# DEPARTMENT OF BIOTECHNOLOGY

## UNIVERSITY OF KASHMIR

## (NAAC Accredited Grade A+)

# PROGRAM OUTCOMES

# PROGRAM SPECIFIC OUTCOMES

# COURSE OUTCOMES

**FOR**

**M.Sc. IN BIOTECHNOLOGY**

**SPONSORED BY DEPARTMENT OF BIOTECHNOLOGY (DBT), MINISTRY OF SCIENCE AND TCHNOLOGY, GOVERNMENT OF INDIA**

**(EFFECTIVE FROM, 2023)**

# PROGRAM OUTCOMES (POs)

The objective of the M.Sc Biotechnology program offered by the department of Biotechnology, University of Kashmir is to utilize the academic expertise and research training of its faculty members in providing the platform for imparting highest level of knowledge in the field of biotechnology to the post graduate students. The curriculum structure is designed in a manner so as to provide in first semester the basic knowledge about the cellular, molecular, immunological and metabolic aspects of the living cells. In the subsequent semester two and three, the courses offered orients the students towards the biotechnology specialization, like genetic engineering, plant biotechnology and Bioprocess engineering and fermentation technology. The aim of these courses is to abreast students with latest concepts in the field of biotechnology. The 4th semester research-training objective is to provide research orientation to students. After the completion of the program, a graduate will be able to demonstrate understanding in the following areas.

**PO1:** Understanding of basic and advanced concepts pertaining to the curriculum.

**PO2:** Integrate principles of biotechnology to solve real-world problems in healthcare, agriculture, and environmental management.

**PO3:** Design and execute research projects, employing advanced techniques (e.g., genetic engineering, cell culture, bioprocess engineering) to foster innovation and contribute to scientific literature

**PO4:** Learn and uphold bioethical standards/norms, and sustainable practices in all biotechnological endeavors, ensuring responsible conduct in research and professional practice.

**PO5:** Effectively communicate scientific findings and collaborate within interdisciplinary teams, contributing to community outreach and societal development.

## PROGRAM SPECIFIC OUTCOMES (PSOs)

After the completion of the program, a graduate will be able to obtain specialized skills and knowledge unique to the M.Sc. Biotechnology program

**PSO1:** Acquire expertise in molecular biology techniques and laboratory practices essential for genetic manipulation and analysis such as cellular techniques, including recombinant DNA technology, PCR, cell culture, and bioprocess engineering.

**PSO2:** Develop the capability to design, execute, and critically evaluate research projects, including a six month research project culminating in a dissertation, journal club discussion, and presentation.

**PSO3:** Integrate interdisciplinary knowledge—including bioinformatics, bioprocess engineering, and immunology—to solve complex biotechnological problems.

**PSO4:** Understand and critically evaluate the ethical and societal implications of biotechnological innovations, ensuring responsible and sustainable practice.

**PSO5:** Foster a culture of continuous professional development through reflective practices and engagement with emerging scientific trends.

## COURSE OUTCOMES (COs)

### BT23101CR – Cell Biology (4 Credits)

**CO1:** Describe and differentiate the structural organization of prokaryotic and eukaryotic cells including organelle function and cytoskeletal architecture.

**CO2:** Analyze cellular communication processes such as signal transduction pathways and their role in regulating cell cycle and apoptosis.

**CO3:** Evaluate experimental data on cell morphology and function to explain physiological and pathological states.

**CO4:** Demonstrate proficiency in laboratory techniques related to cell biology, including microscopic analysis and data interpretation.

## BT23102CR – Molecular Biology-I (4 Credits)

**CO1:** Explain the chemical structure, properties, and biological significance of DNA, RNA, and proteins in cellular processes. Compare and contrast various DNA replication mechanisms (semi-conservative, conservative, dispersive) in prokaryotes and eukaryotes.

**CO2:** Identify and explain the roles of key enzymes involved in DNA replication, repair, and proofreading.

**CO3:** Understand and apply knowledge about transcription in Prokaryotes.

**CO4:** Understand and apply knowledge about transcription in Eukaryotes.

## BT23103CR – Immune Biology (4 Credits)

**CO1:** Describe the structural and functional components of the innate and adaptive immune systems.

**CO2:** Analyze the mechanisms of antigen recognition, presentation, and the activation of T- and B-cell mediated responses.

**CO3:** Evaluate the roles of cytokines and other signaling molecules in modulating immune responses, with reference to vaccine development.

**CO4:** Demonstrate the use of immunological assays in laboratory settings to assess immune function and response.

## BT23104CR – Biomolecules (2 Credits)

**CO1:** Describe the structure, physical, and chemical properties of proteins, nucleic acids, carbohydrates, and lipids.

**CO2:** Analyze the intermolecular forces and biochemical interactions that determine biomolecular stability and function.

**CO3:** Apply the principles of biomolecular chemistry to explain the basis of cellular metabolism and signaling.

## BT23101DCE – Biotechniques (3 Credits)

**CO1:** Explain the principles behind key biotechnological techniques such as electrophoresis, chromatography, and centrifugation.

**CO2:** Demonstrate the practical execution of techniques like SDS-PAGE, blotting (Southern, Northern, Western), and spectrophotometry.

**CO3:** Analyze and troubleshoot experimental results obtained from these techniques, linking theory with practical applications.

## BT23102DCE – Biostatistics (2 Credits)

**CO1:** Describe basic statistical concepts and their relevance to biological data analysis.

**CO2:** Apply statistical tests (e.g., t-test, ANOVA, confidence intervals) to analyze experimental data and draw meaningful inferences. Interpret graphical data representations (histograms, box plots, scatter diagrams) and evaluate their statistical significance.

## BT23103DCE – Laboratory Course-I (3 Credits)

**CO1:** Demonstrate competency in fundamental laboratory practices including solution preparation, titration, and buffer systems.

**CO2:** Perform experiments related to protein estimation, electrophoretic separation, and quantitative analysis of biomolecules.

**CO3:** Analyze and interpret laboratory data, troubleshooting experimental challenges effectively.

**CO4:** Document and communicate experimental protocols and results through well-organized lab reports.

## BT23001GE – Biochemical Techniques (2 Credits, Generic Elective)

**CO1:** Describe the theoretical basis and instrumentation involved in advanced biochemical analytical techniques.

**CO2:** Apply modern biochemical methods for qualitative and quantitative analysis in research settings.

**CO3:** Critically evaluate the strengths and limitations of different analytical techniques in various applications.

## BT23001OE – Introduction to Cancer Biology (2 Credits, Open Elective)

**CO1:** Explain the fundamental concepts of cancer biology, including cell cycle dysregulation, oncogenes, and tumor suppressor mechanisms.

**CO2:** Analyze the molecular and environmental factors contributing to cancer initiation and progression.

**CO3:** Evaluate current diagnostic and therapeutic strategies used in cancer management, including immunotherapeutic approaches.

## BT23201CR – Animal Cell Science and Technology (4 Credits)

**CO1:** Describe the structure, function, and in vitro culture techniques for animal cells, including primary and established cell lines.

**CO2:** Demonstrate the skills required to set up, maintain, and monitor cell culture systems while managing contamination.

**CO3:** Analyze experimental data from cell culture studies to evaluate cell viability, transformation, and response to treatments.

**CO4:** Assess the applications of animal cell technologies in research, drug development, and therapeutic innovations.

## BT23202CR – Molecular Biology-II (4 Credits)

**CO1:** Explain advanced concepts in gene regulation including enhancer-promoter interactions, transcription factors, and epigenetic modifications.

**CO2:** Analyze the structural organization of chromatin and the significance of histone modifications in gene expression.

**CO3:** Understand advanced molecular techniques such as Real-Time PCR and RNA splicing analysis for gene expression studies.

**CO4:** Critically evaluate recent research developments in translation of RNA into proteins and their implications for biotechnology.

## BT23203CR – Advanced Enzymology (4 Credits)

**CO1:** Describe enzyme kinetics, including the derivation and application of the Michaelis-Menten equation.

**CO2:** Analyze the mechanisms of enzyme inhibition and regulation, and their effects on metabolic pathways.

**CO3:** Design and perform enzyme assays to determine kinetic parameters (Km, Vmax) and assess catalytic efficiency.

**CO4:** Evaluate industrial and clinical applications of enzymes and propose improvements based on kinetic data.

## BT23204CR – Environmental Biotechnology (2 Credits)

**CO1:** Explain the principles of bioremediation, biosensors, and the use of microorganisms in environmental cleanup.

**CO2:** Analyze different biotechnological strategies for the monitoring and remediation of environmental pollutants.

**CO3:** Evaluate case studies and propose biotechnological interventions for sustainable environmental management.

## BT23201DCE – Microbiology (2 Credits)

**CO1:** Describe bacterial cell structure, growth, and metabolic characteristics, including differences between Gram-positive and Gram-negative bacteria.

**CO2:** Analyze microbial pathogenicity, toxin mechanisms, and the basis of antibiotic resistance.

**CO3:** Demonstrate proficiency in standard microbiological techniques such as staining, culturing, and biochemical identification.

**CO4:** Evaluate the roles of bacteriophages and gene transfer processes in microbial genetics and evolution.

## BT23202DCE – Intermediary Metabolism (3 Credits)

**CO1:** Explain the metabolic pathways involved in carbohydrate, protein, nucleotide, and fatty acid metabolism.

**CO2:** Analyze the regulation of these metabolic pathways, emphasizing hormonal and allosteric controls.

**CO3:** Evaluate the impact of metabolic disorders by correlating alterations in metabolic pathways with disease states.

**CO4:** Apply metabolic knowledge to design experiments and interpret data in clinical and research settings.

## BT23203DCE – Laboratory Course-II (3 Credits)

**CO1:** Demonstrate practical skills in molecular biology techniques such as DNA/RNA isolation, SDS-PAGE, and Western blotting.

**CO2:** Perform enzyme assays and cell culture experiments accurately, following established protocols.

**CO3:** Analyze experimental data to evaluate outcomes and troubleshoot methodological issues.

**CO4:** Maintain rigorous documentation of experimental procedures and results in lab reports and presentations.

## BT23002GE – Redox Biology (2 Credits, Generic Elective)

**CO1:** Describe the biochemical pathways leading to the formation of reactive oxygen species (ROS) and the cellular defense mechanisms against oxidative stress.

**CO2:** Analyze the roles of enzymatic and non-enzymatic antioxidants in maintaining redox balance.

**CO3:** Evaluate the physiological and pathological implications of oxidative stress in aging and disease.

**CO4:** Apply redox biology principles in designing experiments and interpreting oxidative stress data.

## BT23002OE – Nutritional Biotechnology (2 Credits, Open Elective)

**CO1:** Explain the nutritional requirements and metabolic roles of macronutrients and micronutrients in human health.

**CO2:** Analyze the impact of dietary components on metabolic disorders and overall well-being.

**CO3:** Evaluate biotechnological interventions in food production and nutritional enhancement..

## BT23301CR – Genetic Engineering (4 Credits)

**CO1:** Describe the principles of recombinant DNA technology including restriction enzymes, ligases, and vector design.

**CO2:** Analyze different cloning strategies and genetic manipulation techniques in prokaryotic and eukaryotic systems.

**CO3:** Demonstrate the application of PCR, site-directed mutagenesis, and gene expression analysis in genetic engineering experiments.

**CO4:** Evaluate ethical, legal, and societal issues related to genetic engineering and propose responsible practices.

## BT23302CR – Plant Biotechnology (4 Credits)

**CO1:** Explain the concepts of plant totipotency, tissue culture, and micropropagation, and their applications in plant improvement.

**CO2:** Analyze the mechanisms of plant transformation, including Agrobacterium-mediated and biolistic methods.

**CO3:** Evaluate the production and characterization of genetically modified plants for improved agronomic traits such as disease resistance and stress tolerance.

**CO4:** Apply molecular techniques to assess genetic modifications and interpret phenotypic outcomes in plants.

## BT23303CR – Bioprocess Engineering and Fermentation Technology (4 Credits)

**CO1:** Describe the fundamental principles of bioprocess engineering, including fermentation kinetics and reactor design.

**CO2:** Analyze the critical parameters that affect microbial and cell culture fermentations, linking theory to process optimization.

**CO3:** Demonstrate the ability to design, operate, and monitor bioreactors in a laboratory setting.

**CO4:** Evaluate industrial fermentation processes and propose strategies for improving efficiency and sustainability.

## BT23304CR – Human Genetics (2 Credits)

**CO1:** Explain the basic principles of human genetics, including gene structure, function, and inheritance patterns.

**CO2:** Analyze the genetic basis of common human diseases and the role of genetic variations in disease manifestation.

**CO3:** Evaluate modern genetic diagnostic techniques and their applications in personalized medicine.

## BT23301DCE – Bioethics, Biosafety and Intellectual Property Rights (2 Credits)

**CO1:** Describe the ethical principles governing biotechnology research and clinical applications.

**CO2:** Analyze biosafety protocols and risk management strategies in handling genetically modified organisms and biotechnological materials.

**CO3:** Evaluate the framework of intellectual property rights and their significance in protecting biotechnological innovations.

## BT23302DCE – Systems and Computational Biology (2 Credits)

**CO1:** Explain the principles of systems biology and the importance of modeling biological networks.

**CO2:** Analyze computational tools and bioinformatics methods for processing and interpreting large-scale biological data.

**CO3:** Apply systems biology approaches to integrate data from genomics, proteomics, and metabolomics studies in research projects.

## BT23303DCE – Laboratory Course-III (3 Credits)

**CO1:** Demonstrate proficiency in advanced laboratory techniques pertinent to genetic engineering, plant biotechnology, and bioprocessing.

**CO2:** Perform experiments involving gene cloning, transformation, and expression analysis in microbial and plant systems.

**CO3:** Analyze and troubleshoot experimental protocols, ensuring high-quality data collection and interpretation.

**CO4:** Document laboratory procedures and findings comprehensively for publication and academic presentations.

## BT23003GE – Molecular Mechanism of Plant Life (2 Credits, Generic Elective)

**CO1:** Describe the molecular basis of key physiological processes in plants including photosynthesis, hormone signaling, and stress responses.

**CO2:** Analyze how genetic and environmental factors interact to regulate plant development and adaptation.

**CO3:** Evaluate current research on molecular mechanisms in plants and propose biotechnological solutions to improve plant productivity.

## BT23004GE – Cancer Immunology (2 Credits, Generic Elective)

**CO1:** Explain the mechanisms of tumor immunosurveillance and immune evasion by cancer cells.

**CO2:** Analyze the role of immune cells, cytokines, and checkpoint inhibitors in the context of cancer therapy.

**CO3:** Evaluate recent advances in immunotherapy and propose innovative strategies for cancer treatment based on immunological principles.

## BT23401CR – Proposal Writing (1 Credit, Core)

**CO1:** Develop a clear and concise research proposal that identifies a significant problem in biotechnology and outlines a feasible experimental approach.

**CO2:** Demonstrate the ability to critically review relevant literature and formulate testable hypotheses.

**CO3:** Present the research proposal in a structured format adhering to academic and funding agency standards.

## BT23402CR – Research Based Project (14 Credits, Core)

**CO1:** Design and execute a comprehensive research project that addresses a specific biotechnological challenge, integrating theoretical and practical skills.

**CO2:** Demonstrate proficiency in experimental techniques, data collection, and statistical analysis relevant to the research problem.

**CO3:** Critically interpret research findings, draw evidence-based conclusions, and identify avenues for future investigation.

**CO4:** Prepare a detailed dissertation that documents the research process, results, and implications in a scholarly format

## BT23403CR – Seminar and Journal Club (2 Credits, Core)

**CO1:** Critically review and present recent scientific literature to highlight trends and advances in biotechnology.

**CO2:** Engage in peer discussions and debates to enhance understanding and critical analysis of research findings.

**CO3:** Demonstrate effective oral communication skills in presenting complex scientific concepts to a diverse audience.

## BT23404CR – Project Presentation (3 Credits, Core)

**CO1:** Develop and deliver a structured oral presentation that summarizes research objectives, methodology, results, and conclusions.

**CO2:** Utilize visual aids and presentation tools effectively to communicate complex data clearly.

**CO3:** Respond confidently to questions, demonstrating thorough understanding of the research project and its broader impact.

## BT23405CR – Project Viva (2 Credits, Core)

**CO1:** Defend the research project in an oral examination by articulating the methodology, data analysis, and conclusions clearly.

**CO2:** Critically evaluate and justify research decisions in response to examiner questions and feedback.

**CO3:** Exhibit professional communication and critical thinking skills in a high-stakes academic setting.

## BT23005GE – Basic Recombinant DNA Technology (2 Credits, Generic Elective)

**CO1:** Describe the principles and applications of recombinant DNA technology, including cloning, expression, and vector design.

**CO2:** Demonstrate practical laboratory skills in performing restriction digestion, ligation, and transformation.

**CO3:** Analyze experimental outcomes to assess the efficiency and reliability of recombinant DNA techniques.

## BT23003OE – Bioethics (2 Credits, Open Elective)

**CO1:** Explain the fundamental principles of bioethics and their relevance to biotechnology research and clinical practice.

**CO2:** Analyze ethical dilemmas and biosafety issues associated with emerging biotechnological innovations.

**CO3:** Evaluate existing regulatory frameworks and propose guidelines to ensure ethical conduct and sustainable practices in biotechnology.