Course contents for Molecular Biology and Genetics

1. **Faculty**: FLSB
2. **Course Code**: LSB503
3. **Course Title**: Molecular Biology and Genetics
4. **Number of Credits**: 5 (2L, 1T, 2P)
5. **Course objectives**: All life forms contain nucleic acids that carry information. In this course, we will cover the basic principles of nucleic acids and their structure, how they replicate, repair and mediate function through transcription and translation. Latest concepts in gene regulation and synthetic biology will also be discussed through original paper-based resources. This will also include concepts of molecular genetics, inheritance and developmental genetics.

6. **Minimum prerequisites for taking this course, if any**: Bachelor-level Chemistry, Biochemistry or any branch of Biology.

7. **Course structure with units, if applicable**: The following topics will be covered as part of Molecular Biology course:
   a. Introduction to Molecular Biology: Central Dogma, From molecules to multicellularity, RNA world concept, Milestone experiments in molecular biology

   b. The Double Helix: Watson-Crick's seminal 1953 paper, Dickerson's local fingerprint model, forms of DNA, supercoiling of DNA

   c. Genome Organization: Euchromatin and heterochromatin, formation of heterochromatin, nucleosome organization, concept of X chromosome inactivation, imprinting centers

   d. Regulation of Gene Expression in Prokaryotes: RNA polymerase and sigma factors, catabolic and anabolic operons, regulation by small RNAs, stringent response

   e. Eukaryotic Transcription: Regulation of transcription initiation, importance of 5' and 3'-UTRs, interrupted genes and splicing mechanism, circular RNAs, post-transcriptional regulation and RNA interference, miRNA and lincRNA, mRNA stability and degradation

   f. Translation: Initiation of translation in prokaryotes and eukaryotes, structure of ribosome, translational proofreading, antibiotics, tRNA and rRNA biosynthesis, universal genetic code and translation recoding, synthetic biology

   g. Regulation of Translation: Translation regulation in eukaryotes, integrated stress response, defective ribosomal proteins

h. Eukaryotic Gene Regulation: Chromatin remodeling complexes, enhancers, silencers and insulators, upstream transcription factors, maternal-to-zygotic transition

i. Replication: Rules of replication, DNA helicases and initiation of replication, elongation and termination in pro- and eukaryotes, replication control and licensing factors, telomeres and replication of DNA across telomeric ends, replication fork arrest and rescue mechanisms

j. Mutations, Genome Size and Repair: Spontaneous and induced mutations, types of mutations and repair mechanisms, DNA strand breaks, transposons and genome evolution

k. Non-Mendelian Inheritance: Cytoplasmic inheritance, plasmids and copy number regulation, organization of mitochondria and replication of mitochondrial DNA, histone code and epigenetic inheritance

8 Practicals:

a. Isolation of plasmid DNA from *E.coli* using alkaline lysis method
b. Spectrophotometric estimation of DNA and O.D. scanning
c. Assay of topoisomerase and *Eco*RI activities
d. Analysis of linear and supercoiled DNA migration on agarose gel
e. Characterization of denaturation of DNA using Nanodrop
f. Isolation of bacterial genomic DNA
g. Genomic DNA quantification and agarose gel analysis
h. Demonstration of photoreactivation repair in banana

9 Suggested Readings:

- Lewin's Genes (XII) Krebs J, Goldstein E and Kilpatrick S. Jones & Bartlett Publishers (2018)
- Molecular Biology of the Gene ($6^{ed.}$) James Watson. Benjamin Cummings (2007)
- Introduction to Genetic Analysis, Griffiths, (2008)
- Molecular Cell Biology ($9^{ed.}$) Harvey Lodish et al. W H Freeman and Co (2021)
- Original papers and reviews as provided during the class

10 Evaluation:

Theory:	Mid-semester Written Examination	: 40% Marks
	End-semester Written Examination	: 40% Marks
	Quiz/Assignment/Presentation (oral / poster)/other)	: 20% Marks