carol W Greider, Gisela Storz & Cynthia Wolberger: Oxford University press,3 ISBN 978-0-19-956206-0.

Course Designers

1. Prof. Jayaseelan Murugaiyan. Professor, Dept. Of Biological Sciences. SRM University – AP.

Cell Biology

Course Code	BIO 506	Course Category	Core Elective (CE)				L	T	P	C
							2	1	0	3
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)						
Course Offering Department	Biological Sciences	Professional / Licensing Standards								

Course Objectives / Course Learning Rationales (CLRs)

1. Provide a comprehensive understanding of cell biology, including cell structure, cellular processes, cell cycle regulation, and signalling pathways.
2. Explore the concepts of stem cell biology, including types, differentiation, reprogramming, and potential applications.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Understand the history, evolution, and structural features of prokaryotic and eukaryotic cells.	2	80%	75%
Outcome 2	Comprehend mechanisms of cellular transport, vesicular trafficking, and protein degradation.	2	80%	75%
Outcome 3	Learn the regulation of the cell cycle, including mitosis, meiosis, and the role of growth factors in cancer.	3	70%	65%
Outcome 4	Understand the basics of cell signalling, including receptor-ligand interactions and major signalling pathways.	3	70%	65%
Outcome 5	Grasp the concepts of stem cell types, potency, differentiation, and their prospective applications.	3	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

Program Learning Outcomes (PLO)															
CLOs	POs												PSOs		
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	3	3	2	1	3	3	2			2	2	3	2
Outcome 2	3	2	3	3	2	1	2	3	2			2	2	3	2
Outcome 3	3	2	3	3	3	1	3	2	3			3	3	3	3
Outcome 4	3	3	3	3	3	1	3	3	3			3	3	2	3
Outcome 5	3	3	3	3	3	1	2	3	3			3	3	3	3
Average	3	2.4	3	3	2.6	1	2.6	2.8	2.6			2.6	2.6	2.8	2.6

Course Unitization Plan Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	Introduction to Cell Biology	7		
	History of Cell biology	1	1	1,2
	Evolution of cells	1	1	1,2
	Salient features of cells	1	1	1,2
	Cellular architecture – membranous and membrane-less organelles	2	1	1,2
	Prokaryotic cells and types (bacteria and archaea)	1	1	1,2
Unit 2	Cellular transactions	8		
	Cellular transport	1	2,4	1,2
	Vesicular traffic	1	2,4	1,2
	Mechanisms of vesicle budding and fusion	2	2,4	1,2
	Secretion, Receptor-mediated endocytosis	1	2,4	1,2
	Vesicle-independent trafficking	1	2,4	1,2
	Protein degradation (UPS)	1	2,4	1,2
	lysosomal degradation and autophagy.	1	2,4	1,2
Unit 3	Cell cycle and its regulation	10		
	Cell cycle, checkpoints and regulation	2	3	1,2
	Cell cycle defects and cancer	2	3	1,2
	Mitosis and meiosis	2	3	1,2
	Control of cell division and cell growth - growth factors	2	3	1,2
	Oncogenes, and cancer	1	3	1,2
	Senescence	1	3	1,2

	Cellular Signaling pathways	10		
Unit 4	Basics of cell signalling	2	2,4	1,2
	Signal transduction pathways - receptor-ligand interactions, G-protein coupled receptor signaling, Receptor tyrosine kinase signaling, Wnt signaling, Notch signaling	2	2,4	1,2
	Intracellular messengers	2	2,4	1,2
	Steroid receptors	2	2,4	1,2
	Cell-cell junctions (gap and tight)	2	2,4	1,2
	Stem cells	10		
Unit 5	Stem cells – types	2	5	1,3
	Cellular potency	1	5	1,3
	Differentiation, dedifferentiation,	1	5	1,3
	Cellular reprogramming	2	5	1,3
	in vitro organ culture, Organoids	2	5	1,3
	Prospective applications of stem cells.	1	5	1,3
	Applications of stem cells in medicine	1	5	1,3
Total contact hours		45		

Learning Assessment Theory

Bloom's Level of Cognitive Task	Continuous Learning Assessments (50 %)				End Semester Exam (40 %)
	CLA-1 (10 %)	Mid-1 (20 %)	CLA-2 (15 %)	CLA-3 (15 %)	
Remember	40 %	60 %	30 %	25 %	30 %
Understand	60 %	40 %	30 %	25 %	40 %
Apply			40 %	50 %	30 %
Analyse					
Evaluate					
Create					
Total	100 %	100 %	100 %	100 %	100 %

Recommended Resources

1. Molecular Cell Biology: Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Anthony Bretscher, W. H. Freeman; 9th edition, ISBN: 978-1319208523.
2. Molecular Biology of the Cell: Bruce Alberts, Rebecca Heald, Alexander Johnson, David Morgan, Martin Raff, Keith Roberts, Peter Walter, WW Norton & Co; 7th edition, ISBN: 978- 0393884852.
3. Karp' s Cell Biology: Gerald Karp, Janet Iwasa, Wallace Marshall, Wiley; 8th edition, 2018, ISBN: 978-1119454175.

Course Designers

1. Dr. Pitchaiah Cherukuri, Assistant Professor, Dept. Of Biological Sciences. SRM University – AP.

Microbiology

Course Code	BIO 550	Course Category	Core Elective (CE)				L	T	P	C
							2	1	0	3
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)						
Course Offering Department	Biological Sciences	Professional / Licensing Standards								

Course Objectives / Course Learning Rationales (CLRs)

- Analyze microbial diversity, growth kinetics, physiology, genetics, and stress responses.
- Apply microbial systems in biotechnology, focusing on biofilms, quorum sensing, CRISPR-Cas, and antimicrobials.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Demonstrate an understanding of microbial taxonomy, growth kinetics, and the significance of microbiomes in ecological systems.	2	70%	65%
Outcome 2	Analyse bacterial ultrastructure, gene transfer mechanisms, and the genetic organization of microorganisms	2	80%	70%
Outcome 3	Describe the different microbial stress responses, extremophiles' adaptations, and various communication methods utilized by microorganisms.	3	75%	70%
Outcome 4	Demonstrate an understanding of microbial defense mechanisms, antibiotic resistance, and strategies employed by microbes to evade immune responses.	3	70%	65%
Outcome 5	Evaluate the action and resistance of antimicrobial drugs.	2	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

Program Learning Outcomes (PLO)															
CLOs	POs												PSOs		
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	3	3	1	1	2	3	2	3		3	3	1	2
Outcome 2	2	3	3	3	1	1	2		1			3	3	2	2
Outcome 3	2	3	3	2	1	1	3		1			2	3	2	2
Outcome 4	1	2	3	3	1	1	3		1			3	3	2	2
Outcome 5	2	3	3	3	1	1	2		1			3	3	2	2
Average	2	2.6	3	2.8	1	1	2.4	3	1.2	3		2.8	3	1.8	2

Course Unitization Plan Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	Microbial diversity and growth	7		
	Introduction to microbial diversity- Taxonomy and classification,	1	1	1, 2
	Nutritional Types of Microorganisms, Unculturable bacterial diversity and techniques to study.	2	1	1, 2
	Microbial growth kinetics, Synchronous and asynchronous growth, continuous culture of bacteria & its kinetics,	2	1	1, 2
	Microbial sporulation and its genetics, dormancy, Microbiomes.	2	1	
Unit 2	Microbial physiology and genetics	8		
	Ultrastructure of bacteria, archaea, unicellular eukaryotes, and viruses.	2	2	1, 2, 3
	Bacterial cell shape, division, cytoskeleton, and genome organization.	3	2	1, 2, 3
Unit 3	Microbial stress response and communication	8		
	Microbial stress responses, DNA damage response,	3	3	3,5
	Adaptation mechanisms of extremophiles. Bacteriological potential of extremophiles	2	3	3,5
	Bioluminescence, Bacterial biofilms, Quorum sensing, Electrical communication, Contact-dependent communications in bacteria.	3	3	3,5
Unit 4	Microbial immunity	11		
	Restriction-modification systems, Abortive infection systems, CRISPR-Cas, Type VI secretion systems, bacteriocins, toxin-antitoxin systems,	3	4	3,5
	antibiotic persistence, superinfection exclusion, receptor masking,	3	4	3,5
	programmed cell death,	2	4	3,5
	surface structures such as capsules, biofilms, and antigenic variation in evading host immune responses.	3	4	3,5
Unit 5	Antimicrobials	11		
	Antimicrobial chemotherapy-origin and general characteristics of chemotherapy;	3	5	1-4
	Mechanism of action of Antibacterial, antifungal, antiviral and antiprotozoan drugs;	3	5	1-4
	Factors influencing the effectiveness of antimicrobial drugs	3	5	1-4

	Drug resistance	2	5	
Total contact Hours		45		

Learning Assessment Theory

Bloom's Level of Cognitive Task	Continuous Learning Assessments (50) %				End Semester Exam (50 %)
	CLA-1 (10 %)	Mid-1 (15 %)	CLA-2 (10 %)	CLA-3 (15 %)	
Remember	80 %	60 %	20 %	30 %	35 %
Understand	20 %	40 %	30 %	30 %	35 %
Apply			50 %	40 %	30 %
Analyse					
Evaluate					
Create					
Total	100 %	100 %	100 %	100 %	100 %

Recommended Resources

1. 1. Principles of Microbiology: Atlas, R.M, Mosby; 2nd edition, 1996, ISBN: 978-0815108894.
2. 2. Microbiology, 6th edition (1993), Pelczar, Chan and Krieg; McGraw Hill International
3. 3. Prescott, Harley, and Klein's Microbiology, 8th edition, (2011), Joanne M. Willey, Linda M. Sherwood, Christopher J. Woolverton, McGraw Hill International.
4. 4. Stainer R. Y., Ingraham. J. L., Wheelis M. J., Painter P. R. (1999). General microbiology. MacMillan Educational Ltd. London.
5. 5. Ananthanarayan and Paniker's Textbook of Microbiology: R Ananthanarayan, CK Jayaram, Paniker and Reba Kanungo, Universities Press (India) Pvt. Ltd; 11th edition, 2020, ISBN: 9789389211436.

Course Designers

1. Dr. Sutharsan Govindarajan, Assistant Professor, Dept. Of Biological Sciences. SRM University – AP

SEMESTER II

Introduction to R and Python

Course Code	SEC 501	Course Category	L	T	P	C
			2	0	2	4
Pre-Requisite Course(s)		Co-Requisite Course(s)	Progressive Course(s)			
Course Offering Department	Mathematics	Professional / Licensing Standards				

Course Objectives / Course Learning Rationales (CLRs)

1. In Python, identify and describe essential elements such as syntax, keywords, variables, indentation, data types, lists, tuples, sets, dictionaries, operators, control statements, and loops.
2. Understand the significance of built-in functions, user input-output, matrix computations, linear equations, and graphing curves and surfaces using Matplotlib and file handling in Python.
3. Implement R programming fundamentals, including objects, vectors, matrices, arrays, data manipulation techniques (subsetting, filtering, merging), and data frames, and create visualisations using ggplot2 in R.
4. Synthesise knowledge from Python and R to perform comprehensive data analysis and create reports that include descriptive statistics, linear regression, hypothesis testing, and time series forecasting.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Demonstrate an understanding of Python programming fundamentals, including syntax, keywords, variables, data types, lists, tuples, sets, dictionaries, operators, and control statements.	2	80	70
Outcome 2	Grasp core programming concepts by comprehending the role of built-in functions, user input-output, file handling and graphing curves and surfaces using Matplotlib in Python.	3	75	70
Outcome 3	Apply programming skills in R by effectively using objects, vectors, matrices, arrays, and data frames, and will demonstrate the practical application of data manipulation techniques, including sub-setting, filtering, and merging, and create visualizations using ggplot2 in R.	4	75	70
Outcome 4	Integrate Python and R knowledge to perform sophisticated data analysis that incorporates descriptive statistics, linear regression, hypothesis testing, and time series forecasting, showcasing a synthesis of programming skills across both languages.	4	75	70

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

Program Learning Outcomes (PLO)															
CLOs	POs												PSOs		
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	3	3					1			2	3	1	2
Outcome 2	3	3	3	2	1				2			2	3	2	2
Outcome 3	3	3	3	3	1				2			2	3	2	2
Outcome 4	3	3	3	3	3				3			2	3	2	2

Average	3	3	3	3	2				2			2	3	2	2
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Course Unitization Plan Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used	
Unit 1		8			
	Python Basics: Python setup, syntax, keywords, comments, Variables and data types (int, float, str, bool)	2	1,2	1	
	Control Flow : if, elif, else statements, for and while loops, break and continue	2	1,2	1	
	Collections – Lists and Tuples : Lists – indexing, slicing, methods, Tuples – immutability, unpacking	2			
	Sets and Dictionaries: Sets – properties, operations, Dictionaries – key-value pairs, common methods	2			
Unit 2		6			
	Functions and Scoping : Defining functions, arguments, return, Variable scope, *args, **kwargs	2	2,3	1	
	File I/O and Built-in Functions : File handling (open, read, write, with), Built-in functions (map, filter, zip, enumerate)	2			
	Matplotlib Basics : Line and scatter plots, axis labels, legends, Subplots, customizing styles	2	2,3	1	
Unit 3		10			
	R Programming – Basics : Introduction to R, RStudio, syntax, Data types and basic operations	2	3,4	2	
	Vectors, Lists, Matrices : Vectors – creation, indexing, Lists and matrices – structure and access	2	3,4	2	
	Arrays and Data Frames : Arrays and matrix operations, Data frames – creation, access, structure	2	3,4	2	
	Data Manipulation in R : Filtering, subsetting, merging data frames, apply, lapply, sapply	2	4	3	
	ggplot2 for Visualization : ggplot2 – grammar of graphics, aesthetics, Geoms – geom_point, geom_bar, geom_line	2	4	3	
Unit 4		6			
	Descriptive Statistics & Regression : Summary statistics, visualization with histogram/boxplots, Linear regression in Python and R	2	4	1, 4	
	Hypothesis Testing : t-tests, chi-square, ANOVA – in Python & R, Interpreting p-values and confidence intervals	2	4	1, 4	
	Time Series & Final Integration : Time series basics and forecasting in Python and R, Final Project discussion – integrated data analysis using both languages	2	4	1, 4, 5	
Total contact hours		30			

Course Unitization Plan Lab

Exp No.	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
1	Write a program to demonstrate the use of Python syntax, keywords, and variables.	2	1	1
2	Create a program that uses indentation and comments to improve code readability.	2	1	1
3	Implement a program that showcases different data types in Python (int, float, string, Boolean).	2	1	1
4	Write a program that manipulates lists (e.g., sorting, appending, slicing).	2	1	1
5	Create a program that demonstrates using tuples and sets in Python.	2	2	1
6	Implement a dictionary to store and retrieve information.		2	1
7	Write a program that uses different operators in Python (+, -, *, /, //, %, **).	2	2	1
8	Create a program that includes control statements (if-else, nested if-else, switch-case) and loops (for, while).	2	2	1
9	Write a program to create and manipulate objects in R.	2	3	2
10	Implement a program that demonstrates using vectors and matrices in R.	2	3	2
11	Create a program that works with arrays and lists in R.	2	3	2
12	Write a program to handle missing data in a data frame.	2	3	2
13	Implement a program that reads and writes data to CSV or text files.	2	4	2
14	Create a program that performs data manipulation tasks (subsetting, filtering, merging) on a data frame.	2	4	2
15	Write a program that uses ggplot2 to create a plot in R.	2	3,4	2
Total Contact Hours		30		

Learning Assessment Theory

Bloom's Level of Cognitive Task	Continuous Learning Assessments (60 %)								End Semester Exam (40 %)	
	CLA-1 (20 %)		Mid-1 (20 %)		CLA-2 (10 %)		CLA-3 (10 %)			
	Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Remember	35%	40%	30%	30%	30%	25%	25%	0	20%	25%
Understand	35%	40%	20%	20%	30%	25%	25%	0	20%	25%
Apply	15%	10%	30%	30%	20%	25%	25%	0	30%	25%
Analyse	15%	10%	20%	20%	20%	25%	25%	0	30%	25%
Evaluate	0	0	0	0	0	0	0	0	0	0
Create	0	0	0	0	0	0	0	0	0	0
Total	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %

Recommended Resources

1. Guido van Rossum and the Python development team Python Tutorial Release 3.7.0., ISBN-13: 978-5304117357
2. W. N. Venables, D. M. Smith and the R Core Team, An Introduction to R, ISBN-13: 978-0954161743
3. R in Action, Robert I. Kabacoff, Second Edition, Paperback, Dreamtech Press, ISBN-13: 978-1617291388
4. A Beginner's Guide to R, Alain F. Zuur, Elena N. Ieno, Erik H. W. G. Meesters, Springer New York, ISBN-13: 978-0387938363
5. The Absolute Beginner's Guide to Python Programming, A Step-by-Step Guide with Examples and Lab Exercises, Kevin Wilson, Apress Berkeley, CA, ISBN-13: 978-1484287156
6. Python Programming Fundamentals, Kent D. Lee, Springer London, ISBN-13: 978-1447166412

Course Designers

1. Dr. Tapan Hota, Department of Mathematics, SRM University-AP.

Research Methodology

Course Code	SEC 105	Course Category	Foundation Course (FC)				L	T	P	C
							3	0	0	3
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)						
Course Offering Department	Chemistry	Professional / Licensing Standards								

Course Objectives / Course Learning Rationales (CLRs)

1. To understand research design, methods, and question formulation.
2. To learn ethical principles and learn about intellectual property rights in research.
3. To develop skills to conduct, report, and communicate research effectively.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Identify and explain various research designs and methods.	2	85%	80%
Outcome 2	Formulate clear research questions and design appropriate methodologies for investigation.	3	80%	75%
Outcome 3	Evaluate ethical considerations and intellectual property aspects in research practices.	5	80%	75%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

Program Learning Outcomes (PLO)															
CLOs	POs												PSOs		
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	3	2	3		3	2	3	3	3		2	1	3
Outcome 2	2	1	2	2	1		2	2	1	2	3		3	2	2
Outcome 3	3	3	3	3	2		2	1	2	2	1		1	3	1
Average	2.67	2	2.67	2.33	2		2.33	1.66	2	2.33	2.33		2	2	2

Course Unitization Plan Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	Introduction to Research Design and Methods	9	1	1,2
	Overview of research: Definition, significance, purpose, and types.	4		
	Types of Research: Basic and applied research.	3		
	Google scholar, ResearchGate, Citations, h-index, i10 index	2		
Unit 2	Formulating Research Questions and Hypotheses	9	2	1,3
	Developing clear and focused research questions	3		
	Literature survey, various sources of research information	2		
	Methodology of research	2		
	Importance of research design	1		
	Steps in conducting research	1		
Unit 3	Introduction to scientific ethics	9	3	1,2,3
	Key ethical principles: Honesty, integrity, transparency.	3		
	The role of ethics in experimental design	2		
	Ethical considerations in data collection and analysis.	2		
	Human and animal research ethics.	2		
Unit 4	Report your findings	9	3	1,2,3
	Writing reports, Structuring reports	3		
	Writing journal articles,	2		
	Writing research proposals	2		
	Producing oral presentations	2		
Unit 5	Intellectual Property Rights, Patents, and Technology	9	3	4

	Introduction to IPR: concepts and importance	3		
	Types of intellectual property: patents, copyrights, trademarks, designs, geographical index.	3		
	Patent filing process in India and globally	3		
Total Contact Hours		45		

Learning Assessment Theory

Bloom's Level of Cognitive Task	Continuous Learning Assessments (100 %)				End Semester Exam (50 %)
	CLA-1 (20 %)	Mid-1 (30 %)	CLA-2 (30 %)	CLA-3 (20 %)	
Remember	40 %	10 %	40 %	30 %	--
Understand	60 %	20 %	30 %	30 %	
Apply		20 %	30 %	40 %	--
Analyse		20 %			
Evaluate		30 %			
Create					
Total	100 %	100 %	100 %	100 %	--

Recommended Resources

1. Bordens K.S. and Abbott, B.b.: Research Design and Methods, Mc Graw Hill, 2008. ISBN: 9780073126547.
2. John W. Creswell and J. David Creswell Research Design: Qualitative, Quantitative, and Mixed Methods Approaches" SAGE Publications, 2017, ISBN: 9781506386706.
3. Wayne C. Booth, Gregory G. Colomb, Joseph M. Williams, Joseph Bizup and William T. FitzGerald, The Craft of Research, Fourth Edition, University of Chicago Press, 2016, ISBN: 9780226239736.
4. Arthur R. Miller & Michael H. Davis, Intellectual Property: Patents, Trademarks and Copyright in a Nutshell, Publisher: West Academic Publishing, 2018, ISBN: 9781683285302
5. Peter H. Diamandis, Steven Kotler, The Future is faster than you think, Simon & Schuster, 2020. ISBN: 978-1982109660.

Course Designers

1. Dr. Rajapandiyam J P, Assistant Professor, Department of Chemistry, SRM University AP.

RNA Biology

Course Code	BIO 508	Course Category	Core Course (CC)			
			L	T	P	C
			3	1	0	4
Pre-Requisite Course(s)	Molecular Biology	Co-Requisite Course(s)		Progressive Course(s)		
Course Offering Department	Biological Sciences	Professional / Licensing Standards				

Course Objectives / Course Learning Rationales (CLRs)

1. Provide a comprehensive understanding of RNA origins, biogenesis, and structural properties.
2. Explore the mechanisms of RNA stability, editing, translational control, and RNA's role in gene expression and viral interactions.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Understand the RNA world hypothesis, RNA properties, and RNA purification methods.	2	80%	75%
Outcome 2	Learn the types, biogenesis, and functions of various RNAs.	2	80%	75%
Outcome 3	Comprehend the mechanisms of translation and translational control.	2	70%	65%
Outcome 4	Grasp RNA stability, mRNA degradation, and RNA editing processes.	3	70%	65%
Outcome 5	Explore RNA viruses, nuclear transport mechanisms, and RNA's role in health and disease.	4	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

Program Learning Outcomes (PLO)															
CLOs	POs											PSOs			
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	3	3	1	1	3	3	2			2	1	1	2
Outcome 2	3	2	3	3	2	1	3	3	2			2	2	2	2
Outcome 3	3	2	3	3	3	1	3	3	2			2	3	2	2
Outcome 4	3	2	3	3	3	1	3	3	2			3	3	2	2
Outcome 5	3	3	3	3	3	3	2	3	2	3		3	3	2	2
Average	3	2.2	3	3	2.4	1.4	2.8	3	2	3		2.4	2.4	1.8	2

Course Unitization Plan Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	RNA-the basis of origin of life	8		
	RNA as the first informational and catalytic biopolymer	2	1,2	1,3
	RNA world hypothesis and SELEX	2	1,2,3	1,3
	Endo- and Exo nucleases, RNase inhibitors and their use in RNA research	2	1,2	1,3
	Structural properties of RNA, methods of RNA purification, molecular basis of RNA instability.	2	1,2	1,3
Unit 2	RNA Biogenesis	16		
	Types of RNAs, their properties and functions	2	1,2	1,3
	rRNAs-transcription, processing, modifications, ribosome subunit assembly and transport to cytoplasm	2	2,3	1,3
	RNA Pol II structure Mechanism of pre-mRNA transcription.	2	2,3	1,2,3
	Capping, polyadenylation, Spliceosomes, structure, composition and functions	2	2,3,3	1,2,3
	Pre-mRNA splicing: Intron-exon junction sequences, splicing factors-positive and negative regulators, Exon junction complexes, The splicing cycle	4	1,2,3,4	1,2,3
	Types of splicing: differences between cis splicing and trans splicing, self-splicing, alternate splicing	2	2,3	1,2,3
RNA-binding proteins, hnRNPs, structure and function,	2	1,2,3	1,3	
Unit 3	Translation and control mechanisms	10		
	Ribosomes-composition and structure, Operon structure, Polycistronic mRNAs, SD sequence, and mechanism of translation in prokaryotes.	2	1,2,3	1,2,3
	Eukaryotic mRNA-role of Cap and poly (A)-tail in translation and stability of mRNA, Scanning mechanism of translation. Cap-binding complex and recruitment of small ribosomal subunit on to the mRNA,	2	1,2,3	1,2,4
	Translation initiation, elongation, termination factors and their function	2	1,2,3	1,2,4
	Nuclear and mitochondrial translation, mitochondrial import of tRNAs, ribosome heterogeneity, rRNA modifications and regulation of translation,	2	2,3,4	1,2,4
	Internal ribosome entry sites (IRES) and cap-independent translation, Influence of RNA structure on translation, dicistronic mRNAs, Frameshift and generation of multiple proteins, codon bias	2	2,3,4	1, 2
Unit 4	RNA stability, editing	12		
	RNA stability: mechanisms of mRNA degradation and regulation of gene expression; Role of Cap and poly (A) on mRNA stability, Nonsense-mediated mRNA decay	4	1,2,3,4	1, 2
	hnRNPs, AU-rich elements and binding factors	2	1,2,3	1, 2
	siRNAs. miRNAs and lncRNAs, stress granules and P-bodies	2	1.2.3	1,2,4

	RNA editing: insertion/deletion editing; modification editing mechanisms,	4	2,3,4	1,2,3,4
Unit 5	RNA Viruses research	14		
	RNA viruses, their genomes and mechanism of gene expression	2	1,2,3	5
	Concepts of nuclear transport; RNA and protein transport mechanisms; transport/ retention signals; Nuclear pore complex, Transport receptors;	2	2,3,4	2,3,4
	Contribution of HIV biology in understanding nuclear transport mechanisms.	2	2,3,4	1,2,3,4
	RNA modifications and epitranscriptomic regulation; RNA in health and disease.	2	2,3,4	1,2,3,4
	Student presentations	2	3,4,5	1,2,3,4
	Student presentations	2	3,4,5	1,2,3,4
Student presentations	2	3,4,5	1,2,3,4	
Total contact hours		60		

Learning Assessment Theory

Bloom's Level of Cognitive Task	Continuous Learning Assessments (50 %)				End Semester Exam (40 %)
	CLA-1 (10 %)	Mid-1 (20 %)	CLA-2 (15 %)	CLA-3 (15 %)	
Remember	40 %	60 %	30 %	35 %	20 %
Understand	60 %	40 %	40 %	35 %	40 %
Apply			30 %	30 %	40 %
Analyse					
Evaluate					
Create					
Total	100 %	100 %	100 %	100 %	100 %

Recommended Resources

1. RNA world: Raymond F. Gesteland and John F. Atkins: Cold Spring Harbor Press.1999
2. Gene IX. 9th Edition. Benjamin Lewin
3. RNA-protein Interactions: Kioshi Nagai and Iain W, Mattaj, Oxford University Press,1994
4. Biochemistry, 9th Edition, Jeremy M. Berg, John L. Tymoczko, Gregory J. Gatto Jr., Lubert Stryer 2019 W. H. Freeman and Company, ISBN-13: 978-1319114657:
5. Fields Virology: 5th edition, David M. Knipe and Peter M Howley 2007, Lippincott Williams & Wilkins

Course Designers

1. Prof. C. Durga Rao. Professor, Dept. Of Biological Sciences. SRM University – AP.

Bioinformatics

Course Code	BIO 509	Course Category	Core Course (CC)			L	T	P	C
						2	1	0	3
Pre-Requisite Course(s)		Co-Requisite Course(s)			Progressive Course(s)				
Course Offering Department	Biological Sciences	Professional / Licensing Standards							

Course Objectives / Course Learning Rationales (CLRs)

1. Apply bioinformatics tools for effective analysis of biological data in molecular biology and biotechnology, considering their applications and limitations.
2. Utilize algorithms and computational methods in bioinformatics to tackle challenges such as genome-wide association studies, transcriptomics, proteomics, and machine learning for biological data analysis and simulations.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Understand digital biology data handling and assess bioinformatics applications in molecular biology and biotechnology.	2	90	80
Outcome 2	Apply algorithms effectively in biological data analysis and automation, considering data accuracy and computational models.	2	95	85
Outcome 3	Analyze genomic and transcriptomic data, predict non-coding RNA functions, and perform phylogenetic analyses.	1	70	60
Outcome 4	Utilize bioinformatics tools for omics data interpretation, identifying candidate genes, and exploring protein interactions and drug targets.	3	70	60
Outcome 5	Apply machine learning and simulations to identify patterns in biological data, assess their applicability, and guide experimental design.	3	70	50

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

Program Learning Outcomes (PLO)															
CLOs	POs												PSOs		
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	3	3	1	1	3	3	3	3		2	3	1	2
Outcome 2	3	2	3	3	2	1	3		1			2	3	2	2
Outcome 3	3	2	3	3	3	1	3		1			2	3	2	2
Outcome 4	3	2	3	3	3	1	3		1			2	3	2	2
Outcome 5	3	2	3	3	3	1	3		1			2	3	3	3
Average	3	2	3	3	2.4	1	3	3	1.4	3		2	3	2	2.2

Course Unitization Plan Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	Introduction	5		
	Digitization of Biological data,	1	1	1
	databases and their categories.	2	1	1
	Applications and limitations of Bioinformatics in Molecular Biology and Biotechnology	2	1	1
Unit 2	Algorithms	10		
	The adage: Garbage in, Garbage-out.	1	2	2
	Algorithms: scope and applications.	1	2	2
	Floating point accuracies, rounding-off errors and imperfections in theoretical models used to define biological systems.	3	2	2
	Analysis pipelines, programming,	3	2	2
	automation of tasks and web-applications	2	2	2
Unit 3	Molecular Bioinformatics	10		
	Genome wide association studies.	2	3	4,5
	Alternate splicing analysis	2	3	4,5
	Identifying the Non-coding RNA sequences,	2	3	4,5
	prediction of miRNA targets.	2	3	4,5
	Phylogenetic analysis: Homolog, Ortholog, Paralogs and heterology; Identification of similar genes and proteins.	2	3	4,5
Unit 4	Bioinformatics analysis	10		
	Concept of Omics	2	4	2
	Transcriptomics: Databases	2	4	2
	Candidate gene identification and gene network	2	4	2
	detection associated with biological phenomenon.	2	4	2

	Proteomics: Databases, protein interaction networks and drug targets, drug designing and development.	2	4	2
	Metabolomics.	2	4	2
Unit 5	Machine Learning and Simulations	10		
	Patterns in biological data and techniques for its recognition.	3	5	3,4
	Machine learning approaches in biological research, their limitations and potential.	3	5	3,4
	Simulations and theoretical validations to guide and design wet-lab experimental techniques	4	5	3,4
Total Contact Hours		45		

Learning Assessment Theory

Bloom's Level of Cognitive Task	Continuous Learning Assessments (60 %)				End Semester Exam (40 %)
	CLA-1 (15 %)	Mid-1 (15 %)	CLA-2 (15 %)	CLA-3 (15 %)	
Remember	40 %	60 %	20 %	30 %	30 %
Understand	60 %	40 %	40 %	40 %	40 %
Apply			40 %	30 %	30 %
Analyse					
Evaluate					
Create					
Total	100 %	100 %	100 %	100 %	100 %

Recommended Resources

1. Bioinformatics for beginners: Genes, genomes, molecular evolution, databases and analytical tools: Supratim Choudhuri, Academic Press; 1st edition, 2014, ISBN: 978-0124104716
2. Structural Bioinformatics tools for drug design: Extraction of biologically relevant information from structural databases. Jaroslav Koča, Radka Svobodová Vařeková, Lukáš Pravda, Karel Berka, Stanislav Geidl, David Sehnal, Michal Otyepka, Springer publishers; 1st edition, 2017, ISBN: 978-3319473871
3. Translational Bioinformatics for therapeutic development: Methods and Protocols. Joseph. M, Humana Press; 1st edition, 2021, ISBN: 978-1071608487
4. Computational methods to study the structure and dynamics of biomolecules and biomolecular processes: From Bioinformatics to molecular quantum mechanics. Adam. L, Springer publishers, 2 nd edition, 2019, ISBN: 978-3319958422
5. Methods in Molecular Biology: RNA bioinformatics. Ernesto Picardi, Humana Press; 1st edition, 2016, ISBN: 978-1493946440

Course Designers

1. Dr. Naga Bhushana Rao Karampudi, Assistant Professor, Department of Biological Sciences.

Genetic Engineering

Course Code	BIO 510	Course Category	Core Course (CC)			
			L	T	P	C
			3	1	0	4
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)		
Course Offering Department	Biological Sciences	Professional / Licensing Standards				

Course Objectives / Course Learning Rationales (CLRs)

1. Understand foundational experiments and principles of genetic engineering.
2. Gain proficiency in using enzymes, cloning vectors, and recombinant DNA techniques for gene manipulation and transgenic methodologies.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Understand foundational experiments and principles that led to the development of genetic engineering.	1	80%	75%
Outcome 2	Learn about various enzymes used in genetic engineering and their applications in biotechnology.	2	80%	75%
Outcome 3	Master the use of cloning vectors for the expression and purification of recombinant proteins.	3	70%	65%
Outcome 4	Gain expertise in cloning, sequencing methodologies, and constructing genomic and cDNA libraries.	2	70%	65%
Outcome 5	Develop skills in DNA, RNA, and protein analysis and transgenic methodologies including gene editing and RNA silencing.	2	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

Program Learning Outcomes (PLO)															
CLOs	POs												PSOs		
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	3	3	2	1	3	3	2			2	1	3	2
Outcome 2	3	2	3	3	2	1	2	3	2			2	1	3	2
Outcome 3	3	2	3	3	3	1	3	2	3			3	3	3	2
Outcome 4	3	3	3	3	3	1	3	3	3			3	3	2	2
Outcome 5	3	2	3	3	3	3	2	3	3			3	3	3	2
Average	3	2.2	3	3	2.6	1.4	2.6	2.8	2.6			2.6	2.2	2.8	2

Course Unitization Plan Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	Foundational discoveries leading to genetic engineering	10		
	Foundation experiments for principles of genetic Engineering	2	1	1,2
	Mendel and Barbara MacClintock experiment on genetics	2	1	1,2
	Darwin and Lamarck theory of selection.	2	1	1,2
	Experiments of Griffith, Avery, MacCleod,	1	1	1,2
	Luria and Delbruk experiments on DNA as the transformation principle	1	1	1,2
	Tobacco mosaic virus for RNA as the genetic material in viruses	1	1	1,2
	Introduction of foreign DNA into cells	1	1	1,2
Unit 2	Enzymes used in recombinant DNA	15		
	Enzymes used in genetic engineering: restriction endonucleases	2	1,2	1,2
	DNA polymerases.	2	1,2	1,2
	Bacterial, Eukaryotic and Phage DNA-dependent RNA polymerases	3	1,2	1,2
	poly(A) polymerase, terminal deoxynucleotidyl transferase	3	1,2	1,2
	Exo and endonucleases, reverse transcriptase	3	1,2	1,2
	Use of different enzymes in biotechnology	2	1,2	1,2
Unit 3	Cloning vectors, recombinant protein expression and purification	15		
	Plasmids and bacteriophages.	3	1,2,3	1,2
	Growth and maintenance of Bacteriophages and bacterial strains containing plasmids; and Viruses.	2	1,2,3	1,2
	Plasmid, bacteriophage, cosmid vectors used in cloning and expression of genes	3	1,2,3	1,2
	Phage-promoter-based vectors (Phagemids) and their use in in vitro transcription	2	1,2,3	1,2
	Prokaryotic and Eukaryotic Expression vectors	2	1,2,3	1,2
	Expression/purification of recombinant proteins	3	1,2,3	1,2

Unit 4	Cloning and sequencing methodologies	10		
	Transformation and transfection procedures	1	3,4	1,2
	PCR methods and applications	2	3,4	1,2
	Genomic DNA and cDNA cloning.	2	3,4	1,2
	In vitro packaging systems and construction of genomic and cDNA libraries	2	3,4	1,2
	Detection and characterization methods for genes and chromosomes.	1	3,4	1,2
	Nucleic acid sequencing methods.	1	3,4	1,2
	DNA, and protein microarrays	1	3,4	1,2
Unit 5	DNA, RNA and Protein analysis and transgenic methodologies	10		
	DNA, RNA, and protein isolation, purification, and fractionation methods.	2	3,4,5	1,2
	Radioactive and nonradioactive labelling of nucleic acids and proteins	1	3,4,5	1,2
	Methods for protein analysis and protein- nucleic acid interactions	1	3,4,5	1,2
	Half-life of RNA and protein.	1	3,4,5	1,2
	Site-specific mutagenesis	1	3,4,5	1,2
	Antisense technology- RNA silencing techniques, Gene editing-Crispr-Cas mechanism, Transgenic organisms	2	3,4,5	1,2
	Animal cloning	1	3,4,5	1,2
	Animal, plant and microbial biotechnology	1	3,4,5	1,2

Learning Assessment Theory

Bloom's Level of Cognitive Task	Continuous Learning Assessments (50 %)								End Semester Exam (40 %)	
	CLA-1 (10 %)		Mid-1 (20 %)		CLA-2 (15 %)		CLA-3 (15 %)		Th	Prac
	Th	Prac	Th	Prac	Th	Prac	Th	Prac		
Remember	40 %		60 %		30 %		70 %		30 %	
Understand	60 %		40 %		40 %		30 %		30 %	
Apply					30 %				40 %	
Analyse										
Evaluate										
Create										
Total	100 %		100 %		100 %		100 %		100 %	

Recommended Resources

1. Molecular Cloning. A Laboratory Manual: J. Sambrook and D. W. Russell. Cold Spring Harbor Laboratory Press; 3rd Edition, 2001, ISBN: 978-0879695774
2. Principles of Gene Manipulation and Genomics: S. B. Primrose and R. M. Twyman. Wiley- Blackwell Publishers; 7th edition, 2013, ISBN: 978-1405135443

Course Designers

1. Prof. C. Jayaseelan Murugaiyan. Professor, Dept. of Biological Sciences. SRM University – AP.

Biotechnology Lab

Course Code	BIO	Course Category	Core course (CC)			
			L	T	P	C
			0	0	4	4
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)		
Course Offering Department	Biological Sciences	Professional / Licensing Standards				

Course Objectives / Course Learning Rationales (CLRs)

- To develop proficiency in core genetic engineering workflows using yeast as a model system, moving from gene disruption to complementation and localisation. This provides a complete, industry-relevant skill set in designing, executing, and troubleshooting a multi-week molecular biology project.
- To build advanced competence in protein analysis and sub-cellular fractionation, shifting from basic molecular biology to the analytical and cell biological techniques required for functional genomics and biochemical research.
- To cultivate the ability to generate and integrate multiple lines of experimental evidence (phenotypic selection, PCR, protein expression, and sub-fractionation blots) to conclusively validate a biological hypothesis about gene function and protein localisation.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Execute a complete gene function analysis pipeline in <i>Saccharomyces cerevisiae</i> , including the construction of a gene deletion strain via homologous recombination and its subsequent genetic complementation using a shuttle vector, with verification at the DNA and phenotypic levels.	2,3,4,5,6	80	85
Outcome 2	Perform sub-cellular fractionation of yeast mitochondria into defined compartments (e.g., outer membrane, matrix) and analyse the specific localisation of a target protein within the organelle using immunoblotting techniques.	2,3,4	75	80
Outcome 3	Critically analyse and document a connected series of experiments to build a coherent argument confirming protein localisation, demonstrating the ability to interpret colony PCR, western blot, and fractionation data in a unified biological context.	2,3,4,5	70	90

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)												PSOs		
	POs												PSO 1	PSO 2	PSO 3
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning			
Outcome 1	3	2	2	3	3	2	–	1	1	1	–	2	3	2	2
Outcome 2	3	3	2	2	3	3	–	–	2	2	–	2	2	3	2
Outcome 3	3	3	3	3	3	2	–	2	2	3	1	3	2	2	3

Average	3	2.67	2.33	2.67	3	2.33	–	1	1.67	2	0.33	2	2.33	2.33	2.33
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Course Unitization Plan Lab

Exp No.	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
1	Preparation of gene deletion constructs in yeast via transformation (LiAc method) and homologous recombination			
A.	Designing of PCR primers and performing PCR reactions, verification of PCR product by agarose gel electrophoresis.	15	1,3	1
B.	Transformation in yeast by LiAc-mediated quick transformation.	15	1	1
C.	Homologous recombination in yeast- confirmation of gene knockout cells by selection media and colony PCR	15	1, 3	1
2	Overexpression of selected proteins in yeast and confirmation by Coomassie staining			
A.	Cloning of a mitochondrially-localised gene in a yeast shuttle vector (gTOW59E04-1) (clone back the deleted gene to visualise rescue)	15	1	1
B.	Transformation and expression of protein in yeast cells.	15	1, 2	1
C.	Confirmation of ectopic protein expression by western blot against the tagged epitope (anti-GFP) from whole cell	15	1, 2, 3	1
3	Protein localisation at various sub-mitochondrial components of yeast by western blotting			
A.	Isolation of yeast mitochondria (crude) from respiratory media-grown yeast cells	15	2	1
B.	Detection of the over-expressed protein in crude mitochondria.	15	2, 3	1
Total contact hours			120	

Learning Assessment Lab

Bloom's Level of Cognitive Task	Continuous Learning Assessments (50 %)			End Semester Exam (50 %)
	Experiments (30 %)	Record / Observation Note (10 %)	Viva + Model (10 %)	
Remember	10 %		20 %	10 %
Understand	25 %	30%	30 %	20 %
Apply	35 %	70 %	50 %	30 %
Analyse	10%			20%
Evaluate	10%			10%
Create	10%			10%
Total	100 %	100 %	100 %	100 %

Recommended Resources

1. Protocol book provided.

Course Designers

1. Dr. Writoban Basu Ball, Associate Professor, Department of Biological Sciences, SRM University – AP.

Microbial Biotechnology

Course Code	BIO 502	Course Category	Core Course (CC)			
			L	T	P	C
			2	1	0	3
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)		
Course Offering Department	Biological Sciences	Professional / Licensing Standards				

Course Objectives / Course Learning Rationales (CLRs)

1. Develop expertise in isolating, screening, and enhancing industrially important microbes, alongside exploring metagenomics for biodiversity utilization.
2. Master the production and application of microbial metabolites and products, including primary and secondary metabolites, biofuels, enzymes, antibiotics, and bioplastics, among others.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Describe the techniques for isolating, screening and preservation of industrially important microorganisms.	2	80%	70%
Outcome 2	Understand the production and application of primary and secondary microbial metabolites.	2	70%	65%
Outcome 3	Learn the principles and processes of large-scale fermentation and bioprocessing.	3	70%	65%
Outcome 4	Comprehend the role of microbes in bioremediation and environmental sustainability.	3	70%	65%
Outcome 5	Understand the advanced applications of microbes in plant growth, stress tolerance, and biotechnology innovations.	3	70%	60%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)												PSOs		
	POs												PSO 1	PSO 2	PSO 3
	Scientific and Disciplinary	Analytical Reasoning and	Critical and Reflective	Scientific Reasoning and	Research Related Skills	Modern Tools and ICT Usage	Environment and	Moral, Multicultural	Individual and Teamwork	Communication Skills	Leadership Readiness	Self-Directed and Lifelong			
Outcome 1	3	2	3	3	1	1	2	3	2	3		3	3	1	2
Outcome 2	2	3	3	3	1	1	2		1			3	3	2	2
Outcome 3	2	3	3	2	1	1	3		1			2	3	2	2
Outcome 4	2	2	3	3	1	1	3		1			3	3	2	2
Outcome 5	3	3	3	3	3	1	3	2	1	2		3	3	3	3
Average	2.4	2.6	3	2.8	1.4	1	2.6	2.5	1.2	2.5		2.8	3	2	2.2

Course Unitization Plan Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	Industrially important microbes	5		
	Industrially important microbes	1	1	1,2
	Isolation, screening, and strain enhancement techniques	1	1	1,2
	Preservation methods	2	1	1,2
	Metagenomics - understanding and exploiting microbial diversity	1	1	1,2
Unit 2	Microbial metabolism and products	11		
	Primary and secondary metabolites; Recombinant products	1	1,2	2
	Organic acids, Biosurfactants, chitinous bioresources	1	1,2	2
	Biofuels, Biomass as product	2	1,2	2
	enzymes, melanin, cosmetic products	1	1,2	2
	Mycotoxins, Biofertilizers	1	1,2	2
	biopesticides, biocontrol agents	2	1,2	2
	Antibiotics and L-antibiotics	3	1,2	2
Unit 3	Fermentation and Bioprocessing	9		
	Large scale production	2	1,2,3	2
	Fermentation	2	1,2,3	2
	Bioreactors	3	1,2,3	2
	Upstream and downstream processing.	1	1,2,3	2
	Intracellular and extracellular product accumulation and purification	1	1,2,3	2
Unit 4	Bioremediation	9		
	Role of microbes in environmental sustainability	2	1, 4	2,3,4

	Remediation - Bio, Myco and Phyco- remediation techniques	2	1, 4	2,3,4
	Remediation - Heavy metal, oil contamination, Organic solid wastes	2	1, 4	2,3,4
	Wastewater treatment	3	1, 4	2,3,4
	Advanced applications	11		
Unit 5	Plant growth promoting microbes	2	1, 5	1-5
	Extremophiles for plant stress tolerance	2	1, 5	1-5
	Microbial Biosensors	2	2, 5	1-5
	Bioplastics	1	2, 5	1-5
	Microbial therapeutics	2	2, 5	1-5
	Microbial fuel cells, Recombinant proteins	2	2, 5	1-5
Total Contact Hours		45		

Learning Assessment Theory

Bloom's Level of Cognitive Task	Continuous Learning Assessments (50 %)				End Semester Exam (50 %)
	CLA-1 (10 %)	Mid-1 (15 %)	CLA-2 (10 %)	CLA-3 (15 %)	
Remember	60 %	20 %	20 %	30 %	35 %
Understand	40 %	40 %	40 %	40 %	35 %
Apply	40 %	40 %	40 %	30 %	30 %
Analyse					
Evaluate					
Create					
Total	100 %	100 %	100 %	100 %	100 %

Recommended Resources

1. Microbial Biotechnology: Roles in ecological sustainability and Research. Edited by Pankaj C, Sujata Mani, Preeti Chaturvedi Wiley Publishers; 2023, ISBN: 978-1119834458
2. Microbial Biotechnology: Progress and Trends. Edited by Farshad.D.H, Hongzhang Chen, CRC Press; 1st edition, 2015, ISBN: 978-1482245202
3. Microbial Biomolecules: Emerging approach in agriculture, pharmaceuticals and environment management: Edited by Ajay. K, Muhammad Bilal, Luiz Fernando Romanholo Ferreira, Kumari Madhuree, Elsevier Publishers, 2023, ISBN: 978-0323958509
4. New and future developments in Microbial Biotechnology and Bioengineering: Sustainable Agriculture: Advances in Microbe-based Biostimulants. Edited by Harikesh Singh, Anukool Vaishnav, Elsevier Publishers, 2022, ISBN: 978-0323855785
5. Microbial Products: Applications and Translational Trends, Edited by Mamtesh. S, Gajendra Pratap Singh, Shivani Tyagi, CRC Press, 2022, ISBN: 978-1032308203.

Course Designers

1. a. Dr. Sudeshna Saha, Dept. Of Biological Sciences. SRM University – AP

SEMESTER III

Research Seminar and Report Writing

Course Code		Course Category	SEC			
			L	T	P	C
			3	0	0	3
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)		
Course Offering Department	SEAS	Professional / Licensing Standards				

Course Objectives / Course Learning Rationales (CLRs)

1. Identify and analyze relevant scientific literature to formulate research problems and design appropriate research questions or objectives.
2. Demonstrate effective oral communication and evaluate peer work through seminar presentations.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Identify and review relevant scientific literature to define a clear research problem.	2	80%	75%
Outcome 2	Formulate research questions, objectives, or hypotheses based on critical analysis of existing studies.	4	70%	65%
Outcome 3	Write structured research or project report	4	70%	65%
Outcome 4	Deliver an effective oral presentation of research findings using appropriate visual and verbal communication.	3	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

Program Learning Outcomes (PLO)															
CLOs	POs												PSOs		
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	3	3	2	1	3	3	2			2			
Outcome 2	3	2	3	3	2	1	2	3	2			2			
Outcome 3	3	2	3	3	3	1	3	2	3	3		3			
Outcome 4	3	3	3	3	3	1	3	3	3	3		3			
Average	3	2	3	3	3	1	3	3	3	3		3			

Course Unitization Plan Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	Introduction to Research Writing			
	Define research communication and academic writing	2	1	1
	Types of research writing: reports, proposals, thesis, articles	4	1	1
	Communication strategies based on the audience	3	1	1
Unit 2	Literature Review and Referencing			
	Search scholarly databases	2	1	1,2
	Organize and summarize findings	3	1	1,2
	Use of referencing tools (Mendeley/Zotero) and citation styles (APA, MLA, Chicago)	4	1	1,2,4
Unit 3	Report Writing			
	Construct problem statements, objectives, and hypotheses	3	2,3	1,2
	Design methodology and structure	3	2,3	1,2
	Ethical writing practices and plagiarism check	3	2,3	3
Unit 4	Data Presentation and Interpretation			
	Use of tables, figures, and scientific visuals	5	4	2
	Interpret data and findings logically	4	4	2
Unit 5	Oral Presentation			
	Prepare and deliver effective presentations	4	4	2
	Use of slides, visuals, and speech techniques	3	4	2
	Responding to Q&A	2	4	2
Total Contact Hours			45	

Bloom's Level of Cognitive Task	Continuous Learning Assessments (100 %)							
	CLA-1 (20 %)		CLA-2 (30 %)		CLA-3 (20 %)		CLA-4 (30 %)	
	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Remember	20 %		30 %		20 %		25 %	
Understand	20 %		30 %		25 %		20 %	
Apply	60 %		40 %		25 %		20 %	
Analyse					30 %		35 %	
Evaluate								
Create								
Total	100 %		100 %		100 %		100 %	

Recommended Resources

1. Access to online journals and academic databases
2. Tools: Mendeley/Zotero, Grammarly, MS Word, PowerPoint
3. Plagiarism checking software (Turnitin or similar)
4. Reference style manuals (APA/MLA/Chicago)

Course Designers

1. Dr. Prateek Gupta, Assistant Professor, Dept. of Biological Sciences. SRM University – AP

Design Thinking

Course Code	Course Category	AEC		L	T	P	C
				2	0	0	2
Pre-Requisite Course(s)	Co-Requisite Course(s)	Progressive Course(s)					
Course Offering Department	Professional / Licensing Standards						

Course Objectives / Course Learning Rationales (CLRs)

1. Introduce the principles and process of Design Thinking for solving complex problems.
2. Enable students to empathize with users and define real needs.
3. Facilitate ideation, prototyping, and testing in a user-centered framework.
4. Enhance students' ability to innovate within constraints and collaborate across domains.
5. Promote design as a mindset applicable to any professional and personal challenge.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Understand the principles and phases of the Design Thinking process	2	75%	70%
Outcome 2	Apply empathy to identify real-world problems from a user's perspective	3	70%	65%
Outcome 3	Apply structured ideation techniques to generate innovative ideas	3	70%	65%
Outcome 4	Apply prototyping methods to visualize solutions and gather user feedback	3	65%	60%
Outcome 5	Understand the relevance of design thinking for personal and professional problem-solving	2	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

Program Learning Outcomes (PLO)															
CLOs	POs												PSOs		
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	2	2	2	3	1	1					2	2			
Outcome 2		3	3	3	2	1	2	2	2	2	2	2	2		
Outcome 3	1	3	3	3		1		2	2		2		2	2	
Outcome 4		2	2	3	2	2		2	2	2	2	2	2		
Outcome 5	2	2	3	2			2	2	2	2	3	2		2	
Average	1.4	2.4	2.6	2.8	1.4	1.2	0.4	0.8	2	1.6	1.2	2.2	2	1.2	1

Course Unitization Plan Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	Introduction to Design Thinking	2	1,5	1,2
	History	1	1,5	
	Principles		1,5	
	Design for research impact	1	1,5	
	Design thinking mindset and Science communication		1,5	
Unit 2	Empathy & Problem Discovery	2	2	2,3
	User needs in healthcare, environment, industry	1	2	
	Journey maps, Empathy maps	1	2	
Unit 3	Defining Problem Statements	2	2	1,2
	Synthesizing insights	1	2	
	Cross-disciplinary problem scoping	1	2	
	HMW questions		2	
Unit 4	Ideation Techniques	2	3	1,3
	Divergent/convergent thinking	1	3	
	Brainstorming, Innovative approaches in scientific design	1	3	
	SCAMPER, Crazy 8s		3	
Unit 5	Prototyping	2	4	2,3
	Types of prototypes		4	
	Rapid prototyping		4	
	Low vs. high fidelity		4	
Unit 6	Testing	2	4	2,3

	User testing		4	
	Feedback loops		4	
	Iteration		4	
Unit 7	Design Research	2	2,4	2,3
	Qualitative & quantitative methods		2,4	
	Field research		2,4	
	Insight synthesis		2,4	
Unit 8	Systems Thinking	2	1,5	4
	System maps,		1,5	
	Causal loops		1,5	
	Systemic design challenges		1,5	
Unit 9	Innovation & Creativity	2	3,5	1,5
	Creativity tools		3,5	
	barriers to innovation		3,5	
	TRIZ, Blue Ocean strategy			
Unit 10	Storytelling & Communication	2	5	3
	Storyboarding		5	
	Business pitch storytelling		5	
	Visual communication			
Unit 11	Human-Centered Design	2	2,5	2
	Inclusive design		2,5	
	Accessibility		2,5	
	Ethics in design			

Unit 12	Scaling & Implementation,	2	4,5	1
	Real-world application		4,5	
	scalability, feasibility analysis		4,5	
Unit 13	Case Studies	2	4,5	
	Real-world DT examples,		4,5	
	Failures and insights, social innovation		4,5	
Unit 14	Capstone Project Work	2	2,3,4,5	2,3
	Team project execution using DT process,		2,3,4,5	
	Mentor feedback		2,3,4,5	
Unit 15	Final Showcase & Reflection	2	5	3
	Presentation		5	
	Self-evaluation		5	
	Peer feedback, Reflection journals		5	

Learning Assessment Theory

Bloom's Level of Cognitive Task	Continuous Learning Assessments (50 %)				End Semester Exam (50 %)
	CLA-1 (20 %)	Mid-1 (10 %)	CLA-2 (20 %)	CLA-3 (0 %)	
Remember	10 %		10 %	5 %	20 %
Understand					
Apply	10 %		10 %	5 %	20 %
Analyse					
Evaluate					10 %
Create					
Total	20 %		20 %	10 %	50 %

Recommended Resources

1. Change by Design – Tim Brown
2. Stanford d.school Bootcamp Bootleg
3. Tom Kelley & David Kelley, Creative Confidence
4. Donella Meadows, Thinking in Systems

Other Resources

1. The Lean Startup, Eric Ries, Introduces prototyping, iteration, and customer feedback for innovation. –Book

2. Harvard Business Review: Design Thinking, Tim Brown / Jeanne Liedtka, Scholarly and business cases showing DT in action.
– Article/Case

3. <https://dschool.stanford.edu/>, Stanford d.school, Free resources, guides, and case studies from the leaders in DT education. –
Website

Course Designers

1. Dr. Soumyajyoti Biswas, Assistant Professor, Dept. of Physics, SRM University- AP
2. Dr. Supravat Dey, Assistant Professor, Dept. of Physics, SRM University- AP
3. Dr. Jatis Kumar Dash, Associate Professor, Dept. of Physics, SRM University- AP

Plant and Animal Biotechnology

Course Code	BIO 512	Course Category	Core Course (CC)				L	T	P	C
							3	1	0	4
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)						
Course Offering Department	Biological Sciences	Professional / Licensing Standards								

Course Objectives / Course Learning Rationales (CLRs)

1. Develop expertise in plant tissue culture and genetic manipulation for enhanced crop production and secondary metabolite synthesis.
2. Gain a comprehensive understanding of animal cell culture, transgenic animal production, and vaccine development, while addressing ethical implications in biotechnological applications.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Proficiency in plant tissue culture for agricultural and biotechnological purposes.	2	75%	70%
Outcome 2	Mastery of plant genetic engineering techniques for trait modification and biotechnological innovation.	3	75%	70%
Outcome 3	Skill in culturing mammalian cells for biomedical research and drug testing.	3	70%	65%
Outcome 4	Understanding of transgenic animal production and vaccine development for human and animal health.	3	70%	65%
Outcome 5	Awareness of animal biotechnology applications and ethical considerations in biotechnological research.	3	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	POs											PSOs			
	Scientific and Disciplinary	Analytical Reasoning and	Critical and Reflective	Scientific Reasoning and	Research Related Skills	Modern Tools and ICT Usage	Environment and	Moral, Multicultural	Individual and Teamwork	Communication Skills	Leadership Readiness	Self-Directed and Lifelong	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	3	3	2	1	1	2	2			2	2	3	2
Outcome 2	3	3	3	3	3	1	3	3	2			2	2	3	3
Outcome 3	3	3	3	3	3	1	2	2	3			3	3	3	2
Outcome 4	3	3	3	3	3	1	2	3	3			3	3	2	3
Outcome 5	3	3	3	3	3	2	3	3	3	2		3	3	3	3
Average	3	3	3	3	2.8	1.2	2.2	2.6	2.6	2		2.6	2.6	2.8	2.6

Course Unitization Plan Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	Plant tissue culture	15		
	Plant tissue culture media	1	1,2	3
	Totipotency; Pluripotency	1	1,2	3
	Establishment of cultures, Somatic embryogenesis: somaclonal variation, frequency selection, application and limitation	2	1,2	3
	Somatic hybridization: Isolation of protoplast, methods, major fusogens, other fusogens, identification & selection of protoplast.	3	1,2	3
	Production of Haploid Plants: Anther culture (androgenesis), Pollen culture and Ovary culture	2	1,2	3
	Organogenesis	2	1,2	3
	Germplasm conservation and cryopreservation	1	1,2	3
	Synthetic seed production	1	1,2	3
	Plant cell cultures for secondary metabolite production	1	1,2	3
	National certification and Quality management of TC plants	1	1,2	3
Unit 2	Plant genetic manipulation	15		
	Agrobacterium-plant interaction, virulence, Ti and Ri plasmids	2	1,2	3
	opines and their significance, T- DNA transfer, disarmed Ti plasmid	2	1,2	3
	Genetic transformation: Agrobacterium tumefaciens- mediated gene delivery, cointegrate and binary vectors and their utility	2	1,2	3
	Hairy root culture	1	1,2	3
	Direct gene transfer: PEG-mediated, electroporation, particle bombardment and alternative methods	2	1,2	3
	Screenable and selectable markers	1	1,2	3
	Characterization of transgenics	1	1,2	3
	Chloroplast transformation	1	1,2	3
Marker-free methodologies; advanced methodologies - cisgenesis, intragenesis and genome editing	1	1,2	3	

	Molecular pharming - concept of plants as biofactories, production of industrial enzymes and pharmaceutically important compounds	2	1,2	3
Unit 3	Animal cell cultures	10		
	Culture conditions: Preparation, sterilization, and composition of media	2	3,4	1,2
	Role of carbon dioxide, serum, antibiotics & growth factors in cell culture.	2	3,4	1,2
	Types: primary culture, secondary culture, continuous cell lines, suspension cultures	2	3,4	1,2
	Culturing and maintenance of mammalian cells, tissues, and organs	2	3,4	1,2
	Application of animal cell culture for virus isolation and in vitro testing of drugs	2	3,4	1,2
Unit 4	Transgenic animals and Vaccines	10		
	Transgenic animals: Method of obtaining transgenic animals using fertilized eggs and embryonic blastocyst cells.	2	3,4	1,2
	Animal models for understanding human diseases	2	3,4	1,2
	Animal cloning: Methods of cloning in animal system – rat, sheep, pig	2	3,4	1,2
	Vaccines: strategies, conventional methods of animal vaccine production	2	3,4	1,2
	Recombinant vaccines	2	3,4	1,2
Unit 5	Animal biotechnology applications and ethics	10		
	Gene therapy	2	4,5	1,2
	Cell mediated therapy: Antisense technology	2	4,5	1,2
	Stem cell technology	1	4,5	1,2
	Tissue engineering	2	4,5	1,2
	Gene drive.	1	4,5	1,2
	Ethical issues in Animal Biotechnology	2	4,5	1,2

Learning Assessment Theory

Bloom's Level of Cognitive Task	Continuous Learning Assessments (50 %)								End Semester Exam (50 %)	
	CLA-1 (15 %)		Mid-1 (25 %)		CLA-2 (25 %)		CLA-3 (15 %)			
	Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Remember	60 %		60 %		20 %		30 %		30 %	
Understand	40 %		40 %		20 %		30 %		30 %	

Apply					60 %		40 %		40 %	
Analyse										
Evaluate										
Create										
Total		100 %		100 %		100 %		100 %		100 %

Recommended Resources

1. Textbook of Animal Biotechnology: Carlos Wyatt, Syrawood Publishing House; 2016, ISBN: 978-1682860670.
2. Principles of Gene Manipulation and Genomics: Sandy B. Primrose, John Wiley Blackwell; 7th edition, 2014, ISBN-13: 978-1405135443.
3. Handbook of Plant Biotechnology: Zoe Eastwood, Callisto Reference; 2019, ISBN-13: 978- 1641161114

Course Designers

1. Prof. C. Jayaseelan Murugaiyan. Professor, Dept. Of Biological Sciences. SRM University – AP.

Bioinformatics lab

Course Code	BIO	Course Category	Core course (CC)			
			L	T	P	C
			0	0	2	2
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)		
Course Offering Department	Biological Sciences	Professional / Licensing Standards				

Course Objectives / Course Learning Rationales (CLRs)

1. Develop practical skills in mammalian cell culture, biosynthesis, biocatalysis, and microbial biomass production for applications in biotechnology.
2. Gain proficiency in bioinformatics tools and techniques, including database exploration, sequence analysis, molecular docking, and phylogenetic analysis using programming environments.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Work in Linux operating system environment	2	60	50
Outcome 2	Capable of accessing biological databases and retrieve necessary information for a given task	2	70	60
Outcome 3	Design and implement new biological data analysis	3	70	60
Outcome 4	Explore different web-applications for a given task, analyse the results and select the best suitable approach	3	70	60

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

Program Learning Outcomes (PLO)															
CLOs	POs												PSOs		
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	2	1	2	1	2	2			2	1		2	1	2	3
Outcome 2	1	3	3	2	2	1			1	2		2	2	3	2
Outcome 3	2	2	3	3	3	1			2	2		2	3	2	2
Outcome 4	1	2	2	2	3	1			1	2		2	3	2	3
Average	1.5	2	2.5	2	2.5	1.25			1.5	1.75		2	2.25	2.25	2.5

Course Unitization Plan Lab

Exp No.	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
1	Operating systems and setting up programming environments	5	1	1
2	Exploring NCBI databases: Genome, Gene, Protein, Taxonomy, SNP, HomoloGene.	5	1,2	2,3,4
3	Programmatically parsing the Sequence and Structure files of biomolecules	5	1,2,3	1,2,5
4	Identification of macromolecular interfaces and exploring different approaches: Solvent accessible surface, distance-based methods	5	3,4	1,3,5
5	Torsion angle calculations for protein molecules using core python programming, using biopython library and Pymol	5	3,4	1,2,4
6	Phylogenetic analysis	5	3,4	2,4
7	Molecular docking using SwissDock and Autodock, and characterization of docked structures	5	1,3,4	1,5
8	Design, develop and deploy a web-application	5	2,3	1,3
9	Machine learning in bioinformatics: Train, test and predict and understanding model metrics.	5	2,3,4	2,3
10	Molecular Dynamics simulations and trajectory analysis	5	3,4	1,7
11	Transcriptome data analysis using R	5	2,4	1,6,8
12	Genome assembly and annotation	5	2,3,4	5,6,8
	Total	60		

Learning Assessment Lab

Bloom's Level of Cognitive Task	Continuous Learning Assessments (100 %)		
	Experiments (40 %)	Record / Observation Note (20 %)	Viva + Model (40 %)
Remember	50 %		50 %
Understand			
Apply	50 %	100 %	50 %
Analyse			
Evaluate			
Create			
Total	100 %	100 %	100 %

Recommended Resources

1. Bioinformatics Programming Using Python. by Mitchell L. Model. Publisher(s): O'Reilly Media, Inc. ISBN: 9780596154509.
2. Python Machine Learning: Machine learning and Deep learning with Python, scikit-learn and TensorFlow2. 3rd edition, Sebastian .R and Vahid .M, 2019, Packt publishers. ISBN: 9781787125933
3. Learn to code: learn HTML, CSS & JavaScript & build a website, app and game. Garry Owen, 2022, WDD TRW publishers. ISBN: 979-8417818691
4. Bioinformatics for beginners: Genes, genomes, molecular evolution, databases and analytical tools. Supratim. C (2014). Academic Press.
5. Structural Bioinformatics tools for drug design: Extraction of biologically relevant information from structural databases. Jaroslav. K (2016). Springer publishers.
6. Translational Bioinformatics for therapeutic development: Methods and Protocols. Joseph. M (2021). Humana Press.
7. Computational methods to study the structure and dynamics of biomolecules and biomolecular processes: From Bioinformatics to molecular quantum mechanics. 2nd edition. Adam. L (2019). Springer publishers.
8. Methods in Molecular Biology: RNA bioinformatics. Ernesto Picardi (2015). Humana Press.

Course Designers

Dr. Nagabhushana Rao Karampudi, Assistant Professor, Department of Biological Sciences, SRM University – AP.

Immunology

Course Code	BIO 551	Course Category	Core Elective (CE)				L	T	P	C
							2	1	0	3
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)						
Course Offering Department	Biological Sciences	Professional / Licensing Standards								

Course Objectives / Course Learning Rationales (CLRs)

- Understand the development, components, and functions of the immune system, including innate and adaptive immunity.
- Analyze the mechanisms of autoimmunity, hypersensitivity, immune evasion by pathogens, and cancer immunology.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Explain the structure and function of the immune system, including the roles of antigens and immunoglobulins.	2	80%	75%
Outcome 2	Describe the mechanisms of innate and adaptive immunity, including the complement system and T-cell activation.	3	70%	65%
Outcome 3	Identify and classify autoimmune diseases, hypersensitivity reactions, and the principles of transplantation and vaccination.	4	70%	65%
Outcome 4	Analyze how pathogens evade immune defenses and the implications of immunodeficiency diseases.	2	70%	65%
Outcome 5	Understand the relationship between the immune system and cancer, including tumor antigens and immunotherapy strategies.	2	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

Program Learning Outcomes (PLO)															
CLOs	POs												PSOs		
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	3	3	1	1	3	3	3	3		2	3	1	2
Outcome 2	3	2	3	3	2	1	3		1			2	3	2	2
Outcome 3	3	2	3	3	3	1	3		1			2	3	2	2
Outcome 4	3	2	3	3	3	1	3		1			2	3	2	2
Outcome 5	3	2	3	3	3	3	2		2			3	3	2	2
Average	3	2	3	3	2.4	1.4	2.8	3	1.6	3		2.2	3	1.8	2

Course Unitization Plan Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	Overview of the Immune System	9		
	Overview of the Immune system, Innate and Adaptive immunity: Cells and organs involved	2	1	1, 2
	Properties of antigens. Immunoglobulins: structure, function, genes, and diversity	3	1	1, 2
	Humoral and cell mediated immunity.	2	1	1, 2
	Monoclonal and polyclonal antibodies. Antigen-Antibody interactions.	2	1	1, 2
Unit 2	Innate and Adaptive Immunity	10		
	Innate immunity - Innate immune receptors, PAMPs and DAMPs.	1	1, 2	1, 2
	Inflammation - Cytokines, Chemokines.	1	1, 2	1, 2
	Complement system and activation pathways.	1	1,2	1, 2
	Adaptive immunity - B cell: Plasma and memory cells, Antigen processing and presentation.	1.5	2	1, 2
	T cell - activation, TCR gene rearrangement, superantigens.	1.5	2	1, 2
	T-cell cytotoxicity, Major histocompatibility complex, MHC restriction.	1.5	2	1, 2
	HLA typing and disease association.	1	2	1, 2
Cell-mediated effector functions.	1.5	2,4	1, 2	
Unit 3	Autoimmunity and Hypersensitivity	9		
	Organ specific and systemic autoimmune diseases, induction mechanisms.	2	1,3,4	1, 2
	Gell and Coombs Classification. Hypersensitivity reactions.	3	1,3,4	1, 2
	Transplantation - Graft rejection, clinical manifestations, immunosuppressive therapy, and privileged sites.	2	1,3,4	1, 2
	Vaccines - active and passive			
Unit 4	Immunization, types of vaccines.	2	1,3,4	1, 2
	Immune Evasion	9		

	Immunodeficiency diseases.	1	4	1, 2
	Evasion and subversion of immune defences- Intracellular and Extracellular pathogens.	2.5	4	1, 2
	Immune evasion by bacteria (tuberculosis).	1.5	4	1, 2
	Immune evasion by parasites (malaria).	2	4	1, 2
	Immune evasion by viruses (HIV).	2	4	1, 2
	Cancer Immunology	8		
Unit 5	Cancer and immune system.	1	1,5	2,3
	Terminology and common types of cancer.	1	1,5	2,3
	Malignant transformation of cells.	2	1,5	2,3
	Tumor antigens, Immune response to cancer.	2	1,5	2,3
	Cancer Immunotherapy.	2	1,5	2,3

Learning Assessment Theory

Bloom's Level of Cognitive Task	Continuous Learning Assessments --%				End Semester Exam --%
	CLA-1 --%	Mid-1 --%	CLA-2 --%	CLA-3 --%	
Remember	35	30	20	30	35
Understand	35	30	20	30	35
Apply	30	40	30	40	15
Analyse			30		15
Evaluate					
Create					
Total	100%	100%	100%	100%	100%

Recommended Resources

1. Kuby Immunology. T. Kindt, R. Goldsby, B. A. Osborne, W. H. Freeman. 8th edition. 2018. ISBN: 978-1319114701.
2. Basic Immunology: Functions and Disorders of the Immune System. Abul K. Abbas, Andrew H. Lichtman, Saunders. Elsevier; 4th edition, 2016. ISBN: 978-1455707072.
3. Janeway's Immunobiology: Kenneth Murphy, Casey Weaver, Garland Science; 9th edition, 2016. ISBN: 978-0815345503.

Course Designers

1. Dr. Writoban Basu Ball, Assistant Professor, Department of Biological Sciences, SRM University – AP.

Programming and Computational Biology

Course Code	BIO 554	Course Category	Core Course (CC)				L	T	P	C
							2	1	0	3
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)						
Course Offering Department	Biological Sciences	Professional / Licensing Standards								

Course Objectives / Course Learning Rationales (CLRs)

1. Develop proficiency in programming languages Python and Rust, including object-oriented programming and utilization of key libraries like pandas and biopython for scientific computing.
2. Implement algorithms for scientific tasks and apply programming skills in DNA/protein sequence analysis and transcriptome data processing using Python and related tools.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Master Python and Rust programming with pandas, biopython, and parallel computing skills.	3	80	60
Outcome 2	Implement advanced algorithms for scientific tasks and automate DNA/protein sequence analysis.	3	70	50
Outcome 3	Deploy web servers using NGINX, develop web applications with PHP, HTML, CSS, JavaScript, Django, and Actix-web.	4	60	50
Outcome 4	Utilize Python's scikit-learn for data handling, feature extraction, and prediction model training.	3	70	60
Outcome 5	Develop SQL databases like PostgreSQL and MariaDB, integrating them with programming languages for efficient data management.	4	70	60

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

Program Learning Outcomes (PLO)															
CLOs	POs												PSOs		
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	3	3	1	1	3	3	3	3		2	3	1	2
Outcome 2	3	2	3	3	2	1	3		1			2	3	2	2
Outcome 3	3	2	3	3	3	1	3		1			2	3	2	2
Outcome 4	3	2	3	3	3	1	3		1			2	3	2	2
Outcome 5	3	2	3	3	3	1	3		1			2	3	2	2
Average	3	2	3	3	2.4	1	3	3	1.4	3		2	3	1.8	2

Course Unitization Plan Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	Fundamentals	10		
	Operating systems and programming environments.	2	1	1,3
	Selection of apt programming language for a task. Programming languages: Python, Rust.	2	1	1,3
	Fundamentals of python programming, Object Oriented programming;	2	1	1,3
	Libraries: pandas, biopython, scikit, matplotlib.	2	1	1,3
	Parallel programming libraries: MP, MPI, NVIDIA-CUDA.	2	1	1,3
Unit 2	Programming	15		
	Version control	2	1,2	1,3
	Evaluating the Pros and Cons of Rust versus Python	3	1,2	1,3
	Implementation of algorithms: Torsion angle calculation, Detection of interface atoms in protein complexes.	5	1,2	1,3
	Performing DNA and Protein Sequence searches and automating the processes using programming.	5	1,2	1,3
	Transcriptome data analysis using python-pandas library		1,2	1,3
Unit 3	Web-applications and webservers	10		
	Advantages and limitations of webservers in research.	2	1,2,3	1,4
	Deploying a webserver using NGINX: in Linux and Windows.	2	1,2,3	1,4
	PHP, HTML, CSS and JavaScript.	2	1,2,3	1,4
	Deploying a web-application.	2	1,2,3	1,4
	Introduction to Python's Django web framework and Rust's Actix-web framework	2	1,2,3	1,4
Unit 4	Prediction models and classifiers	10		
	Data handling	3	1,4	1,2
	Feature extraction.	2	1,4	1,2

	Training and Test datasets,	3	1,4	1,2
	Python scikit-learn to train classification and prediction models	2	1,4	1,2
Unit 5	Development of databases	15		
	Advantages of databases.	3	5	4
	Structured Query Language (SQL): PostgreSQL, MariaDB.	2	5	4
	Creating interface between programming languages and databases.	5	5	4
	Developing a database.	5	5	4
Total Contact Hours		60		

Learning Assessment Theory

Bloom's Level of Cognitive Task	Continuous Learning Assessments (60 %)				End Semester Exam (40 %)
	CLA-1 (15 %)	Mid-1 (15 %)	CLA-2 (15 %)	CLA-3 (15 %)	
Remember	40 %	30 %	30 %	40 %	30 %
Understand	60 %	30 %	30 %	30 %	30 %
Apply		40 %	40 %	30 %	40 %
Analyse					
Evaluate					
Create					
Total	100 %	100 %	100 %	100 %	100 %

Recommended Resources

1. Parallel programming for modern high performance computing systems: Pawet Czarnul, CRC Press; 1st edition, 2013, ISBN: 978-0367572129
2. Python Machine Learning: Machine learning and Deep learning with Python, scikit-learn and TensorFlow2: Sebastian. R and Vahid .M, Packt publishers; 3 rd edition, 2019, ISBN: 978- 1787125933
3. Learn to code: learn HTML, CSS & JavaScript & build a website, app and game: Garry Owen, TRW publishers; 2022, ISBN: 979-8417818691
4. Database System Concepts (7th Edition). Abraham Silberschatz, Henry F. Korth, S. Sudarshan. (2021). McGraw Hill. ISBN-13 978-9390727506.

Course Designers

Dr. Nagabhushana Rao Karampudi, Assistant Professor, SRM University-AP.

Molecular Mechanisms of Diseases

Course Code	BIO 557	Course Category	Core Elective (CE)				L	T	P	C
							2	1	0	3
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)						
Course Offering Department	Biological Sciences	Professional / Licensing Standards								

Course Objectives / Course Learning Rationales (CLRs)

- Understand microbial, viral, systemic, neurological, and plant diseases, including their classification and therapeutic strategies.
- Learn the mechanisms of action for antimicrobial, antiviral, and antifungal drugs, and principles of disease management and pathogen impact on hosts.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Understand mechanisms and therapies for bacterial, fungal, and protozoan infections.	2	75%	70%
Outcome 2	Learn about viral diseases, HIV molecular biology, and antiviral treatments.	3	70%	65%
Outcome 3	Study systemic diseases like diabetes and cystic fibrosis, focusing on pathogenesis and treatment.	3	70%	65%
Outcome 4	Comprehend mechanisms and treatments for neurological disorders like Alzheimer's and Parkinson's.	4	70%	65%
Outcome 5	Understand plant disease classification, symptoms, control methods, and pathogen effects on hosts.	3	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

Program Learning Outcomes (PLO)															
CLOs	POs												PSOs		
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	3	3	1	1	3		3			2	3	1	2
Outcome 2	3	2	3	3	2	1	3		1			2	3	2	2
Outcome 3	3	2	3	3	3	1	3		1			2	3	2	2
Outcome 4	3	2	3	3	3	1	3		1			2	3	2	2
Outcome 5	3	2	3	3	3	3	2		2			3	3	2	2

Average	3	2	3	3	2.4	1.4	2.8		1.6			2.2	3	1.8	2
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Course Unitization Plan Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	Common Microbial Diseases and Therapeutics	9		
	Introduction to human microbial infections	1	1	1
	ESKAPEE pathogens and <i>Mycobacterium tuberculosis</i>	1	1	1
	Fungal (<i>Candida albicans</i>) and protozoan (Malaria) infections	1	1	1
	Mechanistic action of antimicrobial drugs: inhibitors of cell wall synthesis, inhibitors of protein synthesis, inhibitors of nucleic acid synthesis, competitive inhibitors, antifungal, anti-protozoan drugs	6	1	1
Unit 2	Viral Diseases	9		
	Viral diseases	1	2	1
	Coronavirus, Retroviruses	2	2	1
	Molecular biology of HIV	2	2	1
	Viral vaccine strategies, antiviral therapy	4	2	1
Unit 3	Systemic Diseases	9		
	Diabetes mellitus (Type 1 and 2)	2	3	2
	Rheumatoid arthritis	2	3	2
	Atherosclerosis	2	3	2
	Cystic fibrosis	2	3	2
	Sickle cell anaemia	1	3	2
Unit 4	Neurological Disorders	9		
	Neurological disorders	1	4	3
	Prions	1	4	3
	Alzheimer's disease	2	4	3

	Multiple sclerosis	1	4	3
	Parkinson's disease	1	4	3
	Huntington's disease	1	4	3
	Degenerative diseases of motor neurons	2	4	3
	Plant Diseases			
Unit 5	Classification of plant diseases, symptoms, signs	1	5	4
	Biological control of plant diseases caused by fungi, viruses, bacteria, and nematodes	5	5	4
	Effects of pathogens on host physiological processes: photosynthesis, respiration, absorption, growth and reproduction	3	5	4
Total Contact Hours		45		

Learning Assessment Theory

Bloom's Level of Cognitive Task	Continuous Learning Assessments (50 %)				End Semester Exam (50 %)
	CLA-1 (10 %)	Mid-1 (15 %)	CLA-2 (10 %)	CLA-3 (15 %)	
Remember	35 %	20 %	30 %	20 %	35 %
Understand	35 %	40 %	30 %	40 %	35 %
Apply	30 %	40 %	60 %	40 %	30 %
Analyse					
Evaluate					
Create					
Total	100 %	100 %	100 %	100 %	100 %

Recommended Resources

1. Medical Microbiology by Patrick Murray, Ken Rosenthal, Michael Pfaller, Elsevier, 2020, ISBN: 9780323674508
2. Robbins and Cotran Pathologic Basis of Disease Professional, Vinay Kumar, Abul K. Abbas, Jon C. Aster, Elsevier, 2015, ISBN 9781455726134
3. Bradley and Daroff's Neurology in clinical practice Author(s): Joseph Jankovic, John C. Mazziotta, Scott L. Pomeroy, Nancy J. Newman Publisher: Elsevier Year: 2021
4. Plant pathology concepts and laboratory exercises by Ownley, Bonnie H.; Trigiano, Robert Nicholas, CRC Press, 2017

Course Designers

Dr. Kaushik Saha, Assistant Professor, Department of Biological Sciences, SRM University – AP.

Genomics and Proteomics

Course Code	BIO 556	Course Category	Core Elective (CE)				L	T	P	C
							2	1	0	3
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)						
Course Offering Department	Biological Sciences	Professional / Licensing Standards								

Course Objectives / Course Learning Rationales (CLRs)

1. Gain a comprehensive understanding of structural and functional genomics, including genomic sequencing methods, expression profiling, and genome technologies.
2. Gain knowledge in proteomics, including protein separation, mass spectrometry, and bioinformatics tools for gene and protein analysis.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Understand genomic data and interpret sequencing methods, global expression profiling, and genome projects theoretically.	2	75%	70%
Outcome 2	Apply theoretical concepts of advanced genomic technologies and microarrays for understanding gene expression and SNP analysis.	3	70%	65%
Outcome 3	Gain theoretical knowledge of proteomic techniques such as protein separation, mass spectrometry, and quantitative analysis.	3	70%	65%
Outcome 4	Utilize theoretical frameworks and bioinformatics tools for protein identification, functional annotation, and protein interactions.	4	70%	65%
Outcome 5	Integrate understanding of genomic and proteomic databases to interpret data, identify candidate genes, and understand protein functions.	4	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

Program Learning Outcomes (PLO)															
CLOs	POs												PSOs		
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	3	3	1	1	3		3			2	3	1	2
Outcome 2	3	2	3	3	2	1	3		1			2	3	2	2
Outcome 3	3	2	3	3	3	1	3		1			2	3	2	2
Outcome 4	3	2	3	3	3	1	3		1			2	3	2	2
Outcome 5	3	2	3	3	3	3	2		2			3	3	2	2
Average	3	2	3	3	2.4	1.4	2.8		1.6			2.2	3	1.8	2

Course Unitization Plan Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	Structural and Functional Genomics	10		
	Genomics – History, Importance of genomics level analysis;	2	1	1-2
	Sequence methods and strategies at various levels – DNA, RNA, protein, metabolites, and phenotype;	2	1	1-2
	Global expression profiling, whole genome analysis and protein expression, microarray analysis,	2	1	1-2
	Genome projects and genome research databases.	2	1	1-2
	Structural, functional, and comparative genomics.	2	1	1-2
Unit 2	Genome Technologies	10		
	Technologies used in Genomics -RFLP, Next Generation sequencing,	2	2,3	1-5
	Microsatellite markers, STS, EST, DNA microarray. .	1	3,4	1-5
	Gene expression profiling, Identification of SNPs, SNPs data bases (DbSNP).	1	3,4	1-5
	Sequence alignment: Global, Local, Pairwise, MSA.	2	3,4	1-5
	Secondary structure predictions-Algorithms, Chao-Fasman Algorithm, Hidden-Markov model	2	3,4	1-5
	Primer designing softwares for PCR analysis	2	3,4	1-5
Unit 3	Proteomics	8		
	Definition of proteomics, goals. Fundamentals of protein and peptide separation techniques,	2	1-3	1-2
	Proteomic approaches (gel based and non-gel based), sample preparation, 1D electrophoresis (SDS-PAGE),	1	3,4	1-4
	2D Gel electrophoresis (2D-PAGE), Differential Gel electrophoresis (2D-DIGE),	2	3,4	1-4
	Staining techniques,	1	3,4	1-4
	Qualitative and Quantitative proteomic analysis	2	3,4	1-4
Unit 4	Proteomic Techniques	8		
	Mass spectrometry: peptide fragmentation mechanisms,	2	1-3	1-2

	Mass spectra and identification of proteins, Search Engine-Mascot.	2	3,4	1-4
	Proteomics of un-sequenced organisms (denovo sequencing approach),	2	3,4	1-4
	Application of qualitative proteomics e.g., microbial species identification.	2	3,4	1-4
Unit 5	Databases and analysis	9		
	Protein arrays- Principles.	1	4,5	1-5
	Interactional proteomics- Gene Ontology (GO) annotation,	1	4,5	1-5
	Proteomics database and their applications.	1	4,5	1-5
	ID mapping for protein accession number. Usage of softwares in understanding function of Genes and Proteins.	1	4,5	1-5
	Protein-protein interaction analysis- STRING, MINT, DIP.	2	4,5	1-5
	Candidate gene identification - concept, tools and OMIM database	2	4,5	1-5
	Reference genome sequences, integrated genomic maps	1	4,5	1-5

Learning Assessment Theory

Bloom's Level of Cognitive Task	Continuous Learning Assessments --%				End Semester Exam --%
	CLA-1 --%	Mid-1 --%	CLA-2 --%	CLA-3 --%	
Remember	35	30	20	30	35
Understand	35	30	20	30	35
Apply	30	40	30	20	15
Analyse			30	20	15
Evaluate					
Create					
Total	100%	100%	100%	100%	100%

Recommended Resources

1. Current topics in computational molecular biology: Jiang, Tao, Ying Xu, and Michael Q. Zhang, MIT Press; 1st edition, 2002., ISBN: 978-0262100922
2. Bioinformatics: sequence and genome analysis; David mount, Cold Spring Harbor Laboratory Press,U.S; 2nd edition, 2005, ISBN: 978-8123912417
3. Principles of gene manipulation and genomics: Primrose, Sandy B, John Wiley Black well, 2014, ISBN: 978-8126548392
4. Bioinformatics and functional genomics: Pevsner Jonathan, Wiley & Blackwell; 3rd edition, 2015, ISBN: 978-1118581780
5. Current topics in computational molecular biology: Jiang, Tao, Ying Xu, and Michael Q. Zhang, MIT Press; 1st edition, 2002., ISBN: 978-0262100922

Course Designers

1. Prof. Jayaseelan Murugaiyan, Professor, Department of Biological Sciences, SRM University – AP.
2. Dr. Naga Bhushana Rao Karampudi, Assistant Professor, Department of Biological Sciences, SRM University – AP

Bionanotechnology

Course Code	BIO 507	Course Category	Core Elective (CE)				L	T	P	C
							2	1	0	3
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)						
Course Offering Department	Biological Sciences	Professional / Licensing Standards								

Course Objectives / Course Learning Rationales (CLRs)

1. Provide a comprehensive understanding of nanoparticle properties, synthesis methods, and interactions with cells.
2. Explore techniques for characterizing nanoparticles and their biomedical applications.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Understand the properties, types, and cellular interactions of nanoparticles.	2	80%	75%
Outcome 2	Learn the physical, chemical, and biological methods for synthesizing nanoparticles.	2	80%	75%
Outcome 3	Comprehend the interactions of nanoparticles with eukaryotic and prokaryotic cells, including bio-distribution and cellular responses.	3	70%	65%
Outcome 4	Apply various techniques for characterizing nanoparticles, such as UV-Vis spectrophotometry, TEM, and DLS.	3	70%	65%
Outcome 5	Explore the biomedical applications of nanomaterials in imaging, drug delivery, and disease diagnosis.	3	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

Program Learning Outcomes (PLO)															
CLOs	POs												PSOs		
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	3	3	2	1	3	3	2			2	2	3	2
Outcome 2	3	2	3	3	2	1	2	3	2			2	2	3	2
Outcome 3	3	2	3	3	3	1	3	2	3			3	3	3	3
Outcome 4	3	3	3	3	3	1	3	3	3			3	3	2	3
Outcome 5	3	3	3	3	3	1	2	3	3			3	3	3	3
Average	3	2.4	3	3	2.6	1	2.6	2.8	2.6			2.6	2.6	2.8	2.6

Course Unitization Plan Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	Nanotechnology an Introduction	8		
	Nanoparticles and their properties	2	1,2	1
	Various species of nanomaterials	2	1,2	1
	Morphology dependant selective properties	1	1,2	1
	Surface encapping and exchange mediated differences	1	1,2	1
	Cellular interaction and physicochemical characteristics.	2	1,2	1
Unit 2	Synthesis of Nanomaterials	7		
	Synthesis of nanoparticles – physical, chemical and biological methods	2	1,2	1
	Mechanism of biosynthesis of nanoparticles.	3	1,2	1
	In vitro biomimetic synthesis of nanoparticles	2	1,2	1
Unit 3	Nanoparticle and Cellular interactions	8		
	Interaction of nanoparticles with eukaryotic and prokaryotic cells	2	3	1
	Fate and Transformation of nanomaterials - bio-distribution and cellular responses	2	3	1
	Free radical mediated ROS generation	2	3	1
	DNA damage	1	3	1
	Enzyme degradations.	1	3	1
Unit 4	Characterization of nanoparticles	12		
	UV-Visible spectrophotometer	1	4,5	1,2
	Dynamic Light Scattering (DLS)	1	4,5	1,2
	X-Ray Diffraction (XRD), Transmission electron microscopy (TEM)	3	4,5	1,2
	Atomic force microscopy (AFM), and Fourier- transform infrared spectroscopy (FTIR)	2	4,5	1,2

	Analytical techniques - Disk diffusion assay (DDA)	1	4,5	1,2
	Minimum inhibitory concentration (MIC), Minimum bactericidal concentration (MBC)	1	4,5	1,2
	MTT Assay, Live-Dead Staining	1	4,5	1,2
	Lactose dehydrogenase assay, ROS staining	1	4,5	1,2
	Necrosis factors	1	4,5	1,2
	Biomedical applications of nanomaterials	10		
Unit 5	Biomedical applications – imaging	2	4,5	1,2
	Molecular and cellular trafficking	2	4,5	1,2
	Racking, drug and gene delivery	2	4,5	1,2
	targeted cancer theranostics	2	4,5	1,2
	Early diagnosis of diseases (cancer, malaria, urinary track infections).	2	4,5	1,2

Learning Assessment Theory

Bloom's Level of Cognitive Task	Continuous Learning Assessments --%				End Semester Exam --%
	CLA-1 --%	Mid-1 --%	CLA-2 --%	CLA-3 --%	
Remember	50	30	35	40	35
Understand	50	30	35	40	35
Apply		40	30	20	30
Analyse					
Evaluate					
Create					
Total	100%	100%	100%	100%	100%

Recommended Resources

1. Nanomaterials and their biomedical applications: Tuhin Subra, Loganathan Mohan Springer; 1st edition, 2021, ISBN: 978-9813362512
2. Biomedical applications of nanoparticles, Alexandru Mihai, Elsevier, 2019, ISBN: 978- 0128165065

Course Designers

1. Dr. Anil K Suresh. Associate Professor, Dept. Of Biological Sciences. SRM University – AP.

Biosafety and IPR

Course Code	BIO 558	Course Category	Core Elective (CE)				L	T	P	C
							2	1	0	3
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)						
Course Offering Department	Biological Sciences	Professional / Licensing Standards								

Course Objectives / Course Learning Rationales (CLRs)

1. Understand biosafety, bioethics, and IPR principles, focusing on risk assessment, ethical considerations, and legal frameworks in biotechnology.
2. Gain knowledge in patent processes, databases, and implications in the pharmaceutical biotechnology industry through case studies.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Apply biosafety measures and ethical principles to biotechnological practices, safeguarding biodiversity and the environment.	3	75%	70%
Outcome 2	Analyze ethical challenges in genetic manipulation and clinical trials, promoting responsible research conduct.	3	70%	65%
Outcome 3	Understand Intellectual Property Rights (IPR) principles and their application in biotechnological innovations	3	70%	65%
Outcome 4	Navigate patenting processes and databases, ensuring compliance and mitigating infringement risks	4	70%	65%
Outcome 5	Evaluate case studies to grasp the legal and ethical impacts of IPR on biotechnological advancements	3	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

Program Learning Outcomes (PLO)															
CLOs	Pos												PSOs		
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	3	3	2	1			2			2	3	1	3
Outcome 2	3	3	3	3	3	2			2			2	3	2	2
Outcome 3	3	3	3	3	3	2			2			2	3	2	2
Outcome 4	3	3	3	3	3	2			1			2	3	2	2
Outcome 5	3	2	3	3	3	3			2			3	3	2	2
Average	3	2.8	3	3	2.8	2			1.8			2.2	3	1.8	2.2

Course Unitization Plan Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	Biosafety	10		
	Biosafety: Risk, hazard, exposure, safeguards, biosafety levels	2	1	1,2,6
	biosafety concerns - from individual to global levels.	2	1	1,2,6
	Protection of biodiversity and environment.	2	1	1,2,6
	Biosafety recommendations for infectious agents and infected animals.	2	1	1,2,6
	Risk assessments, Government of India and international agreements, regulations, and recommendations	2	1	1,2,6
Unit 2	Bioethics	8		
	Ethical issues with regard to GMOs – gene manipulation experiments, stem cells, animal and human cloning.	2	2	1,2,6
	Human genome project and its ethical issues.	2	2	1,2,6
	Ethics in laboratories and clinical trials.	2	2	1,2,6
	Ethical conflicts.	2	2	1,2,6
Unit 3	Intellectual Property Rights (IPR)	10		
	Intellectual Property Rights (IPR): patents, designs, trademarks, copyright, industrial design, trade secrets, traditional knowledge and geographical indications.	2	3	5,6
	Patent: National and international treaties	2	3	5,6
	Convention on patents.	2	3	5,6
	Patentable and not patentable inventions and innovations.	2	3	5,6
	Patent requirements, types, specifications, financial implications and its schemes	2	3	5,6
Unit 4	Patent databases and processes	10		
	Patent databases: national and international, report preparation	2	4	4
	Indian patent acts and amendments.	1	4	4
	Structure of Indian Patent Office.	2	4	4

	Disclosure and not disclosure aspects and process of patenting in India.	1	4	4
	Requirements of international patents.	1	4	4
	Publications of patents – India, Europe and US.	1	4	4
	Patent infringement.	1	4	4
	Biopiracy	1	4	4
Unit 5	IPR case studies and issues	7		
	Patents in the Pharmaceutical Biotechnology Industry: legal and ethical issues	2	5	3,6
	Case studies of patents: basmati rice, turmeric, and neem.	2	5	3,6
	Geographical Indications	2	5	3,6
	Limitations of patent – lack of universal standards, vague language, use of patent to be a monopoly and term limits.	1	5	3,6

Learning Assessment Theory

Bloom's Level of Cognitive Task	Continuous Learning Assessments --%				End Semester Exam --%
	CLA-1 --%	Mid-1 --%	CLA-2 --%	CLA-3 --%	
Remember	35	30	20	30	35
Understand	35	30	20	30	35
Apply	30	40	30	20	15
Analyse			30	20	15
Evaluate					
Create					
Total	100%	100%	100%	100%	100%

Recommended Resources

1. Biotechnology and safety Assessment: Thomas J.A., Fush R.L., Academic press; 3rd edition, 2002, ISBN: 978-0126887211
2. Biological safety Principles & practices: Karen B. Byers, Dawn P. Wooley, ASM Press; 5th edition, 2017, ISBN: 978-1555816209
3. Biotechnology- A Multi-Volume Comprehensive Treatise Legal, Economic and Ethical Dimensions: Dieter Brauer, Hans-Jürgen Rehm, Gerald Reed, Alfred Pühler, Peter Stadler, Wiley VCH; 2nd edition, 1995, ISBN: 978-3527283224
4. Handbook of Indian Patent Law and Practice: Subbaram, N.R, Viswanathan S, Printers and Publishers Pvt. Ltd; 1998
5. Intellectual Property Rights: Critical Concepts in Law, Vaver D, Taylor & Francis; 2006
6. IPR, Biosafety & Bioethics, Goel Deepa, Parashar S, Pearson Publishers; 1st edition, 2013, ISBN: 978-8131774700

Course Designers

1. Prof. Jayaseelan Murugaiyan, Professor, Department of Biological Sciences, SRM University – AP.

A Primer to Neurobiology

Course Code		Course Category		L-T/D-P/Pr-C	2	1	0	3
Total Contact Hours			Total Learning Hours					
Pre-Requisite Course(s)	BIO 501, BIO 506	Co-Requisite Course(s)		Progressive Course(s)				
Course Offering Department	Biological Sciences	Professional / Licensing Standards						

Course Objectives

1. Understand the structural and organizational principles of the nervous system, including its cellular, anatomical, and functional components.
2. Explain the physiological, molecular, and developmental mechanisms underlying neuronal excitability, synaptic transmission, and neural circuit formation.
3. Understand the functional organization of sensory and motor systems and the molecular basis of major neurological and neurodegenerative disorders.

Course Outcomes (COs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
CO 1	Identify and classify the organization of the nervous system, neuronal and glial cell types, and basic neuroanatomical features.	2	75%	70%
CO 2	Illustrate the principles of membrane excitability, action potentials, synaptic transmission, and neurotransmission.	3	75%	70%
CO 3	Summarize the cellular and molecular mechanisms involved in neural development and synapse formation.	3	70%	65%
CO 4	Differentiate the structural and functional organization of major sensory and motor systems.	3	70%	65%
CO 5	Outline the molecular basis and pathological features of major neurodegenerative and neurological disorders.	3	70%	65%

CLOs	Program Learning Outcomes (PLO)
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	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	2	2	2	1	1	1	2	2		2			
Outcome 2	3	3	2	2	2	1	1	1	2	2		2			
Outcome 3	3	2	2	2	2	1	1	1	2	2		2			
Outcome 4	3	2	2	2	2	1	1	1	2	2		2			
Outcome 5	3	2	2	2	2	1	1	1	2	2		2			
Course Average	3	2	2	2	2	1	1	1	2	2		2			

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References
Unit 1	Introduction to the Nervous System			
	Introduction to the nervous system, concept of CNS and PNS	1	1	1,2,4,5
	Neurons and glial cells	3	1	1,2,4,5
	Skull, meninges, ventricles and cerebrospinal fluid, spinal cord organization, anatomical features of the human brain	6	1	1,2,4,5
Unit 2	Neurophysiology and Neurotransmission			
	Membrane transport & excitability	2	2	1,2,4,5
	Resting membrane potential & action potential	2	2	1,2,4,5
	Electrophysiological techniques to study neuronal function	1	2	1,2,4,5
	Synapses: types, pre and post-synapse: Structure and composition, Electrical synapses	2	2	1,2,4,5
	Neurotransmitter systems and principles of neurotransmission, neural code	2	2	1,2,4,5
Unit 3	Development of the Nervous system			
	Neurulation, formation of brain vesicles	3	3	1-6
	Neural tube patterning – anteroposterior axis & dorsoventral axis, neurogenesis	3	3	1-6
	Neuronal migration, Dendritogenesis, molecular biology of axon guidance	3	3	1-6
	Synapse formation, cortical histogenesis	2	3	1-6

Unit	Sensory and Motor Systems			
4	Chemical senses-gustation and olfaction	2	4	1,2,4,5
	Eye and the visual system	2	4	1,2,4,5
	Auditory system	2	4	1,2,4,5
	Somatosensory system	2	4	1,2,4,5
	Motor system	2	4	1,2,4,5
Unit	Neuropathology			
5	Diseases associated with neuronal dysfunction and degeneration			
	Stroke	1	5	6
	Alzheimer's Disease	1	5	6
	Parkinsons Disease	1	5	6
	Spinal Muscular Atrophy	1	5	6
	Amyotrophic Lateral Sclerosis	1	5	6
Total contact hours		45		

Recommended Resources

1. Neuroscience- Exploring the Brain. Mark F Bears. 2016. 4th international edition. Lww
2. Neuroscience. 2018. Dale Purves. 2018. 6th edition. OUP USA
3. Development of the Nervous system. Dan H Sanes. 2019. 4th edition. Academic Press Inc.
4. Principles of Neurobiology. Liqun Luo. 2015. 1st edition. Garland Science
5. Principles of Neural Science. Eric R. Kandel. 2012. 5th edition. McGraw Hill Education
6. Neurodegeneration, Anthony Schapira. 2017, 1st edition, Wiley

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (50%)	
		CLA-1 (15%)		Mid-1 (25%)		CLA-2 (25%)		CLA-3 (15%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	40		50		30		40		30	
	Understand	40		30		30		40		40	
Level 2	Apply	20		20		20		20		20	
	Analyse					20				10	
Level 3	Evaluate										
	Create										
Total		100%		100%		100%		100%		100%	

Course Designers

Dr. Pitchaiah Cherukuri, Assistant Professor, Department of Biological Sciences, SRM University AP

SEMESTER IV

Research Degree Project

Course Code	BIO 515	Course Category	Core Elective (CE)				L	T	P	C
							0	0	14	14
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)						
Course Offering Department	Biological Sciences	Professional / Licensing Standards								

Course Objectives / Course Learning Rationales (CLRs)

1. Equip students with advanced research skills and practical experience in molecular biology and biotechnology through an intensive 6-month research project in industry or academia.
2. Enhance students' ability to independently design, conduct, and analyze scientific research, fostering critical thinking and problem-solving skills in real-world settings.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Independently plan, execute, and manage a research project	4	75%	70%
Outcome 2	Apply advanced theoretical knowledge and practical skills to address complex scientific challenges	4	75%	70%
Outcome 3	Analyze and interpret experimental data using appropriate methodologies and scientific tools	4	75%	70%
Outcome 4	Communicate research findings effectively through written reports, presentations, and scientific discussions	3	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

Program Learning Outcomes (PLO)															
CLOs	Pos												PSOs		
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	3	3	3	1	2	1	3			3	3	3	3
Outcome 2	3	3	3	3	3	1			1	3		3	2	2	3
Outcome 3	3	3	3	3	3			2	3			3	3	2	3
Outcome 4	3	3	3	3	3		2	3	3			3	3	3	3
Average	3	3	3	3	3	1	2	2	2.5	3		3	2.75	2.5	3

Course Unitization Plan Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	Internship orientation, safety training, and introduction to project objectives.	20	1	1-7
Unit 2	Initial training in fundamental molecular biology techniques/ bioinformatics tools	100	2	
	Supervised and independent execution of experiments and data collection.	250	3	
	Final data analysis, preparation of the final report.	30	3	
Unit 3	Presentation of findings to peers and supervisors, with feedback and career discussions.	20	4	

Learning Assessment Theory

Bloom's Level of Cognitive Task	Record/Observation Note --%	Presentation --%
Remember	20	20
Understand	30	30
Apply	30	30
Analyse	20	20
Evaluate		
Create		
Total	100%	100%

Recommended Resources

1. As recommended by the Advisor pertaining to student research interest.
2. <https://pubmed.ncbi.nlm.nih.gov/>
3. <https://www.sciencedirect.com/>
4. www.springer.com
5. <https://onlinelibrary.wiley.com/>
6. Research Methodology
7. Reading assignment related to undergraduate project as guided by faculty.

Course Designers

1. Dr. Writoban Basu Ball, Assistant Professor, Department of Biological Sciences, SRM University – AP.