Syllabus template

Semester: 2	
Course : MOLECULAR MEDICAL MICROBIOLOGY (PGD MMM)	
Paper Title: Advanced Molecular Microbiology	
Paper code: DMMB5201	**Credits:** 4
Hours/week : 4	
Category: Core/MDC/SEC/VAC : Core	
Theory / Practical / Composite : Theory	
No of Modules : 2	

Course Overview: This course introduces key **sequencing techniques** used in disease detection, including **Sanger sequencing** and **Next Generation Sequencing (NGS)**, with applications in pathogen identification, antimicrobial resistance, and microbiome studies. It also covers the fundamentals of **PCR primer and probe design**, including their types, properties, and use of bioinformatics tools for accurate molecular diagnostics.

Course Outcome: By the end of this course, students will be able to:

- Understand Sanger sequencing for microbial identification (16S rRNA, ITS) and use of BLAST.
- Analyze antiviral resistance in HIV, HBV, CMV, and Influenza.
- Explain NGS and WGS applications in pathogen detection and surveillance.
- Differentiate targeted and metagenomic sequencing for diagnostics and microbiome studies.
- Understand types and properties of PCR primers and probes.

Design PCR primers and probes using standard principles and software.

CO1:
Explain the principles and workflow of **Sanger sequencing** and apply it to microbial identification using targets such as **16S rRNA (bacteria)** and **ITS regions (fungi)**, along with interpretation using tools like **NCBI BLAST**.

CO2:
Demonstrate understanding of sequencing-based approaches for **antiviral resistance detection** in clinically relevant viruses such as **HIV, HBV, CMV, and Influenza**, and interpret mutation data for therapeutic decisions.

CO3:
Describe the principles and applications of **Next Generation Sequencing (NGS)** in medical microbiology, including **whole genome sequencing (WGS)** for pathogen surveillance and outbreak investigation (e.g., SARS-CoV-2, Mycobacterium tuberculosis, HIV).

CO4:

Differentiate between **targeted sequencing** and **metagenomic sequencing**, and apply these approaches for **pathogen detection, antibiotic resistance gene (ARG) identification, and microbiome analysis**				
CO5: Understand the design and functional role of **PCR primers and probes**, including different types and their applications in molecular diagnostics				
CO6: Apply key principles (e.g., melting temperature, GC content, specificity) to design effective **PCR primers and probes** using appropriate **bioinformatics tools/software**.				
Prerequisites: ***Basic knowledge about any prior course***				
SYLLABUS				
UNIT/ Module	**CONTENT**	**HOURS or NUMBER OF CLASSES**	**CO Mapping**	**COGNITIVE LEVEL**
I.	Sequencing Techniques for Disease detection Sanger Sequencing 16S rRNA sequencing for bacteria ITS gene sequencing for fungi Use of NCBI BLAST Anti-viral resistance testing: • HIV • HBV • CMV • Influenza 2. Next Generation Sequencing and its application in Medical Microbiology o Whole genome sequencing (WGS) • WGS for WHO priority pathogens • SARS CoV-2 •Mycobacterium tuberculosis • HIV oTargeted Sequencing • ARG (antibiotic resistance genes) • Pathogen identification Metagenomic	**20**	**CO1,CO2,CO3,CO4,CO5**	**K1,K2,K3,K4,K5**

	sequencing • Microbiome studies			
2.	PCR Primer and probes and their design(TMCK+SXC)[20L] 1. PCR Primer and probes and their design o Types of primers o Types of probes o Properties of PCR primers and probes o Primer and probe design software	**20**	**CO1,CO2,CO3,CO4,CO5,**	**K1,K2,K3,K4,K5**

Text Books:

Sachse, K., & Frey, J. (Eds.). (2003). PCR detection of microbial pathogens (Vol. 216). Springer Science & Business Media. Brasher, C. W., DePaola, A., Jones, D. D., & Bej, A. K. (1998).

Detection of microbial pathogens in shellfish with multiplex PCR. Current microbiology, 37, 101-107.

How to: Design PCR primers and check them for specificity. https://www.ncbi.nlm.nih.gov/guide/howto/design-pcr-primers/ Primer BLAST. https://www.ncbi.nlm.nih.gov/tools/primer-blast/

Feeney M, Murphy K, Lopilato J. Designing PCR primers painlessly. J Microbiol Biol Educ. 2014 May 1;15(1):28-9. doi: 10.1128/jmbe.v15i1.634. PMID: 24839513; PMCID: PMC4004736.

Pryce TM, Palladino S, Kay ID, Coombs GW. Rapid identification of fungi by sequencing the ITS1 and ITS2 regions using an automated capillary electrophoresis system. Med Mycol. 2003 Oct;41(5):369 81. doi: 10.1080/13693780310001600435.

Erratum in: Med Mycol. 2004 Feb;42(1): 93. PMID: 14653513. Deurenberg RH, Bathoorn E, Chlebowicz MA, Couto N, Ferdous M, García-Cobos S, Kooistra-Smid AM, Raangs EC, Rosema S, Veloo AC, Zhou K, Friedrich AW, Rossen JW.

Application of next generation sequencing in clinical microbiology and infection prevention. J Biotechnol. 2017 Feb 10;243:16-24. doi: 10.1016/j.jbiotec.2016.12.022. Epub 2016 Dec 29. PMID: 28042011.

HIV Drug Resistance database. Stanford University. https://hivdb.stanford.edu/ HBV Seq. Stanford University. https://hivdb.stanford.edu/HBV/HBVseq/development/HBVseq.html

Web Resources Suggested readings

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

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) Broad questions; 20 marks (5 marks X 4 Questions to be attempted out of 6 questions given)

Course outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive levels
CO1	**Remember:** 1. To Know about different microbes associated with development of Cancer. 2. To know about Quality Management Systems	K1
CO2	**Understand:** 1. The principles behind oncogenesis. 2. The relation between oncogenesis and oncogenic microbes 3. The principles behind quality management systems	K2
CO3	**Apply:** **1.** Apply knowledge of quality management system in everyday work **2.** Application of the knowledge of oncogenic microbes in drug administration.	K3
CO4	**Analyze:** 1. Analysis of the observations and application of drugs when and how to use in bacterial, parasitic, viral oncogenesis. 2. Integration of the concepts of quality management systems in day to day work and in treatment.	K4
CO5	**Evaluate:** 1. Evaluate quality management system, control of oncogenic microbes, and control in laboratory and healthcare settings.	K5