COURSE TITLE	**METAGENOMICS**
COURSE CODE	**01CB0704**
COURSE CREDITS	**3**

Objective:

1 This course aims to provide a thorough understanding of metagenomics, covering its fundamental principles, methodologies, and applications.

Course Outcomes: After completion of this course, student will be able to:

1 Explain the principles of metagenomics and its role in microbial ecology and ecosystem biology.

2 Demonstrate sampling methods and various sequencing approaches.

3 Apply pipelines for quality control, taxonomic classification, and assembly of metagenomic data

4 Analyze metagenomic data for gene prediction, functional annotation, and metabolic pathway analysis

5 Evaluate the impact of metagenomics in human health, environmental studies, and industrial applications

Pre-requisite of course: None

Teaching and Examination Scheme

Theory Hours	Tutorial Hours	Practical Hours	ESE	IA	CSE	Viva	Term Work
2	0	2	50	30	20	25	25

Contents : Unit	Topics	Contact Hours
1	**Introduction to Metagenomics** Definition and scope of metagenomics, microbiome and ecosystems biology, Ecological metagenomics, Comparison of metagenomics with traditional microbiology techniques, databases for metagenomic data, Challenges and limitations in metagenomic studies	7
2	**Sequencing Technologies** Sequencing techniques, types of sequencing: amplicon sequencing,, shotgun metagenomic sequencing	6
3	**Metagenomic Data Analysis** Overview of metagenomics pipelines, Quality control and preprocessing of raw sequencing data, Assembly methods, diversity analysis, Taxonomic classification, Tools for metagenomic data analysis: QIIME, Kraken, MetaPhlAn, MEGAHIT	5

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Contents : Unit	Topics	Contact Hours
4	**Functional Metagenomics** Gene prediction and functional annotation, binning strategy, Functional databases: KEGG, COG, MetaCyc, Meta-transcriptomics	5
5	**Applications and Future Directions in Metagenomics** Human microbiome and health implications, Environmental metagenomics, Industrial applications, Biosafety and IPR issues in metagenomics, Future trends and emerging technologies in metagenomics	5
Total Hours		**28**

Suggested List of Experiments:

Contents : Unit	Topics	Contact Hours
1	**Experiment 1** To retrieve bacterial genome from online repositories	2
2	**Experiment 2** To retrieve raw metagenomic data of specific sample from SRA database.	2
3	**Experiment 3** To identify and retrieve raw metagenomic data of specific sample from ENA database.	2
4	**Experiment 4** To perform Quality Control of raw sequencing reads using FastQC tool.	2
5	**Experiment 5** To filter and remove low-quality reads and adapters using Trimmomatic tool.	2
6	**Experiment 6** To assemble short metagenomic reads into contigs using MetaSPAdes.	2
7	**Experiment 7** To download SILVA database for QIIME bioinformatic pipeline.	2
8	**Experiment 8** To install Mothur and its modules for various operations	2
9	**Experiment 9** To perform sequence processing using Mothur	2
10	**Experiment 10** To align sequences to a reference database	2
11	**Experiment 11** To remove or filter out chimeric sequences	2
12	**Experiment 12** To cluster sequences into OTUs based on similarity	2

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Suggested List of Experiments:

Contents : Unit	Topics	Contact Hours
13	**Experiment 13** To assign taxonomy and identify the types of microbes present in the samples.	2
14	**Experiment 14** To analyze microbial diversity by measuring species richness and evenness within and between samples.	2
Total Hours		**28**

Textbook :

1 Metagenomics: Current Innovations and Future Trends, D. Marco (Ed.), Caister Academic Press, 2011

References:

1 Metagenomics: Theory, Methods and Applications, Metagenomics: Theory, Methods and Applications, D. Marco (Ed.), Caister Academic Press, 2010

2 Metagenomics: Methods and Protocols, Metagenomics: Methods and Protocols, W. R. Streit and R. Daniel (Eds.), , Humana Press, 2010

3 Metagenomics of the Human Body, Metagenomics of the Human Body, K. E. Nelson (Ed.), Springer, 2010

Suggested Theory Distribution:

The suggested theory distribution as per Bloom's taxonomy is as follows. This distribution serves as guidelines for teachers and students to achieve effective teaching-learning process

Distribution of Theory for course delivery and evaluation					
Remember / Knowledge	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Higher order Thinking / Creative**
0.00	0.00	35.00	35.00	30.00	0.00

Instructional Method:

1 The course delivery method will depend upon the requirement of content and need of students. The teacher in addition to conventional teaching method by black board, may also use any of tools such as demonstration, role play, Quiz, brainstorming, MOOCs etc.

2 The internal evaluation will be done on the basis of continuous evaluation of students in the laboratory and class-room.

3 Practical examination will be conducted at the end of semester for evaluation of performance of students in laboratory.

Supplementary Resources:

1 https://www.ncbi.nlm.nih.gov/books/NBK54011/

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Supplementary Resources:

2 https://www.youtube.com/watch?v=RcYXTpNS_XU

3 https://www.youtube.com/watch?v=TnWeVUx5ERU&t=2178s

4 https://www.youtube.com/watch?v=K_xxZDmuim8

5 https://www.youtube.com/watch?v=LUS62N7tSUU

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