Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

Empowered Autonomous Institution

Structure and Curriculum of Four Year Multidisciplinary Degree (Honors/Research) Programme with Multiple Entry and Exit option

Undergraduate Programme of Science and Technology

M.Sc. Degree in Biotechnology

Board of Studies

in

Biotechnology

Rajarshi Shahu Mahavidyalaya, Latur

Empowered Autonomous Institution

[PG I Year]

w.e.f. June, 2026

(In Accordance with NEP-2020)

Review Statement

The NEP Cell reviewed the Curriculum of **M.Sc. Degree in Biotechnology** to be effective from the **Academic Year 2026-27.** It was found that, the structure is as per the NEP-2020 guidelines of Govt. of Maharashtra.

Date: 13/04 /2026

Place: Latur

NEP CELL

Rajarshi Shahu Mahavidyalaya, Latur

Empowered Autonomous Institution

CERTIFICATE

I hereby certify that the documents attached are the Bonafide copies of the Curriculum of **M.Sc. (Degree) in Biotechnology** to be effective from the **Academic Year 2026-27.**

Date: 06 / 04 /2026

Place: Latur

Dr. Sachin Kulkarni
Chairperson
Board of Studies in Biotechnology
Rajarshi Shahu Mahavidyalaya, Latur
Empowered Autonomous Institution

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

Empowered Autonomous Institution

Members of Board of Studies in Biotechnology

Under the Faculty of Science and Technology

Sr. No.	Name	Designation	In position
1	**Dr. Sachin S. Kulkarni** Head, Department of Biotechnology, Rajarshi Shahu Mahavidyalaya, Latur (Empowered Autonomous Institution)	Chairperson	HoD
2	**Prof. Tukaram. A. Kadam** Professor, School of Life Sciences SRTMU, Nanded.	Member	V.C. Nominee
3	**Dr. Umesh Jadhav** Asst. Professor, Department of Microbiology, Savitribai Phule Pune University, Pune	Member	Academic Council Nominee
4	**Dr. Rajesh M. Jorgewad** Asst. Professor, Department of Biotechnology and Bioengineering, KIT college of Engineering, Kolhapur (Autonomous)	Member	Academic Council Nominee
5	**Dr. Ashish Gulve** Asst. Professor, Department of Bioinformatics, Subcenter Campus, SRTMU, Latur	Member	Expert from outside for Special Course
6	**Dr. Rahul Chavan** Asst. Professor, Department of Agricultural Biotechnology, V.D. Agri Biotech College, Latur	Member	Expert from outside for Special Course
7	**Mr. Abhay. M. Desai** Senior Manager,Wockhardt, Chhatrapati Sambhaji Nagar	Member	Expert from Industry
8	**Dr. Santosh Narwade** Serum Institute Pvt.Ltd. Pune	Member	P.G. Alumni
9	**Dr. Manisha. A. Dhotre**	Member	Faculty Member
10	**Mr. Udaybhanu. P. Sirdeshmukh**	Member	Faculty Member
11	**Dr. Ravindra. B. Ade**	Member	Faculty Member
12	**Dr. Sanghapal. S. Kshirsagar**	Member	Faculty Member
13	**Mr. Suraj. D. Kadam**	Member	Faculty Member
14	**Mr. Akash. J. Waghmare**	Member	Faculty Member
15	**Ms. Swati G. Swami**	Member	Faculty Member
16	**Ms. Karuna S. Komatwar**	Member	Faculty Member
17	**Ms. Rohini Shinde**	Member	Faculty Member
18	**Ms. Dhanashri Janakwade**	Member	Faculty Member

From the Desk of the Chairperson…

Biotechnology as a subject is a highly interdisciplinary that combines biological sciences with engineering technologies to manipulate living organisms and biological systems to produce products that advances healthcare, medicine, agriculture, food, pharmaceuticals and environment. At its simplest, biotechnology is technology based on biology - which harnesses cellular and bimolecular processes to develop technologies and products that help to improve our lives and health of our planet.

Taking into consideration of the importance of Biotechnology, Rajarshi Shahu Mahavidyalaya, Latur (Autonomous), have taken an initiative to introduce a new emerging field as an undergraduate Programme in biotechnology under the faculty of science. B. Sc. Biotechnology is a Three-year graduate degree program which is started in the academic year 2004-05 followed by the postgraduate program started in academic year 2006-07.

National Education Policy (NEP) 2020 recognizes the relevance of biotechnology in the education system due to its interdisciplinary nature, potential for research and innovation, and its alignment with the development of 21st-century skills. By integrating biotechnology into the curriculum, the policy aims to prepare students for the challenges and opportunities of a rapidly advancing biotechnology driven world.

NEP-2020 has conceptualized the idea to develop well rounded competent individuals for making the nation a self-reliant and global leader. In the same spirit, we at Department of Biotechnology, have developed a curriculum framework to encompass the goals of NEP 2020. In the overall curriculum we have incorporated choice of courses of study, creating academic pathways having constructive combinations with multiple entry and exit points as well as focus on experiential learning for students by introducing multidisciplinary, skill enhancement, vocational courses along generic elective(s) and course based on Indian knowledge system and actual Hand's on training in the recent and trending areas of Biotechnology.

With reference to global changes occurring in higher education in various national and foreign universities, the newly designed syllabi of B.Sc. Biotechnology as per NEP 2020 guidelines are effectively implemented from June, 2023. The committee members of Board of Studies in Biotechnology also took the local need and employability of graduate students into consideration while framing the given curriculum, keeping in view of the guidelines given in the University Grants Commission, New Delhi.

By aligning curriculum development, pedagogy, interdisciplinary connections, research opportunities, industry collaborations, teacher training, and available infrastructure with the institute, the department of biotechnology plans to integrate students with a comprehensive understanding of biotechnology, foster critical thinking and research skills, and prepare them for future careers in the field.

Dr. Sachin Kulkarni
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Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

Empowered Autonomous Institution

Faculty of Science and Technology

Structure for Two Year Postgraduate Degree Programme in Biotechnology (In accordance with NEP-2020)

Year & Level	Sem	Major		Minor	OE	VSC/ SEC (VSEC)	AEC / VEC	OJT,FP,CEP, RP	Credit per Sem.	Cum./Cr. per exit
		MMC	MEC							
1	**2**	**3**		**4**	**5**	**6**	**7**	**8**	**9**	**10**
6.0	I	MMC-I: 04 Cr. MMC-II: 04 Cr. MMC-III: 04 Cr. MMC-IV: 02 Cr.	MEC-I: 04 Cr.	RMC: 4Cr	.				22	44 Cr. PG First Year
	II	MMC-V: 04 Cr. MMC-VI: 04 Cr. MMC-VII: 04 Cr. MMC-VIII: 02 Cr..	MEC-II: 04 Cr		.			OJT:4Cr/FP-II:4Cr	22	
	Cum. Cr.	28	08	04				04	44	

Abbreviations:

1.	DSC	: Discipline Specific Core (Major)
2.	DSE	: Discipline Specific Elective (Major)
3.	DSM	: Discipline Specific Minor
4.	OE	: Open Elective
5.	VSEC	: Vocational Skill and Skill Enhancement Course
6.	VSC	: Vocational Skill Course
7.	SEC	: Skill Enhancement Course
8.	AEC	: Ability Enhancement Course
9.	MIL	: Modern Indian Languages
10.	IKS	: Indian Knowledge System
11.	FSRCE	: Fostering Social Responsibility & Community Engagement
12.	VEC	: Value Education Course
13.	OJT	: On Job Training
14.	FP	: Field Project
15.	CEP	: Community Engagement Programme
16.	CC	: Co-Curricular Course
17.	RP	: Research Project/Dissertation
18.	SES	: Shahu Extension Services

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

Empowered Autonomous Institution

Name of the Programme: Biotechnology

Programme Outcomes (POs) for Biotechnology	
PO 1	**Disciplinary Knowledge** Recall and apply fundamental and advanced concepts of biotechnology
PO 2	**Understanding of Biological Systems** Explain biological processes and mechanisms using scientific principles.
PO 3	**Application of Knowledge** Apply biological knowledge and laboratory skills to perform experiments and solve biotechnological problems.
PO 4	**Analytical Skills** Analyze biological data, experimental results, and complex biological systems using scientific reasoning and quantitative approaches.
PO 5	**Evaluation of Problems** Evaluate experimental outcomes, research findings, and biotechnological processes for accuracy, reliability, and limitations.
PO 6	**Design & Innovation** Design experiments, develop processes, and propose innovative solutions for healthcare, agriculture, environmental, and industrial biotechnology.
PO 7	**Modern Tool Usage** Apply and evaluate modern laboratory techniques, instrumentation, bioinformatics, and computational tools for biological analysis.
PO 8	**Ethics, Biosafety & Sustainability** Evaluate ethical principles, biosafety practices, sustainability, and societal impact in biotechnology.
PO 9	**Communication & Teamwork** Communicate scientific information effectively and collaborate in multidisciplinary teams.
PO 10	**Lifelong Learning & Employability** Demonstrate and pursue lifelong learning, research, and entrepreneurial skills for professional development and career advancement.

Programme Specific Outcomes (PSOs) for Biotechnology	
PSO No.	After completion of this programme the students will be able to -
PSO 1	Conceptual Understanding & Integration Explain, classify, and integrate fundamental and advanced concepts to interpret and predict complex biological systems and processes.
PSO 2	Experimental & Analytical Competence Apply, perform, design, and validate experimental procedures, and analyze and interpret data using scientific and quantitative approaches.
PSO 3	Applied Problem Solving & Optimization Apply, analyze, design, and optimize solutions to address real-world challenges, including sustainability and resource management.
PSO 4	Computational & Technological Skills Apply, analyze, model, and interpret data using computational tools and advanced technologies for problem-solving.
PSO 5	Research, Ethics & Professional Skills Evaluate, design, implement, and communicate solutions while adhering to ethical, legal, and safety standards, and demonstrating lifelong learning skills.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

Empowered Autonomous Institution

Faculty of Science and Technology

B.Sc. (Honors) in Biotechnology

Year & Level	Semester	Course Code	Course Title	Credits	No. of Hrs.
IV 6.0	VII	601BIO1101 (MMC-I)	Molecular Cell Biology	03	45
		601BIO1105	Lab Course-I	01	30
		601BIO1102 (MMC-II)	System Biology	03	45
		601BIO1106	Lab Course-II	01	30
		601BIO1103 (MMC-III)	Downstream Processing and Product Recovery	03	45
		601BIO1107	Lab Course-III	01	30
		601BIO1104 (MMC-IV)	Teaching, Communication and Research Aptitude	02	30
		601BIO1201 (MEC-I) (A) 601BIO1201 (MEC-I) (B)	Microbiome Biotechnology Or Aquaculture Biotechnology	03	45
		601BIO1202	Lab Course MEC-I	01	30
		601BIO1301	RMC	04	100
	Total Credits			**22**	
	VIII	601BIO2101 (MMC-V)	Advanced Molecular Biotechnology	03	45
		601BIO2105	Lab Course-IV	01	30
		601BIO2102 (MMC-VI)	Diagnostic Immunotechniques and Immunotherapy	03	45
		601BIO2106	Lab Course-V	01	30
		601BIO2103 (MMC-VII)	Emerging Techniques	03	45
		601BIO2107	Lab Course-VI	01	30
		601BIO2104 (MMC-VIII)	Analytical, Quantitative and Scientific Aptitude	02	30
		601BIO1201 (MEC-II) (A) 601BIO1201 (MEC-II) (B)	Animal and Livestock Biotechnology Or Advances in Protein Chemistry	03	45
		601BIO1202	Lab Course-DSE-III	01	30
		OJT-4 Cr/FP-II:4Cr	OJT/Field Project	04	100
	Total Credits			**22**	
Total Credits (Semester III & IV)				**44**	

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Semester - I

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

Empowered Autonomous Institution

Faculty of Science and Technology

Department of Biotechnology

PG IV Sem I

Course Type: MMC-I

Course Title: Molecular Cell Biology

Course Code: 601BIO1101

Credits: 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objectives:

LO 1 Explain fundamental and advanced concepts of cellular organization, molecular mechanisms, and signaling pathways.

LO 2 Apply experimental and analytical techniques to investigate cellular processes and molecular regulation.

LO 3 Analyze intracellular signaling networks, gene regulation, and disease mechanisms including cancer and stem cell biology.

LO 4 Design innovative cell-based experimental strategies and therapeutic approaches in biotechnology and medicine.

Course Outcomes:

After completion of the course the students will be able to-

CO 1 Explain, analyze, and correlate cellular organization, biomolecular interactions, and signaling pathways with physiological functions and disease conditions.

CO 2 Demonstrate, apply, and optimize experimental techniques to investigate and analyze cellular and molecular processes.

CO 3 Analyze, interpret, and evaluate signaling pathways, stem cell mechanisms, and molecular basis of diseases, considering ethical, biosafety, and societal implications.

CO 4 Design, propose, and assess cell-based research strategies and innovative solutions for applications in biotechnology, healthcare, sustainability, and industry, with effective scientific communication.

Unit No.	Title of Unit & Contents	Hrs.
I	**Cellular Organization and Molecular Regulation**	**11**
	1. Advanced cell structure and compartmentalization 2. Membrane dynamics and transport mechanisms 3. Cytoskeleton organization and cell motility 4. Apoptosis and programmed cell death	
	Unit Outcomes: UO 1 Explain cellular organization and regulatory mechanisms. UO 2 Analyze cell cycle and apoptosis pathways.	
II	**Cell Signaling and Communication**	**11**
	1. Principles of cell signaling 2. Receptors: GPCR, RTK, ion channels 3. Signal transduction pathways: MAPK, PI3K-Akt, JAK-STAT 4. Second messengers: cAMP, Ca^{2+}, IP_3	
	Unit Outcomes: UO 1 Explain signaling mechanisms and pathways. UO 2 Analyze intracellular signaling networks.	
III	**Stem Cell Biology and Applications**	**11**
	1. Types of stem cells (ESCs, adult, iPSCs) 2. Stem cell niche and signaling 3. Differentiation and self-renewal mechanisms 4. Regenerative medicine and tissue engineering	
	Unit Outcomes: UO 1 Analyze stem cell biology and differentiation mechanisms. UO 2 Design stem cell-based therapeutic applications.	
IV	**Cancer Biology**	**12**
	1. Hallmarks of cancer 2. Oncogenes and tumor suppressor genes 3. Metastasis and angiogenesis 4. Cancer diagnostics and targeted therapy	
	Unit Outcomes: UO 1 Evaluate molecular mechanisms of cancer development. UO 2 Analyze tumor progression and therapeutic strategies.	

Learning Resources:

1. Biomedical database by PubMed, National Library of Medicine, 2024;
2. Cell and Molecular Biology by Gerald Karp, Wiley, 2020;
3. Cell Biology by Thomas D. Pollard, William C. Earnshaw, Jennifer Lippincott-Schwartz, and Graham T. Johnson, Elsevier, 2017;
4. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications by R. Ian Freshney, Wiley-Blackwell, 2016;
5. Gene Database by National Center for Biotechnology Information (NCBI), NCBI, 2024;
6. Kyoto Encyclopedia of Genes and Genomes (KEGG): Pathway Database by KEGG, KEGG, 2024;
7. Molecular Biology of the Cell by Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, et al., Garland Science, 2022;
8. Molecular Cell Biology by Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Anthony Bretscher, Hidde Ploegh, et al., W.H. Freeman, 2021;
9. The Biology of Cancer by Robert A. Weinberg, Garland Science, 2014;
10. The Cell: A Molecular Approach by Geoffrey M. Cooper and Robert E. Hausman, Sinauer Associates, 2019.

Internal Examination Pattern :

CAT – I: Analytical Case Study on Applied Concepts in the Prescribed Syllabus

CAT – II: Critical Review and Analysis of Research Literature Relevant to the Syllabus

Mapping of POs, PSOs and COs:

COs/POs & PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3	PS O4	PS O5
CO1	3	3	2	3	2	1	1	2	1	1	3	2	1	1	2
CO2	2	2	3	3	2	2	3	2	2	2	2	3	2	2	2
CO3	2	3	2	3	3	2	2	3	2	2	3	3	2	2	3
CO4	2	2	3	3	3	3	2	3	3	2	3	3	3	2	3

Scale : 3 = High, 2 = Moderate, 1 = Low, 0 = No correlation.

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Rajarshi Shahu Mahavidyalaya, Latur

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Faculty of Science and Technology

Department of Biotechnology

PG I Sem I

Course Type: Lab Course

Course Title: Lab Course I (Based on MMC-I)

Course Code: 601BIO1105

Credits: 01 **Max. Marks: 50** **Lectures: 30 Hrs.**

Learning Objectives

LO 1 Explain fundamental principles of cell biology techniques, laboratory safety, microscopy, and molecular assays.

LO 2 Perform cell-based experiments including cell counting, viability assays, protein estimation, and microscopy techniques.

LO 3 Analyze and evaluate experimental data related to cell proliferation, apoptosis, protein expression, signaling pathways, and cancer biology.

LO 4 Design experimental strategies using cell culture, immunological, and molecular techniques for solving problems in biomedical research

Course Outcomes:

After completion of the course, the student will be able to-

CO 1 Describe laboratory safety, cell structure, and principles of key molecular and cellular techniques.

CO 2 Demonstrate practical skills in microscopy, cell counting, viability assays, protein analysis, and basic cell biology experiments.

CO 3 Analyze experimental results and interpret data from assays such as sds-page, elisa, apoptosis detection, and signaling pathway studies.

CO 4 Design and propose experimental workflows for cell-based research including cancer biology, stem cells, and immunological applications.

Practical No.	Unit
1	Study of animal/plant cell structure using microscopy
2	Cell counting using hemocytometer
3	Cell viability assay (Trypan blue exclusion test)
4	Mitotic index determination (onion root tip)
5	Protein estimation (Bradford/Lowry method)
6	SDS-PAGE analysis of cellular proteins
7	Western blotting (demonstration)
8	ELISA for detection of signaling molecules
9	MTT assay for cell proliferation (demonstration)
10	Measurement of cell size using micrometry
11	Study of stages of mitosis (permanent slides)
12	Growth curve of microbial cells (as cell model)
13	Apoptosis detection (Annexin V staining / DNA fragmentation – demo)
14	Study of cancer cells (slides/images/case study)
15	Flow cytometry for cell cycle analysis (demo/video-based)
16	Identification of stem cells (slides/data analysis)
17	Cell culture techniques (aseptic handling – demonstration)
18	Immunofluorescence staining (demo/data interpretation)
19	Case study: Cancer signaling pathway analysis
20	Case study: Cancer immunotherapy (CAR-T/ checkpoint inhibitors)

N.B.: Any Ten Practicals from above.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

Empowered Autonomous Institution

Faculty of Science and Technology

Department of Biotechnology

PG I Sem I

Course Type: MMC-II

Course Title: System Biology

Course Code: 601BIO1102

Credits: 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objectives:

LO 1 Explain core principles of systems biology including emergent properties, systems thinking, and biological network organization.

LO 2 Apply mathematical and computational models (ODEs, stochastic methods, FBA) to analyze biological systems.

LO 3 Analyze the structure and function of gene regulatory, signaling, and metabolic networks.

LO 4 Integrate multi-omics data to interpret biological processes and applications in systems medicine.

Course Outcomes:

After completion of the course the students will be able to-

CO 1 Evaluate biological systems using systems thinking concepts such as robustness, modularity, and network topology.

CO 2 Apply deterministic and stochastic mathematical models to simulate and predict biological behavior.

CO 3 Analyze and interpret network architectures including gene regulatory, signaling, and metabolic pathways.

CO 4 Integrate and interpret multi-omics datasets to develop predictive models for disease and therapeutic.

Unit No.	Title of Unit & Contents	Hrs.
I	**Core Theoretical Foundations of System biology**	**12**
	1. Introduction to Systems Thinking: Reductionism vs. Holism; emergent properties; complexity vs. complicatedness. 2. Biological Networks: Structure and topology of networks (Scale-free, Small-world); nodes and edges.	

Unit No.	Title of Unit & Contents	Hrs.
	3. Properties of Systems: Robustness, modularity, homeostasis, and feedback loops (positive and negative). 4. Chemical bonds – Covalent bond, Hydrogen bond and Van der waals forces, hydrophobic interactions.	
	Unit Outcomes: UO 1 Differentiate between deterministic and stochastic approaches in modeling biological systems. UO 2 Analyze network topologies (scale-free vs. small-world) to assess system robustness and vulnerability.	
II	**Mathematical & Computational Modeling**	**12**
	1. Lennard-Jones (LJ) potential. 2. Gepasi (Biochemical Simulation) 3. Kinetic Modeling: Michaelis-Menten kinetics, Hill equations for cooperativity, and S-systems. 4. Ordinary Differential Equations (ODEs): Modeling concentrations over time (e.g., Runge-Kutta methods for growth models). 5. Stochastic Processes: Noise in gene expression; chemical master equations; Gillespie algorithm. 6. Constraint-Based Modeling: Flux Balance Analysis (FBA) for metabolic networks.	
	Unit Outcome: UO 1 Develop mathematical models (ODEs, Hill equations) to describe dynamic biological processes. UO 2 Apply computational approaches such as FBA and stochastic simulations to evaluate system behavior.	
III	**Network Architectures**	**11**
	1. Gene Regulatory Networks (GRN): Transcriptional control; genetic switches (e.g., Lambda phage lytic/lysogenic switch); feed-forward loops. 2. Signaling Pathways: Two-component systems; MAPK cascades; quorum sensing in bacteria. 3. Metabolic Networks: Pathway analysis; metabolic engineering; enzyme inhibition and regulation	
	Unit Outcomes: UO 1 Analyze information flow and regulatory mechanisms in gene regulatory and signaling networks. UO 2 Evaluate functional dynamics of biological networks such as genetic switches and metabolic pathways.	

Unit No.	Title of Unit & Contents	Hrs.
IV	**Multi-Omics Data Integration**	**10**
	1. Microarray fundamentals 2. Types of Microarray 3. Genomics & Transcriptomics: RNA-Seq analysis and gene expression profiling. 4. Proteomics & Metabolomics: Mass spectrometry data and protein-protein interaction (PPI) networks. 5. Data Integration: Methods for combining multi-omics data to build predictive models. 6. Systems Medicine: Modeling disease progression, drug-target interactions, and personalized medicine.	
	Unit Outcomes: UO 1 Integrate genomics, proteomics, and metabolomics data to construct system-level models. UO 2 Assess applications of systems biology in disease modeling, biomarker discovery, and personalized medicine.	

Learning Resources:

1. A First Course in Systems Biology by Eberhard Voit, Garland Science, 2017
2. An Introduction to Systems Biology: Design Principles of Biological Circuits by Uri Alon, CRC Press, 2019
3. Bioinformatics and Molecular Evolution by Paul G. Higgs and Teresa K. Attwood, Wiley-Blackwell, 2005
4. Computational Systems Biology of Cancer by Emmanuel Barillot, Laurence Calzone, Philippe Hupe, Jean-Philippe Vert, and Andrei Zinovyev, CRC Press, 2012
5. Foundations of Systems Biology by Hiroaki Kitano, MIT Press, 2001
6. Introduction to Synthetic Biology by Mario J. Cano and Raymundo P. Aguilar, Springer Nature, 2020
7. Introduction to Systems Biology by Sangdun Choi, Humana Press, 2007
8. Mathematical Modeling in Systems Biology: An Introduction by Brian P. Ingalls, MIT Press, 2013
9. Metabolic Engineering: Principles and Methodologies by Gregory N. Stephanopoulos, Aristos A. Aristidou, and Jens Nielsen, Academic Press, 1998

10. Systems Biology: A Textbook by Edda Klipp, Wolfram Liebermeister, Christoph Wierling, Axel Kowald, Hans Lehrach, and Ralf Herwig, Wiley-Blackwell, 2016
11. Systems Biology: Properties of Biological Networks by Edda Klipp, Wolfram Liebermeister, Christoph Wierling, and Axel Kowald, Wiley-Blackwell, 2016
12. Systems Biology: Simulation of Dynamic Network States by Bernhard Ø. Palsson, Cambridge University Press, 2011
13. Systems Biology in Practice: Concepts, Implementation and Application by Edda Klipp, Ralf Herwig, Axel Kowald, Christoph Wierling, and Hans Lehrach, Wiley-VCH, 2005
14. Systems Medicine: Physiological Circuits and Pathophysiology by Uri Alon, CRC Press, 2020
15. The Systems Biology Research Tool: From Data to Models by Bernhard Ø. Palsson, Cambridge University Press, 2015

Internal Examination Pattern :

CAT – I: Analytical Case Study on Applied Concepts in the Prescribed Syllabus

CAT – II: Critical Review and Analysis of Research Literature Relevant to the Syllabus

Mapping of POs, PSOs and COs:

COs/POs & PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	3	2	1	2	1	1	1	3	2	2	2	1
CO2	2	3	3	3	2	2	3	1	1	1	2	3	2	3	1
CO3	2	3	2	3	3	2	2	1	1	1	3	3	2	2	1
CO4	3	3	3	3	3	3	3	2	2	2	3	3	3	3	2

Scale : 3 = High, 2 = Moderate, 1 = Low, 0 = No correlation

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Empowered Autonomous Institution

Faculty of Science and Technology

Department of Biotechnology

PG I Sem I

Course Type: Lab Course
Course Title: Lab Course II (Based on MMC-II)

Course Code: 601BIO1106
Credits: 01 **Max. Marks: 50** **Lectures: 30 Hrs.**

Learning Objectives

LO 1 Demonstrate the construction and visualization of biological networks using computational tools.

LO 2 Apply quantitative methods to analyze network topology and identify key features such as hubs, motifs, and centrality.

LO 3 Develop and simulate mathematical models using Python/MATLAB.

LO 4 Interpret and integrate high-throughput omics datasets to establish relationships between molecular interactions and biological functions.

Course Outcomes

After completion of the course, the student will be able to-

CO 1 Construct and analyze biological networks using computational tools and public databases.

CO 2 Evaluate network properties and motifs to distinguish structural and functional characteristics of complex biological systems.

CO 3 Simulate and analyze biochemical and metabolic processes using deterministic and constraint-based modeling approaches.

CO 4 Perform transcriptomics and multi-omics data analysis to derive biologically meaningful insights and predictive models.

Practical No.	Unit
1.	To visualize a biological network and identify its key structural properties
2.	Visualization of Biological Networks: Use software like Cytoscape to map protein-protein interaction (PPI) networks from public databases (e.g., STRING), identifying nodes and edges.

3.	Topological Analysis of Networks: Calculate network parameters such as degree distribution, clustering coefficients, and betweenness centrality to distinguish between Scale-free and Small-world architectures.
4.	Identification of Network Motifs: Write a script or use tools to identify recurring patterns like feed-forward loops within a Gene Regulatory Network (GRN).
5.	Kinetic Modeling of Enzyme Dynamics: Use Python or MATLAB to simulate Michaelis-Menten kinetics and analyze the effects of substrate concentration on reaction velocity.
6.	Modeling Cooperative Binding: Implement the Hill equation to simulate sigmoidal binding curves in multi-subunit protein systems.
7.	Flux Balance Analysis (FBA): Perform constraint-based modeling on a simplified metabolic network (e.g., E. coli core model) to predict optimal growth rates.
8.	MAPK Cascade Simulation: Build a computational model of a signaling pathway to observe how phosphorylation cascades amplify biological signals.
9.	Transcriptomics Data Profiling: Analyze raw RNA-Seq data to perform differential gene expression profiling and identify upregulated pathways.
10.	Multi-Omics Data Integration: Integrate Proteomics and Metabolomics datasets to construct a predictive model for disease progression or drug-target interactions.
11.	To build a functional network of proteins involved in a specific biological process.

N.B.: Any Ten Practicals from above.

Recommended Tools for Lab

- Languages: Python (NumPy, SciPy, Pandas), R (Bioconductor).
- Software: Cytoscape, COPASI, Cell Designer, and MATLAB/Simulink.
- Databases: KEGG (Metabolic pathways), UniProt (Proteomics), and GEO (Genomics).

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

Empowered Autonomous Institution

Faculty of Science and Technology

Department of Biotechnology

PG I Sem I

Course Type: MMC-III

Course Title: Downstream Processing and Product Recovery

Course Code: 601BIO1103

Credits: 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objectives:

LO 1 Explain the principles, stages, and process integration involved in downstream processing of bioproducts.

LO 2 Apply appropriate techniques for cell disruption, primary recovery, and purification in downstream processing.

LO 3 Analyze the efficiency, selectivity, and performance of various separation and purification processes.

LO 4 Design and optimize industrial downstream processing systems considering quality control, regulatory requirements, and real-world applications.

Course Outcomes:

After completion of the course the students will be able to-

CO 1 Explain and analyze the principles, stages, and process integration of downstream processing in relation to upstream bioprocessing and product characteristics.

CO 2 Apply appropriate cell disruption, primary recovery, and solid–liquid separation techniques, and evaluate their suitability based on product type and process requirements.

CO 3 Analyze and evaluate purification and separation techniques such as chromatography, membrane processes, and extraction for efficiency, selectivity, and product quality.

CO 4 Evaluate industrial downstream processing systems and design integrated dsp strategies considering product finishing, quality control, regulatory compliance, and real-world applications.

Unit No.	Title of Unit & Contents	Hrs.
I	**Introduction to Downstream Processing & Process Integration**	**10**
	1. Overview of bioprocess: Upstream vs Downstream processing 2. Role of downstream processing in biotechnology 3. Product characteristics (intracellular vs extracellular) 4. Process flow sheet and stages of DSP 5. Integration with Process Technology (fermentation output → DSP input)	
	Unit Outcomes: UO 1 Explain stages and significance of downstream processing. UO 2 Analyze linkage between upstream production and downstream recovery.	
II	**Cell Disruption and Primary Recovery**	**11**
	1. Cell harvesting techniques: Filtration, centrifugation 2. Cell disruption methods: Mechanical, chemical, enzymatic 3. Removal of cell debris 4. Solid-liquid separation techniques 5. Flocculation and precipitation	
	Unit Outcomes: UO 1 Apply primary recovery and cell disruption techniques. UO 2 Evaluate appropriate methods based on product characteristics.	
III	**Purification and Separation Techniques**	**12**
	1. Chromatography: Ion exchange, affinity, gel filtration 2. Membrane separation: Ultrafiltration, reverse osmosis 3. Liquid-liquid extraction 4. Distillation and drying techniques 5. Protein purification strategies	
	Unit Outcomes: UO 1 Analyze advanced purification and separation techniques. UO 2 Evaluate efficiency and selectivity of purification processes.	
IV	**Product Finishing and Industrial Applications**	**12**
	1. Product polishing and formulation 2. Sterilization and packaging 3. Quality control and regulatory aspects 4. Scale-up and industrial DSP design 5. Case studies: Antibiotics, enzymes, vaccines	
	Unit Outcomes: UO 1 Evaluate industrial downstream processing systems. UO 2 Design DSP strategies for real-world biotechnological applications.	

Learning Resources:

1. Biochemical engineering, Blanch HW, Clark DS, Marcel Dekker, 1995
2. Biochemical engineering fundamentals, Bailey JE, Ollis DF, McGraw Hill, 2017
3. Bioprocess engineering: Basic concepts, Shuler ML, Kargi F, Prentice Hall, 2002
4. Bioreaction engineering principles, Nielsen J, Villadsen J, Springer, 2021
5. Bioseparations engineering: Principles, practice and economics, Ladisch MR, Wiley, 2022
6. Bioseparations: Downstream processing for biotechnology, Belter PA, Cussler EL, Hu WS, Academic Press, 1988
7. Bioseparations science and engineering, Harrison RG, Todd P, Rudge SR, Petrides DP, Oxford University Press, 2015
8. Downstream processing in biotechnology, Wittekar A, Pragati Books, 2012
9. Handbook of bioseparations, Ahuja S, Academic Press, 2000
10. Introduction to biochemical engineering, Clark DS, Prentice Hall, 1997
11. Principles of fermentation technology, Stanbury PF, Whitaker A, Hall SJ, Butterworth-Heinemann, 2017
12. Protein bioseparation using ultrafiltration: Theory and applications, Ghosh R, CRC Press, 2021
13. Protein purification: Principles and practice, Scopes RK, Springer, 1994
14. Separation process principles, Seader JD, Henley EJ, Roper DK, Wiley, 2011

Internal Examination Pattern :

CAT – I: Analytical Case Study on Applied Concepts in the Prescribed Syllabus

CAT – II: Critical Review and Analysis of Research Literature Relevant to the Syllabus

Mapping of POs, PSOs and Cos:

COs/POs & PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	3	2	1	2	1	1	1	3	2	2	1	1
CO2	2	2	3	3	2	2	3	1	1	1	2	3	3	1	1
CO3	2	2	3	3	3	2	3	1	1	1	2	3	3	2	2
CO4	2	2	3	3	3	3	3	3	2	2	3	3	3	2	3

Scale : 3 = High, 2 = Moderate, 1 = Low, 0 = No correlation.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

Empowered Autonomous Institution

Faculty of Science and Technology

Department of Biotechnology

PG I Sem I

Course Type: Lab Course
Course Title: Lab Course III (Based on MMC-III)

Course Code: 601BIO1107
Credits: 01 **Max. Marks: 50** **Lectures: 30Hrs.**

Learning Objectives:

LO 1 Explain principles of laboratory-scale downstream processing techniques and workflows.

LO 2 Apply and perform cell harvesting, disruption, and basic separation techniques for biological samples.

LO 3 Analyze and evaluate purification methods, efficiency, recovery yield and product purity using analytical techniques.

LO 4 Design laboratory-scale downstream processing workflows for bioproduct recovery and purification.

Course Outcomes:

After completion of the course the students will be able to-

CO 1 Explain laboratory-scale downstream processing techniques and their principles.

CO 2 Apply and perform cell harvesting, disruption, and purification procedures effectively.

CO 3 Analyze and evaluate purification efficiency, yield and product quality using appropriate analytical methods.

CO 4 Design simple downstream processing workflows for laboratory-scale bioproduct production.

Practical No.	Unit
1	Preparation of fermentation broth (model system)
2	Cell harvesting by centrifugation
3	Cell harvesting by filtration techniques
4	Mechanical cell disruption (homogenization)
5	Chemical/enzymatic cell disruption methods
6	Separation of cell debris (clarification)
7	Protein precipitation using ammonium sulfate
8	Dialysis for desalting of proteins
9	Ultrafiltration (demonstration/virtual if needed)
10	Ion exchange chromatography (protein separation)
11	Gel filtration chromatography (size-based separation)
12	Thin Layer Chromatography (TLC) for biomolecules
13	Liquid-liquid extraction of biomolecules
14	Determination of protein concentration (Lowry/Bradford method)
15	Drying techniques (lyophilization – demonstration)
16	Sterilization techniques in downstream processing
17	Yield calculation and purification fold analysis
18	Determination of protein concentration (Lowry/Bradford method)

N.B.: Any Ten Practicals from above.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

Empowered Autonomous Institution

Faculty of Science and Technology

Department of Biotechnology

PG I Sem I

Course Type: MMC-IV
Course Title: Teaching, Communication and Research Aptitude
Course Code: 601BIO1104
Credits: 01 **Max. Marks: 50** **Lectures: 30Hrs.**

Learning Objectives:

LO 1 Understand the concepts, objectives and levels of teaching-learning, along with learner characteristics and factors affecting learning.

LO 2 Comprehend different types of communication, barriers, and methods of effective classroom and group communication.

LO 3 Gain knowledge of research methodologies, hypothesis formulation, thesis writing and research ethics using ICT tools.

LO 4 Develop logical reasoning and data interpretation skills for analyzing arguments, solving problems and interpreting data.

Course Outcomes

After completion of the course the students will be able to-

CO 1 Explain and apply teaching-learning principles, instructional strategies, and evaluation techniques in biotechnology education and professional contexts.

CO 2 Demonstrate effective scientific communication skills (oral, written, and digital) for presenting biological concepts and research findings.

CO 3 Analyze research problems, design basic experimental methodologies, formulate hypotheses, and follow ethical practices in life sciences.

CO 4 Apply logical reasoning, quantitative analysis, and data interpretation techniques to solve biological and biotechnological problems.

Unit No.	Title of Unit & Contents	Hrs.
I	**Teaching and Learning Aptitude**	**07 Hrs.**
	1. Teaching: concept, objectives and levels (Memory, Understanding, Reflective) 2. Learner's characteristics (cognitive, emotional, social) 3. Factors affecting teaching-learning process	

Unit No.	Title of Unit & Contents	Hrs.
	4. Teaching methods: teacher-centered vs learner-centered 5. Teaching support systems and evaluation methods	
	Unit Outcomes: UO 1 Explain teaching-learning processes and evaluation systems. UO 2 Apply teaching strategies in academic context.	
II	**Communication and Comprehension**	**07 Hrs.**
	1. Communication: types, characteristics and barriers 2. Verbal, non-verbal and group communication 3. Classroom and mass communication 4. Reading comprehension (passage-based questions)	
	Unit Outcomes: UO 1 Explain communication processes and barriers. UO 2 Apply comprehension and communication skills.	
III	**Research Aptitude**	**08 Hrs.**
	1. Research: meaning, types and characteristics 2. Research methods: experimental, qualitative, quantitative 3. Research process and hypothesis 4. Thesis writing and referencing styles 5. Research ethics and ICT in research	
	Unit Outcomes: UO 1 Explain research methodology and ethics. UO 2 Apply research principles in scientific writing.	
IV	**Logical Reasoning & Data Interpretation**	**08 Hrs.**
	1. Logical reasoning: series, coding-decoding, analogies 2. Structure of arguments, fallacies, syllogism, Venn diagram 3. Indian logic: Pramanas and inference 4. Data interpretation: tables, graphs and charts	
	Unit Outcomes: UO 1 Analyze logical reasoning and argument structures. UO 2 Interpret data using graphical methods.	

Learning Resources:

1. Pearson Education. *UGC NET/SET Paper I guide*. 2023 ed. New Delhi: Pearson Education.
2. Kothari CR. *Research methodology: Methods and techniques*. New Delhi: New Age International Publishers; 2004.
3. Kumar R. *Research methodology: A step-by-step guide for beginners*. New Delhi: SAGE Publications; 2011.
4. McQuail D. *Mass communication theory*. New Delhi: SAGE Publications; 2010.

5. IGNOU. *Teaching and research aptitude study materials*. 2022 ed. New Delhi: IGNOU Publications.
6. Government of India. *National education policy (NEP 2020)*. New Delhi: Ministry of Education; 2020.
7. NCBI. *NCBI database*. 2024 ed. Available from: National Center for Biotechnology Information.
8. National Library of Medicine. *PubMed database*. 2024 ed. Available from: NLM.
9. KEGG. *KEGG pathway database*. 2024 ed. Available from: Kyoto Encyclopedia of Genes and Genomes.
10. UGC. *Higher education system and quality assurance documents*. 2023 ed. New Delhi: University Grants Commission.

Internal Examination Pattern:

CAT – I: Analytical Case Study on Applied Concepts in the Prescribed Syllabus

CAT – II: Critical Review and Analysis of Research Literature Relevant to the Syllabus

Mapping of POs, PSOs and COs:

COs/POs & PSOs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	2	2	1	1	1	2	3	2	3	2	1	1	2
CO2	2	2	2	1	1	1	1	1	3	3	2	1	1	1	3
CO3	3	3	3	3	3	2	2	3	2	2	3	3	2	2	3
CO4	3	2	3	3	3	2	2	1	2	2	2	3	3	3	2

Scale: 3 = High, 2 = Moderate, 1 = Low, 0 = No correlation.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

Empowered Autonomous Institution

Faculty of Science and Technology

Department of Biotechnology

PG I Sem I

Course Type: MEC-I (A)

Course Title: Microbiome Biotechnology

Course Code: 601BIO1201

Credits: 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objectives:

LO 1 Describe and explain microbiome structure, diversity and ecological interactions across different environments.

LO 2 Apply and analyze molecular, sequencing and bioinformatics tools for microbiome characterization and data interpretation.

LO 3 Evaluate the functional roles of microbiomes in human health, agriculture and environmental systems.

LO 4 Design microbiome-based technologies and innovative applications for industrial, agricultural and healthcare sectors.

Course Outcomes:

After completion of the course the students will be able to-

CO 1 Explain and relate microbiome composition, diversity, types, and ecological interactions including host–microbiome relationships.

CO 2 Apply and analyze molecular, sequencing, and bioinformatics tools for microbiome characterization and interpretation.

CO 3 Analyze and evaluate microbiome functions in human health, disease, agriculture, and environmental sustainability.

CO 4 Design microbiome-based solutions and communicate outcomes considering ethics, sustainability, and entrepreneurship.

Unit No.	Title of Unit & Contents	Hrs.
I	**Microbiome Diversity and Ecology**	**11**
	1. Microbiome vs microbiota: composition and organization 2. Types: human, soil, plant and marine microbiomes 3. Microbial diversity: taxonomic, functional and phylogenetic 4. Microbial interactions: mutualism, commensalism, parasitism	

Unit No.	Title of Unit & Contents	Hrs.
	5. Host–microbiome interactions in metabolism and immunity	
	Unit Outcomes: UO 1. Explain microbiome diversity and ecological principles. UO 2 Analyze host–microbiome interactions and functional relationships.	
II	**Cell organelles and Cytoskeleton**	**11**
	1. DNA extraction from microbiome samples 2. 16S rRNA sequencing and metagenomics 3. Next Generation Sequencing (NGS) technologies 4. Shotgun metagenomics and Metatranscriptomics 5. Bioinformatics tools: QIIME, BLAST, KEGG	
	Unit Outcome: UO 1. Apply molecular and sequencing techniques for microbiome analysis. UO 2. Analyze microbiome data using bioinformatics tools.	
III	**Membrane Transport**	**11**
	1. Human microbiome: gut, skin, oral ecosystems 2. Dysbiosis and diseases (IBD, obesity, cancer) 3. Probiotics, prebiotics and symbiotic 4. Environmental microbiomes (soil, water, waste) 5. Role in bioremediation and nutrient cycling	
	Unit Outcomes: UO 1. Evaluate microbiome contributions to health and disease. UO 2 Analyze environmental microbiome functions and applications.	
IV	**Applications and Microbiome Engineering**	**12**
	1. Microbiome engineering and synthetic biology approaches 2. Therapeutics: FMT, microbiome-based precision medicine 3. Agricultural applications: biofertilizers, plant growth promotion 4. Microbiome in climate change and sustainability 5. Ethical, regulatory and biosafety considerations	
	Unit Outcomes: UO 1. Assess microbiome-based technologies and innovations. UO 2 Design microbiome-driven solutions for industrial and environmental systems.	

Learning Resources:

1. Brock Biology of Microorganisms (16th ed.) by Madigan, M. T., Bender, K. S., Buckley, D. H., Sattley, W. M., & Stahl, D. A., published by Pearson, New York, in 2021.
2. KEGG Database by Kyoto Encyclopedia of Genes and Genomes (KEGG), published by KEGG in 2024.
3. Microbiome Analysis: Methods and Applications by Knights, D., & Gilbert, J. A., published by Springer, Cham, in 2020.
4. NCBI Database by National Center for Biotechnology Information (NCBI), published by NCBI in 2024.
5. Prescott's Microbiology (10th ed.) by Willey, J. M., Sherwood, L. M., & Woolverton, C. J., published by McGraw Hill, New York, in 2020.
6. PubMed Database by National Library of Medicine, published in 2024.
7. QIIME Allows Analysis of High-Throughput Community Sequencing Data by Caporaso, J. G., Kuczynski, J., Stombaugh, J., Bittinger, K., Bushman, F. D., Costello, E. K., et al., published in Nature Methods in 2018.
8. Soil Microbiome and Sustainable Agriculture by Singh, B. K., Trivedi, P., Egidi, E., Macdonald, C. A., & Delgado-Baquerizo, M., published by Springer, Cham, in 2021.
9. Structure, Function and Diversity of the Healthy Human Microbiome by Huttenhower, C., published in Nature in 2019.
10. The Human Microbiome Project by Turnbaugh, P. J., Ley, R. E., Hamady, M., Fraser-Liggett, C. M., Knight, R., & Gordon, J. I., published in Nature in 2017.

Internal Examination Pattern:

CAT – I: Analytical Case Study on Applied Concepts in the Prescribed Syllabus

CAT – II: Critical Review and Analysis of Research Literature Relevant to the Syllabus

Mapping of POs, PSOs and COs:

COs/POs & PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	1	1	1	2	1	1	3	2	1	1	2
CO2	2	2	3	3	2	1	3	1	2	2	2	3	1	3	2
CO3	2	3	2	3	3	2	2	3	2	2	3	2	3	2	3
CO4	1	2	3	2	3	3	2	3	3	3	2	3	3	2	3

Scale: 3 = High, 2 = Moderate, 1 = Low, 0 = No correlation.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

Empowered Autonomous Institution

Faculty of Science and Technology

Department of Biotechnology

PG I Sem I

Course Type: Lab Course

Course Title: Lab Course- MEC-I A

Course Code: 601BIO1202

Credits: 01 **Max. Marks: 50** **Hours: 30 Hrs.**

Learning Objectives:

LO 1 Perform microbiome sampling, serial dilution, isolation, enumeration, and morphological/biochemical characterization of microorganisms.

LO 2 Demonstrate DNA extraction, PCR amplification of 16S rRNA gene, agarose gel electrophoresis, and DNA quality assessment.

LO 3 Analyze microbiome sequence data using tools such as BLAST, QIIME, multiple sequence alignment, phylogenetic analysis, and KEGG.

LO 4 Evaluate functional properties of microbiomes including probiotic screening, enzyme activity, antibiotic sensitivity, and environmental applications such as bioremediation.

Course Outcomes:

After completion of the course the students will be able to-

CO 1 Apply microbiological techniques for sampling, isolation, enumeration, and characterization of microbiome organisms.

CO 2 Perform dna extraction, pcr, electrophoresis, and metagenomic analysis for microbiome identification and characterization.

CO 3 Analyze microbiome data using bioinformatics tools (blast, qiime, kegg) and interpret phylogenetic and functional relationships.

CO 4 Evaluate microbiome functions and design applications in probiotics, enzyme production, agriculture, and environmental biotechnology.

Practical No.	Unit
1.	Collection of microbiome samples (soil / plant rhizosphere / water)
2.	Serial dilution and enumeration of microorganisms (CFU method)
3.	Isolation of microbiome bacteria using selective and differential media
4.	Morphological and biochemical characterization of isolates
5.	Isolation and screening of probiotic microorganisms

6.	DNA extraction from microbiome samples (soil/plant/gut surrogate)
7.	PCR amplification of 16S rRNA gene (demonstration/kit-based)
8.	Agarose gel electrophoresis for DNA analysis
9.	Metagenomic DNA quality assessment (UV/gel-based)
10.	DNA extraction from microbiome samples (soil/plant/gut surrogate)
11.	Sequence similarity search using BLAST
12.	Multiple sequence alignment and phylogenetic tree construction
13.	Microbiome diversity analysis using QIIME (software-based/demo)
14.	Functional annotation using KEGG database
15.	Antibiotic sensitivity testing of microbiome isolates
16.	Soil microbiome functional assays (nitrogen fixation / phosphate solubilization)
17.	Study of microbial enzyme activity (amylase / protease production)
18.	Case study: Gut microbiome and disease (data interpretation)
19.	Analysis of microbiome role in bioremediation (simulation/experiment)

N.B.: Any Ten Practicals from above.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

Empowered Autonomous Institution

Faculty of Science and Technology

Department of Biotechnology

PG I Sem I

Course Type: MEC- I B
Course Title: Aquaculture Biotechnology
Course Code: 601BIO1201
Credits: 03 **Max. Marks: 75** **Lectures: 45Hrs**

Learning Objectives:

LO 1 Explain fundamental concepts, scope, biological characteristics, and environmental factors influencing aquaculture systems.

LO 2 Apply microbial, molecular, and immunological techniques for improving aquaculture productivity and disease management.

LO 3 Analyze and evaluate genetic improvement strategies, feed biotechnology, and sustainable aquaculture practices.

LO 4 Design advanced aquaculture systems integrating modern technologies such as biofloc, Recirculating Aquaculture Systems (RAS), and transgenic approaches.

Course Outcomes:

After completion of the course the students will be able to-

CO 1 Analyze and interpret the principles, types, biological components, and environmental factors influencing aquaculture systems, and correlate them with system productivity and sustainability.

CO 2 Apply, analyze, and evaluate microbial and environmental biotechnological approaches such as probiotics, biofloc technology, and bioremediation to optimize aquaculture productivity and water quality management.

CO 3 Analyze, evaluate, and integrate molecular diagnostic tools, disease management strategies, immunological approaches, and genetic improvement techniques for enhancing health and performance in aquaculture systems.

CO 4 Design, develop, and justify sustainable aquaculture systems by integrating feed biotechnology, advanced technologies (RAS, biofloc), and environmental considerations while addressing economic feasibility and ethical aspects.

Unit No.	Title of Unit & Contents	Hrs.
I	**Basics of Aquaculture and Aquatic Environment**	**10**
	1. Introduction to Aquaculture: Definition, scope, and importance 2. Types of aquacultures: Freshwater, brackish water, marine 3. Biology of cultured organisms: Fish, crustaceans, mollusks 4. Water quality parameters: Temperature, pH, dissolved oxygen, salinity 5. Nutritional requirements of aquatic species	
	Unit Outcomes: UO1 Explain basic concepts and types of aquaculture systems. UO2 Interpret the effect of environmental parameters on aquatic life.	
II	**Microbial and Environmental Biotechnology**	**11**
	1. Role of microorganisms in aquaculture ecosystems 2. Probiotics, prebiotics, and biofloc technology 3. Waste management and bioremediation in aquaculture 4. Microbial interactions and aquatic microbiome 5. Water quality management using biotechnology	
	Unit Outcomes: UO1 Apply microbial biotechnology for improving aquaculture productivity. UO2 Analyze the role of microbes in maintaining water quality and ecosystem balance.	
III	**Molecular Tools, Genetics and Disease Management**	**12**
	1. Molecular diagnostic tools: PCR, ELISA, biosensors 2. Disease diagnosis: Viral, bacterial, parasitic infections 3. Fish immunology and vaccines 4. Selective breeding and hybridization 5. Genetic engineering and CRISPR applications in aquaculture	
	Unit Outcomes: UO 1. Analyze molecular tools for disease detection and management. UO 2. Evaluate genetic improvement strategies in aquaculture species.	
IV	**Feed Biotechnology and Advanced Aquaculture Systems**	**12**
	1. Feed formulation and nutritional biotechnology	

Unit No.	Title of Unit & Contents	Hrs.
	2. Use of enzymes, probiotics, and supplements in feed 3. Sustainable aquaculture and environmental impact 4. Recirculating Aquaculture Systems (RAS) 5. Integrated aquaculture systems and biofloc technology	
	Unit Outcomes: UO1 Evaluate feed biotechnology and sustainable aquaculture practices. UO2 Design advanced aquaculture systems using modern biotechnology tools.	

Learning Resources:

1. Aquaculture: Farming Aquatic Animals and Plants, Lucas JS, Southgate PC, Wiley-Blackwell, 2019
2. Aquaculture engineering, Lekang OI, Wiley-Blackwell, 2013
3. Aquaculture microbiology and biotechnology, Walker P, Wiley-Blackwell, 2005
4. Aquaculture nutrition, Webster CD, Lim C, Academic Press, 2002
5. Biofloc technology: A practical guide book, Avnimelech Y, The World Aquaculture Society, 2015
6. Biotechnology in aquaculture, Fingerman M, Nagabhushanam R, CRC Press, 2000
7. Environmental biotechnology, Evans GM, Furlong JC, Wiley, 2010
8. Fish biotechnology, Dunham RA, CABI Publishing, 2011
9. Molecular diagnostics in aquaculture, Adams A, Thompson KD, CABI, 2011
10. Principles of aquaculture, Stickney RR, Wiley, 2005

Internal Examination Pattern :

CAT – I: Analytical Case Study on Applied Concepts in the Prescribed Syllabus

CAT – II: Critical Review and Analysis of Research Literature Relevant to the Syllabus

Mapping of POs, PSOs and COs:

COs/POs & PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	3	2	1	1	2	1	1	3	2	2	1	2
CO2	2	2	3	3	3	2	3	3	1	2	2	3	3	2	3
CO3	2	3	3	3	3	2	3	3	2	2	3	3	2	3	3
CO4	2	2	3	3	3	3	2	3	2	3	3	3	3	2	3

Scale : 3 = High, 2 = Moderate, 1 = Low, 0 = No correlation.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

Empowered Autonomous Institution

Faculty of Science and Technology

Department of Biotechnology

PG I Sem I

Course Type: Lab Course

Course Title: Lab Course MEC-I B

Course Code: 601BIO1202

Credits: 01 **Max. Marks: 50** **Hours: 30**

Learning Objectives:

LO 1 Demonstrate basic laboratory practices including sterilization, media preparation, and safe handling of aquaculture samples.

LO 2 Perform and interpret water quality analysis (pH, DO, temperature, salinity, alkalinity, hardness) and plankton diversity using standard methods.

LO 3 Apply microbiological and molecular techniques such as microbial isolation, staining, probiotic preparation, DNA isolation, and PCR for aquaculture applications.

LO 4 Analyze aquaculture feed composition and disease aspects using biochemical methods and pathogen detection techniques.

Course Outcomes:

After completion of the course the students will be able to-

CO 1 Perform basic laboratory techniques including sterilization, media preparation, and safe handling of aquaculture materials.

CO 2 Analyze and interpret water quality parameters and plankton diversity to assess aquaculture system health.

CO 3 Apply microbiological and molecular techniques for isolation, identification, and detection of aquatic microorganisms and pathogens.

CO 4 Evaluate feed composition and disease conditions using biochemical and microbiological methods relevant to aquaculture.

Practical No.	Unit
1.	Preparation and sterilization of glassware and media used in aquaculture laboratory.

2.	Determination of water quality parameters: pH, dissolved oxygen (DO), temperature, salinity.
3.	Estimation of alkalinity and hardness of water samples.
4.	Isolation and enumeration of aquatic microorganisms from pond water.
5.	Identification of microbial flora using staining techniques (Gram staining).
6.	Preparation and application of probiotic cultures for aquaculture systems.
7.	Study of biofloc formation and microbial aggregation.
8.	Estimation of protein content in fish feed (Lowry/Kjeldahl method).
9.	Estimation of lipid content in aquaculture feed.
10.	Detection of fish pathogens using basic microbiological techniques.
11.	DNA isolation from fish tissue.
12.	PCR-based detection of aquatic pathogens (demonstration/virtual if facility limited).
13.	Study of plankton diversity using microscopic techniques.

N.B.: Any Ten Practicals from above.

Semester - II

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

Empowered Autonomous Institution

Faculty of Science and Technology

Department of Biotechnology

PG I Sem II

Course Type: MMC-V

Course Title: Advanced Molecular Biology

Course Code: 601BIO2101

Credits: 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objectives:

LO 1 Explain principles of recombinant DNA technology, advanced cloning methods, and expression systems, and apply them for designing recombinant constructs.

LO 2 Apply genome editing tools (CRISPR, TALENs, ZFNs) and analyze gene regulation mechanisms including RNA interference and epigenetic modifications.

LO 3 Analyze and interpret high-throughput biological data using omics technologies (NGS, proteomics) and bioinformatics tools.

LO 4 Evaluate and design molecular biotechnology applications in diagnostics, therapeutics, agriculture, and industrial biotechnology.

Course Outcomes:

After completion of the course the students will be able to-

CO 1 Explain and apply recombinant dna technology, cloning strategies, and expression systems for gene manipulation and protein production.

CO 2 Apply genome editing tools and analyze gene regulation processes, including epigenetic and rnai mechanisms.

CO 3 Interpret and analyze high-throughput datasets using bioinformatics tools for sequence, structural, and functional insights.

CO 4 Design recombinant constructs and develop biotechnology-based solutions for applications in healthcare, agriculture, and industry.

Unit No.	Title of Unit & Contents	Hrs.
I	**Advanced Gene Cloning and Expression Systems**	**10**
	1. Principles of recombinant DNA technology and vector biology 2. Advanced cloning methods (Gateway cloning, TA cloning) 3. Selection and use of expression systems (prokaryotic – E. coli; eukaryotic – yeast, insect, mammalian cells)	

Unit No.	Title of Unit & Contents	Hrs.
	4. Vector design, promoters, and selection markers 5. Design recombinant constructs for efficient protein expression 6. Protein expression optimization and purification strategies	
	Unit Outcomes: UO 1 Explain advanced cloning and expression systems. UO 2 Design recombinant constructs for efficient protein production.	
II	**Genome Editing and Gene Regulation**	**11**
	1. Mechanisms of CRISPR/Cas, ZFNs, TALENs 2. Use genome editing tools for targeted modifications 3. RNA interference (RNAi) pathways and gene silencing mechanisms 4. Epigenetic modifications (DNA methylation, histone changes) 5. Regulatory networks controlling gene expression 6. Design strategies for gene regulation and editing	
	Unit Outcome: UO 1 Apply genome editing tools in biotechnology. UO 2 Analyze gene regulation and epigenetic mechanisms.	
III	**High-throughput Molecular Techniques**	**11**
	1. Principles of Next Generation Sequencing (NGS) 2. Use DNA microarrays and transcriptomics tools 3. Proteomics techniques and data interpretation 4. Basics of metabolomics and systems biology 5. Bioinformatics tools for sequence and structural analysis 6. Interpret large-scale biological datasets	
	Unit Outcomes: UO 1 Explain omics technologies and bioinformatics tools. UO 2 Interpret and analyze high-throughput biological data.	
IV	**Applications of Molecular Biotechnology**	**13**
	1. Molecular diagnostics (PCR, RT-PCR, qPCR) 2. Recombinant therapeutics (Insulin, Monoclonal antibodies) 3. Gene therapy approaches and personalized medicine 4. Agricultural biotechnology (GM crops, trait engineering) 5. Industrial biotechnology applications and biosensors 6. Case-based solutions in healthcare and agriculture	
	Unit Outcomes: UO 1 Evaluate applications in healthcare and agriculture. UO 2 Design molecular biotechnology solutions for real-world problems.	

Learning Resources:

1. Advances in Omics Technologies: Exploring Genomics, Proteomics, and Metabolomics – A. K. Rout et al. – Springer – 2025
2. Bioinformatics: Sequence and Genome Analysis – David W. Mount – Cold Spring Harbor Laboratory Press – 2004

3. CRISPR-Cas: A Laboratory Manual – Jennifer A. Doudna, J. Keith Joung – Springer – 2019
4. Gene Cloning and DNA Analysis: An Introduction – T. A. Brown – Wiley-Blackwell – 2016
5. Genome Editing and Engineering: From TALENs to CRISPR – Krishnarao Appasani – Cambridge University Press – 2018
6. Handbook of Molecular Biotechnology – D. Liu – CRC Press – 2024
7. Introduction to Genomics – Arthur M. Lesk – Oxford University Press – 2017
8. Lehninger Principles of Biochemistry – David L. Nelson, Michael M. Cox – W. H. Freeman – 2017
9. Molecular Biology of the Gene – James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Losick – Pearson – 2013
10. Molecular Biotechnology: Principles and Applications of Recombinant DNA – Bernard R. Glick, Jack J. Pasternak, Cheryl L. Patten – ASM Press – 2010
11. Molecular World Today and Tomorrow: Recent Trends in Biological Sciences – W. Z. Zaman (Ed.) – MDPI – 2024
12. Next-Generation Sequencing and Data Analysis: A Practical Guide – Xinkun Cao – CRC Press – 2021
13. Plant Molecular Breeding in Genomics Era: Concepts and Tools – Jameel M. Al-Khayri et al. – Springer – 2024
14. Principles of Gene Manipulation and Genomics – Sandy B. Primrose, Richard M. Twyman – Wiley-Blackwell – 2006
15. Recombinant DNA: Genes and Genomes – A Short Course – James D. Watson, Richard M. Myers, Carol A. Janeway, Amy A. Weiner – Cold Spring Harbor Laboratory Press – 2007

Internal Examination Pattern :

CAT – I: Analytical Case Study on Applied Concepts in the Prescribed Syllabus

CAT – II: Critical Review and Analysis of Research Literature Relevant to the Syllabus

Mapping of POs, PSOs and COs:

COs/POs & PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	2	1	2	3	1	1	1	3	3	2	1	1
CO2	2	3	3	3	2	2	3	2	1	1	3	3	2	2	2
CO3	2	2	3	3	2	1	3	1	1	2	2	3	2	3	1
CO4	2	2	3	2	3	3	2	2	2	2	3	3	3	2	3

Scale : 3 = High, 2 = Moderate, 1 = Low, 0 = No correlation.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

Empowered Autonomous Institution

Faculty of Science and Technology

Department of Biotechnology

PG I Sem II

Course Type: Lab Course

Course Title: Lab Course IV (Based on MMC-V)

Course Code: 601BIO2105

Credits: 01 **Max. Marks: 50** **Lectures: 30 Hrs.**

Learning Objectives:

LO 1 Explain and perform fundamental molecular biology techniques including DNA isolation, PCR, electrophoresis, and recombinant DNA manipulation.

LO 2 Apply genetic engineering techniques such as transformation, cloning (ligation, restriction digestion), and screening methods for recombinant selection.

LO 3 Perform protein expression and analysis techniques (SDS-PAGE, Western blotting, qPCR) and analyze gene expression data.

LO 4 Analyze advanced molecular and bioinformatics approaches including NGS data analysis, metagenomics, CRISPR-based gene editing, and biosensor-based detection.

Course Outcomes:

After completion of the course the students will be able to-

CO 1 Apply molecular biology techniques for dna isolation, amplification, cloning, and genetic modification.

CO 2 Perform and analyze recombinant screening, protein expression, and gene expression studies using standard laboratory methods.

CO 3 Interpret molecular data obtained from electrophoresis, sequencing, and bioinformatics tools for genetic and proteomic analysis.

CO 4 Evaluate and design molecular and biotechnological approaches for diagnostics, genetic engineering, and microbial diversity analysis.

Practical No.	Unit
1	Plasmid DNA isolation (mini-prep method)
2	Isolation of genomic DNA from plant or bacterial cells
3	Polymerase Chain Reaction (PCR) amplification of target DNA

4	Agarose gel electrophoresis for PCR analysis
5	Transformation of *E. coli* and selection of transformants
6	Blue-white screening for identification of recombinant colonies
7	Restriction digestion of DNA and analysis by gel electrophoresis
8	Ligation of DNA fragments into plasmid vectors
9	Protein expression in *E. coli* and analysis using SDS-PAGE
10	Western blotting (immunoblotting) for protein detection (kit-based)
11	Real-Time PCR (qPCR) for gene expression analysis (kit-based)
12	Site-Directed Mutagenesis for Targeted Gene Modification using Mutagenesis Kit
13	Next Generation Sequencing (NGS) Data Analysis for Variant Identification using Software Module
14	Biosensor-Based Detection of Biomolecules (Glucose/Pathogen) using Biosensor Kit
15	Metagenomics Analysis for Microbial Diversity using Simulated Kit/Software Tools
16	DNA Fingerprinting using Short Tandem Repeat (STR) Analysis Kit
17	CRISPR-Cas9 guide RNA design and gene editing simulation / bioinformatics analysis of DNA sequences

N.B.: Any Ten Practicals from above

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

Empowered Autonomous Institution

Faculty of Science and Technology

Department of Biotechnology

PG I Sem II

Course Type: MMC-VI

Course Title: Diagnostic Immunotechniques and Immunotherapy

Course Code: 601BIO2102

Credits: 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objectives:

LO 1 Explain fundamental principles of antigen–antibody interactions, immune responses, and immunodiagnostic techniques.

LO 2 Apply classical and advanced immunological techniques (e.g., ELISA, immunofluorescence, flow cytometry) for disease detection and analysis.

LO 3 Analyze immunoassay data and evaluate diagnostic accuracy, sensitivity, specificity, and performance of immunological techniques and therapies.

LO 4 Design immunodiagnostic and immunotherapeutic strategies including monoclonal antibody-based treatments and vaccine approaches.

Course Outcomes:

After completion of the course the students will be able to-

CO 1 Describe antigen–antibody interactions, immune mechanisms, and principles of immunodiagnostics.

CO 2 Demonstrate the application of classical and advanced immunotechniques for disease diagnosis.

CO 3 Analyze and interpret results of immunological assays and evaluate diagnostic and therapeutic effectiveness.

CO 4 Design and propose immunodiagnostic methods and immunotherapy-based treatment strategies for clinical applications.

Unit No.	Title of Unit & Contents	Hrs.
I	**Basics of Immunodiagnostics**	**11**
	1. Antigen–antibody interactions 2. Diagnostic Parameters -Sensitivity, specificity, cross-reactivity 3. Principles of Immunodiagnostics -Basic principles of immunoassays; 4. Antigen detection vs antibody detection	
	Unit Outcomes: UO 1 Explain immunological principles in diagnostics. UO 2 Analyze factors affecting diagnostic accuracy.	
II	**Classical Immunotechniques**	**11**
	1. Precipitation and agglutination reactions 2. Immunodiffusion techniques (single and double diffusion) 3. Enzyme-Linked Immunosorbent Assay (ELISA) (direct, indirect, sandwich) 4. Radioimmunoassay (RIA)	
	Unit Outcomes: UO 1 Apply classical immunological techniques for disease detection. UO 2 Analyze results obtained from immunoassays.	
III	**Advanced Immunodiagnostic Techniques**	**11**
	1. Immunofluorescence Techniques 2. Flow cytometry and cell sorting 3. Rapid diagnostic tests 4. Western Blotting	
	Unit Outcomes: UO 1 Evaluate modern immunodiagnostic technologies. UO 2 Analyze diagnostic performance of advanced techniques.	
IV	**Immunotherapy and Clinical Applications**	**12**
	1. Monoclonal antibodies and hybridoma technology 2. Immunotherapy in autoimmune and infectious diseases 3. Vaccine development Basics 4. Types of Vaccines and its Applications	
	Unit Outcomes: UO 1 Assess immunotherapeutic strategies and clinical applications. UO 2 Design immunotherapy-based treatment approaches.	

Learning Resources:

1. Basic Immunology: Functions and Disorders of the Immune System by Abul K. Abbas, Elsevier, 2020;
2. Biomedical Database by PubMed, National Library of Medicine, 2024;
3. Cellular and Molecular Immunology by Abul K. Abbas, Andrew H. Lichtman, and Shiv Pillai, Elsevier, 2021;
4. Immunology by Janis Kuby, W.H. Freeman, 2019;
5. Immunology Database by National Center for Biotechnology Information (NCBI), NCBI, 2024;
6. Janeway's Immunobiology by Kenneth Murphy and Casey Weaver, Garland Science, 2022;
7. Roitt's Essential Immunology by Ivan M. Roitt and Peter J. Delves, Wiley, 2017;
8. Roitt's Essential Immunology / Clinical Immunology (Standard Reference) by Peter J. Delves, Seamus J. Martin, Dennis R. Burton, and Ivan M. Roitt, Wiley-Blackwell, 2021;
9. The Immunoassay Handbook by David Wild, Elsevier, 2013;
10. Vaccine and Immunotherapy Guidelines by World Health Organization (WHO), WHO, 2023.

Internal Examination Pattern :

CAT – I: Analytical Case Study on Applied Concepts in the Prescribed Syllabus

CAT – II: Critical Review and Analysis of Research Literature Relevant to the Syllabus

Mapping of POs, PSOs and COs:

COs/POs & PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	1	1	1	1	1	1	1	1	3	1	1	1	1
CO2	2	2	3	2	2	1	3	1	2	2	2	3	2	1	2
CO3	2	2	2	3	3	1	2	2	2	2	2	3	2	1	3
CO4	2	2	3	3	3	3	2	3	2	2	3	3	3	2	3

Scale : 3 = High, 2 = Moderate, 1 = Low, 0 = No correlation.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

Empowered Autonomous Institution

Faculty of Science and Technology

Department of Biotechnology

PG I Sem II

Course Type: Lab Course

Course Title: Lab Course V (Based on MMC-VI)

Course Code: 601BIO2106

Credits: 01 **Max. Marks: 50** **Lectures: 30 Hrs.**

Learning Objectives

LO 1 Explain principles of antigen–antibody interactions, immunoassays, and basic immunological techniques used in diagnostics.

LO 2 Perform classical and modern immunotechniques such as agglutination, precipitation, ELISA, and related assays for disease detection.

LO 3 Analyze and evaluate immunoassay results, diagnostic data, and performance of techniques including sensitivity and specificity.

LO 4 Design experimental approaches for immunodiagnostics and immunotherapy, including interpretation of clinical data and vaccine response analysis.

Course Outcomes:

After completion of the course, the student will be able to-

CO 1 Describe antigen–antibody reactions and principles of immunological techniques used in diagnostics.

CO 2 demonstrate practical skills in performing immunological assays such as agglutination, precipitation, elisa, and related techniques.

CO 3 Analyze and interpret experimental and clinical data from immunoassays and evaluate diagnostic accuracy.

CO 4 Design and propose immunodiagnostic and immunotherapy-based experimental strategies for disease detection and analysis.

Practical No.	Unit
1	Blood grouping by agglutination test
2	Widal test
3	Precipitation reaction
4	Radial immunodiffusion
5	Preparation of antigen and antibody solutions
6	ELISA test
7	Blood grouping Test
8	Double Immunodiffusion
9	Observation of Lymphoid Organs
10	Western blotting
11	VDRL test
12	Flow cytometry (demo/data analysis)
13	RA test
14	RPR test
15	Latex agglutination test
16	Monoclonal antibody production (hybridoma – demonstration/video)
17	Vaccine response analysis (data interpretation)

N.B.: Any Ten Practicals from above.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

Empowered Autonomous Institution

Faculty of Science and Technology

Department of Biotechnology

PG I Sem II

Course Type: MMC-VII

Course Title: Emerging Techniques

Course Code: 601BIO6103

Credits: 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objectives

LO 1 Explain the principles and interpret data obtained from advanced spectroscopic for biomolecular analysis.

LO 2 Apply advanced microscopy and imaging techniques to analyze cellular and molecular structures with high resolution.

LO 3 Analyze and evaluate modern separation and analytical platforms for characterization of complex biological samples.

LO 4 Evaluate and design applications of emerging diagnostic and interdisciplinary technologies in healthcare, agriculture, and environmental biotechnology.

Course Outcomes

After completion of the course, the student will be able to-

CO 1 Explain, interpret and analyze the principles, instrumentation, and applications of advanced spectroscopic techniques for biomolecular structure and interaction studies.

CO 2 Apply and analyze advanced microscopy and imaging techniques to investigate cellular and molecular structures.

CO 3 Analyze and evaluate high-end separation techniques and analytical platforms for complex biological systems.

CO 4 Evaluate and design applications of emerging diagnostic and interdisciplinary technologies for healthcare, environmental, and agricultural solutions.

Unit No.	Title of Unit & Contents	Hrs.
I	**Advanced Spectroscopy Techniques**	**11**
	1. Nuclear Magnetic Resonance (NMR) spectroscopy 2. Fourier Transform Infrared (FTIR) spectroscopy 3. Raman spectroscopy 4. Circular Dichroism (CD) spectroscopy 5. Surface Plasmon Resonance (SPR)	

Unit No.	Title of Unit & Contents	Hrs.
	Unit Outcomes: UO 1 Explain structural characterization using spectroscopic techniques. UO 2 Interpret molecular interaction and spectral data.	
II	**Advanced Microscopy and Imaging Techniques**	**11**
	1. Confocal Laser Scanning Microscopy (CLSM) 2. Scanning and Transmission Electron Microscopy (SEM, TEM) 3. Atomic Force Microscopy (AFM) 4. Super-resolution microscopy (STED, PALM, STORM) 5. Live-cell imaging techniques	
	Unit Outcomes: UO 1. Analyze high-resolution cellular and molecular structures. UO 2. Apply imaging techniques in biological research.	
III	**High-End Separation and Analytical Platforms**	**11**
	1. High-resolution mass spectrometry (LC-MS/MS) 2. Capillary electrophoresis 3. Chromatography advancements (UPLC, FPLC) 4. Hyphenated techniques (GC-MS, LC-MS) 5. Single-cell analysis platforms	
	UO 1 Evaluate advanced separation and analytical technologies. UO 2 Analyze complex biological samples using modern platforms.	
IV	**Emerging Diagnostic and Interdisciplinary Technologies**	**12**
	1. Lab-on-a-chip and microfluidics 2. Biosensors and nanobiosensors 3. CRISPR-based diagnostics (non-editing applications) 4. Digital PCR and ultra-sensitive detection 5. Applications in healthcare, environment and agriculture	
	Unit Outcomes: UO 1 Apply emerging diagnostic technologies in real-world contexts. UO 2 Evaluate interdisciplinary applications of advanced techniques.	

Learning Resources:

1. Skoog DA, Holler FJ, Crouch SR. *Principles of instrumental analysis*. 7th ed. Boston: Cengage Learning; 2017.

2. Pavia DL, Lampman GM, Kriz GS, Vyvyan JA. *Introduction to spectroscopy*. 5th ed. Boston: Cengage Learning; 2015.
3. Silverstein RM, Webster FX, Kiemle DJ. *Spectrometric identification of organic compounds*. 8th ed. Hoboken: Wiley; 2014.
4. Bozzola JJ, Russell LD. *Electron microscopy: Principles and techniques for biologists*. 2nd ed. Sudbury: Jones & Bartlett Learning; 1999.
5. de Hoffmann E, Stroobant V. *Mass spectrometry: Principles and applications*. 3rd ed. Chichester: Wiley; 2007.
6. Miller JM. *Chromatography: Concepts and contrasts*. 2nd ed. Hoboken: Wiley; 2005.
7. Turner APF, Karube I, Wilson GS. *Biosensors: Fundamentals and applications*. Oxford: Oxford University Press; 2008.
8. Berthier J, Silberzan P. *Microfluidics for biotechnology*. 2nd ed. Norwood: Artech House; 2010.
9. Buckingham L. *Molecular diagnostics: Fundamentals, methods and clinical .applications*. 3rd ed. Philadelphia: F.A. Davis Company; 2019.
10. Lakowicz JR. *Principles of fluorescence spectroscopy*. 3rd ed. New York: Springer; 2006.
11. Fan, X., White, I. M. *Optical biosensors for biomedical diagnostics*. Analytical Chemistry.;2021.
12. Zhang, Y., *et al.* *Advances in CRISPR-based diagnostics*. Nature Reviews Methods Primers;2022.
13. Whitesides, G. M. *Microfluidics in biotechnology*. Annual Review of Biomedical Engineering;2020.

Internal Examination Pattern :

CAT – I: Analytical Case Study on Applied Concepts in the Prescribed Syllabus

CAT – II: Critical Review and Analysis of Research Literature Relevant to the Syllabus

Mapping of POs, PSOs and COs:

COs/POs & PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3	PS O4	PS O5
CO1	3	3	2	3	2	1	3	1	1	1	3	3	1	2	1
CO2	2	3	3	3	2	2	3	1	2	1	3	3	2	2	1
CO3	2	2	3	3	3	2	3	1	1	1	2	3	3	2	1
CO4	2	2	3	3	3	3	3	2	2	2	2	3	3	2	3

Scale : 3 = High, 2 = Moderate, 1 = Low, 0 = No correlation.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

Empowered Autonomous Institution

Faculty of Science and Technology

Department of Biotechnology

PG I Sem II

Course Type: Lab Course

Course Title: Lab Course-VI (Based on MMC-VII)

Course Code: 601BIO2107

Credits: 01 **Max. Marks: 50** **Lectures: 30 Hrs.**

Learning Objectives

LO 1 Explain and perform principles and laboratory applications of advanced analytical, spectroscopic and chromatographic techniques.

LO 2 Demonstrate and analyze microscopy, imaging techniques and experimental data obtained from analytical platforms.

LO 3 Evaluate and interpret efficiency, spectral data and performance of separation, detection and diagnostic techniques.

LO 4 Assess and design experimental workflows and applications using emerging analytical and biosensor technologies.

Course Outcomes:

After completion of the course, the student will be able to-

CO 1 Explain and perform advanced analytical and separation techniques in laboratory settings.

CO 2 Demonstrate and analyze microscopy, imaging and experimental data from spectroscopic and chromatographic methods.

CO 3 Evaluate and interpret efficiency and results of analytical, spectroscopic and diagnostic.

CO 4 Assess and design workflows for advanced analytical experiments and real-world applications.

Practical No.	Unit
1	UV-Visible spectrophotometry – protein/DNA estimation
2	FTIR spectrum analysis (functional group identification – demo/data-based)
3	Raman spectroscopy (demonstration/video-based interpretation)

4	Circular Dichroism data analysis (protein secondary structure)
5	NMR spectrum interpretation (basic peaks and structure analysis – dataset-based)
6	Bright field and phase contrast microscopy
7	Fluorescence microscopy (cell staining)
8	Confocal microscopy (CLSM) – demonstration/data analysis
9	SEM/TEM image analysis (ultrastructure interpretation)
10	AFM image interpretation (surface topology study)
11	Thin Layer Chromatography (TLC)
12	Column chromatography (protein/biomolecule separation)
13	Gel electrophoresis (DNA/protein separation)
14	Demonstration/analysis of LC-MS/MS output
15	Capillary electrophoresis (demonstration/data analysis)
16	Biosensor working principle (glucose sensor demonstration/model)
17	Microfluidics (lab-on-chip demonstration/video analysis)
18	Digital PCR / CRISPR diagnostics (concept-based experimental analysis)

N.B.: Any Ten Practicals from above.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

Empowered Autonomous Institution

Faculty of Science and Technology

Department of Biotechnology

PG I Sem II

Course Type: MMC-VIII

Course Title: Analytical, Quantitative and Scientific Aptitude

Course Code: 601BIO2104

Credits: 02 **Max. Marks: 50** **Lectures: 30 Hrs.**

Learning Objectives:

LO 1 Cultivate and demonstrate logical reasoning, pattern recognition, and analytical thinking to solve complex problems efficiently.

LO 2 Apply and compute quantitative aptitude concepts, including arithmetic, algebra, and time-based problem-solving techniques in real-life contexts.

LO 3 Analyze and integrate advanced mathematical concepts such as geometry, permutation, combination, and probability for scientific applications.

LO 4 Interpret, evaluate, and correlate data using statistical tools, graphical methods, and general science concepts with emphasis on environmental sustainability.

Course Outcomes:

After completion of course the student will be able to-

CO 1 Analyze and solve problems involving logical reasoning, pattern recognition, sequences, coding–decoding, and relationships.

CO 2 Compute, apply, and solve numerical and arithmetic problems involving ratios, percentages, profit & loss, time-work, and algebraic concepts.

CO 3 Analyze, evaluate, and apply geometrical concepts, permutation and combination, and probability in real-world and scientific problem-solving.

CO 4 Interpret, analyze, and evaluate data using statistical tools, graphical representations, and apply scientific and environmental concepts for sustainable development.

Unit No.	Title of Unit & Contents	Hrs.
I	**Logical Reasoning and Mental Ability**	**07 Hrs.**
	1. Observational skills and pattern recognition Logical deductions and analytical reasoning 2. Sequence and series 3. Coding-decoding, analogies and relationships	

Unit No.	Title of Unit & Contents	Hrs.
	Unit Outcomes: UO 1 Analyze reasoning and deduction patterns. UO 2 Apply logical reasoning techniques.	
II	**Quantitative Aptitude**	**08 Hrs.**
	1. Numerical ability and arithmetic 2. Ratio, percentage, averages 3. Profit and loss 4. Time, work and speed 5. Quadratic equations 6. Clock, calendar, years, weeks and days	
	Unit Outcomes: UO 1 Apply quantitative techniques in problem solving. UO 2 Analyze mathematical relationships.	
III	**Advanced Mathematics and Probability**	**08 Hrs.**
	1. Geometry of shapes and measurement 2. Directional geometry 3. Moving object dynamics (basic) 4. Permutation and combination 5. Probability	
	Unit Outcomes: UO 1 Apply mathematical and probabilistic concepts. UO 2 Analyze problem-solving strategies.	
IV	**Data Interpretation and General Science**	**07/ Hrs.**
	1. Data analysis and graphical interpretation 2. Statistical tools (mean, variation) 3. General science (basic concepts and applications) 4. Environmental issues and sustainable development	
	Unit Outcomes: UO 1 Interpret data using statistical and graphical tools. UO 2 Evaluate scientific and environmental concepts.	

Learning Resources:

1. Pathfinder Academy. *CSIR-NET life sciences*. 2024 ed. New Delhi: Pathfinder Publication.
2. Aggarwal RS. *Quantitative aptitude for competitive examinations*. 2024 ed. New Delhi: S. Chand Publishing.
3. Verma R, Sharma S. *Logical reasoning and data interpretation*. 2023 ed. New Delhi: Arihant Publications.
4. NCERT. *Mathematics textbooks (Class XI & XII)*. 2023 ed. New Delhi: NCERT.
5. Lucent Publications. *Lucent's general science*. 2024 ed. New Delhi: Lucent Publications.
6. Made Easy Editorial Board. *GATE life sciences guide*. 2024 ed. New Delhi: Made Easy Publications.
7. Verma R. *Fast track objective arithmetic*. 2023 ed. New Delhi: Arihant Publications.

8. Pandey MK. *Analytical reasoning*. 2023 ed. New Delhi: BSC Publishing.
9. Various authors. *Previous years' question papers (CSIR-NET / SET / DBT-JRF / JAM)*. 2024 ed.
10. Government of India. *Scientific and environmental policy documents*. 2023 ed. New Delhi: Government of India.

Internal Examination Pattern :

CAT – I: Analytical Case Study on Applied Concepts in the Prescribed Syllabus

CAT – II: Critical Review and Analysis of Research Literature Relevant to the Syllabus

Mapping of POs, PSOs and COs:

COs/POs & PSOs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	2	1	2	3	2	1	1	0	1	1	2	2	2	1	1
CO2	2	1	3	3	2	2	1	0	1	1	2	3	3	2	1
CO3	2	2	2	3	3	2	1	0	1	1	3	2	3	2	2
CO4	1	2	2	3	3	2	2	3	2	2	2	3	3	3	3

Scale : 3 = High, 2 = Moderate, 1 = Low, 0 = No correlation.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

Empowered Autonomous Institution

Faculty of Science and Technology

Department of Biotechnology

PG I Sem II

Course Type: MEC-II (A)
Course Title: Animal and Livestock Biotechnology
Course Code: 601BIO2201
Credits: 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objectives

LO 1 Examine and interpret the structural and functional aspects of animal cells, culture media composition, growth kinetics, and contamination control mechanisms.

LO 2 Demonstrate and execute standard animal cell culture techniques, including aseptic handling, cell maintenance, and scale-up strategies.

LO 3 Analyze and apply molecular tools such as PCR, genetic markers, genome mapping, and CRISPR for livestock genetic improvement.

LO 4 Evaluate and design biotechnological strategies, including assisted reproductive technologies (ARTs), transgenic approaches, and genomic selection for enhancing livestock productivity and health.

Course Outcomes

After completion of the course, the student will be able to-

CO 1 Critically explain and interpret the principles of animal cell culture, including cell biology, media formulation, growth kinetics, and contamination control.

CO 2 Perform, optimize, and manage animal cell culture techniques, including aseptic practices, cell maintenance, and scale-up operations.

CO 3 Analyze, interpret, and apply molecular tools in livestock genetics and breeding programs.

CO 4 Evaluate, design, and propose advanced biotechnological interventions to improve livestock productivity, health, and sustainability.

Unit No.	Title of Unit & Contents	Hrs.
I	**Basics of Animal Cell Culture**	**12**
	1. Introduction to Animal Cell Culture, Planning and Layout of animal tissue culture laboratory. 2. Cell Culture Media and Reagents: Types, Growth supplements, serum free media, balanced salt solution, other cell culture reagents. 3. Tissue Culture Techniques: Primary and secondary culture, continuous cell lines, suspension culture, Tissue Specific Culture and organ culture. 4. Behaviour of cells in culture conditions, their growth pattern, cell metabolism, estimation of cell number. 5. Contamination and its control	
	Unit Outcomes: UO 1 Describe laboratory design, types of cell cultures, media composition, and growth behavior of animal cells. UO 2 Apply cell culture techniques and analyze issues related to contamination, cell growth patterns, and cell quantification.	
II	**Scale-Up and Commercial Applications of Animal Biotechnology**	**10**
	1. Bioreactor Systems: Mechanical, Hydraulic and Pneumatic 2. Process mode: Batch and continuous 3. Transfection and transformation of cells; Commercial scale production of animal cells, Application of animal cell culture for in vitro testing of drugs. 4. Testing of toxicity of environmental pollutants in cell culture; Application of cell culture technology in production of human and animal viral vaccines and pharmaceutical proteins.	
	Unit Outcomes: UO 1 Explain and apply principles of bioreactor systems, process modes, and large-scale cultivation of animal cells. UO 2 Analyze industrial applications of animal cell culture in drug testing, vaccine production, and environmental toxicity assessment.	
III	**Molecular Techniques and Applications in Livestock Biotechnology**	**10**
	1. Genome organization of any suitable Livestock with example 2. Physical and genetic map, current status of genome maps of livestock. 3. Polymerase Chain Reaction (PCR), its types and applications.	

Unit No.	Title of Unit & Contents	Hrs.
	4. Molecular markers and its applications - Marker Assisted Selection (MAS), RFLP, RAPD, AFLP, Microsatellite/ Minisatellite markers, SNP markers. 5. DNA fingerprinting. DNA sequencing, Genome sequencing, Genomic Library, Genomics database of 6. Livestock. gene editing (e.g., CRISPR/Cas9)	
	Unit Outcomes: UO 1 Explain genome organization, PCR techniques, and molecular markers used in livestock biotechnology. UO 2 Analyze applications of marker-assisted selection, DNA fingerprinting, sequencing, and gene editing in livestock research.	
IV	**Breeding Techniques and Transgenic Technology in Livestock**	**13**
	1. **Introduction to Animal breeding** 2. Methods of cross breeding and its types, assisted reproductive technologies (ARTs) like artificial insemination, in vitro fertilization (IVF), and embryo cloning, 3. Statistical techniques for analyzing molecular genetic data, Quantitative Trait Loci (QTL) mapping and its application in animal breeding 4. Genomic selection in livestock, Applications of transgenic technology in livestock improvement and molecular biopharming.	
	Unit Outcomes: UO 1 Explain and apply principles of animal breeding, crossbreeding, and assisted reproductive technologies (ARTs). UO 2 Analyze QTL mapping, genomic selection, and evaluate transgenic approaches for livestock improvement and biopharming.	

Learning Resources:

1. Animal Biotechnology, Glick, B. R., Pasternak, J. J., & Patten, C. L.; ASM Press, Third Edition, 2010.
2. Animal Biotechnology: Models in Discovery and Translation, Bhan, S., & Singh, S.; CRC Press, First Edition, 2018.
3. Animal Cell Biotechnology: Methods and Protocols, Pörtner, R., & Zeng, A. P.; Humana Press, Third Edition, 2007.

4. Animal Cell Culture and Technology, Butler, M., & Griffiths, B.; Taylor & Francis, Second Edition, 2004.
5. Applications of Biotechnology in Animal Health and Production, Maqbool, A., & Singh, S. P.; Springer, First Edition, 2019.
6. Basic Cell Culture Protocols, Helgason, C., & Miller, C.; Springer, Fourth Edition, 2013.
7. Biotechnology in Animal Husbandry, Pandey, A. K., & Singh, R. K.; Daya Publishing House, First Edition, 2016.
8. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, Freshney, R. Ian; Wiley-Blackwell, Seventh Edition, 2016.
9. Introduction to Animal Biotechnology, Hafez, E. S. E., & Hafez, B.; Wiley-Blackwell, First Edition, 2013.
10. Livestock Biotechnology: Breeding, Genetics, and Genomics, Abdullah, M., & Salim, H. M.; Springer, Second Edition, 2020.
11. Livestock Production and Biotechnology, Cai, Y.; Nova Science Publishers, First Edition, 2017.
12. Molecular Biotechnology: Principles and Applications of Recombinant DNA, Glick, B. R., Pasternak, J. J., & Patten, C. L.; ASM Press, Fourth Edition, 2010.
13. Principles of Tissue Engineering, Lanza, R., Langer, R., & Vacanti, J.; Academic Press, Fourth Edition, 2013.
14. Recombinant DNA Technology, Watson, J. D., Caudy, A. A., Myers, R. M., & Witkowski, J. A.; W.H. Freeman, Third Edition, 2007.
15. Transgenic Animal Technology: A Laboratory Handbook, Pinkert, C. A.; Academic Press, Third Edition, 2014.

Internal Examination Pattern:

CAT – I: Analytical Case Study on Applied Concepts in the Prescribed Syllabus

CAT – II: Critical Review and Analysis of Research Literature Relevant to the Syllabus

Mapping of POs, PSOs and COs:

COs/POs & PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	2	1	1	2	1	1	3	2	1	1	2
CO2	2	2	3	2	2	2	3	2	2	1	2	3	2	2	2
CO3	2	2	3	3	2	2	3	1	2	1	2	3	2	3	2
CO4	2	2	2	3	3	3	2	3	2	2	3	2	3	2	3

Scale : 3 = High, 2 = Moderate, 1 = Low, 0 = No correlation.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

Empowered Autonomous Institution

Faculty of Science and Technology

Department of Biotechnology

PG I Sem II

Course Type: Lab Course
Course Title: Lab Course MEC-II A
Course Code: 601BIO2202
Credits: 01 **Max. Marks: 50** **Lectures : 30 Hrs.**

Learning Objectives

LO 1 Explain and interpret the principles of aseptic techniques, composition of cell culture media, and cellular growth requirements in animal biotechnology.

LO 2 Demonstrate and execute aseptic handling, media preparation, and the establishment and maintenance of primary and secondary animal cell cultures.

LO 3 Analyze and evaluate cell growth kinetics, viability, and cellular responses to external factors such as toxins and viral infections using appropriate laboratory techniques.

LO 4 Apply and analyze molecular marker techniques and genomic data for marker-assisted selection in livestock improvement.

Course Outcomes

After completion of the course, the student will be able to-

CO 1 Demonstrate and maintain aseptic techniques and prepare and optimize culture media to ensure contamination-free animal cell culture systems.

CO 2 Perform and manage primary, secondary, and continuous cell cultures, including cell counting, subculturing, and cryopreservation techniques.

CO 3 Analyze and interpret cell viability, growth patterns, and the effects of toxic agents and viral infections on cultured animal cells.

CO 4 Apply, analyze, and evaluate molecular marker techniques and genomic data for marker-assisted selection and livestock genetic improvement.

Practical No.	Unit
1.	Packing and sterilization of glass and plastic wares for cell culture.
2.	Preparation of reagents and media for cell culture.
3.	Primary culture technique for chicken embryo fibroblast.
4.	Secondary culture of chicken embryo fibroblast.
5.	Cultivation of continuous cell lines.
6.	Quantification of cells by trepan blue exclusion dye.
7.	Isolation of lymphocytes and cultivation of lymphocytes
8.	Study of effect of toxic chemicals on cultured mammalian cells
9.	Study of effect of virus on mammalian cells.
10.	Suspension culture technique
11.	Cryopreservation of cell primary cultures and cell lines
12	Practicals based on genomic databases of livestock and its analysis.
13	A study of molecular markers by using RFLP and AFLP.

N.B.: Any Ten Practicals from above.

Shiv Chhatrapati Shikshan Sanstha's

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Faculty of Science and Technology

Department of Biotechnology

PG I Sem II

Course Type: MEC-II B

Course Title: Advances in Protein Chemistry

Course Code: 601BIO2201

Credits: 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objectives:

LO 1 Analyze and interpret protein structure, classification, folding mechanisms, and stability within biological systems.

LO 2 Apply and evaluate advanced techniques for protein purification, characterization, and structural analysis.

LO 3 Evaluate and interpret protein–ligand interactions, enzyme kinetics, and proteomics approaches using quantitative methods.

LO 4 Design and develop protein engineering strategies and protein-based biotechnological applications for industrial and medical use.

Course Outcomes:

After completion of the course the students will be able to-

CO 1 Analyze and interpret protein structure, classification, folding mechanisms, and stability using fundamental biochemical principles.

CO 2 Apply and evaluate protein purification methods and advanced analytical techniques for structural and functional characterization of proteins.

CO 3 Analyze and interpret enzyme kinetics, protein–ligand interactions, and proteomic data using quantitative and computational approaches.

CO 4 Design and develop protein engineering strategies and propose biotechnological applications for industrial, medical, and research purposes.

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Unit No.	Title of Unit & Contents	Hrs.
I	**Protein Structure and Folding**	**11**
	1. Levels of protein structure: primary, secondary, tertiary, quaternary 2. Protein folding pathways and energy landscape 3. Molecular chaperones and folding diseases	

Unit No.	Title of Unit & Contents	Hrs.
	4. Protein stability and denaturation 5. Protein misfolding and aggregation (amyloids, prions)	
	Unit Outcomes: UO 1. Explain protein structure and folding mechanisms. UO 2. Analyze factors affecting protein stability and misfolding	
II	**Protein Purification and Characterization**	**11**
	1. Protein extraction and purification strategies 2. Chromatography techniques (affinity, ion exchange, gel filtration) 3. Electrophoretic methods (SDS-PAGE, 2D-PAGE) 4. Spectroscopic techniques (UV-Vis, CD, fluorescence) 5. Protein identification and quantification.	
	Unit Outcome: UO 1. Apply purification and analytical techniques. UO 2 Analyze protein characterization data	
III	**Proteomics and Protein Interactions**	**11**
	1. Introduction to proteomics (gel-based and gel-free methods) 2. Mass spectrometry in proteomics (LC-MS/MS) 3. Protein–protein and protein–ligand interactions 4. Enzyme kinetics and inhibition 5. Bioinformatics tools in proteomics	
	Unit Outcomes: UO 1. Analyze proteomics workflows and interaction studies. UO 2 Evaluate enzyme kinetics and protein interaction data.	
IV	**Protein Engineering and Applications**	**12**
	1. Protein engineering: rational design and directed evolution 2. Site-directed mutagenesis 3. Recombinant protein production 4. Therapeutic proteins and monoclonal antibodies 5. Industrial enzymes and applications.	
	Unit Outcomes: UO 1. Assess protein engineering strategies and applications. UO 2 Design protein-based solutions for industrial and medical applications	

Learning Resources:

1. Biochemistry (9th ed.) by Berg, J. M., Tymoczko, J. L., & Gatto, G. J., published by W.H. Freeman in 2019.
2. Biopharmaceuticals: Biochemistry and Biotechnology (3rd ed.) by Walsh, G., published by Wiley in 2018.
3. Fundamentals of Biochemistry (5th ed.) by Voet, D., Voet, J. G., & Pratt, C. W., published by Wiley in 2019.
4. Introducing Proteomics by Lovric, J., published by Wiley-Blackwell in 2011.
5. Lehninger Principles of Biochemistry (8th ed.) by Nelson, D. L., & Cox, M. M., published by W.H. Freeman in 2021.
6. Principles of Proteomics by Twyman, R. M., published by Garland Science in 2019.
7. Protein Purification: Principles and Practice (3rd ed.) by Scopes, R. K., published by Springer in 1994.
8. Protein Database by NCBI, published by NCBI in 2024.
9. UniProt Database by UniProt Consortium, published by UniProt in 2024.
10. KEGG Pathway Database by KEGG, published by KEGG in 2024.

Internal Examination Pattern:

CAT – I: Analytical Case Study on Applied Concepts in the Prescribed Syllabus

CAT – II: Critical Review and Analysis of Research Literature Relevant to the Syllabus

Mapping of POs, PSOs and COs:

COs/POs & PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	1	2	1	1	1	0	0	1	3	2	1	1	1
CO2	2	2	3	2	2	1	3	1	1	1	2	3	2	2	2
CO3	2	2	2	3	3	1	2	0	1	1	2	3	2	3	2
CO4	2	1	3	2	3	3	2	2	2	2	2	3	3	2	3

Scale: 3 = High, 2 = Moderate, 1 = Low, 0 = No correlation.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

Empowered Autonomous Institution

Faculty of Science and Technology

Department of Biotechnology

PG I Sem II

Course Type: Lab Course

Course Title: Lab Course MEC-II -B

Course Code: 601BIO2202

Credits: 01 **Max. Marks: 50** **Hours: 30 Hrs.**

Learning Objectives:

LO 1 Apply and demonstrate principles of protein extraction, estimation, and purification techniques.

LO 2 Use and analyze electrophoretic, chromatographic, and spectroscopic methods for protein analysis.

LO 3 Analyze and interpret enzyme activity, kinetics, and protein-related data using computational

LO 4 Design and evaluate advanced approaches such as proteomics and immunoblotting for protein studies.

Course Outcomes:

After completion of the course the students will be able to-

CO 1 Apply protein extraction, purification, estimation, and enzyme assay techniques.

CO 2 Use electrophoretic, chromatographic, and spectroscopic methods for protein characterization.

CO 3 Analyze enzyme kinetics and protein data using bioinformatics tools.

CO 4 Design advanced protein analysis techniques and biotechnological workflows.

Practical No.	Unit
1.	Protein extraction from biological samples
2.	Protein estimation (Lowry/Bradford method)
3.	SDS-PAGE analysis of proteins
4.	Gel filtration chromatography
5.	Ion exchange chromatography
6.	Enzyme activity assay (e.g., amylase, catalase)
7.	Determination of enzyme kinetics (Km, Vmax)
8.	Effect of pH and temperature on enzyme activity

9.	UV-Vis spectroscopy for protein analysis
10.	Circular Dichroism data interpretation (demo)
11.	Western blotting (demonstration)
12.	Protein structure visualization using bioinformatics tools
13.	Protein sequence analysis (BLAST, alignment)
14.	Case study: Therapeutic proteins
15.	Proteomics data analysis (software-based)

N.B.: Any Ten Practicals from above.

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Extra Credit Activities

Sr. No.	Course Title	Credits	Hours T/P
1	MOOCs	Min. of 02 credits	Min. of 30 Hrs.
2	Certificate Courses	Min. of 02 credits	Min. of 30 Hrs.
3	IIT Spoken English Courses	Min. of 02 credits	Min. of 30 Hrs.

Guidelines:

Extra -academic activities

1. All extra credits claimed under this heading will require sufficient academic input/ contribution from the students concerned.
2. Maximum 04 extra credits in each academic year will be allotted.
3. These extra academic activity credits will not be considered for calculation of SGPA/CGPA but will be indicated on the grade card.

Additional Credits for Online Courses:

1. Courses only from SWAYAM and NPTEL platform are eligible for claiming credits.
2. Students should get the consent from the concerned subject Teacher/Mentor/Vice Principal and Principal prior to starting of the course.
3. Students who complete such online courses for additional credits will be examined/verified by the concerned mentor/internal faculty member before awarding credits.
4. Credit allotted to the course by SWAYAM and NPTEL platform will be considered as it is.

Additional Credits for Other Academic Activities:

1. One credit for presentation and publication of paper in International/National/State level seminars/workshops.
2. One credit for measurable research work undertaken and field trips amounting to 30 hours of recorded work.
3. One credit for creating models in sponsored exhibitions/other exhibits, which are approved by the concerned department.
4. One credit for any voluntary social service/Nation building exercise which is in collaboration with the outreach center, equivalent to 30 hours
5. All these credits must be approved by the College Committee.

Additional Credits for Certificate Courses:

1. Students can get additional credits (number of credits will depend on the course duration) from certificate courses offered by the college.
2. The student must successfully complete the course. These credits must be approved by the Course Coordinators.
3. Students who undertake summer projects/ internships/ training in institutions of repute through a national selection process, will get 2 credits for each such activity. This must be done under the supervision of the concerned faculty/mentor.

Note:

1. The respective documents should be submitted within 10 days after completion of Semester End Examination.
2. No credits can be granted for organizing or for serving as office bearers/ volunteers for Inter-Class / Associations / Sports / Social Service activities.
3. The office bearers and volunteers may be given a letter of appreciation by the respective staff coordinators. Besides, no credits can be claimed for any services/ activities conducted or attended within the college.
4. All claims for the credits by the students should be made and approved by the mentor in the same academic year of completing the activity.
5. Any grievances of denial/rejection of credits should be addressed to Additional Credits Coordinator in the same academic year.
6. Students having a shortage of additional credits at the end of the third year can meet the Additional Credits Coordinator, who will provide the right advice on the activities that can help them earn credits required for graduation.

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Examination Framework

Theory:

40% Continuous Assessment Tests (CATs) and 60% Semester End Examination (SEE)

Practical:

50% Continuous Assessment Tests (CATs) and 50% Semester End Examination (SEE)

Course	Marks	CAT & Mid Term Theory				CAT Practical		Best Scored CAT & Mid Term	SEE	Total
1	2	3				4		5	6	5 + 6
		Att.	CAT I	Mid Term	CAT II	Att.	CAT			
DSC/DSE/ GE/OE/Minor	100	10	10	20	10	-	-	40	60	100
DSC	75	05	10	15	10	-	-	30	45	75
Lab Course/AIPC/ OJT/FP/SEC (Science & Technology)	50	-	-	-	-	05	20	-	25	50
VSC/SEC/ AEC/VEC/CC	50	05	05	10	05	-	-	20	30	50

Note:

1. All Internal Exams are compulsory
2. Out of 02 CATs best score will be considered
3. Mid Term Exam will be conducted by the Exam Section
4. Mid Term Exam is of Objective nature (MCQ)
5. Semester End Exam is of descriptive in nature (Long & Short Answer)

CAT Practical (20 Marks): Lab Journal (Record Book) 10 Marks, Overall Performance 10 Marks.