Department of Biological Sciences

M.Sc. Molecular Biology and Biotechnology
Curriculum and Syllabus

(Applicable to the students admitted from AY: 2023 onwards)

School of Engineering and Sciences
SRM University *AP*, Andhra Pradesh

Department Vision

To integrate innovative teaching, cutting-edge research and creating an environment that inspires both learning and discovery. To emerge as a global leader in value-based education, interdisciplinary research and new ventures in the field of biological sciences.

Department Mission

1. Empower students with skills, knowledge, and ethics for success in the dynamic field of biological sciences, enabling them to address societal challenges.
2. Advancing the frontier of biological sciences through groundbreaking research and fostering pedagogical innovations to create interactive learning experiences.
3. Integrate academic excellence with entrepreneurial spirit to evolve into an interdisciplinary centre.

Program Educational Objectives (PEO)

1. Develop a profound understanding of the fundamental principles and advanced concepts in molecular biology and biotechnology, enabling the application of theoretical knowledge to real-world biological challenges.
2. To update, extend and deepen students 'knowledge thorough a flexible, research-intensive program akin to academia and industry requirements.
3. Cultivate critical thinking skills to analyze complex biological problems, formulate hypothesis and develop innovative solutions.
4. Enhance written and oral communication skills to effectively convey scientific concepts, research findings, and ideas to both scientific and non-scientific audiences, promoting the dissemination of knowledge.
5. Encourage students to develop an entrepreneurial mindset and allow graduates to identify and pursue opportunities for innovation and the application of knowledge in industry and beyond.

Mission of the Department to Program Educational Objectives (PEO) Mapping

	PEO 1	PEO 2	PEO 3	PEO 4	PEO 5
Mission Statement 1	3	2	2	2	2
Mission Statement 2	3	3	3	3	3
Mission Statement 3	3	3	3	3	3

Program Specific Outcomes (PSO)

1. Demonstrate proficiency in key molecular biology techniques, enabling effective contributions to genetic research and biotechnological applications
2. Demonstrate communication skills, scientific writing and data analysing abilities in the fields of molecular biology and biotechnology.
3. Demonstrate competence in molecular biology and biotechnology domains to succeed in entrepreneurship endeavours.

Mapping Program Educational Objectives (PEO) to Program Learning Outcomes (PLO)

Program Learning Outcomes (PLO)															
PEOs	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
PEO 1	3	3	3	3	3	2	3	-	2	2	-	3	3	3	3
PEO 2	3	3	3	3	3	2	3	-	2	2	-	3	3	3	3
PEO 3	3	3	3	3	3	2	3	-	3	2	-	3	3	3	3
PEO 4	3	2	2	2	2	3	1	-	3	3	-	2	2	3	3
PEO 5	2	2	2	2	2	2	1	-	2	3	3	-	2	2	3

Category Wise Credit Distribution			
Course Sub-Category	**Sub-Category Credits**	**Category Credits**	**Learning Hours**
Ability Enhancement Courses (AEC)		3	90
University AEC	0		
School AEC	3		
Value Added Courses (VAC)		3	90
University VAC	1		
School VAC	2		
Skill Enhancement Courses (SEC)		6	180
School SEC	6		
Department SEC	0		
SEC Elective	0		
Foundation / Interdisciplinary courses (FIC)		9	270
School FIC	6		
Department FIC	3		
Core + Core Elective including Specialization (CC)		44	1320
Core	32		
Core Elective (Inc Specialization)	12		
Minor (MC) + Open Elective (OE)	0	0	0
Research / Design / Internship/ Project (RDIP)		19	570
Internship / Design Project / Startup / NGO	0		
Internship / Research / Thesis	19		
Total		**84**	**2520**

Semester wise Course Credit Distribution Under Various Categories						
Category	**Semester**					
	I	**II**	**III**	**IV**	**Total**	**%**
Ability Enhancement Courses - AEC	2	0	1	0	3	**4**
Value Added Courses - VAC	0	3	0	0	3	**4**
Skill Enhancement Courses - SEC	3	3	0	0	6	**7**
Foundation / Interdisciplinary Courses - FIC	3	3	3	0	9	**11**
CC / SE / CE / TE / DE / HSS	17	17	10	0	44	**52**
Minor / Open Elective - OE	0	0	0	0	0	**0**
(Research/ Design/ Industrial Practice/Project/Thesis/Internship) -RDIP	0	0	5	14	19	**23**
Grand Total	**25**	**26**	**19**	**14**	**84**	**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	VAC	U VAC	VAC 501	Community Engagement and Social Responsibility	0	0	1	1*
2	AEC	U AEC	AEC 501	Effective Communication for Impactful Interviews	2	0	0	2
3	SEC	S SEC	SEC 501	Introduction to R and Python	1	1	1	3
4	FIC	D FIC	FIC 502	Medicinal Biopharmaceutical Chemistry	2	0	1	3
5	Core	CC	BIO 501	Molecular Biology	2	2	0	4
6	Core	CC	BIO 502	Microbial Biotechnology	2	1	0	3
7	Core	CC	BIO 503	Biophysical and Biochemical Techniques	2	2	0	4
8	Core	CC	BIO 504	Molecular Biology Lab	0	0	5	3
9	Elective	CE		Core Elective	2	0	1	3
				Semester Total	13	8	5	25

SEMESTER - II								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	VAC	U VAC	VAC 502	Community Engagement and Social Responsibility	0	0	0	1
2	VAC	S VAC	VAC 503	Entrepreneurial Mindset	2	0	0	2
3	SEC	S SEC	SEC 105	Research Design and Methods	2	1	0	3
4	FIC	S FIC	FIC 108	Design Thinking	3	0	0	3
5	Core	CC	BIO 508	RNA Biology	2	2	0	4
6	Core	CC	BIO 509	Bioinformatics	2	1	0	3
7	Core	CC	BIO 510	Genetic Engineering	2	2	0	4
8	Core	CC	BIO 511	Biotechnology and Bioinformatics Lab	0	0	5	3
9	Elective	CE	BIO 550/ BIO 551/ BIO 552	Microbiology (R)/ Immunology (R)/ Pharmaceutical Biotechnology (I)	2	1	0	3
				Semester Total	**15**	**7**	**5**	**26**

SEMESTER - III								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	AEC	Ss AEC	AEC 503	Research Seminar	0	0	1	1
2	FIC	S FIC	FIC 124	Psychology for Everyday Living	3	0	0	3
3	Core	Core	BIO 512	Plant and Animal Biotechnology	3	1	0	4
4	Elective	CE		Core Elective	2	1	0	3
5	Elective	CE		Core Elective	2	1	0	3
6	RDIP	RDIP	BIO 513	Summer Internship	0	0	2	2
7	RDIP	RDIP	BIO 514	Minor Research Project	0	0	3	3
				Semester Total	10	3	6	19

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 Electives								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	Elective	CE	BIO 553	Molecular Virology	2	1	0	3
2	Elective	CE	BIO 554	Programming and Computational Biology	2	1	0	3
3	Elective	CE	BIO 555	Immunotherapeutics	2	1	0	3
4	Elective	CE	BIO 556	Genomics and Proteomics	2	1	0	3
5	Elective	CE	BIO 557	Molecular Mechanisms of Diseases	2	1	0	3
6	Elective	CE	BIO 558	Biosafety and IPR	2	1	0	3
7	Elective	CE	BIO 559	Bioinformatics Analysis pipelines	2	1	0	3
8	Elective	CE	BIO 505	Biochemistry and Metabolism	2	1	0	3
9	Elective	CE	BIO 506	Cell Biology	2	1	0	3
10	Elective	CE	BIO 507	Bionanotechnology	2	1	0	3
11	Elective	CE	BIO 550	Microbiology	2	1	0	3
12	Elective	CE	BIO 551	Immunology	2	1	0	3
12	Elective	CE	BIO 552	Pharmaceutical Biotechnology	2	1	0	3

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Effective Communication for Impactful Interviews

Course Code	AEC 501	**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	Literature & Languages	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

- **This course equips the learners for successful job hunting by fostering a comprehensive understanding and application of the KASB Model in professional communication, enhancing verbal communication skills to excel in interviews, mastering non-verbal communication for a positive first impression, and guiding them in customizing application materials to stand out from the crowd.**

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 key components of verbal and non-verbal communication and their significance in the interview process.**	**1**	**50%**	**50%**
Outcome 2	**Develop the skill to articulate thoughts clearly and concisely, using effective interview responses.**	**2**	**65%**	**60%**
Outcome 3	**Exhibit proficiency in the art of storytelling as a communication tool in interviews.**	**2**	**65%**	**60%**
Outcome 4	**Create personalized and tailored resumes, cover letters, and SOPs to align with specific job or educational opportunities.**	**3**	**70%**	**60%**

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

CLOs	Program Learning Outcomes (PLO)														
	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	2	1	1	1	3	1		3	2	3	2	3	3	1	2
Outcome 2	2	3	3	1	3	1		3	2	3	3	3	3	2	2
Outcome 3	2	1	3	2	3	2		3	2	3	3	3	3	2	2
Outcome 4	2	3	3	2	3	3		3	2	3	3	3	3	2	2
Course Average	2	2	2.5	1.5	3	1.75		3	2	3	2.75	3	3	2	2

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Introduction: An Overview**	9		
	Types of interviews	2	1	4
	Communication as a strategy	3	1	4,5
	The KASB Model	4	1	4
Unit 2	**Articulation Skills**	8		
	The 3 Vs of Communication	2	1	1,4
	Tone, Pitch and Modulation	4	2	4,5
	Practice session	4	2	
Unit 3	**Story Telling**	6		
	The Importance of story telling	2	3	6
	Creating stories around' Tell Me About Yourself'	2	3	6,7
	Group Discussion	2	3	8
Unit 4	**Written Strategy**	10		
	Resume	4	4	2,4
	Cover Letter	4	4	2,4
	SOP	2	4	2,4
Unit 5	**Mock Interview Sessions**	12		
			1,2,3.4	
	Total Hours	**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (60%)								End Semester Exam (40%)	
		CLA-1 (15%)		CLA-2 (15%)		CLA-3 (15%)		Mid Term (__%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	100%		30%		50%				20%	
	Understand										
Level 2	Apply			70%		50%				80%	
	Analyse										
Level 3	Evaluate										
	Create										
Total		100%		100%		100%				100%	

Recommended Resources

1. **Cialdini, R. B. (2021). Influence: The psychology of persuasion (Revised edition). Harper Perennial Modern Classics.**
2. **Dipboye, R. L., & Cole, C. H. (2019). Secrets of a hiring manager: How to land any job and win over any boss. HarperBusiness.**
3. **LaFare, M. (2013). Veritas: A game of lies. Penguin Books.**
4. **Mock, P., & Turner, L. (2019). The interview for dummies (6th edition). John Wiley & Sons.**
5. **Stone, D. D., Patton, B., & Heen, S. (2000). Difficult conversations: How to discuss what matters most (2nd edition). Viking.**
6. **Dolan, G. (2019). Storytelling for job interviews: How to use stories, nail an interview and land your dream job. BookBaby.**
7. **Pink, S. (2014). To sell is human: The science of persuasion. Penguin Books.**
8. **Lewis, V. J. (2018). Group discussion: A practical guide (7th edition). Kogan Page**

Other Resources

Course Designers

1. **Dr. Srabani Basu, Associate Professor, SRM University AP**

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Introduction to R and Python

Course Code	SEC 501	**Course Category**	SEC	**L**	**T**	**P**	**C**
				1	1	1	3
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	PSB	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. To enable students to start data science career by becoming proficient in R and Python programming.
2. To enable students to start using powerful Python libraries, such as, Pandas, NumPy, ggplot, matplotlib, and so on.
3. 3To enable students to solve real-world problems with case studies.
4. To help students to extract data from various sources, make better data visualization plots, and enable to provide meaningful and in-depth insights from the data.

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	Familiarize with Python Environment and several powerful Python libraries	2	80%	80%
Outcome 2	Get idea about Python data types, gather expertise in data pre-processing, visualization, and exploratory data analysis using Python	3	75%	75%
Outcome 3	Get introduced to R-studio, familiarize with data frames and constructs in R	2	85%	85%
Outcome 4	Perform data pre-processing, data visualization and exploratory data analysis using R	3	75%	75%
Outcome 5	Solve simple real-life analytics problems by applying basic machine learning models in R or Python	4	70%	70%

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

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Strategic Thinking and Logical Reasoning	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	Scientific and Disciplinary
Outcome 1	2	2	1	1	2	3	-	-	2	-	-	-	2	2	2
Outcome 2	2	3	3	3	3	3	-	-	2	-	-	-	3	2	2
Outcome 3	2	2	1	1	2	3	-	-	2	-	-	-	2	2	2
Outcome 4	2	3	3	3	3	3	-	-	2	-	-	-	3	2	2
Outcome 5	2	3	3	3	3	3	-	-	3	-	-	-	3	2	2
Average	2	3	2	2	3	3	-	-	2	-	-	-	3	2	2

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Introduction to Python**	1	1	1
	Installation of developer environment- Anaconda and Jupyter			
	Basic Python Programming			
Unit 2	**Python Data types and Control structure**	3	2	1
	Python list, tuple, dictionary, and sets			
	If-else condition, Python loops, Python finctions			
Unit 3	**Numpy and Pandas**	5	2	1
	Basic of Numpy, structure and control of arrays, array operations			
	Introduction to Pandas, file upload and data analysis, indexing dataframe, merging dataframe and arithmetic operations			
Unit 4	**Data Analysis using Python**	6	2	1
	Data extraction and pre-processing			
	Data visualization and Exploratory Data analysis			
Unit 5	**Introduction to R**	3	3	2
	Installation of R-studio			
	Vectors in R			
	Factors in R			
	Introduction to matrices in R			
Unit 6	**Dataframes and Constructs in R**	3	3	2
	Creating, accessing, and operating dataframes; file upload into dataframe			
	Rational and logical operators in R			
	Loops and Built-in functions			
Unit 7	**Data Analysis using R**	9	4,5	2
	Upload Excel files into R, data pre-processing, visualization plots			
	Regression in R			
Total Contact Hours		**30**		

Course Unitization Plan - Lab

Exp No.	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
	Solve real-life datasets and case studies using R	7	3,4,5	2
	Solve real-life datasets and case studies using Python	8	1,2	1
Total Contact Hours		**15**		

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%)	Mid-2 (15%)	
Level 1	Remember	70%	70%	60%	60%	50%
	Understand					
Level 2	Apply	30%	30%	20%	20%	40%
	Analyse					
Level 3	Evaluate	-	-	20%	20%	10%
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Learning Assessment- Lab

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)			End Semester Exam (50%)
		Experiments (20%)	Record / Observation Note (10%)	Viva + Model (20%)	
Level 1	Remember	20%	50%	80%	10%
	Understand				
Level 2	Apply	60%	30%	20%	80%
	Analyse				
Level 3	Evaluate	10%	10%	-	10%
	Create				
Total		**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. An Introduction to Statistical Learning with Applications in Python. Gareth James, Written, Hastie, Tibshirani, Taylor; Springer Publications
2. An Introduction to Statistical Learning with Applications in R. Gareth James, Written, Hastie, Tibshirani, Taylor; Springer Publications

Other Resources

Course Designers

1. Ms. Ishita Sar, Assistant Professor, Paari School of Business, SRM University, AP
2. Prof. Biswajit Mahanty, Professor, Department of Industrial and Systems Engineering, IIT Kharagpur

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Molecular Biology

Course Code	BIO 501	Course Category	CC	L	T	P	C
				2	2	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)

CLOs	Program Learning Outcomes (PLO)														
	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
Course 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

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References
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
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**	**10**		
	Epigenetic regulation	2	3,4,5	1-4
	Transcriptional regulation	2	3,4,5	1-4
	Post - Transcriptional regulation	2	3,4,5	1-4
	Translational regulation	2	3,4,5	1-4
	Post - Translational regulation	2	3,4,5	1-4
Total Contact Hours		**60**		

Learning Assessment

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

Other Resources

Course Designers

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

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Microbial Biotechnology

Course Code	BIO 502	Course Category	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)														
	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	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
Course 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

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
Unit 5	**Advanced applications**	**11**		
	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

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%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	60%		60%		40%		60%		60%	
	Understand										
Level 2	Apply	40%		40%		60%		40%		40%	
	Analyse										
Level 3	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, Elsivier 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.

Other Resources

Course Designers

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

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Biophysical and Biochemical Techniques

Course Code	BIO 503	**Course Category**	CC	**L**	**T**	**P**	**C**
				2	2	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. Gain proficiency in experimental design and execution, including the selection of appropriate biological samples and the isolation of cellular components for detailed analysis.
2. 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	Apply fluorescence and radio-isotopic techniques in biological research and assays.	3	70%	65%

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

CLOs	Program Learning Outcomes (PLO)														
	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
Course 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

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References
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

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

Other Resources

Course Designers

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

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Molecular Biology Lab

Course Code	BIO 504	**Course Category**	CC		**L**	**T**	**P**	**C**
					0	0	5	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. 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 chrom.,4atography and analysis by SDS-PAGE	4	70%	60%

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

CLOs	Program Learning Outcomes (PLO)														
	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	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
Course Average	**3**	**2.75**	**3**	**3**	**3**	**2.75**	**1**	**3**	**3.5**	**2.75**			**3**	**3**	**3**

Course Unitization Plan

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-NTAagarose, SDA-PAGE, Coomassie Blue staining	25	3,4	1
Total Contact Hours		**75**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)			End Semester Exam (50%)
		Experiments (20%)	Record / Observation Note (10%)	Viva + Model (20%)	
Level 1	Remember	50%		50%	50%
	Understand				
Level 2	Apply	50%	100%	50%	50%
	Analyse				
Level 3	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

Other Resources

Course Designers

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

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

COMMUNITY SERVICE AND SOCIAL RESPONSIBILITY

Course Code	VAC 502	**Course Category**	VAC	**L**	**T**	**P**	**C**
				0	0	2	2
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	CEL	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Encourage initiatives that address local needs, foster self-sufficiency, and promote environmental sustainability within the community.
2. Equip participants with a deeper understanding of social issues and a sense of responsibility towards marginalized communities.
3. Inspire active participation in community service programs and foster a culture of giving back among individuals and organizations.
4. Develop and implement programs that contribute to skill development, economic empowerment, and equal opportunities for underprivileged sections of society.

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	Develop effective strategies for identifying and addressing community needs.	3	80%	80%
Outcome 2	Demonstrate empathy and cultural sensitivity when engaging with diverse community groups.	4	80%	75%
Outcome 3	Implement sustainable solutions and evaluate their impact on social well-being.	5	90%	85%
Outcome 4	Collaborate effectively within teams to design and lead community service projects.	6	90%	80%

Learning Assessment

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

Entrepreneurial Mindset

Course Code	**SEC 503**	**Course Category**	**SEC**	**L**	**T**	**P**	**C**
				2	0	0	2
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	**Management**	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Foster creativity and innovation skills to generate entrepreneurial solutions effectively.
2. Cultivate risk management strategies and resilience for navigating entrepreneurial challenges.

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	Discuss the significance of entrepreneurship and assess inherent traits and skills essential for entrepreneurial success and family Business	2	80%	80%
Outcome 2	Apply strategic thinking frameworks for analyzing opportunities and creating startup strategies.	3	70%	70%
Outcome 3	Discuss potential challenges and reasons for failure in entrepreneurial ventures	2	80%	80%
Outcome 4	Analyze various business models, and differentiate between different types of entrepreneurs and intrapreneurs.	3	70%	70%

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

CLOs	**Program Learning Outcomes (PLO)**														
	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 social 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**		
Outcome 2	**3**	**2**	**2**	**2**				**2**		**2**	**3**		**3**	**2**	**3**
Outcome 3	**3**			**1**						**2**	**2**		**3**	**3**	
Outcome 4	**3**	**2**	**2**	**2**				**2**		**2**	**3**		**3**	**3**	**3**
Average	**3**	**2**	**2**	**2**				**2**		**2**	**3**		**2**	**2**	**2**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	Introduction	6		
	Significance of Entrepreneurship	2	1	1,2
	Inherent Traits and Skills required to be possessed by a Potential Entrepreneur	2	1	1,2
	Taxonomy of Entrepreneurship: Types of Entrepreneurs, Distinction between Entrepreneurs and Intrapreneurs	2	1	1,2
Unit 2	Entrepreneurial Opportunity	10		
	Opportunities and Challenges (Pros and Cons) of Entrepreneurship	2	2,3	1,2
	Reasons for Failure of Entrepreneurial Ventures	3	2,3	1,2
	Exploring Entrepreneurial Opportunities	5	2,3	1,2
Unit 3	Entrepreneurial Strategy	10		
	Ideation and idea testing	4	2,3	1,2
	Starting up Strategy: Five-Question Framework and Porter's Five Forces	4	2	1,2
	Entrepreneurial Support	2	2	1,2
Unit 4	Business Model	15		
	Understanding Business Models	5	4	1,2
	Preparing a Business Plan	5	4	1,2
	Basics of Startup finance	5	4	1,2
Unit 5	Family Business	4		
	Introduction to Family Business	2	1	3
	Entrepreneurship in Family Business	2	1	3
Total Contact Hours		45		

Learning Assessment (Theory)

Bloom's Level of Cognitive Task		Continuous Learning Assessments (30%)			End Semester Exam (70%)
		CLA-1 (10%)	CLA-2 (10%)	CLA-3 (10%)	
Level 1	Remember	80%	70%	70%	60%
	Understand				
Level 2	Apply	20%	30%	30%	40%
	Analyse				
Level 3	Evaluate				
	Create				
Total		100%	100%	100%	100%

Recommended Resources

1. Entrepreneurship, Rajeev Roy, Oxford University Press
2. Entrepreneurship: A Small Business Approach, Charles E. Bramford & Garry D. Bruton, McGraw Hill Education

Other Resources

Course Designers

1. Dr Prabal Sen, Visiting Faculty, Paari School of business, SRM University-AP

SRM University *AP*, Andhra Pradesh

Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Research Design and Methods

Course Code	SEC 105	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	Chemistry	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. To understand and apply various research designs and methodologies.
2. Equip students with the practical skills necessary to conduct research independently.
3. Foster an understanding of ethical considerations in research.

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	Students will be able to identify a research problem	2	85%	80%
Outcome 2	Students will develop the ability to critically evaluate and compare different research designs and methodologies.	3	80%	75%
Outcome 3	Students will demonstrate an understanding of ethical considerations in research.	5	80%	75%

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

CLOs	Program Learning Outcomes (PLO)														
	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	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	3	2	3	2	2		2	2	2	2	2		2	2	2

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Introduction to Research Design and Methods**	**10**	**1**	**1,2**
	Overview of research: Definition, significance, purpose, and types.	4		
	Types of Research: Basic and applied research.	4		
	Google scholar, ResearchGate, Citations, h-index, i10 index Bibliography, Reference manager	2		
Unit 2	**Formulating Research Questions and Hypotheses**	**10**	**2**	**1,3**
	Developing clear and focused research questions	2		
	Literature survey, various sources of research information	2		
	Methodology of research	2		
	Importance of research design	2		
	Steps in conducting research	2		
Unit 3	**Introduction to scientific ethics**	**10**	3	**1,2,3**
	Key ethical principles: Honesty, integrity, transparency.	4		
	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**	**10**	3	**1,2,3**
	Writing reports, Structuring reports	2		
	Writing journal articles,	3		
	Writing research proposals	3		
	Producing oral presentations	2		
Total Contact Hours		**45**		

Learning Assessment

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

Recommended Resources

1. Bordens K.S. and Abbott, B.b.: Research Design and Methods, McGraw Hill, 2008.
2. John W. Creswell and J. David Creswell Research Design: Qualitative, Quantitative, and Mixed Methods Approaches" SAGE Publications, 2017
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

Other Resources

Course Designers

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

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Design Thinking

Course Code	FIC 108	Course Category	FIC	L	T	P	C
				3	0	0	3
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	Management	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. Familiarize with the principles of Design Thinking
2. Learn to apply the principles of Design Thinking
3. Apply Design Thinking to solve problems.

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	Importance of Design Thinking	1	75	90
Outcome 2	Grasp the Concepts and process of Design Thinking	3	75	90
Outcome 3	Learn the process of Design Thinking	2	85	90
Outcome 4	Solve a problem using Design Thinking Principles	5	75	65

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

CLOs		Program Learning Outcomes (PLO)														
	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												3	3	3	3
Outcome 2	3										1		3	1	3	3
Outcome 3	3							3			2		3	2	3	3
Outcome 4	3	3	3	3				3	3	3	3		3	3	3	3
Average	3	3	3	3				3	3	3	2		3	2	3	3

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**An Introduction to the innovation Process**	**15**		1,2
	Understanding of Design Thinking & its Importance, Pillars of Design Thinking		2	
Unit 2	**Process – Understanding the Stages of Design Thinking**	**15**	**2**	
Unit 3	**Identifying Opportunity Areas: Problem Framing & Definition**	10	2	
Unit 4	**Idea Generation and Concept Development**	10	2	
Unit 5	**Implementation and Managing Innovation**	10	5	
Total Contact Hours		**60**		

Learning Assessment

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

Recommended Resources

1. Design Thinking – Techniques and Approaches, N. Siva Prasad
2. Nigel Cross , Design Thinking, BERG Publishing, (20110
3. Thomas Lockwood , Design Thinking- Integrating Innovation, Customer Experience and Brand Value, , Design Management Institute, (2009)

Other Resources

1. HBS – Online – Design Thinking & Innovation – course material

Course Designers

1. Satyanarayana Duvvuri, Professor of Practice, Paari school of business, SRM University AP.

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

RNA Biology

Course Code	BIO 508	**Course Category**	CC	**L**	**T**	**P**	**C**
				2	2	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)

CLOs	Program Learning Outcomes (PLO)														
	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
Course 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

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References
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

Bloom's Level of Cognitive Task		**Continuous Learning Assessments (60%)**								**End Semester Exam (40%)**	
		CLA-1 (10%)		**CLA2 (15%)**		**CLA-3 (15%)**		**Mid-2 (20%)**			
		Th	**Prac**	**Th**	**Prac**	**Th**	**Prac**	**Th**	**Prac**	**Th**	**Prac**
Level 1	Remember	40%		60%		70%		60%		70%	
	Understand										
Level 2	Apply	60%		40%		30%		40%		30%	
	Analyse										
Level 3	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

Other Resources

Course Designers

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

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Bioinformatics

Course Code	BIO 509	**Course Category**	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)

CLOs	Program Learning Outcomes (PLO)														
	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
Course Average	**3**	**2**	**3**	**3**	**2.4**	**1**	**3**	**3**	**1.4**	**3**		**2**	**3**	**2**	**2.2**

Course Unitization Plan

Unit No.		Required Contact Hours	CLOs Addressed	References
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	3,4,5
	Alternate splicing analysis	2	3	3,4,5
	Identifying the Non-coding RNA sequences,	2	3	3,4,5
	prediction of miRNA targets.	2	3	3,4,5
	Phylogenetic analysis: Homolog, Ortholog, Paralogs and heterology; Identification of similar genes and proteins.	2	3	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 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

Bloom's Level of Cognitive Task		**Continuous Learning Assessments (60%)**				**End Semester Assessments (40%)**
		CLA-1 (15%)	**Mid-1 (15%)**	**CLA-2 (15%)**	**CLA-3 (15%)**	
Level 1	Remember	60	60	40	40	30
	Understand					
Level 2	Apply	40	40	60	60	70
	Analyse					
Level 3	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

Other Resources

Course Designers

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

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Genetic Engineering

Course Code	BIO 510	**Course Category**	CC	**L**	**T**	**P**	**C**
				2	2	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)

CLOs	Program Learning Outcomes (PLO)														
	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
Course 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

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References
Unit 1	**Foundational discoveries leading to genetic engineering**	**10**		
	Foundation experiments for principles of genetic Engineering	2	1	**1,2**
	Mendel and Barbara MacClintock experiments 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**
	Total Contact Hours	60		

Learning Assessment

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

Other Resources

Course Designers

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

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Biotechnology and Bioinformatics Lab

Course Code	BIO 511	**Course Category**	CC	**L**	**T**	**P**	**C**
				0	0	5	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 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
Outcome 5	Proficiency in diverse techniques such as cell culture, assay methods, fermentation, nanoparticle synthesis, biodegradation, and microalgae cultivation.	3	70	60

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

CLOs	Program Learning Outcomes (PLO)														
	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
Outcome 5	3	3	3	2		1	2		2	2		2	2	3	2
Average	**1.8**	**2.2**	**2.6**	**2**	**2.5**	**1.2**	**2**		**1.6**	**1.8**		**2**	**2.2**	**2.4**	**2.4**

Course Unitization Plan

Exp No.	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
1.	Operating systems and setting up programming environments	5	1	2
2.	Exploring NCBI databases: Genome, Gene, Protein, Taxonomy, SNP, HomoloGene.	5	1,2	2
3.	Programmatically parsing the Sequence and Structure files of biomolecules	5	1,2,3	2
4.	Identification of macromolecular interfaces and exploring different approaches: Solvent accessible surface, distance-based methods	5	3,4	2
5.	Torsion angle calculations for protein molecules using core python programming, using biopython library and Pymol	5	3,4	2
6.	Phylogenetic analysis using PHYLIP	5	3,4	2
7.	Molecular docking using SwissDock	5	1,3,4	2
8.	Mammalian cell culture, transfection, and fluorescent protein expression	5	5	1
9.	Evaluation of drug sensitivity by MTT assay	5	5	1
10.	Alcohol production using yeast	5	5	1
11.	Biosynthesis of nanoparticles	5	5	1
12.	Degradation of textile dyes by biocatalysts	5	5	1

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (100%)		
		Experiments (40%)	Record / Observation Note (20%)	Viva + Model (40%)
Level 1	Remember	50%		50%
	Understand			
Level 2	Apply	50%	100%	50%
	Analyse			
Level 3	Evaluate			
	Create			
Total		**100%**	**100%**	**100%**

Recommended Resources

1. Biotechnology: Academic Cell Update Edition" by David P. Clark and Nanette J. Pazdernik
2. Bioinformatics Programming Using Python. by Mitchell L Model. Publisher(s): O'Reilly Media, Inc. ISBN: 9780596154509.

Other Resources

Course Designers

1. Dr. Anil K Suresh, Associate Professor, Department of Biological Sciences, SRM University – AP.
2. Dr. Nagabhushana Rao Karampudi, Assistant Professor, Department of Biological Sciences, SRM University – AP

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Microbiology

Course Code	BIO 550	Course Category	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. Analyze microbial diversity, growth kinetics, physiology, genetics, and stress responses.
2. 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)

CLOs	Program Learning Outcomes (PLO)														
	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
Course Average	**2**	**2.6**	**3**	**2.8**	**1**	**1**	**2.4**	**3**	**1.2**	**3**		**2.8**	**3**	**1.8**	**2**

Course Unitization Plan

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
	Bacterial gene transfer mechanisms - Conjugation, Transduction, Transformation.	3	2	1, 2, 3
Unit 3	**Microbial stress response and communication**	**8**		
	Microbial stress responses, DNA damage response,	3	3	3,4,5
	Adaptation mechanisms of extremophiles. Bacteriological potential of extremophiles	2	3	3,4,5
	Bioluminescence, Bacterial biofilms, Quorum sensing, Electrical communication, Contact-dependent communications in bacteria.	3	3	3,4,5
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	1-4
Total Contact Hours		**45**		

Learning Assessment

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%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	80%		60%		30%		60%		70%	
	Understand										
Level 2	Apply	20%		40%		60%		40%		30%	
	Analyse										
Level 3	Evaluate										
	Create										
Total		**100%**		**100%**		**100%**		**100%**		**100%**	

Recommended Resources

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

Other Resources

Course Designers

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

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Immunology

Course Code	BIO 551	Course Category	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 the development, components, and functions of the immune system, including innate and adaptive immunity.
2. 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)

CLOs	Program Learning Outcomes (PLO)														
	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	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
Course Average	**3**	**2**	**3**	**3**	**2.4**	**1.4**	**2.8**	**3**	**1.6**	**3**		**2.2**	**3**	**1.8**	**2**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References
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 immunization, types of vaccines.	2	1,3,4	1, 2
Unit 4	**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
Unit 5	**Cancer Immunology**	**8**		
	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
Total Contact Hours		**45**		

Learning Assessment

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

Recommended Resources

1. 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.

Other Resources

Course Designers

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

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Pharmaceutical Biotechnology

Course Code	BIO 552	Course Category	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. Master the production and application of recombinant proteins and nucleic acids, including gene therapy and modern therapeutic techniques.
2. Understand drug development, delivery methods, and regulatory approval processes adhering to GMP standards.

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 recombinant protein production, gene therapy, and RNA interference techniques.	2	75%	65%
Outcome 2	Learn drug development stages and innovative screening methods.	2	70%	60%
Outcome 3	Understand drug metabolism, immunogenicity, and influencing factors.	3	70%	65%
Outcome 4	Explore bulk drug manufacturing techniques and therapeutic categories.	3	75%	70%
Outcome 5	Grasp regulatory processes, including GMP standards and approval procedures.	3	65%	60%

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

CLOs	Program Learning Outcomes (PLO)														
	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	3
Outcome 4	1	2	3	3	1	1	3		1			3	3	2	3
Outcome 5	3	2	3	3	1	1	2	3	2	3		3	3	3	2
Course Average	**2**	**3**	**3**	**3**	**1**	**1**	**3**	**3**	**1**	**3**		**3**	**3**	**2**	**2**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	Recombinant proteins and Nucleic acids	**7**		1,2,3
	Biophysical and Biochemical Characteristics of Therapeutic Proteins, Biosimilars	2	1	1,2,3
	Methods for Recombinant protein production in prokaryotic, plant, and animal cells	2	1	1,2,3
	Gene therapy, CRISPR Cas	2	1	1,2,3
	siRNA, mRNA Vaccines	1	1	1,2,3
Unit 2	**Drug development and Delivery**	**8**		1,2,3
	Overview of pharmaceutical product development – Lead optimization, pre-clinical evaluation, safety and tolerability, shelf life	2	2	1,2,3
	In Silico and Ultrahigh-Throughput Screening methods	2	2	1,2,3
	Drug repurposing	1	2	1,2,3
	Metabolic engineering of medicinal plants and microorganisms	2	2	1,2,3
	Microbiome therapeutics and drug delivery methods	1	2	1,2,3
Unit 3	**Drug metabolism**	**8**		1,2,3
	Pharmacokinetics - Absorption, Distribution, Metabolism and Excretion (ADME) of Drugs	3	3	1,2,3
	Pharmacodynamics	2	3	1,2,3
	Immunogenicity of therapeutic peptides, proteins and other drugs	2	3	1,2,3
	Factors influencing drug metabolism	1		1,2,3
Unit 4	**Processes and Pharmaceutical products**	**11**		1,2,3
	Bulk manufacturing of drugs - Techniques, Types of Reactions, Processes and Special Requirements	6	4	1,2,3
	Therapeutic categories - laxatives, analgesics, steroids and non-steroids, contraceptives, external antiseptics, antacids.	5	4	1,2,3
Unit 5	**Regulatory and Approval processes**	**11**		1,2,3
	GMP in drug development	4	4,5	1,2,3
	Patenting, Clinical trials, post-marketing studies	3	4,5	1,2,3
	Processes involved in drug approval by FDA, EMA, CDSCO	4	4,5	1,2,3
Total Contact Hours		**45**		

Learning Assessment

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%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	70%		60%		80%		60%		70%	
	Understand										
Level 2	Apply	30%		40%		20%		40%		30%	
	Analyse										
Level 3	Evaluate										
	Create										
Total		**100%**		**100%**		**100%**		**100%**		**100%**	

Recommended Resources

1. Pharmaceutical Biotechnology: Drug Discovery and Clinical Applications Prof. Dr. Oliver Kayser, Prof. Dr. Heribert Warzecha, Wiley publishers, 2012, ISBN:978-3527632909
2. Pharmaceutical Biotechnology: Fundamentals and Applications Daan J. A Crommelin, Robert D. Sindelar, Bernd Meibohm, springer, 2019, ISBN: 978-3030007102
3. Introduction to Pharmaceutical Biotechnology: Dispensing, Delivery, Targeting and Regulations of Biotechnological Products. Saurabh Bhatia, Satish Sardana, Tanveer Naved, Institute of Physics Publishing; 2019, ISBN: 978-0750313483

Other Resources

Course Designers

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

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Research Seminar

Course Code	AEC 503	Course Category	AEC	L	T	P	C
				0	0	1	1
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department		Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

- Enter Data

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				
Outcome 2				
Outcome 3				
Outcome 4				

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

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1															
Outcome 2															
Outcome 3															
Average															

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1				
Unit 2				
Unit 3				
Unit 4				
Unit 5				

Learning Assessment

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

Recommended Resources

1. Enter Data

Other Resources

1. Enter Data

Course Designers

1. Enter Data

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Psychology for Everyday Living

Course Code	FIC 124	**Course Category**		**L**	**T**	**P**	**C**
				3	0	0	3
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department		**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

- Enter Data

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				
Outcome 2				
Outcome 3				
Outcome 4				

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

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1															
Outcome 2															
Outcome 3															
Average															

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1				
Unit 2				
Unit 3				
Unit 4				
Unit 5				

Learning Assessment

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

Recommended Resources

1. Enter Data

Other Resources

1. Enter Data

Course Designers

1. Enter Data

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Plant and Animal Biotechnology

Course Code	BIO 512	**Course Category**	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)														
	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	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

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References
Unit 1	**Plant tissue culture**	**15**		
	Plant tissue culture media	1	1,2	1
	Totipotency; Pluripotency	1	1,2	1
	Establishment of cultures, Somatic embryogenesis: somaclonal variation, frequency selection, application and limitation	2	1,2	1
	Somatic hybridization: Isolation of protoplast, methods, major fusogens, other fusogens, identification & selection of protoplast.	3	1,2	1
	Production of Haploid Plants: Anther culture (androgenesis), Pollen culture and Ovary culture	2	1,2	1
	Organogenesis	2	1,2	1
	Germplasm conservation and cryopreservation	1	1,2	1
	Synthetic seed production	1	1,2	1
	Plant cell cultures for secondary metabolite production	1	1,2	1
	National certification and Quality management of TC plants	1	1,2	1
Unit 2	**Plant genetic manipulation**	**15**		1
	Agrobacterium-plant interaction, virulence, Ti and Ri plasmids	2	1,2	1
	opines and their significance, T- DNA transfer, disarmed Ti plasmid	2	1,2	1
	Genetic transformation: Agrobacterium tumefaciens- mediated gene delivery, cointegrate and binary vectors and their utility	2	1,2	1
	Hairy root culture	1	1,2	1
	Direct gene transfer: PEG-mediated, electroporation, particle bombardment and alternative methods	2	1,2	1
	Screenable and selectable markers	1	1,2	1
	Characterization of transgenics	1	1,2	1
	Chloroplast transformation	1	1,2	1
	Marker-free methodologies; advanced methodologies - cisgenesis, intragenesis and genome editing	1	1,2	1
	Molecular pharming - concept of plants as biofactories, production of industrial enzymes and pharmaceutically important compounds	2	1,2	1
Unit 3	**Animal cell cultures**	**10**		
	Culture conditions: Preparation, sterilization, and composition of media	2	3,4	2,3
	Role of carbon dioxide, serum, antibiotics & growth factors in cell culture.	2	3,4	2,3
	Types: primary culture, secondary culture, continuous cell lines, suspension cultures	2	3,4	2,3
	Culturing and maintenance of mammalian cells, tissues, and organs	2	3,4	2,3
	Application of animal cell culture for virus isolation and *in vitro* testing of drugs	2	3,4	2,3
Unit 4	**Transgenic animals and Vaccines**	**10**		2,3
	Transgenic animals: Method of obtaining transgenic animals using fertilized eggs and embryonic blastocyst cells.	2	3,4	2,3
	Animal models for understanding human diseases	2	3,4	2,3
	Animal cloning: Methods of cloning in animal system – rat, sheep, pig	2	3,4	2,3
	Vaccines: strategies, conventional methods of animal vaccine production	2	3,4	2,3
	Recombinant vaccines	2	3,4	2,3
Unit 5	**Animal biotechnology applications and ethics**	**10**		2,3
	Gene therapy.	2	4,5	2,3
	Cell mediated therapy: Antisense technology	2	4,5	2,3
	Stem cell technology	1	4,5	2,3
	Tissue engineering	2	4,5	2,3
	Gene drive.	1	4,5	2,3
	Ethical issues in Animal Biotechnology	2	4,5	2,3

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (50%)	
		CLA-1 (15%)		CLA-2 (25%)		CLA-3 (15%)		Mid-1 (25%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	60%		60%		80%		70%		80%	
	Understand										
Level 2	Apply	40%		40%		20%		30%		20%	
	Analyse										
Level 3	Evaluate										
	Create										
Total		**100%**		**100%**		**100%**		**100%**		**100%**	

Recommended Resources

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

Other Resources

Course Designers

1. Dr. Sutharsan Govindarajan, Asst. Professor, Dept. Of Biological Sciences. SRM University – AP
2. Dr. Prateek Gupta, Asst. Professor, Dept. Of Biological Sciences. SRM University – AP

SRM University *AP*, Andhra Pradesh

Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Summer Internship

Course Code	BIO 513	Course Category	RDIP	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. Provide hands-on experience and enhance technical skills in molecular biology and biotechnology by applying theoretical knowledge in real-world settings.
2. Prepare students for careers in molecular biology and biotechnology through exposure to industry or research environments, improving communication skills, and fostering teamwork.

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 proficiency in key molecular biology techniques or bioinformatics tools	4	75%	70%
Outcome 2	Communicate scientific findings effectively through reports and presentations.	4	75%	70%
Outcome 3	Collaborate successfully in interdisciplinary teams.	2	75%	70%
Outcome 4	Understand and practice ethical research conduct.	2	70%	65%

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

CLOs	Program Learning Outcomes (PLO)														
	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
Course Average	**3**	**3**	**3**	**3**	**3**	**1**	**2**	**2**	**2.5**	**3**		**3**	**2.75**	**2.5**	**3**

Course Unitization Plan

Unit No.	Unit Name	Required Contact hours	CLOs Addressed	References Used
Unit 1	Internship orientation, safety training, and introduction to project objectives.	4	1	1-3
Unit 2	Initial training in fundamental molecular biology techniques/ bioinformatics tools	16	1	
Unit 3	Supervised and independent execution of experiments and data collection.	30	3,4	
Unit 4	Final data analysis, preparation of the final report.	8	2	
Unit 5	Presentation of findings to peers and supervisors, with feedback and career discussions.	2	2,4	
Total Contact Hours		60		

Learning Assessment

Bloom's Level of Cognitive Task		Record / Observation Note (50%)	Presentation (50%)
Level 1	Remember	50%	20%
	Understand		
Level 2	Apply	50%	80%
	Analyse		
Level 3	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. Reading assignment related to as guided by faculty

Other Resources

Course Designers

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

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Minor research project

Course Code	BIO 514	Course Category	RDIP	L	T	P	C
				0	0	3	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 practical research skills in molecular biology and biotechnology through hands-on minor projects.
2. Foster critical thinking and scientific communication by guiding students in designing, conducting, and presenting research.

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	Conduct research projects in molecular biology and biotechnology, applying theoretical knowledge to practical experiments.	3	75%	70%
Outcome 2	Analyze and interpret experimental data, using appropriate scientific methods and tools.	4	75%	70%
Outcome 3	Communicate research findings clearly through written reports and oral presentations.	4	75%	70%

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

CLOs	Program Learning Outcomes (PLO)														
	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	3	3	3	3	1			2			3	3	1	3
Outcome 2	3	3	3	3	3	2			2			3	3	2	2
Outcome 3	3	3	3	3	3	2			2			3	3	2	2
Course Average	**3**	**3**	**3**	**3**	**3**	**2**			**3**			**3**	**3**	**1.8**	**2.2**

Course Unitization Plan

Unit No.	Unit Name	Required Contact hours	CLOs Addressed	References Used
Unit 1	Identify research questions and draft research objectives	10	1	1-6
Unit 2	Design experiments and prepare materials.	15	1	
Unit 3	Perform experiments and analyze data.	50	2	
Unit 4	Compile findings into comprehensive reports.	10	2	
Unit 5	Presentation of research findings	5	3	1-6
Total Contact Hours		**90**		

Learning Assessment

Bloom's Level of Cognitive Task		Record / Observation Note (50%)	Presentation (50%)
Level 1	Remember	50%	20%
	Understand		
Level 2	Apply	50%	80%
	Analyse		
Level 3	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. Reading assignment related to undergraduate project as guided by faculty

Other Resources

Course Designers

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

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Research degree project

Course Code	BIO 515	Course Category	RDIP	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)

CLOs	Program Learning Outcomes (PLO)														
	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
Course Average	**3**	**3**	**3**	**3**	**3**	**1**	**2**	**2**	**2.5**	**3**		**3**	**2.75**	**2.5**	**3**

Course Unitization Plan

Unit No.	Unit Name	Required Contact hours	CLOs Addressed	References Used
Unit 1	Internship orientation, safety training, and introduction to project objectives.	20	1	1-6
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	
Total Contact Hours		**420**		

Learning Assessment

Bloom's Level of Cognitive Task		Record / Observation Note (50%)	Presentation (50%)
Level 1	Remember	50%	20%
	Understand		
Level 2	Apply	50%	80%
	Analyse		
Level 3	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. Reading assignment related to undergraduate project as guided by faculty

Other Resources

Course Designers

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

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Molecular Virology

Course Code	BIO 553	**Course Category**	CE	**L**	**T**	**P**	**C**
				2	1	0	3
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. Develop a comprehensive understanding of virology, including virus taxonomy, replication modes, and evolutionary mechanisms across diverse hosts and environments.
2. Explore viruses' roles in molecular biology, including gene expression regulation and viral vector applications in gene therapy, advancing biotechnological understanding and 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 historical context and key figures in virology.	2	80%	75%
Outcome 2	Classify viruses, analyze their replication strategies, and explore evolutionary mechanisms across hosts.	2	80%	75%
Outcome 3	Evaluate host-virus interactions and immune responses.	2	70%	65%
Outcome 4	Apply virological knowledge to understand cellular processes and biotechnological applications.	3	70%	65%
Outcome 5	Assess the impact of emerging viral diseases and advancements in diagnostics, therapeutics, and vaccines.	3	70%	65%

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

CLOs	**Program Learning Outcomes (PLO)**														
	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	3	3	3	3	1	3	3	2			2	3	2	3
Outcome 4	3	3	3	3	3	1	3	3	2			3	3	2	2
Outcome 5	3	3	3	3	3	3	2	3	2			3	3	2	3
Average	**3**	**2.6**	**3**	**3**	**2.4**	**1.4**	**2.8**	**3**	**2**			**2.4**	**2.4**	**1.8**	**2.4**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References
Unit 1	**History and Basics of Virology**	**10**		
	History and principles of virology	2	1	1,2,3
	Contributions of Jenner, Pasteur, Koch and others to development of virology	2	1	1,2,3
	Virus-definition, Principles of virus structure, sizes and shapes	1	1	1,2,3
	The all-pervasive world of viruses	1	1	1,2,3
	Role of viruses in evolution and natural selection of species	1	1	1,2,3
	Cell culture and its role in study of viruses	1	1	1,2,3
	methods of media preparation	1	1	1,2,3
	virus quantification	1	1	1,2,3
Unit 2	**Virus Taxonomy and modes of virus replication**	**10**		1,2,3
	Classification of viruses	2	1,2	1,2,3
	Positive-, negative- and double-stranded RNA viruses	2	1,2	1,2,3
	Stages and modes of replication	2	2	1,2,3
	DNA viruses	2	2	1,2,3
	viruses of protists, bacteria, yeast, plants and insects	1	2	1,2,3
	Mechanisms of virus evolution	1	2	1,2,3
Unit 3	**Host-virus interactions**	**10**		1,2,3
	Extra- and intra-cellular host-virus interactions	3	3	1,2,3
	Host responses: innate and adaptive immune responses	2	3	1,2,3
	Mechanisms of viral manipulation of intracellular environment to promote virus replication	2	3	1,2,3
	The battle between the virus and the host.	3	3	1,2,3
Unit 4	**Role of viruses in understanding cellular molecular processes**	**10**		1,2,3
	Role of viruses in understanding regulation of eukaryotic gene expression	3	3,4	1,2,3
	role of viruses in recombinant DNA revolution	2	3,4	1,2,3
	viral vectors for gene expression and therapy	3	4	1,2,3
	HIV in understanding nuclear transport and transport receptors	2	4	1,2,3
Unit 5	**Emerging viral diseases, diagnostics, and vaccines**	**5**		1,2,3
	Emerging and re-emerging viral infections	1	4,5	1,2,3
	Diagnostic virology	1	4,5	1,2,3
	Antiviral agents	1	5	1,2,3
	Virus-induced cancer and therapy	1	5	1,2,3
	viral vectors and applications, vaccines	1	5	1,2,3
			45	

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (60%)								End Semester Exam (40%)	
		CLA-1 (10%)		CLA2 (15%)		CLA-3 (15%)		Mid-2 (20%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	40%		60%		40%		60%		70%	
	Understand										
Level 2	Apply	60%		40%		60%		40%		30%	
	Analyse										
Level 3	Evaluate										
	Create										
Total		**100%**		**100%**		**100%**		**100%**		**100%**	

Recommended Resources

1. Fields Virolgy Vol 1: Peter Howley, David M. Knipe, Sean Whelan, Lippincott Williams & Wilkins; 7th edition, 2020, ISBN: 978-1975112547.
2. Fields Virolgy Vol 2, Peter Howley, David M. Knipe, Blossom A. Damania, Jeffrey I. Cohen. Lippincott Williams & Wilkins; 7th edition, 2020, ISBN: 978-1975112578
3. Virology-Principles and Applications: John Carter, Venetia Saunders. 2013, Wiley; 2nd edition, 2020, ISBN: 978 111999142-7.

Other Resources

Course Designers

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

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Programming and Computational Biology

Course Code	BIO 554	**Course Category**	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. 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)

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and ICT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	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

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References
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**	**10**		
	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.	2	1,2	1,3
	Performing DNA and Protein Sequence searches and automating the processes using programming.	3	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**	**5**		
	Advantages of databases.	1	5	4
	Structured Query Language (SQL): PostgreSQL, MariaDB.	1	5	4
	Creating interface between programming languages and databases.	1	5	4
	Developing a database.	2	5	4
		45		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (60%)				End Semester Assessments (40%)
		CLA-1 (15%)	Mid-1 (15%)	CLA-2 (15%)	CLA-3 (15%)	
Level 1	Remember	50	40	30	50	20
	Understand					
Level 2	Apply	50	60	70	50	80
	Analyse					
Level 3	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. 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. 3. Learn to code: learn HTML, CSS & JavaScript & build a website, app and game: Garry Owen, TRW publishers; 2022, ISBN: 979-8417818691
4. 4. Database System Concepts (7th Edition). Abraham Silberschatz, Henry F. Korth, S. Sudarshan. (2021). McGraw Hill. ISBN-13 978-9390727506

Other Resources

Course Designers

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

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Immunotherapeutic

Course Code	BIO 555	Course Category	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 immune system modulation, including immunotherapy principles, cancer immunosurveillance, and immune evasion mechanisms.
2. Gain knowledge in advanced immunotherapy techniques along with their clinical applications and ethical considerations.

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 immune system activation, cancer immunosurveillance, and immune evasion.	2	80%	75%
Outcome 2	Learn about monoclonal antibodies and immune checkpoint inhibitors.	2	70%	65%
Outcome 3	Gain knowledge in adoptive cell therapy and CAR-T cells.	3	70%	65%
Outcome 4	Comprehend cancer vaccines and oncolytic viruses.	3	70%	65%
Outcome 5	Explore emerging immunotherapies and their ethical implications.	4	70%	65%

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

CLOs	Program Learning Outcomes (PLO)														
	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	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
Course Average	**3**	**2**	**3**	**3**	**2.4**	**1.4**	**2.8**	**3**	**1.6**	**3**		**2.2**	**3**	**1.8**	**2**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References
Unit 1	**- Immunomodulation**	**9**		
	Overview of immunotherapy and its historical development. Principles of immune system activation and modulation.	2	1	1, 2, 3
	Cancer immunosurveillance and immunoediting.	3	1	1, 2
	Tumor microenvironment and immune evasion mechanisms.	2	1	1, 2, 3
	Immunotherapy targets: tumor antigens and immune checkpoints.	2	1	1, 2
Unit 2	**Monoclonal Antibodies and Immune Checkpoint Inhibitors**	**10**		
	Monoclonal antibodies: production, engineering, and applications.	2	1, 2	1, 2, 3
	Immune checkpoint inhibitors: CTLA-4, PD-1, and PD-L1.	2	1, 2	1, 2
	Combination therapies with immune checkpoint inhibitors.	2	1,2	1, 2, 3
	Immune-related adverse events and management strategies.	2	2	1, 2
	Biomarkers and patient selection for immune checkpoint inhibitor therapy.	2	2	1, 2
Unit 3	**Adoptive Cell Therapy and CAR-T Cells**	**8**		
	Principles of adoptive cell therapy and its applications. Tumor-infiltrating lymphocyte (TIL) therapy.	2	1,3,4	1, 2, 3
	Chimeric antigen receptor (CAR) T-cell therapy: design and function.	2	1,3,4	1, 2
	CAR-T cells in hematologic malignancies and solid tumors.	2	1,3,4	1, 2
	Toxicities, management, and future directions of CAR-T cell therapy.	2	1,3,4	1, 2, 3
Unit 4	**Cancer Vaccines and Oncolytic Viruses**	**8**		
	Cancer vaccine types: prophylactic and therapeutic.	1	4	1, 2
	Peptide-based and dendritic cell-based cancer vaccines.	2.5	4	1, 2
	Oncolytic viruses: mechanism of action and delivery strategies.	2.5	4	1, 2
	Clinical applications of oncolytic viruses in cancer therapy.	1	4	1, 2
	Challenges and future prospects in cancer vaccine and oncolytic virus development.	1	4	1, 2, 3
Unit 5	**Emerging Immunotherapies**	**10**		
	Bispecific T-cell engagers (BiTEs) and other multispecific antibodies.	1	1,5	1, 2, 3
	T-cell receptor (TCR)-engineered T cells.	1	1,5	1, 2, 3
	Personalized neoantigen-based cancer vaccines.	2	1,5	1, 2, 3
	Combination immunotherapies and overcoming resistance.	2	1,5	1, 2, 3
	Ethical, legal, and social implications of immunotherapy advancements.	2	1,5	1, 2, 3
Total Contact Hours		**45**		

Learning Assessment

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%)	
		Th	Th	Th	Th	Th
Level 1	Remember	70%	60%	40%	60%	70%
	Understand					
Level 2	Apply	30%	40%	60%	40%	30%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Cellular and Molecular Immunology: Abbas, A. K., Lichtman, A. H. Litchman, Pillai. S. Elsevier; 9th edition, 2019, ISBN-13 978-0323479783
2. Janeway's Immunobiology: Murphy, K., Weaver, C, Janeway. W.W. Norton & Company; 9th edition, 2017, ISBN: 978-0815345510
3. Cancer Immunotherapy: Immune Suppression and Tumor Growth George C. Prendergast, Elizabeth M. Jaffee. Academic Press; 2nd edition, 2013, ISBN: 978-0123942968

Other Resources

Course Designers

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

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Genomics and Proteomics

Course Code	BIO 556	Course Category	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)

CLOs	Program Learning Outcomes (PLO)														
	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	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
Course Average	**3**	**2**	**3**	**3**	**2.4**	**1.4**	**2.8**		**1.6**			**2.2**	**3**	**1.8**	**2**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References
Unit I	**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
	Human Genome Project	1	1	1-2
Unit II	**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 III	**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 IV	**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 V	**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
Total Contact Hours		**45**		

Learning Assessment

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%)	
		Th	Th	Th	Th	Th
Level 1	Remember	70%	60%	40%	60%	70%
	Understand					
Level 2	Apply	30%	40%	60%	40%	30%
	Analyse					
Level 3	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

Other Resources

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

SRM University *AP*, Andhra Pradesh
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Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Molecular Mechanisms of Diseases

Course Code	BIO 557	**Course Category**	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 microbial, viral, systemic, neurological, and plant diseases, including their classification and therapeutic strategies.
2. 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)

CLOs	Program Learning Outcomes (PLO)														
	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	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
Course Average	**3**	**2**	**3**	**3**	**2.4**	**1.4**	**2.8**		**1.6**			**2.2**	**3**	**1.8**	**2**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References
Unit I	**Common Microbial Diseases and Therapeutics**	**9**		
	Introduction to human microbial infections	1	1	1
	ESKAPEE pathogens and Mycobacterium tuberculosis	1	1	1
	Fungal (candida albicans) 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 II	**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 III	**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 IV	**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
Unit V	**Plant Diseases**			
	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

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%)	
		Th	Th	Th	Th	Th
Level 1	Remember	70%	60%	40%	60%	70%
	Understand					
Level 2	Apply	30%	40%	60%	40%	30%
	Analyse					
Level 3	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

Other Resources

Course Designers

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

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Biosafety and IPR

Course Code	BIO 558	Course Category	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)

CLOs	Program Learning Outcomes (PLO)														
	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	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
Course Average	**3**	**2.8**	**3**	**3**	**2.8**	**2**			**1.8**			**2.2**	**3**	**1.8**	**2.2**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References
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
Total Contact Hours		**45**		

Learning Assessment

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%)	
		Th	Th	Th	Th	Th
Level 1	Remember	70%	60%	40%	60%	70%
	Understand					
Level 2	Apply	30%	40%	60%	40%	30%
	Analyse					
Level 3	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

Other Resources

Course Designers

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

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Bioinformatics Analysis pipelines

Course Code	BIO 559	**Course Category**	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. Develop programming skills in Python, Bash, and bioinformatics tools for automating analysis pipelines.
2. Gain expertise in transcriptomics, proteomics, genomics, epigenomics, and evolutionary biology data 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	Master programming skills in Python, Bash, and bioinformatics tools for automating analysis pipelines	3	75%	70%
Outcome 2	Analyze RNASeq data, perform differential gene expression analysis, and interpret gene network dynamics	3	70%	65%
Outcome 3	Automate proteomics workflows, including structural alignment, protein modeling, and molecular dynamics simulations	3	70%	65%
Outcome 4	Perform NGS data analysis, genome assembly, and epigenome data analysis for applications in genomics and cancer detection	3	70%	65%
Outcome 5	Conduct phylogenetic and phylogenomic analyses to understand gene evolution and synteny	3	70%	65%

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

CLOs	Program Learning Outcomes (PLO)														
	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	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
Course Average	**3**	**2.8**	**3**	**3**	**2.8**	**2**			**1.8**			**2.2**	**3**	**1.8**	**2.2**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References
Unit 1	**Programming and Software**	**10**		
	Operating Systems	2	1	1,3
	Bash, Python programming: Core, Object Oriented Programming,	2	1	1,3
	biopython, Pandas, Network,	1	1	1,3
	Scikit-learn, matplotlib.	2	1	1,3
	Analysis pipelines and automation.	2	1	1,3
	Working with computer clusters. Version control	1	1	1,3
Unit 2	**Transcriptomics**	**8**		
	RNASeq data analysis pipeline: Raw data to RPKM/FPKM/TPM dataset processing, annotation,	3	2	4
	Correlation analysis, Differential gene expression analysis,	3	2	4
	Candidate gene(s) and gene network dynamics	2	2	4
Unit 3	**Proteomics**	**7**		
	Automating: Database queries, Structural alignment, Scoring,	2	3	1,2,4
	Structure analysis: Visualization softwares: PyMol, VMD.	1	3	1,2,4
	Protein modeling, Docking,	2	3	1,2,4
	Molecular Dynamics simulation studies using ACEMD/NAMD/Gromacs	2	3	1,2,4
Unit 4	**Genomics and Epigenome**	**10**		
	NGS data,	1	4	5
	Genome assembly pipeline: De novo and Reference based using Trinity and Oasis.	2	4	5
	Genome browser,	1	4	5
	Genome wide association studies,	2	4	5
	Cancer detection using NGS data.	2	4	5
	Epigenome data analysis pipeline	2	4	5
Unit 5	**Evolutionary Biology**	**10**		
	Homologous gene identification,	2	5	1,6
	Gene synteny.	2	5	1,6
	Phylogenetic analysis	2	5	1,6
	Tree building, comparisons.	2	5	1,6
	Phylogenomics	2	5	1,6
Total Contact Hours		**45**		

Learning Assessment

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%)	
		Th	Th	Th	Th	Th
Level 1	Remember	70%	60%	40%	60%	70%
	Understand					
Level 2	Apply	30%	40%	60%	40%	30%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Bioinformatics Data Skills: Reproducible and Robust Research with Open-Source Tools Vince.B, O'Reilly Publishers; 1st edition, 2015, ISBN: 978-1449367374.
2. Practical Computing for Biologists: Steven .H, Casey W. Dunn, Sinauer Publishers; 2011, ISBN: 978-0878933914.
3. Python for the Life Sciences: A gentle introduction to Python for life scientists, Alexander. L, Gordon Webster, Springer India; 1st edition, 2021, ISBN: 978-1484275535
4. RNA-Seq Data Analysis: A practical approach, Mikael .H, 2017, CRC publishers; ISBN: 978- 1466595019.
5. Next Generation DNA Sequencing Informatics: Stuart. B, CSH Publishers; 2013, ISBN: 978- 1936113873
6. Computational Phylogenetics: An introduction to designing methods for phylogeny estimation. Warnow. T, Cambridge University Press; 1st edition, 2017, ISBN: 978-1107184718.

Other Resources

Course Designers

1. Prof. Naga Bhushana Rao Karampudi. Assistant Professor, Dept. Of Biological Sciences. SRM University – AP

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Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Bio nanotechnology

Course Code	BIO 507	Course Category	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 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)

CLOs	Program Learning Outcomes (PLO)														
	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
Course 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

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References
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
Unit 5	**Biomedical applications of nanomaterials**	**10**		
	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
Total Contact Hours		**45**		

Learning Assessment

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

Other Resources

Course Designers

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

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Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Cell Biology

Course Code	BIO 506	**Course Category**	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 cell biology, including cell structure, cellular processes, cell cycle regulation, and signaling 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 signaling, including receptor-ligand interactions and major signaling 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)

CLOs	Program Learning Outcomes (PLO)														
	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
Course 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

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References
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
	Eukaryotic cells and types (unicellular and multi-cellular eukaryotes)	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
Unit 4	**Cellular Signaling pathways**	**10**		
	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
Unit 5	**Stem cells**	**10**		
	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

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

Other Resources

Course Designers

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

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Biochemistry and Metabolism

Course Code	BIO 505	**Course Category**	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)

CLOs	Program Learning Outcomes (PLO)														
	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
Course 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

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References
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**		

Learning Assessment

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

Other Resources

Course Designers

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