MASTERS DEGREE PROGRAMME UNDER NEP-2020

CENTRE OF RESEARCH FOR DEVELOPMENT
AND
P. G. PROGRAMME IN MICROBIOLOGY
UNIVERSITY OF KASHMIR
SRINAGAR-190006 J and K, INDIA

CURRICULUM AND CREDIT FRAME WORK UNDER NEP-2020
COURSE STRUCTURE TO BE IMPLEMENTED
FROM ACADEMIC SESSION 2025-2026 ONWARDS

TWO YEARS P. G. PROGRAMME IN MICROBIOLOGY
AND
ONE YEAR P.G. DIPLOMA PROGRAMME IN MICROBIOLOGY

TWO YEARS P. G. PROGRAMME IN MICROBIOLOGY

PROGRAMME LEARNING OUTCOMES (PLOs)

PLO1: Comprehensive Understanding of Microbiology
Develop in-depth theoretical and applied knowledge in diverse fields of microbiology including bacteriology, virology, mycology, and microbial physiology, emphasizing their roles in health, environment, and biotechnology.

PLO2: Proficiency in Laboratory and Analytical Skills
Demonstrate hands-on expertise in microbiological techniques such as culturing, staining, aseptic handling, molecular diagnostics, and advanced instrumentation including PCR, electrophoresis, and spectrophotometry.

PLO3: Application of Microbial Technology
Apply microbiological principles in practical domains such as agriculture, healthcare, food industry, and environmental management, including fermentation technology, bioremediation, and microbial product development.

PLO4: Integration of Interdisciplinary Knowledge
Synthesize concepts from molecular biology, biochemistry, immunology, genomics, and cell biology to solve complex biological problems through an interdisciplinary approach.

PLO5: Computational and Bioinformatics Skills
Utilize bioinformatics tools and databases for microbial genome analysis, metagenomic profiling, sequence alignment, and ecological data interpretation to support research and diagnostics.

PLO6: Ethical, Social, and Environmental Responsibility
Apply ethical principles, biosafety practices, and environmental responsibility in microbiological research, especially in the use of genetically modified organisms and pathogenic microbes.

PLO7: Scientific Communication and Professional Writing
Effectively communicate scientific ideas, research findings, and technical data through oral presentations, posters, journal clubs, reports, and peer-reviewed publications.

PLO8: Lifelong Learning and Career Preparedness
Demonstrate a commitment to lifelong learning by staying current with scientific advancements and acquiring new skills relevant to academic, industrial, or clinical career pathways.

PLO9: Leadership and Collaborative Skills
Develop leadership qualities and teamwork skills essential for managing multidisciplinary scientific projects, organizing research activities, and contributing to collaborative investigations.

PLO10: Research and Innovation Capability
Design, conduct, and analyses independent research projects with originality and critical thinking, contributing to scientific innovation through dissertation writing, proposal drafting, and knowledge dissemination.

Prof. Bashir Ahmad Ganai

INTRODUCTION AND BASIC STRUCTURE OF THE COURSE
TWO YEARS P. G. PROGRAMME IN MICROBIOLOGY

Microbiology: The study of microorganisms, as a subject of study has immense importance, as microorganisms are the first inhabitant of the planet and in fact have over the years made this planet habitable for other life forms. Microorganisms are associated with our day-to-day life and affect us directly or indirectly in a number of ways. Microbiology as a subject has immense applications, in the fields of public health, agriculture, environment, industries, biotechnology etc. This course content is designed in such a way as to impart quality education and training in both the basic and applied aspects of microbiology. Therefore, we intended to produce highly trained professionals who besides serving various public and private organizations in the area of public health, environment, agriculture, food and dairy industry and biotechnology will also become entrepreneurs, who can exploit the services of microorganisms for the benefit of mankind besides creating self-employability opportunities.

The revised syllabi and courses of study for post-graduate Programme in Microbiology will be based on 80 credits (20/ semester). All the 80 credits will spread over 5 different components *viz.* - (i) teaching, (ii) tutorial, (iii) seminar, (iv) three laboratory courses (one each in the first, second and third semester), and (v) project work /Internship in fourth semester. Each semester will consist of at least 20 credits including at least 12 core credits (compulsory), 08 discipline centric elective.

Course Structure: There will be 11 **Core Courses (CC) (11+2)** (theory and laboratory) in all with each semester covering at least 3 core courses. Each core course will be worth 4 credits with theory covering at least 12 credits and practical component 4 credits. There will be 07 **Discipline Centric Elective Courses (DCEC)** courses. The total course of M. Sc. Microbiology will comprise of **80 credits out of which 52 credits are core while and 28 credit would be Discipline Centric Elective Courses (DCEC)**.

Each **CC and DCEC** will be worth of 100 marks and 4 credits comprising of **internal examination of 28 marks** and **external examination of 72 marks**. Internal assessment of theory papers will be based on quiz tests/ assignments/ seminars, etc. The practical component will also be of **internal examination comprising 28 marks** based on student's performance during practical periods and **external examination of 72 marks** through conduct of common test at the end of each semester to finalize awards for the same. The students will be required to submit their lab work records at the end of each semester examination for evaluation by the examiner/teacher(s) concerned.

P. G. 2025 onward batch shall be eligible to opt courses from **SWAYAM online platform** as per the schedule. The learners shall opt for relevant P. G. level credited courses from SWAYAM Platform by five National Coordinators, **i.e. UGC, AICTE, NPTEL, CEC** and **NITTTR.** These online courses only serve as an alternative corridor of courses for students and shall **not be mandatory**.

Project work/ Internship: Project work worth **20 credits** is compulsory for the students and will be assigned in **4th semester** based on choice of the student and space /resource availability in relation to his/her choice. The students for project work will be evenly distributed among faculty members of the Department. The main emphasis will be on developing independent creative thinking and execution of scientific experiments, presentation and scientific writing.

The candidate has to submit dissertation in a bound form at the end of 4th semester. The final evaluation of the project work will be through a **Panel involving internal and external examiners**. Each student has to deliver the entire dissertation work through power point presentation in front of a panel of examiners.

General course outline for first year program

Year -1 (Level-6.0)

First Semester

Course	Course Code	Course Name	Paper Category (Code)	Credits	Total Contact Hrs
Core	MMICCFM125	Fundamentals of Microbiology	CC	4	60
	MMICCBV125	Bacteriology and Virology	CC	4	60
	MMICCLC125	Laboratory Course and Industrial visit	CC	4	60
Discipline Centric Elective	MMICDMM125	Microbial Physiology and Metabolism	DCEC	4	60
	MMICDBT125	Biotechniques	DCEC	4	60

Second Semester

Course	Course Code	Course Name	Paper Category	Credits	Total Contact Hrs
Core	MMICCCE225	Cell Biology and Enzymology	CC	4	60
	MMICCMM225	Medical Microbiology	CC	4	60
	MMICCLC225	Laboratory Course	CC	4	60
Discipline Centric Elective	MMICDEA225	Environmental and Agriculture Microbiology	DCEC	4	60
	MMICDFI225	Food and Industrial Microbiology	DCEC	4	60

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General course outline for 2nd year program
Year -2 (Level-6.5)

Third Semester

Course	Course Code	Course Name	Paper Category	Credits	Total Contact Hrs
Core	MMICCIM325	Immunology	CC	4	60
	MMICCMG325	Molecular Biology and Microbial Genetics	CC	4	60
	MMICCLC325	Laboratory Course	CC	4	60
Discipline Centric Elective	MMICDGG325	Genetic Engineering and Genomics	DCEC	4	60
	MMICDBB325	Biostatistics and Bioinformatics	DCEC	4	60

Fourth Semester

Course	Course Code	Course Name	Paper Category	Credits	Total Contact Hrs
Core	MMICCRP425	Research based project work, dissertation writing and submission in hard bound form	CC	12	180
	MMICCPV425	Presentation and Viva-voce	CC	4	60
Discipline Centric Elective	MMICDSP425	Advanced Research Course	DCEC	4	60

*To be opted based on the area of dissertation

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Course Description First Semester

Core Courses

Course Code:	Title	Credits: 4; Total Contact Hrs. 60
MMICCFM125	FUNDAMENTALS OF MICROBIOLOGY	Max. Marks: 100

Course Learning Outcomes (CLOs)

- Be able to gain in depth knowledge about historical developments in microbiology, basic techniques like preparation of media, sterilization, staining, and microscopy.
- Be able to gain knowledge about culture media and culture techniques
- Be able to know nomenclature, taxonomic trends and major characteristics used in taxonomy.
- Be able to gain knowledge about ultastructure of prokaryotic and eukaryotic cells

Unit –I (MMICCFM125.1)

1.1 Historical perspective of microbiology with reference to Leeuwenhoek, Robert Koch, Louis Pasteur, Edward Jenner, Joshep Lister, Alexander Flemming etc
1.2 Spontaneous and non-spontaneous generation, fields of microbiology
1.3 Microscopy, instrumentation and handling.
1.4 Staining methods: simple, differential, structural and special staining
1.5 Sterilization and methods of sterilization, biosafety and various biosafety levels in a microbiology laboratory

Unit-II (MMICCFM125.2)

2.1. Culture media: classification of media (simple, complex and special media with examples), specific media for the cultivation of bacteria, fungi, algae and protozoa
2.2. Culture techniques (pour plate, spread plate, streaking and swab culture), preservation and maintenance of microbial cultures
2.3. Growth: nutritional requirements, growth kinetics, generation time, growth curve, factors affecting growth.
2.4. Anaerobic culture, batch/continuous culture and their applications
2.5. Biofilm, Quorum sensing, composition, occurrence and its importance

Unit-I I I (MMICCFM125.3)

3.1. Microbial taxonomy, nomenclature and classification of microorganisms, Haeckel's three kingdom classification, Whittaker's five kingdom approach
3.2. Woese domain system (Eukarya, Archae, Eubacteria)
3.3. Genetic and molecular taxonomy and its application in microbial diversity
3.4. General characteristics and classification of fungi.
3.5. General characteristics and classification of algae and protozoa.

Unit-IV (MMICCFM125.4)

4.1. Ultrastructure of prokaryotic cells: Bacteria; cell wall and cell membrane structure (L forms, spheroplast), mesosomes, flagella and motility, cytoplasm inclusions, pilli, fimbrae, capsule and slime layer
4.2. Endospore structure and sporulation process in bacteria
4.3. Differences between prokaryotic and eukaryotic cell
4.4. Ultrastructure and composition of fungi
4.5. Ultrastructure and composition of algae and protozoa

CLO-PLO Matrix for the Course

Unit Wise CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	Average (CLO)
MMICCFM125.1	2.5	2.4	2.3	3.0	2.9	2.8	2.6	2.1	2.3	2.1	2.5
MMICCFM125.2	2.8	2.7	2.6	2.4	2.2	2.5	2.4	2.7	2.5	1.9	2.47
MMICCFM125.3	2.9	2.2	2.5	1.8	2.8	2.5	2.8	2.6	2.5	2.2	2.48
MMICCFM125.4	2.2	2.9	2.5	2.6	1.8	2.7	2.6	2.9	2.6	2.6	2.54
Average (PLO)	2.6	2.55	2.47	2.45	2.42	2.45	2.6	2.57	2.47	2.2	2.47

Recommended Books

1. Prescott's Microbiology by Joanne Willey, Linda Sherwood and Christopher J. Woolverton, McGraw Hill Publisher Companies, Inc. Edition 11th, 2020.
2. Microbiology by Michael J. Pelczaret. al., McGraw Hill Publisher Companies, Inc. Edition 5th, 2001

3. Brock Biology of Microorganisms by Madigan and Martinko, Pearson Education International. Edition 16th, 2021
4. General Microbiology by Roger Y Stanier, ML Wheelis and PR Painter, MacMillan Press Ltd. Edition 5th, 1999
5. Ananthanarayan and Paniker's text book of Microbiology by Reba Kanungo, Universities Press. Edition 12th, 2022

Course Code: **Title** **Credits: 4; Total Contact Hrs. 60**
MMICCBV125 **BACTERIOLOGY AND VIROLOGY** **Max. Marks: 100**

Course Learning Outcomes (CLOs):

- Be able to gain in depth knowledge detailed classification of different bacterial groups.
- Be able to describe properties, characteristics and economic importance of different bacterial species
- Be able to know features, life cycle and taxonomy of different viruses
- Be able to conversant with viral genome diversity and control of viruses.

Unit-I (MMICCBV125.1)

1.1 Historical account of bacterial classification
1.2 Characteristics, classification and economic importance of Gram negative facultative anaerobic rods (Enterobacteriaceae and Vibrionaceae)
1.3 Characteristics, classification and economic importance of Gram-negative aerobic rods and cocci (Pseudomonadaceae, Rhizobiaceae, Neisseriaceae)
1.4 Characteristics, classification and economic importance of Gram-positive aerobic rods and cocci (Corynebacteriaceae, Mycobacteriaceae, Listeriaceae, Streptococcaceae, Staphylococcaceae)
1.5 Characteristics, classification and economic importance of endospore forming Gram positive rods (Bacillaceae and Clostridiaceae)

Unit-II (MMICCBV125.2)

2.1 General characters, classification and economic importance of Cyanobacteria
2.2 General characters classification and economic importance of Mycoplasma
2.3 General characters, classification and economic importance of Rickettsiae
2.4 General characteristics, classification and economic importance of spirochaetes and actinomycetes
2.5 Domain Archea, morphology, genetics, ecology, economic importance and sub-types of archeabacteria

Unit-III (MMICCBV125.3)

3.1 Discovery, composition and structural features of viruses
3.2 Lifecycle of viruses (lytic and lysogeniccycle)
3.3 General features and replication of T4, TMV, Influenza and HIV viruses
3.4 Taxonomy of viruses: classification and nomenclature as per ICTV
3.5 Brief account on bacteriophages, mycophages, phycophages, cyanophages, protozoan viruses

Unit-IV (MMICCBV125.1)

4.1 Isolation and cultivation of plant, animal and bacterial viruses
4.2 Sub viral particles: Satellite viruses, viriods, DI particles and prions
4.3 Oncogenic virus (DNA and RNA viruses)
4.4 Introduction to virotherapy and its types (interferons and viral vaccines)
4.5 Antiviral agents and future perspective

CLO-PLO Matrix for the Course

Unit Wise CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	Average (CLO)
MMICCBV125.1	2.4	1.3	1.2	3.0	1.1	2.0	3.0	3.0	1.7	2.9	2.16
MMICCBV125.2	2.2	2.8	1.6	2.9	1.5	2.2	2.9	2.0	1.9	2.0	2.20
MMICCBV125.3	2.4	2.1	1.9	2.8	2.9	2.0	2.2	1.8	1.8	2.7	2.26
MMICCBV125.4	2.5	2.8	2.9	2.7	2.0	1.7	2.0	2.7	1.9	3.0	2.42
Average (PLO)	2.37	2.25	2.27	2.85	1.87	1.97	2.52	2.37	1.82	2.65	2.26

Recommended Books

1. Brock Biology of Microorganisms by Madigan and Martinko, Pearson Education International. Edition 16th, 2021.
2. Prescott's Microbiology by Joanne Willey, Linda Sherwood and Christopher J. Woolverton, McGraw Hill Publisher Companies,Inc. Edition 11th, 2020.
3. Ananthanarayanand Paniker's text book of Microbiology by Reba Kanungo, Universities Press. Edition 12th, 2022
4. Bergey's Manual of Systematic Bacteriology. Edition 2nd, 2005.
5. Jawetz, Melnick and Adelbergs Medical Microbiology by Brooks et al., McGraw-Hill Medical. Edition 28th, 2019.

Course Code:	**Title**	**Credits: 4; Total Contact Hrs. 60**
MMICCLC125	**LABORATORY COURSE AND INDUSTRIAL VISIT**	**Max. Marks: 100**

Course Learning Outcomes (CLOs)

- Be able to understand the practical aspects of basic microbiology.
- Be able to learn lab practices and calculation needed for preparation of various reagents and buffers.
- Be able to understand different sterilization processes and different staining techniques of given microbial isolate.
- Be able to understand utility of microbiology and microbiologists in industries and institutional establishments

1. Preparation of buffers, other reagents and pH measurements
2. Biochemical and solution calculations
3. Sterilization techniques
4. Types of culture media and their preparations, colony characters of bacteria and fungi
5. Culture techniques
6. Isolation of bacteria from evironmental samples and motility test of bacteria
7. Growth curve of bacteria with reference to *E. coli*
8. Enumerate the CFU of bacteria (any) by serial dilution method
9. Staining techniques – Simple, Gram, Acid-fast, Endospore staining
10. Confirmed test of coliform bacteria
11. Perform antibiotic sensitivity and resistance assay
12. Screening of amylase, lipase and protease producers
13. Isolation of yeast from different samples.
14. Different Industrial visit for practical exposure and entrepreneur skill development
15. Differential intuitional visit to understand role of microbiologists

CLO-PLO Matrix for the Course

Unit Wise CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	Average (CLO)
Total No. of Practical's = 15	2.8	2.4	2.7	2.3	3.0	2.7	2.1	2.0	2.6	2.1	2.47
Average (PLO)	2.8	2.4	2.7	2.3	3.0	2.7	2.1	2.0	2.6	2.1	2.47

Recommended Books

1. Microbiology: A Laboratory Manual by James G. Cappuccino and Natalie Sherman, Pearson Benjamin Cummings Publishers. Edition 11th, 2013
2. Practical Microbiology by D K Maheshwari and R C Dubey, S Chand and Company Publishers. Edition 4th, 2023
3. Alcamo's Laboratory Fundamentals of Microbiology by Pommerville J.C., Jones and Bartlett Publishers, Inc. Edition 1st, 2009

Discipline Centric Elective Course (DCEC)

Course Code:	Title	Credits: 4; Total Contact Hrs. 60
MMICDMM125	MICROBIAL PHYSIOLOGY AND METABOLISM	Max. Marks: 100

Course Learning Outcomes (CLOs)

- Be able to know various types of nutrients utilized by microbes, their mechanism of transport and utilization of sugars via pathways will be learned
- Be able to understanding aerobic respiration, electron transport chain, fermentation, oxidation and reduction reactions.
- Be able to understand lipids, amino acids, proteins, nucleotides, vitamins and their classification, structure, and properties.
- To provide knowledge about the physiology and metabolism of microorganisms

Unit-I (MMICDMM125.1)

1.1 Nutritional diversity in microorganisms, bioluminescence and its mechanism in microorganisms
1.2 Essentiality of major and minor elements, mechanism of nutrient transport in microorganisms (ABC transporters, phosphotransferase, drug export systems and transport of amino acids)
1.3 Chemotrophs: acetogens, methylotrophs, methanogens and their importance
1.4 Methanotrophy: characteristics of methanotrophs, dissimilation of methane by methanotrophs and carbon assimilation by methylotrophs
1.5 Sulfidogenesis: biochemistry of sulfidogenesis, reduction of sulfate and sulfur, sulphur reducing bacteria

Unit-II (MMICDMM125.2)

2.1 Autotrophic nutrition in microorganisms: oxygenic vs anoxygenic photosynthesis
2.2 Photosynthetic pigments (chlorophyll, bacteriochlorophyll, rhodopsin, phycobiliproteins), basic photochemistry of PSI, PSII and light driven electron transport
2.3 Modes of CO_2 fixation (Calvin cycle, reverse TCA cycle, HP pathway)
2.4 Carbohydrate metabolism: classification, structure and functions of carbohydrates, stereoisomerism, aldoses and ketoses
2.5 Various pathways underlying the utilization of different sugars (EMP, ED, HMP) in microorganisms, gluconeogenesis and Pasteur effect

Unit-III MMICDMM125.3

3.1 Aerobic respiration: TCA cycle, glyoxylate cycle
3.2 Electron transport chain, substrate level and oxidative phosphorylation
3.3 Anaerobic respirations: sulphate, nitrate, carbonate respirations and their ecological significance
3.4 Fermentations: types of fermentations (homo, heterolactic and mixed fermentations)
3.5 Oxidation- reduction reactions, measurement of redox potentials, structure of ATP synthase complex; mechanism of ATP synthesis, inhibitors and uncouplers

Unit-IV (MMICDMM125.4)

4.1 Lipids: classification, structure and biosynthesis of glycerides, phospholipids and glycolipids, β-oxidation of saturated and unsaturated fatty acids
4.2 Amino acids: classification, structure and properties of amino acids, biosynthetic pathways of amino acids and their regulation with emphasis on tryptophan, tyrosine and histidine, transamination, deamination
4.3 Proteins: classification and structural organization of proteins (primary, secondary, tertiary and quaternary)
4.4 Nucleotide metabolism: biosynthesis of purine and pyrimidine nucleotides and their degradation
4.5 Vitamins as microbial growth factors

CLO-PLO Matrix for the Course

Unit Wise CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	Average (CLO)
MMICDMM125.1	2.8	2.3	2.2	2.0	1.9	1.0	3.0	2.9	2.6	2.8	2.35
MMICDMM125.2	2.2	3.0	2.9	1.9	2.8	3.0	1.8	1.8	3.0	2.2	2.46
MMICDMM125.3	2.0	2.9	1.2	1.8	2.9	2.9	1.9	1.8	2.8	2.0	2.22
MMICDMM125.4	2.1	2.2	2.0	1.7	3.0	2.0	1.7	2.9	2.4	3.0	2.30
Average (PLO)	2.27	2.6	2.0	1.85	2.65	2.2	2.1	2.3	2.7	2.5	2.26

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Recommended Books

1. Lehninger Principles of Biochemistry by Lehninger by David L. Nelson and Michael M Cox, W.H Freeman and company. Edition 4th, 2005.
2. Biochemistry by Stryer WH et al., W.H Freeman and company. Edition 5th, 2022
3. Brock Biology of Microorganisms by Madigan and Martinko, Pearson Education International. Edition 16th, 2021.
4. Prescott's Microbiology by Joanne Willey, Linda Sherwood and Christopher J. Woolverton, McGraw Hill Publisher Companies, Inc. Edition 11th, 2013Physiology and Biochemistry of Prokaryotes by White David, Oxford University Press. Edition 1st, 1995.

Course Code: MMICDBT125 **Title: BIOTECHNIQUES** **Credits: 4; Total Contact Hrs. 60** **Max. Marks: 100**

Course Learning Outcomes (CLOs)

- Be able to understand the various techniques and instruments required to study and engineer microorganisms.
- Be able to familiarized with the techniques like centrifugation, chromatography, GC-MS, HPLC, Blotting techniques, radio isotopic techniques, spectroscopic techniques, NMR, MALDI-TOF and so on.
- Be able to understand the processes of electrophoresis for separation of macromolecules and applications of radioactivity in biology.
- Be able to prepare students for advanced topics like downstream processing and recombinant DNA technology by building essential technical knowledge.

Unit-I (MMICDBT125.1)

1.1 Centrifugation techniques: basic principles of centrifugation and derivation of relation for coefficient and measurement of sedimentation co-efficient
1.2 Rotors and types of rotors
1.3 Differential and density gradient centrifugation
1.4 Analytical centrifugation and its applications
1.5 Viscosity and its measurement

Unit-II (MMICDBT125.2)

2.1 Basic principles of chromatography and its types
2.2 Ion exchange chromatography
2.3 Gel filtration chromatography
2.4 Affinity chromatography
2.5 HPLC, GC-MS

Unit-III (MMICDBT125.3)

3.1 Electrophoresis: basic principles and types
3.2 Polyacrylamide gel electrophoresis and agarose gel electrophoresis, SDS- PAGE
3.3 Two-dimensional electrophoresis, immune electrophoresis and isoelectric focusing
3.4 Capillary electrophoresis, pulse-field electrophoresis
3.5 Blotting techniques -Southern, Northern and Western blotting

Unit-IV (MMICDBT125.4)

4.1 Radio isotopic techniques: principle and applications of tracer techniques in biology
4.2 Radioactive isotopes, radioactive decay; detection and measurement of radioactivity
4.3 Spectroscopic techniques- principle and working of theory of absorption of light by molecule
4.4 UV- visible spectrophotometer-principle and working
4.5 Fluorescence spectroscopy, MALDI-TOF, NMR and X ray crystallography

CLO-PLO Matrix for the Course

Unit Wise CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	Average (CLO)
MMICDBT125.1	3.0	2.9	2.5	2.0	1.7	1.9	2.1	2.0	2.7	2.6	2.30
MMICDBT125.2	2.0	2.2	2.8	2.0	3.0	2.9	2.7	2.2	2.5	1.9	2.40
MMICDBT125.3	2.5	2.6	3.0	2.6	2.8	3.0	2.0	2.0	2.2	2.1	2.40
MMICDBT125.4	2.5	2.6	1.8	1.9	3.0	2.0	2.2	2.9	2.0	3.0	2.30
Average (PLO)	2.5	2.5	2.5	2.1	2.6	2.4	2.2	2.2	2.3	2.4	2.25

Recommended Books

1. Principles and Techniques of Biochemistry and Molecular Biology by Keith Wilson and John Walker, Cambridge University Press. Edition 8th 2013
2. Biochemistry Laboratory: Modern Theory and Techniques by Rodney F. Boyer, Pearson Prentice Hall. Edition 2nd, 2010
3. Biophysical Chemistry Principles and Techniques by Upadhyay et al., Himalaya Publishing House. Edition 1st, 2020
4. Analytical Biochemistry by Ganai et al., Valley Publications.

Course Description: Second Semester
Core Course (CC)

Course Code: **Title** **Credits: 4; Total Contact Hrs. 60**
MMICCCE225 **CELL BIOLOGY AND ENZYMOLOGY** **Max. Marks: 100**

Course Learning Outcomes (CLOs):

- Be able to know the eukaryotic cell structure, cell cycle, cell cycle progression, signal transduction and scattered plot
- Be able to know membrane structure, signal transduction, cell cycle and various pathways of microorganisms
- Be able to know the enzyme classification, nomenclature, and significance of various types of enzymes
- Be able to know the enzyme kinetics, enzyme inhibition, isozymes and their metabolic significance.

Unit-I (MMICCCE225.1)

1.1 Ultrastructure and organization of unicellular eukaryotic cell
1.2 Nucleus, mitochondria and chloroplasts and their genetic organization
1.3 Endoplasmic reticulum, golgi apparatus, protein trafficking
1.4 Flagella and mechanism of flagellar movements
1.5 Cytoskeletal elements (microtubules and microfilaments)

Unit-II (MMICCCE225.2)

2.1 Membrane structure and dynamics-diversity, structure and physiology of membrane pumps, carriers and channels
2.2 Signal transduction and its mechanism
2.3 Cell cycle -overview, phases of the cell cycle, cell growth and extracellular signals
2.4 Regulations of cell cycle progression (cyclins and cyclin dependent kinases), cell cycle- check points
2.5 Cell differentiation, apoptotic pathways and molecular mechanism of apoptosis

Unit-III (MMICCCE225.3)

3.1 Introduction to enzymology and characteristics of enzymes
3.2 Classification and nomenclature of enzymes (IUB nomenclature)
3.3 Mechanism of enzyme action, theories of mechanism of enzyme action
3.4 Constitutive, inducible and marker enzymes
3.5 Enzyme activators, co-enzyme, prosthetic group and co-factors in enzymatic catalysis, concept of enzyme and substrate specificity, enzyme assay and its units

Unit- IV (MMICCCE225.4)

4.1 Enzyme kinetics, Michaelis-Menton equation and its derivation

4.2 Determination of V_{max}, K_m, K_{cat} and their significance, Lineweaver-Burk plots, Eadie-Hofstee and Hanes plots

4.3 Enzyme inhibition - competitive, uncompetitive, non-competitive, and irreversible, determination of K_m V_{max} K_i in presence of inhibition

4.4 Isozymes and their metabolic significance, allosteric enzymes and co-operativity

4.5 Large scale enzyme extraction, enzyme purification, recovery and yield of enzymes

CLO-PLO Matrix for the Course

Unit Wise CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	Average (CLO)
MMICCCE225.1	1.7	2.4	1.9	2.5	2.0	2.9	3.0	3.0	2.9	2.7	2.50
MMICCCE225.2	3.0	2.7	2.6	2.8	2.0	2.7	2.0	2.2	2.1	2.8	2.40
MMICCCE225.3	2.0	2.2	2.9	3.0	3.0	1.9	2.1	2.6	1.9	2.9	2.40
MMICCCE225.4	3.0	2.9	2.2	2.5	2.0	3.0	2.5	1.9	2.1	2.0	2.40
Average (PLO)	2.4	2.5	2.4	2.7	2.2	2.6	2.4	2.4	2.2	2.6	2.45

Recommended Books

1. Molecular Cell Biology by Lodish et al., W.H Freeman and Company. Edition 5th, 2003
2. Molecular biology of the Cell by Alberts et al., Garland publishing Inc. Edition 5th, 2008
3. Leininger Principles of Biochemistry by Leininger by David L. Nelson and Michael M Cox, W.H Freeman and company. Edition 4th, 2005.
4. Biochemistry by Stryer WH et al., W.H Freeman and company. Edition 7th, 2003
5. Understanding Enzymes by Trevor Palmer, Prentice Hall Publishers. 2008

Course Code: **MMICCMM225** | **Title** **MEDICAL MICROBIOLOGY** | **Credits: 4; Total Contact Hrs. 60** **Max. Marks: 100**

Course Learning Outcomes (CLOs):

- Be able to gain insight of human microflora, their significance, mechanism of pathogenesis of different pathogens and their characteristics.
- Be able to gain knowledge of different types of diseases caused by bacterial pathogens.
- Be able to introduce students to viral pathogens, their characteristics, mode of transmission and different types of diseases caused by viral pathogens and how they are being controlled.
- Be able to gain knowledge about important fungal and protozoan diseases

Unit-I (MMICCMM225.1)

1.1 Normal microbial flora of human body and its importance

1.2 Mechanism of microbial pathogenesis: entry, colonization, growth, mechanism of damage host cell, host-pathogen interactions

1.3 Bacterial virulence factors, Infection Prevention control (IPC)

1.4 Epidemiology of infectious diseases and current pandemics

1.5 Pathogenicity vs virulence; quantitative measures of virulence: minimal lethal dose (MLD), LD_{50}, ID_{50}, $TCID_{50}$. Facultative / obligate intracellular pathogens, pathogenicity islands.

Unit-II (MMICCMM225.2)

2.1 Historical perspective of medical bacteriology

2.2 General characteristics, mode of transmission, pathogenesis and diagnosis of medically important bacterial diseases like Anthrax, Tuberculosis, Leprosy, Cholera, Typhoid, Gastric Ulcer, Tetanus, Pneumonia.

2.3 Etiology, pathogenesis and lab diagnosis of Diarrhea, Meningitis, Nosocomial infections and Zoonoses

2.4 General characteristics, mode of transmission, pathogenesis and diagnosis of diseases caused by *Staphylococcus, Streptococcus, Mycoplasma*, *Chlamydiae* and *Rickettesia*

2.5 Antibacterial drugs: Classification and mode of action. Emergence of bacterial drug resistant strains

Unit-III (MMICCMM225.3)

3.1 Introduction to medical virology
3.2 General characteristics, mode of transmission, pathogenesis and diagnosis of medically important viral pathogens: Chicken Pox, Hepatitis, Herpes, Human Papilloma virus (DNA viruses),
3.3 General characteristics, mode of transmission, pathogenesis and diagnosis of medically important viral pathogens: rabies, mumps, measles, AIDS, dengue (RNA viruses)
3.4 General characteristics, mode of transmission, pathogenesis and diagnosis of emergent viral diseases: Influenza (Swine flu), SARS - COVID-19, Chikungunya, Ebola, Hanta, Marburg, Nepa virus, Zika and Rotavirus
3.5 Human prion diseases**,** novel approaches for viral detection; CRISPR, RT-PCR, immune-sensors, antiviral drugs, classification and mode of action

Unit-IV (MMICCMM225.4)

4.1 Introduction to medical mycology, Mycoses (superficial, subcutaneous, systemic and opportunistic)
4.2 Isolation, characterization and identification of medically important fungal pathogens. Antifungal drugs, classification and mode of action
4.3 Introduction to protozoology: General characteristics, mode of transmission, pathogenesis and diagnosis of protozoan pathogens: *Entamoeba*, *Plasomodium*, *Leishmania*, *Giardia, Toxoplasma* and *Trypanosoma*
4.4 General characteristics, mode of transmission, pathogenesis and diagnosis of platyhelminthes; *Taenia*, S*chistosoma* and Nemathelminthes; *Ascaris*, *Wuchereria*.
4.5 Introduction to clinical microbiology (specimen collection. transport, handling, storage and laboratory analysis)

CLO-PLO Matrix for the Course

Unit Wise CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	Average (CLO)
MMICCMM225.1	2.2	2.3	3.0	2.5	2.8	3.0	2.7	2.1	2.3	2.6	2.50
MMICCMM225.2	2.9	2.5	2.8	2.0	2.1	1.5	2.1	2.8	2.0	3.0	2.30
MMICCMM225.3	3.0	2.7	2.2	2.1	2.2	1.9	2.0	3.0	2.9	2.1	2.40
MMICCMM225.4	1.9	1.8	2.0	2.7	3.0	2.9	2.7	2.5	2.0	2.0	2.30
Average (PLO)	2.5	2.3	2.5	2.3	2.5	2.3	2.3	2.6	2.3	2.4	2.35

Recommended Books

1. Ananthanarayan and Paniker's text book of Microbiology by Reba Kanungo, Universities Press. Edition 12th, 2022
2. Jawetz, Melnick and Adelbergs Medical Microbiology by Brooks et al., McGraw-Hill Medical. Edition 28th, 2019.
3. Prescott's Microbiology by Joanne Willey, Linda Sherwood and Christopher J. Woolverton, McGraw Hill Publisher Companies, Inc. . Edition 11th, 2020
4. Parasitology (Protozoology and Helminthology) by K.D. Chatterjee, CBS Publishers and Distributors. Edition 3rd, 2019.
5. Medical Parasitology by D. R. Arora and B. Arora, CBS Publishers and Distributors. Edition 5th, 2022

Course Code: **Title** **Credits: 4; Total Contact Hrs. 60**
MMICCLC225 **LABORATORY COURSE** **Max. Marks: 100**

Course Learning Outcomes (CLOs):

- Be able to gain an in-depth knowledge of experiments such as isolation of chloroplast and mitochondria by differential centrifugation
- Be able to determine DNA, RNA, carbohydrates, lipids and protein concentrations using standard methods
- Be able to isolate and enumerate microorganisms from various sources and their biochemical characterization
- Be able to determine phosphate and zinc solubilizing potential of phosphate and zinc solubilizing microorganisms

1. Cell cycle: cell division of fungi and bacteria (with the help of slides/models/charts)
2. Differential isolation of chloroplast and mitochondria by differential centrifugation method
3. Estimation of carbohydrates
4. Estimation of lipids
5. Estimation of DNA

6. Estimation of RNA
7. Estimation of protein by Lowry's, and Bradford methods
8. Identification of proteins by SDS-PAGE
9. Study of pH stress tolerance by microbes
10. Study of enzyme kinetics (acid phosphatase and alkaline phosphatase
11. Cultivation and enumeration of bacteriophages
12. To perform biochemical tests (Catalase, Urease test)
13. Indole, Methyl red, Voges-Proskauer, Citrate Utilization Test (IMVIC)
14. Exploration of microbiota from soil sediments.
15. Qualitative assay of Phosphate Solubilizing Bacteria and Zinc Solubilizing Bacteria

CLO-PLO Matrix for the Course

Unit Wise CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	Average (CLO)
Total No. of Practical's = 15	2.7	2.2	2.0	2.9	2.1	1.8	2.9	2.6	2.3	2.7	2.37
Average (PLO)	2.7	2.2	2.0	2.9	2.1	1.8	2.9	2.6	2.3	2.7	2.37

Recommended Books

1. Microbiology: A Laboratory Manual by James G. Cappuccino and Natalie Sherman, Pearson Benjamin Cummings Publishers.
2. Practical Microbiology by D K Maheshwari and R C Dubey, S Chand and Company Publishers Edition 4th 2023
3. Alcamo's Laboratory Fundamentals of Microbiology by Pommerville J.C., Jones and Bartlett Publishers, Inc. Edition 1st, 2009.
4. Experimental Biochemistry by Ganai et al., Kumar Publications, Delhi

Discipline Centric Elective Course (DCEC)

Course Code: MMICDEA225 **Title: ENVIRONMENTAL AND AGRICULTURAL MICROBIOLOGY** **Credits: 4; Total Contact Hrs. 60** **Max. Marks: 100**

Course Learning Outcomes (CLOs):

- Be able to understand importance of environmental microbiology and different bioremediation techniques for decontamination of polluted sites
- Be able to learn how to classify thermophiles and psychrophiles, their mode of adaptation and applications.
- Be able to understand applications of beneficial microbial inoculants, plant diseases and their control methods.
- Be able to gain knowledge about different methods of studying microorganisms, role of microbes for nitrogen fixation and as bioinoculants

Unit-I (MMICDEA225.1)

1.1. Introduction to environmental microbiology: Scope, history, Brief account of microbial interaction, rumen microbiology, coral reefs, Microbial mats.
1.2. Waste water and drinking water treatment, treatment and applications of municipal solid waste. Composting and biogas production.
1.3. Bioremediation: types, and applications, acid mine drainage
1.4. Microbial remediation of pesticides, plastics and Heavy Metals
1.5. Biomonitoring: bioindicators, biosensors and genosensors.

Unit-II (MMICDEA225.2)

2.1. Concept of Extremophiles, thermophiles: classification and ecological aspects, adaptation mechanism.

2.2. Commercial aspects of thermophiles and thermozymes

2.3. Psychrophiles: Classification, diversity, adaptation mechanism and applications

2.4. Classification, distribution, adaptation mechanism and applications of acidophiles and alkaliphiles

2.5. Classification, distribution, adaptation mechanism and applications of Halophiles and Barophiles

Unit-III (MMICDEA225.3)

3.1. Introduction and scope of agricultural microbiology. Contributions of M. Beijerinck, S. Winogradsky, B. Frank and S. Waksman

3.2. Soil microflora, culture dependent and independent methods of studying soil microflora, Rhizosphere, phyllosphere and endophytic microorganisms and their interactions with plants.

3.3. Biological nitrogen fixation (symbiotic and asymbiotic), biochemistry and molecular genetics of nitrogen fixation, microbial transformations of phosphorus and zinc

3.4. Biofertilizers: Production and application of Mycorrhiza, Frankia, *Rhizobium*, *Azotobacter*, and Cyanobacteria and their quality control

3.5. Concept of biopesticides, types and mode of action.

Unit-IV (MMICDEA225.4)

4.1. Introduction to plant pathology, history and scope of plant pathology

4.2. Defense mechanism of plant diseases

4.3. Bacterial diseases - canker, fire blight.

4.4. Fungal diseases - smut, rust and powdery mildew

4.5. Viral diseases - Apple mosaic, tomato leaf curl

CLO-PLO Matrix for the Course

Unit Wise CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	Average (CLO)
MMICCMM225.1	2.2	2.4	2.8	2.9	3.0	2.8	2.1	2.5	3.0	2.9	2.60
MMICCMM225.2	3.0	2.9	2.8	3.0	3.0	2.5	2.2	2.3	2.0	2.1	2.50
MMICCMM225.3	2.2	2.4	2.8	2.0	2.8	2.5	3.0	2.6	1.8	2.0	2.40
MMICCMM225.4	2.1	2.3	2.3	2.9	3.0	1.9	1.8	2.5	2.9	2.1	2.30
Average (PLO)	2.3	2.5	2.6	2.7	2.9	2.4	2.2	2.4	2.4	2.2	2.45

Recommended Books

1. Microbial Ecology Fundamentals and Applications by Ronald M. Atlas and Richard Bartha, Pearson Education International. Edition 4th, 1997

2. Brock Biology of Microorganisms by Madigan and Martinko, Pearson Education International. Edition 16th, 2021

3. Soil Microbiology, Ecology and Biochemistry by Paul E.A., Academic Press. Edition 4th, 2014

4. Physiology and Biochemistry of Extremophiles by Charles Gerday and Nicolas Glansdorff. ASM Press. . Edition 1st, 2014

5. Soil Microbiology by Subba Rao, Science Publishers. Edition 2nd, 1905

Course Code: Title Credits: 4; Total Contact Hrs. 60

MMICDFI225 FOOD AND INDUSTRIAL MICROBIOLOGY Max. Marks: 100

Course Learning Outcomes (CLOs):

- Be able to Know important microbes associated with different food products and recognize the types and causes of spoilage of different food products
- Be able to know various physical, chemical and biological methods of preservation and identify various food borne infections
- Be able to understand industrially important microbes, recent developments in fermentation processes, carbon and nitrogen sources for industrial fermentation
- To provide knowledge about the detection and control of food borne pathogens and toxins

Unit-I (MMICDFI225.1)

1.1. History and development of food microbiology, sources and factors influencing microbial growth in foods (intrinsic and extrinsic factors)

1.2. Degradation of carbohydrates, lipids and proteins

1.3. Microbial spoilage: Fruits, vegetables, milk, meat and canned products

1.4. Control of microorganisms in foods: Physical, chemical and biological methods of preservation

1.5. Probiotics and prebiotics and their significance in human health

Unit-II (MMICDFI225.2)

2.1. Bacterial food borne pathogens: Staphylococcus, Clostridium sps, *Bacillus cereus, Salmonella, E.coli*

2.2. Fungal intoxications: mycotoxicosis- aflatoxins, ochratoxins and patulin

2.3. Food borne viral pathogens: Norwalk virus, hepatitis A virus, hepatitis E virus, and rotavirus

2.4. Microbial examination of milk, meat, egg, fruits, vegetables and their products

2.5. Detection and enumeration of microorganisms in food: Molecular methods (PCR, Q-PCR)

Unit-III (MMICDFI225.3)

3.1. Safety aspects of food products with reference to Mycotoxins, Antibiotics and Heavy Metals

3.2. Biofilm formation on equipment surfaces and their control measures, safe food alternatives (Organic foods)

3.3. Quality control: ISO, SOP, HACCP

3.4. USFDA and FSSAI, genetically modified foods

3.5. Patent and patenting microorganisms

Unit-IV (MMICDFI225.4)

4.1. Upstream processes: Source, isolation, screening of industrially important microorganisms and strain improvement

4.2. Fermenters and fermentation: design and types of fermenters/bioreactors, carbon and nitrogen sources for industrial fermentation

4.3. Downstream processes: filtration, centrifugation, cell disruption, liquid-liquid extraction

4.4. Industrial production of antibiotics (penicillin), enzymes (amylase), aminoacids (glutamic acid) and vitamins (riboflavin)

4.5. Industrial production of Beverages: Production of Alcoholic beverages (Beer and Wine), Organic acids (Citric acid and Acetic acid)

CLO-PLO Matrix for the Course

Unit Wise CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	Average (CLO)
MMICDFI225.1	2.4	2.2	2.6	2.8	1.5	1.8	2.2	1.5	2.6	2.0	2.16
MMICDFI225.2	2.5	1.4	1.8	2.6	3.0	2.9	2.5	1.8	2.4	2.1	2.3
MMICDFI225.3	3.0	2.2	2.6	2.3	1.8	1.5	2.0	2.2	2.7	2.9	2.32
MMICDFI225.4	1.8	2.4	2.2	2.6	2.9	3.0	1.5	1.8	2.2	3.0	2.34
Average (PLO)	2.4	2.0	2.3	2.5	2.3	2.0	2.0	1.8	2.4	2.5	

Recommended Books

1. Principles of Fermentation Technology by P.F. Stanbury, W. Whitaker and S.J. Hall, Elsevier. Edition 3rd 2016.
2. Biotechnology: A Text Book of Industrial Microbiology by W. Cruegerand A. Crueger, Sinauer Associates Inc. Edition 3rd 2017.
3. Food Microbiology by Frazier and Westhoff, TaTa McGraw Hill. Edition 6th 2024.
4. Food Microbiology: Fundamentals and Frontiers by Doyel et.al. ASM Press.
5. Basic Food Microbiology by Banwart G.J., CBS Publishers and Distributors. Edition 2nd 2004.
6. Modern Food Microbiology by Jay et.al. Springer India Ltd. Edition 4th 2005

Course Description Third Semester
Core Courses

Course Code: **Title** **Credits: 4; Total Contact Hrs. 60**
MMICCIM325 **IMMUNOLOGY** **Max. Marks: 100**

Course Learning Outcomes (CLOs):

- Be able to understand fundamental bases of immune system and immune response and also to understand the genetic organisation of the genes meant for expression of immune cell receptors and the bases of the generation of their diversity
- Be able to provide in depth knowledge about antigen and antibody interactions and immunological disorders
- Be able to understand host defence, hypersensitivity (allergy), organ transplantation and certain immunological diseases.
- Be able to understand Immunotechniques, Immunofluoresence, Flow cytometry, Immunoelectronmicroscopy, RIST, RAST and MLR

Unit-I (MMICCIM325.1)

1.1 General principles of immunology: history of immunology (contributions of Louis Pasteur, Edward Jenner, Karl Landsteiner, Paul Ehrlich, Elie Metchnikoff, MacFarlane Burnet, Rodney Porter)
1.2 Structure, composition and function of cells and organs involved in immune system
1.3 Mechanism of immune response
1.4 Antigens, nature and source of antigens, haptens, adjuvants, immunogenicity versus antigenicity
1.5 Antibody-structure and functions-subtypes; structural basis of antibody diversity; theories of antibody formation

Unit-II (MMICCIM325.2)

2.1 Antigen and antibody interactions: *In vitro* methods-agglutination, precipitation, complement fixation
2.2 Phagocytosis, opsonization, neutralization
2.3 Complement system: complement components and complement activation, pathways, regulation of complement system, biological consequences of complement activation, complement deficiencies
2.4 Structure, distribution of MHCs and its functions.
2.5 Herd immunity: Immune response during microbial infections.

Unit-III (MMICCIM325.3)

3.1 Gene regulation and immune response (IR) genes
3.2 HL-A and tissue transplantation-tissue typing, methods for organ and tissue transplantations in humans; graft versus host reaction and rejection
3.3 Tumor immunology**:** tumor antigens, host immune response to tumors
3.4 Tumor escape mechanisms, immuno diagnosis and therapy, Vaccines.
3.5 Hybridoma technology, myeloma cell lines used as fusion partner, fusion method, detection and application of monoclonal antibodies, recombinant antibodies.

Unit-IV (MMICCIM325.4)

4.1 Immunodeficiencies-animal models (Nude and SCID mice), SCID, DiGeorge syndrome, Chediak-Higashi syndrome, leukocyte adhesion deficiency, Chronic Granulomatous Disease (CGD); characteristics of tumor antigens
4.2 Hypersensitivity reactions: type I, II, III and IV the respective diseases, immunological methods of their diagnosis
4.3 Autoimmunity mechanism and diseases. General account of interferons, Lymphokines and cytokines
4.4 Immunotechniques: Immunodiffusion, Immunoelectrophoresis, RIA, ELISA, ELISPOT, Western blotting
4.5 Immunofluoresence, Flow cytometry, Immunoelectronmicroscopy, RIST, RAST and MLR

CLO-PLO Matrix for the Course

Unit Wise CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	Average (CLO)
MMICCIM325.1	2.0	2.2	2.7	3.0	1.8	1.5	2.3	2.6	1.7	2.5	2.20
MMICCIM325.2	2.5	2.9	3.0	1.5	1.9	2.3	2.4	3.0	2.6	2.2	2.40
MMICCIM325.3	3.0	2.2	2.5	2.7	2.5	2.9	3.0	1.8	2.5	2.6	2.50
MMICCIM325.4	2.6	2.8	2.8	2.5	3.0	1.8	2.6	1.9	3.0	2.9	2.50

Average (PLO)	2.5	2.5	2.7	2.4	2.3	2.1	2.5	2.3	2.4	2.5	2.40

Recommended Books

1. Kuby Immunology by Kindt T.J et al., W.H. Freeman and Company. Edition 8th 2018.
2. Immunology- A Short Course by Eli Benjamini, Richard Coico and G. Sunshine. Wiley's.Publication Edition 7th 2015.
3. Cellular and Molecular Immunology by Abbas AK, Lichtman AH and Pillai S: Saunders Elsevier. Edition 9th 2017
4. Fundamental Immunology by William E. Paul, Lippincott Williams and Wilkins. Edition 5th 2003.
5. Roitt's Essential Immunology by Delves PJ et al., Blackwell Publishing/Oxford Univ. Press. Edition 13th 2017

Course Code: MMICCMG325 **Title: MOLECULAR BIOLOGY AND MICROBIAL GENETICS** **Credits: 4; Total Contact Hrs. 60** **Max. Marks: 100**

Course Learning Outcomes (CLOs):

- To acquire knowledge of DNA structure, its forms and basics of genome organization in prokaryotes and eukaryotes
- Be able to understand replication of DNA, transcription of RNA and translation of proteins, DNA damage and their repair mechanism
- Be able to gain an in-depth knowledge about different types of gene families, regulation of gene expression, types of mutagens and different tests of mutagenicity
- Be able to know how gene is being transferred from one bacteria to another and also the general account of plasmids

Unit-I (MMICCMG325.1)

1.1 Historical perspective of DNA, structure and its forms
1.2 Genome organization in prokaryotes and eukaryotes, DNA supercoiling (Linking number, writhes and twists), gene concept and structure of gene
1.3 Prokaryotic and eukaryotic DNA replication
1.4 Experimental evidence for DNA replication in prokaryotes and eukaryotes, reverse transcription
1.5 DNA damage and repair mechanisms

Unit-II (MMICCMG325.2)

2.1 RNA and its types, concept of micro RNA, snRNAs, siRNA, scRNA, snoRNA, hnRNA, lncRNAand their functions. Structure of tRNA
2.2 Transcription: mechanism of transcription in prokaryotes and eukaryotes
2.3 Post-transcriptional modifications and regulation of transcription in eukaryotes
2.4 Genetic code, protein biosynthesis and its mechanism
2.5 Post translational modifications

Unit-III (MMICCMG325.3)

3.1 Gene families: split genes, pseudogenes, non-coding genes, overlapping genes and multi-gene families
3.2 Regulation of gene expression in prokaryotes-operon concept, regulatory elements of operon-inducers, apo-repressors and co–repressors. Positive and negative regulations
3.3 Catabolite repression. Detailed account of structure, function and regulation of *lac* operon, *trp*operon and lambdaoperon
3.4 Mutations: types of mutagens (physical, chemical), types of mutations site directed mutagenesis
3.5 Mutation screening in microorganisms: evaluation of mutagens using microbial systems- Ames test, detection of mutations

Unit-IV (MMICCMG325.4)

4.1 Gene transfer in bacteria: transformation, transduction, conjugation and sexduction
4.2 Molecular basis of recombination- models of homologus recombination, the Holliday model, double strand break repair model, site specific recombination
4.3 Gene mapping in prokaryotes: deletion mapping, complementation, DNA foot printing, chromosome walking and jumping
4.4 A general account of plasmids: Characteristics, functions, genes of plasmids, F plasmids, R-plasmids, Colicinogenic plasmids, Ti-plasmid, broad host range plasmids
4.5 Transposable elements: IS elements, bacterial transposons, mechanism and types of transposition. Genetic phenomena mediated by transposons, transposons as genetic tools.

CLO-PLO Matrix for the Course

Unit Wise CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	Average (CLO)
MMICCMG325.1	2.5	2.2	2.6	3.0	1.5	1.9	2.2	2.9	2.7	1.6	2.30
MMICCMG325.2	2.4	2.0	2.3	2.7	2.5	3.0	1.6	1.8	2.9	2.8	2.30
MMICCMG325.3	1.5	1.8	2.5	2.8	3.0	2.2	2.2	1.5	2.5	3.0	2.30
MMICCMG325.4	2.0	2.2	2.4	2.9	1.9	3.0	1.8	2.5	2.6	2.9	2.40
Average (PLO)	2.1	2.0	2.4	2.8	2.2	2.5	1.9	2.1	2.6	2.5	2.31

Recommended Books

1. Molecular Biology of the Gene by Watson et. al., Benjamin Cummings. . Edition 6th, 2007.
2. Genomes 3 by T.A. Brown, Garland Science. . Edition 3rd , 2006.
3. Microbial Genetics by Freifelder D, Narosa Publishing House. Edition 1st , 1990.
4. Principal of Genetics by E.J Gardner, M.J.Simmons and DP Snustad, John Wiley and Sons
5. Biochemistry by Stryer WH et al., W.H Freeman and company. Edition 8th, 2006.
6. Genetics: A Conceptual Approach by Benjamin A. Pierce, W.H Freeman and company Edition 5th, 2022.

Course Code: **Title** **Credits: 4; Total Contact Hrs. 60**
MMICCLC325 **LABORATORY COURSE** **Max. Marks: 100**

Course Learning Outcomes (CLOs):

- Perform diagnostic tests and identify pathogens using urine analysis, Widal test, and blood grouping.
- Isolate and characterize microbes from clinical, food, soil, and plant samples.
- Apply molecular techniques like DNA isolation, PCR, and gel electrophoresis.
- Assess microbial applications in fermentation, biofilm detection, and metal tolerance.

1. Examination of urine samples for urinary tract infections
2. Isolation and microscopic examination of human fungal pathogen
3. Latex agglutination test (Widal slide test for typhoid fever)
4. Blood grouping and Rh Typing
5. Isolation of lactic acid bacteria from curd
6. Isolation of bacteria and fungi causing food spoilage
7. Isolation of bacteria and fungi from rhizosphere and non-rhizosphere soil samples
8. Isolation of bacteria from root nodule
9. Isolation of genomic DNA from *E. coli*
10. Agarose gel electrophoresis of isolated gDNA
11. Polymerase Chain Reaction (PCR) (amplification of 16S rRNA fragment using *E. coli* gDNA). Visualization of PCR products
12. Screening of bacterial strains for heavy metal tolerance (Pb/Cu/Cr)
13. Isolation of plasmid DNA from *E. coli*
14. Detection of biofilm formation on micro-titter assay plates
15. Alcoholic fermentation by yeasts

CLO-PLO Matrix for the Course

Unit Wise CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	Average (CLO)
Total No. of Practical's = 15	2.6	2.4	2.7	2.5	1.9	2.8	2.6	1.8	2.4	2.6	2.43
Average (PLO)	2.6	2.4	2.7	2.5	1.9	2.8	2.6	1.8	2.4	2.6	2.43

Recommended Books:

1. Microbiology: A Laboratory Manual by James G. Cappuccino and Natalie Sherman, Pearson Benjamin Cummings Publishers. 11th Edition, 2013.
2. Practical Microbiology by D K Maheshwari and R C Dubey, S Chand and Company Publishers. 4th Edition, 2023.
3. Alcamo's Laboratory Fundamentals of Microbiology by Pommerville J.C., Jones and Bartlett Publishers, Inc. 1st Edition, 2009.
4. Gene Cloning and DNA analysis by T.A Brown, Wiley-Blackwell. Edition 3rd , 2006.
5. Molecular Cloning: A laboratory manual by Joseph Sambrook and David Russell CSHL press. Lab Manual, 2012

Discipline Centric Elective Course (DCEC)

Course Code:	**Title**	**Credits: 4; Total Contact Hrs. 60**
MMICDGG325	**GENETIC ENGINEERING AND GENOMICS**	**Max. Marks: 100**

Course Learning Outcomes (CLOs):

- Be able to gain in- depth knowledge about Understanding the basic steps of gene cloning and the role of enzymes and vectors responsible for gene manipulation, transformation and genetic engineering.
- Be able to know the basics of genomics, synthesis, characterization and application in medicine, agriculture and environment.
- Be able to acquire knowledge about novel approaches in exploring microbiomes using omics technology and their applications in agriculture, environment and healthcare.
- Be able to get information about the ethical and legal aspects associated with the release of genetically engineered organisms

Unit-I (MMICDGG325.1)

1.1 Essentials of recombinant DNA technology: cloning vectors-plasmids, cosmids, phagemids, BAC, YAC and expression vectors
1.2 Enzymes in recombinant DNA technology: DNA polymerase, reverse transcriptase, restriction endonucleases, polynucleotide kinase, terminal deoxynucleotidyltransferase, DNase, Methylase, phosphatases, ligases, RNase and their mode of action
1.3 Transformation and selection of recombinants: (Antibiotic, blue/white selection, colony PCR, restriction digestion and colony hybridization)
1.4 *Agrobacterium* based gene transfer in plants; Ti plasmid, structure and functions; chloroplast transformation
1.5 Promoters, reporters and markers used in genetic engineering

Unit-II (MMICDGG325.2)

2.1 Polymerase chain reaction (PCR) and its variants. Quantitative real time PCR (qRT-PCR) their applications
2.2 Construction and screening of genomic and cDNA libraries
2.3 Applications of rDNA technology in medicine (insulin, monoclonal antibodies, antibiotics, vaccine production) and agriculture (growth hormones, biotic and abiotic stress tolerant varieties)
2.4 Gene therapy: Inherited disorders, detection of gene defects, strategies for gene therapy-*in vivo* and *ex vivo* therapies, gene delivery strategies- viral vectors, liposomes their advantages, disadvantages and applications
2.5 Genetically engineered organisms (GEOs): microbes, plants, animals and their ethical issues

Unit-III (MMICDGG325.3)

3.1 History of genomics, introduction to model prokaryotic genomes (*Escherichia* and Lambda phage) in detail
3.2 Elementary idea of eukaryotic genomes (*Saccharomyces*, *Arabidopsis*, *Caenorhabditis*)
3.3 DNA sequencing, whole genome shotgun sequencing: next-generation sequencing and full genome sequencing platforms
3.4 Analysis of structural, functional and comparative genomics with reference to *E. coli*
3.5 From genomics to synthetic biology and bioengineering (*Mycoplasma laboratorium,* synthetic bacteriophage)

Unit-IV (MMICDGG325.4)

4.1 General idea of human microbiome project, Earth microbiome project, hologenome theory. Human genome project
4.2 Metagenomics: definition, principles, methods, library production, high throughput screening, metagenomics of archaeological samples; Sargasso sea project

4.3 Transcriptomics, proteomics, metabolomics, ionomics, culturomics and their applications (Brief account)
4.4 Genome editing and its application
4.5 Application of genomics in medicine, agriculture and environment

CLO-PLO Matrix for the Course

Unit Wise CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	Average (CLO)
MMICDGG325.1	2.0	2.0	2.9	2.2	2.1	1.5	1.6	2.2	3.0	1.9	2.10
MMICDGG325.2	2.1	2.0	2.6	3.0	2.2	1.9	2.0	2.9	2.0	1.8	2.20
MMICDGG325.3	1.9	2.2	2.4	2.9	2.9	1.9	2.8	2.6	1.5	2.0	2.30
MMICDGG325.4	1.6	2.7	2.0	2.0	3.0	2.2	3.0	2.0	1.8	3.0	2.30
Average (PLO)	1.9	2.2	2.4	2.5	2.5	1.8	2.3	2.4	2.0	2.1	2.25

Recommended Books

1. Principles of Gene Manipulation and Genomics by Sandy B. Primrose and Richard Twyman, Blackwell Publishers. Edition 6th, 2001
2. Gene Cloning and DNA analysis by T.A Brown, Wiley-Blackwell. Edition 3rd , 2006.
3. Biotechnology: Expanding Horizons by B.D. Singh, Kalyani Publishers. 2021
4. Molecular Cloning: A laboratory manual by Joseph Sambrookand David Russell CSHL press. Lab Manual, 2012
5. Molecular Biotechnology: Principles and Applications of Recombinant DNA by Glick B.R and Pasternak J.J, ASM Press. Edition 6th, 2022

Course Code: MMICDBB325 **Title: BIOSTATISTICS AND BIOINFORMATICS** **Credits: 4; Total Contact Hrs. 60** **Max. Marks: 100**

Course Learning Outcomes (CLOs):

- Be able to be well versed with different statistical methods, Principles of statistical analysis of biological data, dispersion, skewness and kurtosis.
- Be able to understand large sample test based on normal distribution, application of Mann-Whitney U test, Small sample test based on t-test and F test.
- Be able to understand the basics of bioinformatics like file formats, databases and the basic alignments tools like BLAST, FASTA, etc.
- Be able to get familiar with different types of multiple sequence alignment tools for analysis and will get to know about the basics methods of phylogenetic analysis.

Unit-I (MMICDBB325.1)

1.1 A general account on biostatistics-samples and populations, types of variables, arithmetic mean, mode and median
1.2 Data interpretation: graphs, bar diagrams, average, range, standard deviation, standard error, coefficient of variation
1.3 General criteria for experimental design: latin square, block, completely randomized and split plot design
1.4 Regression and correlation analyses
1.5 Skewness and kurtosis and their measures, percentiles, quantiles, outliers

Unit-II (MMICDBB325.2)

1.1 Tests of statistical significance - t-test, z-test, F-test
1.2 Analysis of variance, ANOVA, One-way Anova (concept and calculation), SPSS and its applications
1.3 Probability: definition, conditional probability, addition and multiplication rules, normal, binomial and Poisson distribution
1.4 Non-parametric Mann-Whitney U test
1.5 Concept of isoclines, ecological diversity, incidences diversity (Simpson's index, Shannon Wiener index

Unit-III (MMICDBB325.3)

1.1 History and scope of bioinformatics
1.2 Role of computers in bioinformatics: Operating systems (unix, linux), concept of networking
1.3 Biological database: literature (PubMed), nucleic acid (NCBI, EMBL) protein (NBRF, PIR, Swiss-Prot) and structural database (PDB)

1.4 Sequence analysis and comparison; Similarity and homology between sequences; sequence alignment–local and global alignment (BLAST, FASTA), Multiple sequence alignment (Clustal W)

1.5 Phylogenetic analysis: types of phylogenetic trees, approaches of constructing phylogenetic trees (UPGMA, maximum parsimony, maximum likelihood, neighbor joining), phylogenetic analysis by MEGA software

Unit-IV (MMICDBB325.4)

2.1 Bioinformatic tools in microbial research: ORF finder, primer design, restriction mapping (NEBcutter), removal of vector contamination (VecScreen), domain finder.

2.2 Promoter analysis databases. (BPROM, PlantPAN)

2.3 Prokayotic and eukaryotic genome analysis software and databases: Microbial genomic database (MBGD), Virus data bank (ICTVdb), Cell line database (ATCC), Ribosomal database project-RDP, Genomes online database-GOLD, The Arabidopsis Information Resource (TAIR), TIGR Rice Genome Annotation)

2.4 Structure prediction: secondary structure of RNA, secondary and tertiary structure of proteins, In silico isoelectric point and molecular weight of proteins using Compute PI/MW,

2.5 In silicosubcellular localization of prokaryotic and eukaryotic protein PSORTb, Cell-PLoc

CLO-PLO Matrix for the Course

Unit Wise CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	Average (CLO)
MMICDBB325.1	3.0	1.9	2.0	3.0	2.9	2.0	2.9	1.8	3.0	1.7	2.40
MMICDBB325.2	2.2	1.8	2.3	1.9	2.8	3.0	2.2	1.7	2.2	1.6	2.10
MMICDBB325.3	2.0	1.7	2.9	2.2	2.7	2.2	3.0	1.9	2.5	1.8	2.20
MMICDBB325,4	2.0	1.6	3.0	2.1	2.2	2.9	2.9	1.5	2.2	2.3	2.20
Average (PLO)	2.3	1.7	2.5	2.3	2.6	2.5	2.7	1.7	2.4	1.8	2.25

Recommended Books

1. Biostatistics: A Foundation for Analysis in the Health Sciences (Wiley Series in Probability and Statistics) by Daniel W Wayne, John Wiley and Sons Inc. Edition 10th, 2013
2. Fundamentals of Biostatistics by Khan and Khanum, Ukaaz Publications. 1994
3. Biostatistics by P.N Arora and P.K. Malhan, Himalaya Publishing House. 2010
4. Statistics for Biologists by Campbell, R.C., Cambridge University Press. Edition 1st, 2013
5. Bioinformatics and Functional Genomics by Jonathan Pevsner, Wiley-Blackwell.
6. Bioinformatics Sequence and Genome Analysis by Mount D.W., Cold Spring Harbor Laboratory Press. Edition 2nd 2009
7. Genome Analysis and Bioinformatics: A Practical Approach by T.R.Sharma, I K International Publishing House. Edition 2nd 2005

Course Description Fourth Semester

Course Code: **MMICCRP425** | **Title** **Research based project work, dissertation writing and submission in hard bound form** | **Credits: 12; Total Contact Hrs. 60** **Max. Marks: 100**

Course Learning Outcomes (CLOs):

- Be able to gain scientific temperament for finding solutions to the research problems.
- Be able to perform experiments independently under the mentorship of a designated teacher.
- Be able to write dissertation and presentation of research work in presence of external experts of the subject.
- Be able to present findings of the study in presence of scientific community comprising of teachers, research scholars and the fellow students.

CLO-PLO Matrix for the Course

Unit Wise CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	Average (CLO)
MMICCRP425	2.3	2.9	2.2	2.2	2.8	2.4	2.7	1.9	2.6	2.5	2.45
Average (PLO)	2.3	2.9	2.2	2.2	2.8	2.4	2.7	1.9	2.6	2.5	2.45

Course Code: **Title** **Credits: 4; Total Contact Hrs. 60**
MMICCPV425 **PRESENTATION AND VIVA-VOCE** **Max. Marks: 100**

Course Learning Outcomes (CLOs):

- Be able to make research-based power point presentation of their research project.
- Be able to defend the research work in presence of all the students and faculty members including external examiner.

CLO-PLO Matrix for the Course

Unit Wise CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	Average (CLO)
MMICCPV425	2.8	3.0	2.7	2.1	2.6	2.5	2.3	2.2	1.8	2.4	2.44
Average (PLO)	2.8	3.0	2.7	2.1	2.6	2.5	2.3	2.2	1.8	2.4	2.44

Course Code: **Title** **Credits: 4; Total Contact Hrs. 60**
MMICCSP425 **Advanced research course** **Max. Marks: 100**

This paper will be separately designed for each student based on their area of interest to be decided in consultation with teachers. The study of the special paper shall lead to the advancement of knowledge of the students in at least one of the relevant areas of microbiology which in turn may decide their future study interests.

Course Learning Outcomes (CLOs):

- Be able to lead to the advancement of knowledge in practical field.
- Be able to familiarize students with the advanced techniques in microbiology.
- Be able to inculcate a mind set that embraces rational thinking

CLO-PLO Matrix for the Course

Unit Wise CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	Average (CLO)
MMICCPV425	2.4	2.7	2.3	2.9	2.4	2.6	2.3	2.6	2.0	2.8	2.5
Average (PLO)	2.4	2.7	2.3	2.9	2.4	2.6	2.3	2.6	2.0	2.8	2.5

CLO-PLOs Mapping Matrix for all the Courses

Course Code	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	Average (CLO)
MMICCFM125	2.6	2.55	2.47	2.45	2.42	2.45	2.6	2.57	2.47	2.2	2.47
MMICCBV125	2.37	2.25	2.27	2.85	1.87	1.97	2.52	2.37	1.82	2.65	2.28
MMICCLC125	2.8	2.4	2.7	2.3	3.0	2.7	2.1	2.0	2.6	2.1	2.47
MMICDMM125	2.27	2.6	2.0	1.85	2.65	2.2	2.1	2.3	2.7	2.5	2.31
MMICDBT125	2.5	2.5	2.5	2.1	2.6	2.4	2.2	2.2	2.3	2.4	2.37
MMICCCE225	2.4	2.5	2.4	2.7	2.2	2.6	2.4	2.4	2.2	2.6	2.44
MMICCMM225	2.5	2.3	2.5	2.3	2.5	2.3	2.3	2.6	2.3	2.4	2.40
MMICCLC225	2.7	2.2	2.0	2.9	2.1	1.8	2.9	2.6	2.3	2.7	2.37
MMICCMM225	2.3	2.5	2.6	2.7	2.9	2.4	2.2	2.4	2.4	2.2	2.46
MMICDFI225	2.4	2.0	2.3	2.5	2.3	2.0	2.0	1.8	2.4	2.5	2.22
MMICCIM325	2.5	2.5	2.7	2.4	2.3	2.1	2.5	2.3	2.4	2.5	2.42
MMICCMG325	2.1	2.0	2.4	2.8	2.2	2.5	1.9	2.1	2.6	2.5	2.31
MMICCLC325	2.6	2.4	2.7	2.5	1.9	2.8	2.6	1.8	2.4	2.6	2.43
MMICDGG325	1.9	2.2	2.4	2.5	2.5	1.8	2.3	2.4	2.0	2.1	2.21
MMICDBB325	2.3	1.7	2.5	2.3	2.6	2.5	2.7	1.7	2.4	1.8	2.25
MMICCRP425	2.3	2.9	2.2	2.2	2.8	2.4	2.7	1.9	2.6	2.5	2.45
MMICCPV425	2.8	3.0	2.7	2.1	2.6	2.5	2.3	2.2	1.8	2.4	2.44
MMICCPV425	2.4	2.7	2.3	2.9	2.4	2.6	2.3	2.6	2.0	2.8	2.5
Average PLO	2.43	2.40	2.42	2.46	2.43	2.33	2.36	2.23	2.31	2.41	2.37

Attainment of CLOs

75% weightage to direct and 25% weightage to indirect evaluation methods may be assigned. The attainment of CLOs can be measured on the basis of the results of internal assessment and Semester End Examination (SEE). The attainment is measured on a 4-point scale after setting the target for CLO attainment. Table below shows the CLO attainment levels for internal assessment as per departmental regulations (assuming the set target of 60% marks) and letter grade A for Semester End Examination (SEE).

CLO Attainment Levels for Internal Assessment and End Semester Examination

Attainment Level	For Continuous Internal Evaluation (CIE)	For Semester End Examination (SEE)
0 (No attainment)	<40% of students score equal to or more than set target %age (say 60 %) for internal assessment of a course.	<40% of students obtained letter grade of 'A' in SEE of a course.
1 (Low level of attainment)	40% to < 50% of students score equal to or more than set target %age (say 60 %) for internal assessment of a course.	40% to < 50% of students obtained letter grade of 'A' in SEE of a course.
2 (Medium level of attainment)	50% to < 60% of students score equal to or more than set target %age (say 60 %) for internal assessment of a course.	50% to < 60% of students obtained letter grade of A in SEE of a course.
3 (High level of attainment)	60% or more of students score equal to or more than set target %age (say 60 %) for internal assessment of a course.	60% or more students obtained letter grade of A in SEE of a course.

Note: The assessment methods for internal assessment are class participation, assignment /presentation/quiz/class test etc. and mid-term examination. The set target is assumed as 60% for internal assessment and grade A for SEE. Varying across departments/institutes to be decided by The Boards of Studies

ONE YEAR P.G. DIPLOMA IN MICROBIOLOGY/
ONE YEAR P.G PROGRAMME IN MICROBIOLOGY

PROGRAMME LEARNING OUTCOMES (PLOs)

PLO1: Comprehensive Understanding of Microbiology
Develop in-depth theoretical and applied knowledge in diverse fields of microbiology including bacteriology, virology, mycology, and microbial physiology, emphasizing their roles in health, environment, and biotechnology.

PLO2: Proficiency in Laboratory and Analytical Skills
Demonstrate hands-on expertise in microbiological techniques such as culturing, staining, aseptic handling, molecular diagnostics, and advanced instrumentation including PCR, electrophoresis, and spectrophotometry.

PLO3: Application of Microbial Technology
Apply microbiological principles in practical domains such as agriculture, healthcare, food industry, and environmental management, including fermentation technology, bioremediation, and microbial product development.

PLO4: Integration of Interdisciplinary Knowledge
Synthesize concepts from molecular biology, biochemistry, immunology, genomics, and cell biology to solve complex biological problems through an interdisciplinary approach.

PLO5: Computational and Bioinformatics Skills
Utilize bioinformatics tools and databases for microbial genome analysis, metagenomic profiling, sequence alignment, and ecological data interpretation to support research and diagnostics.

PLO6: Ethical, Social, and Environmental Responsibility
Apply ethical principles, biosafety practices, and environmental responsibility in microbiological research, especially in the use of genetically modified organisms and pathogenic microbes.

PLO7: Scientific Communication and Professional Writing
Effectively communicate scientific ideas, research findings, and technical data through oral presentations, posters, journal clubs, reports, and peer-reviewed publications.

PLO8: Lifelong Learning and Career Preparedness
Demonstrate a commitment to lifelong learning by staying current with scientific advancements and acquiring new skills relevant to academic, industrial, or clinical career pathways.

PLO9: Leadership and Collaborative Skills
Develop leadership qualities and teamwork skills essential for managing multidisciplinary scientific projects, organizing research activities, and contributing to collaborative investigations.

PLO10: Research and Innovation Capability
Design, conduct, and analyses independent research projects with originality and critical thinking, contributing to scientific innovation through dissertation writing, proposal drafting, and knowledge dissemination.

Prof. Bashir Ahmad Ganai

INTRODUCTION AND BASIC STRUCTURE OF THE COURSE
TWO YEARS P. G. PROGRAMME IN MICROBIOLOGY

Microbiology: The study of microorganisms, as a subject of study has immense importance, as microorganisms are the first inhabitant of the planet and in fact have over the years made this planet habitable for other life forms. Microorganisms are associated with our day-to-day life and affect us directly or indirectly in a number of ways. Microbiology as a subject has immense applications, in the fields of public health, agriculture, environment, industries, biotechnology etc. This course content is designed in such a way as to impart quality education and training in both the basic and applied aspects of microbiology. Therefore, we intended to produce highly trained professionals who besides serving various public and private organizations in the area of public health, environment, agriculture, food and dairy industry and biotechnology will also become entrepreneurs, who can exploit the services of microorganisms for the benefit of mankind besides creating self-employability opportunities.

The revised syllabi and courses of study for post-graduate Programme in Microbiology will be based on 80 credits (20/ semester). All the 80 credits will spread over 5 different components *viz.* - (i) teaching, (ii) tutorial, (iii) seminar, (iv) three laboratory courses (one each in the first, second and third semester), and (v) project work /Internship in fourth semester. Each semester will consist of at least 20 credits including at least 12 core credits (compulsory), 08 discipline centric elective.

Course Structure: There will be 11 **Core Courses (CC) (11+2)** (theory and laboratory) in all with each semester covering at least 3 core courses. Each core course will be worth 4 credits with theory covering at least 12 credits and practical component 4 credits. There will be 07 **Discipline Centric Elective Courses (DCEC)** courses. The total course of M. Sc. Microbiology will comprise of **80 credits out of which 52 credits are core while and 28 credit would be Discipline Centric Elective Courses (DCEC)**.

Each **CC and DCEC** will be worth of 100 marks and 4 credits comprising of **internal examination of 28 marks** and **external examination of 72 marks**. Internal assessment of theory papers will be based on quiz tests/ assignments/ seminars, etc. The practical component will also be of **internal examination comprising 28 marks** based on student's performance during practical periods and **external examination of 72 marks** through conduct of common test at the end of each semester to finalize awards for the same. The students will be required to submit their lab work records at the end of each semester examination for evaluation by the examiner/teacher(s) concerned.

P. G. 2025 onward batch shall be eligible to opt courses from **SWAYAM online platform** as per the schedule. The learners shall opt for relevant P. G. level credited courses from SWAYAM Platform by five National Coordinators, **i.e. UGC, AICTE, NPTEL, CEC** and **NITTTR.** These online courses only serve as an alternative corridor of courses for students and shall **not be mandatory**.

Project work/ Internship: Project work worth **20 credits** is compulsory for the students and will be assigned in **4th semester** based on choice of the student and space /resource availability in relation to his/her choice. The students for project work will be evenly distributed among faculty members of the Department. The main emphasis will be on developing independent creative thinking and execution of scientific experiments, presentation and scientific writing.

The candidate has to submit dissertation in a bound form at the end of 4th semester. The final evaluation of the project work will be through a **Panel involving internal and external examiners**. Each student has to deliver the entire dissertation work through power point presentation in front of a panel of examiners.

General course outline for first year program

Year -1 (Level-6.0)

First Semester

Course	Course Code	Course Name	Paper Category (Code)	Credits	Total Contact Hrs
Core	MMICCFM125	Fundamentals of Microbiology	CC	4	60
	MMICCBV125	Bacteriology and Virology	CC	4	60
	MMICCLC125	Laboratory Course and Industrial visit	CC	4	60
Discipline Centric Elective	MMICDMM125	Microbial Physiology and Metabolism	DCEC	4	60
	MMICDBT125	Biotechniques	DCEC	4	60

Second Semester

Course	Course Code	Course Name	Paper Category	Credits	Total Contact Hrs
Core	MMICCCE225	Cell Biology and Enzymology	CC	4	60
	MMICCMM225	Medical Microbiology	CC	4	60
	MMICCLC225	Laboratory Course	CC	4	60
Discipline Centric Elective	MMICDEA225	Environmental and Agriculture Microbiology	DCEC	4	60
	MMICDFI225	Food and Industrial Microbiology	DCEC	4	60

Prof. Bashir Ahmad Ganai

Course Description First Semester

Core Courses

Course Code:	Title	Credits: 4; Total Contact Hrs. 60
MMICCFM125	FUNDAMENTALS OF MICROBIOLOGY	Max. Marks: 100

Course Learning Outcomes (CLOs)

- Be able to gain in depth knowledge about historical developments in microbiology, basic techniques like preparation of media, sterilization, staining, and microscopy.
- Be able to gain knowledge about culture media and culture techniques
- Be able to know nomenclature, taxonomic trends and major characteristics used in taxonomy.
- Be able to gain knowledge about ultastructure of prokaryotic and eukaryotic cells

Unit –I (MMICCFM125.1)

1.6 Historical perspective of microbiology with reference to Leeuwenhoek, Robert Koch, Louis Pasteur, Edward Jenner, Joshep Lister, Alexander Flemming etc
1.7 Spontaneous and non-spontaneous generation, fields of microbiology
1.8 Microscopy, instrumentation and handling.
1.9 Staining methods: simple, differential, structural and special staining
1.10 Sterilization and methods of sterilization, biosafety and various biosafety levels in a microbiology laboratory

Unit-II (MMICCFM125.2)

2.1. Culture media: classification of media (simple, complex and special media with examples), specific media for the cultivation of bacteria, fungi, algae and protozoa
2.2. Culture techniques (pour plate, spread plate, streaking and swab culture), preservation and maintenance of microbial cultures
2.3. Growth: nutritional requirements, growth kinetics, generation time, growth curve, factors affecting growth.
2.4. Anaerobic culture, batch/continuous culture and their applications
2.5. Biofilm, Quorum sensing, composition, occurrence and its importance

Unit-I I I (MMICCFM125.3)

3.1. Microbial taxonomy, nomenclature and classification of microorganisms, Haeckel's three kingdom classification, Whittaker's five kingdom approach
3.2. Woese domain system (Eukarya, Archae, Eubacteria)
3.3. Genetic and molecular taxonomy and its application in microbial diversity
3.4. General characteristics and classification of fungi.
3.5. General characteristics and classification of algae and protozoa.

Unit-IV (MMICCFM125.4)

4.6. Ultrastructure of prokaryotic cells: Bacteria; cell wall and cell membrane structure (L forms, spheroplast), mesosomes, flagella and motility, cytoplasm inclusions, pilli, fimbrae, capsule and slime layer
4.7. Endospore structure and sporulation process in bacteria
4.8. Differences between prokaryotic and eukaryotic cell
4.9. Ultrastructure and composition of fungi
4.10. Ultrastructure and composition of algae and protozoa

CLO-PLO Matrix for the Course

Unit Wise CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	Average (CLO)
MMICCFM125.1	2.5	2.4	2.3	3.0	2.9	2.8	2.6	2.1	2.3	2.1	2.5
MMICCFM125.2	2.8	2.7	2.6	2.4	2.2	2.5	2.4	2.7	2.5	1.9	2.47
MMICCFM125.3	2.9	2.2	2.5	1.8	2.8	2.5	2.8	2.6	2.5	2.2	2.48
MMICCFM125.4	2.2	2.9	2.5	2.6	1.8	2.7	2.6	2.9	2.6	2.6	2.54
Average (PLO)	2.6	2.55	2.47	2.45	2.42	2.45	2.6	2.57	2.47	2.2	2.47

Recommended Books

6. Prescott's Microbiology by Joanne Willey, Linda Sherwood and Christopher J. Woolverton, McGraw Hill Publisher Companies, Inc. Edition 11th, 2020.
7. Microbiology by Michael J. Pelczaret. al., McGraw Hill Publisher Companies, Inc. Edition 5th, 2001

8. Brock Biology of Microorganisms by Madigan and Martinko, Pearson Education International. Edition 16th, 2021
9. General Microbiology by Roger Y Stanier, ML Wheelis and PR Painter, MacMillan Press Ltd. Edition 5th, 1999
10. Ananthanarayan and Paniker's text book of Microbiology by Reba Kanungo, Universities Press. Edition 12th, 2022

Course Code: **Title** **Credits: 4; Total Contact Hrs. 60**
MMICCBV125 **BACTERIOLOGY AND VIROLOGY** **Max. Marks: 100**

Course Learning Outcomes (CLOs):

- Be able to gain in depth knowledge detailed classification of different bacterial groups.
- Be able to describe properties, characteristics and economic importance of different bacterial species
- Be able to know features, life cycle and taxonomy of different viruses
- Be able to conversant with viral genome diversity and control of viruses.

Unit-I (MMICCBV125.1)

1.6 Historical account of bacterial classification
1.7 Characteristics, classification and economic importance of Gram negative facultative anaerobic rods (Enterobacteriaceae and Vibrionaceae)
1.8 Characteristics, classification and economic importance of Gram-negative aerobic rods and cocci (Pseudomonadaceae, Rhizobiaceae, Neisseriaceae)
1.9 Characteristics, classification and economic importance of Gram-positive aerobic rods and cocci (Corynebacteriaceae, Mycobacteriaceae, Listeriaceae, Streptococcaceae, Staphylococcaceae)
1.10 Characteristics, classification and economic importance of endospore forming Gram positive rods (Bacillaceae and Clostridiaceae)

Unit-II (MMICCBV125.2)

2.6 General characters, classification and economic importance of Cyanobacteria
2.7 General characters classification and economic importance of Mycoplasma
2.8 General characters, classification and economic importance of Rickettsiae
2.9 General characteristics, classification and economic importance of spirochaetes and actinomycetes
2.10 Domain Archea, morphology, genetics, ecology, economic importance and sub-types of archeabacteria

Unit-III (MMICCBV125.3)

3.6 Discovery, composition and structural features of viruses
3.7 Lifecycle of viruses (lytic and lysogeniccycle)
3.8 General features and replication of T4, TMV, Influenza and HIV viruses
3.9 Taxonomy of viruses: classification and nomenclature as per ICTV
3.10 Brief account on bacteriophages, mycophages, phycophages, cyanophages, protozoan viruses

Unit-IV (MMICCBV125.1)

4.6 Isolation and cultivation of plant, animal and bacterial viruses
4.7 Sub viral particles: Satellite viruses, viriods, DI particles and prions
4.8 Oncogenic virus (DNA and RNA viruses)
4.9 Introduction to virotherapy and its types (interferons and viral vaccines)
4.10 Antiviral agents and future perspective

CLO-PLO Matrix for the Course

Unit Wise CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	Average (CLO)
MMICCBV125.1	2.4	1.3	1.2	3.0	1.1	2.0	3.0	3.0	1.7	2.9	2.16
MMICCBV125.2	2.2	2.8	1.6	2.9	1.5	2.2	2.9	2.0	1.9	2.0	2.20
MMICCBV125.3	2.4	2.1	1.9	2.8	2.9	2.0	2.2	1.8	1.8	2.7	2.26
MMICCBV125.4	2.5	2.8	2.9	2.7	2.0	1.7	2.0	2.7	1.9	3.0	2.42
Average (PLO)	2.37	2.25	2.27	2.85	1.87	1.97	2.52	2.37	1.82	2.65	2.26

Recommended Books

6. Brock Biology of Microorganisms by Madigan and Martinko, Pearson Education International. Edition 16th, 2021.
7. Prescott's Microbiology by Joanne Willey, Linda Sherwood and Christopher J. Woolverton, McGraw Hill Publisher Companies,Inc. Edition 11th, 2020.
8. Ananthanarayanand Paniker's text book of Microbiology by Reba Kanungo, Universities Press. Edition 12th, 2022
9. Bergey's Manual of Systematic Bacteriology. Edition 2nd, 2005.
10. Jawetz, Melnick and Adelbergs Medical Microbiology by Brooks et al., McGraw-Hill Medical. Edition 28th, 2019.

Course Code:	**Title**	**Credits: 4; Total Contact Hrs. 60**
MMICCLC125	**LABORATORY COURSE AND INDUSTRIAL VISIT**	**Max. Marks: 100**

Course Learning Outcomes (CLOs)

- Be able to understand the practical aspects of basic microbiology.
- Be able to learn lab practices and calculation needed for preparation of various reagents and buffers.
- Be able to understand different sterilization processes and different staining techniques of given microbial isolate.
- Be able to understand utility of microbiology and microbiologists in industries and institutional establishments

16. Preparation of buffers, other reagents and pH measurements
17. Biochemical and solution calculations
18. Sterilization techniques
19. Types of culture media and their preparations, colony characters of bacteria and fungi
20. Culture techniques
21. Isolation of bacteria from evironmental samples and motility test of bacteria
22. Growth curve of bacteria with reference to *E. coli*
23. Enumerate the CFU of bacteria (any) by serial dilution method
24. Staining techniques – Simple, Gram, Acid-fast, Endospore staining
25. Confirmed test of coliform bacteria
26. Perform antibiotic sensitivity and resistance assay
27. Screening of amylase, lipase and protease producers
28. Isolation of yeast from different samples.
29. Different Industrial visit for practical exposure and entrepreneur skill development
30. Differential intuitional visit to understand role of microbiologists

CLO-PLO Matrix for the Course

Unit Wise CLOs	**PLO1**	**PLO2**	**PLO3**	**PLO4**	**PLO5**	**PLO6**	**PLO7**	**PLO8**	**PLO9**	**PLO10**	Average (CLO)
Total No. of Practical's = 15	2.8	2.4	2.7	2.3	3.0	2.7	2.1	2.0	2.6	2.1	2.47
Average (PLO)	2.8	2.4	2.7	2.3	3.0	2.7	2.1	2.0	2.6	2.1	2.47

Recommended Books

4. Microbiology: A Laboratory Manual by James G. Cappuccino and Natalie Sherman, Pearson Benjamin Cummings Publishers. Edition 11th, 2013
5. Practical Microbiology by D K Maheshwari and R C Dubey, S Chand and Company Publishers. Edition 4th, 2023
6. Alcamo's Laboratory Fundamentals of Microbiology by Pommerville J.C., Jones and Bartlett Publishers, Inc. Edition 1st, 2009

Discipline Centric Elective Course (DCEC)

Course Code:	Title	Credits: 4; Total Contact Hrs. 60
MMICDMM125	MICROBIAL PHYSIOLOGY AND METABOLISM	Max. Marks: 100

Course Learning Outcomes (CLOs)

- Be able to know various types of nutrients utilized by microbes, their mechanism of transport and utilization of sugars via pathways will be learned
- Be able to understanding aerobic respiration, electron transport chain, fermentation, oxidation and reduction reactions.
- Be able to understand lipids, amino acids, proteins, nucleotides, vitamins and their classification, structure, and properties.
- To provide knowledge about the physiology and metabolism of microorganisms

Unit-I (MMICDMM125.1)

1.6 Nutritional diversity in microorganisms, bioluminescence and its mechanism in microorganisms
1.7 Essentiality of major and minor elements, mechanism of nutrient transport in microorganisms (ABC transporters, phosphotransferase, drug export systems and transport of amino acids)
1.8 Chemotrophs: acetogens, methylotrophs, methanogens and their importance
1.9 Methanotrophy: characteristics of methanotrophs, dissimilation of methane by methanotrophs and carbon assimilation by methylotrophs
1.10 Sulfidogenesis: biochemistry of sulfidogenesis, reduction of sulfate and sulfur, sulphur reducing bacteria

Unit-II (MMICDMM125.2)

2.6 Autotrophic nutrition in microorganisms: oxygenic vs anoxygenic photosynthesis
2.7 Photosynthetic pigments (chlorophyll, bacteriochlorophyll, rhodopsin, phycobiliproteins), basic photochemistry of PSI, PSII and light driven electron transport
2.8 Modes of CO_2 fixation (Calvin cycle, reverse TCA cycle, HP pathway)
2.9 Carbohydrate metabolism: classification, structure and functions of carbohydrates, stereoisomerism, aldoses and ketoses
2.10 Various pathways underlying the utilization of different sugars (EMP, ED, HMP) in microorganisms, gluconeogenesis and Pasteur effect

Unit-III MMICDMM125.3

3.6 Aerobic respiration: TCA cycle, glyoxylate cycle
3.7 Electron transport chain, substrate level and oxidative phosphorylation
3.8 Anaerobic respirations: sulphate, nitrate, carbonate respirations and their ecological significance
3.9 Fermentations: types of fermentations (homo, heterolactic and mixed fermentations)
3.10 Oxidation- reduction reactions, measurement of redox potentials, structure of ATP synthase complex; mechanism of ATP synthesis, inhibitors and uncouplers

Unit-IV (MMICDMM125.4)

4.6 Lipids: classification, structure and biosynthesis of glycerides, phospholipids and glycolipids, β-oxidation of saturated and unsaturated fatty acids
4.7 Amino acids: classification, structure and properties of amino acids, biosynthetic pathways of amino acids and their regulation with emphasis on tryptophan, tyrosine and histidine, transamination, deamination
4.8 Proteins: classification and structural organization of proteins (primary, secondary, tertiary and quaternary)
4.9 Nucleotide metabolism: biosynthesis of purine and pyrimidine nucleotides and their degradation
4.10 Vitamins as microbial growth factors

CLO-PLO Matrix for the Course

Unit Wise CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	Average (CLO)
MMICDMM125.1	2.8	2.3	2.2	2.0	1.9	1.0	3.0	2.9	2.6	2.8	2.35
MMICDMM125.2	2.2	3.0	2.9	1.9	2.8	3.0	1.8	1.8	3.0	2.2	2.46
MMICDMM125.3	2.0	2.9	1.2	1.8	2.9	2.9	1.9	1.8	2.8	2.0	2.22
MMICDMM125.4	2.1	2.2	2.0	1.7	3.0	2.0	1.7	2.9	2.4	3.0	2.30
Average (PLO)	2.27	2.6	2.0	1.85	2.65	2.2	2.1	2.3	2.7	2.5	2.26

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Recommended Books

5. Lehninger Principles of Biochemistry by Lehninger by David L. Nelson and Michael M Cox, W.H Freeman and company. Edition 4th, 2005.
6. Biochemistry by Stryer WH et al., W.H Freeman and company. Edition 5th, 2022
7. Brock Biology of Microorganisms by Madigan and Martinko, Pearson Education International. Edition 16th, 2021.
8. Prescott's Microbiology by Joanne Willey, Linda Sherwood and Christopher J. Woolverton, McGraw Hill Publisher Companies, Inc. Edition 11th, 2013Physiology and Biochemistry of Prokaryotes by White David, Oxford University Press. Edition 1st, 1995.

Course Code: MMICDBT125 **Title: BIOTECHNIQUES** **Credits: 4; Total Contact Hrs. 60** **Max. Marks: 100**

Course Learning Outcomes (CLOs)

- Be able to understand the various techniques and instruments required to study and engineer microorganisms.
- Be able to familiarized with the techniques like centrifugation, chromatography, GC-MS, HPLC, Blotting techniques, radio isotopic techniques, spectroscopic techniques, NMR, MALDI-TOF and so on.
- Be able to understand the processes of electrophoresis for separation of macromolecules and applications of radioactivity in biology.
- Be able to prepare students for advanced topics like downstream processing and recombinant DNA technology by building essential technical knowledge.

Unit-I (MMICDBT125.1)

1.6 Centrifugation techniques: basic principles of centrifugation and derivation of relation for coefficient and measurement of sedimentation co-efficient
1.7 Rotors and types of rotors
1.8 Differential and density gradient centrifugation
1.9 Analytical centrifugation and its applications
1.10 Viscosity and its measurement

Unit-II (MMICDBT125.2)

2.6 Basic principles of chromatography and its types
2.7 Ion exchange chromatography
2.8 Gel filtration chromatography
2.9 Affinity chromatography
2.10 HPLC, GC-MS

Unit-III (MMICDBT125.3)

3.6 Electrophoresis: basic principles and types
3.7 Polyacrylamide gel electrophoresis and agarose gel electrophoresis, SDS- PAGE
3.8 Two-dimensional electrophoresis, immune electrophoresis and isoelectric focusing
3.9 Capillary electrophoresis, pulse-field electrophoresis
3.10 Blotting techniques -Southern, Northern and Western blotting

Unit-IV (MMICDBT125.4)

4.6 Radio isotopic techniques: principle and applications of tracer techniques in biology
4.7 Radioactive isotopes, radioactive decay; detection and measurement of radioactivity
4.8 Spectroscopic techniques- principle and working of theory of absorption of light by molecule
4.9 UV- visible spectrophotometer-principle and working
4.10 Fluorescence spectroscopy, MALDI-TOF**,** NMR and X ray crystallography

CLO-PLO Matrix for the Course

Unit Wise CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	Average (CLO)
MMICDBT125.1	3.0	2.9	2.5	2.0	1.7	1.9	2.1	2.0	2.7	2.6	2.30
MMICDBT125.2	2.0	2.2	2.8	2.0	3.0	2.9	2.7	2.2	2.5	1.9	2.40
MMICDBT125.3	2.5	2.6	3.0	2.6	2.8	3.0	2.0	2.0	2.2	2.1	2.40
MMICDBT125.4	2.5	2.6	1.8	1.9	3.0	2.0	2.2	2.9	2.0	3.0	2.30
Average (PLO)	2.5	2.5	2.5	2.1	2.6	2.4	2.2	2.2	2.3	2.4	2.25

Recommended Books

5. Principles and Techniques of Biochemistry and Molecular Biology by Keith Wilson and John Walker, Cambridge University Press. Edition 8th 2013
6. Biochemistry Laboratory: Modern Theory and Techniques by Rodney F. Boyer, Pearson Prentice Hall. Edition 2nd, 2010
7. Biophysical Chemistry Principles and Techniques by Upadhyay et al., Himalaya Publishing House. Edition 1st, 2020
8. Analytical Biochemistry by Ganai et al., Valley Publications.

Course Description: Second Semester
Core Course (CC)

Course Code: **Title** **Credits: 4; Total Contact Hrs. 60**
MMICCCE225 **CELL BIOLOGY AND ENZYMOLOGY** **Max. Marks: 100**

Course Learning Outcomes (CLOs):

- Be able to know the eukaryotic cell structure, cell cycle, cell cycle progression, signal transduction and scattered plot
- Be able to know membrane structure, signal transduction, cell cycle and various pathways of microorganisms
- Be able to know the enzyme classification, nomenclature, and significance of various types of enzymes
- Be able to know the enzyme kinetics, enzyme inhibition, isozymes and their metabolic significance.

Unit-I (MMICCCE225.1)

1.6 Ultrastructure and organization of unicellular eukaryotic cell
1.7 Nucleus, mitochondria and chloroplasts and their genetic organization
1.8 Endoplasmic reticulum, golgi apparatus, protein trafficking
1.9 Flagella and mechanism of flagellar movements
1.10 Cytoskeletal elements (microtubules and microfilaments)

Unit-II (MMICCCE225.2)

2.6 Membrane structure and dynamics-diversity, structure and physiology of membrane pumps, carriers and channels
2.7 Signal transduction and its mechanism
2.8 Cell cycle -overview, phases of the cell cycle, cell growth and extracellular signals
2.9 Regulations of cell cycle progression (cyclins and cyclin dependent kinases), cell cycle- check points
2.10 Cell differentiation, apoptotic pathways and molecular mechanism of apoptosis

Unit-III (MMICCCE225.3)

3.6 Introduction to enzymology and characteristics of enzymes
3.7 Classification and nomenclature of enzymes (IUB nomenclature)
3.8 Mechanism of enzyme action, theories of mechanism of enzyme action
3.9 Constitutive, inducible and marker enzymes
3.10 Enzyme activators, co-enzyme, prosthetic group and co-factors in enzymatic catalysis, concept of enzyme and substrate specificity, enzyme assay and its units

Unit- IV (MMICCCE225.4)

4.6 Enzyme kinetics, Michaelis-Menton equation and its derivation

4.7 Determination of V_{max}, K_m, K_{cat} and their significance, Lineweaver-Burk plots, Eadie-Hofstee and Hanes plots

4.8 Enzyme inhibition - competitive, uncompetitive, non-competitive, and irreversible, determination of K_m V_{max} K_i in presence of inhibition

4.9 Isozymes and their metabolic significance, allosteric enzymes and co-operativity

4.10 Large scale enzyme extraction, enzyme purification, recovery and yield of enzymes

CLO-PLO Matrix for the Course

Unit Wise CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	Average (CLO)
MMICCCE225.1	1.7	2.4	1.9	2.5	2.0	2.9	3.0	3.0	2.9	2.7	2.50
MMICCCE225.2	3.0	2.7	2.6	2.8	2.0	2.7	2.0	2.2	2.1	2.8	2.40
MMICCCE225.3	2.0	2.2	2.9	3.0	3.0	1.9	2.1	2.6	1.9	2.9	2.40
MMICCCE225.4	3.0	2.9	2.2	2.5	2.0	3.0	2.5	1.9	2.1	2.0	2.40
Average (PLO)	2.4	2.5	2.4	2.7	2.2	2.6	2.4	2.4	2.2	2.6	2.45

Recommended Books

6. Molecular Cell Biology by Lodish et al., W.H Freeman and Company. Edition 5th, 2003
7. Molecular biology of the Cell by Alberts et al., Garland publishing Inc. Edition 5th, 2008
8. Leininger Principles of Biochemistry by Leininger by David L. Nelson and Michael M Cox, W.H Freeman and company. Edition 4th, 2005.
9. Biochemistry by Stryer WH et al., W.H Freeman and company. Edition 7th, 2003
10. Understanding Enzymes by Trevor Palmer, Prentice Hall Publishers. 2008

Course Code: **MMICCMM225** | **Title** **MEDICAL MICROBIOLOGY** | **Credits: 4; Total Contact Hrs. 60** **Max. Marks: 100**

Course Learning Outcomes (CLOs):

- Be able to gain insight of human microflora, their significance, mechanism of pathogenesis of different pathogens and their characteristics.
- Be able to gain knowledge of different types of diseases caused by bacterial pathogens.
- Be able to introduce students to viral pathogens, their characteristics, mode of transmission and different types of diseases caused by viral pathogens and how they are being controlled.
- Be able to gain knowledge about important fungal and protozoan diseases

Unit-I (MMICCMM225.1)

1.6 Normal microbial flora of human body and its importance

1.7 Mechanism of microbial pathogenesis: entry, colonization, growth, mechanism of damage host cell, host-pathogen interactions

1.8 Bacterial virulence factors, Infection Prevention control (IPC)

1.9 Epidemiology of infectious diseases and current pandemics

1.10 Pathogenicity vs virulence; quantitative measures of virulence: minimal lethal dose (MLD), LD_{50}, ID_{50}, $TCID_{50}$. Facultative / obligate intracellular pathogens, pathogenicity islands.

Unit-II (MMICCMM225.2)

2.6 Historical perspective of medical bacteriology

2.7 General characteristics, mode of transmission, pathogenesis and diagnosis of medically important bacterial diseases like Anthrax, Tuberculosis, Leprosy, Cholera, Typhoid, Gastric Ulcer, Tetanus, Pneumonia.

2.8 Etiology, pathogenesis and lab diagnosis of Diarrhea, Meningitis, Nosocomial infections and Zoonoses

2.9 General characteristics, mode of transmission, pathogenesis and diagnosis of diseases caused by *Staphylococcus, Streptococcus, Mycoplasma*, *Chlamydiae* and *Rickettesia*

2.10 Antibacterial drugs: Classification and mode of action. Emergence of bacterial drug resistant strains

Unit-III (MMICCMM225.3)

3.6 Introduction to medical virology

3.7 General characteristics, mode of transmission, pathogenesis and diagnosis of medically important viral pathogens: Chicken Pox, Hepatitis, Herpes, Human Papilloma virus (DNA viruses),

3.8 General characteristics, mode of transmission, pathogenesis and diagnosis of medically important viral pathogens: rabies, mumps, measles, AIDS, dengue (RNA viruses)

3.9 General characteristics, mode of transmission, pathogenesis and diagnosis of emergent viral diseases: Influenza (Swine flu), SARS - COVID-19, Chikungunya, Ebola, Hanta, Marburg, Nepa virus, Zika and Rotavirus

3.10 Human prion diseases**,** novel approaches for viral detection; CRISPR, RT-PCR, immune-sensors, antiviral drugs, classification and mode of action

Unit-IV (MMICCMM225.4)

4.6 Introduction to medical mycology, Mycoses (superficial, subcutaneous, systemic and opportunistic)

4.7 Isolation, characterization and identification of medically important fungal pathogens. Antifungal drugs, classification and mode of action

4.8 Introduction to protozoology: General characteristics, mode of transmission, pathogenesis and diagnosis of protozoan pathogens: *Entamoeba*, *Plasomodium*, *Leishmania*, *Giardia, Toxoplasma* and *Trypanosoma*

4.9 General characteristics, mode of transmission, pathogenesis and diagnosis of platyhelminthes; *Taenia*, S*chistosoma* and Nemathelminthes; *Ascaris*, *Wuchereria*.

4.10 Introduction to clinical microbiology (specimen collection. transport, handling, storage and laboratory analysis)

CLO-PLO Matrix for the Course

Unit Wise CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	Average (CLO)
MMICCMM225.1	2.2	2.3	3.0	2.5	2.8	3.0	2.7	2.1	2.3	2.6	2.50
MMICCMM225.2	2.9	2.5	2.8	2.0	2.1	1.5	2.1	2.8	2.0	3.0	2.30
MMICCMM225.3	3.0	2.7	2.2	2.1	2.2	1.9	2.0	3.0	2.9	2.1	2.40
MMICCMM225.4	1.9	1.8	2.0	2.7	3.0	2.9	2.7	2.5	2.0	2.0	2.30
Average (PLO)	2.5	2.3	2.5	2.3	2.5	2.3	2.3	2.6	2.3	2.4	2.35

Recommended Books

6. Ananthanarayan and Paniker's text book of Microbiology by Reba Kanungo, Universities Press. Edition 12th, 2022
7. Jawetz, Melnick and Adelbergs Medical Microbiology by Brooks et al., McGraw-Hill Medical. Edition 28th, 2019.
8. Prescott's Microbiology by Joanne Willey, Linda Sherwood and Christopher J. Woolverton, McGraw Hill Publisher Companies, Inc. . Edition 11th, 2020
9. Parasitology (Protozoology and Helminthology) by K.D. Chatterjee, CBS Publishers and Distributors. Edition 3rd, 2019.
10. Medical Parasitology by D. R. Arora and B. Arora, CBS Publishers and Distributors. Edition 5th, 2022

Course Code: **MMICCLC225** | **Title** **LABORATORY COURSE** | **Credits: 4; Total Contact Hrs. 60** **Max. Marks: 100**

Course Learning Outcomes (CLOs):

- Be able to gain an in-depth knowledge of experiments such as isolation of chloroplast and mitochondria by differential centrifugation
- Be able to determine DNA, RNA, carbohydrates, lipids and protein concentrations using standard methods
- Be able to isolate and enumerate microorganisms from various sources and their biochemical characterization
- Be able to determine phosphate and zinc solubilizing potential of phosphate and zinc solubilizing microorganisms

16. Cell cycle: cell division of fungi and bacteria (with the help of slides/models/charts)
17. Differential isolation of chloroplast and mitochondria by differential centrifugation method
18. Estimation of carbohydrates
19. Estimation of lipids
20. Estimation of DNA

21. Estimation of RNA
22. Estimation of protein by Lowry's, and Bradford methods
23. Identification of proteins by SDS-PAGE
24. Study of pH stress tolerance by microbes
25. Study of enzyme kinetics (acid phosphatase and alkaline phosphatase
26. Cultivation and enumeration of bacteriophages
27. To perform biochemical tests (Catalase, Urease test)
28. Indole, Methyl red, Voges-Proskauer, Citrate Utilization Test (IMVIC)
29. Exploration of microbiota from soil sediments.
30. Qualitative assay of Phosphate Solubilizing Bacteria and Zinc Solubilizing Bacteria

CLO-PLO Matrix for the Course

Unit Wise CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	Average (CLO)
Total No. of Practical's = 15	2.7	2.2	2.0	2.9	2.1	1.8	2.9	2.6	2.3	2.7	2.37
Average (PLO)	2.7	2.2	2.0	2.9	2.1	1.8	2.9	2.6	2.3	2.7	2.37

Recommended Books

5. Microbiology: A Laboratory Manual by James G. Cappuccino and Natalie Sherman, Pearson Benjamin Cummings Publishers.
6. Practical Microbiology by D K Maheshwari and R C Dubey, S Chand and Company Publishers Edition 4th 2023
7. Alcamo's Laboratory Fundamentals of Microbiology by Pommerville J.C., Jones and Bartlett Publishers, Inc. Edition 1st, 2009.
8. Experimental Biochemistry by Ganai et al., Kumar Publications, Delhi

Discipline Centric Elective Course (DCEC)

Course Code: MMICDEA225 **Title: ENVIRONMENTAL AND AGRICULTURAL MICROBIOLOGY** **Credits: 4; Total Contact Hrs. 60** **Max. Marks: 100**

Course Learning Outcomes (CLOs):

- Be able to understand importance of environmental microbiology and different bioremediation techniques for decontamination of polluted sites
- Be able to learn how to classify thermophiles and psychrophiles, their mode of adaptation and applications.
- Be able to understand applications of beneficial microbial inoculants, plant diseases and their control methods.
- Be able to gain knowledge about different methods of studying microorganisms, role of microbes for nitrogen fixation and as bioinoculants

Unit-I (MMICDEA225.1)

1.6. Introduction to environmental microbiology: Scope, history, Brief account of microbial interaction, rumen microbiology, coral reefs, Microbial mats.
1.7. Waste water and drinking water treatment, treatment and applications of municipal solid waste. Composting and biogas production.
1.8. Bioremediation: types, and applications, acid mine drainage
1.9. Microbial remediation of pesticides, plastics and Heavy Metals
1.10. Biomonitoring: bioindicators, biosensors and genosensors.

Unit-II (MMICDEA225.2)

2.1. Concept of Extremophiles, thermophiles: classification and ecological aspects, adaptation mechanism.

2.2. Commercial aspects of thermophiles and thermozymes

2.3. Psychrophiles: Classification, diversity, adaptation mechanism and applications

2.4. Classification, distribution, adaptation mechanism and applications of acidophiles and alkaliphiles

2.5. Classification, distribution, adaptation mechanism and applications of Halophiles and Barophiles

Unit-III (MMICDEA225.3)

3.1. Introduction and scope of agricultural microbiology. Contributions of M. Beijerinck, S. Winogradsky, B. Frank and S. Waksman

3.2. Soil microflora, culture dependent and independent methods of studying soil microflora, Rhizosphere, phyllosphere and endophytic microorganisms and their interactions with plants.

3.3. Biological nitrogen fixation (symbiotic and asymbiotic), biochemistry and molecular genetics of nitrogen fixation, microbial transformations of phosphorus and zinc

3.4. Biofertilizers: Production and application of Mycorrhiza, Frankia, *Rhizobium*, *Azotobacter*, and Cyanobacteria and their quality control

3.5. Concept of biopesticides, types and mode of action.

Unit-IV (MMICDEA225.4)

4.1. Introduction to plant pathology, history and scope of plant pathology

4.2. Defense mechanism of plant diseases

4.3. Bacterial diseases - canker, fire blight.

4.4. Fungal diseases - smut, rust and powdery mildew

4.5. Viral diseases - Apple mosaic, tomato leaf curl

CLO-PLO Matrix for the Course

Unit Wise CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	Average (CLO)
MMICCMM225.1	2.2	2.4	2.8	2.9	3.0	2.8	2.1	2.5	3.0	2.9	2.60
MMICCMM225.2	3.0	2.9	2.8	3.0	3.0	2.5	2.2	2.3	2.0	2.1	2.50
MMICCMM225.3	2.2	2.4	2.8	2.0	2.8	2.5	3.0	2.6	1.8	2.0	2.40
MMICCMM225.4	2.1	2.3	2.3	2.9	3.0	1.9	1.8	2.5	2.9	2.1	2.30
Average (PLO)	2.3	2.5	2.6	2.7	2.9	2.4	2.2	2.4	2.4	2.2	2.45

Recommended Books

1. Microbial Ecology Fundamentals and Applications by Ronald M. Atlas and Richard Bartha, Pearson Education International. Edition 4th, 1997

2. Brock Biology of Microorganisms by Madigan and Martinko, Pearson Education International. Edition 16th, 2021

3. Soil Microbiology, Ecology and Biochemistry by Paul E.A., Academic Press. Edition 4th, 2014

4. Physiology and Biochemistry of Extremophiles by Charles Gerday and Nicolas Glansdorff. ASM Press. . Edition 1st, 2014

5. Soil Microbiology by Subba Rao, Science Publishers. Edition 2nd, 1905

Course Code: Title Credits: 4; Total Contact Hrs. 60

MMICDFI225 FOOD AND INDUSTRIAL MICROBIOLOGY Max. Marks: 100

Course Learning Outcomes (CLOs):

- Be able to Know important microbes associated with different food products and recognize the types and causes of spoilage of different food products
- Be able to know various physical, chemical and biological methods of preservation and identify various food borne infections
- Be able to understand industrially important microbes, recent developments in fermentation processes, carbon and nitrogen sources for industrial fermentation
- To provide knowledge about the detection and control of food borne pathogens and toxins

Unit-I (MMICDFI225.1)

1.1. History and development of food microbiology, sources and factors influencing microbial growth in foods (intrinsic and extrinsic factors)

1.2. Degradation of carbohydrates, lipids and proteins

1.3. Microbial spoilage: Fruits, vegetables, milk, meat and canned products

1.4. Control of microorganisms in foods: Physical, chemical and biological methods of preservation

1.5. Probiotics and prebiotics and their significance in human health

Unit-II (MMICDFI225.2)

2.1. Bacterial food borne pathogens: Staphylococcus, Clostridium sps, *Bacillus cereus, Salmonella, E.coli*

2.2. Fungal intoxications: mycotoxicosis- aflatoxins, ochratoxins and patulin

2.3. Food borne viral pathogens: Norwalk virus, hepatitis A virus, hepatitis E virus, and rotavirus

2.4. Microbial examination of milk, meat, egg, fruits, vegetables and their products

2.5. Detection and enumeration of microorganisms in food: Molecular methods (PCR, Q-PCR)

Unit-III (MMICDFI225.3)

3.1. Safety aspects of food products with reference to Mycotoxins, Antibiotics and Heavy Metals

3.2. Biofilm formation on equipment surfaces and their control measures, safe food alternatives (Organic foods)

3.3. Quality control: ISO, SOP, HACCP

3.4. USFDA and FSSAI, genetically modified foods

3.5. Patent and patenting microorganisms

Unit-IV (MMICDFI225.4)

8.1. Upstream processes: Source, isolation, screening of industrially important microorganisms and strain improvement

8.2. Fermenters and fermentation: design and types of fermenters/bioreactors, carbon and nitrogen sources for industrial fermentation

8.3. Downstream processes: filtration, centrifugation, cell disruption, liquid-liquid extraction

8.4. Industrial production of antibiotics (penicillin), enzymes (amylase), aminoacids (glutamic acid) and vitamins (riboflavin)

8.5. Industrial production of Beverages: Production of Alcoholic beverages (Beer and Wine), Organic acids (Citric acid and Acetic acid)

CLO-PLO Matrix for the Course

Unit Wise CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	Average (CLO)
MMICDFI225.1	2.4	2.2	2.6	2.8	1.5	1.8	2.2	1.5	2.6	2.0	2.16
MMICDFI225.2	2.5	1.4	1.8	2.6	3.0	2.9	2.5	1.8	2.4	2.1	2.3
MMICDFI225.3	3.0	2.2	2.6	2.3	1.8	1.5	2.0	2.2	2.7	2.9	2.32
MMICDFI225.4	1.8	2.4	2.2	2.6	2.9	3.0	1.5	1.8	2.2	3.0	2.34
Average (PLO)	2.4	2.0	2.3	2.5	2.3	2.0	2.0	1.8	2.4	2.5	

Recommended Books

7. Principles of Fermentation Technology by P.F. Stanbury, W. Whitaker and S.J. Hall, Elsevier. Edition 3rd 2016.
8. Biotechnology: A Text Book of Industrial Microbiology by W. Cruegerand A. Crueger, Sinauer Associates Inc. Edition 3rd 2017.
9. Food Microbiology by Frazier and Westhoff, TaTa McGraw Hill. Edition 6th 2024.
10. Food Microbiology: Fundamentals and Frontiers by Doyel et.al. ASM Press.
11. Basic Food Microbiology by Banwart G.J., CBS Publishers and Distributors. Edition 2nd 2004.
12. Modern Food Microbiology by Jay et.al. Springer India Ltd. Edition 4th 2005

CLO-PLOs Mapping Matrix for all the Courses

Course Code	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	Average (CLO)
MMICCFM125	2.6	2.55	2.47	2.45	2.42	2.45	2.6	2.57	2.47	2.2	2.47
MMICCBV125	2.37	2.25	2.27	2.85	1.87	1.97	2.52	2.37	1.82	2.65	2.28
MMICCLC125	2.8	2.4	2.7	2.3	3.0	2.7	2.1	2.0	2.6	2.1	2.47
MMICDMM125	2.27	2.6	2.0	1.85	2.65	2.2	2.1	2.3	2.7	2.5	2.31
MMICDBT125	2.5	2.5	2.5	2.1	2.6	2.4	2.2	2.2	2.3	2.4	2.37
MMICCCE225	2.4	2.5	2.4	2.7	2.2	2.6	2.4	2.4	2.2	2.6	2.44
MMICCMM225	2.5	2.3	2.5	2.3	2.5	2.3	2.3	2.6	2.3	2.4	2.40
MMICCLC225	2.7	2.2	2.0	2.9	2.1	1.8	2.9	2.6	2.3	2.7	2.37
MMICCMM225	2.3	2.5	2.6	2.7	2.9	2.4	2.2	2.4	2.4	2.2	2.46
MMICDFI225	2.4	2.0	2.3	2.5	2.3	2.0	2.0	1.8	2.4	2.5	2.22

Attainment of CLOs

75% weightage to direct and 25% weightage to indirect evaluation methods may be assigned. The attainment of CLOs can be measured on the basis of the results of internal assessment and Semester End Examination (SEE). The attainment is measured on a 4-point scale after setting the target for CLO attainment. Table below shows the CLO attainment levels for internal assessment as per departmental regulations (assuming the set target of 60% marks) and letter grade A for Semester End Examination (SEE).

CLO Attainment Levels for Internal Assessment and End Semester Examination

Attainment Level	For Continuous Internal Evaluation (CIE)	For Semester End Examination (SEE)
0 (No attainment)	<40% of students score equal to or more than set target %age (say 60 %) for internal assessment of a course.	<40% of students obtained letter grade of 'A' in SEE of a course.
1 (Low level of attainment)	40% to < 50% of students score equal to or more than set target %age (say 60 %) for internal assessment of a course.	40% to < 50% of students obtained letter grade of 'A' in SEE of a course.
2 (Medium level of attainment)	50% to < 60% of students score equal to or more than set target %age (say 60 %) for internal assessment of a course.	50% to < 60% of students obtained letter grade of A in SEE of a course.
3 (High level of attainment)	60% or more of students score equal to or more than set target %age (say 60 %) for internal assessment of a course.	60% or more students obtained letter grade of A in SEE of a course.

Note: The assessment methods for internal assessment are class participation, assignment /presentation/quiz/class test etc. and mid-term examination. The set target is assumed as 60% for internal assessment and grade A for SEE. Varying across departments/institutes to be decided by The Boards of Studies