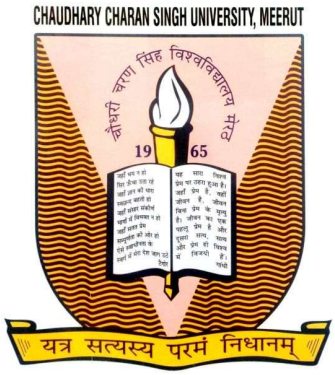
SCHEME AND CURRICULUM

Ph.D. Microbiology

Effective from the session 2023



Department of Microbiology
Chaudhary Charan Singh University
Meerut- 250004 (U.P.), India

SCHEME AND CURRICULUM
Ph.D. Microbiology
Department of Microbiology

Chaudhary Charan Singh University, Meerut-250004

Program Objectives

- Imparting skills and knowledge in advance research methodologies
- Solving the existing scientific problems in area of basic and applied microbiology
- Creating a highly skilled professionals with expertise in current trends of research in area of microbiology
- Imparting hand on experience to students of different techniques and instrumentations of advance biological sciences
- Generating independent researchers who are capable of translating the research developed at laboratory scale to the industrial level.
- Imparting skills needed to become a successful academician, scientists or entrepreneur
- Inculcating the scientific ethics, temperament to contribute to field of science and help in nation building

Program outcomes

- The students successfully completing the course will have following skills
- Solid basic knowledge of research methodologies in area of modern biological sciences
- Contributing new methodologies and results in area of the basic and advanced microbiology for taking the research to next level
- Innovative scientists, skilled workforce to work in specialized area of microbiology
- Independent researchers who can contribute through fulfilling responsibility of academicians, scientist and entrepreneur
- Can start independent research and can contribute in solving new problems faced in current science or in future.

Employability

- As academicians in different university or colleges at national and international levels
- As a researcher at different research institute at national and international level where they can initiate their independent research
- They can be absorbed by R& D sector of different biotechnological based company

Mission Statements of the Department

M1	To impart knowledge and training across the different fields of microbiology in order to equip students for academics/industry.
M2	To enhance awareness of current research across various fields of microbiology and to bring student's knowledge to the latest state-of-the-art in their area of interest.
M3	To integrate theoretical and experimental learning in order to encourage critical scientific thinking.

Program Educational Outcome (PEO)
After five years of successful completion of the program, the student will be able to

PEO1	Understand the research methodology and inculcate analytical thinking
PEO2	Develop inquisitive thinking and experimental applications of scientific learnings
PEO3	Learn methods of data analysis and data validation techniques
PEO4	Trained to become an expert in their field of research
PEO5	Demonstrate precision and reproducibility with their experimental set up

Program Outcomes (PO)
On the successful completion of the program, the student will be able to

PO1	Understand research applications and methodologies
PO2	In depth knowledge and understanding of their field
PO3	Imbibe critical scientific thinking
PO4	Design and develop specific experimental set up to answer their research questions
PO5	Demonstrate efficacy in skilled experiments
PO6	Preparedness to engage

Pre-PhD (Microbiology)

Syllabus
Effective from the session: 2023-2024

Semester	Core/ Elective	Paper Code	Title of the Paper	Credit
Ist	Core		Research Methodology	04
Ist	Core		Advanced Analytical Techniques	04
Ist	Core		Recent Trends in Microbiology	04
Ist			Assignment and Review	04
			Total	**16**

***Research Methodology**

***Common Course as decided by the University:**

Subject: Common for all faculties (Tentative)		
Course Code: -----	**Course Title:** Research Methodology	Theory

Course Objectives: The main objective of this paper is to

1. Identify and discuss the role and importance of research.
2. Identify and discuss the issues and concepts salient to the research process.
3. Identify and discuss the complex issues inherent in selecting a research problem, selecting an appropriate research design, and implementing a research project.
4. Identify and discuss the concepts and procedures of sampling, data collection, analysis and reporting.

Course Outcomes: At the end of this course, the students should be able to:

CO1. Understand some basic concepts of research and its methodologies.

CO2. Explain key research concepts and issues read, comprehend, and explain research articles in their academic discipline.

CO3. Select and define appropriate research problem and parameters.

CO4. Organize and conduct research (advanced project) in a more appropriate manner.

CO5. Write a research report and thesis.

CO6. Write a research proposal (grants).

Credits: 4	**Core Compulsory**
Max. Marks: 100	Min. Pass Marks:55

Total No. of Lectures-Tutorial (in hours per week): L-T: 4-0-0

Unit	**Topics**	**No. of Lectures 60**
I	Perception & Definition of Research, Objectives & Motivations of Research, Importance of Research, Types of Research, Research Methods versus Methodology, Process of Research; Review of Literature, Formulation of the Research Problem, Sources and Identification of a Research Problem, Status of the Research Problem, Formulation of Hypothesis, Research Design,	12
II	Outlines of Synopsis; Project Proposal, Project Report Writing; Research Paper Writing; Components of Research Reports; ThesisWriting: Outlines of Thesis, Reference citing, Formats of Writing References, Bibliography; Plagiarism.	12
III	Intellectual Property (IP), Intellectual Property Rights (IPR), Intellectual Property Law, Different fields of Intellectual Property Rights, Patents, Publication Ethics: Definitions importance Conflicts of Interest, Publication Misconduct Definition, Concept, Problems that lead to Unethical Behavior and vice	12

	versa, Types Identification of publication misconduct, Complaints and Appeals; Violation of publication ethics, Authorship and Contributor ship; Predatory Publishers and Journals.	
IV	Web Browsers, Search Engines, MS Word: Handling Graphs, Tables and Charts, Formatting in MS-Word, MS Power Point: Creating Slide Show, Screen Layout and Views, Applying Design Template, MS Excel: Features, Formulas and Functions.	12
V	Subject Classification Index, Citation, Citation Index, Impact Factor, h-index, i-10index, INFLIBNET, Introduction to Peer Reviewed and Open Access Journals, e-Journals, e-Library, Research Databases, Institute for Scientific Information (ISI) & Journal Citation Reports, Science Citation Index (SCI), Social Sciences Citation Index (SSCI), Arts and Humanities Citation Index (AHCI), Databases: UGC care list,Web of Science (WoS), Scopus.	12

Teaching Learning Process: Class discussions/ demonstrations, Power Point presentations, Class activities/ assignments, Field visits., Internship, etc.

Suggested Readings:

1. **Creswell. W**.: Research Design, Qualitative, Quantitative and Mixed Methods Approaches (3rdEdition), SAGE, Inc., 2018.
2. **Gupta. S**: Research Methodology: Methods and Statistical Techniques, Deep & Deep Publications, 2010.
3. **Gupta. S.P.:** Statistical Methods, Sultan Chand &Sons, 2014.
4. **Kumar. R**: Research Methodology: A Step-by-Step Guide for Beginners (3rd Edition), SAGE, Inc., 2011.
5. **Melville. S. and Goddard. W.:** Research Methodology: An Introduction (2nd edition), Juta Academic, 2004.
6. **Shortis, T**.: The Language of ICT: Information and Communication Technology, Taylor & Francis, 2016.
7. Research Methodology: Methods and Techniques by C.R. Kothari, Second revised edition
8. Research Methodology: A step by step guide for beginners by Ranjit Kumar
9. Research methodology: Methods and Statistical techniques, by Santosh Gupta
10. Statistical Methods, by S.P. Gupta
11. Research Design, Qualitative, Quantitative and mixed method approaches, by W. Creswell, 3rd edition.
12. Information Communication Technology, by Tim Shorts Handbook of Communication and Social Interaction Skills, by John O. Green, Brant Raney Burleson
13. **शोधप्रविधि – डॉ॰विनयमोहनशर्मा**
14. **अनुसंधानप्रविधि, सिद्धांतऔरप्रक्रिया - एस॰एन॰गणेशन**
15. **अनुसंधानप्रविधि - डॉ॰एस॰एन॰राय**
16. **अनुसंधानकीप्रविधिएवंप्रक्रिया–डॉ॰राजेन्द्रमिश्र**
17. **साहित्यअनुशीलन: विभिन्नदृष्टियाँ – डॉ॰दयाशंकरशुक्ल**
18. **अनुसंधानप्रविधिऔरप्रक्रिया–डॉ॰मुधखराटे/डॉ॰शिवाजीदेवरे**

Course: Advanced Analytical Techniques
Course Code:

Course objective: To provide an advanced understanding of the core principles of varioustechniques used in biological experiments.		
Learning outcomes: • Demonstrate principles of various basic and advanced techniques used in biologicalexperiments • Critically analyze and interpret the results obtained from biological experiments		
Credits: 4	**Core Compulsory**	
Max. Marks: 100	Min. Pass Marks:55	
Total No. of Lectures-Tutorial (in hours per week): L-T: 4-0-0		
UNIT	**TOPICS**	**No. of lectures 60**
I	**Recombinant DNA techniques** Use of Restriction and modification enzymes in cloning; Plasmid vector; Transformation and Plasmid isolation; PCR; Southern Blotting, Northern Blotting, RFLP, RAPD, Western Blotting, DNA finger printing, DNA sequencing methods (Sanger's chain termination method, and automated DNA sequencing); Real time PCR and Microarrays and their applications, RNAi and Genome editing.	**12**
II	**Biostatistics** Types and sources of data, data collection methods, primary data, secondary data, analysis for specific type of data, tabulation and graphical representation, central tendency, dispersion, skewness, correlation, regression, chi-square test, t- and F- tests, ANOVA- One way and two-way, important non-parametric tests like Sign, Run, Kendall's coefficient.	**12**
III	**Genomics and Proteomics** Next generation sequencing (NGS); Genome annotation, Phylogenetic Analysis-Methods and Tools, gene prediction, ORF finding. Homology: Ortholog& paralog Global expression profiling; RNA-seq. and protein expression, Microbial genomic resources.UV and fluorescence spectroscopy; Circular Dichroism; Mass spectrometry - Principles and their applications; Protein separation techniques and instrumentation (Gel filtration, Ion exchange and Affinity chromatography, 1D and 2D Polyacrylamide gel electrophoresis); Immunochemical detection of proteins.; Introduction and overview of Metabolomics; Nanotechnology and its Applications in Microbiology.	**12**
IV	**Microbial and Cellular Techniques** Microbial techniques; Microbial growth and kinetics (synchronous culture, continuous and batch and fed-batch cultures, chemostat and turbidostat); Methods for identifying microbes (polyphasic approach); Cell disruption and fractionation of organelles; Isolation and purification of membrane proteins; Various methods to study cell-cell and cell-virus fusion; Flow cytometry techniques; Confocal and Atomic Force Microscopy; Biosafety &Types of	**12**

	Biosafety cabinets.	
V	**Experimental Models and instrumentation in Biology** Rodent and non-rodent models, worms as models for studying human-microbe interactions, Handling and maintenance of animals, Ventilated cages, Different routes of injections and collection of various biological components, Formulation of feed and design of experiments. Principle, instrumentation and environmental applications of Neutron Activation Analysis, X- Ray Fluorescence, X-Ray Diffraction, AAS, Hyphenated techniques-LC-MS/MS, GC-MS/MS, HPTLC-MS, ICP-MS.	**12**

Suggested readings:

1. Ausubel FW. Current Protocols in Molecular Biology. Wiley-Blackwell. 2011. Print
2. Burgess R. and Deutcher MP. Guide to Protein Purification. Academic Press, San Diego, USA. 2009. Print
3. Butler, M. Animal Cell Culture & Technology. 1st edition. Tailor & Francis Publishers (UK). 2004. Print
4. Freshney, R.I. Culture of Animal cells: A Manual of Basic Technique and specialized applications. 7th edition. Wiley-Blackwell. 2016. Print
5. Green M.R. and Sambrook J. Molecular Cloning: A Laboratory Manual. Vol. I, II, III. 4th edition. Cold spring harbor laboratory press. 2013. Print
6. Principles and Techniques of Biochemistry and Molecular Biology (2018) 8th ed. Wilson K and Walker J, Cambridge University Press, ISBN No. 131661476X.
7. Physical Biochemistry: Principles and Applications (2010) 2nd ed., Sheehan, D., Wiley Blackwell (West Sussex), ISBN: 978-0-470-85602-4 / ISBN: 978-0-470-85603-1.
8. Physical Biochemistry: Applications to Biochemistry and Molecular Biology (1982) 2nd ed., Freifelder D, W.H. Freeman and Company (New York), ISBN:0-7167-1315-2 / ISBN:0-7167-1444-2.
9. Instrumental methods of analysis (1988) 7th ed. H. H. Willard, L. L. Merritt, J. A. Dean and F. A. Settle (United States).
10. D.S. Goodsell 2013 Bio-nanotechnology: Lessons from Nature, John Wiley
11. C. N. Banwell and E. M. McCash; Fundamentals of Molecular Spectroscopy, 4th Edition. Tata McGraw Hill, 1994.
12. D. L. Pavia, G. M. Lampman, G. S. Kriz and J. R. Vyvyan, Introduction to Spectroscopy, 5th Edition. Cengage India, 2011

Recent Trends in Microbiology
Course Code:

Course code	**Course Title**: Recent Trends in Microbiology	Theory
Course objective: To provide an advanced understanding of the core principles of various techniques used in biological experiments. **Learning outcomes:** • Demonstrate principles of various basic and advanced techniques used in biological experiments • Critically analyze and interpret the results obtained from biological experiments		
Credits: 4		**Core Compulsory**
Max. Marks: 100		Min. Pass Marks:55
Total No. of Lectures-Tutorial (in hours per week): L-T: 4-0-0		

Unit	**Topics**	**No. of lectures: 60**
I	**Agriculture and Environment Microbiology** Advances in biofertilizer technology and biological nitrogen fixation. Microbial successions and transformation of organic matter during composting and biogas production; Microorganisms and microbial enzymes as soil health indicators, biological control of fungal pathogens and insects. Microbial fuel cell-principles and technological Implications, Bioremediation, Bio-stimulation, Bioaugmentation and Biosorption, Applications of bioremediation to decontaminate various niches. Recent techniques in industrial wastewater treatment and disposal processes.	**12**
II	**Clinical Microbiology** Microbial Interactions with humans –normal microflora of human body, Collection, transport and culturing of clinical samples (sputum, urine, blood,stools) for microbiological analysis; Detection and identification of Bacteria, Viruses (Plants and Animal) and Fungi (Plants and Animal) using automated microbial identification systems and molecular techniques. Quorum sensing and Quorum quenching in bacteria, Determination of MIC of Antimicrobial agents; Mechanism of resistance to antimicrobial agents; Molecular methods for detecting antibacterial and antiviral resistance gene.	**12**
III	**Microbiome** An introduction of human microbiome project, Human gut/oral/skin microbiota, current research methods of microbiome analysis including culture-dependent and culture-independent tools, whole genome vs. 16srRNA/ITS/Multi-loci-based gene analysis of microbiome, role of human microbiome in health and communicable or non-communicable diseases (Cancer, Diabetes, Malnutrition etc.), human gut microbiota and immunity, Role of microbiome in therapeutic and diagnostic. A brief overview of plant and animal microbiome	**12**
IV	**Host Pathogen interaction** Interaction of microorganisms with plants and their effect on plant growth. Plant pathogenesis, Growth, reproduction, survival and	**12**

	dispersal of important plant pathogens. Plant disease resistance – pathogen associated molecular patterns, pattern recognition receptors, PTI, effectors, ETI. Molecular approaches for plant protection - applications and constraints. Plantdefense strategies; hypersensitivity responses including oxidative burst, phenolics, phytoalexins, PR proteins, elicitors and their effects on host plants.	
V	**Fermentation Technology** Characteristics of industrially relevant microbes, their maintenance and preservation; Bioreactor design and types of fermenter; Microbial growth kinetics in batch, continuous & fed-batch fermentation process**;** Microbial growth kinetics-Monod equation; Raw materials used in fermentation media and upstream processes; Solid state fermentation & submerged fermentation; Downstream processing (product recovery), Biotransformation.Microbial Strain Improvement using recombinant DNA technology and metabolic engineering; Fermentation process economics	**12**

Suggested readings:

1. Rao, N.S.S. (2015). Soil Microbiology. Oxford & IBH Publishing Co., New Delhi.
2. Jeffery C. Pommerville (2014). Alcamo's Fundamental Microbiology, Jones pub.
3. Pepper IL,Gerba CP and Brusseau ML (2006). Environmental and Pollution Science. Academic Press. USA
4. Forster CF and John DA (2000). Environmental Biotechnology. Ellis Horwood Ltd. Publication.
5. Greenwood D (2015). Medical Microbiology, 18th Edition, Elsvier.
6. Murray PR, Pfaller MA, Tenover FC and Yolken RH (2007). Clinical Microbiology. ASM Press.
7. Reed G (2004). Industrial Microbiology. CBS Publishers (AVI Publishing Co.)
8. Stanbury PF, Whitekar A. and Hall (2006). Principles of Fermentation Technology. Pergaman. McNeul and Harvey.
9. Creuger and Creuger (2005). Biotechnology- A textbook of Industrial Microbiology, Panima pub.
10. Casida LE (2010). Industrial Microbiology, Wiley Eastern.
11. Atlas RM (Latest Edition). Petroleum Microbiology. Macmillan Publishing Co.
12. Willey J, Sherwood L. and Woolverton C (2014). Prescott's Microbiology, 9thedi McGraw Hil

Assignment and Review	04

(Rakesh Pandey)
Subject Expert

(Hemant Kumar Gautam)
Subject Expert

(Rajesh Kumar Sharma)
Subject Expert

(Rajeev Singh)
Subject Expert

(Y. Vimala)
Coordinator

(Jitender Singh)
Head, Microbiology

(Prof. Jaimala)
Dean, Faculty of Science