B.Sc. (Hons.) Microbiology

DISCIPLINE SPECIFIC CORE COURSE – 19: MICROBIAL GENETICS AND GENOMICS

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
MICROB-DSC701: MICROBIAL GENETICS AND GENOMICS	4	3	0	1	Class XII pass with Biology/ Biotechnology/ Biochemistry	NA

Learning Objectives

The Learning Objectives of this course are as follows:

- The major objective of this course is to introduce the students to acquire a clear understanding of the genetic make-up of microorganisms, the organization of microbial genomes and their structure-function analysis, as well as the maintenance of genome integrity through various repair mechanisms.
- The students will gain insights into how microorganisms evolve by horizontal transfer of genetic material, thus also leading to greater biodiversity.
- They will recognize the importance of microorganisms as model systems in exploring the structure, function, and regulation of genes.
- They will learn to design basic experiments in microbial genetics relating phenotypes with the genotypes through the use of mutants.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Student will be able to describe the organization of bacterial, viral, eukaryotic and organelle genomes, and discuss the methodology employed in studying structural and functional genomics.
- Student will be able to recall various natural plasmids, their functions and their significance.

- Student will be able to evaluate the importance of stem cells and their associated technologies and applications.
- Student will be able to describe the fundamentals of different types of transposons and mechanisms of transposition.
- Student will be able to discuss the various mechanisms of natural gene transfer in bacteria and fungi and solve problems in genetic analysis particularly related to genetic mapping and strain construction..
- Student will be able to describe the importance of mutations and the repair mechanisms that operate in cells to maintain genome integrity, and use the microbial test for detecting the carcinogenic/mutagenic potential of chemicals.
- Student will be able to discuss the alternate life styles of phage lambda, the potential of the CRISPR-Cas bacterial defense mechanism and the applications of the CRISPR-Cas system in making gene knockouts

SYLLABUS OF DSC-19

UNIT – I (10 hours)

The organization and structure of genomes and extrachromosomal elements: Genome sizes and gene densities. Genome organization in bacteria (*E. coli*) and eukaryotic microorganisms (*Saccharomyces cerevisiae*, *Neurospora*). Introduction to methods in genomics: structural and functional genomics and analysis. Plasmids: circular and linear (with examples). Host range: broad and narrow (with examples). Properties and importance of: R Plasmids, F plasmids, colicinogenic plasmids, degradative plasmids, yeast 2µ plasmid. Plasmid replication mechanisms: theta (unidirectional and bidirectional) and rolling circle. Plasmid partitioning, Plasmid amplification, Plasmid incompatibility, regulation of plasmid copy number, plasmid curing.

UNIT – II (4 hours)

Bacteriophage genetics: Genome organization of MS2, T4 and lambda phages. Regulation of lytic- lysogeny switch in lambda phage.

UNIT – III (9 hours)

Transposable elements: Bacterial transposons: insertion elements, composite and non-composite transposons. Mechanism of transposition: Replicative and non-replicative transposition. Mu transposon. Eukaryotic transposable elements: yeast (Ty retrotransposon), Drosophila (Copia elements and P elements in hybrid dysgenesis), Maize (Ac/Ds and Spm/dSpm). Applications of transposons.

UNIT – IV (10 hours)

Genetic transfer mechanisms: Horizontal gene transfer in bacteria and its significance, Bacterial transformation: competence and mechanism. Bacterial conjugation: Hfr and F' strains, conjugation mechanism, use of interrupted mating technique for gene mapping. Bacterial transduction: generalized and specialized

transduction, gene mapping by recombination and co-transduction of markers. Integrons as agents of bacterial evolution. Fungi: Homologous recombination, evidence of horizontal gene transfer in fungi.

UNIT – V (12 hours)

Mutations and DNA repair: Types of mutations: spontaneous and induced. Physical, chemical and biological mutagens. Base substitutions, frameshifts, deletions, insertions, duplications, inversions, silent mutations, missense mutations, nonsense mutations, conditional and lethal mutations. Loss- and gain-of-function mutants. Reversion and suppression: true revertants, intra- and inter-genic suppression. Mutator genes. Uses of mutations. Ames Test. Repair mechanisms: photoreactivation, recombination-dependent repair, SOS repair, mismatch repair, excision repair, NHEJ repair. Site directed mutagenesis.

Practical component

UNIT 1: (20 hours)

Mutations and mutagenesis: Preparation of master and replica plates. Study of the effect of mutagens on bacteria: effect of ethidium bromide-induced mutagenesis (chemical mutagenesis) on bacterial growth and survival – analysis by plating of serial dilution followed by cfu counts. Effect of UV irradiation (physical mutagenesis) on bacterial growth and survival – analysis by preparation of survival curve. Ames Test by virtual lab and / or demonstration.

Unit 2: (10 hours)

Methods of genetic transfer: Group experiment: transfer of genetic material between bacteria by conjugation. Transformation of plasmid DNA. Bacterial transduction by virtual lab.

Essential/recommended readings

Theory:

1. Lewin's Essential Genes by J. Krebs, E. Goldstein and S. Kilpatrick. 4th edition. Jones andBartlett Publishers, USA. 2020.
2. Snyder and Champness Molecular Genetics of Bacteria by T.M. Henkin and J.E. Peters. 5th edition. ASM Press. 2020.
3. Concepts of Genetics by W.S. Klug, M.R. Cummings, C. Spencer and M. Palladino. 11thedition. Pearson Education, USA. 2018.
4. Genetics: A Conceptual Approach, by B.A. Pierce. 7th edition. W.H. Freeman and Co, UK. 2019.
5. Principle of Genetics by D.P. Snustad and M.J. Simmons. 7th edition. John Wiley and Sons,UK. 2015.
6. Molecular Biology of the Gene by J.D. Watson, T.A. Baker, S.P. Bell, A. Gann,

M. Levine and R. Losick. 7th edition. Pearson Education, USA. 2014.

7. iGenetics- A Molecular Approach by P.J. Russell. 3rd edition. Benjamin Cummings, USA.2009.

8. Microbial Genetics by S. Maloy, J. Cronan and D. Friefelder. 2nd edition. Jones and Barlett, USA. 2004.

Practicals:

1. Molecular Cloning: A Laboratory Manual by M. Green and J. Sambrook Volumes 1-3. 4th edition. Cold Spring Harbor Laboratory Press, USA. 2012.

2. Benson's Microbiological Applications, Laboratory Manual in General Microbiology by A. Brown and H. Smith. 15th edition. McGraw-Hill Education, USA. 2022.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.