Course Code	Course Name	Credits
26BY507	MOLECULAR BIOLOGY AND IMMUNOLOGY	04

Course Objectives

- To learn about the concept of DNA as the genetic material.
- To study the central dogma of molecular biology (replication, transcription, and translation) in respect to prokaryotes and eukaryotes.
- The students will be able to identify the cellular and molecular basis of immune responsiveness.
- To understand and be able to distinguish various cell types involved in immune responses and associated functions.

Learning Outcomes

Upon successful completion of this course it is intended that a student will be able to:

- Acquaint themselves with concepts in prokaryotic, eukaryotic, and viral genetics
- Study in detail the properties of DNA, RNA and proteins and learning how these are regulated.
- Learn the basic concepts of Immunology, properties of immune system and types of immunity
- Describe immunological response and how it is triggered and regulated.

Unit 1 - Introduction (12 Hrs.)

Heredity and the genetic material; The discovery of transforming principle (Griffith's experiment); Identification of the transforming principle (Avery, MacLeod and McCarty's experiment); (Hershey and Chase experiment); Watson and Crick's discovery of the structure of DNA; Different forms of DNA (A, B and Z DNA), circular and linear DNA; Discovery of RNA as the genetic material in some organisms [Heinz Fraenkal-Conrat's experiment].

Unit 2 – Replication and Recombination (12 Hrs.)

DNA replication- conservative, dispersive and semi-conservative, Meselson and Stahl's experiment; Modes of replication- theta replication, rolling circle replication, linear eukaryotic replication; Requirements of replication- replicon, direction of replication, continuous and discontinuous replication, Okazaki fragments- experiment by Reiji Okazaki; Details of bacterial and eukaryotic DNA-end replication problem, telomeres and telomerase; Fidelity of DNA replication; DNA replication inhibitors. Recombination- Enzymes required for recombination- Holiday model, gene conversion; DNA repair system- Proofreading, mismatch repair, direct repair, base-excision repair, nucleotide excision repair, SOS response.

Unit 3 - Transcription (12 Hrs.)

Concept of gene, one gene one enzyme hypothesis, complementation test; Transcription in prokaryotes & eukaryotes; RNA polymerase, transcription factors and machinery, formation of initiation complex, transcription activator and repressor; Eukaryotic mRNA processing (5' capping & 3' polyadenylation); Post transcriptional processing- RNA splicing, Alternative splicing, exon shuffling, cis and trans splicing, RNA transport and regulation, RNA stability and RNA editing.

Unit 4 – Translation and Gene Regulation (12 Hrs.)

The genetic code- breaking the genetic code, characteristics of the code, Exceptions to the standard code; Structure of tRNA- clover leaf and 'inverted L' models, wobble hypothesis; Structure of mRNA- monocistronic and polycistronic mRNAs. Process of translation in prokaryotes and eukaryotes; Polyribosomes, non-ribosomal protein synthesis; Translation inhibitors; Post translational modifications of proteins; Molecular chaperons. Gene Regulation: Genes and regulatory elements; Gene regulation in bacterial cells- operon structure, negative and positive control, inducible and repressible operons, lac operon of *E.coli*, trp operon of *E.coli*, attenuation and antitermination; Gene regulations in eukaryotes- histone modification, methylation and acetylation, gene regulation through RNA splicing, gene regulation through processes that affect translation or by modification of proteins.

Unit 5 - Immunology (12 Hrs.)

History and scope of immunology. Innate and adaptive immunity**.** Cells and organs of immune system**.** Antigens and antibodies: structure, classes, functions**.** Major Histocompatibility Complex (MHC)**.** Cytokines and complement system**.** Antigen-antibody interactions**.** Humoral Immune response- plasma cells and antibody secretion. Cell mediated immune response- Cytokines, natural killer cells and antibody dependent cell mediated cytotoxicity. Autoimmunity.

Reference Books:

1. Gupta, P. K. (2003). *Cell and molecular biology* (2nd ed.). Rastogi Publications
2. Lodish, H., Berk, A., Matsudaira, P., Kaiser, C. A., Krieger, M., Scott, M. P., & Zipursky, S. L. (2004). *Molecular cell biology* (5th ed.). W. H. Freeman.
3. Cooper, G. M., & Hausman, R. E. (2013). *A molecular approach* (6th ed.). Sinauer Associates.
4. Allison, L. A. (2021). *Fundamental molecular biology* (3rd ed.). Wiley-Blackwell.
5. Kannan, I. (2007). *Immunology*. MJP Publishers.
6. Owen, J. A., Punt, J., & Stranford, S. A. (2013). *Kuby immunology* (7th ed.). W. H. Freeman.