

SUBJECT SPECIFIC COMPETENCIES

The competencies will have a judicious mix of all domains of learning and may show predominance in one domain. The Post-Graduate student during the training programme should acquire the following predominant domain specific competencies to achieve the defined goals:

A) Predominant in Cognitive Domain (Knowledge):

At the end of the course, the student should have acquired knowledge in the following competencies:

Paper I: General Microbiology (GM) & Immunology (IG) General

Microbiology (GM):

- i. Describe important historical events and developments in microbiology
- ii. Describe nomenclature, classification, morphology, growth requirements, pathogenesis and laboratory diagnosis of different bacteria, viruses, parasites and fungi.
- iii. Explain the importance of normal flora microbes, including Microbiome in health and disease.
- iv. Explain the factors influencing and significance of microbial environment in health care setup.
- v. Describe the epidemiology of common infectious diseases, host-parasite relationship and their significance.
- vi. Describe various types of microscopes and microscopic techniques used in diagnostic microbiology.
- vii. Explain various methods of isolation, identification and preservation of microbes in laboratory.
- viii. Explain the type, mechanism of action and applications of microbial toxins, other virulence factors & microbial products like Bacteriocins.
- ix. Explain the concept & application of various biosafety and biosecurity issues in laboratory and patient care including physical, biological containment and standard precautions.
- x. Discuss the various methods of sterilization and disinfection and apply them in the

- laboratory and in patient care.
- xi. Explain the basic principles of bacterial genetics and applications of molecular techniques in medical microbiology.
 - xii. Explain the concept of microbiological surveillance including patient screening methods, organism typing and genome sequencing methodologies.
 - xiii. Explain the concept and application of quality assurance, quality control and accreditation in diagnostic microbiology.
 - xiv. Describe the significance and causes/reasons regarding emerging infectious diseases with strategies for their identification and control.
 - xv. Explain the concept and application of molecular biology techniques in the laboratory diagnosis of infectious diseases.
 - xvi. Explain the concept and use of information technology (LIS, WHO NET etc.) in microbiology laboratory effectively.
 - xvii. Describe the principles & implementation of animal and human ethics involved in diagnostics and research in Microbiology
 - xviii. Explain the principles and application of recent technological advances, automation, and application of Artificial Intelligence, nanotechnology, biosensors, bioinformatics, etc. in diagnosis & research in Microbiology.
 - xix. Explain the importance and methods of testing microbiology of air, water and food in patient care both in community/ hospital setting.
 - xx. Explain in detail about types & mechanism of action of Antimicrobial agents, their pharmacokinetics & pharmacodynamics, along with mechanism of drug resistance.
 - xxi. Describe types and applications of Bacteriophages in diagnostic and therapeutic of infections

Immunology (IG)

- i. Describe the structure and function of the immune system, immunological mechanisms in health and response of the host immune system to infections. (Innate and acquired immunity, Cells involved in immune response, Antigens , Immunoglobulins, Mucosal immunity, Cell mediated immunity, Cytokines, MHC complex, Immune tolerance etc)
- ii. Explain the complement system and describe its role in health and disease.

- iii. Describe the mechanism/s in immunological disorders (hypersensitivity, autoimmune disorders and immunodeficiency states) and discuss the laboratory methods used in their diagnosis including measurement of immunological parameters
- iv. Describe the types & principles of antigen and antibody reactions and immunological techniques used in diagnostic microbiology as well as in research.
- v. Describe the immunological mechanisms of transplantation and tumor immunity.
- vi. Describe the mechanism/s and significance of immune-potentiation and immune-modulation.
- vii. Describe various types, techniques and advances in the development and applications of vaccines including UIP and immunotherapy and reverse vaccinology.
- viii. Explain the role of animals in immunology.

PAPER II Clinical / Systemic Microbiology –I (CM –I)

- i. Discuss in depth about the etiological agents, source, transmission, host-parasite interaction, clinical manifestations, laboratory diagnosis, treatment, prevention, epidemiology, national, international guidelines in the situations/ scenario given below:

- **Infections of various organs and systems of the human body**

Microbiological basis of infective syndromes of various organs and systems of human body viz. CVS and blood, Respiratory Tract Infections, Urinary Tract Infections, Central Nervous System infections, Reproductive Tract Infections, Gastrointestinal Tract infections, Hepatobiliary System, Skin and Soft tissue infections, Musculoskeletal system, infections of Eye, Ear and Nose etc)

PAPER III: Clinical / Systemic Microbiology – II (CM-II)

- i. Discuss in depth about the etiological agents, source, transmission, host-parasite interaction, clinical manifestations, laboratory diagnosis, treatment, prevention, epidemiology, national, international guidelines in the situations/ scenario given below:
 - **Infectious diseases as per the source/risk**
 - **Opportunistic Infections** in special and high risk host
 - **Infections in special situations/ scenario.**

Microbiological basis of infective syndromes as per the source/risk e.g. Blood borne, sexually transmitted infections congenital, vector borne, food, air & water borne, zoonotic, laboratory acquired, occupational infections etc. Opportunistic Infections in special and high risk host eg Pregnancy, neonates, geriatrics, diabetics, immunocompromised host due to any reason, patients with Implants/Devices, dialysis etc, Infections in special situations/ scenario -Tropical, Travel related, Emerging/ Remerging Infectious diseases seen commonly, agents of bioterrorism etc.

- ii. Elicit relevant history, interpret laboratory results with clinic-microbiological correlation and develop diagnostic and treatment algorithms.

Following organisms (bacteria, fungi, virus and parasites) must be covered under clinical/systemic microbiology and the list must be updated to include newly identified microbes from time to time-

Bacteria:

1. Gram positive cocci of medical importance including *Staphylococcus*, *Micrococcus*, *Streptococcus*, *anaerobic cocci* etc.
2. Gram negative cocci of medical importance including *Neisseria*, *Branhamella*, *Moraxella* etc.
3. Gram positive bacilli of medical importance including *Lactobacillus*, *Coryneform organisms*, *Bacillus* and *aerobic bacilli*, *Actinomyces*, *Nocardia*, *Actinobacillus* and other *actinomycetales*, *Erysipelothrix*, *Listeria*, *Clostridium* and other spore bearing anaerobic bacilli etc.
4. Gram negative bacilli of medical importance including *Enterobacteriaceae*, *Vibrios*, *Aeromonas*, *Plesiomonas*, *Haemophilus*, *Bordetella*, *Brucella*, *Gardnerella*, *Pseudomonas* and other *non-fermenters*, *Pasteurella*, *Francisella*, *Bacteroides*, *Fusobacterium*, *Leptotrichia* and other anaerobic gram negative bacilli etc.

5. *Helicobacter, Campylobacter, Calymmatobacterium, Streptobacillus, Spirillum* and miscellaneous bacteria
6. *Mycobacteria*
7. *Spirochaetes*
8. *Chlamydia*
9. *Mycoplasmatales; Mycoplasma, Ureaplasma, Acholeplasma and other Mycoplasmas.*
10. *Rickettsiae, Coxiella, Bartonella* etc.
11. Any newly emerging bacteria

Fungi:

1. Yeasts and yeast like fungi of medical importance including *Candida, Cryptococcus, Malassezia, Trichosporon, Geotrichum, Saccharomyces* etc.
2. Mycelial fungi of medical importance including *Dermatophytes, Aspergillus, Zygomycetes, Pseudallescheria, Fusarium, Piedra, other dematiaceous hyphomycetes and other hyalohyphomycetes* etc.
3. Dimorphic fungi including *Histoplasma, Blastomyces, Coccidioides, Paracoccidioides, Sporothrix, Talaromyces marneffeii* etc.
4. Fungi causing Mycetoma, Chromoblatomycosis, Occulomycosis Otomycosis, Phaeohyphomycosis etc
5. *Pythium insidiosum*
6. *Prototheca*
7. *Pneumocystis jirovecii*
8. *Lacazia loboi (Loboa loboi)*
9. Laboratory contaminant fungi
10. Fungi causing Mycetism and mycotoxicosis
11. Any newly emerging fungi

Virus:

1. DNA viruses of medical importance including Pox viruses, Herpes viruses, Adeno viruses, Hepadna virus, Papova and Parvo viruses etc.

2. RNA viruses of medical importance including Picorna viruses, Toga viruses, Flavi viruses, Orthomyxo viruses, Paramyxo viruses, Reo viruses, Rhabdo viruses, Arena viruses, Bunya viruses, Retro viruses, Filo viruses, Human immunodeficiency virus, Arbo viruses, Corona viruses, Calci viruses etc.
3. Oncogenic viruses
4. Bacteriophages
5. Slow viruses including prions
6. Unclassified viruses
7. Virioids
8. Any newly emerging virus

Parasite:

1. Protozoan parasites of medical importance including *Entamoeba*, *Free living amoebae*, *Giardia*, *Trichomonas*, *Leishmania*, *Trypanosoma*, *Plasmodium*, *Toxoplasma*, *Sarcocystis*, *Cryptosporidium*, *Cyclospora* *Isospora*, *Babesia*, *Balantidium*, etc.
2. Helminths of medical importance including those belonging to Cestoda (*Diphyllobothrium*, *Taenia*, *Echinococcus*, *Hymenolepis*, *Dipylidium*, *Multiceps* etc.), Trematoda (*Schistosomes*, *Fasciola*, *Fasciolopsis*, *Gastrodiscoides*, *Paragonimus*, *Clonorchis*, *Opisthorchis* etc.) and Nematoda (*Ascaris lumbricoides*, *Ancylostoma duodenale*, *Enterobius vermicularis*, *Trichuris trichiura*, *Filariasis* etc.)
3. *Rhinosporidium seeberi*
4. Entomology: common arthropods and other vectors viz. mosquito, sand fly, ticks, mite, cyclops, louse, myasis etc.
5. Neglected tropical parasitic diseases
6. Any newly emerging parasite

Paper IV: Applied Microbiology (AM) & Recent Advances:

Student should be able to apply knowledge & comprehension about following applied aspects:

- i. **Prophylaxis** - Basic Principles and applications of general, immune as well as chemo- prophylaxis of infections in various clinical situations / scenarios.

- ii. **Vaccinology:** types of vaccines, principles, methods of preparation of vaccines and administration of vaccines.
- iii. **Health care associated Infections** - types, pathogenesis, diagnosis, prevention, control and surveillance of health care associated infections.
- iv. Biomedical waste and its management.
- v. **Role of microbes in non-communicable diseases** - infectious agents in origin and progression of non-communicable diseases like cancer, diabetes, musculoskeletal disorder and influence of these microbes on mental health.
- vi. **Antimicrobial Resistance Detection and Prevention:** classification, mechanism of action, detection and reporting drug resistance to antimicrobials (antibacterial, antiviral, antifungal, antimycobacterial and antiparasitic agents).
- vii. Investigation of an infectious disease outbreak in hospital and outbreak/epidemic/pandemic in community.
- viii. Information technology (computers) in microbiology.
- ix. Automation in Microbiology.
- x. Molecular techniques in the laboratory diagnosis of infectious diseases.
- xi. Statistical analysis of microbiological data and research methodology.
- xii. Animal and human ethics involved in microbiological work.
- xiii. Laboratory safety and management.

B. Predominant in Affective Domain

- i. Communicate effectively & empathically with patients and their relatives during sample collection, history taking, counseling and reporting results.
- ii. Acquire Consent taking and counseling skills and demonstrate these to undergraduates.
- iii. Communicate effectively with peers, and consultants for better clinical correlation of laboratory findings as well as research.
- iv. Demonstrate effective communication and attitudinal skill while teaching undergraduate students.

- v. Function as an effective team member and leader with good conflict management skills.
- vi. Adopt ethical principles, particularly maintenance of confidentiality when dealing with laboratory reports.
- vii. Demonstrate ability to recognize and manage ethical and professional conflicts and abide by prescribed ethical and legal codes of conduct and practice.
- viii. Demonstrate altruistic professional behavior with respect, discipline, responsibility, accountability, punctuality and integrity at all times while dealing with patients and their relatives.

C. Psychomotor Domain: (Skills)

C1. The postgraduate student should be able to *perform the following and/or interpret the results independently or as a part of a team*:

Laboratory skills:

- Collect, transport and store appropriate specimens for microbiological investigations.
- Receive and process clinical specimens after appropriate preparation of samples for the appropriate investigation (centrifugation, extraction, mincing concentration etc.)
- Processing of samples by various methods like:
 - Macroscopic/gross examination of samples.
 - Choose the most appropriate microscopic method for demonstration of pathogens.
 - Prepare, examine, and demonstrate microbes in direct smears for diagnosis of infectious disease/s.
 - Isolate and identify pathogenic microbe from clinical specimens (by conventional & automated methods).
 - Perform, interpret & record antimicrobial susceptibility testing of the isolate.
 - Perform rapid, conventional and automated serological techniques for diagnosis of infectious diseases and immunological diseases.
- Maintain records and ensure quality control in microbiology.

- Maintain and preserve microbial cultures.
- Operate and maintain instruments used in the laboratory for sterilization and disinfection and patient care with quality control.
- Operate and maintain common laboratory equipment like microscopes, water bath, centrifuge, incubator, automated culture system, micro-centrifuge, ELISA washer and reader etc.
- Perform and assess significance of microbial contamination of food, water and air.
- Biosafety measures - biosafety cabinets, chemical material safety data sheet (MSDS), fire safety, needle stick injury management.

Organisms (Bacteria, Fungi, Virus and Parasites) based Laboratory skills:

- **Direct microscopic methods for demonstration of infectious agents:**
 - a. Wet mount examination for - looking for cells and organisms (bacteria, fungi, parasite)
 - i. Saline mount stool sample - parasitic morphology
 - ii. Iodine mount-parasitic morphology
 - iii. KOH for fungi
 - iv. Negative staining
 - b. Staining methods
 - i. Preparation of stains & quality check
 - ii. Preparation of peripheral blood smears from various samples
 - iii. Staining techniques - simple, differential, special staining methods - capsule, spore, flagella etc.
 - iv. Gram Staining
 - v. Acid Fast staining (with modifications).
 - vi. Leishman & Giemsa for demonstration of intracellular pathogen bacteria, parasite, fungi etc.
 - vii. Albert staining.
 - c. Fluorescent staining
 - i. Auramine staining - Mycobacterium tuberculosis.

- ii. QBC – for malaria.
 - iii. Calcoflor white staining for fungus
- d. Isolation of pathogens
 - i. Preparation of glass wares
 - ii. Sterilization procedures
 - iii. Media preparation-required for isolation & identification
 - iv. Quality check of all media - functional as well as sterility check and maintenance of the record
 - v. Inoculation methods of various samples – surface, streak, stab etc depending on sample
 - vi. Incubation methods - aerobic, anaerobic, microaerophilic, capnophilic depending on the pathogens.
- e. Identification of pathogen
 - i. Colony characters – various characters to be noted in different media.
 - ii. Staining to identify – Gram’s / Alberts / Acid Fast/ Lactophenol cotton blue depending on pathogen.
 - iii. Motility by hanging drop preparation and other methods.
 - iv. Biochemical reactions - phenotypic-enzymatic, oxidative fermentative, sugar fermentation, other special tests helping to identify up to species level.
 - v. Serotyping.
- f. Antibiotic Susceptibility Testing
 - i. Selection of antibiotic disks as per CLSI/EUCAST based on the probable identification of organism - bacteria, fungi.
 - ii. Detection of drug resistant strains - MRSA, VISA, VRE, ESBL, MBL, CRE etc.
 - iii. Broth microdilution methods for bacteria and fungi.
- **Immunological tests**
 - i. i. Collection, preparation and storage of samples
 - ii. ii. Perform Rapid tests //Latex agglutination/ ICT/ELISA etc

- **Molecular tests**
 - i. PCR/RTPCR – all steps till interpretation
 - ii. CBNAAT
 - **Biomedical waste management skills.**
 - **Quality control skills in all areas.**
- **Clinical Microbiology Skills**
- (Infectious Disease Case Based Skill)**
- i. Demonstrate ability to take and interpret the history of infectious disease case.
 - ii. Be able to clinically examine the case and diagnose.
 - iii. Take decision for choice of samples to be collected for diagnosis
 - iv. Suggest optimum choice of antimicrobial agent to be prescribed with reasons.
- **Infection Prevention and Control Skills-**
- i. Hand hygiene skills
 - ii. Donning and doffing of PPE
 - iii. Transmission based precautions in patient care
 - iv. Segregation and disposal of biomedical waste in laboratory and hospital
 - v. Handling of sharps
 - vi. Post-exposure prophylaxis when exposed to blood and body fluids
 - vii. Spillage management
 - viii. Sterilization policy of environment and devices in the hospital as per the latest guidelines.
 - ix. Calculation of HAI infection rates.
 - x. Plan & conduct HAI surveillance & infection control audits

C 2. Should be able to **perform under supervision** and/or interpret the results of *the following desirable procedures independently or as a part of a team*:

- Demonstration of microbe by:

- i. IF – autoimmune diseases
- ii. IF – antigen demonstration in fungi/viral infection /cellular changes
- Isolation & Identification
 - using - newer automated systems f
 - or bacterial identification, Mycobacterial culture and Mycobacterial susceptibility
- Immunological test
 - i. Nephelometry/ turbidometry method for quantitative CRP/ASO/RA test
 - ii. Chemi-Luminiscence Immuno Assay
- Perform molecular & newer diagnostic tests for diagnosis of infectious disease.

C 3. Should observe the following procedures independently or as a part of a team and/or interpret the results of* : (optional)

- Demonstration of microbes by Electron microscope
- Viral culture & identification of growth of viruses
- Immunological test
 - iii. Quantiferon
 - iv. Flowcytometry
- Molecular -
 - i. Genome Sequencing methods
 - ii. Molecular typing.

Note: If any of the above facilities are not available in the institute effort to collaborate and post the students in nearby laboratory to acquire the skills shall be made.

**MAPPING OF PROGRAMME OUTCOMES [POs] AND
COURSEOUTCOMES [COs] OF PG
PROGRAMMES**

No	
PO 1	Knowledge and Skills
PO 2	Planning and problem solving abilities
PO 3	Communication
PO 4	Research Aptitude
PO 5	Professionalism and Ethics
PO 6	Leadership
PO 7	Societal Responsibilities
PO 8	Environment and Sustainability
PO 9	Lifelong Learner

MICROBIOLOGY

Year

Course Code	Course Title
01220301	MD Microbiology

PROGRAMME OUTCOMES

CO No.	At the end of the course, the learner should be able to:	Mapped Programme Outcomes
CO 1	Recognize the importance of clinical microbiology in the context of the health needs of the community and the national priorities in the health section.	PO1,PO2,PO3, PO4, PO5, PO6, PO7,PO9
CO 2	Practice clinical microbiology ethically and in step with the principles of primary health care.	PO1,PO2,PO3, PO4, PO5, PO6, PO7,PO9
CO 3	Demonstrate sufficient understanding of the basic sciences relevant to clinical microbiology	PO1,PO2,PO3, PO4, PO5, PO6, PO9
CO 4	Identify social, economic, environmental, biological and emotional determinants of health in a given case, and take them into account while planning therapeutic, rehabilitative, preventive and primitive measure/strategies	PO1,PO2,PO3,PO 4, PO5, PO6, PO7,PO8, PO9
CO 5	Diagnose and manage majority of the conditions in clinical microbiology on the basis of clinical assessment, and appropriately selected and conducted investigations including prevention	PO1,PO2,PO3, PO4, PO5, PO6, PO7,PO8, PO9
CO 6	Demonstrate skills in documentation of individual case details as well as morbidity and mortality rate relevant to infectious diseases.	PO1,PO2,PO3, PO4, PO5, PO6, PO7,PO8, PO9
CO 7	Demonstrate empathy and humane approach towards patients and their families and exhibit interpersonal behaviour in accordance with the societal norms and expectations	PO1,PO2,PO3, PO5, PO6, PO7, PO8,PO9

CO No.	At the end of the course, the learner should be able to:	Mapped Programme Outcomes
CO 8	Organize and supervise the chosen/assigned health care services demonstrating adequate managerial skills in the clinic/hospital or the field situation.	PO1,PO2, PO3, PO4, PO5, PO6, PO7,PO8, PO9
CO 9	Develop skills as a self-directed learner, recognize continuing education needs; select and use appropriate learning resources in clinical microbiology	PO1,PO2,PO3, PO4, PO5, PO7, PO8,PO9
CO 10	Demonstrate competence in basic concepts of research methodology and epidemiology and be able to critically analyze relevant published research literature as well as effectively and responsibly implement national health programme.	PO1,PO2, PO3, PO4, PO5, PO6, PO7,PO8, PO9
CO 11	Develop skills in using educational methods and techniques as applicable to the teaching of medical/nursing students, general physicians and paramedical health workers	PO1,PO2, PO3, PO4, PO5, PO6, PO7,PO8, PO9
CO 12	Function as an effective leader of a health team engaged in health care, research or training.	PO1,PO2, PO3, PO4, PO5, PO6, PO7,PO8, PO9