Shri Shivaji Education Society Amravati's

SCIENCE COLLEGE

Congress Nagar, Nagpur

Accredited with CGPA of 3.51 at 'A+' Grade by NAAC Bangalore
A college with Potential for Excellence

An Institutional Member of APQN Recognized
Centre for Higher Learning &Research
A Mentor College under "Paramarsh Scheme" of UGC, New Delhi
A Mentor College under Paris Sparsh Scheme of Maharashtra State
An ISO 21001:2018 Certified Institution
National Institute Ranking Framework (NIRF) Rank-band: 201-300

DEPARTMENT OF MICROBIOLOGY

PO, CO, PSO

Learning Outcome-Based Curriculum Framework in B.Sc. Microbiology

In the ever-evolving field of microbiology, where scientific advancements and technological innovations are continually shaping the landscape, a robust and dynamic educational framework is essential for preparing future professionals and researchers. The Learning Outcome-Based Curriculum Framework for the BSc (Hons/Res) in Microbiology is designed to address this need by providing a structured, outcome-oriented approach to education.

The Learning Outcome-Based Curriculum Framework for the BSc (Hons/Res) in Microbiology represents a commitment to excellence in education. By focusing on measurable outcomes and aligning educational objectives with industry needs, this framework aims to produce highly skilled and knowledgeable graduates who are well-prepared to make meaningful contributions to the field of microbiology and related disciplines.

Learning Outcomes

The curriculum is designed with specific learning outcomes in mind, which are intended to:

- **Enhance Knowledge:** Provide a comprehensive understanding of microbiological principles and applications.
- **Develop Skills:** Foster practical skills in laboratory techniques, data analysis, and research methodologies.
- **Promote Critical Thinking:** Encourage analytical thinking and problem-solving abilities in microbiological contexts.
- **Facilitate Communication:** Improve students' ability to effectively communicate scientific findings and ideas.
- **Prepare for Careers:** Equip students with the competencies required for successful careers in various sectors related to microbiology.

Nature and Extent: The B.Sc. (Hons/Res) Microbiology programme covers a wide range of basic and applied courses as well as courses of interdisciplinary nature.

Aims of the Programme: The core courses offered in the programme aim to build a strong conceptual microbiological knowledge base in the student, the contents of electives and skill enhancement courses help them explore their fitness and suitability to pursue studies in these areas.

Program Specific Outcomes (PSOs) in B.Sc. (Hons/Res) Microbiology

The Program Specific Outcomes (PSOs) serve as a benchmark for both teaching and assessment within the B.Sc. (Hons/Res) in Microbiology curriculum. They provide a clear framework for what students should be able to achieve by the end of their studies, guiding educators in designing effective teaching strategies and evaluating student progress. For students, PSOs offer a concrete understanding of the expectations and goals of their program, helping them focus their learning efforts and career planning.

These outcomes are designed to reflect the unique demands of the microbiology field, ensuring that graduates are well-equipped to contribute meaningfully to research, industry, and healthcare sectors. By aligning PSOs with current trends and advancements in microbiology, the program aims to produce highly competent professionals and researchers.

The Program Specific Outcomes (PSOs) in the B.Sc. (Hons/Res) in Microbiology represent a commitment to providing students with a comprehensive, specialized education that prepares them for

successful careers and research roles. By defining clear and targeted outcomes, the program ensures that graduates are equipped with the necessary skills and knowledge to excel in the dynamic and interdisciplinary field of microbiology.

Key Program Specific Outcomes (PSOs)

1. **Mastery of Microbiological Concepts and Techniques:**
    - **Outcome 1:** Demonstrate a deep understanding of fundamental microbiological principles, including microbial diversity, physiology, and genetics.
    - **Outcome 2:** Apply advanced techniques in microbiology, including molecular biology methods, microbial culture, and analytical procedures, to solve complex scientific problems.

2. **Proficiency in Research and Data Analysis:**
    - **Outcome 1:** Design and execute microbiological experiments using appropriate methodologies, ensuring accuracy and reliability in data collection.
    - **Outcome 2:** Analyse experimental data using statistical tools and interpret results to draw valid conclusions and contribute to scientific knowledge.

3. **Application of Knowledge to Real-World Problems:**
    - **Outcome 1:** Apply microbiological knowledge to address practical challenges in various domains such as medical microbiology, environmental management, and industrial applications.
    - **Outcome 2:** Develop innovative solutions for contemporary issues, such as antimicrobial resistance, bioremediation, and vaccine development.

4. **Development of Critical Thinking and Problem-Solving Skills:**
    - **Outcome 1:** Employ critical thinking to evaluate scientific literature, identify research gaps, and propose hypotheses for investigation.
    - **Outcome 2:** Address complex microbiological problems with a systematic approach, utilizing both theoretical knowledge and practical experience.

5. **Effective Communication and Collaboration:**
    - **Outcome 1:** Communicate scientific information clearly and effectively through written reports, oral presentations, and professional interactions.
    - **Outcome 2:** Collaborate effectively within multidisciplinary teams, demonstrating leadership and interpersonal skills in scientific and research contexts.

6. **Ethical and Professional Conduct:**
    - **Outcome 1:** Adhere to ethical standards in scientific research and practice, ensuring integrity and responsibility in all professional activities.
    - **Outcome 2:** Understand and comply with regulatory and safety protocols relevant to microbiological research and laboratory work.

Course Outcomes CORE PAPERS/ MINOR PAPERS

B.Sc. Semester I – BCH1T01 Discipline Specific Core Course (DSC-1) Microbiology Paper - I (Fundamentals of Microbiology) Theory

Course outcomes
After this course the students will be able to

- ✓ Students will understand the contributions of different scientists in the fields of Microbial science.
- ✓ Students will have knowledge about the established and emerging fields of science with respect to Microbiology.
- ✓ Students will have knowledge about basic structure & nutritional requirement of bacteria.
- ✓ Develop practical skills to handle microorganism aseptically 5. Understand the use of apparatus and their use without fear.
- ✓ Correlate their Microbiology theory concepts with practical outcomes.

Course Outcomes CORE PAPERS/ MINOR PAPERS

B.Sc. Semester I – BCH1T02 Discipline Specific Core Course (DSC-2)-Microbiology Paper-II (Basic Techniques in Microbiology) Theory

Course Outcomes
After this course the students will be able to

- ✓ Students will be able to understand the needs and basics of techniques used in observing microbes.
- ✓ Students will be aware of applications of basic techniques.
- ✓ Students will learn sterilization and disinfection principles and procedures.
- ✓ Students will learn cultivation & aseptically handling of microorganism.

Course Outcomes B.Sc. Semester I – Vocational Skill Course (VSC) BVS1P01 Calibration, Validation & Handling of Laboratory Equipment Practical

Course outcomes
After this course the students will be able to

- ✓ Student will learn the basic knowledge of calibration, validation handling of laboratory instruments.
- ✓ The knowledge is very useful for opting job in industries.
  Understanding Calibration Concepts.
- ✓ Explain the principles and importance of calibration in maintaining the accuracy and precision of laboratory instruments.
- ✓ Describe the different types of calibration procedures (e.g., linearity, span, and offset) and their applications in various types of laboratory equipment.
- ✓ Demonstrate the ability to calibrate laboratory instruments using standard calibration methods and protocols.

- ✓ Apply calibration techniques to a variety of instruments such as pipettes, spectrophotometers, and balances, ensuring they meet specified accuracy and precision requirements.
- ✓ Define validation and its role in verifying the performance and reliability of laboratory methods and equipment.
- ✓ Differentiate between validation and verification processes and describe the steps involved in validating laboratory equipment and analytical methods.
- ✓ Develop and implement validation protocols for laboratory equipment and procedures, including method validation, instrument qualification, and performance verification.
- ✓ Analyze validation data and interpret results to ensure compliance with regulatory and industry standards.

Course Outcomes B.Sc. Semester I –Skill Enhancement Course (SEC) BVS1P02
Quality Control Testing of Fermented Food
Practical

Course Outcome

- ✓ Explain the principles and microbiological processes involved in the fermentation of various food products.
- ✓ Describe the types of microorganisms used in fermentation and their roles in producing desirable characteristics in fermented food.
- ✓ Identify key quality control parameters for fermented foods, including sensory attributes, microbial safety, chemical composition, and shelf life.
- ✓ Discuss the significance of each parameter in maintaining the quality and safety of fermented food products.
- ✓ Demonstrate proficiency in using analytical techniques to assess the quality of fermented foods, such as microbiological assays, chemical analyses, and sensory evaluations.
- ✓ Apply methods for detecting common contaminants and spoilage microorganisms in fermented products.
- ✓ Perform microbial testing to ensure the safety of fermented foods, including enumeration of beneficial microorganisms and detection of pathogens.
- ✓ Interpret microbial test results and implement corrective actions to address safety concerns in fermented food products.
- ✓ Conduct chemical analyses to determine the composition of fermented foods, including pH, acidity, alcohol content, and nutrient levels.
- ✓ Assess the nutritional value of fermented products and understand how fermentation affects nutrient content.
- ✓ Conduct sensory evaluations to assess the flavor, aroma, texture, and appearance of fermented foods.
- ✓ Use sensory data to make informed decisions about product quality and acceptability.
- ✓ Understand and apply regulatory standards and guidelines related to the quality control of fermented foods (e.g., FDA, USDA, Codex Alimentarius)
- ✓ Ensure compliance with safety and quality regulations, including labeling requirements and standards for ingredient usage.
- ✓ Implement quality assurance practices to monitor and maintain the consistency and safety of fermented food products throughout the production process.
- ✓ Develop and maintain documentation related to quality control procedures, including standard operating procedures (SOPs) and quality records.

- ✓ Identify common quality issues in fermented foods and apply problem-solving techniques to address and resolve these issues.
- ✓ Use critical thinking skills to diagnose problems related to fermentation and implement effective solutions.
- ✓ Evaluate and recommend improvements to existing quality control practices to enhance the safety and quality of fermented food products.
- ✓ Stay informed about emerging trends and advancements in quality control and incorporate relevant practices into the testing and production processes.

Course Outcomes B.Sc. Semester I – Generic/Open Electives I (GE/OE) BGO1T01
Introduction and Scope of Microbiology
Theory

Course outcome

- ✓ Students will be able to understand diversity of microorganisms.
- ✓ Students will be aware of prokaryotic & eukaryotic cellular organization.
- ✓ Justify various scopes of microbiology.
- ✓ These outcomes aim to ensure that students not only gain theoretical knowledge but also develop practical skills and a critical understanding of how microbiology intersects with various aspects of science and daily life.

Course Outcomes B.Sc. Semester I – Generic/Open Electives I (GE/OE) BGO1T02
Introduction to Microscopy & Staining
Theory

Course outcome

- ✓ Students will be able to understand diversity of microorganisms.
- ✓ Students will be aware of prokaryotic & eukaryotic cellular organization.
- ✓ Justify various scopes of microbiology.
- ✓ These outcomes aim to ensure that students not only gain theoretical knowledge but also develop practical skills and a critical understanding of how microbiology intersects with various aspects of science and daily life.

Course Outcomes CORE PAPERS/ MINOR PAPERS
B.Sc. Semester II– (BMI1T03) Discipline Specific Core Course (DSC-3)-Microbiology
Paper-III (Microbial Diversity) Theory

Course Outcomes
After completing this course student will be able to

- ✓ Acquire basics and importance of Microbiology.
- ✓ Learn about basic characteristics features of microorganisms.
- ✓ Describe the classification of Bactria.
- ✓ Gain insights into the important characters, classification & life cycle of viruses.

Course Outcomes CORE PAPERS/ MINOR PAPERS
B.Sc. Semester II– (BMI1T04) Discipline Specific Core Course (DSC-4)-Microbiology Paper-IV (Chemistry of Biomolecules)) Theory

Course Outcomes
After completing this course student will be able to

- ✓ Students will learn about different types of biomolecules and their functions.
- ✓ To categorize on the types of enzymes and their mechanism.
- ✓ Students will learn about the various diseases due to deficiency of vitamins.

Course Outcomes B.Sc. Semester II – Vocational Skill Course (VSC) BVS2P03
Preparation & Standardization of Laboratory Reagents
Practical

Course outcomes
After this course the students will be able to

- ✓ Student will learn the basic knowledge of solution and reagents preparation.
- ✓ The knowledge is very useful for opting job in industries.
- ✓ Learn about different types of laboratory reagents, including their properties, uses, and the importance of purity and concentration.
- ✓ Understand the chemical principles underlying the preparation of reagents, such as solution concentration, dilution, and chemical reactions.
- ✓ Gain knowledge about the principles of standardization and calibration, including how to use standard solutions and reference materials.
- ✓ Develop practical skills in preparing various types of reagents, including solutions, buffers, and standards, following precise protocols and safety procedures.
- ✓ Acquire the ability to standardize reagents accurately using techniques such as titration, spectrophotometry, and other analytical methods.
- ✓ Learn to implement quality control measures to ensure the accuracy and reliability of prepared reagents, including documentation and record-keeping.
- ✓ Cultivate a meticulous approach to reagent preparation and standardization, emphasizing precision and accuracy to ensure reliable experimental results.
- ✓ Develop a strong understanding of laboratory safety practices and regulatory compliance related to reagent handling and preparation.
- ✓ Foster the ability to troubleshoot issues that may arise during the preparation and standardization processes, such as reagent degradation or measurement errors.
- ✓ Apply knowledge of reagent preparation and standardization to design and conduct experiments with consistent and reproducible results.
- ✓ Use standardized reagents to generate data for analysis, ensuring that experimental outcomes are valid and reliable.
- ✓ Integrate best practices in reagent preparation and standardization into routine laboratory work, contributing to high-quality research and accurate results.
- ✓ These outcomes ensure that students are well-equipped to handle the technical and practical aspects of reagent preparation and standardization, which are crucial for reliable experimental work in any scientific laboratory setting.

Course Outcomes B.Sc. Semester II –Skill Enhancement Course (SEC) BVS2P04
Testing of Food Adulteration
Practical

Course outcomes
After this course the students will be able to

- ✓ Student will learn the basic knowledge of food adulteration testing
- ✓ The knowledge is very useful for opting job in industries.
- ✓ A course on the testing of food adulteration focuses on equipping students with the skills and knowledge to identify and analyse adulterants in food products.
- ✓ The course typically covers various analytical techniques and regulatory aspects related to food safety.
- ✓ Gain a comprehensive understanding of what constitutes food adulteration, including the types of adulterants (e.g., chemical, biological, physical) and their potential impact on health.
- ✓ Learn about national and international food safety regulations and standards related to food adulteration, including the role of agencies like the FDA, EFSA, and local health departments.
- ✓ Understand various methods used for detecting and quantifying adulterants in food products, such as chromatography, spectroscopy, and sensory analysis.
- ✓ Develop skills in preparing food samples for analysis, including techniques for homogenization, extraction, and concentration of substances of interest.
- ✓ Acquire hands-on experience with different analytical methods used to test for adulteration, including the use of instruments like gas chromatographs (GC), high-performance liquid chromatographs (HPLC), and mass spectrometers (MS).
- ✓ Learn to interpret analytical results and identify the presence and concentration of adulterants, including the use of statistical methods to assess the significance of findings.
- ✓ Cultivate a meticulous approach to testing procedures, recognizing the importance of accuracy and reliability in detecting food adulteration.
- ✓ Understand the ethical implications of food adulteration and the importance of integrity in reporting and addressing adulteration issues.
- ✓ Develop a commitment to food safety and consumer protection, emphasizing the role of proper testing in ensuring the quality and safety of food products.
- ✓ Apply testing techniques in quality control settings within food production and processing industries to ensure products meet safety and quality standards.
- ✓ Utilize knowledge and skills to help companies comply with food safety regulations and standards, contributing to consumer protection and public health.
- ✓ Use expertise in food adulteration testing to educate consumers and advocate for safer food practices and better food labelling.
- ✓ By the end of the course, students should be proficient in identifying and analysing food adulteration using various techniques, and be well-versed in the regulatory and ethical aspects of food safety.

Course Outcomes B.Sc. Semester II – Generic/Open Electives II (GE/OE) BGO2T03
Microbial world
Theory

Course outcomes
After this course the students will be able to

- ✓ A course on the "Microbial World" typically provides a broad theoretical foundation in microbiology, focusing on the diversity, functions, and significance of microorganisms.
- ✓ Understand the vast diversity of microorganisms, including bacteria, viruses, fungi, protozoa, and algae. This includes their classification, structure, and basic biology.
- ✓ Learn about the roles of microorganisms in various environments, including their functions in ecosystems, their interactions with other organisms, and their roles in processes such as nutrient cycling, fermentation, and disease.
- ✓ Gain insight into the genetic makeup of microorganisms, including concepts of microbial genetics, gene expression, and horizontal gene transfer.
- ✓ Apply theoretical knowledge to research and development in various fields, such as medical microbiology, environmental science, and biotechnology.
- ✓ Use understanding of microbial concepts to educate others and promote awareness of microbiological issues, including public health and environmental conservation.
- ✓ Utilize knowledge of microorganisms to address practical problems, such as developing new antibiotics, improving waste management processes, or understanding microbial contributions to climate change.
- ✓ By the end of the course, students should have a thorough theoretical understanding of the microbial world, its diversity, functions, and applications, and be prepared to apply this knowledge in various academic and professional contexts.

Course Outcomes B.Sc. Semester II – Generic/Open Electives II (GE/OE) BGO2T04
Biomolecules
Theory

Course outcomes
After this course the students will be able to

- ✓ Apply theoretical knowledge to research in areas such as drug development, genetic engineering, and metabolic engineering, using understanding of biomolecules to drive innovation.
- ✓ Use knowledge of biomolecules to educate others, including explaining biochemical concepts to students, colleagues, or the public in an accessible manner.
- ✓ Utilize knowledge of biomolecules in clinical diagnostics, therapeutic development, and environmental monitoring, such as understanding biomarkers of disease or assessing the impact of pollutants on bio molecular systems.
- ✓ By the end of the course, students should have a solid theoretical foundation in the study of biomolecules, understanding their structures, functions, and roles in biological systems, and be well-prepared to apply this knowledge in various academic and professional contexts.

Course Outcomes CORE PAPERS/ MINOR PAPERS

B.Sc. Semester III – BMI3T05 Discipline Specific Core Course (DSC-1) Microbiology Paper - I (Metabolism) Theory

Course Outcomes

- ✓ Understanding of fundamental metabolic pathways in microorganisms
- ✓ Ability to explain catabolic and anabolic reactions in microbial metabolism
- ✓ Knowledge of enzymes and their roles in microbial metabolic processes
- ✓ Comprehension of energy production mechanisms, including glycolysis, Krebs cycle, and oxidative phosphorylation
- ✓ Insight into fermentation processes and their applications in microorganisms
- ✓ Understanding of the role of photosynthesis in microbial metabolism
- ✓ Ability to describe different types of microbial respiration (aerobic and anaerobic)
- ✓ Recognition of the importance of metabolic diversity in microbial adaptation and survival
- ✓ Skills to analyze metabolic pathways and identify key regulatory points
- ✓ Understanding of the relationship between metabolism and microbial growth
- ✓ Knowledge of the impact of environmental factors on microbial metabolic activities
- ✓ Familiarity with techniques to study microbial metabolism experimentally
- ✓ Insight into the application of microbial metabolism in biotechnology and industry
- ✓ Awareness of recent advances and research trends in microbial metabolism
- ✓ Development of critical thinking skills in analyzing metabolic processes in diverse microorganisms

Course Outcomes CORE PAPERS/ MINOR PAPERS
B.Sc. Semester III – BMI3T06 Discipline Specific Core Course (DSC-2)-Microbiology Paper II (Environmental Microbiology) Theory

Course Outcomes

- ✓ Understanding of the role of microorganisms in various environmental processes
- ✓ Knowledge of microbial diversity in different ecosystems (soil, water, air)
- ✓ Ability to explain the cycling of essential elements (carbon, nitrogen, sulfur) by microorganisms
- ✓ Insight into the interactions between microorganisms and other organisms in the environment
- ✓ Comprehension of microbial contributions to soil fertility and plant growth
- ✓ Understanding of biogeochemical processes mediated by microbes
- ✓ Knowledge of the role of microbes in wastewater treatment and pollution control
- ✓ Ability to explain the microbial degradation of pollutants (bioremediation)
- ✓ Understanding of microbial adaptations to extreme environments
- ✓ Skills in using microbiological techniques to study environmental samples
- ✓ Awareness of the impact of human activities on microbial ecology and the environment
- ✓ Insight into the applications of environmental microbiology in biotechnology and industry
- ✓ Understanding of public health aspects related to environmental microbiology (pathogens in water, air quality)
- ✓ Knowledge of the use of microbes as indicators of environmental quality
- ✓ Awareness of current research trends and advances in environmental microbiology

Course Outcomes B.Sc. Semester III – Vocational Skill Course (VSC) BVS3P05 Diagnostic Microbiology
Practical

Course Outcomes

- ✓ Understanding of the principles and techniques used in the diagnosis of microbial infections
- ✓ Knowledge of the characteristics and identification of clinically important microorganisms
- ✓ Ability to perform and interpret various staining techniques (Gram, acid-fast, etc.)
- ✓ Proficiency in culturing and isolating bacteria, fungi, viruses, and parasites from clinical specimens
- ✓ Knowledge of the biochemical, molecular, and serological methods for microbial identification
- ✓ Understanding of antimicrobial susceptibility testing and interpretation of results
- ✓ Ability to differentiate between normal microbial flora and pathogens in clinical samples
- ✓ Knowledge of safety and quality control measures in the microbiology laboratory
- ✓ Understanding of sample collection, transport, and storage requirements for accurate diagnosis
- ✓ Skills in using microscopy, culture media, and automated systems for microbial detection
- ✓ Insight into the diagnosis of emerging and re-emerging infectious diseases
- ✓ Ability to interpret diagnostic results and correlate them with clinical conditions
- ✓ Knowledge of point-of-care testing and rapid diagnostic methods for infectious diseases
- ✓ Awareness of antibiotic resistance mechanisms and their detection in clinical isolates
- ✓ Understanding of current advances and challenges in diagnostic microbiology

Course Outcomes CORE PAPERS/ MINOR PAPERS
B.Sc. Semester IV – BMI4T07 Discipline Specific Core Course (DSC) Microbiology
Paper I (Food Microbiology) Theory

Course Outcome

- ✓ Understanding of the role of microorganisms in food production, spoilage, and preservation
- ✓ Knowledge of the characteristics of foodborne pathogens, spoilage organisms, and beneficial microbes
- ✓ Ability to identify and describe microbial fermentation processes used in food production (e.g., yogurt, cheese, bread)
- ✓ Understanding of the factors influencing microbial growth in foods, including temperature, pH, water activity, and preservatives
- ✓ Proficiency in using microbiological techniques to detect and enumerate microorganisms in food samples
- ✓ Knowledge of foodborne diseases, their transmission, and prevention methods
- ✓ Ability to implement and assess food safety practices, such as HACCP (Hazard Analysis Critical Control Points)
- ✓ Understanding of the principles and methods of food preservation, including pasteurization, canning, drying, and refrigeration
- ✓ Knowledge of food spoilage mechanisms and methods to control spoilage microorganisms
- ✓ Insight into the use of probiotics, prebiotics, and beneficial microbes in functional foods
- ✓ Ability to interpret microbiological data and correlate it with food safety and quality standards

- ✓ Awareness of the regulatory standards and guidelines related to food microbiology and safety
- ✓ Understanding of the role of molecular methods in food pathogen detection and identification
- ✓ Insight into the applications of microbial biotechnology in the food industry
- ✓ Awareness of current research trends and challenges in food microbiology and food safety

Course Outcomes CORE PAPERS/ MINOR PAPERS
B.Sc. Semester IV – BMI4T08 Discipline Specific Core Course (DSC)- Microbiology
Paper II (Dairy Microbiology) Theory

Course Outcome

- ✓ Understanding of the role and types of microorganisms in milk and dairy products
- ✓ Knowledge of the microbial composition of raw milk and factors influencing its microbial quality
- ✓ Ability to identify spoilage microorganisms and pathogens associated with dairy products
- ✓ Understanding of the principles of milk fermentation and the role of lactic acid bacteria in dairy processing
- ✓ Knowledge of dairy product fermentation processes, including yogurt, cheese, butter, and kefir production
- ✓ Proficiency in microbiological techniques for the detection, enumeration, and identification of microorganisms in dairy samples
- ✓ Understanding of microbial standards and regulations governing dairy product safety and quality
- ✓ Knowledge of pasteurization, sterilization, and other preservation methods used in the dairy industry to control microbial growth
- ✓ Insight into the mechanisms of spoilage in dairy products and methods for spoilage prevention
- ✓ Ability to implement and assess hygiene and sanitation practices in dairy processing facilities
- ✓ Understanding of the use of probiotics and starter cultures in the production of functional dairy foods
- ✓ Awareness of the health implications of consuming contaminated dairy products and methods for ensuring safety
- ✓ Knowledge of modern molecular techniques for detecting pathogens and beneficial microbes in dairy products
- ✓ Insight into the role of dairy microbiology in product innovation and development
- ✓ Awareness of current research trends, challenges, and technological advancements in dairy microbiology

Course Outcomes B.Sc. Semester IV – Generic/Open Electives (GE/OE) BGO4T06
Basics of Biomolecules
Theory

Course Outcome

- ✓ Understanding of the structure, properties, and functions of essential biomolecules (carbohydrates, proteins, lipids, nucleic acids)
- ✓ Knowledge of the chemical bonds and interactions that stabilize biomolecular structures
- ✓ Ability to explain the role of carbohydrates in energy storage and structural functions in cells
- ✓ Understanding of protein structure (primary, secondary, tertiary, quaternary) and its relation to function
- ✓ Knowledge of enzyme properties, mechanisms of action, and factors affecting enzyme activity
- ✓ Insight into the structure and function of lipids in membrane formation, energy storage, and signaling
- ✓ Understanding of nucleic acids (DNA, RNA) and their roles in genetic information storage and transfer
- ✓ Familiarity with the basic concepts of metabolism, including the pathways for the synthesis and breakdown of biomolecules
- ✓ Ability to describe the importance of vitamins and coenzymes in biochemical reactions
- ✓ Knowledge of laboratory techniques for the isolation, identification, and analysis of biomolecules
- ✓ Understanding of the role of biomolecules in cellular processes, such as signal transduction and energy production
- ✓ Insight into the applications of biomolecules in biotechnology, medicine, and nutrition
- ✓ Awareness of recent advances in biomolecular research, such as genomics, proteomics, and metabolomics
- ✓ Ability to critically analyze the impact of biomolecular interactions on health and disease
- ✓ Knowledge of the importance of biomolecules in the development of pharmaceuticals and therapeutics

Course Outcomes B.Sc. Semester IV–Skill Enhancement Course (SEC) BVS4P06
Mushroom Cultivation
Practical

Course Outcome

- ✓ Gain knowledge of the fundamental biology, life cycle, and taxonomy of different mushroom species.
- ✓ Learn about the nutritional and medicinal properties of various edible and medicinal mushrooms.
- ✓ Acquire practical skills in the cultivation methods of mushrooms, including substrate preparation, spawning, and casing.

- ✓ Understand sterilization techniques and proper inoculation methods to prevent contamination during mushroom cultivation.
- ✓ Learn how to select, prepare, and manage different substrates (e.g., straw, sawdust) for optimal mushroom growth.
- ✓ Gain insights into controlling environmental factors such as temperature, humidity, light, and ventilation for successful mushroom cultivation.
- ✓ Identify common contaminants in mushroom cultivation and learn how to manage and prevent contamination.
- ✓ Learn the correct methods for harvesting mushrooms and post-harvest handling to maintain quality and extend shelf life.
- ✓ Develop strategies for managing pests and diseases that affect mushroom crops.
- ✓ Understand the economic aspects of mushroom farming, including production, marketing, and the establishment of a mushroom cultivation business.
- ✓ Learn about the safety measures, hygiene, and regulations involved in mushroom cultivation to ensure safe production for consumption.
- ✓ Explore the role of biotechnology in mushroom cultivation, including strain improvement and genetic manipulation.
- ✓ Develop laboratory skills in microbiology specific to mushroom cultivation, such as culture techniques, isolation, and identification.
- ✓ Learn the principles of sustainable agriculture and how to apply them to mushroom cultivation for eco-friendly production.
- ✓ Gain the ability to conduct research and experiments in mushroom cultivation, contributing to advances in fungal biotechnology.

Course Outcomes CORE PAPERS/ MINOR PAPERS
B.Sc. Semester V – BMI5T09 Discipline Specific Core Course (DSC)-Microbiology
Paper I (Medical Microbiology- Host Parasite Relationship) Theory

Course Outcome

- ✓ Understand the fundamental concepts of microbiology, including the classification, structure, and function of microorganisms.
- ✓ Gain knowledge of the role of microorganisms in human health and disease, focusing on pathogenic bacteria, viruses, fungi, and parasites.
- ✓ Learn the mechanisms of microbial pathogenicity and the host immune response to infections.
- ✓ Understand the principles and applications of sterilization, disinfection, and aseptic techniques in clinical settings.
- ✓ Acquire practical skills in culturing, isolating, and identifying medically important microorganisms using various laboratory techniques.
- ✓ Develop the ability to perform diagnostic microbiological tests for the detection and identification of pathogens in clinical specimens.
- ✓ Learn the mechanisms of action of antimicrobial agents and the principles of antibiotic resistance.
- ✓ Understand the methods for testing the susceptibility of microorganisms to antimicrobial agents.
- ✓ Gain insights into the epidemiology, transmission, and control of infectious diseases in populations.

- ✓ Study the body's immune system, including the role of vaccines in preventing infectious diseases.
- ✓ Learn the principles of infection prevention and control in healthcare settings to minimize the spread of infections.
- ✓ Develop critical thinking and problem-solving skills in diagnosing and managing infectious diseases.
- ✓ Understand the emerging trends in medical microbiology, including novel pathogens, antimicrobial resistance, and biotechnological applications in medicine.
- ✓ Learn to interpret laboratory data and reports to support clinical decision-making.
- ✓ Gain awareness of the ethical and safety issues related to handling infectious agents in a laboratory setting.

Course Outcomes CORE PAPERS/ MINOR PAPERS
B.Sc. Semester V – BMI5T10 Discipline Specific Core Course (DSC)-Microbiology
Paper II (Molecular Biology) Theory

Course Outcome

- ✓ Understand the structure, function, and properties of nucleic acids (DNA and RNA) and their role in genetic information storage and transmission.
- ✓ Learn the mechanisms of DNA replication, repair, recombination, and the regulation of gene expression.
- ✓ Gain knowledge of transcription, RNA processing, and translation processes in both prokaryotic and eukaryotic systems.
- ✓ Study the principles of gene regulation, including operons, transcription factors, and epigenetic modifications.
- ✓ Acquire practical skills in molecular biology techniques, such as DNA extraction, PCR, gel electrophoresis, cloning, and sequencing.
- ✓ Understand the role and applications of recombinant DNA technology in genetic engineering, biotechnology, and medicine.
- ✓ Learn about the mechanisms of genetic mutations, their effects on gene function, and methods for mutation detection.
- ✓ Study the concepts of genomics, proteomics, and bioinformatics for analyzing large-scale biological data.
- ✓ Explore the principles of cell signalling pathways and their role in regulating cellular functions and responses.
- ✓ Gain insights into the molecular basis of diseases, including genetic disorders, cancer, and infectious diseases.
- ✓ Develop the ability to design and conduct molecular biology experiments, including hypothesis formulation, data analysis, and interpretation.
- ✓ Learn about the ethical, legal, and social implications of molecular biology research and genetic engineering.
- ✓ Understand the applications of molecular biology in various fields, such as medicine, agriculture, forensic science, and environmental science.
- ✓ Study the techniques used for gene editing, such as CRISPR-Cas9, and their potential applications and limitations.
- ✓ Gain knowledge of current advancements in molecular biology, including gene therapy, synthetic biology, and personalized medicine.

Course Outcomes CORE PAPERS/ MINOR PAPERS
B.Sc. Semester V – BMI5T11 Discipline Specific Core Course (DSC)-Microbiology
Paper III (Immunology) Theory

Course Outcome

- ✓ Understand the basic concepts and components of the immune system, including innate and adaptive immunity.
- ✓ Learn the structure, function, and roles of primary and secondary lymphoid organs in the immune response.
- ✓ Study the characteristics, development, and functions of immune cells, such as T cells, B cells, macrophages, dendritic cells, and natural killer cells.
- ✓ Gain knowledge of antigen recognition, processing, and presentation in the activation of immune responses.
- ✓ Understand the molecular mechanisms of antibody generation, diversity, and the role of immunoglobulins in immunity.
- ✓ Learn the principles of cell-mediated and humoral immune responses and their roles in protecting against pathogens.
- ✓ Explore the complement system, its components, and its role in immune defense and inflammation.
- ✓ Study the mechanisms of immune regulation, including cytokine signaling, tolerance, and immunosuppression.
- ✓ Understand the concepts of hypersensitivity, autoimmunity, and immunodeficiency, including their causes, mechanisms, and clinical implications.
- ✓ Learn the basis of vaccination, including the design and function of different types of vaccines.
- ✓ Acquire practical skills in immunological techniques, such as ELISA, flow cytometry, immunohistochemistry, and Western blotting.
- ✓ Study the interaction between the immune system and pathogens, including viral, bacterial, fungal, and parasitic infections.
- ✓ Understand the principles and applications of immunotherapies, including monoclonal antibodies, CAR-T cell therapy, and checkpoint inhibitors.
- ✓ Gain insights into tumor immunology, the role of the immune system in cancer development, and strategies for immunotherapy in cancer treatment.
- ✓ Explore the ethical, clinical, and research implications of manipulating the immune system for therapeutic purposes.

Course Outcomes B.Sc. Semester V – Electives 1 (DSE) BMI5T12
A. Bioprocess Technology B. Haematology and Clinical Biochemistry
Theory

Course Outcome

A. Bioprocess Technology

- ✓ Understand the principles of bioprocess engineering and its applications in biotechnology.
- ✓ Learn the design, operation, and optimization of bioreactors for microbial, animal, and plant cell cultures.
- ✓ Study the kinetics of microbial growth, product formation, and substrate utilization.
- ✓ Gain knowledge of upstream processing, including media formulation, sterilization, and inoculum preparation.
- ✓ Learn downstream processing techniques for product recovery, purification, and quality control.
- ✓ Understand the use of enzymes in bioprocessing and enzyme immobilization techniques.
- ✓ Explore industrial applications of bioprocess technology, including pharmaceuticals, biofuels, and food production.
- ✓ Develop skills in monitoring and controlling bioprocess parameters for large-scale production.
- ✓ Study the principles of Good Manufacturing Practices (GMP) and regulatory aspects of bioprocess industries.

B. Haematology and Clinical Biochemistry

- ✓ Understand the structure, function, and formation of blood cells and the role of hematopoiesis.
- ✓ Learn the methods for blood collection, handling, and storage in clinical settings.
- ✓ Study the principles of common hematological tests, including complete blood count (CBC) and blood smear analysis.
- ✓ Gain knowledge of blood disorders, such as anemia, leukemia, and clotting disorders, and their diagnostic markers.
- ✓ Understand the biochemical composition of blood and the clinical significance of various blood analytes.
- ✓ Learn techniques for analyzing blood chemistry, including liver and kidney function tests, lipid profiles, and glucose levels.
- ✓ Develop skills in performing laboratory tests for the diagnosis and monitoring of diseases.
- ✓ Study the principles of quality control, accuracy, and safety in hematology and biochemistry laboratories.
- ✓ Explore the interpretation of laboratory results in the context of patient health and disease management.

Course Outcomes B.Sc. Semester V – Vocational Skill Course (VSC) BVS5P07
Water analysis
Practical

Course Outcome

- ✓ Understand the importance of microbiological water analysis in assessing water quality and public health.
- ✓ Learn the common waterborne pathogens, including bacteria, viruses, and protozoa, and their impact on human health.
- ✓ Study the principles of microbial contamination in different water sources, such as drinking water, recreational water, and wastewater.
- ✓ Gain knowledge of the standard methods for sampling, collection, and storage of water for microbiological analysis.
- ✓ Learn various microbiological techniques, such as membrane filtration, multiple-tube fermentation, and enzyme-based methods, for detecting and enumerating waterborne microorganisms.
- ✓ Understand the use of indicator organisms, such as coliforms and Escherichia coli, in water quality testing.
- ✓ Study the regulations and guidelines for water quality standards set by agencies like the World Health Organization (WHO) and the Environmental Protection Agency (EPA).
- ✓ Acquire skills in interpreting water analysis results to determine water safety and quality.
- ✓ Understand the procedures for detecting and quantifying microbial biofilms in water distribution systems.
- ✓ Learn about advanced molecular techniques, such as PCR and qPCR, for the detection of specific pathogens in water samples.
- ✓ Gain knowledge of disinfection methods and the impact of physical, chemical, and biological factors on microbial water quality.
- ✓ Develop problem-solving skills in addressing water contamination issues and devising control measures.
- ✓ Study the principles of water treatment processes, including filtration, chlorination, and UV disinfection.
- ✓ Understand the ethical and safety considerations involved in microbiological water testing and reporting results.

Course Outcomes CORE PAPERS/ MINOR PAPERS
B.Sc. Semester VI– BMI6T13 Discipline Specific Core Course (DSC)-Microbiology
Paper I (Industrial Microbiology) Theory

Course Outcome

- ✓ Understand the role of microorganisms in industrial processes and their applications in biotechnology.
- ✓ Learn the selection, screening, and optimization of microbial strains for industrial use.
- ✓ Study the growth kinetics and metabolic pathways of industrially important microorganisms for product formation.

- ✓ Gain knowledge of fermentation technology, including batch, fed-batch, and continuous culture systems.
- ✓ Learn about the design, operation, and scaling up of bioreactors for industrial fermentation.
- ✓ Understand upstream processing techniques, such as media formulation, sterilization, and inoculum development.
- ✓ Study downstream processing methods for product recovery, purification, and quality control.
- ✓ Learn the production processes for microbial products, such as antibiotics, enzymes, organic acids, vitamins, and biofuels.
- ✓ Understand the principles and applications of enzyme technology and microbial immobilization in industry.
- ✓ Gain insights into the production of fermented foods and beverages using microorganisms.
- ✓ Study the use of genetic engineering and recombinant DNA technology in improving microbial strains for enhanced production.
- ✓ Learn about the principles of bioprocess monitoring, control, and automation in industrial microbiology.
- ✓ Understand the regulatory aspects, including Good Manufacturing Practices (GMP) and quality assurance, in industrial microbial production.
- ✓ Explore waste management and the role of microorganisms in environmental biotechnology, such as bioremediation and waste treatment.
- ✓ Develop problem-solving skills for troubleshooting and optimizing industrial microbiological processes.

Course Outcomes CORE PAPERS/ MINOR PAPERS
B.Sc. Semester VI– BMI6T14 Discipline Specific Core Course (DSC)-Microbiology
Paper II (Medical Microbiology-Microbial Diseases) Theory

Course Outcomes

- ✓ Understand the classification, morphology, and physiology of medically important microorganisms, including bacteria, viruses, fungi, and parasites.
- ✓ Learn the mechanisms of microbial pathogenicity, including adhesion, invasion, toxin production, and immune evasion.
- ✓ Study the epidemiology, transmission, and clinical features of major microbial diseases affecting humans.
- ✓ Gain knowledge of the host immune response to different pathogens and how it influences disease progression and outcome.
- ✓ Learn the laboratory techniques for isolating, culturing, and identifying pathogens from clinical specimens.
- ✓ Understand the principles of diagnostic microbiology, including serological, molecular, and biochemical methods for disease detection.
- ✓ Study the mechanisms of action, therapeutic uses, and limitations of antimicrobial agents used to treat microbial diseases.
- ✓ Explore the concepts of antimicrobial resistance, its development in pathogens, and strategies to combat it.
- ✓ Learn about the prevention and control measures for infectious diseases, including vaccination, sanitation, and public health policies.
- ✓ Understand the clinical manifestations, complications, and management of common microbial diseases, such as tuberculosis, HIV/AIDS, malaria, and influenza.

- ✓ Develop the ability to interpret laboratory data and clinical information to diagnose and manage microbial infections.
- ✓ Study emerging and re-emerging infectious diseases, their impact on public health, and strategies for surveillance and control.
- ✓ Gain insights into the principles and practices of infection control in healthcare settings to prevent nosocomial infections.
- ✓ Explore the role of microbiota in health and disease, including the impact of dysbiosis on various conditions.
- ✓ Learn about the ethical, safety, and biosafety considerations in handling and researching pathogenic microorganisms.

Course Outcomes CORE PAPERS/ MINOR PAPERS
B.Sc. Semester VI– BMI6T15 Discipline Specific Core Course (DSC)-Microbiology
Paper III (Recombinant DNA Technology and Applications) Theory

Course Outcome

- ✓ Understand the fundamental principles of recombinant DNA technology, including gene cloning, vector design, and genetic modification.
- ✓ Learn the techniques for isolating, cutting, and modifying DNA using restriction enzymes, ligases, and other molecular tools.
- ✓ Study the methods for constructing recombinant DNA molecules and introducing them into host cells, such as bacterial transformation and transfection in eukaryotic cells.
- ✓ Gain knowledge of different cloning vectors, including plasmids, bacteriophages, cosmids, and artificial chromosomes, and their specific applications.
- ✓ Learn the techniques for amplifying DNA using Polymerase Chain Reaction (PCR) and its variants for cloning and analysis.
- ✓ Understand the principles and applications of gel electrophoresis, DNA sequencing, and blotting techniques (Southern, Northern, Western) in recombinant DNA research.
- ✓ Explore the use of expression vectors for producing recombinant proteins in prokaryotic and eukaryotic systems.
- ✓ Study gene editing technologies, such as CRISPR-Cas9, and their applications in genetic modification and functional genomics.
- ✓ Learn about the applications of recombinant DNA technology in medicine, including the production of pharmaceuticals, vaccines, and gene therapy.
- ✓ Understand the role of recombinant DNA technology in agriculture, such as developing genetically modified crops with enhanced traits (e.g., pest resistance, improved yield).
- ✓ Gain insights into the use of recombinant DNA techniques in environmental biotechnology, including bioremediation and waste treatment.
- ✓ Study the principles of biosafety and bioethics in recombinant DNA research, including regulatory guidelines for genetically modified organisms (GMOs).
- ✓ Develop problem-solving skills in designing and executing experiments involving recombinant DNA techniques.
- ✓ Learn about the commercial applications of recombinant DNA technology in various industries, including biotechnology, food, and forensic science.
- ✓ Explore the advancements in synthetic biology and its potential to create novel biological systems and applications.

Course Outcomes B.Sc. Semester VI – Electives 2 (DSE) BMI6T16
A. Applied Agricultural Microbiology B. Biostatistics
Theory

Course Outcome

A. Applied Agricultural Microbiology

- ✓ Understand the role of microorganisms in soil health, plant growth, and nutrient cycling.
- ✓ Learn about microbial interactions with plants, including beneficial microbes such as rhizobia, mycorrhizae, and plant growth-promoting bacteria.
- ✓ Study the applications of microorganisms in biological pest control and the management of plant diseases.
- ✓ Gain knowledge of microbial fermentation processes used in the production of agricultural products, such as silage and biofertilizers.
- ✓ Understand the principles of microbial inoculants and their use in improving crop yields and soil fertility.
- ✓ Learn the techniques for isolating, characterizing, and applying microorganisms in agriculture.
- ✓ Study the role of microorganisms in bioremediation of agricultural soils contaminated with pesticides, heavy metals, and other pollutants.
- ✓ Explore the use of genetically modified microorganisms and microbial biotechnology in enhancing agricultural productivity.
- ✓ Understand the principles of sustainable agricultural practices and the role of microorganisms in promoting soil and environmental health.

B. Biostatistics

- ✓ Understand the fundamental concepts of biostatistics, including descriptive statistics, probability distributions, and statistical inference.
- ✓ Learn to apply statistical methods to analyze and interpret data from biological and medical research.
- ✓ Study techniques for designing experiments and surveys, including sampling methods and sample size determination.
- ✓ Gain knowledge of hypothesis testing, including t-tests, chi-square tests, and ANOVA, to evaluate the significance of research findings.
- ✓ Learn to use regression and correlation analysis to explore relationships between variables and make predictions.
- ✓ Understand the principles of survival analysis and time-to-event data, including Kaplan-Meier curves and Cox proportional hazards models.
- ✓ Develop skills in using statistical software for data analysis, such as R, SPSS, or SAS.
- ✓ Study the interpretation of statistical results in the context of biological and medical research, including understanding p-values and confidence intervals.
- ✓ Explore advanced biostatistical methods, such as multivariate analysis, mixed models, and Bayesian statistics.
- ✓ Understand the ethical considerations and proper reporting of statistical analyses in research publications and presentations.

Course Outcomes B.Sc. Semester VI – Vocational Skill Course (VSC) BVS6P08
Biofertilizers & Biopesticides
Practical

Course Outcomes

- ✓ Understand the definitions, types, and roles of biofertilizers and biopesticides in sustainable agriculture.
- ✓ Learn about the different types of biofertilizers, including nitrogen-fixing bacteria, phosphate-solubilizing microbes, and mycorrhizal fungi, and their mechanisms of action.
- ✓ Study the production, formulation, and application methods for various biofertilizers and their impact on soil fertility and crop growth.
- ✓ Gain knowledge of biopesticides, including microbial, botanical, and biochemical types, and their mechanisms for pest and disease management.
- ✓ Learn about the production processes for biopesticides, including fermentation, extraction, and formulation.
- ✓ Understand the principles of integrated pest management (IPM) and the role of biopesticides in IPM strategies.
- ✓ Study the benefits and limitations of using biofertilizers and biopesticides compared to chemical fertilizers and pesticides.
- ✓ Explore the regulatory aspects and quality control measures for biofertilizers and biopesticides.
- ✓ Learn about the application techniques for biofertilizers and biopesticides, including soil application, seed treatment, and foliar spraying.
- ✓ Develop skills in evaluating the efficacy and safety of biofertilizers and biopesticides in field trials and laboratory settings.
- ✓ Understand the environmental impacts and sustainability benefits of using biofertilizers and biopesticides in agriculture.
- ✓ Study the current research trends and innovations in biofertilizer and biopesticide development and their future prospects in sustainable agriculture.

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