VANITA VISHRAM WOMEN'S UNIVERSITY
SCHOOL OF SCIENCES
DEPARTMENT OF MICROBIOLOGY

MASTER OF SCIENCE (M.Sc.) MICROBIOLOGY PROGRAMME
under Learning Outcomes-based Curriculum Framework (LOCF)
for Post Graduate (PG) Education

SEMESTERS 4
Core Courses (CC)
Syllabus applicable to the students seeking admission in the M.Sc.- Microbiology
under LOCF
w.e.f. the Academic Year 2022-2023

Course Structure

Semester IV				
Number of Core Courses	**Credits in each Core Course**			
Course	Theory	Practical	Tutorial	Credits
MB21370: Molecular Virology	4	0	0	4
MB21380: Dissertation		16		16
Core course 'n' (total number) = 1T+1P	4	16	0	4
Total credits in Core Course	**20**			

MASTER OF SCIENCE MICROBIOLOGY

SEMESTER 4
CORE COURSE PAPER 12

MB21370 MOLECULAR VIROLOGY

Course Objectives:

The course will facilitate the understanding of molecular virology by examining common processes and principles in viruses to illustrate viral complexity, to understand viral reproduction. The course will teach the strategies by which viruses spread within a host, and are maintained within populations. It covers the molecular biology of viral reproduction and addresses the interplay between viruses and their host organisms

Course learning outcomes : By the end of this course the students-

CO1: Is able to describe classification of viruses

CO2: Is able to describe tools for studying virus structure, process of virus attachment and entry, virus assembly and release

CO3: Is able to describe steps in replication of genome of RNA viruses, retroviruses, and DNA viruses

CO4: Is able to describe steps in virus infection, transmission, patterns of infection, virus virulence, and host defense against virus infection

CO5: Is able to describe methods of making virus vaccines and antiviral drugs, drivers of virus evolution, and emerging viruses

CO6: Is able to describe unusual infectious agents, virus mediated cellular transformation

and oncogenesis

CO7: Is able to describe evasion strategies used by viruses, and learn to apply their knowledge to investigate virus outbreak

THEORY COURSE (4 Credits)		
Unit-1	**Virus Structure and Assembly:** General structure of virion &types,Virus attachment and entry, Initiation of infection, Affinity, Avidity, cellular receptor for viruses. Getting into the nucleus, virus disassembly, metastable structures, concentrating components for assembly, getting things to the right place. How do viruses make sub-assemblies, sequential and concerted assembly. Packaging signals, packaging of segmented genome, acquisition of an envelope, budding strategies.	**15 Lectures**
Uni-2	**RNA directed RNA synthesis, Reverse Transcription and Integration, Translation, and genome replication of DNA viruses:** Identification of RNA polymerase, how RNA synthesis occurs in viruses? Reverse transcriptase, retrovirus genome organization, steps of DNA synthesis in retroviruses. Regulation of translation in virus infected cells. Basic rules of genome replication in DNA viruses, viral origins of DNA replication. Generic steps in transcription, host polymerases, initiation, splicing, alternate splicing, promoter structure, steps in regulation of transcription, enhancers, virus coded transcriptional regulators, transcriptional cascade, export.	**15 Lectures**
Unit-3	**Virus Infections basics, interaction with host, acute and persistent infections:** Fundamental questions of viral pathogenesis. Virion defenses to hostile environment, viral spread, viremia, determinants of tissue tropism. Virus shedding, transmission of infection, host defense, innate immune response, virus virulence, identifying virulence genes. Toxic viral proteins, cellular virulence genes, immunopathology, systemic inflammatory response syndrome. Immune complexes, virus induced auto-immunity, general pattern of infection. Inapparent acute infections, defense against the acute infection. Influenza, Polio, Measles, Rotavirus, persistent infections, chronic and latent Infections.	**15 Lectures**
Unit-4	**Vaccines and antiViral drugs, virus evolution and emerging viruses:** Herd immunity, requirement of an effective vaccine, different ways of making vaccine. Inactivated vaccine, subunit vaccines, subunit vaccines, live attenuated vaccines, polio eradication. Antiviral drugs, search for antiviral drugs, the path for drug discovery, mechanism based screens, cell based screen, antiviral screening. Resistance to antiviral drugs, main drivers of virus evolution, the quasi-species concept, error threshold, genetic bottlenecks, Muller ratchet, genetic shift and drift. Theories on origin of virus, evolution of new viruses, emerging viruses, Factors that drive viral emergence, evolving host-virus relationship.	**15 Lectures**

Reference Book

1. Principles of Virology: Molecular Biology, Pathogenesis and Control of Animal Viruses

by S.J. Flint, L.W. Enquist, V.R. Racaniello, A.M. Skalka. 4th edition. ASM Press. 2015.

2. Introduction to Modern Virology by N. Dimmock, A. Easton, K. Leppard. 7th edition. Blackwell Publishing. 2016.

3. Basic Virology by Edward K. Wanger, M. Hewiett, D. Bloom, D. Camerini. 3rd edition. Blackwell Publishing. 2007.

4. Principles of Molecular Virology by A.J. Cann. 6th edition. Elsevier Academic Press. 2015.

MB21380: Dissertation

Max marks: 400 **Duration: 240 hours (16 credits)**

Continuous evaluation (IA) 160 marks

Dissertation 200 marks

Presentation and *viva-voce* 40 marks

Total **400** marks

Course Objectives:

The primary object of this course is to expose the student to research culture and technology. The student learns how to choose a research problem, plan and perform experiments, collect data, and analyze the data qualitatively and quantitatively. The student gets trained in presenting the results in the form of an oral presentation as well as a thesis. The student presents his/ her research orally at the end of the semester, and this is coupled to a *viva-voce*. This not only equips the student fora career in research/ industry, but also fosters self-confidence and self-reliance in the student as he/she learns to work and think independently.

Course Learning Outcomes:

CO1. Student is able to conceive a problem based on current published research

CO2. Student is able to carry out comprehensive survey of literature on the topic of research

CO3. Student is able to make culture media for various microbes

CO4. Student is able to isolate microorganism from different environmental/ food sources

CO5. Student is able to identify the isolated microorganism using biochemical and molecular methods

CO6. Student is able to assess the microorganism's ability to produce various enzymes and becomes well-versed in different enzymatic assay systems

CO7. Student learns correct handling and use of instruments

CO8. Student learns correct handling of reagents and chemicals

CO9. Student learns how to execute experiments correctly.

CO10. Student learns the importance of including controls in all experiments

CO11. Student learns how to plot the results.

CO12. Student learns how to analyze data, using statistical tools where necessary

CO13. Student learns how to interpret the results from all possible angles.

CO14. Student learns how to present the project in the form of a slide show before and audience of 20-30 people.

CO15. Student is exposed to the science of thesis writing.

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SEMESTERS 4
Department Specific Elective (DE)

Syllabus applicable to the students seeking admission in the M.Sc.- Microbiology
under LOCF
w.e.f. the Academic Year 2023-2024

Structure of the Course

Semester IV				
Number of Department Elective Courses	**Credits in each Elective Course**			
Course	Theory	Practical	Tutorial	Credits
MB24020: Advance Instrumental Microbiology	4	0	0	4
MB24040: Food Microbiology	4	0	0	4
MB24050: Research Methodology	4	0	0	4
MB24060: Scientific Writing	4	0	0	4
Elective Course 'n'(total no) = 1T	-	-	-	-
Total credits in Elective Courses	**8**			
Two Elective will be from list of Four subjects				

List of Elective Courses

Department Elective (DE)

1. MB24010: Biophysical and Biochemical Methods**
2. MB24020: Advance Instrumental Microbiology
3. MB24030: Plant-Pathogen Interactions**
4. MB24040: Food Microbiology**
5. MB24050: Research Methodology
6. MB24060: Scientific Writing

MASTER OF SCIENCE MICROBIOLOGY

SEMESTER 4
DEPARTMENT ELECTIVE COURSE PAPER 2

MB24020 ADVANCED INSTRUMENTAL MICROBIOLOGY

Course Objectives:

To introduce the student to the variety of biophysical and biochemical techniques currently available to probe the structure and function of the biological macromolecules, make them aware of the physical principles behind each technique and the instrumentation involved, make them familiar with various methods of analyzing the output data, and to build a strong foundation in the area of bacterial cell structure, division, survival and propagation.

Course learning outcomes : By the end of this course the students-

CO1: Be able to carry out the analysis of the data from CD and Fluorescence experiments to monitor the stability of the protein under different environmental conditions

CO2: Be familiar with the output of fluorescence and confocal microscopy

CO3: Be able to evaluate the quality and highlights of the structure reported/deposited in journals/structural databases.

CO4: Be able to design a multi-step purification protocol for a target protein

CO5: Be able to understand and correctly interpret the migration of protein molecule on PAGE under native and SDS conditions

CO6: Follow the safety precautions while using radioactive methods

THEORY COURSE
(4 Credits)

Unit-1	**Separation techniques: Centrifugation Techniques:** Basics of centrifugation based methods: viscosity, diffusion, sedimentation equilibrium, dialysis, solvent fractionation, centrifugation, Biological applications and interpretations of Density Gradient methods, Ultracentrifugation methods.	**15 Lectures**
Uni-2	**Separation techniques: Electrophoretic Techniques:** Basics of electrophoresis: electrophoretic mobility and affecting factors, Biological applications and interpretation of different types of electrophoresis: PAGE, gradient gel, Agarose Gel Electrophoresis, 2D Electrophoresis, Dialectrophoresis, iso-electric focusing.	**15 Lectures**
Unit-3	**Macromolecular structure determination:** Basics of X-ray Crystallography: symmetry, space groups, unit cells, structure factors, reciprocal lattice, Fourier transform, electron density, phase problems and it's solutions, Biological applications and interpretations. Basics of Magnetic resonance spectroscopy: chemical shifts, resonance condition, relaxation studies, coupling and decoupling, biological application and interpretations of Nuclear Magnetic Resonance (NMR) & Electron Spin Resonance (ESR).	**15 Lectures**

Unit-4	**Molecular Diagnostics & microbial epidemiology:** Objectives of microbial epidemiology. Biochemical and Immunological tools - biotyping, serotyping, phage typing, multilocus enzyme electrophoresis (MLEE); Molecular typing: RAPD, rep (REP, ERIC, BOX)-PCR, IS based typing, RFLP, PFGE, AFLP, SSR, SNP, MLST, VNTR and whole genome sequence, use of geographical information system (GIS) for microbial epidemiology	**15 Lectures**

Reference Book

1. Fundamentals of Molecular Spectroscopy by Colin Banwell. 4th edition. McGraw Hill.1994.
2. Principles of Fluorescence Spectroscopy by J. Lakowicz, R. Joseph. 2nd edition.Springer.1999.
3. Molecular Fluorescence: principles and Applications by B. Valeur. 2nd edition. Wiley. 2013.
4. NMR – Conformation of Biological Molecules by G. Govil, R.V. Hosur. 1st edition. Springer- Verlag, 2011.
5. Biomolecular crystallography: Principles, practice and application to structural biology by B. Rupp. 1st edition. Garland Science. 2009.
6. Optical methods in Biology by E.M. Slayter. 1st edition. John Wiley. 1970.
7. NMR of proteins and nucleic Acids by K. Wuthrich. 1st edition. Wiley Interscience Publications. 1988.
8. Biophysical chemistry, Part 2: Techniques by C. R. Cantor, P. R. Schimmel. 1st edition. W.H Freeman and Co. 2008.

SEMESTER 3
DEPARTMENT ELECTIVE COURSE PAPER 4
MB24040 FOOD MICROBIOLOGY

Course Objectives:

The course will enable students to understand the taxonomical classification, phenotypic and biochemical identification of food associated molds, yeasts, yeast-like fungi and bacteria. The course will teach the strategies to develop fermented and non-fermented milk products, plant based products, fish products, meat products bioactive compounds and malt beverages, wines, distilled liquors and vinegar. The role of microbes in food spoilage, preservation and various food borne diseases will be discussed

Course learning outcomes : By the end of this course the students-

CO1: Will know about production and evaluation of the quality of starter cultures and fermented milk products and understands the use and production of probiotics, prebiotics and nutraceuticals.

CO2: Is aware of fermentation protocols for production of microbial biomass such as edible yeasts, mushrooms, single cell proteins and single cell oils. The student also learns about production of microbial carotenoid pigments such as lycopene and β-carotene.

CO3: Gathers information regarding microbes causing food intoxications and food-borne

infections.

CO4: Knows traditional food preservation techniques including drying, salting, pickling, refrigeration, freezing, oxidation, vacuum packaging, canning/bottling, smoking, sugaring, chemical preservation and irradiation.

CO5: Is able to utilize modern techniques viz. high-pressure processing (HHP), bacteriocins,manosonication(MS) and pulsed electric field (PEF) for effective food preservation. Thestudent can also calculate kinetics of inactivation, process and product parameters.

CO6: Gains knowledge about conventional methods for food quality analysis and is able to use the most recent and non-invasive techniques of quantification and detection of food borne microbes and pathogens such asESS and various new imaging techniques.

CO7: Understands the relevance of microbial standards for food safety, quality assurance programs that revolutionize food safety.

THEORY COURSE
(4 Credits)

Unit-1	**Microbiology of foods fermented food:** Microbial habitat of specific food materials, adaptations and changes in microbiome of food. Production of fermented milk and milk products, plant-based products, fish products, meat products and nutraceuticals. Manufacture of starter cultures from lab to pilot scale. Batch submerged and solid-state fermentation of foods	**15 Lectures**
Uni-2	**Food beverages and enzymes:** Concept of human microbiome, probiotics and prebiotics. Insight into health benefits of fermented milk products. Understanding benefits of tradition and non-traditional fermented foods. Introduction to the concept of bioactive compounds and brief study of such compounds from fermented foods including malt beverages, wines, distilled liquors and vinegar.	**15 Lectures**
Unit-3	**Microbial spoilage of foods and Food preservation:** Types and causes of spoilage of cereals and cereals products, spoilage of vegetables and fruits, spoilage of meat and meat products, spoilage of eggs and other poultry products, spoilage of milk and milk products. Study of microorganisms responsible for spoilage and microbial succession during spoilage. General principles of food preservation, various physical, chemical, and biological methods of preservation. New developments in food preservation techniques. **8**	**15 Lectures**
Unit-4	**Food-borne diseases:** Food borne infections including bacterial, viral and fungal infections. Study of infections due to food borne parasites. In depth study of various types and causes of food intoxication. Summary of prevention of microbial food infections. Identification and first aid for specific types of food infections.	**15 Lectures**

Reference Book

1. Food Microbiology by W.C. Frazier, D.C. Westhoff , K.N. Vanitha. 5th edition. McGrawHill Education. 2013.

2. Modern Food Microbiology by J.M. Jay, M.J. Loessner, D.A. Golden. 7th edition. Springer. 2006.

3. Fundamental Food Microbiology by B. Rayand A. Bhunia. 5th edition. CRC press. 2013.

4. Food Microbiology by M. R. Adams, M. O. Moss, P. McClure. 4th edition. Royal Society of Chemistry. 2015.

5. Food Microbiology: Fundamentals and Frontiers by M. P. Doyle, L. R. Beuchat. 3rdedition. ASM press. 2007.

6. Food Microbiology: An Introduction by T. Montville, K. Matthews, K.Kniel. 4th edition. ASM press. 2017.

SEMESTER 4
DEPARTMENT ELECTIVE COURSE PAPER 5
MB24050 RESEARCH METHODOLOGY

Course Objectives:

The course is introduced to induct student toward scientific way to design experiment, data collection, analysis and report writing skills.

Course learning outcomes : By the end of this course the students-

CO1: will understand scientific terminology used in research

CO2: will learn to generate and test hypothesis with appropriate method of data collection

CO3: will understand the data analysis and writing the outcome of the project in form of report

THEORY COURSE
(4 Credits)

Unit-1	**Research Fundamentals and Terminology**: Meaning and Objective of research, features of a good research study, scientific method, Study designs and variations: basic, applied, historical, exploratory, experimental, ex-post-facto, case study, diagnostic research, crossover design, case control design, cohort study design, multifactorial design.	**15 Lectures**
Uni-2	**Defining Research problem and data Collection**: Hypothesis, theory and scientific law: development, structure, conditions, sources, formulation, explanation of hypothesis; structure, identification, elements, classification, functions of theory; scientific laws and principles, Methods and techniques of data collection: types of data, methods of primary data collection(observation/ experimentation/ questionnaire/ interviewing/ case/ pilot study , methods), methods of	**15 Lectures**

	secondary data collection(internal/ external), schedule method.	
Unit-3	**Sampling and sampling distributions**: Sampling frame, importance of probability sampling, simple random sampling, systematic sampling, stratified random sampling, cluster sampling, problems due to unintended sampling, ecological and statistical population in the laboratory, Variables: nominal, ordinal, discontinuous, continuous and derived.	**15 Lectures**
Unit-4	**Data analysis and report writing**: Experimental data collection and data processing: Processing operations, problems in processing, elements of analysis in data processing, software for data processing, Report writing and presentation: types of research reports, guidelines for writing a report, report format, appendices, Miscellaneous information, poster and oral presentations.	**15 Lectures**

Reference Book

1. Kothari, C.R.1985, Research Methodology- Methods and Techniques, New Delhi, Wiley Eastern Limited.
2. Das, S.K. 1986. An Introduction to Research, Kolkata, Mukherjee and Company Pvt. Ltd.
3. Misra R.P., 1989, Research Methodology: A Handbook, New Delhi, Concept Publishing Company 4. Kumar, R., 2005, Research Methodology-A Step-by-Step Guide for Beginners (2nd.ed.), Singapore, Pearson Education.
5. Bhattachraya, D.K., 2006, Research Methodology (2nd.ed.), New Delhi, Excel Books.
6. Panneerselvam R.,2012, Research Methodology, New Delhi, PHI Learning Pvt. Ltd.
7. Khan, Irfan Ali, 2008, Fundamentals of Biostatistics, Ukaaz Publications
8. Rosner B.A., 2011, Fundamentals of Biostatistics, Cengage Learning
9. Katz J.M., 2009, Form Research to Manuscript: A guide to scientific writing, USA, Springer Science 10. Saravanavel, P. 1990. Research methodology. Allahabad, Kitab Mahal

SEMESTER 4
DEPARTMENT ELECTIVE COURSE PAPER 6
MB24060 Scientific Writing and Biostatastics

Course Objectives:

The objectives of this course are to give background on history of science, emphasizing methodologies used to do research, use framework of these methodologies for understanding effective lab practices and scientific communication and appreciate scientific ethics.

Course learning outcomes : By the end of this course the students-

OC1: Understand history and methodologies of scientific research, applying these to recent published papers;

OC2: Understand and practice scientific reading, writing and presentations;

OC3: Appreciate scientific ethics through case studies.

THEORY COURSE (4 Credits)		
Unit-1	**History of science and science methodologies:** Empirical science; scientific method; manipulative experiments and controls; deductive and inductive reasoning; descriptive science; reductionist vs holistic biology.	**15 Lectures**
Unit-2	**Process of Communication:** Concept of effective communication-setting clear goals for communication; determining outcomes and results; initiating communication; avoiding breakdowns while communicating; creating value in conversation; barriers to effective communication; non-verbal communication-interpreting non-verbal cues; importance of body language, power of effective listening; recognizing cultural differences; Presentation skills - formal presentation skills; preparing and presenting using over-head projector, PowerPoint; defending interrogation; scientific poster preparation & presentation; participating in group discussions; Computing skills for scientific research - web browsing for information search; search engines and their mechanism of searching; hidden Web and its importance in scientific research; internet as a medium of interaction between scientists; effective email strategy using the right tone and conciseness	**15 Lectures**
Unit-3	**Scientific Communication:** Technical writing skills - types of reports; layout of a formal report; scientific writing skills - importance of communicating science; problems while writing a scientific document; plagiarism, software for plagiarism; scientific publication writing: elements of a scientific paper including abstract, introduction, materials & methods, results, discussion, references; drafting titles and framing abstracts; publishing scientific papers - peer review process and problems, recent developments such as open access and nonblind review; plagiarism; characteristics of effective technical communication; scientific presentations; ethical issues; scientific misconduct.**13**	**15 Lectures**
Unit4	**Biostatistics:** Probability: counting, conditional probability, discrete and continuous random variables; Error propagation; Populations and samples, expectation, parametric tests of statistical significance, nonparametric hypothesis tests, linear regression, correlation & causality, analysis of variance, factorial experiment design. Introduction and applications of SPSS and R softwares.	**15 Lectures**

Reference Books

1. Valiela, I. (2001). Doing Science: Design, Analysis, and Communication of Scientific Research. Oxford: Oxford University Press.
2. On Being a Scientist: a Guide to Responsible Conduct in Research. (2009). Washington, D.C.: National Academies Press.
3. Gopen, G. D., & Smith, J. A. The Science of Scientific Writing. American Scientist, 78 (Nov-Dec 1990), 550-558.
4. Mohan, K., & Singh, N. P. (2010). Speaking English Effectively. Delhi: Macmillan India. 5. Movie: Naturally Obsessed, The Making of a Scientist.
6. Rosner, B. (2000). Fundamentals of Biostatistics. Boston, MA: Duxbury Press.
7. Daniel, W. W. (1987). Biostatistics, a Foundation for Analysis in the Health Sciences. New York: Wiley.