MBIO 2020 Microbiology II

(Introduction into Microbial Genetics)

3 credit hours (including labs)

Course outline

Introduction: Microbial Genetics as Molecular Computing

1. Cellular information flow as a computational algorithm.
2. Basic terminology.

Bacterial chromosome replication

1. Nucleic acid synthesis as a template-dependent polymerization.
2. Mode of action of RNA and DNA polymerases.
3. Replicating fork and replisome.
4. Leading and lagging strands. Okazaki fragments.
5. Semi-conservative, bi-directional, semi-discontinuous process.

Transcription and Translation: coupled stages of gene expression

1. Synthesis and structure of rRNA, tRNA, and mRNA.
2. Genetic code and bacterial protein synthesis.
3. Prokaryotic ribosome and elongation cycle.
4. Post-translational modifications.

Regulation of Microbial Gene Expression:

1. Biosynthetic (*trp*) and catabolic (*lac*) operons.
2. Positive and negative control.
3. Dual control: catabolite repression.
4. Control by sigma-factors and promoter strength.
5. RNA-based regulation (at the level of translation).

Viruses and Lateral Gene Transfer:

1. Discovery, general properties and importance.
2. Cultivation and quantitation of viruses.

Bacterial Viruses (Bacteriophages):

1. T-even phages and chromosomal permutations.
2. dsDNA-, ssDNA-, and ssRNA- phages.
3. Reproduction of ssRNA phages (Leviviridae).

Temperate Phages and Lysogeny (Lambda phage):

1. Features of lysogens and basis of latency.
2. Lysogenic conversion.
3. λ temperate phage of *E. coli.*

Mutations and Genetic Homeostasis:

1. Types of mutations.
2. Mechanisms of mutations; mutagenes.
3. Bacterial DNA repair systems.
4. Effects of mutation at protein level.
5. Detection and selection of mutants.
6. Reversions and suppression mutations.

Gene Transfer Systems in Bacteria:

1. General principles of gene transfer in bacteria.
2. Natural and artificial transformation.
3. Generalized transduction; cotransduction; mapping.
4. Specialized transduction; LFT; HFT; complementation.
5. Bacterial conjugation: F-plasmid; F^+ x F^- crosses; Hfr x F^- crosses; F-duction.

Gene Manipulation Techniques:

1. Recombinant DNA Technology.
2. Polymerase Chain Reaction (PCR).
3. Site-specific Mutagenesis (based on PCR).

APPENDIX I: Basic information on Structure of Nucleic Acids

1. Structure of nucleosides and nucleotides.
2. Levels of structure of DNA and RNA.

APPENDIX II: Transcription and Translation

1. Some unusual bases in tRNA.
2. Reaction of peptide bond formation.

APPENDIX III: Lac Operon

1. Allolactose analogs.
2. Structural basis for cAMP-mediated allosteric control of the catabolite activator protein (CAP).

APPENDIX IV: Chemical Modifications of DNA

1. HMC
2. Some Mutagens.

APPENDIX V: Microbial Growth

1. Binary fission. The growth curve – batch culture.
2. Measurement of microbial growth.
3. Growth rate and doubling time.

APPENDIX VI: Non-Viral Genetic Systems:

1. Viroids.
2. Prions.