

Course Structure and Syllabus
of
Ph.D. (Microbiology) Course Work
Effective from Session 2024-25 onwards



Department of Microbiology

Dr. Shakuntala Misra National Rehabilitation

University, Mohaan Road, Lucknow-226017

India.

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(Prem Prakash Pandey)

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Program Objective

The Pre-Ph.D. Coursework equips doctoral candidates with essential knowledge, advanced research skills and a multidisciplinary perspective. The objectives of the program are to:

1. Establish a robust theoretical foundation in Microbiology.
2. Improve research skills and enhance methodological expertise.
3. Encourage interdisciplinary approaches to tackle complex problems.
4. Foster ethical standards and integrity in research practices.

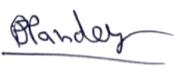
Program Outcome

Upon completing the Pre-Ph.D. Coursework, candidates will:

1. Show a comprehensive understanding and expertise in microbiology.
2. Effectively identify and define research problems.
3. Use appropriate research methodologies to solve selected problems.
4. Contribute to the academic community by producing high-quality scholarly work.
5. Demonstrate the ability to clearly present and communicate research findings.

Course Structure

S. No.	Course code	Paper Title	Credit	Max Marks
1	PHDMB-101	Research Methodology	4	100
2	PHDMB -102	Advances in Microbial Techniques	3	100
3	PHDMB -103	Fermentation Technology	3	100
4	PHDMB -104	Research Ethics and Research Presentation	2	100
Total			12	400


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PHDMB 101
RESEARCH METHODOLOGY
(CREDITS 4)

Course Learning Objectives

1. To grasp the basic principles of research methodology.
2. To become acquainted with experimental methods and techniques.
3. To enhance statistical skills.
4. To encourage critical thinking and analysis.

UNIT I

Introduction to research methodology: Definition of research, components of a research topic, identification of a research topic, selection of research topic, thinking like a researcher, qualities of a researcher, understanding and applying fundamental research concepts.

UNIT II

Research Design and Planning: Concept and importance of research design, literature survey, role and significance of literature review in the research process, identifying relevant literature for review, organising and managing references, sources of literature.

UNIT III

Hypothesis Generation and Testing: Defining the research problem, formulating research hypotheses and understanding their role in research, characteristics of a reasonable hypothesis, steps and procedures involved in hypothesis testing.

UNIT IV

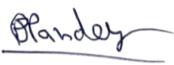
A. Data Interpretation and Analysis: The importance of objectivity in interpreting data, understanding double-masked studies and their significance and creating and analysing frequency tables, pie charts, bar diagrams, percentages and t-tests.

B. Good Laboratory Practices: Biosafety, handling of biological materials safely, personal protection and safety protocols, radiation safety, record keeping, data organisation, practices for organising equipment and workspaces

Course Learning Outcomes

At the end of this course, students will be able to:

1. Define and apply research principles effectively.
2. Utilise computational tools proficiently.
3. Analyse errors with accuracy.
4. Operate advanced experimental techniques successfully.
5. Critically evaluate scientific literature thoroughly.


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PHDMB 102
ADVANCES IN MICROBIAL TECHNIQUES
(CREDITS 3)

Course Learning Objectives

1. To provide foundational knowledge of the principles and techniques of microbiology.
2. To help students understand research techniques that range from basic to advance in the diverse field of microorganisms.
3. To equip students with the skills needed to use various microbial techniques, operate instruments for experiments and analyse experimental data.

UNIT- I

Principles and methods of Studying Microbial biodiversity: Collection of environmental samples (soil, water and air), transport and preservation technique in microbial studies; Understanding microbial diversity by culture-dependent and culture-independent approaches; Introduction to light, dark field, phase-contrast, confocal fluorescent, scanning and transmission electron microscopy; Fixation techniques for EM, Basic principle of staining techniques (Gram, Capsule, Flagella, Endospore, Acid Fast Fluorochrome and Nucleic acid); Principle and method of sterilization.

UNIT- II

Principles and applications of electrophoresis: Agarose gel electrophoresis; SDS-PAGE, Two-dimensional gel electrophoresis, native PAGE; Principle of chromatography, gel-filtration, ion exchange, affinity, thin layer, gas and high-pressure liquid chromatography (HPLC), FPLC. Fractionation of cell organelles.

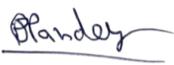
UNIT- III

Principles and applications of spectrophotometry: UV-Visible spectrophotometry, (Beer-Lambert's law), IR spectroscopy, fluorescence and Mass spectroscopy (MALDI TOF); ORD/CD NMR, ESR, atomic absorption and plasma emission spectroscopy. Principles and methods used for the analysis of biopolymers include X-ray crystallography.

Course Learning Outcomes

At the end of this course, students will gain,

1. Basic understanding of microbial structure, sterilization, disinfection and sampling techniques in microbiology.
2. Innovative scientists and a skilled workforce to fulfil microbiology needs.
3. Independent researchers who can contribute by fulfilling the roles of scientists, academics and entrepreneurs in microbiological disciplines.


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PHDMB 103
FERMENTATION TECHNOLOGY
(CREDITS 3)

Course Learning Objectives

1. Understand microbial strain management effectively.
2. Master the development of upstream bioprocessing.
3. Comprehend techniques for downstream processing.
4. Evaluate the economics and industrial viability of bioprocesses.
5. Develop strategies for sustainable bioprocessing.

UNIT I

Microbial strains: Isolation, preservation and improvement of microbial strains; Sources of industrially viable microorganisms, isolation and their maintenance strategies, culture collection banks; Preservation of industrially significant microbes.

UNIT II

Bioprocesses Engineering: Development of upstream bioprocesses; Growth dynamics and kinetics of product formation, process optimisation; Fermentation methods, solid-state and submerged fermentation, batch, fed-batch and continuous fermentation strategies and their practical applications; Fermentors and their types, special reference to airlift, stirred tank and bubble column fermentors.

UNIT III

A. Product Recovery: Development of downstream processes; Introduction to membrane filtration, centrifugation, sedimentation, flocculation, methods for cell disruption (physico-chemical, mechanical and enzymatic approaches) along with liquid-liquid extraction, crystallisation, spray drying and chromatography.

B. Bioprocess economics: Costs associated with bioprocessing, capital expenditures for equipment, raw material procurement; Fermentation scaling operations up or down, industrial viability, recovery expenses and water management practices; Strategies for effluent treatment, resource recycling and sustainability.

Course Learning Outcomes

At the end of this course, students will be able to:

1. Design and implement strategies for isolating, preserving and maintaining industrially viable microbial strains.
2. Optimise fermentation processes, apply growth kinetics principles and effectively use various fermentors for industrial applications.
3. Acquire hands-on proficiency in downstream processing techniques, enabling efficient product recovery and purification.
4. Evaluate the economic aspects of bioprocessing and propose viable solutions to enhance industrial scalability and profitability.
5. Integrate sustainability practices into bioprocess operations, focusing on effluent treatment, resource conservation and environmentally responsible biomanaufacturing.

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(Pranav Prakash Pandey)

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PHDMB 104

RESEARCH ETHICS AND RESEARCH PRESENTATION (CREDITS 2)

Course Learning Objectives

1. Introduction to research ethics
2. The importance of ethics in scientific research
3. Understanding the ethics of research publication
4. Addressing unethical behaviors in research
5. Plagiarism prevention and maintaining research integrity

UNIT I

Introduction to Research Ethics: Historical instances of unethical scientific practices; *Plagiarism:* definition, types and its impact on scientific credibility, self-plagiarism, authorship disputes and responsibilities; Animal research ethics and welfare considerations; Data integrity and transparency in experimental design, data fraud and fabrication; *Human ethics violations in research:* notable historical cases.

UNIT II

Introduction to Research Work Presentation: Overview of knowledge dissemination in the scientific community; Structure and layout of a research paper, tips for clarity, coherence and scientific rigor; Preparation of oral and poster presentations; journal impact factor, citation index, h-index, i-10 index; Selection of appropriate journals for publication, predatory journals, open-source software tools.

Course Learning outcomes

Upon successful completion of this course, students will be able to:

1. Understand the principles of research ethics.
2. Foster ethical research practices.
3. Maintain ethical standards in publishing.
4. Recognise and address misconduct in publishing.
5. Utilise tools to prevent plagiarism.
6. Assess and tackle unethical research practices.

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Suggested Readings

PHDMB 101

1. Research Methodology: Methods and Techniques by C. R. Kothari, New Age International Publishers, ISBN: 81-224-1522-9 2.
2. Evans, I., Thornton, H., & Chalmers, I. Testing treatments: Better research for better healthcare. 2nd Ed. London: Pinter & Martin, 2011. Type: Text: ISBN: 978-1-905177-48-6.

PHDMB 102

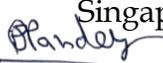
1. Wilson K and Walker, Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press.
2. Poster GWH and Potter GW, Analysis of Biological Molecules: An Introduction to Principles, Instrumentation, and Techniques, Kluwer Academic Publishers.
3. Rao DM. Swamy AVN and Reddy DD, Instrument Methods of Analysis. CIS Publishers and Distributors
4. Williams BL. and Wilson K, A Biologists Guide to Principle and Techniques of Practical Head summary John Willey and Sons Inc New York.
5. Dubey RK and Maheshwari DK, Practical Microbiology, S Chand & Company, New Delhi.
6. Marco D, Metagenomic Current Innovation and Future Trends, Caister Academic Press.

PHDMB 103

1. Principles of Fermentation Technology (2nd Edition, 2013) by P.F. Stanbury, W. Whitaker & S.J. Hall, Elsevier India Pvt. Ltd., New Delhi.
2. Bioprocess Engineering Principles (2nd Edition, 2012) by Academic Press/Elsevier India Pvt. Ltd. New Delhi.
3. Bioprocess Engineering: Basic Concepts (2nd Edition, 2011) by Michael L. Shuler and Fikret Kargi, Prentice Hall India learning Pvt. Ltd., New Delhi.
4. Biotechnology: A Text Book of Industrial Microbiology (2000) by W. Crueger & A. Crueger, Panima Publishing Corporation, New Delhi/Bangalore.
5. Modern Industrial Microbiology & Biotechnology (2007) by N. Okafer, Scientific Publishers, Enfield, USA.

PHDMB 104

1. Research and Publication Ethics (1st Edition, 2023) by Singh Upendra Prata, Ahlawat Sakshi, Sharma Sushma. Sultan Chand & Sons, 23, Daryaganj, Ansari Road, New Delhi.
2. Research and Publication Ethics (2023) by Santosh Kumar Yadav, Springer Nature, Singapore.


(Prem Prakash Pandey)



