Syllabus template

Semester: 1	
Course : MOLECULAR MEDICAL MICROBIOLOGY (PGD MMM)	
Paper Title: Basics of Microbiology and Infectious Diseases	
Paper code: DMMB5102	**Credits:** 4
Hours/week : 4	
Category: Core/MDC/SEC/VAC : Core	
Theory / Practical / Composite : Theory	
No of Modules : 2	

Course Overview: This course introduces the **principles and applications of Molecular methods** for diagnosing infectious diseases. It covers essential **laboratory equipment**, nucleic acid extraction techniques, and methods for assessing DNA quality and quantity.

The course focuses on **Polymerase Chain Reaction (PCR)** and its various types, along with other amplification and non-amplification molecular techniques. It also includes rapid diagnostic methods such as **Cartridge Based Nucleic Acid Amplification Test (CBNAAT)**.

Additionally, students are introduced to **DNA sequencing technologies** and their role in pathogen detection and analysis. The course provides a foundation for understanding modern molecular diagnostics in clinical microbiology.

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

1. Understand the principles and applications of molecular diagnostic methods used in infectious diseases.
2. Identify and operate key instruments used in a molecular biology laboratory.
3. Perform and compare different nucleic acid extraction techniques (manual and automated).
4. Explain and apply **Polymerase Chain Reaction (PCR)** and its various types in pathogen detection.
5. Differentiate between amplification-based and non-amplification molecular methods.
6. Interpret results from molecular diagnostic techniques including **Cartridge Based Nucleic Acid Amplification Test (CBNAAT)**.
7. Understand the role of DNA sequencing technologies in diagnosis, epidemiology, and antimicrobial resistance studies.
8. Apply molecular techniques for accurate, rapid, and sensitive detection of infectious agents in clinical samples.

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CO1: Remember:

- Recall the basic concepts of molecular diagnosis of infectious diseases.
- List the equipment used in a molecular biology laboratory, including nucleic acid extraction systems, spectrophotometers, fluorometers, PCR systems, and sequencing platforms.
- Identify different types of molecular diagnostic methods, including amplification-based and non-amplification techniques.
- Recall the steps involved in nucleic acid extraction (DNA and RNA) by manual and automated methods.
- List the principles and types of **Polymerase Chain Reaction (PCR)**.
- Identify rapid molecular diagnostic methods such as **Cartridge Based Nucleic Acid Amplification Test (CBNAAT)**.

- Recall different DNA sequencing methods, including Sanger sequencing and next-generation sequencing platforms

CO2: Understand:

- Explain the principles and workflow of molecular diagnosis of infectious diseases.
- Describe the functions and working mechanisms of equipment used in a molecular biology laboratory.
- Explain the classification of molecular diagnostic methods, including amplification-based and non-amplification techniques.
- Describe the processes involved in nucleic acid extraction (DNA and RNA) and compare manual and automated methods.
- Explain the principle, steps, and variations of **Polymerase Chain Reaction (PCR)**.
- Interpret the working and clinical significance of rapid molecular diagnostic methods such as **Cartridge Based Nucleic Acid Amplification Test (CBNAAT)**.
- Explain the basic principles of DNA sequencing technologies and their applications in infectious disease diagnosis.

CO3: Apply:

- Apply appropriate molecular diagnostic techniques for the detection of infectious agents in clinical samples.
- Perform nucleic acid extraction (DNA and RNA) using manual and automated methods.
- Operate and utilize key molecular laboratory equipment for diagnostic purposes.
- Apply **Polymerase Chain Reaction (PCR)** and its variants for amplification and detection of target nucleic acids.
- Use rapid molecular diagnostic methods such as **Cartridge Based Nucleic Acid Amplification Test (CBNAAT)** in clinical diagnosis.
- Apply suitable molecular methods based on the type of pathogen and clinical requirement.

- Interpret basic results obtained from molecular diagnostic techniques for clinical decision-making

CO4: Analyze:

- Analyze the workflow of molecular diagnostic methods for infectious diseases from sample collection to result interpretation.
- Differentiate between various molecular techniques, including amplification-based and non-amplification methods.
- Compare different nucleic acid extraction methods (manual vs automated) in terms of efficiency, accuracy, and contamination risk.
- Analyze the differences between conventional PCR, real-time PCR, and advanced variants of **Polymerase Chain Reaction (PCR)**.
- Distinguish between different molecular platforms such as sequencing systems and rapid diagnostic tools like **Cartridge Based Nucleic Acid Amplification Test (CBNAAT)**.
- Examine the advantages and limitations of various molecular diagnostic methods in clinical practice.
- Analyze molecular test results for accuracy, reliability, and potential sources of error.

CO5: Evaluate:

- Evaluate the suitability of different molecular diagnostic methods for specific infectious diseases.

- Assess the performance of nucleic acid extraction methods in terms of purity, yield, and clinical applicability.
- Evaluate the effectiveness of various PCR techniques, including conventional PCR and advanced variants of **Polymerase Chain Reaction (PCR)**, for pathogen detection.
- Judge the diagnostic accuracy, sensitivity, and specificity of molecular tests such as **Cartridge Based Nucleic Acid Amplification Test (CBNAAT)**.
- Evaluate the advantages and limitations of different sequencing technologies in infectious disease diagnosis and epidemiological studies.
- Critically appraise amplification-based versus non-amplification molecular methods for clinical use.
- Justify the selection of appropriate molecular diagnostic approaches based on clinical scenarios and laboratory requirements.

CO6: Create:

- Design appropriate molecular diagnostic workflows for detection and identification of infectious pathogens.
- Develop stepwise protocols for nucleic acid extraction (DNA/RNA) using manual and automated systems.
- Design PCR-based diagnostic strategies using **Polymerase Chain Reaction (PCR)** and its advanced variants for specific clinical applications.
- Construct integrated molecular testing approaches combining amplification, detection, and sequencing methods.
- Plan the use of rapid diagnostic systems such as **Cartridge Based Nucleic Acid Amplification Test (CBNAAT)** for point-of-care infectious disease diagnosis.
- Develop interpretative frameworks for combining results from different molecular diagnostic platforms.
- Propose optimized molecular diagnostic solutions for emerging and re-emerging infectious diseases in clinical laboratory settings.

Prerequisites: ***Basic knowledge about any prior course***

SYLLABUS

UNIT/ Module	CONTENT	HOURS or NUMBER OF CLASSES	CO Mapping	COGNITIVE LEVEL
I.	Conventional Methods for Diagnosis of Infectious Diseases Equipment and instruments in a Medical Laboratory: a. Biosafety cabinet b. Laminar Flow hood c. Fume Hood d.	**20**	**CO1,CO2, CO3,CO4,CO 5,CO6**	**K1,K2, K3,K4,K5,K6**

	Autoclave e. Centrifuge: swing bucket and fixed-angle, non-refrigerated and refrigerated f. pH meter g. Analytical balance h. Hot air oven i. Deep freezer: minus 20°C and minus 80°C j. Incubators: 25°C, 37°C and Carbon dioxide k. Lyophilizer l. Air particle counter m. Membrane filtration system for water microbiology n. Total Dissolved Solids (conductivity) meter o. Chlorine meter p. Light microscope q. Fluorescence Microscope r. Automated Blood culture and mycobacterial culture system s. Automated bacterial and yeast identification and susceptibility testing system t. Serology analyzers based on ELISA, ELFA, CLIA, ELFA methods.			
II.	Molecular Methods for Diagnosis of Infectious Diseases Equipment in a Molecular Biology Laboratory: a. Nucleic acid extraction systems: automated b. Bead beater c. System to check quality and quantity of DNA post extraction: d. Nanodrop spectrophotometer e. System to quantify DNA: Qubit fluorometer f. System to detect DNA integrity post extraction (e.g. Tape Station) g. End point PCR system h. Real-time PCR system (qPCR) i. j. Droplet Digital PCR system (ddPCR) Cartridge Based Nucleic acid amplification systems k. DNA sequencing system by Sanger method l. Next Generation Sequencing Systems: MiSeq (Illumina), Ion Studio, Oxford Nanopore Technology.	**6**	**CO1,CO2,CO3,CO4,CO5,CO6**	**K1,K2,K3,K4,K5,K6**
III.	Classification and types of molecular methods for the diagnosis of infectious diseases Amplification based molecular methods: • Target amplification: • Polymerase Chain reaction • LCR, SDA, NASBA, LAMP, isothermal amplification • Signal amplification • Hybrid capture assay • Branched DNA assay • Non-amplification based molecular methods: • FISH • Miscellaneous	**6**	**CO1,CO2,CO3,CO4,CO5,CO6**	**K1,K2,K3,K4,K5,K6**

	methods: Line Probe Assay, Gene chips or DNA micro-array			
IV.	Nucleic acid Extraction m. DNA extraction n. RNA extraction o. Manual method p. Automated method	**3**	**CO1,CO2,CO3,CO4,CO5,CO6**	**K1,K2,K3,K4,K5,K6**
V.	Polymerase Chain Reaction and its types q. End point PCR r. Real-time PCR s. Qualitative PCR t. Quantitative PCR u. Nested PCR v. Multi-plex PCR w. PCR followed by melt- curve analysis x. Droplet Digital PCR CBNAAT: Cartridge Based Nucleic Acid Amplification systems	**5**	**CO1,CO2, CO3,CO4,CO5,CO6**	**K1,K2,K3,K4,K5,K6**

Text Books

Ananthanarayan and Paniker's Textbook of Microbiology, Twelfth Edition. 2022.
Paniker's Textbook of Medical Parasitology

Web Resources Suggested readings

1. WHO. Laboratory biosafety manual, 3rd edition, 2004. https://www.who.int/publications/i/item/9241546506 WHO.
2. Laboratory Biosafety manual, 4th edition. 2020. https://www.who.int/publications/i/item/9789240011311 WHO.
3. Laboratory Biosecurity Guidance. 2023. https://www.who.int/publications/i/item/9789240095113

Evaluation Total Marks: 100 CIA: 20 Marks: (Each module: 10 marks) End semester Exam: 80 Marks (Each module: 40 marks)

Paper Structure for Theory Semester Exam Paper Structure: End semester Exam: 80 Marks
Two Modules: 40 marks each Question Pattern: Each Module: MCQ-20 marks (2 marksX10 questions to be attempted out of 12 questions given) (5 marks X 4 Questions to be attempted out of 6questions given)attempted out of 6questions given)

Course outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive levels
CO1	**CO1: Remember:** • Recall the basic concepts of molecular diagnosis of infectious diseases. • List the equipment used in a molecular biology laboratory, including nucleic acid extraction systems, spectrophotometers, fluorometers, PCR systems, and sequencing platforms. • Identify different types of molecular diagnostic methods, including amplification-based and non-amplification techniques.	K1

	• Recall the steps involved in nucleic acid extraction (DNA and RNA) by manual and automated methods. • List the principles and types of **Polymerase Chain Reaction (PCR)**. • Identify rapid molecular diagnostic methods such as **Cartridge Based Nucleic Acid Amplification Test (CBNAAT)**. • Recall different DNA sequencing methods, including Sanger sequencing and next-generation sequencing platforms	
CO2	**CO2: Understand:** • Explain the principles and workflow of molecular diagnosis of infectious diseases. • Describe the functions and working mechanisms of equipment used in a molecular biology laboratory. • Explain the classification of molecular diagnostic methods, including amplification-based and non-amplification techniques. • Describe the processes involved in nucleic acid extraction (DNA and RNA) and compare manual and automated methods. • Explain the principle, steps, and variations of **Polymerase Chain Reaction (PCR)**. • Interpret the working and clinical significance of rapid molecular diagnostic methods such as **Cartridge Based Nucleic Acid Amplification Test (CBNAAT)**. Explain the basic principles of DNA sequencing technologies and their applications in infectious disease diagnosis.	K2
CO3	**CO3: Apply:** • Apply appropriate molecular diagnostic techniques for the detection of infectious agents in clinical samples. • Perform nucleic acid extraction (DNA and RNA) using manual and automated methods. • Operate and utilize key molecular laboratory equipment for diagnostic purposes. • Apply **Polymerase Chain Reaction (PCR)** and	K3

	its variants for amplification and detection of target nucleic acids. • Use rapid molecular diagnostic methods such as **Cartridge Based Nucleic Acid Amplification Test (CBNAAT)** in clinical diagnosis. • Apply suitable molecular methods based on the type of pathogen and clinical requirement. • Interpret basic results obtained from molecular diagnostic techniques for clinical decision-making	
CO4	**CO4: Analyze:** • Analyze the workflow of molecular diagnostic methods for infectious diseases from sample collection to result interpretation. • Differentiate between various molecular techniques, including amplification-based and non-amplification methods. • Compare different nucleic acid extraction methods (manual vs automated) in terms of efficiency, accuracy, and contamination risk. • Analyze the differences between conventional PCR, real-time PCR, and advanced variants of **Polymerase Chain Reaction (PCR)**. • Distinguish between different molecular platforms such as sequencing systems and rapid diagnostic tools like **Cartridge Based Nucleic Acid Amplification Test (CBNAAT)**. • Examine the advantages and limitations of various molecular diagnostic methods in clinical practice. Analyze molecular test results for accuracy, reliability, and potential sources of error	K4
CO5	**CO5: Evaluate:** • Evaluate the suitability of different molecular diagnostic methods for specific infectious diseases. • Assess the performance of nucleic acid extraction methods in terms of purity, yield, and clinical applicability. • Evaluate the effectiveness of various PCR techniques, including conventional PCR and	K5

	advanced variants of **Polymerase Chain Reaction (PCR)**, for pathogen detection. • Judge the diagnostic accuracy, sensitivity, and specificity of molecular tests such as **Cartridge Based Nucleic Acid Amplification Test (CBNAAT)**. • Evaluate the advantages and limitations of different sequencing technologies in infectious disease diagnosis and epidemiological studies. • Critically appraise amplification-based versus non-amplification molecular methods for clinical use. • Justify the selection of appropriate molecular diagnostic approaches based on clinical scenarios and laboratory requirements.	
CO6	**CO6: Create:** • Design appropriate molecular diagnostic workflows for detection and identification of infectious pathogens. • Develop stepwise protocols for nucleic acid extraction (DNA/RNA) using manual and automated systems. • Design PCR-based diagnostic strategies using **Polymerase Chain Reaction (PCR)** and its advanced variants for specific clinical applications. • Construct integrated molecular testing approaches combining amplification, detection, and sequencing methods. • Plan the use of rapid diagnostic systems such as **Cartridge Based Nucleic Acid Amplification Test (CBNAAT)** for point-of-care infectious disease diagnosis. • Develop interpretative frameworks for combining results from different molecular diagnostic platforms. • Propose optimized molecular diagnostic solutions for emerging and re-emerging infectious diseases in clinical laboratory settings.	K6