DEPARTENT OF MICROBIOLOGY
M.Phil / Ph.D Course Work Syllabus

CONTENTS

Paper Code	Paper Number and Name	Credits	Full Marks
MIC-RS-C-101	Research Methodology (School of Life Sciences Level Paper) – To be prepared at the School Level	4 Credits	100 Marks
MIC-RS-C-102	Preparation of Research Proposal	4 Credits	100 Marks
MIC-RS-E-103	Emerging areas of research in Medical Microbiology	4 Credits	100 Marks
MIC-RS-E-104	Emerging areas of research in Food Microbiology	4 Credits	100 Marks
MIC-RS-E-105	Emerging areas of research in Environmental Microbiology	4 Credits	100 Marks
MIC-RS-E-106	Emerging areas of research in Industrial Microbiology	4 Credits	100 Marks
	Dissertation for M. Phil	12 Credits	

(*) - **Candidate has to opt any one Elective (E) paper depending on their choice of specialization.**

Paper- 1: MIC-RS-C-102: Research Methodology **4 Credit**

To be prepared at the School Level

Paper - 2: MIC-RS-C-102: Preparation of Research Proposal **4 Credit**

Preparation of Research Proposal through review and survey of literature in the topic of research. Identification of gaps in the knowledge and preparation of specific objectives and rationale to bridge the gaps. Preparation of a real time budget and infrastructure requirements.

(**To be evaluated by all faculty members**)

Paper -3: MIC-RS-E-103: Emerging areas of research in Medical Microbiology **4 Credit**

Unit I: Microbiological Techniques

Aseptic techniques: (Physical and chemical methods of Sterilization and Disinfection), Isolation and pure culture Techniques, Staining (Simple staining, Grams staining, Capsule, Spore and Acid fast staining), Sample selection, sample collection and sample transport. Preservation Techniques. Antibiotic susceptibility techniques: disc diffusion and Minimum Inhibitory Concentration. Brief overview of Biosafety, Institutional Biosafety Committee, Institutional Ethical Committee. Biodiversity Act.

Unit II: Study of Important Human Pathogens

Infection and disease process in humans. Pathogenesis, clinical feature and Laboratory diagnosis of important bacterial, viral, fungal and parasitic diseases. Important molecular methods of identification and typing of pathogenic microorganisms. Vaccines.

Unit III: Advanced Techniques in Microbiology: I

Polymerase Chain Reaction (PCR), Denaturing Gradient Gel Electrophoresis (DGGE), Restriction Fragment Length Polymorphism (RFLP), Amplified Ribosomal DNA and Restriction Analysis (ARDRA), PFGE.

Unit IV: Advanced Techniques in Microbiology: II

Phenotypic Identification of bacteria and fungi including automated method by Biolog and other methods. Sequencing including next generation sequencing techniques. Techniques of metagenomics.

Reading List:

1. Ananthanarayan and Paniker. 2013. *Ananthanarayan and Paniker's Textbook of Microbiology*. C.K. Jayaram Paniker, 9th edition, Orient Blackswan, India.
2. Bottone, E. J. 2006. *Atlas of the Clinical Microbiology of Infectious Diseases, Volume 2: Viral, Fungal and Parasitic Agents.* 1st edition, Informa Health Care Publishing, USA.
3. Brooks, G., Carroll, K. C., Butel, J. and Morse, S. 2007. *Medical Microbiology (Jawetz, Melnick, and Adelberg's Medical Microbiology)*. 24th edition ,McGraw-Hill Medical,USA.
4. Cappuccino, J. G. and Sherman, N. 2007. *Microbiology- A Laboratory Manual.* 7th Edition, Pearson Education, Inc. and Dorling Kindersley (India) Pvt Ltd, Delhi, India.
5. Collee, J.G., Fraser, A. G., Marmion, B. P. Simmons. 2011. *Mackie & McCartney Practical Medical Microbiology*. 14th edition, Churchill Livingstone, UK/
6. Goldman, E and Green, L.H. 2008. Practical Handbook of Microbiology. 2nd Edition, CRC Press, USA.
7. Murray, P. R., Baron, E. J., Jorgensen, J. H. and Landry, M. J. 2014. *Manual of Clinical Microbiology* (2 Volume Set). 10th edition, ASM Press, USA.

Paper - 4: MIC-RS-E-104: Emerging areas of research in Food Microbiology 4 Credit

Unit I: Microbiological Techniques

Aseptic techniques: (Physical and chemical methods of Sterilization and disinfection), Isolation and pure culture Techniques, Staining (Simple staining, Grams staining, Capsule, Spore and Acid fast staining), Sample selection, sample collection and sample transport. Preservation Techniques. Antibiotic susceptibility techniques: disc diffusion and Minimum Inhibitory Concentration. Brief overview of Biosafety, Institutional Biosafety Committee, Institutional Ethical Committee.

Unit II: Microorganisms in foods and their study

Factors affecting growth and survival of microorganisms in foods; Classification, physiology and Genotypic identification of microorganisms associated with the foods: Lactic acid bacteria, *Bifidobacteria, Propionibacteria*, *Bacillus*, yeasts and molds; techniques to study un-culturable microorganisms in foods.

Unit III: Prebiotics, Probiotics and Functional foods

Brief overview of gut microbiome; Prebiotic and Probiotic: Prebiotics – criteria of prebiotics, effects of prebiotics on metabolism and or absorption of nutrients; prebiotics in infant formulas; Probiotics: Criteria for probiotics, Development of Probiotics for animal and human use; Functional foods- health claims and benefits, Development of functional foods.

Unit IV: Food Safety Management

Indicators of food safety, Microbiological quality and microbiological criteria, sampling plans; quality control using microbiological criteria, control at source; Good Manufacturing Practices; Rapid detection of pathogenic bacteria and viruses in the foods by various methods.

Reading List:

1. Vos, P., Garrity, G., Jones, D., Krieg, N.R., Ludwig, W., Rainey, F.A., Schleifer, K.-H., Whitman, W. (Eds.), M. 2009. *Bergey's Manual of Systematic Bacteriology*, The Firmicutes, Volume 3, Springer-Verlag, New York.
2. Gibson, G.R. and Christine M. Williams. 2001. *Functional foods: Concept to product*. CRC Press, Boca Raton, Boston.
3. Gibson, GR and Roberfroid 2008 Handbook of Prebiotics, CRC Press, Taylor & Francis Group, Boca Raton, FL
4. Goktepe, I., Juneja, V.K. and Ahmedna M. 2006. *Probiotics in Food Safety and Human Health*. CRC Press, Taylor & Francis Group, Boca Raton, FL
5. Adams, M.R. and Nout, M.J.R. 2001. *Fermentations and Food Safety. Aspen Publication.*
   Aspen Publishers, Inc., Gaithersburg, Maryland.
6. Salminen, S. and Wright, A.V. 1998. Lactic *acid bacteria Microbiology and Functional Aspects.* 2nd Ed., Marcel Dekker, New York.

7. Wood, B.J.B. and Holzalpfel, W.H. 1995. The genera of Lactic acid bacteria. Vol 1 and 2. Springer, US.

Paper - 4: MIC-RS-E-105: Emerging areas of research in Environmental Microbiology 4 Credit

Unit I: Microbiological Techniques

Aseptic techniques: (Physical and chemical methods of Sterilization and disinfection), Isolation and pure culture Techniques, Staining (Simple staining, Grams staining, Capsule, Spore and Acid fast staining), Sample selection, sample collection and sample transport. Preservation Techniques. Antibiotic susceptibility techniques: disc diffusion and Minimum Inhibitory Concentration. Brief overview of Biosafety, Institutional Biosafety Committee, Institutional Ethical Committee.

Unit II: Instrumentation Techniques

Polymerase Chain Reaction (PCR), Recombinant DNA techniques, Restriction Fragment Length Polymorphism (RFLP), Denaturing/ Temperature Gradient Gel Electrophoresis (DGGE/TGGE), Sanger Sequencing, Pyrosequencing, HPLC, HPTLC, GC-MS, LC-MS.

Unit III: Bacterial response to antimicrobials

Effects of various phytochemicals and antibiotics on microorganisms. Methods of phytochemical extraction. Cellular defense strategy of microorganisms against phytochemicals, cellular oxyradicals and antioxidative strategies in bacteria. New perspectives on the use of phytochemicals as antimicrobial and antioxidant agents.

Unit IV: Extreme Environments

Extremophiles: Introduction, Diversity, Habitat, Physiology and applications of Acidophilic, Alkaliphilic. Thermophilic, Psychrophilic, Barophilic, Halophilic microorganism and Microorganism resistant to radiations.

Reading List:

1. Patra, A.K (Ed.). 2012**.** *Dietary Phytochemicals and Microbes*. Springer.
2. Anitori, R. P. 2012. *Extremophiles: Microbiology and Biotechnology*. Caister Academic Press.
3. Field, K. G. and Ream, W. 1999. *Molecular Biology Techniques: An Intensive Laboratory Course.* Academic Press.
4. Gerday, C., Glansdorff, N. (Eds) 2007. *Physiology and Biochemistry of Extremophiles*, first edition, ASM Press.
5. Harborne, J. B. Phytochemical Methods: A Guide to Modern Techniques of Plant Analysis.2012. Springer Science & Business Media.
6. Robb, F. Antranikian, G., Gorgan, D. Driessen, A. 2012. *Thermophiles: Biology and Technology at High Temperature*, CRC Press.

7. Wilson, K. and Walker, J. 2008. *Practical Biochemistry - Principles and Techniques*. 5th edition, Cambridge Low Price Edition.

Paper – 6: MIC-RS-E-106: Emerging areas of research in Industrial Microbiology 4 Credits

Unit I: Introduction to Industrial Microbiology

An introduction to fermentation process. Screening of industrial microbes – Detection and assay of fermentation products. Classification of fermentation types. Metabolic engineering. Strain selection and improvement, mutation - protoplast fusion and recombinant DNA technique for strain development. Preservation methods of cultures.

Unit II: Microbial growth and Fermentation kinetics:

Batch kinetics –single substrate, dual substrates – sequential utilization, multiple substrates – simultaneous utilization, substrate inhibition, product synthesis (primary and secondary metabolite), toxic inhibition, death constant.

Fed-batch kinetics – fixed volume, variable volume and cyclic fed-batch, applications and examples of fed-batch systems.

Continuous cultivation system –applications and examples of continuous cultivation system; comparison between various cultivation systems.

Unit III: Bioprocess System:

Bioprocess Technology. Types of Fermenters. Fermentation in batch culture: Media formulation, Solid-Sate and submerged fermentation; mechanically & non-mechanically agitated fermenters.
Fermentation processes: optimization, and factors affecting downstream processing and recovery.

Unit IV: Fermentation technology for microbial products

Fermentative production of antibiotics (Penicillin), Solvents (Ethanol), Biopolymer (PHAs) and Recombinant DNA products e.g. Insulin and amylase. Mixed Acid Fermentation
Industrial application of enzymes, Microbial leaching and Biodegradation.
Enzyme immobilization and different techniques used for immobilizationand cell based biotransformation.

Reading List:

1. Casida, L.E. 2005.*Industrial Microbiology*. 2nd edition. New Age International Limited.
2. Crueger, W. and Crueger, A. 2003.*Biotechnology: A textbook of Industrial Microbiology*.
3. Panima Publishing Corporation.Stanbury, P. F., Hall, S. J. and Whitaker, A. 1999. *Principles of Fermentation Technology*. 2nd edition, Butterworth-Heinemann.
4. Flickinger, M. C. and Drew S. W., The Encyclopedia of Bioprocess Technology: Fermentation, Biocatalysis and Bioseparation, Volumes 1 - 5, John Wiley Publisher.