GSFC UNIVERSITY
EDUCATION RE-ENVISIONED
An ISO 9001:2015 Certified

COURSE CURRICULUM

M.Sc. Biotechnology

Batch:2025-2026
Academic Year: 2025-26
Updated on: May, 2025

GSFC University
School of Sciene, Vigyan Bhavan, P. O. Fertilizernagar, Vadodara - 391750, Gujarat, India

VISION

- GSFCU strives to be the best compact boutique institution with a futuristic approach, encouraging student centric culture and sharpened focus on developing industry ready & employable students with all-round development.

MISSION

- Establish an institution, which promotes creativity and innovation.
- Develop unique quality standards for academic excellence and pedagogical innovations.
- Remain agile through learning ecosystem with flexible processes & systems.
- Holistic growth for industry readiness.

No.	Programme Outcomes (POs)	Blooms' Taxonomy Domain	Blooms' Taxonomy Sub Domain
PO1	To impart knowledge regarding basic concepts of applied biological sciences.	Basic Knowledge	Explain, Describe, Discuss, Recall, Locate
PO2	To explain the relationships between biological sciences, chemical sciences, physical sciences and mathematical sciences.	Interdisciplinary approach	Apply, Practice, Interpret, Select, Correlate
PO3	To perform procedures as per laboratory standards in the areas of Biological Sciences and to think analytically.	Practical learning	Compare, Classify, Select, Investigate
PO4	To communicate effectively in terms of reading, writing, speaking and delivering the view to others.	Effective Communication and social Interaction	Explain, Describe, outline, Predict, Summarize
PO5	To culminate and understand the moral values for any of the subjects with respect to good practices and humanity.	Ethics	Judge, Assess, Estimate, Predict, Argue
PO6	To explain the importance of ecological balance along with conservation of natural resources for human well being.	Environment and Sustainability	Construct, Develop, Produce

No.	Programme Specific Outcomes (PSOs)	Blooms' Taxonomy Domain	Blooms' Taxonomy Sub Domain
PSO1	Understanding of biotechnology related research and industrial applications.	Remembering and Understanding	Explain, Describe, Discuss, Recall, Locate
PSO2	Expertise in interpreting complex data related to biotechnology problems and challenges.	Application and Analysing	Apply, Practice, Interpret, Select, Correlate
PSO3	Expertise in knowledge needed to solve current and emerging technologies.	Analysing	Compare, Classify, Select, Investigate
PSO4	Understanding related to questions they need to ask and in – depth research they need to conduct.	Understanding	Explain, Describe, outline, Predict, Summarize
PSO5	Expertise in communicating issues related to industrial biotechnology to a wide audience.	Evaluating	Judge, Assess, Estimate, Predict, Argue
PSO6	Expertise in solving complex social and ethical problems confronting the industry and the government.	Creating	Construct, Develop, Produce

Mapping of POs & PSOs:

	PO1	PO2	PO3	PO4	PO5	PO6
PSO1	2	2	3	3	3	2
PSO2	3	2	2	2	3	3
PSO3	3	3	3	2	2	1
PSO4	3	3	2	2	2	2
PSO5	2	3	2	3	2	2
PSO6	2	2	2	2	3	2
Avg.	2.5	2.5	2.3	2.3	2.5	2

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); 0 None

No.	Programme Educational Outcomes (PEOs)	Blooms' Taxonomy Domain	Blooms' Taxonomy Sub Domain
PEO1	Graduates will establish successful careers in biotechnology, pharmaceuticals, agriculture, healthcare, or research sectors at the national and international levels.	Basic Knowledge	Explain, Describe, Discuss, Recall, Locate
PEO2	Graduates will pursue higher education (Ph.D. or postdoctoral research) and/or engage in continuous professional development and advanced certifications.	Practical learning	Apply, Practice, Interpret, Select, Correlate
PEO3	Graduates will apply interdisciplinary knowledge, demonstrate leadership, and work effectively in collaborative teams with ethical and professional values.	Interdisciplinary learning	Compare, Classify, Select, Investigate
PEO4	Graduates will contribute to sustainable development and innovation by addressing societal, environmental, and industrial challenges through biotechnology.	Environment and Sustainability	Explain, Describe, outline, Predict, Summarize
PEO5	To develop and understand the ethical values for any of the subjects with respect to good practices and humanity.	Ethics	Judge, Assess, Estimate, Predict, Argue

Mapping of POs & PEOs:

	PO1	PO2	PO3	PO4	PO5	PO6
PEO1	3	3	3	3	3	2
PEO2	3	2	2	2	3	3
PEO3	3	3	3	2	2	1
PEO4	3	3	3	2	2	2
PEO5	2	3	2	3	2	2
Avg.	2.5	2.5	2.3	2.3	2.5	2

Definition of Credit:

1 Hour Lecture (L) per week	1 credit
1 Hour Tutorial (T) per week	1 credit

2 Hours Practical (P) per week	1 credit
1 Hour Practical (P) per week	0.5 credit
3 Hours Experiential learning	1 credit

Course code Definitions:

Lecture	L
Tutorial	T
Practical	P
Professional core courses /Major (Core)	PCC
Professional Elective courses /Minor Stream	PEC
Open Elective courses	OEC
Non-credit courses	NC
Project (Experiential learning)	PROJ
Experiential learning ex. Internship, Industrial Visit, Field visit, etc,	EL
Multidisciplinary courses	MDC
Ability Enhancement Course	AEC
Skill Enhancement Course	SCE
Value Added Courses	VAC

Structure of Postgraduate Programme:

Sr. No.	Category	Credit Breakup
1	Professional core courses -**Major (Core)**	45
2	Professional Elective courses relevant to chosen specialization/branch - **Minor Stream**	19
3	Project work, seminar and internship in industry or elsewhere	26
4	Multidisciplinary courses	15
	Total	**105**

1. Professional Major Courses (Core)

i. Number of Professional Core Courses (Major): 9
ii. Credits: 45

Sr. No.	Course Code	Course Name	Semester	Teaching Scheme (Hours/week)				Teaching Credit			
				L	P	T	Total	L	P	T	Total
1	MSBO131	Advanced Biomolecules & Biochemistry	I	3	2	0	5	3	2	0	5
2	MSBO132	Basics of Bioinformatics	I	2	2	1	5	2	2	1	5
3	MSBO133	Plant and Animal Biotechnology	I	3	2	0	5	3	2	0	5
4	MSBO134	Molecular Diagnostics	I	3	2	0	5	3	2	0	5
5	MSBO231	Advanced Cell and Molecular Biology	II	3	2	0	5	3	2	0	5
6	MSBO233	Bioprocess Engg. and Technology	II	3	2	0	5	3	2	0	5
7	MSBO234	Advance Immunology	II	3	2	0	5	3	2	0	5
8	MSBO323	Genetic Engineering	III	3	2	0	5	3	2	0	5
9	MSBO324	Computational Biology	III	3	2	0	5	3	2	0	5
		Total		**26**	**18**	**1**	**45**	**26**	**18**	**1**	**45**

2. Multidisciplinary Courses (MDC)

i. Number of Multidisciplinary Courses:04
ii. Credits: 15

Sr. No.	Course Code	Course Name	Semester	Teaching Scheme (Hours/week)				Teaching Credit			
				L	P	T	Total	L	P	T	Total
1	MSBO238	Nano Science	II	3	2	0	5	3	2	0	5
2	MSBO322	Emerging Technology	III	3	2	0	5	3	2	0	5
3	MSBO327	Ecology & Evolution	III	3	0	0	3	3	0	0	3
4.	NOC01	NPTEL	III	0	2	0	2	0	2	0	2
		Total		**9**	**6**	**0**	**15**	**9**	**6**	**0**	**15**

3. Skill Enhancement Courses (Internships & Dissertation)

i. Number of Skill Enhancement Courses:04
ii. Credits: 26

Sr. No.	Course Code	Course Name	Semester	Teaching Scheme (Hours/week)				Teaching Credit			
				L	P	T	Total	L	P	T	Total
1	MSBO138	Internship	I	0	2	0	2	0	2	0	2
2	MSBO237	Internship	II	0	2	0	2	0	2	0	2

3	MSBO328	Internship	III	0	2	0	2	0	2	0	2
4	MSBO401	Dissertation & Viva	IV	0	20	0	20	0	20	0	20
		Total		**0**	**26**	**0**	**26**	**0**	**26**	**0**	**26**

4. Elective courses

i. Number of Skill Enhancement Courses: 08
ii. Credits: 19

Sr. No.	Course Code	Course Name	Semester	Teaching Scheme (Hours/week)				Teaching Credit			
				L	P	T	Total	L	P	T	Total
1	MSBO135	Biostatistics	I	2	0	0	2	2	0	0	2
2	MSBO137	Genetics	I	2	0	0	2	2	0	0	2
3	MSBO136	Biopython	I	2	0	0	2	2	0	0	2
4	MSBO232	Research Methodology & IPR	II	2	0	0	2	2	0	0	2
5	MSBO236	Advance biopython	II	2	0	0	2	2	0	0	2
6	MSBO325	Agriculture Microbiology	III	3	0	0	3	3	0	0	3
7	MSBO326	Food technology	III	3	0	0	3	3	0	0	3
8	MSBO327	Ecology and evolution	III	3	0	0	3	3	0	0	3
		Total		**19**	**0**	**0**	**19**	**19**	**0**	**0**	**19**

About the Programme:

Science forms the basic foundation for any technological and engineering creation. Considering the evolving national and international landscape in the field of Science and Technology, there is significant demand for basic sciences coupled with substantial knowledge of their applications. GSFC University is dedicated to maintaining high academic standards.

The M.Sc. The Biotechnology Program is a degree designed for four semesters in a way that establishes a solid foundation of subjects while addressing applications and recent developments. Students will also gain theoretical and practical knowledge by completing an industrial internship after each semester.

Teaching and Examination Scheme

Semester I

Sr. No.	Course Code	Course Name	Course Type	L	T	P	T	P	MSE	CEC	ESE	LW	LE/VIVA	Total Marks
1	MSBO131	Advanced Biomolecules & Biochemistry	Compulsory	3	0	2	05		20	40	40	50		150
2	MSBO132	Basics of Bioinformatics	Compulsory	2	1	2	05		20	40	40	50		150
3	MSBO133	Plant and Animal Biotechnology	Compulsory	3	0	2	05		20	40	40	50		150
4	MSBO134	Molecular Diagnostics	Compulsory	3	0	2	05		20	40	40	50		150
5	MSBO135	Biostatistics	Elective	2	0	0	02		20	40	40	00		100
6	MSBO136	Biopython	Elective	2	0	0			20	40	40			
7	MSBO137	Genetics	Elective	2	0	0			20	40	40			
8	MSBO138	Internship	Compulsory Skill Enhancement	0	0	2	02		0	0	0	50		50
	Total						**24**							**750**

Semester II

Sr. No.	Course Code	Course Name	Course Type	L	T	P	T	P	MSE	CEC	ESE	LW	LE/VIVA	Total Marks
1	MSBO231	Advanced Cell and Molecular Biology	Compulsory	3	0	2	05		20	20	40	50		50
2	MSBO238	Nanoscience	Compulsory	3	0	0	05		20	20	40	50		
3	MSBO233	Bioprocess Engg. and Technology	Compulsory	3	0	2	05		2	20	40	50		50
4	MSBO234	Advanced Immunology	Compulsory	3	0	2	05		2	20	40	50		50
5	MSBO232	Research methodology and IPR	MDC/Elective	3	0	2	02		20	20	40	00		50
6	MSBO236	Advanced Biopython	Elective	2	0	0			20	20	40			
7	MSBO237	Internship	Compulsory Skill Based	0	0	2	02		2	0	0			50
	Total						**24**							**750**

Semester III

Sr. No.	Course Code	Course Name	Course Type	L	T	P	T	P	MSE	CEC	ESE	LW	LE/VIVA	Total Marks
1	MSBO321	Project Proposal Prep.	Core	3	0	2	05		20	20	40	50		150
2	MSBO322	Emerging Technology	MDC	3	0	0	05		20	20	40	50		150
3	MSBO323	Genetic Engineering	Core	3	0	2	05		2	20	40	50		150
4	MSBO324	Computational Biology	Core	3	0	2	05		2	20	40	50		150
5	MSBO325	Agriculture Microbiology	Elective	3	0	0	03		20	20	40	00		100
6	MSBO326	Food Technology	Elective	3	0	0			20	20	40			
7	MSBO328	Ecology & Evolution	MDC	3	0	0			20	20	40			
8	NOC01	NPTEL Online Courses	Elective	0	0	0	02		0	0	0	00		100
9	MSBO328	Internship+Dissertation clubed	Skill Based	0	0	2	02		0	0	0	00		50
	Total						**27**							**850**

Semester IV

Sr. No.	Course Code	Course Name	Course Type	L	T	P	T	P	MSE	CEC	ESE	LW	LE/VIVA	Total Marks
1	MSBO411	Dissertation & Viva	Project Work	0	0	20	20		00	00	00	100		100
	Total						**20**							**100**

COURSE CODE MSBO131	COURSE NAME ADVANCED BIOMOLECULES AND BIOCHEMISTRY	SEMESTER I

Teaching Scheme (Hours)				Teaching Credit			
Lecture	Practical	Tutorial	Total Hours	Lecture	Practical	Tutorial	Total Credit
3	4	0	45+60	3	2	0	5

Course Pre-requisites	Students should have basic knowledge about advanced biomolecules and biochemistry
Course Category	Core Professional.
Course focus	Scientific Temperament & Employability
Rationale	Advanced biomolecules and biochemistry are vital for students as they provide a comprehensive understanding of the molecular basis of life processes, laying the foundation for research and innovation in biotechnology, medicine, and drug discovery, thereby preparing students for careers in academia, industry, and healthcare.
Course Revision/ Approval Date:	06/03/24
Course Objectives (As per Blooms' Taxonomy)	1. **Remember** To introduce the field of advanced biomolecules and biochemistry. 2. **Apply** To understand advanced biomolecules and biochemistry. 3. **Analyses** Understanding of advanced biomolecules and biochemistry 4. **Create** Understanding of strategies to study advanced biomolecules and biochemistry 5. **Understand** advanced biomolecules and biochemistry

Course Content (Theory)	Weightage	Contact hours
Unit 1: Carbohydrate and its metabolism: Structure, classification, function, clinical significance and metabolism.	**20%**	**9**
Unit 2: Protein and amino acid and it's metabolism: Structure, classification, function, clinical significance and metabolism.	**20%**	**9**
Unit 3: Lipids and it's metabolism: Structure, classification, function, clinical significance and metabolism.	**20%**	**9**
Unit 4: Nucleic acid and it's metabolism: Structure, classification, function, clinical significance and metabolism.	**20%**	**9**
Unit 5: Cell membrane: It's integrity, complexity and molecular structure.	**20%**	**9**
Practicals: 1.Preparing various stock solutions and working solutions that will be needed for the course. 2 To determine an unknown protein concentration by plotting a standard graph of BSA using UV-Vis Spectrophotometer and validating the Beer- Lambert's Law. 3 To prepare an Acetic-Na Acetate Buffer and validate the Henderson-Hasselbeck Equation. 4 Titration of Amino Acids and separation of aliphatic, aromatic and polar amino acids by thin layer chromatography. 5 Experimental verification that absorption at OD260 is more for denatured DNA as compared to native double stranded DNA. 6 Reversal of the same following DNA renaturation. Kinetics of DNA renaturation as a function of DNA size. 7 Identification of an unknown sample as DNA, RNA or protein using available laboratory tools. (Optional Experiments) 8 Biophysical methods (Circular Dichroism Spectroscopy, Fluorescence Spectroscopy). (Online: Video Tutorials) 9 Determination of mass of small molecules and fragmentation patterns by Mass Spectrometry (Online: Video Tutorials)		

Instructional Method and Pedagogy:
Audio-Visual Lectures, Quizzes, Debates, Project works, Case studies, and Assignments Practical exercises are designed to understand the theory as taught in classroom. Hands on in practical session.

Course Outcomes:	Blooms' Taxonomy Domain	Blooms' Taxonomy Sub Domain
After successful completion of the above course, students will be able to: **CO1** They will be able to recall and describe key biochemical pathways and processes involved in metabolism, signaling, and regulation within living organisms.	Remember	Explain, Describe, Discuss, Recall,
CO2 They will demonstrate the ability to summarize and compare different biochemical processes and their significance in cellular function and organismal physiology.	Apply	Interpret, Select,
CO3 Students will critically evaluate scientific literature and research findings related to advanced biomolecules and biochemistry, identifying strengths, weaknesses, and gaps in existing knowledge.	Analyses and Evaluation	Compare, Classify, Select,
CO4 Utilizing their knowledge of biomolecules and biochemical principles, students will analyze experimental data and design experiments to investigate biological questions or solve practical problems.	Create	Construct, Develop,
CO5 They will demonstrate creativity and innovation in problem-solving, synthesizing information to generate new insights or applications in biotechnology, medicine, or other relevant fields.	Understand	Explain, Describe, outline, Predict, Summarise

Learning Resources	
1.	Textbook & Reference Books 1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006).Biochemistry. VI Edition. 2. W.H Freeman andCo. 2. Buchanan, B., Gruissem, W. and Jones, R. (2000) Biochemistry and Molecular Biology of Plants. American Society of Plant Biologists. 3. Nelson, D.L., Cox, M.M. (2004) Lehninger Principles of Biochemistry, 4th Edition, WH Freeman and Company, New York, US 4. A.L. Lehninger: Biochemistry.
2.	Journals & Periodicals 1. JBC 2. Current Science
3	Other Electronic resources: NPTEL

<table>
<tr><th>Evaluation Scheme</th><th>Total Marks</th></tr>
<tr><td>Theory: Mid semester Marks</td><td>20 marks</td></tr>
<tr><td>Theory: End Semester Marks</td><td>40 marks</td></tr>
<tr><td>Theory: Continuous Evaluation Component Marks</td><td>
<table>
<tr><td>Attendance</td><td>05 marks</td></tr>
<tr><td>MCQs</td><td>10 marks</td></tr>
<tr><td>Skill enhancement activities / case study</td><td>15 marks</td></tr>
<tr><td>Presentation/ miscellaneous activities</td><td>10 marks</td></tr>
<tr><td>Total</td><td>40 Marks</td></tr>
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<tr><td>Practical Marks</td><td>
<table>
<tr><td>Attendance</td><td>05 marks</td></tr>
<tr><td>Practical Exam</td><td>30 marks</td></tr>
<tr><td>Viva</td><td>10 marks</td></tr>
<tr><td>Journal</td><td>5 marks</td></tr>
<tr><td>Total</td><td>50 Marks</td></tr>
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Mapping of PSOs and COs

PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO						
CO1	1	-	2	1	1	-
CO2	1	3	2	2	-	-
CO3	1	-	-	1	2	1
CO4	2	3	2	-	2	2
CO5	2	1	-	1	-	2

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Mapping of POs and COs

PO	PO1	PO2	PO3	PO4	PO5	PO6
CO						
CO1	3	2	-	2	2	1
CO2	-	1	1	2	-	-
CO3	2	-	-	1	2	1
CO4	2	1	2	3	2	2
CO5	-	1	-	2	-	3

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURS CODE MSBO132	COURSE NAME BASICS OF BIOINFORMATICS	SEMESTER I

Teaching Scheme (Hours)				Teaching Credit			
Lecture	Practical	Tutorial	Total Hours	Lecture	Practical	Tutorial	Total Credit
2	4	1	30+60+15	2	2	1	5

Course Prerequisites	Basic Knowledge of computers
Course Category	Core
Course focus	Scientific Temperament & Employability
Rationale	Know how to develop your skills in Python Retrieve and analyze the biological data
Course Revision/ Approval Date:	09/05/2025
Course Objectives (As per Blooms' Taxonomy)	• **To Remember** Recall fundamental concepts of molecular biology—including DNA, RNA, and protein structures—and understand bioinformatics databases and tools such as NCBI, BLAST, and GenBank. • **To Understand** and Explain the role of bioinformatics in analyzing biological data and its importance in modern research. • **To Analyze Analyze** Interpret biological datasets to identify patterns and relationships.Evaluate the results of bioinformatics tools to draw meaningful conclusions. • **To Apply** Utilize bioinformatics software to perform sequence analysis and data visualization. • **To Create** Develop simple bioinformatics pipelines to address specific biological questions

Course Content Theory	**Weigh tage**	**Contact hours**
Unit 1: Introduction to Bioinformatics . Explore bioinformatics fundamentals, applications, and key biological databases, including protein, nucleic acid, and structural databases	**20%**	**6**
Unit 2: Pair wise alignment: Introduction, Dot Plot, Dynamic Programming, K- tuple, Fasta, Blast and introduction to scoring matrices	**20%**	**6**
Unit 3: Overview of Multiple Sequence Alignment (MSA), covering its introduction, key algorithms—including dynamic programming, progressive, and iterative methods—and commonly used tools.	**20%**	**6**
Unit 4: Phylogenic Analysis: Concepts of neutral evolution, molecular divergence and molecular clocks; Phylogenetic representations, Definition and description, various types of trees; Steps in constructing a tree Phylogenetic analysis algorithms: Maximum Parsimony, UPGMA, Transformed Distance, Neighbors-Relation and Neighbor-Joining	**20%**	**6**
Unit 5: Data ethics and Database: Data ethics, Introduction to Databases, DBMS Definition, Characteristics of DBMS, Application and advantages of DBMS	**20%**	**6**

Practicals:

1. Retrieving sequences from public Nucleotide databases (e.g., NCBI GenBank, EMBL, DDJB).
2. Retrieving sequences from public Protein databases (UniProt)
3. Retrieving sequences from public Protein Structural databases (PDB)
4. Performing sequence similarity searches using tools like BLAST (Basic Local Alignment Search Tool).
5. Pairwise sequence alignment (e.g., global alignment, local alignment) using tools such as EMBOSS Needle or BLAST.
6. Multiple sequence alignment (e.g., using ClustalW, MUSCLE) to align multiple sequences for comparative analysis.
7. Identifying open reading frames (ORFs) in nucleotide sequences.
8. Predicting protein structure and function from amino acid sequences using tools like InterProScan or Pfam.
9. Constructing phylogenetic trees using various methods (e.g., Neighbor-Joining, Maximum Likelihood).

Tutorial

SNo	Name	Contact hrs
1	Unit 1: Introduction to Bioinformatics	3hrs
2	Unit 2: Pair wise alignment	3hrs
3	Unit 3: Overview of Multiple Sequence Alignment (MSA)	3hrs
4	Unit 4: Phylogenic Analysis:	3hrs
5	Unit 5: Data ethics and Database	3hrs

Learning Resources	
1.	**Textbook & Reference Book** 1. Lesk,A.M.(2002).IntroductiontoBioinformatics.Oxford:OxfordUniversityPress. 2. Mount, D. W.(2001). Bioinformatics: Sequence and Genome Analysis. Cold Spring 3. Harbor, NY: Cold Spring Harbor Laboratory Press. 4. Baxevanis, A. D.,& Ouellette, B. F.(2001). Bioinformatics: a Practical Guide to the 5. Analysis of Genes and Proteins. New York:Wiley-Interscience. 6. Pevsner,J.(2015). Bioinformatics and Functional Genomics. Hoboken, NJ.: Wiley-Blackwell
2.	**Journals & Periodicals** 1. Journal of Bioinformatics and Computational Biology 2. Bioinformatics 3. Bioinformatics and Biology Insights 4. BMC Bioinformatics 5. Briefings in Bioinformatics
3	**Other Electronic resources**: 1) MH Education 2) NPTEL 3) Coursera

Evaluation Scheme		**Total Marks 100**
Mid semester Marks	20	
End Semester Marks	40	
Continuous Evaluation Marks	Attendance	5 marks
	Quiz	10 marks
	Skill enhancement activities / case study	10 marks
	Presentation/ miscellaneous activities	15 marks

Course Outcomes	1.Develop an understanding of basic theory of biological databases.
	2. Appreciate their relevance for investigating specific contemporary biological questions through the use of bioinformatics tools
	3. Critically analyse and interpret results of bioinformatic analysis
	4. Develop the abilities for conducting in silico experiments.
	5. Demonstrate mastery of the core concepts of Bioinformatics
Additional Information to enhance learning	Expert talk required on specific topics.

Mapping of PSOs and COs

PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO						
CO1	1	-	2	1	1	-
CO2	1	3	2	2	-	-
CO3	1	-	-	1	2	1
CO4	2	3	2	-	2	2
CO5	2	1	-	1	-	2

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Mapping of POs and COs

PO	PO1	PO2	PO3	PO4	PO5	PO6
CO						
CO1	3	2	-	2	2	1
CO2	-	1	1	2	-	-
CO3	2	-	-	1	2	1
CO4	2	1	2	3	2	2
CO5	-	1	-	2	-	3

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE MSBO133	COURSE NAME PLANT & ANIMAL BIOTECHNOLOGY	SEMESTER I

Teaching Scheme (Hours)				Teaching Credit			
Lecture	**Practical**	**Tutorial**	**Total Hours**	**Lecture**	**Practical**	**Tutorial**	**Total Credit**
3	4	0	45+60	3	2	0	5

Course Prerequisites	Students should have basic knowledge about Plant & Animal Biotechnology
Course Category	Core Professional.
Course focus	Scientific Temperament & Employability
Rationale	Able to gain fundamental knowledge in animal and plant biotechnology and their applications.Understand the molecular techniques required for animal and plant biotechnologyThe students will be technically and critically trained with good practical exposure to perform both the plant and animal culture, which is the at most required in this field of science skilled candidates are absorbed in well established and commercial tissue culture unitsThis area can be taken up as a micropropagation business with smaller investment by entrepreneurs. learn molecular techniques.
Course Revision/ Approval Date:	06/03/24
Course Objectives (As per Blooms' Taxonomy)	**1. Remember** Able to gain fundamental knowledge in animal and plant biotechnology and their applications. **2. Apply** Understand the molecular techniques required for animal and plant biotechnology **3. Analyses** This area can be taken up as a micropropagation business with smaller investment by entrepreneurs. **4. Create** The students will be technically and critically trained with good practical exposure to perform both the plant and animal culture which is the at most required in this field of science, skilled candidates are absorbed in well established and commercial tissue culture units **5. Understand** learn molecular techniques.

Course Content (Theory)	Weightage	Contact hours

Unit 1: Introduction to Animal and Plant Physiology (Plant tissue culture and animal cell culture)	**20%**	**10+4**
Unit 2: Micropropagation and haploid production (Plant genetic manipulation)	**20%**	**10+4**
Unit 3: Protoplast culture and cybrids (Animal reproductive biotechnology and vaccinology)	**20%**	**8+4**
Unit 4: Animal Cell culture and Plant Tissue Culture (Plant and animal genomics)	**20%**	**9+4**
Unit 5: Applied plant and animal biotechnology (Molecular mapping and marker assisted selection)	**20%**	**8+4**

Practical:

1. Prepare culture media with various supplements for plant tissue culture.
2. Isolate plant protoplast by enzymatic and mechanical methods and attempt fusion by PEG (available material).
3. Undertake plant genomic DNA isolation by CTAB method and its quantitation by visual as well as spectrophotometric methods
4. Count cells of an animal tissue and check their viability.
5. Prepare culture media with various supplements for plant and animal tissue culture.
6. Prepare single cell suspension from spleen and thymus.
7. Monitor and measure doubling time of animal cells.
8. Perform PCR amplification of 'n' number of genotypes of a species for studying the genetic variation among the individuals of a species using random primers.

Instructional Method and Pedagogy:

Audio-Visual Lectures, Quizzes, Debates, Project works, Case studies, and Assignments Practical exercises are designed to understand the theory as taught in the classroom. Hands on in practical session.

Course Outcomes:	Blooms' Taxonomy Domain	Blooms' Taxonomy Sub Domain
After successful completion of the above course, students will be able to		Explain, Describe, Discuss, Recall, Locate
CO1 The objectives of this course are to introduce students to the principles, practices and application of animal biotechnology, animal genomics, genetic transformation and molecular breeding animals.	Remember	
CO2 The objectives of this course are to introduce students to the principles, practices and application of plant biotechnology plant tissue culture, plant and genomics, genetic transformation and molecular breeding of plants.	Apply	Apply, Practice, Interpret, Select, Correlate
CO3 Intended to introduce the student to the principles and practical considerations of animal cell and tissue culture	Analyses and Evaluation	Compare, Classify, Select, Investigate
CO4 Intended to introduce the student to the principles and practical considerations of plant cell and tissue culture	Create	Construct, Develop, Produce
CO5 The objectives of this course are to introduce students to the cell culture technique enables to understand the structure and functions of cells which is programmed by Genetic Engineering tools and techniques for the production of	Understand	Explain, Describe, outline, Predict, Summarise

Learning Resources

1.	Textbook & Reference Book Reference books : 1. Gordon, I. (2005). Reproductive Techniques in Farm Animals. Oxford: CAB International. 2. Levine, M. M. (2004). New Generation Vaccines. New York: M. Dekker. 3. Pörtner, R. (2007). Animal Cell Biotechnology: Methods and Protocols. Totowa, NJ: Humana Press. Reference books : 1. Gordon, I. (2005). *Reproductive Techniques in Farm Animals*. Oxford: CAB International. 2. Levine, M. M. (2004). *New Generation Vaccines.* New York: M. Dekker. 3. Pörtner, R. (2007). *Animal Cell Biotechnology: Methods and Protocols*. Totowa, NJ: Humana Press.
2.	Journals & Periodicals 1. ISSCR journals and Cell science. 2. Periodicals: Current scienc
3	Other Electronic resources: NPTL and UGC pathsala

Evaluation Scheme	Total Marks
Theory: Mid semester Marks	20 marks
Theory: End Semester Marks	40 marks
Theory: Continuous Evaluation Component Marks	

Attendance	05 marks
MCQs	10 marks
Skill enhancement activities / case study	15 marks
Presentation/ miscellaneous activities	10 marks
Total	**40Marks**

Practical Marks	

Attendance	05 marks
Practical Exam	30 marks
Viva	10 marks
Journal	5 marks
Total	**50 Marks**

Mapping of PSOs and COs

PO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO						
CO 1	1	-	-	-	-	-
CO 2	1	-	-	-	-	-
CO 3	2	3	3	3	2	1

CO 4	2	3	3	2	2	2
CO 5	2	-	1	-	-	-

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Mapping of POs and COs

PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO						
CO1	3	-	-	-	-	-
CO2	3	1	-	-	-	-
CO3	-	2	2	1	1	2
CO4	-	1	3	1	3	2
CO5	1	-	3	1	2	-

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE MSBO134	COURSE NAME MOLECULAR DIAGNOSTICS	SEMESTER I

Teaching Scheme (Hours)				Teaching Credit			
Lecture	Practical	Tutorial	Total Hours	Lecture	Practical	Tutorial	Total Credit
3	4	0	45+60	3	2	0	5

Course Pre-requisites	Students should know have basic knowledge of molecular diagnostics.
Course Category	**Specialization**
Course focus	**Specialization**
Rationale	Scientific Temperament & Employability
Course Revision/ Approval Date:	6/03/2024
Course Objectives (As per Blooms' Taxonomy)	1. The objectives of this course are to sensitize students about recent advances in diagnostics and various facets of molecular medicine which has potential to profoundly alter many aspects of modern medicine including preor post-natal analysis of genetic diseases and identification of individuals predisposed to disease ranging from common cold to cancer 2. Adequate knowledge about recent advances and technological developments in the field of diagnostics 3. Selection of an appropriate diagnostic method/tool for a particular disease condition and sample type. 4. Expertise to perform any diagnostic test with an ability to troubleshoot. 5. The objectives of this course are to sensitize students about recent advances in molecular biology.

Course Content (Theory)	Weightage	Contact hours
Unit 1: Introduction to Molecular Diagnostics	**20%**	**10**
Unit 2: Nucleic Acid Amplification Techniques	**20%**	**10**
Unit 3: Regression Analysis: Simple linear regression, Multiple linear regression, Logistic regression, Model diagnostics and interpretation	**20%**	**10**
Unit 4: Survival Analysis: Kaplan-Meier estimator, Cox proportional hazards model, Survival curves and censoring, Applications in clinical trials and epidemiological studies.	**20%**	**10**
Unit 5: Diagnostic Assays for Infectious Diseases and Epidemiological Study Designs: Observational studies vs. experimental studies, Cross-sectional studies, Cohort studies, Meta-analysis	**20%**	**05**
Practicals: • Extraction of DNA and RNA from various sample types (e.g., cells, tissues, blood) using different methods (e.g., phenol-chloroform extraction, silica-based columns). • Setting up and performing PCR reactions to amplify specific DNA sequences. • Assessment of nucleic acid quality and quantity (e.g., spectrophotometry, fluorometry) • Quantitative measurement of DNA or RNA targets. By using RT PCR		

Instructional Method and Pedagogy: Audio-Visual Lectures, Quizzes, Debates, Project works, Case studies, and Assignments Practical exercises are designed to understand the theory as taught in classroom. Hands on in practical session.

Course Outcomes:	**Blooms' Taxonomy Domain**	**Blooms' Taxonomy Sub Domain**
After successful completion of the above course, students will be able to: **CO1** Able to understand various facets of molecular procedures and basics of genomics, proteomics and metabolomics that could be employed in early diagnosis and prognosis of human diseases	Understand, Remember& apply	Explain, Describe, Discuss, Recall, Locate

CO2 Acquire knowledge of various diagnostic tools used in healthcare, industry and research **CO3** Identify the role and importance of molecular diagnostics such as real-time PCR, epidemiological genotyping, microfluidics, bio-imaging and sequencing technologies **CO4** Students will be able to Incorporate both in silico and lab based techniques as part of a combined molecular diagnostics strategy. **CO5** Perform selected laboratory techniques, interpret results and prepare reports	Apply Evaluate Apply Understand, Remember& apply	Apply, Practice, Interpret, Select, Correlate Compare, Classify, Select, Investigate Construct, Develop, Produce Explain, Describe, outline, Predict, Summarize

Learning Resources	
1	Textbook 1. Campbell, A. M., & Heyer, L. J. (2006). Discovering Genomics, Proteomics, and Bioinformatics. San Francisco: Benjamin Cummings. 2. Brooker, R. J. (2009). Genetics: Analysis & Principles. New York, NY: McGraw- Hill. 3. Glick, B. R., Pasternak, J. J., & Patten, C. L. (2010). Molecular Biotechnology: Principles and Applications of Recombinant DNA. Washington, DC: ASM Press. 4. Coleman, W. B., & Tsongalis, G. J. (2010). Molecular Diagnostics: for the Clinical Laboratorian. Totowa, NJ: Humana Press.
2	Reference book : Molecular Diagnostics, 3rd Edition Editors: George P. Patrinos Wilhelm Ansorge Phillip B. Danielson. Hardcover ISBN: 9780128029718. eBook ISBN: 9780128029886
3	Journal : Journal of Molecular Diagnostics, Nature reviews
5	Periodicals: Current science
6	Other Electronic resources: NPTL and UGC Pathshala lectures

<table>
<tr><th>Evaluation Scheme</th><th>Total Marks</th></tr>
<tr><td>Theory: Mid semester Marks</td><td>20 marks</td></tr>
<tr><td>Theory: End Semester Marks</td><td>40 marks</td></tr>
<tr><td>Theory: Continuous Evaluation Component Marks</td><td>
<table>
<tr><td>Attendance</td><td>05 marks</td></tr>
<tr><td>MCQs</td><td>10 marks</td></tr>
<tr><td>Skill enhancement activities / case study</td><td>15marks</td></tr>
<tr><td>Presentation/ miscellaneous activities</td><td>10 marks</td></tr>
<tr><td>Total</td><td>40 Marks</td></tr>
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</td></tr>
<tr><td>Practical Marks</td><td>
<table>
<tr><td>Attendance</td><td>05 marks</td></tr>
<tr><td>Practical Exam</td><td>30 marks</td></tr>
<tr><td>Viva</td><td>10 marks</td></tr>
<tr><td>Journal</td><td>5 marks</td></tr>
<tr><td>Total</td><td>50 Marks</td></tr>
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Mapping of PSOs and COs

PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO						
CO1	3	3	1	2	0	3
CO2	2	2	3	2	1	2
CO3	3	2	3	2	2	2
CO4	2	3	2	2	1	1
CO5	3	2	2	1	2	0

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Mapping of POs and COs

PO	PO1	PO2	PO3	PO4	PO5	PO6
CO						
CO1	3	2	0	0	2	0
CO2	3	2	3	1	2	2
CO3	2	3	3	1	2	2
CO4	1	3	2	1	3	3
CO5	2	2	3	2	3	0

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE MSBO135	COURSE NAME BIOSTATISTICS	SEMESTER I

Teaching Scheme (Hours)				Teaching Credit			
Lecture	Practical	Tutorial	Total Hours	Lecture	Practical	Tutorial	Total Credit
2	0	0	30	2	0	0	2

Course Pre-requisites	Students should have basic Biostatistics
Course Category	Elective
Course focus	Skill development
Rationale	In this course students will learn descriptive statistics and its basic applications in real life. Students will also learn different types of tests for Hypothesis testing. Sutdents will understand the concepts of correlation and learn the methods of regression. They will also get an exposure to differntial and integral calculus and learn to solve the system of linear equations.
Course Revision/ Approval Date:	06/3/24
Course Objectives **(As per Blooms' Taxonomy)**	To enable the student to: **1 Remember:** Use mean and variance to visualise the data and making decisions. **2 Apply:** Use the degree and direction of association between two variables, and fit a regression model to the given data **3 Understand, Apply:** Identify the type of statistical situation to which different tests can be applied. **4 Understand:** the fundamental concepts of Derivatives and Integration of functions **5 Understand, Apply:** Explain what is meant by statistical inference and concepts of approximation for system of equations

Course Content (Theory)	Weightage	Contact hours
Unit 1: Limits, Complete and Partial Differentials of Function	**20%**	**6**
Unit 2: Majors of Central tendency and Measures of dispersion	**20%**	**6**
Unit 3: Introduction to theory of Probability and Theoitical Distribution	**20%**	**6**
Unit 4: Correlation Analysis and Regression Analysis	**20%**	**6**
Unit 5: Statistical Inference and Tests of Hypothesis, ANNOVA	**20%**	**6**

Instructional Method and Pedagogy: Chalk-board, Presentation, Use ofGeogebra. Group Discussion, Case Study, Quizziz application.

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Course Outcomes:	Blooms' Taxonomy Domain	Blooms' Taxonomy Sub Domain
After successful completion of the above course, students will be able to:		
CO1: **Apply:** Calculate the simple linear regression equation for a set of data and able to solve the system of equations	Apply	Describe, Find
CO2: **Remember, Understand:** Know the practical issues arising in sampling studies	Remember, Understand	Demonstrate & Examine, Find
CO3: **Apply, Analyse:** Appropriately interpret results of analysis of variance tests, would be able to understand the variation in distribution of the data and importance of hypothesis testing using different tests.	Apply, Analyse:	Describe, Demonstrate & Examine, Find
CO4: **Analyse:** Analyse statistical data using MS-Excel.The student would be able to correlate the given data and estimate the value of unknown variable.	Analyse:	Describe, Demonstrate & Examine

Learning Resources	
1.	Reference Books: 1. Probability and Statistics By T K V Iyengar, S chand, 3rd Edition, 2011. 2. Fundamentals of Mathematical Statistics by S C Gupta & V K Kapoor, Sultan Chand & Sons, New Delhi 2009.

2.	Journals & Periodicals:
3.	Other Electronic Resources: Geometry and Algebra: Geogebra.org/Calculator MATLAB : Mathworks.com/ https://www.tutorialspoint.com/matlab/matlab_syntax.htm

Evaluation Scheme	**Total Marks**
Theory: Mid semester Marks	20 marks
Theory: End Semester Marks	40 marks
Theory: Continuous Evaluation Component Marks	Attendance: 05 marks MCQs: 10 marks Open Book Assignment: 15 marks Open Book Assignment: 10 marks **Total: 40 Marks**
Practical Marks	Attendance: 05 marks Practical Exam: 20 marks Viva: 10 marks Journal: 10 marks Discipline: 05 marks **Total: 50 Marks**
Project/ Industrial Internship Marks	Quantity of the Project/Industrial in terms of Language, Presentation & format.: 30 marks Practical understanding of the subject on the Project/Industrial.: 30 marks Industry/ University mentor's feedback on the Project/ Industrial.: 30 marks Attendance: 10 marks **Total: 100 Marks**

Mapping of PSOs & COs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	1	2	0	0	0	1	1
CO2	1	2	0	0	0	1	1
CO3	1	2	0	0	0	1	1
CO4	2	2	1	0	0	1	2
CO5	2	3	0	1	0	1	2

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Mapping of POs & COs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	1	1	0	0
CO2	2	2	1	1	0	0
CO3	1	2	1	1	0	0
CO4	2	2	2	1	1	0
CO5	2	2	1	1	1	0

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE MSBO137	COURSE NAME GENETICS	SEMESTER I

Teaching Scheme (Hours)				Teaching Credit			
Lecture	Practical	Tutorial	Total Hours	Lecture	Practical	Tutorial	Total Credit
2	0	0	2	2	0	0	2

Course Pre-requisites	Basic knowledge of Genetics.
Course Category	Discipline specific elective
Course focus	Employability
Rationale	Studying genetics is important not only for scientific discovery but also for its real-world applications in medicine, agriculture, technology, and ethical policy development. It's a foundational discipline with widespread implications across nearly every aspect of our lives.
Course Revision/ Approval Date:	
Course Objectives (As per Blooms' Taxonomy)	1. Demonstrate a thorough understanding of genetic principles and molecular mechanisms. 2. Apply genetic concepts to practical problems in fields such as healthcare, agriculture, and biotechnology. 3. Interpret and analyze genetic data using bioinformatics tools. 4. Critically evaluate ethical issues related to genetics and biotechnology. 5. Contribute to ongoing research in genetics by designing and conducting experiments or computational studies.

Course Content (Theory)	Weightage	Contact hours
Unit 1: Understand the Fundamentals of Genetics: Mendelian inheritance, Punnett squares, genotype/phenotype relationships, and basic genetic principles like dominance, recessiveness, and co-dominance.	**20%**	**06**
Unit 2: Genetic Variation and Evolution: Genetic diversity, mutation, genetic drift, natural selection, and evolutionary mechanisms.	**20%**	**06**
Unit 3: Population Genetics and Human Genetics: Hardy-Weinberg equilibrium and gene flow.	**20%**	**06**
Unit 4: Genetic Research and Data Analysis: Hypothesis development, experimental design, data collection, data interpretation, and scientific communication.	**20%**	**06**
Unit 5: Ethical, Legal, and Social Implications of Genetics: Ethical concerns regarding genetic testing, privacy issues, the implications of gene editing (e.g., CRISPR), genetic discrimination, and the use of genetic data.	**20%**	**06**

Instructional Method and Pedagogy:
Audio-Visual Lectures, Quizzes, Debates, Project works, Case studies, and Assignments Practical exercises are designed to understand the theory as taught in classroom. Hands on in practical session.

Course Objectives:		Blooms' Taxonomy Domain	Blooms' Taxonomy Sub Domain
CO1	Demonstrate a thorough understanding of genetic principles and molecular mechanisms.	Understand, Remember and apply	Explain, Describe, Discuss
CO2	Genetic Variation and Evolution: Genetic diversity, mutation, genetic drift, natural selection, and evolutionary mechanisms.	Analyse and apply	Apply, Practice, Interpret, Select, Correlate
CO3	Population Genetics and Human Genetics: Hardy-Weinberg equilibrium and gene flow.	Understand and Remember	Apply and Practice
CO4	Genetic Research and Data Analysis: Hypothesis development, experimental design, data collection, data interpretation, and scientific communication.	Analyse	Construct, Develop, Produce
CO5	Ethical, Legal, and Social Implications of Genetics: Ethical concerns regarding genetic testing, privacy issues, the implications of gene editing (e.g., CRISPR), genetic discrimination, and the use of genetic data.	Understand, Remember and apply	Explain, Describe, outline, Predict, Summarize

Learning Resources	
1	Textbook: 1. Genomes" by T.A. Brown 2. Introduction to Genetic Analysis" by Anthony J. F. Griffiths, Susan R. Wessler, Sean 3. Carroll, and John Doebley. "Genetic Analysis: An Integrated Approach" by Mark F. Sanders and John A. Bowman
2	Reference Books: 1. Principles of Genetics" by D. Peter Snustad and Michael J. Simmons 2. Molecular Biology of the Gene" by James D. Watson, Tania A. Baker, and Stephen P. Bell 3. Genetics: Analysis of Genes and Genomes" by Daniel L. Hartl and Elizabeth W. Jones.
3	Journal: Nature Genetics American Journal of Human Genetics (AJHG)
4	Periodicals: Nature Reviews Genetics Genetic Engineering & Biotechnology News (GEN)
5	National Center for Biotechnology Information (NCBI) Ensembl UCSC Genome Browser

Evaluation Scheme	Total Marks
Theory: Mid semester Marks	20 marks
Theory: End Semester Marks	40 marks
Theory: Continuous Evaluation Component Marks	

Attendance	05 marks
MCQs	10 marks
Open Book Assignment	15 marks
Article Review	10 marks
Total	**40 Marks**

Mapping of PSOs and CO for Agriculture Microbiology:

PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO					
CO1	1	1	2	3	0
CO2	1	1	2	3	3
CO3	1	1	1	2	2
CO4	1	1	1	1	2

CO5	1	2	2	2	1

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Mapping of PO and CO for Agriculture Microbiology

PO	PO1	PO2	PO3	PO4	PO5
CO					
CO1	1	2	2	2	3
CO2	1	1	2	2	3
CO3	1	1	1	2	3
CO4	1	1	1	1	2
CO5	2	2	2	2	1

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE MSBO136	COURSE NAME BIOPYTHON	SEMESTER I

Teaching Scheme (Hours)				Teaching Credit			
Lecture	Practical	Tutorial	Total Hours	Lecture	Practical	Tutorial	Total Credit
2	0	0	30	2	0	0	2

Course Prerequisites	Basic Knowledge of computers
Course Category	Elective
Course focus	Scientific Temperament & Employability
Rationale	Know how to develop your skills in Python. Retrieve and analyze the biological data
Course Revision/ Approval Date:	06/03/24
Course Objectives (As per Blooms' Taxonomy)	• **To Remember** the basic concepts of python • **Understand** to edit and run Python code • **To analyze and evaluate** file-processing python programs that produce output to the terminal and/or external files • **Apply** the knowledge of python to analyse the biological data • **To Create** stand-alone python programs to process biological data

Course Content (Theory)	Weightage	Contact hours
Unit 1 Computers system. Introduction to Python. Python Character set. Tokens. Variables and Assignments.	**20%**	**6**
Unit 2 Imperative programming constructs: functions, if-statements, loops (for, while), switchstatements, expressions. Basic data structuring constructs: variables, arrays, strings, structs, types, and pointers, Reading and writing files	**20%**	**8**
Unit 3: Data handling: Data types, Mutable and Immutable types, operators, Expressions, Working with the math module of python, testing small sections of code, Debugging — strategies, debuggers, common errors Profiling — figuring out what's taking so long, Make — automating compilation.	**20%**	**8**

Unit 4: Linear data structures: arrays, lists, stacks, queues; binary search, Dictionary. Biopython Packages.	**20%**	**8**

Course Outcomes	1.Develop an understanding of basic theoretical concepts of Python.
	2. Appreciate their relevance for investigating specific contemporary biological questions through the use of Biopython
	3. Understand the concepts of object-oriented programming as used in Python
	4. Learn Biopython to enhance your skills for conducting in silico experiments.
	5. Demonstrate mastery of the core concepts of Bioinformatics
Additional Information to enhance learning	Expert talk required on specific topics.

Learning Resources	
1.	**Textbook & Reference Book** 1) Python: - The Bible- 3 Manuscripts in 1 Book: -Python Programming for Beginners -Python Programming for Intermediates -Python Programming for Advanced by Maurice J Thompson 2) Learning python (5th Edition) by Mark Lutz, O'Reilly Media, Inc (2013). ISBN:9781449355739 3) Python programming for biology by Tim J. Stevens and Wayne Boucher. Cambridge University Press 1st Ed. (2015) ISBN:9780511843556
2.	**Journals & Periodicals**
3	**Other Electronic resources**: 1) MH Education 2) NPTEL 3) Coursera

Evaluation Scheme	**Total Marks**		
Theory: Mid semester Marks	20 marks		
Theory: End Semester Marks	40 marks		
Theory: Continuous Evaluation Component Marks		Attendance	05 marks
		MCQs	10 marks
		Skill enhancement activities / case study	15marks
		Presentation/ miscellaneous activities	10 marks
		Total	**40 Marks**

Practical Marks	

Attendance	05 marks
Practical Exam	30 marks
Viva	10 marks
Journal	5 marks
Total	**50 Marks**

Mapping of PSOs and COs

PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO						
CO1	3	3	1	2	0	3
CO2	2	2	3	2	1	2
CO3	3	2	3	2	2	2
CO4	2	3	2	2	1	1
CO5	3	2	2	1	2	0

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Mapping of POs and Cos

PO	PO1	PO2	PO3	PO4	PO5	PO6
CO						
CO1	3	2	0	0	2	0
CO2	3	2	3	1	2	2
CO3	2	3	3	1	2	2
CO4	1	3	2	1	3	3
CO5	2	2	3	2	3	0

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE	COURSE NAME	SEMESTER
MSBO231	ADVANCED CELL & MOLECULAR BIOLOGY	II

Teaching Scheme (Hours)				Teaching Credit			
Lecture	Practical	Tutorial	Total Hours	Lecture	Practical	Tutorial	Total Credit
3	4	0	45+60	3	2	0	5

Course Pre-requisites	Graduate Degree in Biological Sciences
Course Category	Core Compulsory
Course focus	Career in Research and Industry
Rationale	The course in Advanced Cell and Molecular Biology is designed to deepen postgraduate students' understanding of cellular and molecular mechanisms that underpin the complexities of life processes. With an emphasis on advanced techniques, molecular interactions, and cellular signalling, this course prepares students for research and industry roles requiring an in-depth knowledge of cellular functions. It builds on foundational concepts and delves into experimental and applied aspects of molecular biology, aligning with current scientific developments in genomics, proteomics, and bioinformatics.
Course Revision/ Approval Date:	
Course Objectives **(As per Blooms' Taxonomy)**	**Understand** and describe the intricate structure and function of cells, organelles, and biomolecules. **Analyse** complex cellular processes and how they contribute to overall cellular function and integrity. **Evaluate** mechanisms of cell signalling and molecular pathways in normal and disease states. **Apply** molecular biology techniques to investigate cell structures and biomolecular interactions. **Create** hypotheses for experimental studies, interpreting data in the context of cellular and molecular biology research.

Course Content (Theory)	Weightage	Contact hours
Unit 1: Cell Structure and Function Topics: Cell membranes, organelle structure and function, cytoskeleton, cell junctions. Key Concepts: Advanced insights into the physical and chemical properties of cellular components and their functions. Pedagogies: Interactive lectures, visual aids, and case studies on cell organization.	**20%**	**09**
Unit 2: Biomolecular Interactions and Enzyme Functions **Topics:** Protein folding and function, enzyme kinetics, post-translational modifications, protein-protein interactions. **Key Concepts:** The molecular basis of enzyme function and the importance of structural biology in understanding biomolecular interactions. **Pedagogies:** Demonstration of molecular modelling software, problem-based learning, group discussions on case studies.	**20%**	**09**
Unit 3: Gene Expression and Regulation **Topics:** Transcription and translation mechanisms, RNA processing, gene silencing, epigenetics, regulation by miRNA. **Key Concepts:** Regulatory mechanisms of gene expression and the role of molecular biology techniques in studying these processes. **Pedagogies:** Flipped classroom with assigned readings, peer-teaching sessions, discussions on recent research papers.	**20%**	**09**
Unit 4: Cell Cycle, Cell Death, and Cancer Biology **Topics:** Cell cycle checkpoints, mechanisms of apoptosis, necrosis, autophagy, cancer biology, oncogenes and tumour suppressor genes. **Key Concepts:** Understanding cell cycle control and its relevance to cancer development. **Pedagogies:** Case-based learning using examples of diseases, animated videos, group projects on cell cycle regulators.	**20%**	**09**
Unit 5: Cell Signalling and Molecular Pathways **Topics:** Signal transduction pathways, G-protein coupled receptors, kinases, phosphatases, second messengers. **Key Concepts**: Detailed study of cellular communication and molecular mechanisms of signalling pathways.	**20%**	**09**

Pedagogies: Simulation-based learning, analysis of pathway databases, discussion on therapeutic targeting of signalling pathways.		

List of Practical

Sr. No	List of Practical	Weightage	Contact hours
1.	Cell Culture Techniques: Hands-on experience with cell culture, maintenance, and contamination control, reflecting on the use of model systems in cellular research.	**20%**	**06**
2.	Fluorescence Microscopy: Observation of cell morphology and organelle structure using fluorescent dyes, supporting understanding of cell organization.	**20%**	**06**
3.	Protein Extraction and Quantification: Extraction from cells and quantification by Bradford or BCA assay, introducing students to protein analysis techniques.	**20%**	**06**
4.	Western Blotting and Gel Electrophoresis: For protein separation and detection, correlating with studies on protein expression and function.	**20%**	**06**
5.	RNA Isolation and qPCR: RNA extraction and quantitative PCR to examine gene expression levels, complementing the gene regulation unit.	**20%**	**06**

Instructional Method and Pedagogy:

Case-Based Learning (CBL), Problem-Based Learning (PBL), Use of Simulations and Interactive Models

Course Outcomes:	Blooms' Taxonomy Domain	Blooms' Taxonomy Sub Domain
CO1 Demonstrate advanced knowledge of cell structure and function at a molecular level.	Understand, Remember	Explain, Describe, Discuss, Recall, Locate
CO2 Analyse and interpret signalling pathways and molecular interactions.	Remember and apply	Apply, Practice, Interpret, Select, Correlate
CO3 Apply theoretical knowledge to experimental techniques in molecular and cell biology.	Apply	Compare, Classify, Select, Investigate
CO4 Critically evaluate research data and scientific literature in cellular biology.	Analyse	Construct, Develop, Produce

CO5 Develop an experimental approach to solve biological problems and present findings effectively.	Apply	Explain, Describe, outline, Predict, Summarize

Sr. No.	Learning Resources
1.	**Textbook:** 1. "Molecular Biology of the Cell" by Alberts et al. 2. "Molecular Cell Biology" by Lodish et al. 3. "Lehninger Principles of Biochemistry" by Nelson and Cox 4. "The Cell: A Molecular Approach" by Geoffrey M. Cooper and Robert E. Hausman 5. "Essential Cell Biology" by Alberts et al.
2.	**Reference books** 1. "Biochemistry" by Berg, Tymoczko, and Stryer "Molecular Biology" by Robert F. Weaver "Cell and Molecular Biology: Concepts and Experiments" by Gerald Karp "Molecular Biology: Principles and Practice" by Cox, Doudna, and O'Donnell
3.	**Journal** Cell Nature Reviews Molecular Cell Biology Journal of Cell Biology (JCB) Molecular Biology of the Cell (MBoC) Annual Review of Cell and Developmental Biology
4.	**Periodicals:** Nature Methods and Biotechniques Current Protocols in Molecular Biology Methods in Enzymology
5.	Other Electronic resources: Coursera: Molecular Biology - Part 1: DNA Replication and Repair edX: Biochemistry and Cell Biology

<table>
<tr><th>Evaluation Scheme</th><th colspan="2">Total Marks</th></tr>
<tr><td>Theory: Mid semester Marks</td><td colspan="2">20 marks</td></tr>
<tr><td>Theory: End Semester Marks</td><td colspan="2">40 marks</td></tr>
<tr><td>Theory: Continuous Evaluation Component Marks</td><td colspan="2"><table>
<tr><td>Attendance</td><td>05 marks</td></tr>
<tr><td>MCQs</td><td>10 marks</td></tr>
<tr><td>Open Book Assignment</td><td>15 marks</td></tr>
<tr><td>Article Review</td><td>10 marks</td></tr>
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</table></td></tr>
<tr><td>Practical Marks</td><td colspan="2"><table>
<tr><td>Attendance</td><td>05 marks</td></tr>
<tr><td>Practical Exam</td><td>20 marks</td></tr>
<tr><td>Viva</td><td>10 marks</td></tr>
<tr><td>Journal</td><td>10 marks</td></tr>
<tr><td>Discipline</td><td>05 marks</td></tr>
<tr><td>Total</td><td>50 Marks</td></tr>
</table></td></tr>
</table>

Mapping of PSOs and CO

PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO						
CO1	3	3	2	2	3	1
CO2	3	1	1	2	2	2
CO3	3	2	1	1	-	-
CO4	2	2	3	-	-	3
CO5	-	-	-	2	-	3

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Mapping of PO and CO

PO	PO1	PO2	PO3	PO4	PO5	PO6
CO						
CO1	3	-	3	-	1	-
CO2	2	-	3	-	1	-
CO3	3	-	3	-	1	-
CO4	3	-	3	-	1	-
CO5	2	-	3	-	1	-

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE MSBO238	COURSE NAME NANOSCIENCE	SEMESTERII

Teaching Scheme (Hours)				Teaching Credit			
Lecture	Practical	Tutorial	Total Hours	Lecture	Practical	Tutorial	Total Credit
3	4	0	105	3	2	0	5

Course Prerequisites	Students should have basic knowledge about physics, chemistry and biology.
Course Category	Core Professional.
Course focus	Scientific Temperament & Employability
Rationale	Studying nanoscience allows students to explore the fundamental nature of matter at the atomic and molecular levels, which is crucial for developing next-generation technologies. The ability to manipulate matter at nano scale opens the door to innovations in medicine, materials development, energy production, and environmental sustainability. This course aims to provide that foundational understanding, enabling students to contribute meaningfully to cutting-edge research and industry developments in their respective fields.
Course Revision/ Approval Date:	08/05/2025
Course Objectives (As per Blooms' Taxonomy)	**1. Remember** Concepts of basic nanoscience. **2. Apply** To understand various nanoformulation. **3. Analyses** Interactions of nanomaterial with living systems. **4. Create** an understanding how nanoparticles developed and applied on field. **5. Understand** applications of nanomaterials..

Course Content (Theory)	Weigh tage	Contact hours
Unit 1:Introduction and classification of nanoparticles Introduction to Nanoscience, Nanotechnology and Nanobiotechnology; Classification of nanomaterials on the basis of size, shape, dimension, organic, inorganic, and carbon based nanomaterials	**20%**	**9**
Unit 2: Synthesis and properties of nanoparticles Synthesis of nanomaterials: Top down & bottom up methods; Chemical and green synthesis; Properties of nanoparticles - physical, optical, electronic, magnetic, catalytic	**20%**	**9**

Unit 3: Characterization of nanoparticles Characterization of nanoparticles by - DLS, UV-Vis spectroscopy, FTIR, XRD, XPS, SEM, TEM, XRM, AFM	**20%**	**9**
Unit 4: Applications of nanomaterials - I Medicine- diagnosis & therapy, artificial implants, tissue engineering; Food - processing & packaging; Agriculture - fertilizers & pesticides	**20%**	**9**
Unit 5: Applications of nanomaterials - II Cosmetics - formulation; Energy - nanomaterials for energy storage; Environment - remediation& waste management, Sensors – nanodevice, NEMS, MEMS; Nano – toxicity and Life Cycle Assessment	**20%**	**9**
List of practical: 1. Synthesis of metal nanoparticles by chemical route. 2. Synthesis of metal nanoparticles by hydrothermal route. 3. Green synthesis of metal nanoparticles. 4. Study optical properties of nanoparticles by using UV-Vis spectroscopy. 5. Synthesis of polymeric nanoparticles. 6. To determine the drug concentration using UV-Vis spectroscopy. 7. Antibacterial activity of drug loaded nanoparticles.		
Instructional Method and Pedagogy: Audio-Visual Lectures, Quizzes, Debates, Project works, Case studies, and Assignments Practical exercises are designed to understand the theory as taught in the classroom. Hands on in practical session.		

Course Outcomes:	Blooms' Taxonomy Domain	Blooms' Taxonomy Sub Domain
After successful completion of the above course, students will be able to:		
CO1 The objectives of this course are to build upon postgraduate level knowledge of nanoscience, nanotechnology and types of nanomaterials.	Remember	Explain, Describe, Discuss, Recall, Locate
CO2 The course shall make the students aware of various synthesis methods and properties of nanomaterials.	Apply	Apply, Practice, Interpret, Select,
CO3 The course will make the students aware of various precise methods of nanomaterial characterization.	Analyses and Evaluation	Compare, Classify, Select, Investigate
CO4 To Understand the application of nanomaterials in various fields.	Create	Develop, Produce
CO5 To Understand the application of nanomaterials in various fields.	Understand	Explain, Describe, outline, Predict, Summarise

Learning Resources	
1.	Textbook & Reference Book 1. Nanomaterials Chemistry by Rao C. N., A. Muller, A. K. Cheetham,, WileyVCH , 2007 2. Nanostructures and Nanomaterials, synthesis, properties and applications by Guozhong Cao, Imperial College Press, 2004 3. Nanotechnology in agriculture and food production by Jennifer Kuzma and Peter VerHage, Woodrow Wilson International, 2006 4. Bio nanotechnology by David S Goodsell, John Wiley & Sons, 2004. 5. Nano biomaterials Handbook by Balaji Sitharaman, Taylor & Francis Group, 2011. 6. Ansel‟s Pharmaceutical Dosage Forms and Drug Delivery Systems. By: Loyd V. Allen,Howard C. Anse 7. Carbon Nanotubes: Properties and Applications- Michael J. O'Connell 8. Nanotechnology Applications for Tissue Engineering, 1st Edition, Editors: Sabu Thomas, Yves Grohens, & Neethu Ninan. 2015, Elsevier 9. Edelstein A S and Cammarata R C, "Nanomaterials: Synthesis, Properties and Applications",Taylor and Francis, 2012 10. Vielstich, Handbook of fuel cells: Fuel cell technology and applications, Wiley, CRC Press, (2003). 11. Nanosensors: Physical, Chemical, and Biological by Vinod Kumar Khanna, Publisher: CRC Press. 12. Wiesner, M.R., and Bottero, J.Y. (Ed.) "Environmental Nanotechnology: Applications and Impacts of Nanomaterials" McGraw-Hill, New York. 2007 13. Nanomedicines and Nanoproducts: Applications, Disposition, and Toxicology in the Human Body 14. Application of Nanotechnology in Drug Delivery: Edited by Ali Demir Sezer, ISBN

	978- 953-51- 1628- 8, 552 pages, Publisher: InTech 15. Handbook of Nanotoxicology, Nanomedicine and Stem Cell Use in Toxicology. Saura C Sahu, Daniel A Casciano.
2.	Journals & Periodicals 1. Nanoscale 2. ACS Nano 3. Nano Today 4. Nature Nanotechnology
3	Other Electronic resources: 1) NPTEL

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<tr><td>Open Book Assignment</td><td>15 marks</td></tr>
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<tr><td>Practical Marks</td><td>
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<tr><td>Attendance</td><td>05 marks</td></tr>
<tr><td>Practical Exam</td><td>20 marks</td></tr>
<tr><td>Viva</td><td>10 marks</td></tr>
<tr><td>Journal</td><td>10 marks</td></tr>
<tr><td>Discipline</td><td>05 Marks</td></tr>
<tr><td>Total</td><td>50 Marks</td></tr>
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</table>

Mapping of PSOs and COs

PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	1	2
CO2	1	2	3	1	1
CO3	2	1	1	2	2
CO4	1	2	2	3	3
CO5	2	3	1	2	4

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Mapping of PO and COs

PO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	2	1	2
CO2	3	1	2	1	1
CO3	1	2	1	2	1
CO4	2	1	2	3	3
CO5	1	2	3	2	4

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE	COURSE NAME	SEMESTER
MSBO233	BIOPROCESS ENGG. AND TECHNOLOGY	II

Teaching Scheme (Hours)				Teaching Credit			
Lecture	**Practical**	**Tutorial**	**Total Hours**	**Lecture**	**Practical**	**Tutorial**	**Total Credit**
3	4	0	45+60	3	2	0	5

Course Pre-requisites	Graduate Degree in Biological Sciences
Course Category	Core Compulsory
Course focus	Career in Research and Industry
Rationale	This course is designed to provide postgraduate students with a comprehensive understanding of bioprocess engineering, particularly focusing on industrial-scale production using bioreactors and bio fermenters. With the growing relevance of biotechnology in industries such as pharmaceuticals, agriculture, food, and environmental management, this curriculum aims to impart the practical and theoretical skills necessary for designing, optimizing, and scaling up bioprocesses. Students will gain insights into the complexities of bioreactor design, process monitoring, and control mechanisms essential for the efficient production of biochemical products.
Course Revision/ Approval Date:	

Course Objectives **(As per Blooms' Taxonomy)**	Understand the principles and concepts of bioprocess engineering, including cell culture techniques, microbial growth, and fermentation. Analyse different bioreactor designs and their applications in industrial-scale biotechnology. Apply quantitative methods for optimizing bioprocess parameters and maximizing product yield. Evaluate process control and monitoring methods to ensure quality and efficiency in biotechnological production. Create solutions for scaling up laboratory bioprocesses to meet industrial demands while maintaining cost-efficiency and sustainability.

Course Content (Theory)	**Weightage**	**Contact hours**
Unit 1: Introduction to Bioprocess Engineering • Overview of bioprocessing in industrial biotechnology • Microbial growth kinetics and stoichiometry • Biocatalysts, enzyme kinetics, and applications • Industrial microorganisms and cell lines used in bioprocessing.	20%	09
Unit 2: Bioreactor Design and Analysis • Types of bioreactors: Batch, fed-batch, continuous, and perfusion • Principles of bioreactor operation and mixing • Scale-up and scale-down processes • Design considerations for industrial bioreactors	20%	09
Unit 3: Process Control and Optimization • Process parameters: pH, temperature, dissolved oxygen, and nutrient feed • Monitoring techniques and process analytical technology (PAT) • Control strategies: PID control, cascade control, and feed-forward control • Optimization techniques for yield improvement	20%	09

Unit 4: Downstream Processing and Product Recovery • Separation and purification of bioproducts • Filtration, centrifugation, precipitation, and chromatography techniques • Product quality and regulatory compliance in bioprocessing • Cost analysis and economic considerations	20%	09
Unit 5: Emerging Technologies and Sustainability in Bioprocessing • Bioprocess innovations: single-use bioreactors, continuous biomanufacturing • Sustainable practices in industrial biotechnology • Waste management and bioprocess integration • Future trends in bioprocess engineering	20%	09

List of Practical

Sr. No	List of Practical	Weightage	Contact hours
1	Microbial Growth Kinetics: Cultivation of microbial cultures to analyse growth phases and calculate specific growth rates.	20%	06
2	Enzyme Kinetics Study: Practical analysis of enzyme activity and calculation of kinetic parameters.	20%	06
3	Bioreactor Simulation: Using software for bioreactor modelling and process parameter optimization.	20%	06
4	Downstream Processing Techniques: Separation and purification using filtration and chromatography.	20%	06
5	Process Control Lab: Hands-on experience with PID control in bioreactors and monitoring real-time parameters. Industrial Visit	20%	06

Instructional Method and Pedagogy:

1. Lectures and Interactive Discussions: Establish foundational concepts.
2. Case Studies and Industrial Examples: Link theory to real-world applications.
3. Simulation Software: Use of tools like SuperPro Designer or Aspen Plus for bioprocess modelling.
4. Laboratory Practical's: Provide hands-on experience to reinforce theoretical knowledge.
5. Industry Guest Lectures and Panel Discussions: Gain insights from industry professionals on current trends.

Course Outcomes:	Blooms' Taxonomy Domain	Blooms' Taxonomy Sub Domain
CO1 Understand the principles and concepts of bioprocess engineering, including cell culture techniques, microbial growth, and fermentation.	Remembering & Understanding	Explain, Describe, Discuss, Recall, Locate
CO2 Analyse different bioreactor designs and their applications in industrial-scale biotechnology.	Analysing	Apply, Practice, Interpret, Select, Correlate
CO3 Apply quantitative methods for optimizing bioprocess parameters and maximizing product yield.	Apply	Compare, Classify, Select, Investigate
CO4 Evaluate process control and monitoring methods to ensure quality and efficiency in biotechnological production.	Evaluate	Construct, Develop, Produce

CO5 Create solutions for scaling up laboratory bioprocesses to meet industrial demands while maintaining cost-efficiency and sustainability.	Create	Explain, Describe, outline, Predict, Summarize

Sr. No.	Learning Resources
1	**Textbook:** 1. Textbook of Bioprocess Engineering by Shuler, Michael L., and Fikret Kargi 2. Bioprocess Engineering: Basic Concepts by Pauline M. Doran 3. Principles of Fermentation Technology by Peter F. Stanbury, Allan Whitaker, and Stephen J. Hall
2	**Reference books** 1. Biochemical Engineering Fundamentals by James E. Bailey and David F. Ollis 2. Bioreactor Design and Product Yield Optimization by Mukesh Doble and Anil Kumar Kruthiventi
3	**Journal** Biotechnology and Bioengineering Journal of Industrial Microbiology & Biotechnology Biochemical Engineering Journal Trends in Biotechnology Applied Microbiology and Biotechnology
4	**Periodicals:**

5	**Other Electronic resources:** 1. Bioprocessing for Biotech Products (FutureLearn) – Covers bioprocessing principles, with a focus on drug development and industrial applications. 2. Introduction to Biomanufacturing and Bioprocessing (Coursera) – Offered by the University of California, this course is useful for students focusing on scalable bioprocessing techniques. 3. Biochemical Engineering (NPTEL) – An Indian platform course that addresses enzyme kinetics, bioreactor design, and applications in industrial biotechnology. **4.** Biotechnology and Bioprocessing (edX) – Offered by MIT, this course covers advanced concepts in bioprocessing, including scale-up and optimization techniques.

Evaluation Scheme	**Total Marks**
Theory: Mid semester Marks	20 marks
Theory: End Semester Marks	40 marks
Theory: Continuous Evaluation Component Marks	

Attendance	05 marks
MCQs	10 marks
Open Book Assignment	15 marks
Article Review	10 marks
Total	40 Marks

Practical Marks

Attendance	05 marks
Practical Exam	20 marks
Viva	10 marks
Journal	10 marks
Discipline	05 marks
Total	50 Marks

Mapping of PSOs and CO

PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO						
CO1	3	3	2	2	3	1
CO2	3	1	1	2	2	2
CO3	3	2	1	1	-	-
CO4	2	2	3	-	-	3
CO5	-	-	-	2	-	3

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Mapping of PO and CO

PO	PO1	PO2	PO3	PO4	PO5	PO6
CO						
CO1	3	-	3	-	1	-
CO2	2	-	3	-	1	-
CO3	3	-	3	-	1	-
CO4	3	-	3	-	1	-
CO5	2	-	3	-	1	-

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE	COURSE NAME	SEMESTER
MSBO234	ADVANCE IMMUNOLOGY	II

Teaching Scheme (Hours)				Teaching Credit			
Lecture	Practical	Tutorial	Total Hours	Lecture	Practical	Tutorial	Total Credit
3	4	0	45+60	3	2	0	5

Course Pre-requisites	Advance knowledge of Immunology
Course Category	Discipline specific Specialization
Course focus	Employability
Rationale	Advanced Immunology is a specialized field within immunology that delves deeper into the immune system's complex mechanisms and its interactions with pathogens, diseases, and therapies. It builds upon fundamental immunological concepts and explores cutting-edge research, clinical applications, and experimental techniques.
Course Revision/ Approval Date:	
Course Objectives (As per Blooms' Taxonomy)	1. To explain and analyse the complex mechanisms of immune responses at the molecular, cellular, and systemic levels. 2. Demonstrate an understanding of advanced immunological topics such as immunotherapy, vaccine development, and immunogenetics. 3. To be proficient in interpreting current research findings and applying this knowledge to clinical and experimental settings. 4. To have a strong foundation in the experimental techniques and methodologies used in modern immunological research. 5. To be prepared to contribute to the advancement of immunology in academic, clinical, or industrial settings.

Course Content (Theory)	Weightage	Contact hours
Unit 1: Introduction to Immunology Origin, Development, and Differentiation of Lymphocytes, Ontogeny and Physiology of the Immune System, Immunoreactive Cells: Structure and Functions. Practical: Isolation of WBC and its viability check	12.5%	09
Unit 2: Antigens and antigenicity Type of antigens, Factors affecting antigenicity, Antigen recognition, Epitope. Practical: Enzyme-Linked Immunosorbent Assay, Immunoprecipitation	12.5%	09
Unit 3: Immunoglobulins Classes of Immunoglobulins, Structure of Immunoglobulins, Functions of Immunoglobulins. Epitope-Paratope interaction. Practical: Ouchterlony Double Diffusion, Radial Immunodiffusion	12.5%	09
Unit 4: Immunogenicity Types of Immune response, The Role of Antibodies and antigen in Immune Response, Immune Memory and Vaccination, Immune regulation. Practical: Finding an antigenic determinant for vaccine development: In silico	12.5%	09
Unit 5: Hypersensitivity Hypersensitivity – Types and Mechanisms, Autoimmunity and it's types, Immune Regulation Mechanisms, Role of Cytokines, Lymphokines, and Chemokines. Practical: Coombs Test, Complement Fixation Test	12.5%	09

Instructional Method and Pedagogy:

Audio-Visual Lectures, Quizzes, Debates, Project works, Case studies, and Assignments Practical exercises are designed to understand the theory as taught in classroom. Hands on in practical session.

Course Objectives:		Blooms' Taxonomy Domain	Blooms' Taxonomy Sub Domain
CO1	On completion of this course, students should be able to explain and analyse the complex mechanisms of immune responses.	Understand, Remember& apply	Explain, Describe, Discuss

CO2	On completion of this course, students should be able to understand the advanced immunological topics.	Analyse	Apply, Practice, Interpret, Select, Correlate
CO3	On completion of this course, students should be able to be proficient in interpreting current research findings in Immunology.	Understand and remember	Apply and Practice
CO4	On completion of this course, students should be able to have a strong foundation in the experimental techniques and methodologies used in modern immunological research.	Analyses	Construct, Develop, Produce
CO5	On completion of this course, students should be able to get prepared to contribute to the advancement of immunology in academic, clinical, or industrial settings.	Understand, Remember& apply	Explain, Describe, outline, Predict, Summarize

Learning Resources	
	Textbook: • Ivan M. Roitt, J. Brostoff and D. K. Male, Immunology, Gower Medical Publishing, London.1993.
2	**Reference Books:** • Clark WR, The experimental foundations of modern immunology. John Wiley and Sons Inc. New York. 1991. • Janis Kuby, Immunology, II edition. W. H. Freeman and Company, New York. 1993. 4. Janeway Travers, Immunobiology- the immune system in health and disease. Current Biology Ltd. London, New York. 3rd ed.,1997. • Peter J. Delves, Ivan M. Roitt, Encyclopedia of Immunology; Academic Press. 2 nd Ed., 1998. • Chapel H and Halbey M, Essentials of Clinical Immunology. ELBS. 1986. 7. Leslie Hudson and Frank C. Hay. Practical Immunology. Blackwell Scientific Publication. 3rd ed., 1989.
3	**Journal:** • Nature Immunology • The Journal of Immunology • Frontiers in Immunology • Annual Review of Immunology
4	**Periodicals:** • Annual Review of Immunology • Immunological Reviews
5	**Other Electronic resources:** Immunology Research (SpringerLink), Preprint Servers (bioRxiv, medRxiv), PubMed, Google Scholar, Europe PMC, BioMed Central, ImmunoQuery

Evaluation Scheme	Total Marks	
Theory: Mid semester Marks	20 marks	
Theory: End Semester Marks	40 marks	
Theory: Continuous Evaluation Component Marks		
	Attendance	05 marks
	MCQs	10 marks
	Open Book Assignment	15 marks
	Article Review	10 marks
	Total	40 Marks

Mapping of PSOs and CO for Agriculture Microbiology:

PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO						
CO1	1	-	2	2	-	1
CO2	1	-	2	-	3	-
CO3	3	3	3	2	2	-
CO4	3	3	3	-	-	3
CO5	3	1	3	3	3	3

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Mapping of PO and CO for Agriculture Microbiology

PO	PO1	PO2	PO3	PO4	PO5	PO6
CO						
CO1	3	2	3	-	-	2
CO2	2	3	3	-	-	1
CO3	3	2	3	2	-	2
CO4	3	2	3	-	-	3
CO5	3	3	-	3	3	3

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE	COURSE NAME	SEMESTER
MSBO236	ADVANCE BIO PYTHON	II

Teaching Scheme (Hours)				Teaching Credit			
Lecture	Practical	Tutorial	Total Hours	Lecture	Practical	Tutorial	Total Credit
2	0	0	2	2	0	0	2

Course Pre-requisites	10+2 examination in science
Course Category	Discipline specific elective
Course focus	Employability
Rationale	Learn Coding
Course Revision/ Approval Date:	14/03/2020
Course Objectives (As per Blooms' Taxonomy)	Ability to create Series
	Data frames and apply various operations.
	Visualize data using relevant graphs.
	Understand libraries like NumPy, Pandas and Matplotlib

Course Content (Theory)	Weightage	Contact hours
Unit 1: Functions: scope, parameter passing, mutable/immutable properties of data objects, pass arrays to functions, return values, functions using libraries: mathematical, and string functions. · File handling: open and close a file, read, write, and append to a file,	20%	6

standard input, output, and error streams, relative and absolute paths.		
Unit 2: Introduction to libraries in Python, Data Handling using Pandas -Introduction to Python libraries- Pandas, Matplotlib, NumPy.	20%	6
Unit 3: Data structures in Pandas - Series and Data Frames. Series: Creation of Series from – ND array, dictionary, scalar value; mathematical operations; Head and Tail functions; Selection, Indexing and Slicing	20%	6
Unit 4: Data Visualization, Purpose of plotting; drawing and saving following types of plots using Matplotlib – line plot, bar graph, histogram, customizing plots: adding label, title, and legend in plots.	20%	6

Instructional Method and Pedagogy:

Audio-Visual Lectures, Quizzes, Debates, Project works, Case studies, and Assignments Practical exercises are designed to understand the theory as taught in classroom. Hands-on in practical session.

Course Outcomes:	**Blooms' Taxonomy Domain**	**Blooms' Taxonomy Sub Domain**
After successful completion of the above course, students will be able to: **CO1:** Understand and Utilize Core Python Libraries	Remember, Understanding	Describe
CO2: Gain proficiency in using Panda's data structures, specifically Series and Data Frames, to organize, manipulate, and analyse structured data efficiently.	Remember, Understanding, apply	Explain
CO3: Perform Data Manipulation with Series and Data Frames	Understanding Analyse	Explain
CO4: Implement Data Importing and Exporting:	Understanding	Describe
CO5: Visualize Data Using Matplotlib:	Remember, Understanding	Describe

<table>
<tr><td>Evaluation Scheme</td><td>Total Marks = 150</td></tr>
<tr><td>Theory: Mid semester Marks</td><td>20 marks</td></tr>
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<tr><td>Attendance</td><td>05 marks</td></tr>
<tr><td>MCQs</td><td>10 marks</td></tr>
<tr><td>Open Book Assignment</td><td>15 marks</td></tr>
<tr><td>Research Paper Review</td><td>10 marks</td></tr>
<tr><td>Total</td><td>40 Marks</td></tr>
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<tr><td>Practical Marks</td><td><table>
<tr><td>Attendance</td><td>05 marks</td></tr>
<tr><td>Practical Exam</td><td>30 marks</td></tr>
<tr><td>Viva</td><td>10 marks</td></tr>
<tr><td>Journal</td><td>05 marks</td></tr>
<tr><td>Total</td><td>50 Marks</td></tr>
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Sr. No.	Learning Resources
1.	**Reference books:** 1) Python: - The Bible- 3 Manuscripts in 1 Book: -Python Programming for Beginners -Python Programming for Intermediates -Python Programming for Advanced by Maurice J Thompson 2) Learning python (5th Edition) by Mark Lutz, O'Reilly Media, Inc (2013). ISBN:9781449355739 3) Python programming for biology by Tim J. Stevens and Wayne Boucher. Cambridge University.Press 1st Ed. (2015) ISBN:9780511843556

2.	**Journal & Periodicals:** 1. Briefings of Bioinformatics 2. Bioinformatics 3. Journal of Computational Biology **4. BMC Bioinformatics**
3.	**Other Electronic resources:** NPTEL, Coursera, MH Education

Mapping of PSOs and COs

PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	-	1	2	1	1	-
CO2	1	2	2	2	3	-
CO3	2	-	3	1	2	1
CO4	2	3	2	-	2	2
CO5	2	1	-	1	-	2

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Mapping of PO and COs

PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	-	2	2	1
CO2	3	2	1	2	1	-
CO3	2	-	-	1	2	1
CO4	2	1	2	3	2	2
CO5	-	1	-	2	-	3

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE	COURSE NAME	SEMESTER
MSBO232	RESEARCH METHODOLOGY & IPR	II

Teaching Scheme (Hours)				Teaching Credit			
Lecture	Practical	Tutorial	Total Hours	Lecture	Practical	Tutorial	Total Credit
2	0	0	30	2	0	0	2

Course Pre-requisites	Graduate Degree in Biological Sciences
Course Category	Elective
Course focus	Understanding research processes, methodologies, and intellectual property rights fundamentals.
Rationale	The subject "Research Methodology & IPR" equips students with essential skills for systematic research, data analysis, and intellectual property protection, fostering innovation, academic integrity, and effective utilization of research outcomes.
Course Revision/ Approval Date:	
Course Objectives (As per Blooms' Taxonomy)	1. **Understand** the importance of research, its ethical considerations, and distinguish between qualitative, quantitative, and mixed methods. 2. **Analyse** research questions, define problems, and **apply** suitable experimental and non-experimental designs. 3. **Evaluate** sampling techniques, address errors, and **develop** strategies for data collection and statistical analysis. 4. **Explain** types of IPR and assess their role in protecting innovations and traditional knowledge. 5. **Understand** international frameworks (GATT, WTO, WIPO, TRIPS) to the impact of IPR on research and biotechnology.

Course Content (Theory)	Weightage	Contact hours
Unit I: Introduction to Research Methodology: Definition and importance of research, Types of research (qualitative, quantitative, methods), The research process (formulating research questions, hypothesis, etc.). Ethical considerations in research.	**20%**	**06**
Unit II: Research Problems & Research Design: Defining research problems. Important concepts in research design, dependent and independent variables, research hypothesis, experimental and non-experimental hypothesis.	**20%**	**06**
Unit III: Sampling Techniques: Sampling theory, types of sampling, Steps in sampling, Sample size. Data Collection Methods andAnalysis.	**20%**	**06**
Unit IV: Introduction To Intellectual Property: Types of IP: patents, trademarks, copyright, industrial design, protection of new GMOs.	**20%**	**06**
Unit V: Frameworks of IPR: International Framework for the protection of IP; IP as a factor in R&D; IPs of relevance to biotechnology and few case studies.	**20%**	**06**

Instructional Method and Pedagogy:

Audio-Visual Lectures, Quizzes, Debates, Project works, Case studies, and Assignments Practical exercises are designed to understand the theory as taught in the classroom. Hands on in a practical session.

Course Outcomes:	Blooms' Taxonomy Domain	Blooms' Taxonomy Sub Domain
CO1 Explain the importance of research and differentiate between types of research methodologies (qualitative, quantitative, mixed methods). Discuss the research process and ethical considerations involved in conducting research.	Understand, Remember & Apply	Explain, Describe, Discuss, Recall, Locate
CO2 Identify and define research problems and formulate hypotheses. Apply steps and techniques to create effective research designs, including experimental, quasi-experimental, and non-experimental designs.	Remember	Apply, Practice, Interpret, Select, Correlate
CO3 Compare and classify sampling techniques, analyse the steps in sampling, and differentiate between sampling and non-sampling errors. Investigate appropriate methods for data collection and statistical analysis in research.	Remember	Compare, Classify, Select, Investigate
CO4 Analyse and construct frameworks for intellectual property rights (IPR), including patents, trademarks, copyrights, industrial designs, and protection of GMOs. Develop an understanding of international frameworks like GATT, WTO, WIPO, and TRIPS.	Analyse	Construct, Develop, Produce
CO5 Summarize the role of intellectual property in research and development, particularly in biotechnology, and predict its impact through case studies. Explain the historical and contemporary significance of IPR in fostering innovation.	Understand, Remember & Apply	Explain, Describe, Outline, Predict, Summarize

Sr. No.	Learning Resources
1.	**Textbook:** 1. On Being a Scientist: A Guide to Responsible Conduct Research. (2009). Washington, D.C.: National Academies Press. 2. Gopen, G. D., & Smith, J.A. The Science of Scientific Writing. American Scientist, 78 (Nov-Dec 1990), 550-558.
2.	**Reference Books:** 1.Valiela, I. (2001). Doing Science: Design, Analysis, and Communication of Scientific Research. Oxford: Oxford University Press. 2.Mohan, K., & Singh, N. P. (2010). Speaking English Effectively. Delhi: Macmillan India.
3.	**Journal:** 1. International Journal of Research Methodology 2. International Journal of Science and Research Methodology
4.	**Periodicals:** Journal of Research Practice
5.	**Other Electronic resources:** Movies: Naturally Obsessed: The Making of a Scientist

Evaluation Scheme	Total Marks
Theory: Mid semester Marks	20 marks
Theory: End Semester Marks	40 marks
Theory: Continuous Evaluation Component Marks	

Attendance	05 marks
MCQs	10 marks
Open Book Assignment	15 marks
Article Review	10 marks

	Total **40 Marks**

Mapping of PSOs and CO for Research Methodology & IPR

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	2	2	1	1	-
CO2	3	3	3	2	1	-
CO3	3	3	3	2	-	-
CO4	2	2	2	3	3	3
CO5	2	2	3	2	3	2

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Mapping of PO and CO for Research Methodology & IPR

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	-	-	2	-
CO2	3	3	2	-	-	-
CO3	3	2	3	-	-	-
CO4	2	2	2	2	3	2
CO5	2	2	-	2	3	3

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE	COURSE NAME	SEMESTER
MSBO321	PROJECT PROPOSAL PREPARATION	III

Teaching Scheme (Hours)				Teaching Credit			
Lecture	Practical	Tutorial	Total Hours	Lecture	Practical	Tutorial	Total Credit
3	0	0	45	3	0	0	3

Course Pre-requisites	Graduate Degree in Biological Sciences
Course Category	Core Compulsory
Course focus	Employability in Industry and career in Research
Rationale	The course in Project proposal preparation expands the understanding and ideology of Post Graduate students on the preparation of project proposal aspects. With a deep understanding and importance on the basic aspects and overview of Project proposal, various steps in the preparation of Project proposal, proposal evaluation, various Government funding agencies in India and Gujarat
Course Revision/ Approval Date:	
Course Objectives **(As per Blooms' Taxonomy)**	1. To impart in-depth knowledge about the Overview about Proposal writing and Tips for writing an effective Proposal. 2. To have insight types of various proposal and Proposal Outline. 3. To be informed about the various steps for writing a proposal. 4. To retrieve the knowledge of various points pertaining to the Evaluation of Proposal. 5. To learn in brief about the various National level and State level funding agencies.

Course Content (Theory)	Weightage	Contact hours
Unit I: Overview: Overview about the Project proposal writing; Preamble of Proposal writing; Basic details required for Proposal writing; Tips for writing an effective Proposal – Clarity and conciseness- Objectives – Innovative approaches – Budget – Team Qualification; Significance and importance of effective Proposal writing.	**20%**	**09**
Unit II: Types of Proposal & Outlines: Types: Solicited Proposals – Unsolicited Proposals – Internal Proposals – Research Proposals- Network Project Proposals; Event (Seminar/ Workshop) Proposals; Outline: Cover page, Executive summary, Table of contents, Introduction, Objectives, Methodology / Approach, Budget, Teams Qualification, Outcome/Deliverables, Conclusion.	**20%**	**09**
Unit III: Steps for writing a proposal: Steps: Executive summary, Background, National and International Status, Goals/ Objectives, Methodology, Innovativeness of the Proposal; Expected outcome, Time line and Schedule; Infrastructure resources; Budget, Investigators background;	**20%**	**09**
Unit IV: Evaluation of Proposals: Scientific merit – Clarity of Hypothesis – Attainable goals – Relevance and ability to implement approaches – Innovativeness of the proposed idea – Background of Investigator; Panel Evaluation: Individual evaluation – Consensus group – Panel review – Final decision;	**20%**	**09**
Unit V: Funding agencies: Brief Overview about Indian Funding agencies – Overview about Anusandhan National Research Foundation (ANRF); Indian Council of Medical Research (ICMR); Department of Science Technology; Gujarat – Gujarat Council for Science and Technology (GUJCOST); Gujarat State Biotechnology Mission (GSBTM); Knowledge Consortium Gujarat – SHODH scheme (PhD Scholars in Gujarat)	**20%**	**09**

Instructional Method and Pedagogy:

Audio-Visual Lectures, Quizzes, Debates, Project works, Case studies, and Assignments Practical exercises are designed to understand the theory as taught in the classroom. Hands on in a practical session.

Course Outcomes:		Blooms' Taxonomy Domain	Blooms' Taxonomy Sub Domain
CO1	On completion of this course, students should be able to understand the basics and brief overview about proposal Writing and tips for writing an effective proposal.	Understand, Remember & apply	Explain, Describe, Discuss, Recall, Locate

CO2	Demonstrate and understanding the types of proposal and Brief outline about overview of proposal writing	Remember	Apply, Practice, Interpret, Select, Correlate
CO3	Demonstrate and understanding the various steps in the writing the proposal.	Remember	Compare, Classify, Select, Investigate
CO4	Demonstrate and understanding the various phases in the Evaluation of submitted proposal.	Analyses	Construct, Develop, Produce
CO5	Demonstrate the various National and State level funding Agencies and impart their role in the Development of Science and Technology.	Understand, Remember& apply	Explain, Describe, outline, Predict, Summarize

Learning Resources	
1	Textbook: 1. Gurumani, N. 2011. Biological Research Methodology for Biological Sciences; MJP Publishers, Chennai. 2. Kothari, C.R., 2023. Research methodology – Methods and Techniques, New Age International Publishers, New Delhi.
2	Reference books 1. Laake, :P., Benestad, B.B. Olsen, B.R., 2004. Research Methodology in the Medical and Biological Sciences, Elsevier Publications.
3	Journal 1. BMC Medical Research Methodology 2. International Journal of Research Methodology
4	Periodicals: 1. University News 2. Current Science
5	Other Electronic resources: https://libguides.jsu.edu/bioresearch/design https://research.com/research/how-to-write-research-methodology https://www.kantata.com/blog/article/8-tips-for-writing-a-project-proposal

<table>
<tr><th>Evaluation Scheme</th><th>Total Marks</th></tr>
<tr><td>Theory: Mid semester Marks</td><td>20 marks</td></tr>
<tr><td>Theory: End Semester Marks</td><td>40 marks</td></tr>
<tr><td>Theory: Continuous Evaluation Component Marks</td><td>
<table>
<tr><td>Attendance</td><td>05 marks</td></tr>
<tr><td>MCQs</td><td>10 marks</td></tr>
<tr><td>Open Book Assignment</td><td>15 marks</td></tr>
<tr><td>Article Review</td><td>10 marks</td></tr>
<tr><td>Total</td><td>40 Marks</td></tr>
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<tr><td>Practical Marks</td><td>
<table>
<tr><td>Attendance</td><td>05 marks</td></tr>
<tr><td>Practical Exam</td><td>20 marks</td></tr>
<tr><td>Viva</td><td>10 marks</td></tr>
<tr><td>Journal</td><td>10 marks</td></tr>
<tr><td>Discipline</td><td>05 marks</td></tr>
<tr><td>Total</td><td>50 Marks</td></tr>
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Mapping of PSOs and CO for Microbial Physiology

PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO						
CO1	3	3	2	2	3	1
CO2	3	1	1	2	2	2
CO3	3	2	1	1	-	-
CO4	2	2	3	-	-	3
CO5	-	-	-	2	-	3

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Mapping of PO and CO for Microbial Physiology

PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO						
CO1	3	-	3	-	1	-
CO2	2	-	3	-	1	-
CO3	3	-	3	-	1	-
CO4	3	-	3	-	1	-
CO5	2	-	3	-	1	-

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE	COURSE NAME	SEMESTER
MSBO322	EMERGING TECHNOLOGIES	III

Teaching Scheme (Hours)				Teaching Credit			
Lecture	Practical	Tutorial	Total Hours	Lecture	Practical	Tutorial	Total Credit
3	4	0	45+60	3	2	0	5

Course Pre-requisites	Graduate degree in Biological Sciences
Course Category	Core Compulsory
Course focus	Career in Research and Industry
Rationale	Broad-based in nature encompassing several new technologies that current experimental researchers are employing to probe complex system biology questions in life-sciences. Emerging technologies enhance research precision, exploring areas like epigenetics, proteomics, and microbial diversity.
Course Revision/ Approval Date:	
Course Objectives **(As per Blooms' Taxonomy)**	1. **Remember** Concepts of new technologies 2. **Apply** understanding of Experimental approaches 3. **Analyses** appreciate current-day research tool-kit. 4. **Create** an understanding how interactions network develops 5. **Understand** applications both scientific and industrial

Course Content (Theory)	Weightage	Contact hours
Unit 1: Microscopy **Theory:** Optical microscopy methods **Basic Microscopy:** Light Microscopy- lenses and microscopes, resolution: Rayleigh's approach, Darkfield; Phase Contrast; Differential Interference Contrast; fluorescence and fluorescence microscopy: what is fluorescence, what makes a molecule fluorescent, fluorescence microscope; optical arrangement, light source; filter sets: excitation filter, dichroic mirror, and barrier, optical layout for image capture; CCD cameras; back illumination, binning; recording colour; three CCD elements with dichroic beams platters, boosting the signal. **Advanced Microscopy:** Confocal microscope: scanning optical microscope, confocal principle, resolution and point spread function, light source: gas lasers &solid-state, primary beam splitter; beam scanning, pinhole and signal channel configurations, detectors; pixels and voxels; contrast, spatial sampling: temporal sampling: signal-to noise ratio, multichannel images. nonlinear microscopy: multiphoton microscopy; principles of two-photon fluorescence, advantages two-photon excitation, tandem scanning (spinning disk) microscopes, deconvolving confocal images; image processing, three-dimensional reconstruction; advanced fluorescence techniques: FLIM, FRET, and FCS, Fluorescence Lifetime, Fluorescence Resonant Energy Transfer (FRET), Fluorescence Correlation Spectroscopy (FCS), Evanescent Wave Microscopy; Near-Field and Evanescent Waves, Total Internal Reflection Microscopy; Near-Field Microscopy; BeyondtheDiffractionLimit:StimulatedEmissionDepletion(STED),SuperRes olution Summary, Super-Resolution Imaging with Stochastic Optical Reconstruction Microscopy (STORM) and Photoactivated Localization Microscopy (PALM)	**20%**	**09**
Unit 2: Mass spectroscopy & AAS **Theory:** Mass spectroscopy Ionization techniques; mass analysers/overview MS; FT-ICR and Orbitrap, fragmentation of peptides; proteomics, nano LCMS; Phosphor proteomics; interaction proteomics, mass spectroscopy in structural biology; imaging mass spectrometry, AAS and its applications in life sciences	**20%**	**09**
Unit 3: System & Structural Biology **Theory:** Systems biology High throughput screens in cellular systems, target identification, validation of experimental methods to generate the omics data, bioinformatics analyses, mathematical modelling and designing testable predictions. Structural biology X-ray diffraction methods, solution &solid-state NMR, cryo-electron microscopy, small angle X-ray scattering, atomic force microscopy.	**20%**	**09**

Unit 4: CRISPR technology **Theory:** CRISPR-CAS History of its discovery, elucidation of the mechanism including introduction to all the molecular players, development of applications for in vivo genome engineering for genetic studies, promise of the technology as a next generation therapeutic method.	**20%**	**09**
Unit 5: NANOBODIES **Theory:** NANOBODIES Introduction to nanobodies, combining nanobody with phage-display method for development of antibody against native proteins, nanobody as a tool for protein structure-function studies, use of nanobodies for molecular imaging, catabolic antibodies using nanobodies.	**20%**	**09**

List of Practical

Sr. No	List of Practical	Weightage	Contact hours
1	To study the working and principle of fluorescent microscopy/ inverted microscopy	20%	06
2	Demonstration of Atomic Absorption Spectroscopy	20%	06
3	Protein structure prediction and Bioinformatics analysis	20%	06
4	Demonstration of RT-PCR/ Cloning/ Designing Guide RNA using bioinformatic tools	20%	06
5	Demonstration of ELISA/HPLC/GC	20%	06

Instructional Method and Pedagogy:
Audio-Visual Lectures, Quizzes, Debates, Project works, Case studies, and Assignments Practical exercises are designed to understand the theory as taught in the classroom. Hands on and demonstration in a practical session.

Course Outcomes:		**Blooms' Taxonomy Domain**	**Blooms' Taxonomy Sub Domain**
CO1	Students will come to know the new technologies that current experimental researchers are employing to probe complex questions in life-sciences	Remember	Explain, Describe, Discuss, Recall, Locate
CO2	Enhance research capabilities in students by knowing the new principles so as to appreciate current-day research tool-kit better	Apply	Apply, Practice, Interpret, Select, Correlate

CO3	Understanding the need for Technologies	Analyses and Evaluation	Compare, Classify, Select, Investigate
CO4	Understanding the advanced technologies.	Create	Construct, Develop, Produce
CO5	Applications of Emerging Technologies	Understand	Explain, Describe, outline, Predict, Summarize

Learning Resources

1	Textbook: 1. Campbell, I.D. (2012). Biophysical Techniques. Oxford: Oxford University Press. 2. Serdyuk, I. N., Zaccai, N. R., & Zaccai, G. (2007). Methods in Molecular Biophysics: Structure, Dynamics, Function. Cambridge: Cambridge University Press. 3. Phillips, R., Kondev, J., & Theriot, J.(2009). Physical Biology of the Cell. New York: Garland Science. 4. Nelson, P.C., Radosavljević, M.,&Bromberg, S.(2004). Biological Physics: Energy, Information, Life. New York: W.H.Freeman.
2.	Reference books & articles 1. Huang, B., Bates, M., & Zhuang, X. (2009). Super-Resolution Fluorescence Microscopy. Annual Review of Biochemistry, 78(1),993-1016.doi:10.1146/annurev. biochem.77.061906.092014. 2. Mohanraju, P.,Makarova, K. S., Zetsche, B., Zhang, F.,Koonin, E. V.,& Oost, J. V. (2016).Diverse Evolutionary Roots and Mechanistic Variations of the CRISPR-Cas Systems. Science, 353(6299). doi:10.1126/science.aad5147. 3. Lander, E.(2016).The Heroes of CRISPR. Cell, 164(1-2), 18-28.doi:10.1016/j. cell.2015.12.041. 4. Ledford, H.(2016).TheUnsungHeroesofCRISPR.Nature,535(7612),342-344. doi:10.1038/535342a. 5. Jinek,M., Chylinski, K., Fonfara,I., Hauer,M.,Doudna,J.A., &Charpentier,E. (2012). A Programmable Dual-RNA-Guided DNA Endonuclease in Adaptive Bacterial Immunity. Science, 337(6096), 816-821.doi:10.1126/science.1225829. 6. Hamers-Casterman,C.,Atarhouch,T.,Muyldermans,S.,Robinson,G.,Hammers, C., Songa, E. B., Hammers, R. (1993). Naturally Occurring Antibodies Devoid of Light Chains. Nature, 363(6428), 446-448.doi:10.1038/363446a0. 7. Sidhu, S. S., & Koide, S. (2007). Phage Display for Engineering and Analysing Protein Interaction Interfaces. Current Opinion in Structural Biology, 17(4), 481-487. doi:10.1016/j.sbi.2007.08.007. 8. Steyaert, J., & Kobilka, B. K.(2011). Nanobody Stabilization of G Protein-Coupled Receptor Conformational States. Current Opinionin Structural Biology, 21(4), 567-572. doi:10.1016/j.sbi.2011.06.011.

Evaluation Scheme	Total Marks
Theory: Mid semester Marks	20 marks
Theory: End Semester Marks	40 marks
Theory: Continuous Evaluation Component Marks	

Attendance	05 marks
MCQs	10 marks
Open Book Assignment	15 marks
Article Review/ Presentation	10 marks
Total	**40 Marks**

Practical Marks	

Attendance	05 marks
Practical Exam	30 marks
Viva	10 marks
Journal	05 marks
Total	**50 Marks**

2	9. Vincke, C., & Muyldermans, S. (2012). Introduction to Heavy Chain Antibodies and Derived Nanobodies. Single Domain Antibodies, 15-26. doi:10.1007/978-1-61779-968- 6_2. 10. Verheesen, P.,& Laeremans, T.(2012). Selection by Phage Display of Single Domain Antibodies Specific to Antigens in their Native Conformation. Single Domain Antibodies, 81-104.doi:10.1007/978-1-61779-968-6_6. 11. Li,J.,Xia,L.,Su,Y.,Liu,H.,Xia,X.,Lu,Q.Reheman,K.(2012).Molecular Imprint of Enzyme Active Site by Camel Nanobodies. Journal of Biological Chemistry J. Biol. Chem., 287(17), 13713-13721.doi:10.1074/jbc.m111.336370. 12. Sohier,J.,Laurent,C.,Chevigné,A.,Pardon,E.,Srinivasan,V.,Wernery,U.Galleni, M. (2013). Allosteric Inhibition of VIM Metallo-β-Lactamases by a Camelid Nanobody. Biochemical Journal, 450(3), 477-486. doi:10.1042/bj20121305. Chakravarty, R., Goel, S., & Cai, W.(2014). Nanobody: The "Magic Bullet" for Molecular Imaging?Theranostics,4(4),386-398.doi:10.7150/thno.8006.
3	Journal 1. JBC, 2. Science, 3. Plos biology
4	Periodicals: 1. Current science
5	Other Electronic resources: 1) MH Education 2) NPTEL

Mapping of PSOs and CO for Emerging Technologies

PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO						
CO1	1	-	2	1	1	-
CO2	1	3	2	2	-	-
CO3	1	-	-	1	2	1
CO4	2	3	2	-	2	2
CO5	2	1	-	1	-	2

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Mapping of PO and CO for Emerging Technologies

PO	PO1	PO2	PO3	PO4	PO5	PO6
CO						
CO1	3	2	-	2	2	1
CO2	-	1	1	2	-	-
CO3	2	-	-	1	2	1
CO4	2	1	2	3	2	2
CO5	-	1	-	2	-	3

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE	COURSE NAME	SEMESTER
MSBO323	GENETIC ENGINEERING	III

Teaching Scheme (Hours)				Teaching Credit			
Lecture	Practical	Tutorial	Total Hours	Lecture	Practical	Tutorial	Total Credit
3	4	0	45+60	3	2	0	5

Course Pre-requisites	Graduate Degree in Biological Sciences
Course Category	Core Compulsory
Course focus	Career in Research and Industry
Rationale	Genetic engineering is fundamental in modern biotechnology, enabling manipulation of genetic material to produce desirable traits, develop therapeutic interventions, and drive industrial applications. This course aims to provide students with the skills necessary for understanding, analyzing, and applying genetic engineering techniques in fields ranging from agriculture to industrial biotechnology and medicine. Emphasis is placed on practical applications, such as industrial-scale production, the use of bio fermenters, and bioethical considerations.
Course Revision/ Approval Date:	
Course Objectives **(As per Blooms' Taxonomy)**	• **Understand** the fundamental concepts, tools, and techniques of genetic engineering, including recombinant DNA technology, gene cloning, and vector systems. (Remembering & Understanding) • **Analyze** various genetic modification techniques and evaluate their application in therapeutic and industrial biotechnology. (Analyzing & evaluating) • **Apply** genetic engineering techniques for developing genetically modified organisms (GMOs) and assessing their industrial viability. (Applying) • **Evaluate** the ethical, legal, and social implications (ELSI) of genetic engineering and propose responsible practices. (Evaluating) • **Design** experiments for cloning, gene expression, and protein production using advanced genetic tools and bioprocess systems. (Creating)

Course Content (Theory)	Weightage	Contact hours
Unit 1: Basics of Genetic Engineering **Topics**: Overview, historical perspectives, DNA structure and function, recombinant DNA technology, restriction enzymes, ligases.	**20%**	**09**
Unit 2: Cloning Vectors and Gene Cloning Techniques **Topics**: Types of vectors (plasmids, bacteriophages, YAC, BAC), transformation and transfection methods, selectable markers, screening techniques.	**20%**	**09**
Unit 3: Genetic Engineering Tools and Techniques **Topics**: PCR, RT-PCR, CRISPR-Cas9, gene editing, gene knockout techniques, gene synthesis.	**20%**	**09**
Unit 4: Industrial Applications and Bioprocess Engineering **Topics**: Large-scale production in bio-fermenters, design and optimization, metabolic engineering, applications in pharmaceuticals, agriculture, and biofuels.	**20%**	**09**
Unit 5: Ethical, Legal, and Social Implications (ELSI) **Topics**: Regulatory frameworks, biosafety, ethical issues, intellectual property rights, public perception.	**20%**	**09**

List of Practical

Sr. No	List of Practical	Weightage	Contact hours
1	**Isolation and Purification of Plasmid DNA** – Introduction to vector systems and plasmid manipulation.	20%	06
2	**PCR Amplification of Target Genes** – Application of PCR in gene cloning.	20%	06
3	**Restriction Enzyme Digestion and DNA Ligation** – Basics of recombinant DNA technology.	20%	06
4	**Transformation of Bacteria with Recombinant Plasmids** – Practical application of gene cloning.	20%	06

5	**Expression and Purification of Recombinant Protein in E. coli** – Understanding downstream processes and bioprocess scale-up.	20%	06

Instructional Method and Pedagogy:

- **Flipped Classrooms**: Pre-lecture readings and videos, with in-class discussions on case studies.
- **Problem-Based Learning (PBL)**: Practical problems for each topic to develop critical thinking.
- **Peer Teaching**: Students present techniques and discuss applications.
- **Field Visits**: To biotechnological labs or industries for practical exposure.
- **Simulation Exercises**: Virtual labs for genetic engineering tools and industrial processes.

Course Outcomes:		Blooms' Taxonomy Domain	Blooms' Taxonomy Sub Domain
CO1	**Recall** the key terminologies, processes, and tools used in genetic engineering.	Remembering	Explain, Describe, Discuss, Recall, Locate
CO2	**Describe** vector systems and explain their applications in genetic manipulation and gene transfer.	Understanding	Apply, Practice, Interpret, Select, Correlate
CO3	**Conduct** laboratory experiments on gene cloning, DNA extraction, and PCR amplification.	Applying	Compare, Classify, Select, Investigate
CO4	**Assess** the implications of genetically engineered organisms for biosafety, bioethics, and regulatory compliance.	Evaluating	Construct, Develop, Produce
CO5	**Design** and implement a project that demonstrates proficiency in creating genetically modified microorganisms for industrial purposes.	Creating	Explain, Describe, outline, Predict, Summarize

Learning Resources	
1	**Textbook:** 1. Brown, T. A. **"Gene Cloning and DNA Analysis: An Introduction."** 2. Primrose, S. B., & Twyman, R. M. **"Principles of Gene Manipulation and Genomics."** 3. Sambrook, J., & Russell, D. W. **"Molecular Cloning: A Laboratory Manual."**
2	**Reference books** 1. Alberts, B. et al. **"Molecular Biology of the Cell."** 2. Glick, B. R., & Pasternak, J. J. **"Molecular Biotechnology: Principles and Applications of Recombinant DNA."**
3	**Journal** 1. Nature Biotechnology 2. Journal of Industrial Microbiology and Biotechnology 3. Trends in Biotechnology 4. BMC Biotechnology
4	**Periodicals:**
5	Other Electronic resources: 1. SWAYAM: Genetic Engineering: Theory and Applications – Focuses on gene editing tools, cloning, and industrial applications. 2. Coursera: Biotechnology and Genetic Engineering – Covers genetic modification, CRISPR technology, and practical applications. 3. edX: Principles of Synthetic Biology by MIT – In-depth on genetic circuits, CRISPR, and synthetic biology applications.

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<tr><td>Article Review</td><td>10 marks</td></tr>
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<tr><td>Practical Marks</td><td>
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<tr><td>Attendance</td><td>05 marks</td></tr>
<tr><td>Practical Exam</td><td>20 marks</td></tr>
<tr><td>Viva</td><td>10 marks</td></tr>
<tr><td>Journal</td><td>10 marks</td></tr>
<tr><td>Discipline</td><td>05 marks</td></tr>
<tr><td>Total</td><td>50 Marks</td></tr>
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Mapping of PSOs and CO

PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO						
CO1	3	3	2	2	3	1
CO2	3	1	1	2	2	2
CO3	3	2	1	1	-	-
CO4	2	2	3	-	-	3
CO5	-	-	-	2	-	3

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Mapping of PO and CO

PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO						
CO1	3	-	3	-	1	-
CO2	2	-	3	-	1	-
CO3	3	-	3	-	1	-
CO4	3	-	3	-	1	-
CO5	2	-	3	-	1	-

1: Slight (low);2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE: MSBO324	COURSE NAME: COMPUTATIONAL BIOLOGY	L	T	P	C
		3	0	2	5
Total Credits: 5	Total Hours in Semester: 45+60	Total Marks: 150			

1	Course Pre-requisites: Students should contain basic knowledge about computer system, software etc.
2	Course Category: Compulsory
3	Course Revision/ Approval date:
4	Course Objectives
	4.1 To introduce Computational biology and involvement of computers to analyse biological system.
	4.2 Structural visualization of Complex Biomolecules.
	4.3 To explain the complex mechanism of Molecular modelling and Structure-based drug development.
	4.4 This course will pave a way for technological Insite for Molecular Docking.
	4.5 To give inputs on Ligand-based drug development.

Course Content	Weightage	Contact hours	Pedagogy
Unit 1: Introduction to computational biology basics and biological databases and pairwise and multiple sequence alignments. Genome analysis Comparative genomics, Probabilistic functional gene networks, Human genome project, Genomics and crop improvement. Study available GWAS, ENCODE, HUGO projects, extract and build sub databases	**20%**	**9**	Audio-Visual Lectures
Unit 2: Structure visualization: Retrieving and drawing structures, Macromolecule viewing platforms, Structure validation and correction, Structure optimization, Analysis of ligand-protein interactions; Tools such as PyMol or VMD.	**20%**	**9**	Project works and assignments will be given post completion of the topic/unit.
Unit 3: Molecular modelling and Structure-based drug development: Theory: Significance and need, force field methods, energy, buried and exposed residues; side chains and neighbours; fixed regions; hydrogen bonds; mapping properties onto surfaces; RMS fit of conformers and protein chains, assigning secondary structures; sequence alignment: methods, evaluation, scoring; protein curation: backbone construction and side chain addition; different types of protein chain modelling: ab initio, homology, hybrid, loop; Template recognition and alignments; Modelling parameters and considerations; Model analysis	**20%**	**9**	Stimulations and Video lectures

and validation; Model optimization; Substructure manipulations, annealing, protein folding and model generation; loop generating methods; loop analysis; Analysis of active sites using different methods in studying protein–protein interactions			
Unit 4: Molecular docking: Types and principles, Semi-flexible docking, Flexible docking; Ligand and protein preparation, Macromolecule and ligand optimization, Ligand conformations, Clustering, Analysis of docking results and validation with known information. Extra precision docking platforms, Use of Small-molecule libraries, Natural compound libraries for virtual high through put screenings.	**20%**	**9**	Discussion, debates, project works and assignments will be given post completion of the topic/unit.
Unit 5: Ligand-based drug development Theory: Quantitative structure activity relationships; Introduction to chemical descriptors like 2D, 3D and Group-based; Radar plots and contribution plots and Activity predictions, Pharmacophore modelling, Pharmacophore-based screenings of compound library, analysis and experimental validation.	**20%**	**9**	Audio-Visual Lectures and quizzes, debates, project works and assignments will be given post completion of the topic/unit.
Practical: 1. Using NCBI, Uniprotweb and PDB resources. 2. Introduction and use of various genome databases 3. Sequence information resource: Using NCBI, EMBL, Genbank, Entrez, Swissprot/ rEMBL, UniProt. 5. Similarity searches using tools like BLAST and interpretation of results. 6. Multiple sequence alignment using ClustalW. 7. Phylogenetic analysis of protein and nucleotide sequences. 8. Use of gene prediction methods (GRAIL, Genscan, Glimmer). 9. Using RNA structure prediction tools. 10. Use of various primer designing and restriction site prediction tools. 11. Use of different protein structure prediction databases (PDB, SCOP, CATH). 12. Construction and study of protein structures using Deepview/PyMol. 13. Homology modelling of proteins. 14. Small Ligand Docking via Argus.			

Instructional Method and Pedagogy: Audio-Visual Lectures, Quizzes, Debates, Project works, Case studies, and Assignments Practical exercises are designed to understand the theory as taught in the classroom. Hands-on in practical session.

Course Outcomes:	Blooms' Taxonomy Domain	Blooms' Taxonomy Sub Domain
After successful completion of the above course, students will be able to: **CO1** Develop an understanding of the basic theory of these computational tools; **CO2** Develop required database extraction, integration, coding for computational tools and methods necessary for all Omics; **CO3** Create hypothesis for investigating specific contemporary biological questions	Understand, Remember& apply Understand, Remember& apply Apply	Explain, Describe, Discuss, Recall, Locate Apply, Practice, Interpret, Select, Correlate Compare, Classify, Select,
CO4 Critically analyze and interpret results of their study with respect to whole systems. CO5 Provide help to experiment with or develop appropriate tools;	Apply Understand, Remember& apply	Investigate Construct, Develop, Produce Explain, Describe, outline, Predict, Summarize

Learning Resources	
1	Textbook: 1. Mount, D. W. (2001). *Bioinformatics: Sequence and Genome Analysis*. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press. 2. Bourne, P.E., & Gu, J. (2009). *Structural Bioinformatics*. Hoboken, NJ: Wiley-Liss. *3.* Lesk, A. M. (2004). *Introduction to Protein Science: Architecture, Function, and Genomics*. Oxford: Oxford University Press.
2	Reference books : 1. Campbell, M & Heyer, L. J. (2006), *Discovering Genomics, Proteomics and Bioinformatics*, Pearson Education. 2. Oprea, T. (2005). C*hemo informatics in Drug Discovery,* Volume 23. Wiley Online Library. 3. Gasteiger, J.& Engel, T. (2003), *Chemo informatics: a Textbook*, Wiley Online Library.
3	Journal: Bioinformatics and Biology Insights
5	Periodicals: BMC Bioinformatics
6	OtherElectronicresources: https://iop.vast.ac.vn/theor/conferences/smp/1st/kaminuma/SWISSPROT/index.htm 1

Evaluation Scheme	Total Marks

Theory: Mid semester Marks	20 marks
Theory: End Semester Marks	40 marks
Theory: Continuous Evaluation Component Marks	
Practical Marks	

Attendance	05 marks
Practical Exam	20 marks
Viva	10 marks
Journal	10 marks
Discipline	05 marks
Total	**50 Marks**

Mapping of PSO and COs

PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO						
CO1	2	-	-	-	2	-
CO2	2	-	3	-	-	-
CO3	1	-	1	-	-	3
CO4	-	1	-	1	-	3
CO5						

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Mapping of PO and COs

PO	PO1	PO2	PO3	PO4	PO5	PO6
CO						
CO1	3	-	-	-	2	-
CO2	1	1	2	-	-	-
CO3	-	3	2	-	-	-
CO4	-	-	-	1	-	-
CO5						

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE MSBO325	COURSE NAME AGRICULTURE MICROBIOLOGY	SEMESTER III

Teaching Scheme (Hours)				Teaching Credit			
Lecture	Practical	Tutorial	Total Hours	Lecture	Practical	Tutorial	Total Credit
3	0	0	45	3	0	0	3

Course Pre-requisites	Basic knowledge of agriculture microbiology.
Course Category	Discipline specific elective
Course focus	Employability
Rationale	Agricultural Microbiology lies in the growing need for advanced scientific knowledge to address key challenges in agriculture, such as food security, environmental sustainability, and the efficient use of natural resources. Agricultural microbiology plays a pivotal role in improving agricultural productivity, enhancing soil health, and combating plant diseases, while maintaining ecological balance.
Course Revision/ Approval Date:	
Course Objectives (As per Blooms' Taxonomy)	1. To emphasize principles involved in role of microbes present in soil and carry out various biogeochemical cycles. 2. To understand the role of microbes in plant growth and killing the plant pathogens: Biofertilizers (Biogeochemical cycle-Nitrogen fixation) and Biopesticides. 3. To impart the knowledge of Microbial transformation in soil and production of organic manures. 4. To understand the various plant diseases caused by bacteria, fungi and other agents. To understand the methods to control them by biological techniques. 5. To understand the molecular plant microbe interactions. The study of designing new techniques to recycle agricultural wastes.

Course Content (Theory)	Weightage	Contact hours
Unit 1: Soil microbial ecology: Soil biota, types of organisms in different soils; Soil microbial biomass; Factors influencing the soil microflora. Different Agriculturally important beneficial microorganisms – free living, symbiotic (rhizobial, mycorrhizal, actinorhizal), associative and endophytic nitrogen fixers including cyanobacteria. **Microbial interactions:** Different interfaces of interactions - Plant-microbe, microbe-microbe, soil microbe, soil-plant-microbe interactions leading to symbiotic, associative, endophytic and pathogenic interactions, unculturable soil biota. Plant growth promoting rhizobacteria (PGPR). Mechanism of plant growth promotion by PGPR.	**20%**	**09**
Unit 2: Introduction to biofertilizers: definition, types of biofertilizers; Characteristic features of the following biofertilizer organisms: Azospirillium, Azotobacter, Bacillus, Pseudomonas, Rhizobium, Frankia, Anabaena and Nostoc . Mechanisms of action of different bio-inoculants for plant growth. Significance of biofertilizers. Mass scale production and quality control of bio-inoculants. Biofertilizer inoculation and microbial communities in the soil. **Biological nitrogen fixation:** Biochemistry of N_2 fixation, nif operon, mechanism of nitrogen fixation. Symbiotic nitrogen fixation: Rhizobium-Legume association, Actinorhizal associations, contribution of symbiotic nitrogen fixation. Denitrification. Phosphate solubilization and mobilization. Mycorrhizae- Ecto and endomycorrhizae, VAM and their importance in agriculture.	**20%**	**09**
Unit 3: Microbial transformations: of nitrogen, phosphorus, sulphur, iron and manganese in soil. Biochemical composition and biodegradation of soil organic matter and crop residues. Biodegradation of pesticides, Organic wastes and their use for production of biogas and manures. Microbial degradation of polymers: lignin, cellulose, hemicelluloses. Factors affecting the degradation of organic matter. **Organic manures:** Preparation, properties, and use in crop production, nutrient enriched compost, green manure; Composting, vermicomposting	**20%**	**09**
Unit 4: Some important plant diseases and their etiological studies: Diseases of field, vegetable, orchard and plantation crops and their control; causes and classification of plant diseases; principles of biological control of diseases. Methods to exclude pathogens from host- Quarantines and Inspections, Crop certification, Evasion or avoidance of pathogen, use of pathogen-free propagating material, pathogen-free seeds and vegetative propagating materials. Plant immunization; Direct protection; Integrated control, Biopesticides – *Bacillus thuringiensis*, *B. sphaericus*, *B. popilliae*, *Pseudomonas syringae*. **Biocontrol** – Concept, types, mode of action, uses and practical constraints & applications of biocontrol agents. Biocontrol agent for sustainable agriculture. Different types of biocontrol agents. Biopesticides and bioherbicides, Biopesticides- classification, advantages. Major biopesticides based on bacteria, viruses & fungi (*Bacillus thuringiensis* (Bt) toxin, Boverin, DeVine, Collego).	**20%**	**09**
Unit 5: Molecular plant microbe-interactions: Cell signalling, Quorum sensing, and Biofilm formation. Invasion of plant tissue: Resistance mechanisms against attack by plant pathogens. Molecular detection of pathogens. Integrated pest management-concepts and components; host plant resistance-biological control of insect pests; Recycling of agricultural wastes – Microbiology of biogas, bioethanol and value added products. Mushroom cultivation and vermicomposting.	**20%**	**09**

Instructional Method and Pedagogy:
Audio-Visual Lectures, Quizzes, Debates, Project works, Case studies, and Assignments Practical exercises are designed to understand the theory as taught in classroom. Hands on in practical session.

Course Objectives:		Blooms' Taxonomy Domain	Blooms' Taxonomy Sub Domain
CO1	On completion of this course, students should be able to emphasize principles involved in role of microbes present in soil and carry out various biogeochemical cycles.	Understand, Remember& apply	Explain, Describe, Discuss
CO2	On completion of this course, students should be able to understand the role of microbes in plant growth and killing the plant pathogens: Biofertilizers (Biogeochemical cycle-Nitrogen fixation) and Biopesticides.	Analyse	Apply, Practice, Interpret, Select, Correlate
CO3	On completion of this course, students should be able to impart the knowledge of Microbial transformation in soil and production of organic manures.	Understand and Remember	Apply and Practice
CO4	On completion of this course, students should be able to understand the various plant diseases caused by bacteria, fungi and other agents. They should also able to understand the methods to control them by biological techniques.	Analyses	Construct, Develop, Produce
CO5	On completion of this course, students should be able to understand the molecular plant microbe interactions and able to design new techniques to recycle agricultural wastes.	Understand, Remember& apply	Explain, Describe, outline, Predict, Summarize

Learning Resources	
1	Textbook: • Kaushik, B. D. (2007). Principles of agricultural microbiology. Kalyani Publishers. • Sharma, H. D. (2013). Agricultural microbiology. Rastogi Publications.
2	Reference Books: • Paul, E. A. (2014). Soil microbiology, ecology, and biochemistry (4th ed.). Academic Press. https://doi.org/10.1016/B978-0-12-415955-6.00001-7 • Glick, B. R. (2014). Plant growth-promoting rhizobacteria: Applications and perspectives. Springer. https://doi.org/10.1007/978-3-319-10929-4 • Caruso, G., & Lo, F. (Eds.). (2021). Advances in plant and agricultural microbiology. Elsevier. https://doi.org/10.1016/B978-0-12-819965-2.00001-7 • Martínez-Romero, E., & Arguelles-Arias, A. (2016). Microbial diversity in the agriculture ecosystem. Springer. https://doi.org/10.1007/978-3-319-32060-7 • Singh, D. P., & Gupta, V. K. (Eds.). (2019). *Microorganisms in sustainable agriculture and biotechnology*. Springer. https://doi.org/10.1007/978-3-319-92643-0 • Widmer, F., & Mohn, W. W. (2017). Microbial ecology of the rhizosphere (1st ed.). Springer. https://doi.org/10.1007/978-3-319-45579-5
3	Journal: • FEMS Microbiology Ecology • Applied and Environmental Microbiology
4	Periodicals: • Soil Biology and Biochemistry • Biological Control
5	Other Electronic resources: Agricultural Research Service (ARS) – USDA, National Agricultural Library (NAL) – USDA, Science Direct, PubMed.

Evaluation Scheme	Total Marks
Theory: Mid semester Marks	20 marks
Theory: End Semester Marks	40 marks
Theory: Continuous Evaluation Component Marks	

Attendance	05 marks
MCQs	10 marks
Open Book Assignment	15 marks
Article Review	10 marks
Total	**40 Marks**

Mapping of PSOs and CO for Agriculture Microbiology:

PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO						
CO1	1	-	2	2	-	1

CO2	1	-	2	-	3	-
CO3	3	3	3	2	2	-
CO4	3	3	3	-	-	3
CO5	3	1	3	3	3	3

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Mapping of PO and CO for Agriculture Microbiology

PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO						
CO1	3	2	3	-	-	2
CO2	2	3	3	-	-	1
CO3	3	2	3	2	-	2
CO4	3	2	3	-	-	3
CO5	3	3	-	3	3	3

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE MSBO326			COURSE NAME FOOD TECHNOLOGY			SEMESTER III	
Teaching Scheme (Hours)				Teaching Credit			
Lecture	Practical	Tutorial	Total Hours	Lecture	Practical	Tutorial	Total Credit
3	0	0	45	3	0	0	3

Course Pre-requisites	Graduate Degree in Biological Sciences
Course Category	Elective
Course focus	Employability as well as Entrepreneurship in Food Industry
Rationale	1.Interdisciplinary Integration: Combines microbiology, biotechnology, and engineering to innovate in food production and safety. 2. Food Safety and Microbial Control: Applies microbiological expertise to control pathogens and improve food safety. 3. Development of Functional Foods: Uses biotechnology to create health-enhancing food products with bioactive compounds. 4. Innovative Food Processing: Explores advanced processing techniques like fermentation and enzyme applications for better food quality and sustainability. 5. Sustainability: Focuses on eco-friendly food production, reducing waste, and enhancing sustainability through biotechnological innovations. 6. Career Opportunities: Opens career paths in food industry R&D, product development, food safety, and quality control. 7. Nutritional Enhancement: Enhances food nutritional quality to promote public health and address dietary needs. 8. Societal Impact: Contributes solutions to global challenges like food security, malnutrition, and obesity.
Course Revision/ Approval Date:	
Course Objectives (As per Blooms' Taxonomy)	**1. Knowledge (Remembering):** Recall fundamental concepts in food microbiology, food preservation techniques, and the role of microorganisms in food production. (Identify, List, Define) **2. Comprehension (Understanding)**: Explain the biochemical processes involved in food fermentation, spoilage, and the role of microbes in these processes (Explain, Describe, Summarize) **3. Application (Applying):** Apply microbiological and biotechnological principles to solve practical food safety and preservation issues (Apply, Demonstrate, Use) **4. Analysis (Analyzing)**: Analyze the impact of food processing techniques (e.g., pasteurization, fermentation) on food safety, quality, and nutritional value (Analyze, Compare, Differentiate.) **5. Synthesis (Creating)**: Design innovative food products or preservation methods using modern biotechnological tools and microbial applications (Design, Create, Develop.) **6. Evaluation (Evaluating)**: Evaluate the effectiveness of different food preservation methods and the role of genetically modified organisms in food production (Evaluate, Assess, Critique)

Course Content (Theory)	Weightage	Contact hours
Unit I: Food Processing Techniques Introduction: importance, conventional methods, difference between processing and preservation. a. Thermal processing – pasteurisation, commercial sterilisation (12 D), sterilisation, UHT. b. Non – thermal processing – use of light and sound, high pressure, pulsed electric field, irradiation. c. Drying and dehydration – tunnel, tray, vacuum, spray, freeze drying. d. Fermentation / enzyme technology – different products.	**20%**	**09**
Unit II: Chemical and Microbial Aspect a. Composition – proximate, nutritional b. Additives / Preservatives – types, roles, functions. c. Spoilage – different food categories. d. Pathogens f. Probiotics.	**20%**	**09**
Unit III: Preservation and Packaging a. Principles of preservation – physical, chemical, biological. b. Traditional methods – drying, fermentation, pickling (in oil, Fermented) salting, smoking, canning c. Packaging – materials, migration, CAP controlled atmospheric packaging, MAP (modified), active packaging, edible films, biodegradable fils, smart packaging, sustainable packaging.	**20%**	**09**
Unit IV: Quality and Safety a. Evaluation of quality – physical, chemical, microbiological, sensory. b. Laws and Regulations – national FSSAI, international CODEX, ISO. c. HACCP. d. Food recall e. Misbranding and adulteration.	**20%**	**09**
Unit V: Future trends a. Sustainable food systems – vertical farming, lab grown meat. b. Alternative Protein sources – proteins from algae, meat alternatives. c. Personalised diet and health d. Reduction in food wastage, byproducts from food waste e. AI and IoT in food technology, 3D printing of food.	**20%**	**09**

Instructional Method and Pedagogy:
Audio-Visual Lectures, Quizzes, Debates, Project works, Case studies, and Assignments Practical exercises are designed to understand the theory as taught in the classroom. Hands on in a practical session.

Course Outcomes:		Blooms' Taxonomy Domain	Blooms' Taxonomy Sub Domain
CO1	Students will be able to recall key principles of food microbiology, food safety, and food preservation techniques.	Understand, Remember	Explain, Describe, Discuss, Recall, Locate
CO2	Students will demonstrate an understanding of the biochemical and microbiological processes involved in food fermentation, spoilage, and preservation.	Understand, Remember	Apply, Practice, Interpret, Select, Correlate
CO3	Students will be able to apply microbiological techniques to solve food safety challenges and design appropriate food preservation strategies.	Apply, Analyses	Compare, Classify, Select, Investigate
CO4	Students will analyze various food processing methods, understanding their effects on food quality, safety, and nutritional value.	Apply, Analyses	Construct, Develop, Produce
CO5	Students will be able to design innovative food products or preservation systems by integrating biotechnological and microbiological knowledge. And Students will evaluate the effectiveness of different food technologies and their potential impacts on food sustainability, quality, and safety.	Understand, apply, Create,	Explain, Describe, outline, Predict, Summarize

Learning Resources	
1	Textbook: 1. Modern Food Microbiology, 4th edition by J.M. Jay, Springer, 2006. 2. Food Microbiology by M.R. Adams, Royal Society of Chemistry, 2008. 3. Frazier, W.C. and Westhoff, D.C. (2013). Food Microbiology. 5th Ed. Tata McGraw Hill. 4. Food Science and Technology by Geoffrey Campbell-Platt, John Wiley & Sons, 2017 5. Handbook of Food Engineering Edited By Dennis R. Heldman, Daryl B. Lund, Cristina Sabliov 6.
	Reference books 1. Doyle, M.P. and Buchanan, R.L. (2012), Food Microbiology, ASM Press, Washington. 2. Handbook of Food Preservation By M.Shafi ur Rahman, 2nd Edition CR Press, Taylor and Fransis Group 3. Food Science and Technology by Gordon W. Fuller 4. Food Process Engineering and Technology by Zeki Berk 5. Introduction to Food Science and Technology By Geoffrey Campbell-Platt
3	Journal 1. Journal of Food Science and Technology 2. International Journal of Food Science and Technology
4.	Electronic resources:

Evaluation Scheme	Total Marks
Theory: Mid semester Marks	20 marks
Theory: End Semester Marks	40 marks
Theory: Continuous Evaluation Component Marks	

Attendance	05 marks
MCQs	10 marks
Open Book Assignment	15 marks
Article Review	10 marks
Total	**40 Marks**

Mapping of PSOs and CO

PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO						
CO1	3	3	2	2	3	1
CO2	3	1	1	2	2	2
CO3	3	2	1	1	-	-
CO4	2	2	3	-	-	3

CO5	-	-	-	2	-	3

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Mapping of PO and CO for Microbial Physiology

PO	PO1	PO2	PO3	PO4	PO5	PO6
CO						
CO1	3	-	3	-	1	-
CO2	2	-	3	-	1	-
CO3	3	-	3	-	1	-
CO4	3	-	3	-	1	-
CO5	2	-	3	-	1	-

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE MSBO327	COURSE NAME ECOLOGY AND EVOLUTION	SEMESTER III

Teaching Scheme (Hours)				Teaching Credit			
Lecture	Practical	Tutorial	Total Hours	Lecture	Practical	Tutorial	Total Credit
3	00	0	45	3	0	0	3

Course Pre-requisites	Students should have basic understanding about the ecosystem and environment
Course Category	**Elective**
Course focus	Employability
Rationale	To understand various aspects related to ecology and evolution
Course Revision/ Approval Date:	
Course Objectives (As per Blooms' Taxonomy)	1. Remember: To gain knowledge on the concept of habitat and population dynamics 2. Apply: To understand theories and principles of population genetics and prey-predator interactions 3. Analyses: To learn major events happening during the evolutionary time-scale 4. Apply: To understand population growth curve and evolution. 5. Understand: To examine the evolutionary basis of altruism as well as behaviour interactions

Course Content (Theory)	Weightage	Contact hours
Unit 1: Population Ecology and Niche Theory Concept of habitat and niche, niche width and overlap, fundamental and realized niche, resource partitioning, character displacement, population growth curves, population regulation, life history strategies (r and K selection), concept of metapopulation.	**20%**	**10**
Unit 2: Community Ecology and Biogeography Community assembly, organization and succession, species-area relationships, Types of interactions, ecophysiology (physiological adaptations to abiotic environment), prey predator interactions (Lotka-Voltera equation), theory of island biogeography.	**20%**	**08**
Unit 3: Molecular and Evolutionary Origins of Life Origin of basic biological molecules, Concept of Oparin and Haldane, Experiment of Miller, Evolutionary time scale- Eras, periods and epoch, Major events in the evolutionary time scale, Human Evolution.	**20%**	**09**
Unit 4: Evolutionary Mechanisms and Population Genetics Population growth rates (density dependent/independent), Gene frequency: Hardy-Weinberg Law, migration and random genetic drift, Adaptive radiation, Isolating mechanisms, Speciation: Allopatricity and Sympatricity, Co-Evolution	**20%**	**09**
Unit 5: Behavioural Ecology and Neurobiology Altruism and evolution-Group selection, Kin selection, Reciprocal altruism, Neural basis of learning, memory, cognition, sleep and arousal, biological clocks; Development of behaviour, Mating systems.	**20%**	**09**
Instructional Method and Pedagogy: Audio-Visual Lectures, Quizzes, Debates, Project works, Case studies, and Assignments.		

Course Objectives:		Blooms' Taxonomy Domain	Blooms' Taxonomy Sub Domain
CO1	Understand the concepts of habitat and ecological niche, Population dynamics and selection strategies.	Understand, analyse	Explain, Describe, Discuss
CO2	Understand and evaluate community assembly and its interactions along with theory of island biogeography and its relevance to species distribution.	Understand, Evaluate and Apply	Practice, Interpret, Correlate
CO3	Explore and understand origin of life and major events in the evolutionary time scale.	Apply, Remember	Explain, Describe
CO4	Analyse and understand population growth and explore concept of adaptive radiation as well as co-evolution.	Understand, Remember and Apply	Create and Analyse
CO5	Examine the evolutionary basis of altruism and how behaviour develops in individuals through genetic and environmental interactions.	Apply, Understand & Remember	Explain, Describe, Summarize

Learning Resources	
1	Reference Books 1. Odum, E. P., & Barrett, G. W. (2005). *Fundamentals of ecology* (5th ed.). Brooks/Cole 2. Smith, R. L., & Smith, T. M. (2015). *Elements of ecology* (9th ed.). Pearson 3. Maynard Smith, J. (1993). *The theory of evolution* (Canto ed.). Cambridge University Press 4. Stiling, P. (2015). *Ecology: Theories and applications* (5th ed.). Pearson 5. Ridley, M. (2004). *Evolution* (3rd ed.). Blackwell Publishing 6. E.S. Morton and B. Stutchbury.2001. *Behavioural ecology*. Academic Press 7. Douglas J. Futuyma, 1998. *Evolutionary Biology*, Sinauer Associates, Inc. Sunderland
2	Journals and Periodicals: 1. Nature Ecology and Evolution 2. Frontiers in Ecology and the Environment 3. Global Ecology and Biogeography 4. Journal of Ecology
3	Other Electronic Sources 1. NPTEL

Evaluation Scheme	Total Marks
Theory: Mid semester Marks	20 marks
Theory: End Semester Marks	40 marks
Theory: Continuous Evaluation Component Marks	Attendance 05 marks MCQs 10 marks Open Book Assignment 15 marks Article Review 10 marks **Total 40 Marks**

Mapping of PSOs and COs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2	1	2	1	1	1
CO2	1	3	2	2	1	1
CO3	2	1	1	1	2	1
CO4	3	3	2	2	2	2
CO5	2	2	1	1	1	3

Mapping of POs and COs

PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	2	2	1
CO2	2	3	1	2	1	1
CO3	2	1	2	1	2	1
CO4	2	3	2	2	2	3
CO5	1	2	1	2	3	3

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None