CURRICULUM & SYLLABUS

DOCTOR OF PHILOSOPHY (Ph.D.)

IN

MICROBIOLOGY

[w. e. f. 2025-26]

FACULTY OF SCIENCE & HUMANITIES
SRM UNIVERSITY DELHI-NCR, SONEPAT
39, Rajiv Gandhi Education City, Sonepat
Haryana-131029

Course Structure
Details of Course Ph.D. Microbiology
Course WorkCredits:Theory

I. Course Theory-4 Subjects 4X3=12+2=14

(4 Papers)

Total 14 Credits

Doctor of Philosophy (Ph.D.) Microbiology
Course Work

Course Code	Course Name	Total Credit (C)	Maximum Marks
21RES701	Research Methodology	4	100
25RES711	Laboratory Techniques In Life Science	4	100
25PMB721	Laboratory Techniques and Advanced Research in Microbiology	4	100
RPE100	Research Publication & Ethics	2	100
	Total	**14**	**400**

RESEARCH METHODOLOGY

21RES701 **Credit 4**

Unit 1: Introduction to Research

Introduction, Philosophical Underpinnings, Meaning of Research, Objectives of Research, Motivations in Research, Types of Research, Research Approaches, Significance of Research, Scope of Research, Literature Review, Research Methods vs. Research Methodology, Research Process, Research and Scientific Methods, Criteria of Good Research, Research Questions, Research problem, Selecting the Problem, Necessity and Techniques of Research Problem, Qualitative & Quantitative Research, Research Proposal, Synopsis, Transdisciplinarity, Multidisciplinarity&Interdisciplinarity in Research.

Unit II: Data Collection & Sampling

Collection of Primary Data/Sources, Secondary Data/Sources, Observation Method, Interview, Libraries, Archives & Repositories, Questionnaire, Schedules, Case Study and other Innovative Methods, Research Procedure. Sampling, Steps and Criteria for selecting a Sample procedure, Characteristics of Good Sampling, Types of Sample Design, Selecting Random Samples, Complex Random Sampling Design.

Unit III: Data Analysis & Interpretation

Measures of Central Tendency, Dispersion, Correlation & Regression, Chi-Square Test: applications, Steps, Characteristics, Limitations, Analysis of Variance & Co-variance. Hypothesis: Meaning, Basic Concepts, Flow Diagram, Testing, of Means, Testing of Hypothesis testing of Correlation coefficients, Limitations of Tests of Hypothesis. Theory & Empirical approaches, Ethnographic, Comparative and Interpretative Research.

Unit IV: Research Tools & Ethics in Research

Computer Fundamentals, Basics, Data Representation, Word Processing Package, Creating & Editing a Word Document.Ethical issues related to Publishing & Plagiarism, LaTex tool for Detection& Elimination of Plagiarism, Intellectual Property Rights, Copy Rights & Patent Laws.

Unit V: Research Report & Presentations

Structure & Components of Research Report, Types of Report, Layout of Research Report, Mechanism of Writing a Research Report. Presentation: Tailoring the presentation to the target audience, Oral Presentation, Poster Presentation, Submission of Research Article, Thesis Writing, Visual& Delivery.

Text books

- Adam Pzreworsky and Frank Solomon. *On the Art of Writing Proposals*, rev. edn, New York, 1995.
- Blaxter Loraine, Hughes Christina and Tight Malcolm. *How to Research*, Open University Press, 2006.Gerard Guthrie. *Basic Research Methods*, Sage, London, 2010.

Reference books:

- Kothari, C. R. *Research Methodology: Methods and Techniques*, New Age Publishers, Delhi, 2018.
- Rand R. Wilcox, *Fundamentals of Modern Statistical Research*, Springer, New York, 2010.

Ross, Timothy J. *Fuzzy Logic with Engineering Applications*, 2nd Edn. Wiley Publications, 2005.

LABORATORY TECHNIQUES IN LIFE SCIENCES (Biotechnology/Microbiology)	
Course Code: 25RES711	Continuous Evaluation: 40 Marks
Credits: 4	End Semester Examination: 60 Marks
L T P : 4 0 0	Course Type: Theory
Prerequisite: NIL	

The course is aimed to provide an insight into critical review of literature and assessing the research trends, quality and extension potential of life science research and equip students to undertake life science research.

COURSE OBJECTIVES (CO):

1. To understand the animal cell culture & Molecular Biology Techniques
2. To understand the Microorganisms and Microbial Technology.
3. To understand the Animal Biotechnology and Immunological Techniques.
4. Understand the basic concept of Computational Biology and Computer Aided Drug Design
5. Understand the Biosafety & Bioethics, field work, seminars & other academic activities

COURSE LEARNING OUTCOMES (CLO):

The syllabus has been prepared in accordance with National Education Policy (NEP). After completion of course, students would be able to:

1. Explain the details of maintenance animal cell culture and molecular biology techniques associated with research.
2. Introduction to various types of microbes, Growth of bacteria; Control of Microbes. Microbial production, purification and bio-process applications.
3. Introduction to various immunological techniques, Principles and applications, Hybridoma technology.
4. Explain the basic concepts of drug discovery and development process along with molecular modelling and virtual screening
5. Explain socio-legal aspects of ethics in medicine, biotechnology and Biosafety guidelines for research on GMOs. Learn about writing research proposal.

MAPPING COURSE OBJECTIVES & COURSE LEARNING OUTCOMES

CO'S	**CLO'S**				
	CLO1	**CLO2**	**CLO3**	**CLO4**	**CLO5**
CO1					
CO2					
CO3					
CO4					
CO5					

Elective Units

Unit 1. Cell culture &Molecular Biology Techniques

Basic lab techniques and lab safety, Introduction of Light and fluorescence microscope, Cell culture: Introduction to sterile cell culture technique. Counting viable cells and subculture into multiwell plates. Cell counting using hemocytometers. Cell attachment (adhesion) and growth. Cell staining techniques: Culturing of primary cells, preparation of human chromosome, Application of primary cell culture techniques. Isolation of chromosomal DNA, Preparation of cellular extract, isolation of nuclear extract and cytoplasmic extract.

Principles of Molecular Biology Techniques, Introduction to basic and advanced information on DNA, RNA and proteins. Isolation and purification of DNA samples from different cell types and tissues, DNA concentration techniques, Restriction Digestion and analysis, Ligation of DNA to create recombinant molecules. Southern Blotting: Agarose gel electrophoresis, DNA transfer techniques, isotopic and non-isotopic probe labeling methods, hybridization, X-ray film exposure, interpretation of results. Northern Blotting: Blotting of isolated and purified total and/or poly(A+) mRNA from cells and from tissues. Denaturing gel electrophoresis, RNA transfer techniques, isotopic and non-isotopic probe labeling methods, hybridization, X-ray film exposure, interpretation of results. Western Blotting, Fundamentals of PCR, primer design, PCR amplification tools and techniques, hot-start PCR, TA cloning, characterization of PCR.

2. Microbiology and Microbial Technology

The world of microbiology and development of microbiology as a scientific discipline, Methods of studying microbes: Introduction to various types of microbes, Growth of bacteria; Control of Microbes; Isolation, identification and characterization of bacteria. Prokaryotic cell structure and function, Transformation, Competent cell preparation. Microbial production, purification and bio-process applications of industrial enzymes; Production and purification of recombinant proteins on a large scale, Enzymes for industry/ medicine, Immobilized enzyme technology, Bioremediation of contaminated soil and waste land. Waste Management Strategies, Kinetics of microbial growth, Biopesticides in integrating pest management, Bio-energy, Bio-diesel: Tree borne and algal oils and Trans-esterification. Hydrogen and Electricity from microbes, Biosafety in relation to recombinant organisms.

3. Animal Biotechnology and Immunological Techniques

Routes of immunization, Types of adjuvant and their importance, Antigen- Antibodies interaction, Monoclonal and Polyclonal Antibodies, ELISA techniques, principle and applications, Immunoradiometric Assay: Principles and applications, Hybridoma technology. Gene therapy, Stem cell in therapeutics, Oncogenes, Tumor Suppressor Genes and Cancer Biology, AIDS and other Immuno-deficiency diseases.

4. Computational Biology and Computer AidedDrug Design

Sequence Alignment, PAM and BLOSUM matrices, Dot Plot, Local alignment (Smith-Waterman algorithm) and Global alignment (Needleman-Wunch algorithm), Multiple Sequence Alignment and its applications, Database searching using FASTA and BLAST, Phylogenetic Analysis, Construction and visualization of phylogenetic tree, Distance and character based tree construction methods, Molecular dynamics simulation, Structure-based drug design and Ligand-based drug design, Molecular docking and Virtual screening, in silico ADME/T prediction, QSAR modeling, Pharmacogenetics and Pharmacogenomics, Systems Biology, Networks in biology, Biological

Network Databases, Protein-protein interaction networks, Biochemical networks, Flux balance analysis.

5. Biosafety & Bioethics, field work, seminars & other academic activities would be mandatory with any of the above specialization courses.

Guidelines for Biosafety, Institutional Biosafety committee, InstitutionalAnimal ethics committee, Institutional ethics committee, Patents and Intellectual property Rights, Bioethics (Animal, Human), Human cloning

Writing research proposal, Communication skills (Writing and Oral), Seminar presentation, Design and teach one practical to the students

Text books

- Evolution of Translational Omics: Lessons Learned and the Institute of Medicine, Board on Health Sciences Policy, Board on Health Care Services · 2012
- Jenni Punt, Sharon Stranford, Patricia Jones, Judith A Ow "Kuby Immunology" WH Freeman & Co. eight edition 2022.
- IPR, Biosafety and Bioethics, Deepa Goel, Shomini Parashar
- Molecular Biology and Genetic Engineering By P. K. Gupta · 2008
- T. A. Brown. Gene Cloning and DNA Analysis: An Introduction, 6th Edition. 2010. Blackwell
- Graham .L. Patrick. An Introduction to Medicinal Chemistry.Oxford University Press. 1995

References books

- Cell Biology (Cytology, Biomolecules and Molecular Biology),Verma P.S. & Agarwal V.K.
- Cell Biologys,Gerald Karp · 2013
- Essential Bioinformatics - Jin Xiong · 2006· 2013
- Principles of Biochemistry, Lehninger-7th Edition, 2017
- Molecular Cloning: A Laboratory Manual (Fourth Edition) Michael R. Green, Howard Hughes Medical Institute, University of Massachusetts Medical School; Joseph Sambrook, Peter MacCallumCancer Institute, Melbourne, Australia

LABORATORY TECHNIQUES AND ADVANCED RESEARCH IN LIFE SCIENCES	
Course Code: 25PMB721	Continuous Evaluation: 40 Marks
Credits: 4	End Semester Examination: 60 Marks
L T P : 4 0 0	Course Type: Theory
Prerequisite: Introductory courses in Microbiology, Molecular Biology, or equivalent	

The course is providing a comprehensive understanding of advanced microbiology, combining theory with research applications.

Course Objectives (COs):

CO1: Understand advanced microbial diversity, evolution, and physiology.
CO2: Learn cutting-edge techniques in microbial genetics, genomics, and metagenomics.
CO3: Analyze recent research findings in microbiology and related fields.
CO4: Explore the role of microorganisms in healthcare, environment, and industry.
CO5: Develop independent research skills in microbiology and its interdisciplinary applications.

Course Learning Outcomes (CLOs):

CLO1: Demonstrate in-depth knowledge of microbial genetics, evolution, and physiology.
CLO2: Apply advanced molecular and genomic techniques to study microorganisms.
CLO3: Critically evaluate microbiological research and synthesize new ideas.
CLO4: Investigate the role of microorganisms in health, disease, and the environment.
CLO5: Design and execute independent research projects in microbiology.

CO and CLO Mapping:

Course Objectives (COs)	Course Learning Outcomes (CLOs)				
	CLO1	CLO2	CLO3	CLO4	CLO5
CO1					
CO2					
CO3					
CO4					
CO5					

Course Content:

Unit 1: Microbial Diversity and Evolution **12 Hr**

Classification and evolution of microorganisms, Microbial diversity and extremophiles, Culture-dependent and culture-independent techniques for studying microbial communities, Metagenomics and microbial community analysis, Microbial roles in ecosystem functioning.

Unit 2: Microbial Genetics and Genomics **12 Hr**

Genetic material in microorganisms: replication, transcription, translation, Mechanisms of gene transfer: conjugation, transformation, transduction, Genomics: next-generation sequencing and bioinformatics analysis, Epigenetic regulation in microbes, Applications of microbial genomics in biotechnology

Unit 3: Microbial Physiology and Metabolism **12 Hr**

Microbial cell structure and function, Energy metabolism in microorganisms: respiration and fermentation, Stress response in microorganisms, Microbial interactions: symbiosis and pathogenesis, Applications in bioreactors and bioprocess engineering

Unit 4: Microbes in Health and Disease **12 Hr**

Human microbiome and its role in health, Pathogenesis and host-microbe interactions, Antimicrobial resistance mechanisms, emerging infectious diseases, Microbial therapeutics: probiotics, prebiotics, and biotherapeutics

Unit 5: Environmental and Industrial Microbiology **12 Hr**

Microbial roles in nutrient cycling: carbon, nitrogen, sulfur cycles, Microbial bioremediation of pollutants, Microorganisms in bioenergy production: biofuels and biogas, Industrial applications of microorganisms: fermentation, enzymes, pharmaceuticals, Case studies in environmental microbiology and industrial biotechnology

Textbooks:

1. **Brock Biology of Microorganisms"**** by Michael T. Madigan, Kelly S. Bender, Daniel H. Buckley, W. Matthew Sattley, and David A. Stahl, 15th Edition, Pearson, 2017.
2. **Microbial Genetics** by Stanley R. Maloy, John E. Cronan, and David Freifelder. 2nd Edition, Jones and Bartlett Publishers, 1994.
3. **Molecular Microbiology: Diagnostic Principles and Practice** by David H. Persing, 3rd Edition, ASM Press, 2020.

Reference Books:

1. **Microbial Biotechnology: Fundamentals of Applied Microbiology** by Alexander N. Glazer and Hiroshi Nikaido, 2nd Edition, Cambridge University Press, 2007.
2. **Environmental Microbiology: Fundamentals and Applications** by Jean-Claude Bertrand, Pierre Caumette, Philippe Lebaron, 2nd Edition, Springer, 2015.
3. **Principles of Fermentation Technology** by Peter F. Stanbury, Allan Whitaker, Stephen J. Hall, 3rd Edition, Elsevier, 2016.

Research and Publication Ethics

RPE100 **Credit 2**

OBJECTIVE:

This course has total 6 units focusing on basics of philosophy of science and ethics, research integrity,
publication ethics. Hands-on-sessions are designed to identify research misconduct and predatory publications. Indexing and citation databases, open access publications, research metrics (citations, hindex, Impact Factor, etc.) and plagiarism tools will be introduced in this course.

COURSE CONTENTS:

1. Pedagogy: Classroom teaching, guestlectures, group discussions, and practical sessions.
2. Evaluation: Continuous assessment will be done through tutorials, assignments, quizzes, and group
discussions. Weightage will be given for active participation. Final written examination will be conducted
at the end of the course.
3. Course structure: The course comprises of six modules listed in table below. Each module has 4-5
units.

MODULES UNIT TITLE TEACHING HOURS

Theory

RPE 01 Philosophy and Ethics 4

RPE 02 Scientific Conduct 4

RPE 03 Publication Ethics 7

Practice

RPE 04 Open Access Publishing 4

RPE 05 Publication Misconduct 4

RPE 06 Databases and Research Metrics 7

Total 30

SYLLABUS IN DETAIL

THEORY

 RPE 01: PHILOSOPHY AND ETHICS (3 hrs.)

1. Introduction to philosophy: definition, nature and scope, concept, branches
2. Ethics: definition, moral philosophy, nature of moral judgments and reactions

 RPE 02: SCIENTIFICCONDUCT (5 hrs.)

1. Ethics with respect to science and research
2. Intellectual honesty and research integrity
3. Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP)
4. Redundant publications: duplicate and overlapping publications, salami slicing
5. Selective reporting and misrepresentation of data

2

 RPE 03: PUBLICATION ETHICS (7 hrs.)

1. Publication ethics: definition, introduction and importance
2. Best practices / standards setting initiatives and guidelines: COPE, WAME, etc.
3. Conflicts of interest
4. Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa, types
5. Violation of publication ethics, authorship and contributorship

6. Identification of publication misconduct, complaints and appeals
7. Predatory publishers and journals

PRACTICE

 RPE 04: OPEN ACCESS PUBLISHING (4 hrs.)

1. Open access publications and initiatives
2. SHERPA/RoMEO online resource to check publisher copyright & self-archiving policies
3. Software tool to identify predatory publications developed by SPPU
4. Journal finder/journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggested, etc.

 RPE 05: PUBLICATION MISCONDUCT (4hrs.)

(A) Group Discussions (2 hrs.)

1. Subject specific ethical issues, FFP, authorship
2. Conflicts of interest
3. Complaints and appeals: examples and fraud from India and abroad

(B) Software tools (2 hrs.):Use of plagiarism software like Tumitin, Urkund and other open source
software tools

 RPE 06: DATABASES AND RESEARCH METRICS (7hrs.)

(A) Databases (4 hrs.)

1. Indexing databases
2. Citation databases: Web of Science, Scopus, etc.

(B) Research Metrics (3 hrs.)

1. Impact Factor of journal as per Journal Citation Report, SNIP, SIR, IPP, Cite Score
2. Metrics: h-index, g index, i10 index, altmetrics