SEMESTER-V

BSC. (HONS.) BOTANY

DISCIPLINE SPECIFIC CORE COURSE – 13: Molecular Biology of the Cell

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		
Molecular Biology of the Cell – DSC 13	**4**	**2**	0	**2**	Class XII pass with Biology/ Biotechnology	**Nil**

Learning Objective:

- To gain comprehensive knowledge about of genetic material, central dogma, genetic code, DNA replication, transcription, modification of transcript, translation and regulation of gene expression.

Learning Outcomes: At the end of this course the student will understand:

1. structure and function of nucleic acids at molecular level.
2. the concept of central dogma and genetic code.
3. molecular details of DNA replication and its types.
4. cellular processes of transcription and translation including modification of transcripts and polypeptides/proteins
5. mechanisms regulating gene expression.

Unit 1: Nucleic acids as carriers of genetic information **02 Hours**

Discovery of nucleic acids, Experiments that established nucleic acids (DNA & RNA) as the carrier of genetic information: Griffith's, Hershey & Chase, Avery, McLeod & McCarty, and Fraenkel-Conrat's experiment.

Unit 2: Structure and organisation of the genetic material **03 Hours**

DNA double helix structure (Chargaff's rule; Watson and Crick model); salient features of DNA double helix. Types of DNA: A, B & Z conformations, denaturation and renaturation (only melting profile- Tm), types of RNA (mRNA, rRNA, tRNA, small RNAs). split genes (Phillip Sharp)

Unit 3: Central Dogma and Genetic Code **04 Hours**

Beadle and Tatum's one gene one enzyme hypothesis; The Central Dogma, Genetic code and its salient features, Experiments for deciphering Genetic code (Experiments by Nirenberg &Matthaei, and Har Gobind Khorana). Adaptor hypothesis by Crick; Baltimore and Temin's discovery of reverse transcription

Unit 4: Replication of DNA **06 Hours**

Delbruck's Dispersive mechanism model; Bloch and Butler's conservative replication model; Messelson and Stahl's semi-conservative replication model; Mechanism - initiation, elongation and termination; Enzymes and other proteins involved in DNA replication; General principles – bidirectional, semiconservative and semi-discontinuous replication (Replisome), RNA priming (Primase &Primosome); Various modes of DNA replication, including rolling circle, θ (theta) mode of replication, replication of linear dsDNA. Replication of the 5'end of linear chromosome (end-replication problem & Telomerase).

Unit 5: Mechanism of Transcription **05 Hours**

Transcription process in prokaryotes (Initiation, Elongation and Termination); structure and function of RNA polymerase enzyme; concept of promoters and transcription factors; comparison between prokaryotic and eukaryotic transcription; concept of post-transcriptional modifications (introduction to eukaryotic mRNA processing: 5' capping; Splicing and alternative splicing; 3' poly A tailing).

Unit 6: Mechanism of Translation **05 Hours**

Translation in prokaryotes: Initiation, Elongation and Termination; concept of charging of tRNA and role of aminoacyl synthetases; ribosome structure and assembly (prokaryotes and eukaryotes); comparison between prokaryotic and eukaryotic translation; post-translational modifications (phosphorylation, glycosylation).

Unit 7: Gene Regulation **05 Hours**

Gene regulation in prokaryotes: Operon concept; inducible & repressible systems; regulation of lactose metabolism in *E. coli* (inducible system, positive & negative control); regulation of tryptophan synthesis (Repression-De-repression and concept of Attenuation) in *E. coli.* Gene regulation in eukaryotes: concept of gene silencing by DNA methylation and RNA interference.

Practicals **60 hours**

1. Isolation of plasmid and genomic DNA from *E. coli* and quantification using agarose gel electrophoresis
2. Isolation of genomic DNA from plant samples (atleast two different genera / species) using CTAB method and quantification using agarose gel electrophoresis
3. Quantification of unknown DNA by diphenylamine reagent (colorimetry).

4. To estimate the generation time of *Escherichia coli* (prokaryote) and budding yeast (eukaryote) by spectrophotometric measurement and plotting growth curve as an indirect method to study DNA replication
5. To study control of replication in budding yeast with the help of specific inhibitors (beta-lactams:-Clavulanic acid, Ceftazidime, Piperacillin, Ceftriaxone etc) and studying budding frequency.
6. To study control of transcription in *Escherichia coli* with the help of prokaryotic (Rifampicin) and eukaryotic (Actinomycin-D) transcription inhibitors and plotting growth curve
7. To study control of translation in *Escherichia coli* with the help of prokaryotic (Kanamycin / Streptomycin) inhibitors using an IPTG-inducible system.
8. To understand the regulation of lactose (*lac*) operon (positive & negative regulation) and tryptophan (*trp*) operon (Repression and De-repression & Attenuation) through digital resources/data sets.

Suggestive readings:

1. William S. Klug, Michael R. Cummings, Charlotte A. Spencer, Michael A. Palladino, & Darrell Killian (2019). Concepts of Genetics. Pearson; 12th edition.
2. Watson J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M., Losick, R. (2007). Molecular Biology of the Gene, Pearson Benjamin Cummings, CSHL Press, New York, U.S.A. 6th edition.
3. Snustad, D.P. and Simmons, M.J. (2019). Principles of Genetics. John Wiley, 7th edition.
4. Russell, P. J. (2010). iGenetics- A Molecular Approach. Benjamin Cummings, U.S.A. 3rd edition.

Additional Resources:

1. Griffiths, A.J.F., John Doebley J., Peichel, C., Wassarman D.A. (2020). Introduction to Genetic Analysis. W H Freeman & Co; 12th edition
2. Micklos D A., Freyer G.A. (2003) DNA Science: A First Course (2nd Edition), Cold Spring Harbor Laboratory; Greg A., CSHL Press, USA

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