II SEMESTER

MOLECULAR BIOLOGY Hours: 52

Course outcomes:

After successful completion of the course, students will be able to:

CO 1. Understand the processes involved in the central dogma of molecular biology i.e. replication, transcription and translation in both prokaryotic and eukaryotic systems.
CO 2. Comprehend translational modifications, transport and inhibition.
CO 3. Learn about control and regulation of gene expressions and operon models are discussed.
CO 4. Elucidate mechanisms and agents of cancer.
CO 5. Acquire knowledge in developmental biology and cell signalling.

Unit I (13 hrs)

Central Dogma of molecular biology and its modifications. Identification of DNA as genetic material, experiments of Griffith, Avery MacLeod and McCarthy. DNA Replication: Semiconservative mechanism, prokaryotic and eukaryotic DNA replication, Okazaki fragments; enzymology and control of DNA replication; inhibitors of replication; Replication in Øx 174, M-13, T-phages and Lambda phages. Molecular mutation (mechanisms of missense, nonsense, transition, transversion and frame-shift mutation, lethal mutation, origin of spontaneous mutation and control). DNA damage – mechanical and chemical; types of DNA repair, photo-reactivation, base excision, recombination, mismatch, SOS.

Unit II (13 hrs)

Transcription: Prokaryotic and Eukaryotic Transcription - RNA polymerase sub units, different sigma factors, initiation, elongation and termination - rho dependent and independent; antitermination, control by antisense RNA; attenuation and other influences of translational apparatus on the process of transcription, eukaryotic promoters, enhancers, transcription factors, various protein motifs involved in DNA protein interaction during transcription. RNA processing enzymes, modification in RNA: 5'-Cap formation; Transcription termination; 3'-end processing and polyadenylation; Splicing; RNA Editing, Nuclear export of mRNA; mRNA stability. Different modes of mRNA, tRNA, and rRNA splicing, role of various snRNPs.

Unit III (13 hrs)

Translation in Prokaryotes and Eukaryotes: Genetic code, initiation of translation, chain elongation, Termination, post-translational modification and structure determination and involvement of different translational factors at different stages of the process. Folding of polypeptides; involvement of molecular chaperons. Protein splicing. Inhibitors of translation, translational control mechanism. Organization of prokaryotic and eukaryotic genomes. Regulation of gene expression in prokaryotes and eukaryotes, operon concept, catabolic repression, repressible enzyme systems, control by attenuation, positive control, gene regulation in eukaryotes, transcriptional regulation, post-transcriptional regulation. Environmental regulation of gene expression.

Unit IV (13 hrs)

C-value paradox, co-linearity of genes, split genes, gene families. Transposable elements, Discovery, types and their significance in bacteria and Eukaryotes. Epigenetics, functional

perturbation, knockdown (interference RNA, small interference RNA), knockout technology, micro RNA.

References

1) Molecular Biology of the Cell. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K., Watson, J.D. Garland Publishing, Inc., 2002
2) The Cell - A Molecular Approach. Cooper, G.M. Sunderland: Sinauer Associates, Inc, 2000
3) Cell and Molecular Biology. De Robertis, E.D.P. and De Robertis, E.M.F. B.I. Waverly Pvt. Ltd., 1971
4) Developmental Biology. Gilbert, S.F. Sinauer Associates, Inc., 2000
5) Molecular cell Biology. Lodish, H., Berk, A., Zipursky, S.L. et al. WH. Freeman and Co, 2000
6) Cell & Molecular Biology – Concepts & experiments. Karp, G., Harris, D., Wiley & sons, 1999
7) Principles of Cell and Molecular Biology. Kleinsmith, L.J. & Kish, V.M. McLaughlin, S., Trost, K., Mac Elree, E., Harper Collins Publishers, 1995
8) Genes VII. Lewin, B. Oxford University Press, 2000
9) Molecular biology: genes to proteins. Tropp BE., Jones & Bartlett, 2010
10) Essential of Molecular biology. Freifelder D., Jones & Bartlett, 1985
11) Molecular Biology of Gene. Watson JD., Baker TA., Bell SP., et al., Pearson Edu. Inc. 2013
12) Molecular Biotechnology: Principles and applications of recombinant DNA. Glick BR. and Pasternak JJ. ASM Press, Washington, 2009

rDNA TECHNOLOGY — Hours: 52

Course outcome

After successful completion of the course, students will be able to:

CO 1. Use the various tools and strategies utilized in the construction and production of recombinant DNA molecules *in vitro* and *in vivo*.

CO 2. Learn the various techniques utilized for the introduction of recombinant DNA molecules in bacteria, yeast and mammalian cells.

CO 3. Elucidate the steps involved in the genetic engineering from amplification of DNA molecules to cloning of molecules, and screening strategies for clone identification.

CO 4. Understand the importance of high capacity vectors, plasmids and the various steps involved in genomic library preparation to understand complex genomes.

CO 5. Differentiate between different gene mapping methods, analysis of gene expression by various methods, and techniques used for introduction of mutations

UNIT I (13 hrs)

Restriction – modification systems, Restriction enzymes – type I, II and III, specificity, sticky ends and blunt ends, isoschizomers. Double digests. DNA ligases, optimum ligation conditions. Enzymes to modify the terminals of DNA- Alkaline phosphatase, polynucleotide kinase, DNase I, S1 nuclease, DNA polymerase and Klenow fragment, Terminal nucleotidyl transferase, RNase H and DNA topoisomerase. Use of linkers, adapters and homopolymer tailing. Other methods of joining DNA molecules: TA cloning of PCR products, Construction of genomic libraries, construction of cDNA libraries, methods of cDNA synthesis; PCR: Design, optimization, types and applications.

UNIT II (13 hrs)

Essential features of vectors for transforming bacteria and yeast, animals and plants. Special vectors: Shuttle vectors, expression vectors, Construction of Artificial chromosomes vectors BACs, YACs and MACs. Cosmids, phagemids and phasmids. Fusion vectors. Viral vectors.