Techniques in Microbiology and Biotechnology

Core course for Pre-PhD: 4 credits

Yenepoya Research Centre
Yenepoya (Deemed to be University)
University Road, Deralakatte
Mangalore – 575018

Course Name: Techniques in Microbiology and Biotechnology

1. Course Type :Core
2. Level :Ph.D. (Pre-PhD course work)
3. Credit Value: :4 Credits
4. Total Hours : 60 (L:P:S: 10:25:25)
5. Total Marks: : 100 (IA= 40 + Final exam= 60)

6. Course Objectives

- To expose the research scholars to gain knowledge and skills on the important techniques used in microbiology and biotechnology needed for PhD research.
- Train the research scholars to acquire skills to perform experiments relevant for research in emerging areas of microbiology/ biotechnology.
- To sensitise the research scholars to biohazards, biosafety and ethical issues in microbiology and biotechnology research.

7. Learning Outcome

- This course will enable the students apply the knowledge on different research techniques to design a methodology for microbiology/biotechnology research
- This course will also provide insights into laboratory etiquettes, team work and safety protocols to needed for success in research

8. Competencies

On completion of the course, the scholars will be competent to perform the following activities:

1. Describe and demonstrate different sterile laboratory techniques applying the principles of good laboratory practices
2. Describe and select appropriate molecular techniques including sequencing and bioinformatics tools for addressing research problems
3. Perform operations including maintenance of bio-analytical instrumentations used in microbiology research
4. Differentiate between available genome sequencing methods, applications, limitations
5. Design primers and perform PCR experiments with suitable protocols
6. Describe the IPR issues and national biodiversity regulations for commercial utilization of the microbial resources.
7. Practice bio-safety protocols for handling and disposal of biological materials used in research

8. Practice ethics while performing the research and maintain integrity while reporting the results/data.

9. Content of the Course

Module 1: Bio-Analytical Methods

1.1 Approaches for sterile laboratory environment and its importance. Different sources of contamination and its implications.

1.2 Good laboratory practices- Principles and protocols

1.3 Different types of imaging techniques-Digital photography and its applications in recording data, Microscopy and its applications (Optical, Fluorescence, Confocal, SEM and TEM), image resolution and representation of images in manuscripts and reports

1.4 Different types bioanalytical instrumentation and their application-Spectroscopy (UV-Vis, Fluorescence, IR, NMR), different types of centrifuges, Chromatographic instruments (TLC, HPTLC, GPC, LC systems and GC).

Module 2: Molecular Techniques

2.1 Different types of PCR and their applications-Primer design, Isolation of high quality DNA and RNA (different methods) and quantification.

2.2 Principles, applications and protocols of electrophoresis and blotting techniques.

2.3 Principles, applications and protocols of ELISA, Immunocytochemistry, Flow cytometry techniques.

2.4 Cell culture techniques-different types of cells and culturing requirements. Assays using mammalian cells (MTT, cell viability, cell proliferation and migration assays), cell lysate and long term storage.

2.5 Techniques involved in gene cloning and expression (Vectors, Restriction enzymes, Ligation and clone selection).

Module 3: Application of Genomics and Bioinformatics

3.1 Genomics: Sequencing technologies - Sanger sequencing-principle, methodology and applications; multiple generations of NGS; Sequencing strategies based on clonal amplification technology, bridge amplification, pyrosequencing, Illumina Sequencing by synthesis platform (SBS); PacBio (SMRT technology), Oxford Nanopore system etc.

Techniques used in meta-genomics. Databases (NCBI, EMBL, KEGG, DDBJ, GitHub and other related databases).

3.2 Bioinformatics tools: Open and commercial data analysis tools and pipelines; Impact of read length, read depth, and sequence coverage across multiple NGS technology platforms. (MEGA, Seqtk, Khmer, Prokka, BLAST, MUMmer, Quast, GATK, RaxML, GeneFinder, Mauve and related tools).

3.3 Application of genomics in microbial taxonomy, Microbial resources (culture collections national and international), Culture deposits. Polyphasic taxonomy of bacteria and fungi.

Module 4: Biohazards, Risk groups and Biosafety Levels

4.1 Biohazards-blood and body fluids, tissues and clinical samples, zoonotic, laboratory grown cultures.

4.2 Risk groups-Classification, examples (Bacteria, fungi, virus, protozoans and other infectious materials).

4.3 Biosafety levels and protocols (BSL-1 to 4) and occupational safety.

4.4 Bio-Waste Management: Sources- Bio-medical waste (Hazardous and non-hazardous), Infectious waste. Other hazardous- radioactive waste, discarded glass, pressurized containers, chemical waste, cytotoxic waste, incinerator ash. Steps for waste management-segregation, collection and storage, transportation and treatment and disposal.

Module 5: Ethics and IPR

5.1 Ethics in research involving human samples and animals for in-vivo studies (examples with case studies).

5.2 Ethics and research integrity in collection, interpretation and reporting of data.

5.3 Intellectual property right (IPR): Kinds of IPR- Patent, Copyright, Trade Mark, Design, Geographical Indication, Variants and Layout Design – Genetic Resources and Traditional Knowledge – Trade.

5.4 Filing and hearing IPR, Patent granting agencies

5.5 National biodiversity authority-regulation for commercial utilization or biosurvey and

bioutilization of biological resources.

Teaching-learning methods

Modules	**Teaching-learning**		
	Lecture	Practical/Hands on/Problem based Learning	Self study
Module 1: Bio-Analytical Methods	1.1		
			1.2 (Seminar)
	1.3	1.3 (Group discussion)	
	1.4	1.4 (PBL)	
Module 2: Molecular techniques	2.1	2.1	2.1
		2.2	
	2.3	2.3 (Team work)	
	2.4	2.4 (Report generation)	2.4
	2.5	2.5	
Module 3: Application of Genomics and bioinformatics	3.1	3.1	3.1
			3.2 (Seminar)
		3.3	3.3
Module 4: Biohazards, Risk groups and Biosafety levels	4.1		4.1 (Seminar)
			4.2 (Seminar)
	4.3	4.3 (PBL)	
	4.4	4.4	
Module 5: Ethics and IPR			5.1
	5.2		
	5.3		
		5.4 (Group discussion)	5.4
		5.5 (Group discussion)	

10. Assessments

Formative assessments: (40 Marks)

1	Internal Exams - 40 marks each (2)	20 M
2	Seminar (2)	8 M
3	Group discussion (2 Including ethical and regulatory issues)	6 M
4	Case studies (2)	6 M

Summative Assessment: (60 marks)

Sl. No.	Details	Q X M
Two Questions to assess the knowledge and problem solving abilities in the given context		4X10 M=40 M
1	Knowledge on application of any of the major instruments used in the microbiology/biotechnology research or generating data (example; use of spectrophotometer for bacterial growth kinetics study)	
2	Problem solving ability: Designing experimental protocol for a given research problem and interpretation of data (E.g. sample processing for acquiring SEM/TEM image of a microbe /setting up a RT-PCR experiment and interpreting theCT-Curves/FTIR spectrum/Design a primer from given sequence/constructing a phylogenetic tree/dendrogram).)	
3 4	Two questions to assess the analytical skills to solve a given hypothetical research problem Write the methodology for solving a given research problem (example; expression of a particular gene with respect to exposure to an inhibitor to be used as an antimicrobial/isolation and identification of a biotechnologically important metabolite producing microbe and method for describing or characterizing the metabolite).	
5	Descriptive questions to assess knowledge, attitude, ethics from module 4 and 5	4X5=20 M

*A question bank will be maintained with multiple scenarios.

Learning Resources

Student should refer leading Journals and publishers in the subject category and list is not limited to specific titles.

Reference books

1. Abul Abbas, Andrew H. Lichtman (2017). Cellular and Molecular Immunology, 9th edition. Elsevier.
2. Bergey's Manual of Systematic Bacteriology, Vol. 1-5, Springer-Verlag, New York, NY.
3. Brown TA (2010). Gene cloning and DNA analysis: An introduction. Wiley-Blackwell.
4. David L. Nelson, Michael M. Cox (2017). Lehninger Principles of Biochemistry, 6th edition, W. H. Freeman.
5. Karp G (2009). Cell and molecular biology: Concepts and experiments. 7th edition. John Wiley & Sons.
6. Lodish H, et al. (2008). Molecular Cell Biology. W. H. Freeman.
7. Primrose S B (1994). Molecular Biotechnology, 2nd edition, Blackwell Scientific Publications.
8. Rekadwad B. (Ed.) (2020). Microbial Systematics- Taxonomy, Microbial Ecology, Diversity. CRC Press (Imprint Taylor & Francis)

Online Resources: Journal articles, reviews, perspective, case studies

URLs

- European Molecular Biology Laboratory (https://www.embl.de/)
- PubMed (https://www.ncbi.nlm.nih.gov/pmc/)
- Intellectual Property India (http://www.ipindia.nic.in/)
- World Intellectual Property Organization (https://www.wipo.int/)
- World Data Centre for Microorganisms-Culture Collection Information Worldwide (http://www.wfcc.info/ccinfo/home/)
- National Ethical Guidelines for Biomedical and Health Research involving Human Participants", 2017, published by Indian Medical Research, 2017
- DBT Biosafety guidelines
- IPR guidelines

* * * * * * * * *