Syllabus
Third Semester Courses in
MSc
BIOTECHNOLOGY
(2024-2025)

Contents:

- **Syllabus for Core Courses:**
  - PSBTY6501CR1 Bioprocess Technology
  - PSBTY6502CR1 Pharmaceutical Biotechnology
  - PSBTY6503CR1 Biotechnology Enterprise
  - PSBTY6501RP1 Research Project

- Evaluation and Assessment guidelines

APPROVED SYLLABUS

PRINCIPAL
ST. XAVIER'S COLLEGE
AUTONOMOUS
MUMBAI - 400 001.

MSc II in BIOTECHNOLOGY		
Course Title: BIOPROCESS TECHNOLOGY	**Course Code:** PSBTY6501CR1	
Credits 4: Theory = 60 hrs		
No.	**Course Objectives**	
1.	The course aims at educating students about the strategies employed in process industries and its implementation into biological systems to produce valuable biotech-based metabolites.	
2.	The engineering concepts including cell growth kinetics, process design, and transport operation, downstream processing will be covered during the course.	
3.	Students will have a comprehensive understanding of bioprocess operations along with practical skills in applying these concepts to optimize microbial processes at an industrial scale.	
CO	**Course Outcomes** ***On completing the course, the learner will be able to***	**Bloom's Taxonomy Level (BT level)**
1.	Understand the microbial processes and parameters controlling them. Explore stoichiometry of microbial growth and product formation.	Remembering
2.	Comprehend the various industrial substrates, growth media, energy, and material balances, gas and mass transfer, and downstream processes . Understand the advantages and challenges associated with bioprocess.	Understanding
3.	Apply the acquired knowledge in designing and optimizing microbial processes across different operational modes.	Applying
4.	Analyze real-world case studies of industrial microbial processes. Gain insights into optimizing process parameters for enhanced microbial performance.	Analyzing
5.	Develop problem-solving abilities in the context of microbial growth, process optimization, substrate utilization, product formation and effluent treatment.	Evaluating, Creating

UNIT I		**PRINCIPLES OF BIOPROCESS TECHNOLOGY**	**(15)**
	1.	Industrial substrates and growth medium	
	2.	Energy and Material Balances - Introduction to material-balance calculations, stoichiometry of microbial growth and product formation, energy – balance calculations with and without reactions	
	3.	Kinetics of microbial growth, substrate utilization, and product formation: Batch, Fed-Batch and continuous processes	
	4.	Scale up concepts and its challenges	
	5.	Solid state fermentation	
	6.	Processes using recombinant organisms: hosts, vectors, genetic instability.	
UNIT II		**PROCESS DYNAMICS AND OPERATIONS**	**(15)**
	1.	Mass transfer: Review of basic concepts – Diffusivity, theory of diffusion, role of diffusion in bioprocessing, mass transfer coefficients, Theories of mass transfer, Convective mass transfer – Liquid-solid mass transfer, liquid-liquid mass transfer, gas liquid mass transfer.	
	2.	Oxygen transport to microbial cultures: Gas exchange; O_2 transfer, critical oxygen concentration, determining the oxygen uptake rate.	
	3.	Heat transfer: Sterilization –batch and continuous heat sterilization, filter sterilization of liquid media and air. Design of sterilization equipment. thermal death curve.	
UNIT III		**DOWNSTREAM PROCESSING**	**(15)**
	1.	Flocculation and floatation	
	2.	Filtration	
	3.	Centrifugation	
	4.	Cell disruption	
	5.	Liquid extraction	
	6.	Precipitation and Adsorption	
	7.	Dialysis and Reverse osmosis	
	8.	Chromatography	
	9.	Crystallization and drying	

UNIT IV		INDUSTRIAL APPLICATIONS	(15)
	1.	Microbial technology in food production: Role of microbial fermentation in food and beverages; food ingredients and additives prepared ; Bioconversion from food wastes to useful products; Food preservation via microbes	
	2.	Role of microbes in effluent treatment	
	3.	Biopolymers/micro-polymers	
	4.	Antibiotics	
	5.	Vitamins	
	6.	Amino acids and alcohols	
	7.	Immobilized cell systems	
	8.	Types and nature of waste generated from bioprocesses.	
	9.	Case studies	

Reference Books:

1. Alvarado-Morales, M., & Angelidaki, I. (2021). Valorization of municipal organic waste into purified lacticacid Bioresource Technology, 342, 125933. https://doi.org/10.1016/j.biortech.2021.125933
2. Baranwal, J., Barse, B., Fais, A., Delogu, G. L., & Kumar, A. (2022). Biopolymer: A Sustainable Material for Food and Medical Applications. Polymers, 14(5),983. https://doi.org/10.3390/polym14050983
3. Danial, A. W., Hamdy, S. M., Alrumman, S. A., Gad El-Rab, S. M. F., Shoreit, A. A. M., & Hesham, A. E.-L. (2021). Bioplastic Production by Bacillus wiedmannii AS-02 OK576278 Using Different Agricultural Wastes. Microorganisms, 9(11), 2395. https://doi.org/10.3390/microorganisms9112395
4. Glazer A.N. & Nikaido H. (1995) *Microbial Biotechnology: Fundamentals of Applied Microbiology*. W.H. Freeman & Company, New York.
5. López-Gómez, J., Pérez-Rivero, C., & Venus, J. (2020). Valorisation of solid biowastes: The lactic acid alternative. Process Biochemistry, 99,222–235. https://doi.org/10.1016/j.procbio.2020.08.029
6. Matkawala, F., Nighojkar, S., Kumar, A., & Nighojkar, A. (2021). Microbial alkaline serine proteases: Production, properties and applications. World Journal of Microbiology and Biotechnology, 37, 1-12.
7. Michael L. Shuler, Fikret Kargı (2008) *Bioprocess Engineering: basic concepts*. Prentice Hall Publishers. New York.
8. Nath, P. C., Ojha, A., Debnath, S., Sharma, M., Nayak, P. K., Sridhar, K., & Inbaraj, B. S. (2023). Valorization of Food Waste as Animal Feed: A Step towards Sustainable Food Waste

Management and Circular Bioeconomy. Animal, MDPI, 13(8), 1366. https://doi.org/10.3390/ani13081366

9. Pauline M. Doran, *Bioprocess Engineering Principles*. Academic Press, 1995.
10. Singhal, G., Bhagyawant, S. S., & Srivastava, N. (2020). Microbial enzymes in food industry: Types and applications. In Microbial Fermentation and Enzyme Technology (pp. 61-71). CRC Press.
11. Stanbury P.F., Whitaker A, Hall S.J. (2007) *Principles of Fermentation Technology*, Butterworth-Heinemann
12. Wulf Crueger and Anneliese Crueger (1990) Biotechnology: *A Textbook of Industrial Microbiology*. Panima Publishers. New Delhi

Evaluation (Core Theory): Total marks per course – 100.

- Formative Assessment 'for' Learning (continuous internal assessment - CIA to improve learning).

  CIA- 40 marks

  CIA 1: Written test -20 marks

  CIA 2: Assignment -20 marks

- Summative Assessment 'of' Learning (focus on outcomes, quantitative data for outcomes of instruction).

  End Semester Examination – 60 marks.

  One question from each unit for 15 marks, with internal choice. Total marks per question with choice -20 to 22.

Distribution of Bloom's Taxonomy Levels for the Course Assessment

Units	Remembering	Understanding	Analyzing And Application	Evaluation and Creation
*Percentage	10-20%	30-35%	30-40%	20-25%

MSc II BIOTECHNOLOGY		
Course Title: PHARMACEUTICAL BIOTECHNOLOGY **Course Code: PSBTY6502CR1**		
Credits 4 (Theory) 60 hours		
No.	**Course Objectives**	
1. 2. 3.	The course will provide an insight into the research and development carried out in discovery of biotechnology based therapeutic peptides and proteins. This course will give students a brief overview of formulation of biological compounds citing various examples and processes involved. The core of this course will encompass the journey of the biologic from bench to bedside.	
CO	**Course Outcomes** ***On completing the course, the learner will be able to***	**Bloom's Taxonomy Level (BT level)**
1	Demonstrate fundamental knowledge in the process of biologics drug discovery	Remembering, Understanding
2	Apply pharmacokinetic-pharmacodynamic (PKPD) principles to analyze the behavior of protein-based therapeutics in vivo	Applying
3	Understand and apply CADD methods in various stages of the drug discovery pipeline,	Understanding, Applying
4	Analyze case studies highlighting successful biopharmaceutical drug discovery and development efforts	Analyzing
5	Demonstrate knowledge and will be equipped with skills, and techniques necessary to formulate, analyze, and evaluate biotech-based products in preclinical settings, ensuring their safety, efficacy, and compliance with regulatory requirements.	Analyzing, Evaluating,
6	Evaluate safety and ethical considerations in drug development and contribute effectively to the discovery and development of novel therapeutic agents.	Evaluating and creating

APPROVED SYLLABUS

UNIT I		**Pharmacology aspects of Peptide and Protein therapeutics**	**(15)**
	1.	Introduction to Biopharmaceuticals, Differences between small molecule drugs, generics, Biologics and Biosimilars	
	2.	Basic characteristics of of therapeutic peptides and proteins : Temperature and stress sensitive, sensitive to pressure and solvent, aggregation behavior, degradation pattern, difference between degradation, aggregation and precipitation ,stability and characterisation	
	3.	Principles of pharmacokinetics and pharmacodynamics :	
	4.	Terminologies, Drug-receptor interactions, Drug transporters, Drug Enzyme interactions, Drug Metabolism	
	5.	PKPD of Protein based therapeutics.	
	6.	Immunogenicity of therapeutic proteins	
UNIT II		**Drug Discovery approaches (Practicals included)**	5L 10PR sessions
	1.	Introduction to drug discovery and development [Introduction, concept, history, drug development process outline, concept of ligand and target]	
	2.	Drug discovery approaches - Traditional screening and CADD.	
	3.	Ligands: [agonists, inhibitors, and allosteric modulators]	
	4.	Target: Classes of molecular target, Target identification	
	5.	Drug and drug databases ; Drug Properties	
	6.	Computer-Aided Drug Design in the Drug Discovery Pipeline [Structure based CADD, Ligand Based CADD]	
	7.	Case Studies	
UNIT III		**Formulation And Preclinical Aspects of Biotech Based Products**	**(15)**
	1.	Microbiological considerations- Sterility, Decontamination Pyrogen removal·	
	2.	Excipients and additives Role of excipients and additives on stabilizing biologicals; Pharmacopoeia approved excipients, additives and stabilizers, anti-aggregation agents, buffer components etc	
	3.	Formulation and delivery systems: Characteristics of liquid, powder formulation, particulate formulation for biologicals, liposomal	

		formulation and solid lipid nanoparticle formulation. Different nano carrier-based formulation; Examples of biological formulation: Insulin formulation, formulation of monoclonal antibodies, vaccines in pharmacotherapy	
	4.	Product Analysis- Protein-based contaminants • Removal of altered forms of the protein of interest from the product stream • Detection of protein-based product impurities • Immunological approaches to detection of contaminants • Endotoxin and other pyrogenic contaminants • Microbial and viral contaminants • Miscellaneous contaminants	
	5.	Preclinical *Invitro -Invivo* testing methods. *Invitro* Cytotoxicity, Genotoxicity Regulatory Toxicology (including ICH guidelines): Acute vs Chronic studies (selection of species, duration and evaluation) Safety Pharmacology- Mutagenicity and Carcinogenicity studies, Reproductive and Developmental Toxicology studies, Mechanistic Toxicology (including biomarkers) New trends in preclinical evaluation- NAMs- 3D cultures, organ on a chip models.	
UNIT IV		**Regulations and ethical concerns in Drug Development (Biologics)**	**(15)**
	1.	Biosafety- Primary containment for biohazards; biosafety levels; GRAS organisms, biosafety levels of specific microorganisms; recommended biosafety levels for infectious agents ,definition of GMOs, LMOs	
	2.	Framework for Regulations in Recombinant DNA technology usage : Convention on Biological Diversity, Cartagena Protocol on Biosafety, WTO Agreements, Codex Alimentarius, Role of IBSC, RCGM, GEAC, and others, National Biotechnology Regulatory Bill 2013, The DNA Technology (Use and Application) Regulation Bill – 2019, Recombinant DNA Research and Biocontainment guidelines-2017	
	3.	Risk assessment- risk characterization and development of analysis plan (management and communication including GMP, GLP, and HACCP)	
	4.	Clinical Trials and regulatory framework:	

		Good clinical practice guidelines, Clinical Trial Phases: Objectives of Phase I, II, III and IV clinical studies , Pharmacovigilance- Adverse reactions monitoring and reporting. Regulatory requirements: FDA, EMA, CDSCO Ethical aspects - patient confidentiality, informed consent, Human and animal experimentation, animal rights/welfare, sharing benefits and protecting future generations.	

Reference Books:

1. *Biologicals*. (n.d.). CDSCO. https://cdsco.gov.in/opencms/opencms/en/biologicals/
2. Brody, T. (2016). *Clinical trials: Study design, endpoints and biomarkers, drug safety, and FDA and ICH guidelines*. Academic Press.
3. *CFR - Code of federal regulations title 21*. (2023, December 22). https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/cfrsearch.cfm?cfrpart=600
4. Crommelin, D. J., & Sindelar, R. D. (2002). *Pharmaceutical biotechnology: Fundamentals and applications* (2nd ed.). CRC Press.
5. *Good manufacturing practices*. (n.d.). World Health Organization (WHO). https://www.who.int/teams/health-product-policy-and-standards/standards-and-specifications/gmp
6. *Guidance, compliance & regulatory information (Biologics)*. (2022, December 14). U.S. Food and Drug Administration. https://www.fda.gov/vaccines-blood-biologics/guidance-compliance-regulatory-information-biologics
7. *ICH official web site : ICH*. (n.d.). ICH Official web site : ICH. https://www.ich.org/page/ich-guidelines
8. Jacobsen, T., & Wertheimer, A. (2016). *Modern pharmaceutical industry*. Kendall/Hunt Publishing Company.
9. Kayser, O., & Müller, R. H. (2006). *Pharmaceutical biotechnology: Drug discovery and clinical applications*. John Wiley & Sons.
10. Laurence L. Brunton, Björn C. Knollmann. (2001). *Goodman & Gilman's: The Pharmacological Basis of Therapeutics,* (14th ed.). Tata McGraw Hill.
11. Nally, J. D. (2016). *Good manufacturing practices for pharmaceuticals*. CRC Press.
12. Schüklenk, U., & Singer, P. (2021). *Bioethics: An anthology*. John Wiley & Sons.
13. Stromgaard, K., Krogsgaard-Larsen, P., & Madsen, U. (2016). *Textbook of drug design and discovery* (5th ed.). CRC Press.
14. Walsh, G. (2013). *Biopharmaceuticals: Biochemistry and biotechnology*. John Wiley & Sons.
15. Walsh, G. (2013). *Pharmaceutical biotechnology: Concepts and applications*. John Wiley & Sons.

Evaluation (Theory, PSBTY6502CR1): Total marks per course – 100

- Formative Assessment 'for' Learning
  (continuous internal assessment - CIA to improve learning).

CIA - 40 marks

CIA 1: Written test - 20 marks.

CIA 2: Test / Assignment / Presentations / Infographics / Quiz / as prescribed - 20 marks.

- Summative Assessment 'of' Learning
  (focus on outcomes, quantitative data for outcomes of instruction)

End Semester Examination - 60 marks

One question from each unit for 15 marks, with internal choice. Total marks per question with choice -20 to 22.

Distribution of Bloom's Taxonomy levels for the course assessment

Learning Levels	Remembering	Understanding	Analyzing and Application	Evaluation	Creation
*Percentage	10-15%	25-35%	20-25%	15-20%	10-15%

MSc II BIOTECHNOLOGY		
Course Title: BIOTECHNOLOGY ENTERPRISE **Course Code: PSBTY6503CR1**		
Credits 4: Theory= 60 hrs		
No.	**Course Objectives**	
1.	The course is formulated to foster a deeper understanding of the complex interactions between biotechnology, ecosystems, and human society in shaping environmental sustainability.	
2.	The course will offer an overview of the fundamentals of patent law, exploring its regional and global regulations, specifically focusing on their application in safeguarding biotechnological inventions.	
3.	The course will elaborate on the strategic considerations involved in biotechnology entrepreneurship	
CO	**Course Outcomes** ***On completing the course, the learner will be able to***	**Bloom's Taxonomy Level (BT level)**
1.	Analyze the role of biotechnological tools such as genetic engineering, bioremediation, and biofuels in mitigating environmental degradation.	Analysing ,Applying
2.	Apply principles of intellectual property law to facilitate the commercialization of biotechnology research and product generation.	Applying
3.	Employ the fundamental aspects of entrepreneurship to write and review a business plan	Creating

UNIT I		**Biotechnology and Environmentally Sustainable Development**	**(15)**
	1.	Definition and concepts of sustainable development, Integration of: a. Economic, Social and Environmental sustainability	
	2.	Environmental sustainability and role of biotechnology	
	3.	Carbon sequestration, Carbon footprint and credits	

	4.	Biomass management and value added products	
	5.	Sustainability in agriculture: Bio-pesticides, Bio-fertilizers	
	6.	Energy and Environment: Bioenergy	
	7.	IOT for water and air quality monitoring	
	8.	Case studies	
UNIT II		**Basic Concepts of IPR**	**(15)**
	1.	Basics of IPR, Types of IPR, Biotechnology and the law: objective, evolution, Commercial potential of biotech inventions, rational for IPR protection, Permissible and non-permissible Biotechnology patenting in India, Indian Patent Act 1970	
	2.	Patenting biotech inventions: objectives, concepts of novelty and concepts of inventive step, microorganisms, and moral issues in patenting biotech inventions	
	3.	Patenting issues related to Biosimilars	
	4.	Protection of geographical indications: objectives, justification, international position, multilateral treaties, national level	
	5.	Protection of traditional knowledge: objective, the concept of traditional knowledge,sui generis regime, bio-prospecting and bio-piracy,protectability,traditional knowledge on the international arena, traditional knowledge at WTO, traditional knowledge at the national level, traditional knowledge digital library	
	6.	Plant varieties protection: objectives, justification, criteria for protection, international position, plant varieties protection in India, plant varieties protection under TRIPs	
	7.	Case studies	
UNIT III		**Patent Search & Analysis**	**(15)**
	1.	Patent Treaty: WIPO Treaties; Budapest Treaty; Patent Cooperation Treaty (PCT) and implications; procedure for filing a PCT application;	

		role of a Country Patent Office; filing of a patent application; precautions before patenting-disclosure/non-disclosure-patent application- forms and guidelines including those of National Bio-diversity Authority (NBA) and other regulatory bodies, fee structure, time frames; types of patent applications: provisional and complete specifications; PCT and conventional patent applications; international patenting-requirement, procedures and costs; financial assistance for patenting.	
	2.	Introduction to existing schemes; publication of patents-gazette of India, status in Europe and US; patent infringement- meaning, scope, litigation, case studies and examples; commercialization of patented innovations; licensing – outright sale, licensing, royalty;	
	3.	Patenting by research students and scientists-university/organizational rules in India and abroad, collaborative research - backward and forward IP; benefit/credit sharing among parties/community, commercial (financial) and non-commercial incentives	
	4.	Patent reviews and Case studies	
	5.	Patent databases - country-wise patent searches (USPTO, EPO, India)	
UNIT IV		**Principles of Entrepreneurship and Business plan**	**(15)**
A		Entrepreneurship	
	1	Definition, characteristics, qualities and functions of entrepreneurs; Entrepreneurial, entrepreneurial motivation; Entrepreneurship Theories	
	2	Entrepreneurship types: Social entrepreneurship and Technology entrepreneurship, Family business; Startup landscape and innovation hubs; Entrepreneurship: Role in economic development. Entrepreneurial climate in India; Financial support - funding and policy support, Start-up India Programme [BIRAC/BIG, Business Incubation and other schemes] Case studies on biotech start ups	
B		Business Plan	

	3	Business concept: Idea selection, brainstorming, project planning, conceptualization and feasibility report, Idea generation and Product planning, process design, IP generation, Project cost estimate, project profits	
	4	Sources of Finance: Venture capital, angel investment, crowdfunding. Mechanics of setting up new enterprises –forms of business organization.	

Reference Books:

1. David Pressman (2016) *Patent It Yourself* 18th edition, Nolo Publishers
2. Jördening, H. J., & Winter, J. (Eds.). (2005). *Environmental biotechnology: concepts and applications.*
3. Maarten Bode, (2008) *Taking traditional knowledge to the market*, Orient Longman Publishers
4. Matei, F., & Zirra, D. (Eds.). (2019). *Introduction to Biotech Entrepreneurship: From Idea to Business: A European Perspective.* Springer International Publishing.
5. Prabudha Ganguly, (2001) Intellectual Property rights- unleashing the knowledge economy, Tata McGraw Hill Publishing Company Ltd.
6. Ratledge, C., & Kristiansen, B. (Eds.). (2006). Basic biotechnology. Cambridge University Press.
7. Rosillo-Calle, F., & Woods, J. (2012). The biomass assessment handbook (Vol. 4). Taylor & Francis.
8. Sharma, N., Sodhi, S., & Abhinashi, B. (2022). Basic concepts in environmental biotechnology.
9. Shimasaki, C. (Ed.). (2020). Biotechnology Entrepreneurship: Leading, Managing and Commercializing Innovative Technologies. Academic Press.
10. Sudeep Chaudhuri (2005), the WTO and India's Pharmaceutical industry, Oxford University Press.
11. Vandana Shiva (2002), Protect or Plunder? Understanding Intellectual Property Rights, Zed Books.
12. Wang, L. K., Ivanov, V., Tay, J. H., & Hung, Y. T. (Eds.). (2010). Environmental biotechnology (Vol. 10). Springer Science & Business Media.

Research articles:

1. Bobulski, J., Szymoniak, S., & Pasternak, K. (2024). An IoT System for Air Pollution Monitoring with Safe Data Transmission. Sensors, 24(2), 445.
2. Fenibo, E. O., Ijoma, G. N., & Matambo, T. (2021). Biopesticides in sustainable agriculture: A critical sustainable development driver governed by green chemistry principles. Frontiers in Sustainable Food Systems, 5, 619058.
3. Ganesan, R., Manigandan, S., Samuel, M. S., Shanmuganathan, R., Brindhadevi, K., Chi, N. T. L., & Pugazhendhi, A. (2020). A review on prospective production of biofuel from microalgae. Biotechnology Reports, 27, e00509.
4. Hughes, J. (2013). Bowman v. Monsanto Company. Public Land & Resources Law. Review, (4), 1-2.(https://core.ac.uk/download/pdf/232675921.pdf)
5. Knox, R., & Curfman, G. (2022). The Humira patent thicket, the Noerr-Pennington doctrine and antitrust's patent problem. Nature biotechnology, 40(12), 1761–1763. (https://doi.org/10.1038/s41587-022-01583)
6. Kumar J, Ramlal A, Mallick D, Mishra V. An Overview of Some Biopesticides and Their Importance in Plant Protection for Commercial Acceptance. Plants (Basel). 2021 Jun 10;10(6):1185.
7. Ledford, H. (2021). Inside the lawsuit that ended US gene patenting Nature,598(7882),561–562.(https://doi.org/10.1038/d41586-021-02905-9)
8. McLaughlin, H., Littlefield, A. A., Menefee, M., Kinzer, A., Hull, T., Sovacool, B. K., ... & Griffiths, S. (2023). Carbon capture utilization and storage in review: Sociotechnical implications for a carbon reliant world. Renewable and Sustainable Energy Reviews, 177, 113215.
9. Miller M, Kisiel A, Cembrowska-Lech D, Durlik I, Miller T. IoT in Water Quality Monitoring-Are We Really Here? Sensors (Basel). 2023 Jan 14;23(2):960.
10. Nayak, N., Mehrotra, R., & Mehrotra, S. (2022). Carbon biosequestration strategies: A review. Carbon Capture Science & Technology, 4, 100065.
11. Patent docs:Barry V. Medtronic, inc. (Fed. Cir. 2019). (n.d.).(https://www.patentdocs.org/.m/2019/01/barry-v-medtronic-inc-fed-cir-2019.html)

12. Patents for medical and surgical methods and diagnostics: Gestalt law. GESTALT. (n.d.). (https://www.gestalt.law/insights/patents-for-medical-and-surgical-methods-and-diagnostics)

13. Simmons, W. J. (2013). Bowman v. Monsanto and the protection of patented replicative biologic technologies. Nature Biotechnology, 31(7), 602-606.

Evaluation (Theory, PSBTY6503CR1): Total marks per course – 100

- Formative Assessment 'for' Learning

  CIA - 40 marks

  CIA 1: Written test - 20 marks.

CIA 2: Test / Assignment / Presentations / Quiz / as prescribed - 20 marks.

- Summative Assessment 'of' Learning

  End Semester Examination - 60 marks

One question from each unit for 15 marks, with internal choice.
Total marks per question with choice 20 - 22 marks.

Distribution of Bloom's Taxonomy Levels for the Course Assessment

Units	Remembering	Understanding	Analyzing And Application	Evaluation and Creation
*Percentage	NA	45-50%	30-40%	20-25%

MSc II in BIOTECHNOLOGY		
Course Title:	**RESEARCH PROJECT**	**Course Code: PSBTY6501RP1**
Credits: 6	**Practical Course**	
	Course Objectives	
	• The focus of the course is on research, research planning, and research reporting. • Learners will be encouraged to undertake independent research that makes an original contribution to knowledge. • Plan and manage a complex project within strict time constraints. • Comply with relevant ethical, safety, and documentation processes as appropriate for the project.	
CO	**Course Outcomes** ***On completing the course, the learner will be able to***	**Bloom's Taxonomy Level (BT level)**
1	Demonstrate an ability to plan a research project, and author a research proposal	Applying
2	Demonstrate adequate knowledge in the subject of their research project, through an integrated literature review, application of research methods appropriate to generate reliable data for their research questions	Applying, and analyzing
3	Show proficiency in managing time effectively and utilizing expertise both independently and within a team setting.	Applying
4	Exhibit the capacity to gather research findings, analyze and integrate them with existing literature, and present them in a globally recognized format that is clear, concise, and impartial.	Analyzing, Evaluating, and creating
5	Display the capability to reflect on the strengths and weaknesses of their research and methodology, offering constructive feedback on how to enhance future endeavors.	Evaluating and analyzing

Content			12 -16 hours/week
		Each student will work as a part of one group project covering the aspects of core concepts of Microbiology, Molecular biology, Environment Biotechnology, Bioinformatics and Animal Cell technology, supervised by the faculty member for a period of three months in the department. The research work will be divided into evaluative phases. Phase 1- Ideation, Literature Review and Proposal writing Phase 2- Research work, Data generation and analysis Phase 3- Report writing	

Evaluation (Practical- Research Project, PSBTY6501RP1):
Total marks– 300

Formative Assessment 'for' Learning

- CIA-120 marks
  - Phase 1 submission and presentation – 40
  - Phase 2 -Continuous assessment of work done –80

Summative Assessment 'of' Learning

- End Semester Examination – 180 marks.
  - Report Submission and Presentation- 140 marks.
  - *Viva Voce*- 40 marks.

Distribution of Bloom's Taxonomy Levels for the Course Assessment

Units	Remembering	Understanding	Analyzing And Application	Evaluation and Creation
*Percentage	NA	35-40%	30-40%	20-25%