DISCIPLINE SPECIFIC CORE COURSE –11 (BIOMED-DSC-11) MOLECULAR BIOLOGY

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	Department offering the course
		Lecture	Tutorial	Practical/Practice			
Molecular Biology **BIOMED-DSC-11**	**4**	**3**	**-**	**1**	**XIIth Passed**	**Basic knowledge of biology**	**Biomedical Science**

Learning objectives

- The objective of the course is to offer detailed and comprehensive knowledge about the mechanisms of DNA replication, repair, transcription and translation in prokaryotes and eukaryotes so that students can apply this knowledge in enhancing their analytical and research problem solving skills.
- As the course progresses, students would comprehend the basic mechanism of DNA replication in prokaryotes and eukaryotes along with associated discerning features.
- Students would also understand the mechanism of introduction of mutations and how these are repaired inside the cell.
- Students would be able to understand that, molecular biology as a field started with an in-depth research and studies on prokaryotes and only recently our understanding of life processes in eukaryotes have increased considerable.

Learning outcomes

- This course focuses on the molecular processes involving biomolecules and provides students with a range of theoretical knowledge and associated practical skills.
- Students would comprehend biological processes such as Replication, Transcription and Translation. While studying the unit on Replication, students would also appreciate how various kinds of errors can be introduced and if not removed may manifest themselves as mutations.
- The course would help them understand established repair mechanisms to take care of these mutations. Hand-in-hand and related practical knowledge would help students build their foundation for future courses like Medical Biotechnology and Genome Organization and Function.

- Students would appreciate the recent advances in molecular biology that have led to the completion of genomic projects that are changing the face of modern biology, especially in areas of medicine, agriculture and biotechnology. Research in this field has also helped in understanding the molecular basis of illnesses and use of genetic manipulation in biotechnology to make valuable products including blood clotting factors, insulin and vaccines.

SYLLABUS OF BIOMED-DSC-11

Unit-I: The Replication of DNA in Prokaryotes and Eukaryotes (14 hrs)

An introduction to chemistry of DNA synthesis. Enzyme and proteins involved in DNA replication–helicase, topoisomerases, DNA polymerases, DNA ligase, primase, RNaseH, telomerase, sliding clamp, sliding clamp loader and SSBs. Mechanism of action of DNA polymerase, DNA transactions during replication-bidirectional replication, semi-conservative, discontinuous. Mechanics at the DNA replication fork: RNA priming, initiation and termination of DNA replication (comparing prokaryotes with eukaryotes), regulation of bacterial DNA replication, replicating the 5' end of linear chromosome, replication coupled to chromatin synthesis in eukaryotes. Various models of DNA replication including Trombone model, D-loop (mitochondrial), Theta mode of replication, Rolling circle model, replication of linear ds-DNA.

Unit-II: The Mutability and Repair of DNA (6 hrs)

Replication Errors (transitions, transversion and thymine dimer), DNA Damage (deamination, depurination and dimerization). DNA repair: Direct repair, Mismatch repair, Excision Repair, Photo reactivation, Recombination Repair, SOS response.

Unit-III: Information Transfer–I: Mechanism of Transcription. (8 hrs)

Basic transcription apparatus. Transcription in Prokaryotes: Initiation, elongation and termination of transcription, Promoter sequences and concept of abortive initiation. Transcription in Eukaryotes: Types of RNA polymerases, RNA polymerase II, Promoters, TBP and other transcription factors. Transcription by RNA polymerase I and III. Inhibitors of transcription- rifampicin and- amanitin.

Unit-IV: Post-Transcriptional Modifications (8 hrs)

Split Genes, Concept of introns and exons, RNA splicing pathways: Spliceosomes and Self splicing introns (Group I and Group II introns), Ribozymes, Variants of splicing: alternative splicing, exon shuffling and RNA

editing, Mutually exclusive splicing (example Drosophila Dscam gene), Mechanism determining the sex of Drosophila.

Unit-V: Information Transfer-II: Mechanism of Translation (9 hrs)

Features of genetic code and exceptions in some systems. Types of RNA: Messenger RNA, Ribosomal RNA and Transfer RNA, Ribosomal structure, Charging of tRNA, Amino-acyl tRNA synthetases, Proteins and factors involved in translation. Process of translation: Initiation, elongation and termination (Prokaryotes and Eukaryotes), Fidelity of translation, Translation-Coupled removal of defective mRNA. Inhibitors of protein synthesis–tetracyclins, aminoglycosides, chloramphenicol and aminoglycosides.

Practical (30 hrs)

(Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Calculations and preparation of various stock and working solutions of Molecular Biology experiments (Number 2 to 9).
2. Isolation of genomic DNA from bacterial cells.
3. Isolation of genomic DNA from blood/tissue.
4. Fractionation of DNA by agarose gel electrophoresis.
5. To determine the lambda max for DNA and protein.
6. Quantify and analyze the purity of DNA using spectrophotometer (estimating at 260 nm, 280 nm and 320 nm).
7. Quantitative estimation of salmon sperm/calf thymus DNA using colorimetric assay using Diphenylamine reagent.
8. In vitro gene amplification method of Polymerase Chain Reaction (PCR): Primer designing and setting up of the reaction.
9. Analysis of the PCR products.

Essential readings:

- Karp, G. (2020). 9th Edition. *Cell and molecular biology: Concepts and experiments.* NewJersey, USA: Wiley Publishers, ISBN-13: 978-1119598244
- Cox, M. M. Doudna J. A. and Donnell, M. O. (2015). 2nd Edition. *Molecular biology: Principles and practice.* London, UK: W H Freeman & Co Publishers, ISBN-13: 978-1464126147

- Watson, J. D. Baker T. A. Bell, S. P. Gann, A. Levine, M. and Losick, R. (2013). 7thEdition. *Molecular Biology of the Gene.* New York, USA: Cold Spring Harbor Laboratory Press, ISBN-13: 978-0-321-76243-6.
- Green, M.R. and Sambrook, J. (2012). 4th Edition. *Molecular cloning: A laboratory manual,* New York, USA: Cold Spring Harbor Laboratory Press, ISBN-13:978-1936113422.
- Hardin, J. Bertoni, G.P. Kleinsmith, L.J. and Becker, W.M. (2008). 7thEdition. *The world of the cell.* San Francisco, USA: Benjamin Cummings Publishers, ISBN-13:978-0805393934.

Suggestive Readings

- Kornberg, A. (2005). 2nd Edition. *DNA replication.* California, USA: University Science Books, ISBN-13: 978-1891389443.