**Programme: M.Sc. (Microbiology)**
**Course Code: MITC-402**
**Title of the Course: MICROBIAL GENETICS [T]**
**Number of Credits: 3, Theory**
**Contact hours: 45**
**Effective from Academic Year: 2022-23**

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| **Prerequisites** | It is assumed that students have basic knowledge of Mendelian genetics, structure of DNA and RNA, Prokaryotic and eukaryotic genome organisation, mutation concept, basic knowledge about replication, transcription. | |
| **Objective:** | This course develops concept of Classical Mendelian genetics and deviation from Mendelian principles, Microbial genome organization (Prokaryotic and Eukaryotic), Viral Genetics, Mutagenesis and Bacterial plasmids.<br><br>Understanding the concepts of replication, transcription and their regulation in prokaryotes and microbial eukaryotes. | |
| **Content:** | | |
| **1.** | **Microbial genome organization, gene regulation and genetic transfer** | **(15)** |
| **1.1** | Classical Mendelian genetics; deviation from Mendelian principles; Origin of mitochondria and plastids – Endosymbiotic theory, DNA in Mitochondria and plastids, Mitochondrial and plastid genes inherited by Non-Mendelian mechanism; Introduction to epigenetic inheritance. | |
| **1.2** | Prokaryotic & Eukaryotic genome size & structure, exceptions in prokaryotic genome (linear chromosome in *Borrelia burgdorferi*); Introduction to synthetic genome (*Mycoplasma genitalium*), pseudogenes and their significance, C-value paradox, polyploidy in prokaryotes.<br>Prokaryotic and Eukaryotic replication, transcription and regulation.<br>Structure of Prokaryotic genes (lac and trp operon) and Eukaryotic Genes (interrupted Genes, intron splicing mechanisms).<br>Microbial gene transfer (Conjugation, transformation, transduction). | |
| **1.3** | Genomic organization, replication and regulation of Lytic and Lysogenic Phages - T4 and Lambda Phage | |
| **2.** | **Genomic Rearrangements and Mutagenesis** | **(15)** |
| **2.1** | Mechanism of General and programmed DNA rearrangements, Antigenic and phase variation in bacteria.<br>Transposons: IS elements – Composite transposons (Tn3, Tn10), Ty, Copia and P type, Mechanism of transposition. Role of transposons in DNA rearrangements, microbial genome evolution and drug resistance.<br>Deletion, duplication, inversion, translocation.<br>Integrons and Genomic islands - pathogenicity islands. | |
| **2.2** | **Mutagenesis, mutation and mutants**: Somatic and germinal mutation, spontaneous and induced mutations, site directed mutagenesis using PCR and cassette mutagenesis, and random mutagenesis. Tautomeric shift, | |

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| | transition, transversion; Concept of clustered regularly interspaced short palindromic repeats (CRISPR) - Cas9.<br>**DNA Damage:** Thymine dimer, apyrimidinic site and apurinic site, cross linking, deamination of base, base mismatch.<br>**Types of mutations:** silent mutation, missense mutation, nonsense mutation, Read through mutation, frameshift- insertion and deletion mutation, suppressor mutation, leaky mutation.<br>**Mutagenic chemicals and radiations and their mechanism of action**: Base analogues (5-Bromouracil and 2-amino purines), alkylating agents (EMS, NTG), Intercalating agents (acridines, Acriflavins), Hydroxylamine; mutagenic radiations- UV, X-rays and gamma rays. Ames test; Auxotrophy. Importance of mutations. | |
| **3.** | **Fungal Genetics**: Yeast - *Saccharomyces cerevisiae/ Schizosaccharomyces pombe* and *Neurospora* genomes as model genetic systems; Chromosome replication, 2µ plasmid, Yeast Artificial Chromosomes (YAC), tetrad analysis, genetic compatibility and non-compatibility genes, heterokaryosis, Parasexuality, Petite mutants of yeast, Killer yeast. | **(07)** |
| **4.** | **Bacterial plasmids**: Types of plasmids, F plasmids and their use in genetic analysis-$F^+$/Hfr cells/ F'cells, Col plasmids, R plasmids- plasmids with genes encoding metal resistance and antibiotic resistance - efflux pump/MDR bacteria, degradative plasmids, Ti plasmid.<br>Replication in plasmids. Concept of copy number (Col Plasmid) and compatibility; Bacterial plasmids as research tools. | **(08)** |
| **Pedagogy:** | Lectures/tutorials/assignments | |
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| **References/ Readings** | Alberts, B., Johnson, A., Lewis, J., Morgan, D., Raff, M., Roberts, K. and Walter, P., Molecular Biology of the Cell, Garland Science. | |
| **(Latest Editions)** | Birnboim, H.C. and Doly, J., (1979) A rapid alkaline extraction procedure for screening recombinant plasmid DNA. Nucleic Acid Research, 7: 1513-1523. | |
| | Dale, J.W. and Park, S.F., Molecular Genetics of Bacteria, John Wiley | |
| | Freifelder, D. Molecular biology, a comprehensive introduction to prokaryotes and eukaryotes. JANE'S PUBLISHING INC., BOSTON, MA(USA). | |
| | Gardner, E.J., Simmons, M.J. and Snustad, D.P., Principles of Genetics, John Wiley & Sons. | |
| | Green, M. R. and Sambrook, J., Molecular Cloning: A laboratory manual, Cold Spring Harbour Laboratory Press, New York. | |
| | Holmes, D.S. and Quigley, M., (1981) A rapid boiling method for the preparation of bacterial plasmids. Anal Biochem., 114(1): 193-197. | |
| | Krebs J.E., Lewin B., Goldstein E.S. and Kilpatrick, S.T., LEWIS Genes XI, Jones and Bartlett Publishers. | |
| | Maloy, S. R., Cronan, J. E. and Freifelder, D., Microbial Genetics, Jones and Bartlett Publishers. | |

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| | Peter, J. R., *i*Genetics: A Molecular Approach, Pearson Education. | |
| | Sambrook, J., Fritsch, E. F. and Maniatis, T., Molecular Cloning: A Laboratory Manual, Cold Spring Harbor Laboratory, New York. | |
| | Streips, U.N. and Yasbin, R.E., Modern Microbial Genetics, John Wiley. | |
| | Synder, L., Peters, J. E., Henkin, T. M. and Champness, W., Molecular Genetics of Bacteria, ASM Press. | |
| | Trun, N. and Trempy, J., Fundamental Bacterial Genetics, John Wiley & Sons. | |
| | Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., Losick, R. Molecular Biology of the Gene, Pearson/Benjamin Cummings | |
| **Learning Outcomes** | 1) Explains principles/concept of prokaryotic and eukaryotic genetics, viral genetics and their application.<br>2) Learn Mutagenesis, mutation and mutants and their significance in evolution.<br>3) Understanding the concepts of bacterial and eukaryotic plasmids. | |

**Programme: M.Sc. (Microbiology)**
**Course Code: MIPC-402**
**Title of the Course: MICROBIAL GENETICS [P]**
**Number of Credits: 1, Practical**
**Contact hours: 30**
**Effective from Academic Year: 2022-23**

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| **Prerequisites** | Students should have basic knowledge of DNA and RNA structure and Prokaryotic and eukaryotic genome. | |
| **Objective:** | To learn the basic principles and techniques of microbial genetics. | |
| **Content:** | | **(30)** |
| 1. | Isolation of genomic DNA from bacteria. | |
| 2. | Isolation of plasmid DNA from bacterial cells by Alkaline Lysis method. | |
| 3. | Spectrophotometric quantification and determination of purity of bacterial plasmid and genomic DNA. | |
| 4. | Agarose gel electrophoresis, visualization and documentation of plasmid and genomic DNA using Gel Doc system. | |
| 5. | UV mutagenesis and screening of pigment deficient mutants of *Serratia marcescens*. | |
| **Pedagogy:** | Hands-on experiments in the laboratory, video, online data | |
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| **References/ Readings** | As given under Theory Course MITC-402 | |
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| **Learning Outcomes** | 1. Understanding the principles and concept of Prokaryotic DNA isolation and purification.<br>2. Exposure to the basic techniques of Mutagenesis. | |