GURU KASHI UNIVERSITY

Masters of Science in (Medical Laboratory Technology) Clinical Microbiology

PG Curriculum (Appendix-III)
Session: 2025-26

Faculty of Health and Allied Sciences

Graduate Attributes of the Programme: -Masters of Science in (Medical Laboratory Technology) Clinical Microbiology

Type of learning outcomes	**The Learning Outcomes Descriptors**
Graduates should be able to demonstrate the acquisition of:	
Learning outcomes that are specificto disciplinary/interdisciplinary areas of learning	Accurately identify and characterize microorganisms (bacteria, viruses, fungi, and parasites) using modern laboratory techniques, including molecular biology, culture, microscopy, and biochemical testing.
	Understand and apply knowledge of the immune system's response to infection, including the role of innate and adaptive immunity, immune evasion strategies, and the principles of vaccine development.
	Demonstrate proficiency in managing a clinical microbiology laboratory, including quality control, safety procedures, workflow optimization, and compliance with regulatory standards.
	Design and implement clinical protocols for pathogen detection and susceptibility testing, utilizing advanced diagnostic platforms and interpreting susceptibility data for effective treatment strategies.
Generic learning outcomes	Demonstrate the ability to critically analyze complex microbiological problems, develop hypotheses, design experiments, and interpret data to solve clinical microbiology-related challenges.
	Enhance the ability to collaborate effectively with healthcare professionals in clinical, diagnostic, and public health settings.
	Demonstrate ethical conduct and professionalism in all aspects of laboratory practice, adhering to established standards.
	Cultivate leadership capabilities to manage laboratory settings and drive innovation in response to emerging healthcare challenges.
	Adhere to quality control procedures, laboratory safety protocols, and best practices to ensure the accuracy, reliability, and safety of microbiological testing and diagnostics in clinical practice.
	Develop leadership skills in clinical microbiology settings, including project management, resource allocation, and staff supervision, to enhance laboratory and healthcare service delivery.

	Apply theoretical knowledge to real-world clinical situations, translating laboratory findings into practical, evidence-based clinical decisions that improve patient outcomes.

Programme learning outcomes: A Postgraduate Certificate is awarded to students who have demonstrated the achievement of the outcomes located at level 6:

Element of the Descriptor	**Programme learning outcomes relating to Post Graduate Certificate**
The graduates should be able to demonstrate the acquisition of:	
Knowledge and Understanding	A comprehensive understanding of the structure, function, and classification of microorganisms, including bacteria, viruses, fungi, and parasites, within the context of clinical microbiology.
	Understand the mechanisms of microbial pathogenesis and the role of microorganisms in the development of infectious diseases, including the molecular and cellular interactions between pathogens and host cells.
	Develop a foundational knowledge of the laboratory techniques and instrumentation used in clinical microbiology, including sample collection, pathogen isolation, and susceptibility testing.
	Understand the role of the immune system in defense against microbial infections, including basic concepts of innate and adaptive immunity, and how these principles are applied in diagnostics and vaccine development.
General, technical and professional skills required to perform and accomplish tasks	Apply critical thinking to identify, analyze, and resolve issues related to clinical microbiology. Demonstrate the ability to evaluate complex problems, develop hypotheses, and propose practical solutions.
	Communicate microbiological findings and clinical results clearly and effectively, both orally and in writing, to colleagues, healthcare providers, and patients. Adapt communication style to different audiences, ensuring clarity and understanding.
	Adapt to new technologies, methods, and challenges in clinical microbiology. Stay open to changing practices in response to emerging infectious diseases, technological advancements, or shifts in healthcare policies.
	Exhibit ethical behavior in all professional interactions, including maintaining patient confidentiality, ensuring integrity in laboratory practices, and adhering to professional codes of conduct.
Application of knowledge and skills	Apply theoretical and practical knowledge of clinical microbiology to perform accurate microbial diagnosis. This includes interpreting results from microbial cultures, PCR

	tests, microscopy, and other diagnostic procedures to identify pathogens in clinical samples. Apply knowledge of laboratory best practices, quality control, and safety protocols to ensure accurate, efficient, and safe diagnostic procedures. This includes following SOPs (Standard Operating Procedures) and regulatory guidelines to maintain high laboratory standards. Apply knowledge of antimicrobial resistance (AMR) and stewardship principles in clinical microbiology to advice on responsible use of antimicrobial agents. Ensure that AMR data are effectively used to guide treatment plans and prevent overuse of antibiotics in clinical settings.
Generic learning Outcomes	Analyze complex microbiological problems, applying theoretical knowledge to practical situations and making informed, evidence-based decisions. Analyze complex microbiological problems, applying theoretical knowledge to practical situations and making informed, evidence-based decisions. Adhere to ethical principles, including patient confidentiality, informed consent, and the responsible use of diagnostic tools and antimicrobial agents. Exhibit a commitment to continuous professional development, staying current with emerging trends, research, and technologies in clinical microbiology.
Constitutional, humanistic, ethical, and moral values	Understand and respect the laws, regulations, and frameworks governing healthcare and microbiological practices, including patient rights, safety, and privacy. Graduates will maintain confidentiality, obtain informed consent, and be committed to responsible use of diagnostic tools, promoting fairness and equity in healthcare. Exhibit personal integrity and professionalism, ensuring that their actions contribute to the well-being of patients and the broader community.
Employability and job-ready skills, and entrepreneurship skills and capabilities/qualities and mindset	Graduates will be skilled in laboratory techniques, diagnostic methods, and microbial identification, ensuring they are capable of performing essential tasks in clinical microbiology settings from day one. Graduate will be able to apply scientific principles to solve complex clinical microbiology problems, interpret results accurately, and make informed decisions, which are highly valued in healthcare environments.

	The ability to communicate complex microbiological information clearly to clinical teams, patients, and stakeholders will make graduates highly employable in multidisciplinary healthcare settings.
Credit requirements	Successful completion of first two semesters of 2-year PG programmes and earns 44 credits, and then a Post Graduate Diploma in (Medical Lab. Technology) Clinical Micro be awarded to that candidate.
Entry requirements	B.Sc. (Medical Laboratory Technology) with atleast 45% in the aggregate

Program Structure

Semester 1st									
Course Code	**Course Title**	**Type of course**	**L**	**T**	**P**	**No. of Credits**	**Int.**	**Ext.**	**Total Marks**
MML1400	Clinical Microbiology and Immunology	Core course	4	0	0	4	30	70	100
MML1401	Laboratory Management	Core course	4	0	0	4	30	70	100
MML1402	Molecular Biology and Genetics	Core course	4	0	0	4	30	70	100
MML1403	Microbiological Techniques I	Practicum course	0	0	8	4	30	70	100
IKS0022	Indian Cultural Studies	Indian Knowledge System	2	0	0	2	15	35	50
Discipline Elective (Any one of the following)									
MML1405	Clinical Hematology	Disciplinary Elective	4	0	0	4	30	70	100
MML1406	Clinical Biochemistry								
Total			**18**	**00**	**08**	**22**	**165**	**385**	**550**

Semester 2nd									
Course Code	**Course Title**	**Type of course**	**L**	**T**	**P**	**No. of Credits**	**Int.**	**Ext.**	**Total Marks**
MML2450	Systemic Bacteriology	Core course	4	0	0	4	30	70	100
MML2451	Mycology and Parasitology	Core course	4	0	0	4	30	70	100
MML2452	Virology	Core course	4	0	0	4	30	70	100
MML2453	Microbiological Techniques II	Practicum course	0	0	8	4	30	70	100
MML2454	Project I	Skill Based	0	0	4	2	15	35	50
Discipline Elective (Any one of the following)									
MML2455	Quality Control and Assurance	Disciplinary Elective	4	0	0	4	30	70	100
MML2456	Histopathology and Cytopathology								
Total			**16**	**00**	**12**	**22**	**165**	**385**	**550**

Programme learning outcomes: A Postgraduate Certificate is awarded to students who have demonstrated the achievement of the outcomes located at level 6.5:

Element of the Descriptor	**Programme learning outcomes relating to Post Graduate Certificate**
The graduates should be able to demonstrate the acquisition of:	
Knowledge and Understanding	Graduates will gain expertise in cutting-edge microbiological techniques, including molecular identification of pathogens using PCR, next-generation sequencing (NGS), and CRISPR technology. They will also understand the integration of AI and genomic approaches in diagnostic microbiology, improving pathogen detection, antimicrobial resistance tracking, and personalized medicine.
	Graduates will develop proficiency in designing research projects, collecting and analyzing data using advanced biostatistical methods (e.g., regression analysis, hypothesis testing), and utilizing statistical software. They will also understand the ethical considerations in research, including informed consent and data reproducibility, ensuring the integrity of their studies.
	Graduateswill be equipped with knowledge on research ethics, including proper authorship, avoiding plagiarism, and navigating the peer review process. They will also learn about intellectual property rights, protecting innovations through patents, and the ethical implications of data sharing, ensuring transparency in research.
	Graduates will develop essential technical, communication, and leadership skills required for diverse roles in clinical microbiology, research, and diagnostics. They will be prepared for entrepreneurial ventures, such as establishing diagnostic services or creating microbiology-related products, with an understanding of grant writing, commercialization, and navigating intellectual property and regulatory processes
General, technical and professional skills required to perform and accomplish tasks	Graduates will acquire specialized skills in laboratory techniques for microbial identification, including culture methods, PCR, sequencing, and antimicrobial susceptibility testing. This technical competence ensures they can accurately diagnose infections and contribute to patient management.
	Develop strong analytical skills to interpret microbiological

	data, including genetic sequencing results, resistance patterns, and clinical diagnostic outcomes. This includes using statistical tools and bioinformatics platforms to make informed decisions that impact patient care and treatment strategies.
	Demonstrate the ability to apply critical thinking and problem-solving techniques when facing complex microbiological challenges, such as identifying novel pathogens, interpreting conflicting diagnostic results, or addressing antimicrobial resistance issues in clinical settings.
	Graduates will develop the ability to communicate complex scientific information clearly to diverse audiences, including clinicians, researchers, and patients. They will also work effectively in multidisciplinary teams, collaborating with healthcare professionals to ensure the timely and accurate diagnosis and treatment of infections.
Application of knowledge and skills	Graduates will apply cutting-edge microbiological and molecular diagnostic techniques, such as PCR, next-generation sequencing (NGS), and CRISPR, to accurately identify pathogens and detect antimicrobial resistance (AMR), enabling rapid, precise diagnosis and improved patient management in clinical settings. Graduates will design and conduct research projects in clinical microbiology, utilizing advanced research methodologies and biostatistical tools to analyze data, interpret results, and contribute to evidence-based decision-making in both clinical and research settings. Graduates will apply knowledge of research publication ethics and intellectual property rights to ensure their research adheres to ethical guidelines, publishes responsibly, and protects innovations like diagnostic technologies or treatments, fostering integrity and commercialization potential.
Generic learning outcomes	Demonstrate the ability to critically evaluate scientific data, identify problems, and apply appropriate solutions in clinical microbiology and related fields. They will develop the capacity to assess complex situations, make informed decisions, and troubleshoot microbiological challenges. Graduates will be proficient in research methodologies, including designing experiments, collecting and analyzing

	data, and interpreting results. They will be equipped to conduct independent research, critically appraise scientific literature, and contribute to advancements in the field of clinical microbiology. Graduates will adhere to high ethical standards in clinical microbiology, demonstrating professionalism in all aspects of their work, including patient care, research, and interactions with colleagues. They will respect confidentiality, maintain integrity, and comply with legal and regulatory frameworks governing clinical and research practices.
Constitutional, humanistic, ethical, and moral values	Graduates will demonstrate a deep understanding of the ethical principles related to clinical microbiology, including patient confidentiality, informed consent, and the responsible use of microbiological data. Graduates will understand and uphold the professional values of accountability, transparency, and honesty in all aspects of their work. They will adhere to the legal and regulatory frameworks of healthcare, and maintain high standards of conduct in clinical and research settings, ensuring trustworthiness and credibility.
Employability and job-ready skills, and entrepreneurship skills and capabilities/qualities and mindset	Graduates will acquire a high level of technical proficiency in clinical microbiology, including pathogen identification, diagnostic testing, molecular techniques, and laboratory management. This skillset will make them job-ready, able to confidently perform complex tasks in clinical laboratories, healthcare settings, or research environments. Graduates will develop an entrepreneurial mindset, fostering creativity and innovation. They will be equipped to identify business opportunities in clinical microbiology, such as launching diagnostic services, developing new microbiological products, or starting biotechnology ventures. They will also understand the process of securing funding and navigating regulatory challenges. Graduateswill be committed to continuous professional development, staying current with advancements in microbiology, molecular diagnostics, and immunology. This mindset will support their career growth, ensuring they remain competitive and responsive to emerging trends in the field.
Credit	A student will be awarded with Master of Science in

requirements	Medical Lab. Technology (Cl. Micro.) after successful completion of four semesters of 2-year PG Programme by earning 88 credits, OR A student will be awarded with Master of Science in Medical Lab. Technology (Cl. Micro.) after successful completion of two semesters of 1-year PG Programme by earning 44 credits in the case of lateral entry to 2ndyear after 4-year Bachelor Degree (Honours) or 4-year Bachelor Degree (Honours with Research) or after 1-year PG Diploma in the concerned subject as per the eligibility conditions.
Entry requirements	Bachelor's degree with Honours/ Honours with Research in relevant subject (4-Years) or One-year PG Diploma in relevant subject with at least 45% marks or equivalent CGPA in aggregate, after 3-year Bachelor Degree.

Semester 3rd

Course Code	Course Title	Type of course	L	T	P	No. of Credits	Int.	Ext.	Total Marks
MML3500	Advances in Microbiology and Molecular Diagnostic Techniques	Core course	4	0	0	4	30	70	100
MML3501	Advances in Immunohematology Techniques	Core course	4	0	0	4	30	70	100
MML3502	Dissertation (Phase I)	Skill Based	0	0	0	12	200	100	300
MML3503	Project II	Skill Based	0	0	4	2	15	35	50
Total			**08**	**00**	**04**	**22**	**275**	**275**	**550**

Semester 4th

Course Code	Course Title	Type of course	L	T	P	No. of Credits	Int.	Ext.	Total Marks
MML4550	Research Methodology and Biostatistics	Core course	4	0	0	4	30	70	100
MML4551	Dissertation (Phase II)	Skill Based	0	0	0	12	200	100	300
MML4552	Employability and Entrepreneurship in Microbiology	EEC	2	0	0	2	15	35	50
Discipline Elective (Any one of the following)									
MML4553	Biomedical Instrumentation	Disciplinary Elective	4	0	0	4	30	70	100
MML4554	Research Publication Ethics and Intellectual Property Right								
Total			**10**	**00**	**00**	**22**	**275**	**275**	**550**
Grand Total			**52**	**00**	**24**	**88**	**880**	**1,320**	**2,200**

1st SEMESTER

Course Title: Clinical Microbiology and Immunology	L	T	P	Cr.
Course Code: MML1400	4	0	0	4

Total Hours: 60

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Identify and characterize different microbial pathogens using various laboratory techniques, including culturing, staining, and molecular methods.
2. Understand the principles of the immune system and its role in defending the body against infectious diseases, as well as the mechanisms of immune evasion employed by pathogens.
3. Develop the ability to interpret diagnostic microbiological tests, including antibiotic susceptibility testing and serological assays, to guide clinical decision-making.
4. Gain knowledge of the mechanisms of antimicrobial resistance and understand the clinical implications of its emergence in various pathogens.
5. Identify the structure, classification, and function of microorganisms including bacteria, viruses, fungi, and parasites.

Course Contents

UNIT-I **15 Hours**

Introduction and historical developments of microbiology, scope of microbiology, general characteristics of prokaryotes and eukaryotes, classification of prokaryotes, introduction to mycology, virology and parasitology; Classification of microbes with special reference to prokaryotes & eukaryotes, Morphological classification of bacteria; Importance of microscopy, principle, operation and applications of light microscope, phase contrast microscopy, fluorescence microscopy, electron microscopy; General structure and functions of gram positive and gram negative bacteria, cell wall, cell membrane, cytoplasmic inclusions and mesosomes, flagella, capsule, ribosome, chromosome, plasmid and endospore, morphological classification of bacteria.

UNIT-II **15 Hours**

Growth and Nutrition of Microbes, General nutritional & other requirements of the bacteria, Classification of bacteria on the basis of their nutritional requirements, Physical conditions required for growth, Normal growth cycle of bacteria (growth curve) Culture media Introduction, Classification of culture media (Example & Uses) solid media, liquid media, semisolid, Media, routine/synthetic/defined media, basal media, enriched, enrichment, Selective differential media, sugar fermentation media, transport media,

preservation media and anaerobic culture media, Quality control in culture media, Automation in culture media preparation Aerobic & anaerobic culture methods: Concepts, Methods Used for aerobic cultures, Methods used for anaerobic cultures; Sterilization and Disinfection; Biomedical waste management in the laborator.

UNIT-III **15 Hours**

History and introduction to immunology Immunity, Innate, acquired immunity, complement system: Definition, Basic concepts about its components, Complement activation pathways, and Basic concepts about their mechanisms Definition, types of antigens and determinants of antigenicity; Definition, types, structure and properties of immunoglobulin Antigen-Antibody reactions Definition, Classification, General features and mechanisms, Applications of various antigen antibody reactions Principle, procedure and applications of under mentioned in Medical Microbiology: Complement fixation test, Immunofluorescence, ELISA, SDS-PAGE, Western blotting.

UNIT-IV **15 Hours**

Immune response: Introduction Basic concepts of Humoral and Cellular immune responses Hypersensitivity: Definition, Types of hypersensitivity reactions Basic concepts of autoimmunity and brief knowledge about autoimmune diseases;Widal, VDRL, ASO, CRP, and Brucella tube agglutination, Rose-Waaler, Automation in diagnostics serology Vaccines: Definition, Types, Vaccination schedule, Brief knowledge about Extended Programme of immunization ‘(EPI) in India.

Transactional modes: Video based teaching, Collaborative teaching, Case based teaching, Question-Answer

Suggested Readings:

- Collee, J. G., Mackie, T. J., and McCartney, J. E. (1996). Mackie & McCartney practical medical microbiology. New York: Churchill Livingstone.
- Ananthanarayan, R. and Paniker, C., 1980. Textbook of microbiology. 1st ed. Orient Longman. Ananthanarayan, R.; Panicker, J.K. (2005) [1978].
- Textbook of Microbiology (7 ed.) L Mukherjee, K., Swarajit. G. (2010).
- Medical Laboratory Technology (Volume I). Willey, J., Sherwood, L. and Woolverton, C. (2013).
- Prescott's Microbiology: 9th revised edition. London: MCGRAW HIL

Course Title: Laboratory Management	**L**	**T**	**P**	**Cr.**
Course Code: MML1401	**4**	**0**	**0**	**4**

Total Hours: 60

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Identify and implement key safety guidelines, risk assessments, and regulatory standards to ensure a safe and compliant laboratory environment.
2. Manage laboratory space, equipment, and inventory efficiently, ensuring proper stock control, maintenance schedules, and optimal resource utilization.
3. Apply quality control methods, data validation, and assurance techniques to ensure the accuracy, consistency, and reliability of laboratory results.
4. Manage, supervise, and collaborate with laboratory teams, fostering a productive work environment through clear communication, leadership, and training initiatives.
5. Create, manage, and track laboratory budgets, including cost-benefit analysis, procurement processes, and cost control to maximize laboratory efficiency and sustainability.

Course Contents

UNIT-I **15 Hours**

Laboratory Management: Definition and scope of laboratory management, Types of laboratories: Research, clinical, industrial, and academic, Roles and responsibilities of a laboratory manager;Laboratory Structure and Organization: Laboratory hierarchy and reporting structure, Key laboratory personnel: Lab managers, technicians, researchers, and support staff, Organizational models: Centralized vs. decentralized labs, Setting up a laboratory: Space planning and layout;Regulatory Standards and Compliance: Overview of regulations: OSHA, GLP (Good Laboratory Practice), GMP (Good Manufacturing Practice), ISO 17025, International and local regulatory bodies: FDA, EPA, WHO, ICH, etc., Safety guidelines, protocols, and certifications (e.g., biohazard, chemical safety), Ethical standards in laboratory operations.

Unit-II **15 Hours**

Laboratory Operations and Resource Management: Types of laboratory equipment: Analytical instruments, microscopes, fume hoods, etc., Selection and acquisition of laboratory instruments, Calibration, maintenance, and troubleshooting of equipment, Documentation and record-keeping for equipment usage and maintenance; Principles of inventory management: Stock control, reorder levels, and shelf-life management, Supplier relationship management and procurement strategies, Inventory tracking and software systems (e.g., Laboratory Information Management Systems – LIMS), Lab

consumables and reagent management;Quality Control and Assurance: Principles of quality control (QC) and quality assurance (QA), Standard Operating Procedures (SOPs) for laboratory processes, Laboratory audits and internal reviews, Statistical process control and performance metrics in laboratory operations, troubleshooting common quality issues in laboratory results.

Unit-III **15 Hours**

Personnel Management and Training: Role of laboratory managers in personnel supervision, Recruitment and staffing in laboratory settings, Performance evaluations, feedback, and staff development, Motivating and retaining laboratory staff, Legal and ethical considerations in managing laboratory personnel; Communication skills for laboratory managers, Facilitating team collaboration and interdisciplinary communication, Managing conflict and ensuring a positive working environment, Role of meetings, reports, and digital tools in team communication; Leadership styles in laboratory settings, Decision-making and problem-solving techniques for laboratory managers, Strategies for conflict resolution and team motivation, Building a productive and innovative lab culture.

Unit-IV **15 Hours**

Budgeting and Financial Planning: Principles of budgeting in a laboratory setting, Creating and managing laboratory budgets: Capital and operational expenses, Cost-benefit analysis and financial forecasting, Managing grant funding and external financial support, Monitoring laboratory expenses and financial performance; Cost Control and Efficiency in Laboratory Operations: Identifying areas for cost savings in laboratory operations, Energy-efficient lab practices and reducing waste, Minimizing downtime and optimizing resource utilization, Managing laboratory supplies to avoid waste; Sustainable laboratory practices: Reducing environmental impact, Waste management and recycling in laboratory settings, Green chemistry and environmentally friendly technologies in laboratories, Sustainable laboratory design and construction; Identifying and integrating new technologies and innovations in laboratory management, Risk management and contingency planning, Trends and future developments in laboratory management and technology.

Transactional modes: Video based teaching, Collaborative teaching, Case based teaching, Question-Answer

Suggested Readings:

- *McPherson, R. A., & Pincus, M. R. (2021). Henry's clinical diagnosis and management by laboratory methods (24th ed.). Elsevier.*

- *Harmening, D. M. (2018). Modern blood banking and transfusion practices (7th ed.). F.A. Davis Company.*
- *Garcia, L. S. (2020). Clinical laboratory management. ASM Press.*
- *Weissfeld, A. S., & Trevino, E. A. (2022). Laboratory management: Principles and processes. Springer.*
- *Burtis, C. A., Bruns, D. E., & Sawyer, B. G. (2020). Tietz fundamentals of clinical chemistry and molecular diagnostics (8th ed.). Elsevier.*

Course Title: Molecular Biology and Genetics	**L**	**T**	**P**	**Cr.**
Course Code: MML1402	**4**	**0**	**0**	**4**

Total Hours: 60

Learning Outcomes: On completion of this course, the successful students will be able to:

1. To understand the fundamental concepts of molecular biology, including the structure and function of nucleic acids, genes, and proteins.
2. To explore the mechanisms of gene expression, regulation, and the molecular basis of cellular processes such as replication, transcription, and translation.
3. To gain knowledge of genetic variation, inheritance patterns, and the role of mutations in genetic diseases and evolution.
4. To develop proficiency in molecular techniques and tools, such as PCR, sequencing, cloning, and gene editing, for research and diagnostic applications.
5. To apply genetic principles to contemporary issues in biotechnology, medicine, and agriculture, and critically evaluate genetic data in research.

Course Contents

UNIT-I **15Hours**

Cellular organization: Structure, Membrane structure and function (Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, membrane pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes; Structural organization and function of intracellular organelles (Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility); Organization of genes and chromosomes (Operon, unique and repetitive DNA, interrupted genes, gene families, structure of chromatin and chromosomes, heterochromatin, euchromatin, transposons); Cell division and cell cycle (Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle).

UNIT-II **15Hours**

DNA replication, repair and recombination (Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication, extrachromosomal replicons, DNA damage and repair mechanisms, homologous and site-specific recombination); RNA synthesis and processing (transcription factors and machinery, formation of initiation complex, transcription activator and repressor, RNA polymerases, capping, elongation, and termination, RNA processing, RNA editing, splicing, and polyadenylation, structure and function of different types of RNA, RNA transport); Protein synthesis and processing (Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors,

termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, and translational proof-reading, translational inhibitors, Post- translational modification of proteins); Control of gene expression at transcription and translation level (regulating the expression of phages, viruses, prokaryotic and eukaryotic genes, role of chromatin in gene expression and gene silencing).

UNIT-III **15Hours**

Mendelian principles: Dominance, segregation, independent assortment; Concept of gene : Allele, multiple alleles, pseudo allele, complementation tests; Extensions of Mendelian principles : Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters; Gene mapping methods : Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids, development of mapping population in plants; Extra chromosomal inheritance: Inheritance of Mitochondrial and chloroplast genes, maternal inheritance; Microbial genetics : Methods of genetic transfers – transformation, conjugation, transduction and sex-duction, mapping genes by interrupted mating, fine structure analysis of genes; Mutation : Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis; Structural and numerical alterations of chromosomes: Deletion, duplication, inversion, translocation, ploidy and their genetic implications.

UNIT-IV **15Hours**

Bioinformatics: Introduction, aims, and scope; Prediction and pattern, homologues and analogues sequence, Protein structure, Motif and domain, Chaperon protein and its clinical significance; Biological Databases, definition and types; Protein databases: Primary: PDB, SWISS-PROT/UniProt, TrEMBL, Secondary: PROSITE, PRINTS, BLOCKS,PROFILE, SCOPE, CATH, PDBsum, Sequence alignment: Local and global alignment, Pairwise alignment: PAM matrices, BLOSUM matrices, DotPlot, BLAST; DNA sequence analysis: Six frame translation, UTRs and its identification in FASTA sequence, ORF, Kozak sequence and their identification from FASTA file, EST analysis tools; Phylogenetic analysis; Next generation sequencing analysis; Primer designing.

Transactional modes: Video based teaching, Collaborative teaching, Case based teaching, Question-Answer

Suggested Readings:

- *Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2014). Molecular Biology of the Cell (6th ed.). Garland Science.*
- *Lewin, B. (2017). Genes XII (12th ed.). Jones & Bartlett Learning.*
- *Griffiths, A. J. F., Wessler, S. R., Carroll, S. B., &Doebley, J. (2020). Introduction to Genetic Analysis (12th ed.). Macmillan Learning.*
- *Tropp, B. E. (2012). Principles of Molecular Biology. Jones & Bartlett Learning.*

Course Title: Microbiological Techniques I	**L**	**T**	**P**	**Cr.**
Course Code: MML1403	**0**	**0**	**8**	**4**

Total Hours: 60

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Develop practical skills in laboratory techniques, including microscopy, culturing microorganisms, and isolating pathogens to gain hands-on experience in microbiological analysis.
2. Enhance the ability to interpret experimental results accurately, drawing connections between laboratory findings and theoretical knowledge in microbiology and immunology.
3. Improve understanding of the immune response through the design and execution of experiments involving antigen-antibody interactions, immune cell function, and vaccination studies.
4. Gain proficiency in the safe handling and disposal of biological materials, ensuring compliance with laboratory safety protocols and ethical guidelines.
5. Foster critical thinking and problem-solving abilities by analyzing experimental data, troubleshooting issues in protocols, and proposing solutions to optimize laboratory outcomes.

List of Practical's / Experiments: 60 hours

- Isolation, identification, and antibiotic susceptibility profile of the pathogenic microorganisms from skin/pus.
- Isolation, identification, and antibiotic susceptibility profile ofthe pathogenic microorganisms from blood sample.
- Isolation, identification, and antibiotic susceptibility profile ofthe pathogenic microorganisms from Urine sample.
- Isolation, identification, and antibiotic susceptibility profile ofthe pathogenic microorganisms from throat.
- Isolation, identification, and antibiotic susceptibility profile ofthe pathogenic microorganisms from sputum sample.
- Isolation, identification, and antibiotic susceptibility profile ofthe pathogens present in air.
- To perform VDRL Tests.
- To perform Brucella Agglutination test.
- To perform RA, CRP, and ELISA test.

Suggested Readings:

- *Collee, J. G., Mackie, T. J., and McCartney, J. E. (1996). Mackie & McCartney practical medical microbiology. New York: Churchill Livingstone.*
- *Ananthanarayan, R. and Paniker, C., 1980. Textbook of microbiology. 1st ed. Orient Longman. Ananthanarayan, R.; Panicker, J.K. (2005) [1978].*

- *Textbook of Microbiology (7 ed.) L Mukherjee, K., Swarajit. G. (2010).*
- *Medical Laboratory Technology (Volume I). Willey, J., Sherwood, L. and Woolverton, C. (2013).*
- *Prescott's Microbiology: 9th revised edition. London: MCGRAW HILL*

Course Title: Indian Cultural Studies	**L**	**T**	**P**	**Cr.**
Course Code: IKS0022	**2**	**0**	**0**	**2**

Total Hours: 30

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Understanding Modern Indian Thought: Students will gain a theoretical foundation to explore how Indian philosophical and cultural ideas since the early 20th century have shaped individual and collective experiences.
2. Analyzing Cultural Transformations: Learners will investigate the impact of modern Indian thought on personal identity and cultural context, understanding its role in shaping societal values and worldviews.
3. Developing Conceptual Vocabulary: Students will become familiar with key ideas and terminologies introduced in the course, enabling them to critically engage with and interpret modern Indian intellectual traditions.
4. Articulating Personal and Shared Experiences: Learners will cultivate the ability to express their own and others & experiences using the conceptual and philosophical frameworks discussed in the course.
5. Describe the key elements of Indian culture, including art, architecture, music, dance, festivals, and literature.

Course Content

Unit I **7 Hours**

Introduction: (Orientalist, colonial and contemporary representation of India)

Unit II **8 Hours**

Indian difference: (Aurobindo, Ramanujan, Bankimchandra, Malhotra and others), Self and subjectivity: (Gandhi, Upadhyay, M.N. Roy, Ashis Nandy, Dharmapal and others)

Unit III **7 Hours**

Home, Nation and the World: (Nehru, Tagore, Ambedkar, Savarkar, Mazumdar, Malaviya and others)

Unit IV **8 Hours**

Swaraj: (Lajpat Rai, Gandhi, Tilak, Rajaji, Alvares, Balagangadhar and others), Art and aesthetics: (Coomaraswamy, Hiriyana, Radhakrishnan, Aurobindo, Naipaul, Devy and others)

Transactional Mode: Seminars, Group discussion, Team teaching, Focused group discussion, Assignments, Project-based learning, Simulations, reflection and Self-assessment

Suggested Readings:

- *Knut A. Jacobsen. Ed. Modern Indian Culture and Society. Routledge: London, 2009.*
- *Upadhyay, Deendayal. Integral Humanism. 1965. http://www.chitrakoot.org/download/IntegralHumanism.pdf*
- *Savarkar, V.D. The Essentials of Hindutva. http://savarkar.org/en/encyc/2017/5/23/2_12_12_04_essentials_of_hind tva.v001.pdf_1.pdf*
- *Vasudha Dalmia & Rashmi Sadana. Eds. The Cambridge Companion to Modern Indian Culture. Cambridge University Press: Cambridge, 2012.*
- *Alvares, Claude. "A Critique of the Eurocentric Social Science and the Question of Alternatives". Economic and Political Weekly. 46. 22, 2011.*
- *Ambedkar, B.R. Pakistan or the Partition of India. Columbia University: http://www.columbia.edu/itc/mealac/pritchett/00ambedkar/ambedkar_partition*
- *Balagangadhara,S.N. Reconceptualizing India Studies. Oxford University Press: New Delhi, 2012.*
- *Chatterjee, Partha. Nationalist Thought and the Colonial World: A Derivative Discourse. Zed Books: London,1993.*
- *Chattopadhyay, Bankimchandra. "Is Nationalism a Good Thing?" and "Critics of Hinduism". In Awakening Bharat Mata, ed. Swapan Dasgupta. Penguin: New Delhi, 2019.*
- *Coomaraswamy, A.K. "Indian Nationality". Indian Philosophy in English: From Renaissance to Independence. Oxford University Press: New York, 2011.*
- *Gandhi, M.K. Hind Swaraj. Navjeevan Publishing: Ahmedabad, 1938.*
- *Ghosh, Aurobindo. "A Defence of Indian Culture". The Renaissance in India and other Essays on Indian Culture. Sri Aurobindo Ashram: Pondicherry, 2002.*

Course Title: Clinical Hematology	**L**	**T**	**P**	**Cr.**
Course Code: MML1405	**4**	**0**	**0**	**4**

Total Hours: 60

Learning Outcomes: On completion of this course, the successful students will be able to:

1. To understand the principles and practices of clinical hematology, including the structure and function of blood cells, bone marrow, and the hematopoietic system.
2. To gain knowledge of the pathophysiology, diagnosis, and management of hematological disorders such as anemia, leukemia, lymphoma, and clotting disorders.
3. To develop proficiency in laboratory techniques used in clinical hematology, including blood smear examination, complete blood count (CBC), and coagulation tests.
4. To explore the molecular and genetic basis of hematological diseases and understand their implications for diagnosis, prognosis, and treatment.
5. To critically evaluate and apply clinical hematology knowledge in patient management, including the use of blood transfusions, stem cell therapies, and targeted treatments.

Course Contents

UNIT-I **15 Hours**

Introduction to Hematology, Definition, Importance, Important equipment used, Laboratory organization and safety measures in Hematology Laboratory, Introduction to blood, its composition, function and normal cellular components; Anticoagulants Types, mode of action and preference of anticoagulants for different hematological studies, Collection and preservation of blood sample for various hematological investigations, Formation of cellular components of blood (Hemopoiesis) Erythropoiesis, Leucopoiesis, Thrombopoiesis, Hemoglobin: definition, types, structure, synthesis and degradation, Morphology of normal blood cells, Normal Hemostasis & physiological properties of coagulation factor.

UNIT-II **15 Hours**

Investigation of patients with blood diseases: Anemia, Iron Metabolism, Iron deficiency anemia, Anemia in Chronic Diseases- Hypo-and aplastic anemias, Acquired hemolytic anemias, Immune, autoimmune and drug-induced immune hemolytic anemias; Malignant Diseases of the Blood and Hematopoietic organs, Major Pathogenetic Mechanisms of Neoplastic Growth, Classification of malignant diseases of the blood and hematopoietic organs. Acute leukemias, Acute myeloblastic leukemia, Acute lymphoblastic leukemia. Principal differences from myeloblastic leukemias. Thrombocytopathies and thrombocytopenia; Diagnostic methods and diagnostic criteria. Principles of treatment, treatment phases, therapeutic response.

UNIT-III **15Hours**

Hemoglobinometry: hemoglobinometry definition, Total Leucocyte count (TLC), Differentiate leucocyte count (DLC), Erythrocyte Sedimentation Rate (ESR), Packed cell volume/ Hematocrit value, red cell indices (RCL), Absolute Eosinophil count (ESR), Reticulocyte count, Platelet count, Preparation of blood films, methods of preparation (Thick and thin smear/film) staining technique in Hematology (Romansky stains): Principle, composition, preparation staining reagents and procedure for the Giemsa and Leishman stain.

UNIT-IV **15Hours**

Bleeding disorders: Introduction Causes of bleeding disorders Vascular defect, Platelet defect, Factor deficiency, Inhibitors, Hyper fibrinolysis, Types of bleeding disorders, Inherited bleeding disorders, Acquired bleeding disorders, Hemostasis, Bleeding diatheses, Mechanisms of hemostasis. Laboratory diagnostics, clotting assays. Congenital bleeding disorders (coagulopathies). Definition. Classification. Clinical Characteristics of hemorrhagic diathesis. Hemophilia-A and Hemophilia-B. Pathogenesis, Treatment of Hemophilia with Inhibitors. Von Ville brand's disease.

Transactional modes: Video based teaching, Collaborative teaching, Case based teaching, Question-Answer

Suggested Readings:

- *Bain, B. J., Bates, I., & Laffan, M. A. (2016). Dacie and lewis practical hematology e-book. Elsevier Health Sciences.*
- *Robbins, S. L. (2002). Pocket companion to Robbins pathologic basis of disease. Elsevier Health Sciences TW.*
- *Kumar, V., Abbas, A. K., & Aster, J. C. (2017). Robbins basic pathology e-book. Elsevier Health Sciences.*
- *Godkar, P. B., &Godkar, D. P. (2003). Textbook of medical laboratory technology. Bhalani.*
- *Sood, R. (2009). Concise Book of Medical Laboratory Technology: Methods and Interpretations. Jaypee Brothers Medical Publishers (P) Limited.*

Course Title: Clinical Biochemistry	**L**	**T**	**P**	**Cr.**
Course Code: MML1406	**4**	**0**	**0**	**4**

Total Hours: 60

Learning Outcomes: On completion of this course, the successful students will be able to:

1. To understand the biochemical basis of normal cellular functions and metabolism, including enzyme kinetics, biochemical pathways, and the role of cofactors and vitamins.
2. To gain knowledge of the molecular mechanisms underlying metabolic disorders, and the diagnostic and therapeutic approaches for conditions such as diabetes, dyslipidemia, and metabolic syndrome.
3. To develop proficiency in performing and interpreting common clinical biochemistry tests, such as serum electrolytes, enzyme levels, lipids, proteins, and metabolic panels.
4. To explore the principles and applications of biochemical assays in the diagnosis and monitoring of diseases, including renal, hepatic, and endocrine disorders.
5. Describe the structure and function of biomolecules (proteins, enzymes, carbohydrates, lipids, nucleic acids).

Course Contents

UNIT-I **15 Hours**

Structure of atoms, molecules and chemical bonds; Composition, structure and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins); Stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.); Principles of biophysical chemistry (pH, buffer, reaction kinetics, thermodynamics, colligative properties); Bioenergetics, glycolysis, oxidative phosphorylation, coupled reaction, group transfer, biological energy transducers; Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isozymes; Conformation of proteins (Ramachandran plot, secondary structure, domains, motif and folds); Conformation of nucleic acids (helix (A, B, Z), t-RNA, micro-RNA); Stability of proteins and nucleic acids, Metabolism of carbohydrates, lipids, amino acids nucleotides and vitamin.

UNIT-II **15 Hours**

Clinical Laboratory Techniques: Basic laboratory equipment and instrumentation used in clinical biochemistry, Methods for the determination of serum electrolytes, glucose, proteins, and lipids; Spectrophotometry, chromatography, and electrophoresis in clinical biochemistry; Enzyme Assays and Biomarkers: Principles of enzyme assays and their clinical relevance, Common biomarkers for organ function: Liver enzymes, cardiac enzymes, renal biomarker; Use of enzyme levels in the diagnosis of disease (e.g., liver, kidney, myocardial infarction); Electrolyte Imbalance and Acid-Base Disorders, Measurement and clinical significance of electrolytes (Na^+, K^+, Cl^-, Ca^{2+}), Understanding acid-base disturbances: Metabolic acidosis, alkalosis,

Laboratory methods for diagnosing and correcting electrolyte imbalances; Protein Metabolism and Disorders: Methods of protein quantification: Total protein, albumin, globulin, and protein electrophoresis, Disorders related to abnormal protein metabolism: Hypoalbuminemia, hyperproteinemia, Evaluation of renal and hepatic function using protein assays.

UNIT-III **15Hours**

Carbohydrate Metabolism Disorders: Biochemistry of diabetes mellitus and insulin resistance, Laboratory tests for glucose metabolism: Fasting blood glucose, HbA1c, OGTT, Disorders: Diabetes, hypoglycemia, galactosemia; Lipids and Lipid Disorders: Lipid metabolism and the role of lipoproteins (HDL, LDL, VLDL), Atherosclerosis, hyperlipidemia, and lipid profile tests, Clinical management of dyslipidemia and associated risks; Proteins and Amino Acid Disorders: Role of amino acids and proteins in metabolism, Inborn errors of metabolism: Phenylketonuria, homocystinuria, Clinical tests for protein and amino acid metabolism: Urea cycle, blood urea nitrogen, creatinine levels; Endocrine Disorders and Metabolic Effects: Biochemical basis of thyroid, adrenal, and pituitary disorders, Hormone assays: Thyroid hormones, cortisol, insulin, growth hormone, Metabolic effects of endocrine dysfunction: Cushing's syndrome, hypothyroidism, hyperthyroidism.

UNIT-IV **15Hours**

Renal Function and Uremic Diseases: Biochemistry of kidney function and the role of creatinine, urea, and uric acid; Disorders: Acute renal failure, chronic kidney disease, glomerulonephritis, Laboratory diagnostics and management of renal diseases; Liver Function and Hepatic Disorders: Liver function tests: ALT, AST, ALP, bilirubin, albumin, Hepatic disorders: Hepatitis, cirrhosis, liver failure, jaundice, Diagnostic approaches for liver diseases and clinical management; Cardiac Biomarkers and Cardiovascular Diseases: Biochemical markers in the diagnosis of cardiovascular diseases (e.g., troponins, BNP, CK-MB), Role of lipids in cardiovascular health: LDL, HDL, triglycerides, Diagnosis and management of myocardial infarction, heart failure, and atherosclerosis; Cancer Biomarkers and Oncological Biochemistry: Overview of cancer biochemistry: Tumor markers, genetic mutations, and metabolic changes, Common cancer biomarkers: PSA, CA-125, CEA, AFP, Role of clinical biochemistry in cancer diagnosis, monitoring, and treatment.

Transactional modes: Video based teaching, Collaborative teaching, Case based teaching, Question-Answer

Suggested Reading:

- *Ahmed, N. (2017). Clinical Biochemistry (2nd ed.). Oxford University Press.*
- *Ferrier, D. R. (2017). Lippincott Illustrated Reviews: Biochemistry (7th ed.). Wolters Kluwer.*
- *Murphy, M., & Rajeev, R. (2022). Clinical Biochemistry (7th ed.). Elsevier.*
- *Marshall, W. J., & Bangert, S. K. (2020). Clinical Chemistry (9th ed.). Elsevier.*
- *Tietz, N. W., &Sonnenwirth, A. C. (2018). Tietz Fundamentals of Clinical Chemistry and Molecular Diagnostics (7th ed.). Elsevier.*

2nd SEMESTER

Course Title: Systemic Bacteriology	**L**	**T**	**P**	**Cr.**
Course Code: MML2450	**4**	**0**	**0**	**4**

Total Hours:60

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Illustrate morphology, biochemical reactions, to differentiate bacteria and their related diseases.
2. Differentiate between gram-positive and gram-negative bacteria by using staining.
3. Perform antibiotic susceptibility testing for recommendation of antibiotic for treatment.
4. Learn structural and morphological characteristics, pathogenicity, clinical manifestations and laboratory diagnosis of different types of bacteria.
5. Recognize key bacterial pathogens associated with systemic infections, including those that affect the cardiovascular, respiratory, gastrointestinal, genitourinary, and nervous systems.

Course Contents

UNIT-I **10Hours**

Epidemiology and control of community infections: Study of normal flora of human body, control and prevention of community, epidemiological markers, different carries and sources of infection, Gram positive cocci: A detailed account of morphological characteristics, pathogenicity, clinical manifestations and laboratory diagnosis of Staphylococcus, Streptococcus, Enterococcus and Pneumococcus.

UNIT-II **20Hours**

Gram negative bacilli: A detailed account of cultural and morphological characteristics, pathogenicity, clinical manifestations and laboratory diagnosis of Corynebacterium, Bacillus and Clostridiumspp., Mycobacterium tuberculosis and Mycobacterium leprae, Neisseria; E. coli, Klebsiella pneumoniae, Shigella, Salmonella, Enterobacter cloacae, Serratia marcescens, Proteus Mirabilis, Vibrio cholerae, Pseudomonas aeruginosa, Stenotrophomonas maltophilia, Acinetobacter spp., Hemophilus influenzae, Mycoplasma, Rickettsiae, Treponema palladium, and Yersinia pestis.

Unit-III **15Hours**

Pathogenicity and Virulence: Definitions of pathogenicity and virulence, Factors affecting bacterial virulence: Adhesins, invasins, and toxins; Bacterial Toxins: Exotoxins: Mechanisms of action (e.g., A-B toxins, superantigens), Endotoxins and their role in systemic inflammation and shock, Examples of

major bacterial toxins and their diseases (e.g., botulinum toxin, cholera toxin);Host-Bacteria Interaction: Mechanisms of bacterial entry: Invasion of tissues and evasion of host defenses,Interaction with the immune system: Immunoevasion strategies (e.g.,antigenic variation, capsule formation);Bacterial Infections of Organ Systems:Pathogenesis of bacterial infections in the respiratory, gastrointestinal, urinary, and cardiovascular systems, Systemic spread and septicemia.

Unit-IV **15Hours**

Bacterial Genome: Structure of the bacterial chromosome and plasmids, Transcription, translation, and regulation in bacteria; Genetic Variation and Horizontal Gene Transfer, Mutation: Types and causes;Horizontal gene transfer: Transformation, transduction, and conjugation;The role of genetic recombination in bacterial evolution;Antibiotic Resistance Mechanisms:Mechanisms of resistance: Enzymatic degradation, target modification, efflux pumps, Plasmids and mobile genetic elements in the spread of resistance, Clinical implications of resistance;Bacterial Adaptation and Survival: Formation of spores (e.g., *Bacillus*, *Clostridium*),Biofilm formation and its clinical relevance, Bacterial stress responses: Heat shock proteins, SOS response.

Transactional modes: Video based teaching, Collaborative teaching, Case based teaching, Question-Answer

Suggested Readings:

- *Collee, J. G., Mackie, T. J., and McCartney, J. E. (1996). Mackie & McCartney practical medical microbiology. New York: Churchill Livingstone.*
- *Ananthanarayan, R. and Paniker, C., 1980. Textbook of microbiology. 1st ed. Orient Longman. Ananthanarayan, R.; Panicker, J.K. (2005) [1978].*
- *Textbook of Microbiology (7 ed.) L Mukherjee, K., Swarajit. G. (2010).*
- *Medical Laboratory Technology (Volume I). Willey, J., Sherwood, L. and Woolverton, C. (2013).*
- *Prescott's Microbiology: 9th revised edition. London: MCGRAW HILL*

Course Title: Mycology and Parasitology	L	T	P	Cr.
Course Code: MML2451	4	0	0	4

Total Hours: 60

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Describe the pathogenesis, life cycles, and epidemiology of key fungal and parasitic pathogens, including their transmission, clinical manifestations, and global impact on human health.

2. Gain the ability to apply various diagnostic techniques for identifying fungal and parasitic infections, including microscopy, culture methods, molecular diagnostics (e.g., PCR), and serological assays
3. Evaluate the mechanisms of action of antifungal and antiparasitic agents, understand challenges in drug resistance, and recommend appropriate therapeutic options for treating fungal and parasitic diseases.
4. Understand and be able to design control and prevention strategies for fungal and parasitic infections at both the individual and public health levels, including vector control, sanitation measures, and prophylactic treatments.
5. Develop the ability to critically assess emerging fungal and parasitic diseases, recognize the challenges posed by antimicrobial resistance, and propose innovative solutions for managing these emerging health threats.

Course Content

UNIT-I **15Hours**

Overview of Medical Mycology: Definition, scope, and significance of medical Mycology in human health, Classification and Morphology of Fungi: Structure, classification, and identification of medically important fungi (e.g., Ascomycota, Basidiomycota, Zygomycota, Deuteromycota), Fungal Pathogenesis: Mechanisms of fungal infection, virulence factors, and host immune response to fungal pathogens; Systemic Fungal Infections: Mycoses affecting deep tissues and organs (e.g., Histoplasmosis, Blastomycosis, Coccidioidomycosis), Superficial and Cutaneous Mycoses: Dermatophytes, *Candida,* and other superficial infections (e.g., Tinea infections, Candidiasis); Opportunistic Mycoses: Fungal infections in immunocompromised hosts (e.g., Aspergillosis, Cryptococcosis, Mucormycosis); Diagnosis of Fungal Infections: Microscopy, culture techniques, molecular methods (PCR, sequencing), and serology; Antifungal Agents and Resistance: Mechanisms of action of antifungal drugs, resistance mechanisms, and emerging antifungal resistance.

UNIT-II **15Hours**

Overview of Medical Parasitology: Importance of parasitic diseases, host-parasite interaction, and epidemiology; Protozoan Parasites and Diseases: Malaria: Causative agent (*Plasmodium*), life cycle, pathogenesis, clinical features, diagnosis, and treatment; Amebiasis: *Entamoebahistolytica*, clinical presentation, diagnosis, and therapy; Leishmaniasis: *Leishmania* species,

transmission, clinical types (cutaneous, visceral), diagnosis, and treatment; Giardiasis: *Giardia lamblia*, clinical symptoms, pathogenesis, diagnosis, and treatment; Trypanosomiasis: *Trypanosomabrucei* (African Sleeping Sickness) and *T. cruzi* (Chagas disease), life cycle, clinical manifestations, and treatment options; Protozoan Diagnosis: Microscopy, stool examination, blood smears, serology, and PCR-based diagnostics; Protozoan Drug Resistance: Mechanisms of resistance, challenges in treatment, and future therapeutic approaches.

UNIT-III **15Hours**

Helminthic Parasites and Diseases: Nematodes (Roundworms): Ascaris lumbricoides, hookworms, strongyloidiasis, filariasis (*Wuchereriabancrofti*), clinical features, diagnosis, and treatment; Trematodes (Flukes): *Schistosoma* species, liver flukes, clinical manifestations, diagnosis, and therapeutic options; Cestodes (Tapeworms): Taenia species, echinococcosis, diagnosis, and treatment strategies; Ectoparasites: Scabies: Sarcoptesscabiei, clinical presentation, diagnosis, and treatment, Pediculosis: Lice infestations (head, body, pubic lice), diagnosis, and treatment; Life Cycles and Epidemiology: Transmission modes, environmental factors, and life cycles of helminths and ectoparasites, Diagnosis of Helminthic and Ectoparasitic Infections: Stool examination, blood tests, serological assays, and imaging techniques; Treatment and Control of Helminthic Diseases: Anthelmintic drugs, resistance patterns, and public health measures.

UNIT-IV **15Hours**

Epidemiology of Fungal Infections: Global distribution, high-risk populations, and environmental factors influencing fungal infections; Control and Prevention of Fungal Infections: Public health approaches, antifungal prophylaxis, vaccination, and hygiene practices; Epidemiology of Parasitic Diseases: Impact of parasitic diseases globally, risk factors, and major endemic regions; Control and Prevention of Parasitic Diseases: Malaria Control: Vector control (mosquito nets, insecticides), chemotherapy, and vaccine development, Helminth Control: Mass drug administration (MDA), sanitation, and health education, Ectoparasite Control: Topical treatments, vector control, and public health measures, Emerging Infections and Antimicrobial Resistance: Emerging fungal and parasitic infections, resistance patterns, and future public health challenges.

Transactional modes: Video based teaching, Collaborative teaching, Case based teaching, Question-Answer

Suggested Readings:

- *Collee, J. G., Mackie, T. J., and McCartney, J. E. (1996). Mackie & McCartney practical medical microbiology. New York: Churchill Livingstone.*
- *Ananthanarayan, R. and Paniker, C., 1980. Textbook of microbiology. 1st ed. Orient Longman. Ananthanarayan, R.; Panicker, J.K. (2005) [1978].*
- *Textbook of Microbiology (7 ed.) L Mukherjee, K., Swarajit. G. (2010).*
- *Medical Laboratory Technology (Volume I). Willey, J., Sherwood, L. and Woolverton, C. (2013).*
- *Prescott's Microbiology: 9th revised edition. London: MCGRAW HILL*

Course Title: Virology	**L**	**T**	**P**	**Cr.**
Course Code: MML2452	**4**	**0**	**0**	**4**

Total Hours: 60

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Understand the fundamental principles of virology, including virus classification, structure, and replication.

2. Analyze virus pathogenesis and the mechanisms of host-virus interactions.
3. Apply diagnostic techniques for viral infections and interpret laboratory results.
4. Evaluate antiviral therapies and their mechanisms of action.
5. Analyze emerging viral diseases and contribute to new research approaches and public health strategies.

Course Content

Unit-I **15Hours**

Introduction to Virology: Historical background and discovery of viruses, General characteristics of viruses, Virus replication cycle; Virus Classification, Viral taxonomy (Baltimore classification), DNA vs. RNA viruses, Enveloped vs. non-enveloped viruses; Viral Morphology and Structure: Capsid, nucleic acids, and envelope, Viral genome organization and replication strategies; Virus-Host Interaction: Host range and tropism, Mechanisms of viral entry into host cells, Viral latency and persistence.

Unit-II **15Hours**

Viral Pathogenesis: Mechanisms of viral disease production, Acute vs. chronic infections, Oncogenesis and viral-associated cancers; Viral Immune Evasion Mechanisms: Immunoevasion strategies of viruses (e.g., antigenic variation, immune suppression), Impact of immune response on viral diseases; Host Immune Response: Innate immunity to viral infections, Adaptive immunity: Antibody and T-cell responses, Vaccination and herd immunity; Viral Immunology: Role of interferons and cytokines in antiviral defense, Immune-mediated tissue damage in viral infections.

Unit-III **15Hours**

Clinical Diagnosis of Viral Infections: Symptoms and clinical features of common viral infections, Viral load measurements and serological tests; Laboratory Diagnostic Techniques: Virus isolation (cell culture, animal models), PCR-based methods for detection (qPCR, RT-PCR), Antibody and antigen detection assays; Newer Diagnostic Approaches, Next-generation sequencing in virology, Molecular diagnostics and point-of-care testing; Viral Epidemiology and Surveillance, Epidemiological methods for tracking viral outbreaks, Use of diagnostic data for public health response.

Unit-IV **15Hours**

Common Human Viral Infections: Respiratory viruses (Influenza, SARS-CoV-2), Enteric viruses (Norovirus, Rotavirus), Hepatitis viruses (HBV, HCV), HIV/AIDS and Retroviruses; Emerging and Re-emerging Viral Infections: Zoonotic viruses (Ebola, Zika, SARS, MERS), Arboviruses (Dengue, Chikungunya, Yellow Fever), Pandemic threats and preparedness; Viral Therapy and Antiviral Drugs: Antiviral drug classes and mechanisms of action, Resistance to antiviral therapies, Vaccines and antiviral drugs in development: Current Research in Medical Virology: Gene editing and virotherapy, Advances in vaccine development, Future directions in virology research.

Transactional modes: Video based teaching, Collaborative teaching, Case based teaching, Question-Answer

Suggested Readings:

- *Collee, J. G., Mackie, T. J., and McCartney, J. E. (1996). Mackie & McCartney practical medical microbiology. New York: Churchill Livingstone.*
- *Ananthanarayan, R. and Paniker, C., 1980. Textbook of microbiology. 1st ed. Orient Longman. Ananthanarayan, R.; Panicker, J.K. (2005) [1978].*
- *Textbook of Microbiology (7 ed.) L Mukherjee, K., Swarajit. G. (2010).*
- *Medical Laboratory Technology (Volume I). Willey, J., Sherwood, L. and Woolverton, C. (2013).*
- *Prescott's Microbiology: 9th revised edition. London: MCGRAW HILL*

Course Title: Microbiological Techniques II	**L**	**T**	**P**	**Cr.**
Course Code: MML2453	**0**	**0**	**8**	**4**

Total Hours: 60

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Identify and classify fungal pathogens using microscopy, culture, and molecular techniques.

2. Diagnose parasitic infections using microscopy, serology, and molecular tools.
3. Isolate and characterize viruses through cell culture, PCR, and sequencing.
4. Understand fungal, parasitic, and viral pathogenesis and host interactions.
5. Apply knowledge of treatments and emerging resistance in fungal, parasitic, and viral infections.

List of Practical **60 hours**

- To perform serodiagnosis of HIV infection kit by triode kit.
- To perform serodiagnosis of Hepatitis B by cassette method.
- To perform staining of fungi by lacto-phenol cotton blue.
- To isolate and identify fungi from skin sample.
- To isolate and identify fungi from hair, and from nail sample.
- To perform routine microscopic examination of stool for parasitic infections.
- To perform parasitic examination of stool for by physical and chemical method.
- To perform parasitic microscopic examination of sputum.
- To isolate and identify *Candida* species by germ tube test.

Suggested Readings:

- *Collee, J. G., Mackie, T. J., and McCartney, J. E. (1996). Mackie & McCartney practical medical microbiology. New York: Churchill Livingstone.*
- *Ananthanarayan, R. and Paniker, C., 1980. Textbook of microbiology. 1st ed. Orient Longman. Ananthanarayan, R.; Panicker, J.K. (2005) [1978].*
- *Textbook of Microbiology (7 ed.) L Mukherjee, K., Swarajit. G. (2010).*

Course Title: Project I	**L**	**T**	**P**	**Cr.**
Course Code: MML2454	**0**	**0**	**4**	**2**

Total Hours: 30

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Apply molecular techniques to detect and identify pathogens in clinical samples, focusing on resistance.

2. Conduct antimicrobial susceptibility testing and interpret results for infection treatment.
3. Understand pathogenicity and drug resistance mechanisms to inform diagnostics and therapies.
4. Analyze epidemiological data on infectious agents' spread, diversity, and resistance patterns.
5. Design experiments to study pathogen-host interactions, particularly in immunocompromised individuals.

Tentative Project list

- Develop and optimize a PCR-based method for rapid detection of multi-drug-resistant bacteria in clinical samples.
- Study the genetic diversity and transmission dynamics of *Mycobacterium tuberculosis* strains.
- Investigate the impact of the human microbiome on the development and severity of *Clostridium difficile* infections, focusing on microbial interactions.
- Conduct antimicrobial susceptibility testing on hospital-acquired pathogens, examining patterns of resistance to commonly used antibiotics in a clinical setting.
- Explore the role of bacterial biofilms in chronic infections, particularly in relation to wound infections and implant-associated infections.
- Evaluate the potential of bacteriophage therapy in treating antibiotic-resistant bacterial infections, using in vitro and animal model systems.
- Investigate host immune responses to fungal infections, specifically focusing on *Candida albicans*, and its ability to evade immune detection in immunocompromised individuals.
- Assess the prevalence and mechanisms of antimicrobial resistance in urinary tract infection pathogens, including both Gram-positive and Gram-negative organisms.
- Develop a diagnostic approach for detecting viral infections such as *Dengue* or *Zika* virus in clinical samples using ELISA or RT-PCR.

Course Title: Quality Control and Assurance	**L**	**T**	**P**	**Cr.**
Course Code: MML2455	**4**	**0**	**0**	**4**

Total Hours: 60

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Understand Quality Control (QC) and Quality Assurance (QA) principles in medical microbiology.
2. Apply QC/QA methods to validate laboratory practices.

3. Develop and evaluate Standard Operating Procedures (SOPs).
4. Monitor diagnostic equipment, reagents, and personnel performance.
5. Analyze quality management systems and regulatory compliance.

Course Content

Unit-I **15Hours**

Principles of Quality Control and Quality Assurance: Definitions, importance, and objectives of QC and QA, Difference between QC and QA; Quality Standards in Medical Microbiology, National and international quality standards (ISO, CLSI, CAP, etc.), Regulatory bodies and their role (FDA, WHO); Role of QC and QA in Laboratory Diagnostics: Ensuring accurate, reliable, and reproducible results, Risk management in microbiological testing; Ethical and Legal Aspects of Quality Management, Ethical practices in laboratory settings, Compliance with legal requirements and accreditation standards.

Unit-II **15Hours**

Development of Standard Operating Procedures (SOPs): Structure and format of SOPs, Writing clear, concise, and effective SOPs; Implementation of SOPs in Medical Microbiology: SOPs for sample collection, processing, and testing, Training staff and ensuring compliance; Monitoring and Evaluation of Laboratory Practices: Internal audits and reviews, Continuous improvement strategies; Record Keeping and Documentation: Maintaining proper documentation for traceability, Importance of accurate records for QA.

Unit-III **15Hours**

Performance Monitoring in Microbiology Laboratories: Quality control charts and statistical methods (e.g., Levey-Jennings charts), Routine testing and quality assessment; Evaluation of Diagnostic Equipment and Reagents: Calibration and maintenance of laboratory instruments, Quality assurance for reagents and consumables; Personnel Performance and Competency: Training, assessment, and competency evaluations, Ensuring consistency in laboratory practices; Proficiency Testing and External Quality Assurance (EQA), Inter-laboratory comparison and external audits, Corrective actions for identified deficiencies.

Unit-IV **15Hours**

Regulatory Requirements and Guidelines: An Overview of key regulations (NABL, CLIA, FDA, WHO, ISO 15189), National and international guidelines

for microbiology laboratories; Laboratory Accreditation Process: Steps for obtaining and maintaining laboratory accreditation, Roles of accrediting bodies (e.g., CAP, ISO 15189); Quality Management Systems (QMS): Structure and implementation of a QMS in microbiology laboratories, Key components: documentation, audits, corrective actions; Continuous Improvement and Risk Management, Implementing continuous improvement processes, Identifying and managing risks in the laboratory environment.

Transactional modes: Video based teaching, Collaborative teaching, Case based teaching, Question-Answer

Suggested Readings:

- *Gaffney, J. S., Gudmundsson, G. H., & Hultgren, B. (2012). Quality assurance in the clinical laboratory: Guidelines and standards. Academic Press.*
- *Miller, W. G., & Horowitz, G. L. (2009). Clinical laboratory quality control essentials. AMA Press.*
- *Price, C. P., & Christenson, R. H. (2011). Evidence-based laboratory medicine and quality assurance (2nd ed.). AACC Press.*
- *Burtis, C. A., Ashwood, E. R., & Bruns, D. E. (2015). Tietz fundamentals of clinical chemistry and molecular diagnostics (7th ed.). Elsevier Health Sciences.*
- *Barwick, M. (2014). Quality assurance in laboratory practice: A comprehensive guide for medical professionals (3rd ed.). Medical Publishing House.*

Course Title: Histopathology and Cytopathology	**L**	**T**	**P**	**Cr.**
Course Code: MML24556	**4**	**0**	**0**	**4**

Total Hours: 60

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Demonstrate proficiency in the preparation, staining, and microscopic examination of tissue samples for histopathological and cytological analysis.

2. Develop a deep understanding of the pathophysiological processes underlying various diseases through the examination of cellular and tissue alterations.
3. Apply advanced diagnostic techniques such as immunohistochemistry, molecular pathology, and cytology in clinical settings to diagnose and prognosticate disease.
4. Interpret and integrate cytological and histopathological findings to assist in the diagnosis, staging, and treatment planning of cancer and other diseases.
5. Critically assess emerging technologies and ethical practices in the fields of histopathology and cytology, with an emphasis on personalized medicine and digital pathology.

Course Content

Unit-I **15 Hours**

Introduction to Histopathology: Definition and scope of histopathology, Importance in diagnosis and research; Tissue Collection and Preparation: Methods of tissue collection (biopsy, surgical specimens), Tissue fixation and preservation techniques (e.g., formalin fixation); Tissue Processing and Embedding: Dehydration, clearing, and infiltration techniques, Paraffin embedding and sectioning techniques; Microscopic Examination: Principles of light microscopy and electron microscopy; Histopathological and Cytological Diagnostic Techniques: The role of histopathology and cytology in diagnosing diseases.

Unit-II **15Hours**

Staining Techniques: Hematoxylin and eosin (H&E), special stains (e.g., PAS, Silver stain), immunohistochemistry, and fluorescence microscopy; Molecular Pathology: PCR, in situ hybridization, and next-generation sequencing in tissue samples; Histopathology of Major Organ Systems: Pathological changes in tissues of the lungs, liver, kidneys, heart, etc. Tumor Histopathology: Benign vs malignant lesions, grading and staging of tumors, and molecular markers; Histopathological Techniques in Inflammatory Diseases: Chronic vs acute inflammation, autoimmune diseases.

Unit-III **15Hours**

Cytology Techniques: Fine needle aspiration (FNA), exfoliative cytology, Interpretation of Cytological Smears: Cellular morphology, cellular artifacts, and the significance of findings; Cytology in Cancer Diagnosis: The role of

cytology in the early detection of cancers (e.g., Pap smear, breast FNA); Molecular Cytology: DNA/RNA-based techniques in cytology, liquid biopsy; Cytological Tumor Markers: The application of molecular cytology for prognostic and diagnostic purposes in cancers.

Unit-IV **15Hours**

Integration of Histopathology and Cytology in Clinical Practice: Role in routine diagnostics and specialized consultations; Clinical Case Studies: Real-life case studies in different specialties, including oncology, infectious diseases, and autoimmunity; Role of Histopathology and Cytology in Personalized Medicine: Companion diagnostics, targeted therapies, and liquid biopsy; Ethical and Legal Considerations: Consent for biopsies, handling of specimens, confidentiality, and pathology report interpretation; Emerging Trends in Histopathology and Cytology: Artificial intelligence in diagnostics, digital pathology, and the future of personalized pathology.

Transactional modes: Video based teaching, Collaborative teaching, Case based teaching, Question-Answer

Suggested Reading

- *Cibas, E. S., &Ducatman, B. S. (2019). Cytology: Diagnostic principles and clinical correlates (5th ed.). Elsevier Health Sciences.*
- *Koss, L. G., & Melamed, M. R. (2005). Koss' diagnostic cytology and its histopathologic bases (5th ed.). Lippincott Williams & Wilkins.*
- *Orell, S. R., Sterrett, G. F., & Whitaker, D. (2012). Fine needle aspiration cytology (5th ed.). Churchill Livingstone.*
- *Gray, W., & Kocjan, G. (2010). Diagnostic cytopathology (3rd ed.). Churchill Livingstone.*
- *Bibbo, M., & Wilbur, D. C. (2008). Comprehensive cytopathology (3rd ed.). Saunders Elsevier.*

3RD SEMESTER

Course Title: Advances in Microbiology and Molecular Diagnostic Techniques	**L**	**T**	**P**	**Cr.**
Course Code: MML3500	**4**	**0**	**0**	**4**

Total Hours: 60

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Explain and apply advanced microbiological techniques like NGS, CRISPR, and real-time PCR for microorganism identification.
2. Use molecular diagnostic tools such as PCR and gene sequencing to detect pathogens and genetic disorders.
3. Interpret bioinformatics data for microbial genome analysis, antimicrobial resistance tracking, and pathogenicity prediction.
4. Analyze and interpret molecular diagnostic test results, considering their limitations and clinical applications.
5. Understand the ethical, legal, and social implications of molecular diagnostics, including privacy and public health concerns.

Course Content

Unit-I **15Hours**

Introduction to Microbiology: Classification and characteristics of microorganisms (bacteria, viruses, fungi, and parasites); Microbial Pathogenesis: Mechanisms of microbial infections, virulence factors, and host-pathogen interactions; Molecular Biology Basics: DNA, RNA, and protein synthesis. Overview of molecular techniques; Basic Techniques in Microbial Identification: Culture methods, Gram staining, and biochemical tests; Molecular Biology Techniques: Polymerase chain reaction (PCR), nucleic acid probes, gel electrophoresis.

Unit-II **15 Hours**

Polymerase Chain Reaction (PCR) and its Variants: Real-time PCR, quantitative PCR, multiplex PCR, and nested PCR; Next-Generation Sequencing (NGS): Principles, applications in microbiology, and pathogen genomics; Microarray Technology: DNA microarrays for pathogen detection, strain identification, and resistance profiling; Molecular Diagnostic Assays: Techniques like Southern blotting, Northern blotting, and Fluorescent in situ Hybridization (FISH); Metagenomics: High-throughput sequencing for microbial diversity analysis, application in clinical diagnostics.

Unit-III **15Hours**

Rapid Diagnostic Tests (RDTs): Lateral flow assays, immunochromatographic tests, and biosensors; Point-of-Care Diagnostics: Development and use of portable diagnostic devices for infectious diseases (e.g., handheld PCR devices, CRISPR-based diagnostics); Molecular Diagnostics for Viral Infections: Advancements in diagnosing viral diseases like HIV, hepatitis, and SARS-CoV-2; Antibiotic Resistance Detection: Molecular methods for detecting resistance genes, antimicrobial susceptibility testing, and antibiotic

resistance profiling; CRISPR-based Diagnostics: Application of CRISPR/Cas systems for pathogen detection and molecular diagnostics.

Unit-IV **15 Hours**

Clinical Microbiology in Practice: Integrating molecular diagnostics in clinical decision-making and patient management; Microbial Epidemiology: Using molecular methods for outbreak investigations, surveillance, and tracking disease spread; Bioinformatics in Microbial Diagnostics: Data analysis, interpretation of genomic sequences, and pathogen identification; Emerging Technologies in Molecular Microbiology: CRISPR diagnostics, microfluidics, and lab-on-a-chip systems; Ethical, Legal, and Social Issues: Ethical considerations in genomic-based diagnostics, privacy, and regulation of molecular testing.

Transactional modes: Video based teaching, Collaborative teaching, Case based teaching, Question-Answer

Suggested reading:

- Li, D. T., & Gray, B. D. (2013). *Molecular diagnostics: Techniques and applications for the clinical laboratory* (2nd ed.). Academic Press.
- Persing, D. H., Tenover, F. C., Hayden, R. T., & Palavecino, E. (2016). *Molecular microbiology: Diagnostic principles and practice* (3rd ed.). ASM Press.
- Coleman, W. B., &Tsongalis, G. J. (2019). *Molecular pathology: The molecular basis of human disease* (3rd ed.). Elsevier.
- Ferretti, L., & Alberti, A. (2020). *Next-generation sequencing and computational biology for precision medicine* (1st ed.). Springer.
- Bustin, S. A., & Nolan, T. (2020). *The PCR revolution: Basic to advanced techniques* (2nd ed.). CRC Press.

Course Title: Advances in Immuno hematological Techniques	**L**	**T**	**P**	**Cr.**
Course Code: MML3501	**4**	**0**	**0**	**4**

Total Hours: 60

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Understand advanced immunohematology techniques in blood transfusion and compatibility testing.

2. Gain proficiency in modern lab technologies like molecular techniques and flow cytometry.
3. Analyze and interpret complex immunohematology data for diagnosis and transfusion management.
4. Understand regulatory and ethical standards in immunohematology.
5. Apply knowledge to real-world clinical and laboratory settings to enhance problem-solving skills.

Course Content

Unit-I **15 Hours**

Blood Group Systems: ABO system and its clinical relevance, Rh system: Genetic basis and significance in transfusion medicine, Extended blood group systems: Kell, Kidd, Duffy, MNS, etc.; Molecular basis of blood group antigens and antibodies,Antigen-antibody interactions and their role in blood transfusion; Immunohematology Reactions: Direct and indirect antiglobulin tests (DAT and IAT), Hemagglutination, hemolysis, and gel card technology; Applications and Challenges: Blood compatibility testing and crossmatching, Problems of alloimmunization and the management of alloantibodies, Challenges in blood group typing in special populations (e.g., newborns, immunocompromised patients).

Unit-II **15Hours**

Traditional vs. Modern Blood Typing Techniques: Manual blood typing methods and their limitations, Automated blood typing systems: Principles and advantages; Molecular Blood Typing: DNA-based techniques for blood group antigen determination, PCR-based genotyping and next-generation sequencing (NGS) for high-resolution blood group typing, Use of molecular diagnostics in rare blood group antigen identification; Microarray and High-Throughput Techniques: Blood group antigen microarrays for simultaneous detection of multiple blood groups, Application of high-throughput sequencing and bioinformatics in immunohematology; Point-of-Care Blood Typing: Development of portable blood typing devices, Innovations in handheld devices for field-based blood typing in emergency settings.

Unit-III **15 Hours**

Antibody Screening and Identification Techniques: Principles of antibody screening: Enzyme tests, indirect antiglobulin test (IAT), Use of solid-phase red cell adherence technology in antibody detection, Methods for identifying alloantibodies and autoantibodies; Clinical Significance of Antibody Detection: Role of red cell antibodies in hemolytic transfusion reactions (HTRs), Antibody-mediated hemolytic disease of the fetus and newborn (HDFN), Crossmatching and its role in preventing transfusion reactions; Innovations in Antibody Identification: Use of automated platforms for

antibody identification, Advances in antigen typing for rare and clinically significant antibodies, Applications of molecular techniques in antibody identification, Case Studies and Clinical Applications: Case-based learning: Identifying and managing complex antibody profiles, Strategies for dealing with difficult crossmatch situations.

Unit-IV **15Hours**

CRISPR-Cas9 and Genome Editing: Potential applications of gene editing in modifying blood group antigens, CRISPR-based approaches for creating universal blood donors; Next-Generation Sequencing (NGS) and Immunohematology: NGS technology for identifying rare and novel blood group antigens, Its role in personalized medicine and transfusion compatibility; Artificial Intelligence and Machine Learning in Blood Group Prediction: AI algorithms for predicting blood group antigen profiles, Integration of AI in automating blood typing and crossmatch prediction; Synthetic Blood and Blood Substitutes: Overview of synthetic blood products and their potential to reduce dependence on donor blood, Challenges and current research in developing safe and effective blood substitutes, Global Challenges and Innovations in Blood Transfusion: Technological solutions to blood shortages, Impact of emerging technologies on blood transfusion practices in resource-limited settings.

Transactional modes: Video based teaching, Collaborative teaching, Case based teaching, Question-Answer

Suggested reading

- *Friedman, M. T., West, K. A., Bizargity, P., Annen, K., Gur, H. D., & Hilbert, T. (2023). Immunohematology, transfusion medicine, hemostasis, and cellular therapy: A case study approach (3rd ed.). Springer.*
- *Ajmani, P. S. (2020). Immunohematology and blood banking: Principles and practice. Springer Nature.*
- *Harmening, D. M. (2018). Modern blood banking and transfusion practices (7th ed.). F.A. Davis Company.*
- *Blaney, K. D., & Howard, P. R. (2013). Basic & applied concepts of blood banking and transfusion practices (3rd ed.). Elsevier.*
- *Roback, J. D., Grossman, B. J., Harris, T., & Hillyer, C. D. (2011). Technical manual (17th ed.). AABB Press.*

Course Title: Dissertation (Phase I)	L	T	P	Cr.
Course Code: MML3502	0	0	24	12

Total Hours: 180

Course Learning Outcomes: After completion of this course, the learner will be able to:

1. Conduct independent research and critically analyse scientific literature.
2. Design experiments and use appropriate methodologies to investigate microbiological questions.

3. Analyse and interpret data to draw valid conclusions.
4. Communicate findings clearly through a well-structured dissertation.
5. Evaluate ethical considerations and adhere to research guidelines.

Course Content

Dissertation (Phase) I will include Synopsis approval from Doctoral Advisory Committee (DAC) will be taken by the student and after that it will send to Institutional Research Committee (IRC), followed by Institutional Ethical Committee (IEC) for final approval.

Course Title: Project II	**L**	**T**	**P**	**Cr.**
Course Code: MML3503	**0**	**0**	**4**	**2**

Total Hours: 30

Course Learning Outcomes: After completion of this course, the learner will be able to:

1. Develop proficiency in blood typing techniques, including ABO and Rh systems, and understand their clinical significance.
2. Gain skills in crossmatching and antibody screening to ensure safe blood transfusion practices.

3. Understand the principles behind the detection and identification of blood group antibodies using various immunohematological methods.
4. Analyze and interpret results from blood compatibility tests to prevent transfusion reactions.
5. Demonstrate the ability to apply immunohematology knowledge in clinical scenarios to improve patient outcomes.

Tentative Project

- Create and validate a quick and reliable blood typing system for clinical use in blood banks.
- Investigate the prevalence and types of clinically significant antibodies in pregnant women to assess risks in transfusions and haemolytic disease of the newborn.
- Compare various blood compatibility testing methods (e.g., direct antiglobulin test, crossmatching) to improve transfusion safety.
- Study the correlation between the presence of blood group antibodies and the risk of transfusion reactions, and explore preventive measures.
- Analyze the genetic basis of ABO blood group variations across different ethnic groups to understand population-specific distribution patterns.
- Assess the reliability of hemagglutination inhibition assays for identifying clinically significant antibodies in blood donors and recipients.
- Investigate the effects of ABO incompatibility in organ transplantation outcomes and explore potential immunological interventions.
- Conduct a study on the prevalence of Rh incompatibility and the effectiveness of prenatal interventions to prevent haemolytic disease of the newborn.
- Design a comprehensive screening protocol to identify and recruit blood donors with rare blood group types to support transfusion services.

4TH SEMESTER

Course Title: Research Methodology and Biostatistics	L	T	P	Cr.
Course Code: MML4550	4	0	0	4

Total Hours: 60

Learning Outcomes: After completion of this course, the learner will be able to:

1. Design research studies with appropriate methods and questions.
2. Collect data accurately and ethically.
3. Analyze data using statistical tools to draw valid conclusions.
4. Review and synthesize existing literature to support findings.
5. Communicate results effectively through reports and presentations.

Course Content

UNIT-I **15Hours**

Introduction to Research: Definition of Research, Types & Methods of research, Applied versus Fundamental research, exploratory research, Observational research, Inductive and Deductive approaches; Designing Research protocol: Research Protocol Development, Literature search, Identification of Research problem, Research gap, Research question, Research Hypothesis, Null and Alternative Hypothesis, Study Objectives; Data and types: Types of Data, Primary and Secondary data, Scales of measurement of data- Nominal data, Ordinal, Interval and Ratio scale, Variables and Confounders, Dependent and Independent Variables, Extraneous variable, Control variable.

UNIT-II **15 Hours**

Literature Review: Importance of literature review, Sources of literature: Journals, books, and online databases, Organizing and synthesizing research findings; Research Design: Meaning of Research Design, Need for Research Design, Features of a Good Design, Different Research Designs, Basic Principles of Experimental Designs; Study population: Selecting Cases and Control, Comparison Group, Target population, Matching, Case Definition, Inclusion and Exclusion Criteria; Qualitative vs. Quantitative research methods; Data Collection and analysis : Types and sources of data – Primary and secondary, Methods of collecting data, Concept of sampling and sampling methods – sampling frame, sample, characteristics of good sample, simple random sampling, purposive sampling, convenience sampling, snowball sampling.

Unit-III **15 Hours**

Statistics: Measures of central tendency: Mean, median, and mode, Measures of dispersion: Range, variance, and standard deviation, Frequency distributions and histograms, Data visualization: Bar charts, pie charts, and box plots; Probability and Probability Distributions: Basic probability concepts, Probability distributions: Normal distribution, binomial distribution, and Poisson distribution, Law of large numbers and central limit theorem.

Unit-IV **15 Hours**

Chi-square test for independence and goodness of fit, One-way and two-way analysis of variance (ANOVA), Post-hoc tests following ANOVA; Regression Analysis: Simple linear regression, Multiple linear regression, Model assumptions and diagnostics, Logistic regression (binary outcomes), Poisson regression (count data); Biostatistics for Clinical Trials: Design and analysis of clinical trials, Randomization techniques, Statistical monitoring of trials, Regulatory considerations (e.g., FDA guidelines.

Transactional modes: Video based teaching, Collaborative teaching, Case based teaching, Question-Answer

Suggested Reading

- *Sharma, S. (2016). Research methodology and biostatistics. Elsevier India.*
- *Rao, P. S. R. S. (2007). Statistical methods in health sciences. Springer.*
- *Daniel, W. W., & Cross, C. L. (2018). Biostatistics: A foundation for analysis in the health sciences (11th ed.). Wiley.*
- *Pagano, M., & Gauvreau, K. (2018). Principles of biostatistics (2nd ed.). CRC Press.*
- *Glantz, S. A. (2012). Primer of biostatistics (7th ed.). McGraw-Hill Education.*

Course Title: Dissertation (Phase II)	**L**	**T**	**P**	**Cr.**
Course Code: MML4551	**0**	**0**	**24**	**12**

Total Hours: 180

Course Learning Outcomes: After completion of this course, the learner will be able to:

1. Conduct independent research and critically analyze scientific literature.
2. Design experiments and use appropriate methodologies to investigate microbiological questions.
3. Analyze and interpret data to draw valid conclusions.
4. Communicate findings clearly through a well-structured dissertation.

5. Evaluate ethical considerations and adhere to research guidelines.

Course Content

Dissertation (Phase) II - Dissertation will be evaluated for **300 marks** on the parameter laid down in the proforma for the evaluation in which the students will give a presentation on the dissertation and an open viva-exam examination will be conducted by the external examiner. Student will submit three hard copies of her/his dissertation along with soft copy as PDF file to the Department and 1 Review & Research paper based on his/her research work.

Course Title: Employability and Entrepreneurship in Microbiology	**L**	**T**	**P**	**Cr.**
Course Code: MML4552	**2**	**0**	**0**	**2**

Total Hours: 30

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Understand career opportunities and roles in medical microbiology across clinical, research, and biotech sectors.
2. Develop key professional skills such as communication, problem-solving, and teamwork for the job market.

3. Foster an entrepreneurial mindset to create business models and innovations in medical microbiology.
4. Learn the process of translating research into marketable products, including IP, regulations, and marketing.
5. Gain awareness of ethical, legal, and social responsibilities in medical microbiology and entrepreneurship.

Course Content

Unit-I **5 Hours**

Jobs in Medical Microbiology: Microbiologist, clinical laboratory scientist, epidemiologist, quality control analyst, research scientist; Career paths and opportunities: Academic research, clinical microbiology, pharmaceutical industry, and public health sectors; Professional Development and Core Skills: CV/Resume Writing and Job Application Strategies: Creating an impactful CV tailored to medical microbiology roles, Writing cover letters that highlight skills and experience relevant to microbiology positions, Using LinkedIn and other professional networks to find job opportunities and build connections; Interview Preparation and Networking: Preparing for interviews: Common interview questions, presenting research and laboratory experience, and responding to role-specific scenarios Professional networking: Attending microbiology conferences, seminars, and workshops (e.g., ASM, ECDC), Mentorship and internship opportunities in microbiology.

Unit-II **8 Hours**

Introduction to Healthcare Entrepreneurship: The role of entrepreneurship in the healthcare and biotechnology sectors, Identifying market needs and opportunities within medical microbiology (e.g., rapid diagnostic tests, antimicrobial resistance solutions), Case studies of successful medical microbiology startups and innovations; Innovation in Microbiology: Understanding the latest trends and innovations in microbiology: Next-generation sequencing, CRISPR technology, point-of-care diagnostics, and microbiome research, Identifying gaps in the market and leveraging new technologies to address healthcare challenges, Business plan for a medical microbiology startup: Identifying the target market, setting goals, and building a sustainable business model, Financial planning: Budgeting, pricing, and securing funding, Funding and Investment in Medical Microbiology Startups: Sources of funding for health tech and biotech startups: Venture capital, angel investors, government grants, and crowdfunding, Strategies for pitching your startup idea to investors: Crafting an elevator pitch and creating compelling presentations, Collaborating with academic and industry partners to fund research and product development;

Regulatory Considerations and Market Entry: Understanding regulatory requirements for microbiology-related products: FDA, CE Mark, WHO guidelines, Navigating the process of clinical trials and getting products to market.

Unit-III **8 Hours**

Intellectual Property (IP) and Commercialization: The basics of intellectual property: Patents, copyrights, and trademarks in biotechnology and healthcare, Protecting innovations in microbiology through patents: Processes, challenges, and international IP laws, Licensing and commercialization strategies for microbiology products or services; Collaboration with Industry and Academia: Collaborative research and development (R&D) between universities, hospitals, and biotech companies, Partnerships for commercializing microbiological innovations: Licensing agreements, joint ventures, and spin-offs, Engaging with stakeholders such as clinicians, researchers, and regulators to bring products to market; Regulatory Pathways and Approval Process: Overview of regulatory frameworks for medical products and diagnostics (e.g., FDA, EMA, WHO). Understanding the process of clinical trials and obtaining product certifications, Regulatory considerations for antimicrobial agents, diagnostic kits, and microbiological devices; Marketing and Distribution: Building a marketing strategy for microbiological products, Distribution channels and strategies for reaching healthcare providers, research labs, and diagnostic centers, Managing intellectual property, competition, and pricing in a growing market.

Unit-IV **9 Hours**

Ethical Challenges in Medical Microbiology:Ethical considerations in microbiology research: Consent, patient confidentiality, and data protection, Ethical issues in diagnostic testing, clinical trials, and antimicrobial resistance; Addressing societal issues like access to diagnostics, equity in healthcare, and global health challenges; Legal Considerations in Medical Microbiology Ventures: Understanding the legal aspects of starting and managing a biotech company: Business registration, intellectual property laws, contracts, and licensing, Navigating regulatory and compliance requirements: Clinical trials, medical device regulations, and ethical approval processes, Liability and risk management in medical microbiology businesses; Social Responsibility in Healthcare Entrepreneurship: The role of healthcare startups in addressing public health issues, such as emerging infectious diseases, antimicrobial resistance, and pandemic preparedness, Corporate social responsibility (CSR) and sustainable practices in biotech entrepreneurship, Addressing health equity through affordable diagnostics and treatments; Global Health and Policy Considerations:The role of

international health organizations (WHO, CDC, etc.) in shaping microbiology-related policies, Navigating global healthcare markets: Challenges in low- and middle-income countries, Understanding the regulatory and policy landscape for microbiological products globally; Ethical Marketing and Corporate Governance: Ethical marketing in healthcare: Truthful advertising, transparency, and patient trust, Corporate governance and ethical leadership in medical microbiology ventures, Maintaining high standards of ethics and integrity in research and business operations.

Transactional modes: Video based teaching, Collaborative teaching, Case based teaching, Question-Answer

Suggested Reading:

- *Heggenhougen, H. K., & Quah, S. R. (2008). Entrepreneurship in healthcare: A global perspective. Academic Press.*
- *Phillips, J. M., & Stalter, A. M. (2021). Leadership and entrepreneurship in nursing and healthcare: A practical guide. Springer.*
- *Burns, L. R. (2014). The business of healthcare innovation. Cambridge University Press.*
- *Harris, J. S., & Roussel, L. A. (2020). Management and leadership for nurse administrators (8th ed.). Jones & Bartlett Learning.*
- *Buchbinder, S. B., & Shanks, N. H. (2021). Introduction to healthcare management (4th ed.). Jones & Bartlett Learning.*

Course Title: Biomedical Instrumentation	**L**	**T**	**P**	**Cr.**
Course Code: MML4553	**4**	**0**	**0**	**4**

Total Hours: 60

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Understand the principles and applications of biomedical instruments.
2. Calibrate and maintain biomedical devices for accurate measurements.
3. Analyze data from biomedical instruments for diagnostics.
4. Design and optimize biomedical instrumentation systems.
5. Evaluate the performance and safety of biomedical devices.

Course Content

UNIT-I **15 Hours**

Overview of biomedical instrumentation and its role in medical diagnostics, Principles and working mechanisms of common biomedical instruments (e.g., microscopes, spectrophotometers, ECG, and EEG), Applications of instrumentation in medical microbiology (e.g., microbial diagnostics, PCR, and flow cytometry), Basic electrical and electronic components used in biomedical instrumentation.

Unit-II **15 Hours**

Methods for calibrating and validating biomedical instruments, Preventive maintenance practices for ensuring accuracy and reliability of devices, troubleshooting techniques for common issues in biomedical instruments., Hands-on practices for operating and maintaining microbiological diagnostic tools (e.g., incubators, autoclaves, biosafety cabinets).

Unit-III **15 Hours**

Techniques for collecting data using biomedical instruments in microbiology, Methods for analyzing and interpreting data from laboratory instruments (e.g., PCR data, spectrophotometry, and ELISA), Statistical tools for analyzing experimental results, Integration of data into clinical microbiology for diagnosis and research purposes.

Unit-IV **15 Hours**

Introduction to advanced biomedical instruments and their applications in medical microbiology (e.g., mass spectrometry, next-generation sequencing, and biosensors), Role of automation in clinical microbiology and laboratory diagnostics, Future trends in biomedical instrumentation and its impact on medical research and healthcare, Ethical and regulatory considerations in the use of biomedical instruments in healthcare settings**.**

Transactional modes: Video based teaching, Collaborative teaching, Case based teaching, Question-Answer

Suggested Reading

- *Webster, J. G. (2021). Medical instrumentation: Application and design (5th ed.). Wiley.*
- *Horan, M. (2020). Biomedical instrumentation systems (3rd ed.). Cengage Learning.*
- *Khandpur, R. (2021). Handbook of biomedical instrumentation (4th ed.). McGraw-Hill Education.*
- *Hsieh, J. (2020). Biomedical sensors and instruments (2nd ed.). CRC Press.*
- *Jacob, L. (2022). Biomedical engineering: Principles and applications (2nd ed.). Elsevier.*

Course Title: Research Publication Ethics and Intellectual Property Right	**L**	**T**	**P**	**Cr.**
Course Code: MML4554	**4**	**0**	**0**	**4**

Total Hours: 60

Learning Outcomes: After completion of this course, the learner will be able to:

1. Understand research ethics, responsible conduct, and proper citation.
2. Evaluate research publications for ethical compliance and data integrity.
3. Learn about intellectual property rights (IPR) and their role in research.

4. Address ethical dilemmas related to authorship, data sharing, and conflicts of interest.
5. Manage and protect intellectual property, ensuring legal compliance.

Course Content

Unit-I **15 Hours**

Scientific Writing: Structure of a scientific paper (Title, abstract, introduction, methodology, results, discussion, conclusion); Writing a research proposal: Objectives, methodology, expected outcomes, Academic writing style and language (Clarity, conciseness, and logical flow), Citation and referencing: Understanding various citation styles (APA, MLA, Chicago, etc.), Reference management tools.

Unit-II **15 Hours**

Plagiarism: Types, plagiarism detection software, Publication misconduct and Publication Ethics, Plagiarism avoiding techniques, regulation of plagiarism in India; Publication Ethics: Integrity and Ethics, Best Practices, Intellectual Honesty & Research Integrity: Scientific Misconducts & Redundant Publications, Conflict of Interest, Publication Misconduct, Violation of Publication Ethics, Authorship and Contributorship; Identification of Publication Misconduct: Fabrication, Falsification and Plagiarism (FFP), Predatory Publishers & Journals.

Unit-III **15 Hours**

Open Access Publishing: Concept of OER, Concept of open license, Open access publishing, Open access content management; Database and Research Metrics: Indexing Databases, Citation Databases: Web of Science, Scopus, Google Scholar, Metrics: h-index, g-ind, i10 index, Understanding Citation Metrics for Quality Research: Impact & Visualization Analysis; Peer Review and Journal Selection: Understanding the peer-review process, Types of journals: Open access vs. subscription-based journals, How to select a journal for publication, Writing a cover letter and responding to reviewer comments.

Unit-IV **15 Hours**

Intellectual Property Rights (IPR): Definition and types of intellectual property (IP): Copyright, patents, trademarks, and trade secrets; The importance of IP in research and innovation, Historical development and international IP laws (e.g., the role of WIPO, TRIPS Agreement); Key IP terms: Patentable inventions, originality, novelty, and industrial applicability; Patents: Overview of the patent system: Types of patents, Steps involved in obtaining a patent: Application, examination, and grant, Patentability requirements: Novelty, non-obviousness, and usefulness, Patent infringement and enforcement; Licensing and Commercialization of IP: Types of IP licenses: Exclusive vs. non-exclusive licenses, Licensing agreements and revenue sharing, Commercialization of research findings: Startups, spin-offs, and patent exploitation, Technology transfer offices: Role in university-based IP commercialization; Patent issues in academic research: Balancing public knowledge with commercial interests, Ethical concerns in patenting research outcomes, Impact of IP laws on collaborative research, IP in publicly funded research.

Transactional modes: Video based teaching, Collaborative teaching, Case based teaching, Question-Answer

Suggested Reading

- *Yadav, S. K. (2023). Research and publication ethics. Springer Nature.*
- *Resnik, D. B. (2020). The ethics of research with human subjects: Protecting people, advancing science, promoting trust. Springer*
- *Shamoo, A. E., & Resnik, D. B. (2015). Responsible conduct of research (3rd ed.). Oxford University Press.*
- *Macrina, F. L. (2014). Scientific integrity: Text and cases in responsible conduct of research (4th ed.). ASM Press.*
- *WIPO. (2020). Understanding intellectual property. World Intellectual Property Organization*