Course Code: ZOC 104 **Course Title: Molecular Biology**
Number of Credits: 3
Effective from AY: 2020 -21

Prerequisite for the Course:	Basic knowledge of nuclear and cellular components and functioning of the cell.	
Objectives:	This course develops concepts in molecular biology enhancing knowledge about the major processes in the cell throwing light upon the details of the central dogma. This knowledge is a prerequisite for biomedical/ biochemical research and shall enable students to have a clear understanding of all the dynamic processes of the nucleus which can be further applied in various fields of research.	
Content:	**Module 1** **Nucleic Acids, bonds, types of DNAs, DNA packaging and model organisms.** Watson and Crick to double helix DNA model. Research work of Rosalind Franklin, Maurice Wilkins, Linus Pauling and Erwin Chargaff on DNA structure. RNA structure. The triple helical structure of the collagen protein by Dr. G.N Ramachandra, and Ramachandran Plot. Different bonding and different types of DNA (B-DNA, A-DNA & Z-DNA). DNA packaging in bacteria (Nucleoid) and Eukaryotes. Chromatin structure, structural features (Telomere, Centromere and Repetitive sequences) of chromosomes and their functions. Lampbrush and polytene chromosomes. Karyotyping (C-banding, G-banding); Chromosomal abrasions and diseases *Drosophila melanogaster* and *Caenorhabditis elegans*as genetic model organisms. Evolution of Genomes: Gene duplication, whole genome duplication, transposable elements, Exon shuffling, Genome reduction and gene loss, mutations, horizontal gene transfer. Paralogous, orthologous, Homeobox genes; and degenerative evolution. **Module 2** **DNA Damage and DNA Repair** Types of DNA damages**:** Double stranded break, single stranded break, Mismatch, deamination, Thymidine dimer, inversion, deletion,	**12 hours**

	insertion, Covalent X-linking, AP site. Different types of Mutagens**:** Base analogues (5-Bromouracil and 2-amino purines), EMS, acridines, NTG, Hydroxylamine; mutagenic radiations- UV, X-rays and gamma rays. Ames test; Auxotrophy; Somatic and germline mutations with examples in Human DNA repair mechanisms in Eukaryotes and Prokaryotes: Nucleotide Excision repair, mismatch repair, recombination repair, homologous end joining, photo reactivation and SOS Repair. Homologous recombinational repair: Role of *RecA/RadA/Rad51* in DNA damage repair. Role of BRCA1 in DNA damage repair. Mutation in BRCA1 as development of breast cancer. Role of p53 protein in DNA repair and tumor suppressor. **Module 3** **How cells read the Genome** DNA to Protein**:** Replication process in prokaryotes and Eukaryotes: Rolling circle/theta model, telomere replication. Transcription in prokaryotes: prokaryotic promotors, Rho dependent and Rho independent transcription termination. Transcription and Post transcriptional modifications in eukaryotes: Eukaryotic promoters, transcription factors and RNA polymerase I, II, III. Transcription Inhibitors. Splicing, 5'-caping, 3'-poly A tail. Various non coding RNAs and their role in different biological processes: rRNA, tRNA, snoRNA, snRNA,exRNAs, scaRNAs, gRNA, Telomerase RNA,long ncRNAs (Xist and HOTAIR). Translation of mRNA in prokaryotes and Eukaryotes: Initiation, elongation and termination. Polycistronic and monocistronic mRNA. Shine-Dalgarno (SD) Sequence, Kozak sequence, IRES sequence, Ribosomes, Genetic code,codon bias, wobble hypothesis, degeneracy of codon. Posttranslational modification of proteins (Protein splicing, phosphorylation,methylation, N-linked glycosylation).Inhibitors of protein synthesis (Aminoglicosides and macrolide antibiotics, Puromycin).	**12 hours** **12 hours**

	RNA world and origin of life: Ribozymes (Ribonuclease P, self-splicing introns I and II, spliceosome, viroids, hair pin ribozyme, hammer head ribozyme).Some viruses contain RNA as genetic material e.g. TMV, HIV; Concept of reverse transcription; Viroid, Virusoid, Prions. Regulation of Gene expression in Prokaryotes and Eukaryotes**:** Heterochromatin and euchromatin – acetylation, phosphorylation, methylation. Epigenetics. Gene dosage effect.Real time PCR technology (qPCR): Absolute quantification and Relative quantification, Cycle threshold (Ct values), SYBR Green Technology and Taq Man probe technology. Various Reporter dyes and quenchers used in Taq Man probe technology. Multiplexing with real-time PCR technology. Regulation of gene expression at transcription level in prokaryotes:*lac* operon and *trp* operon. transcriptional attenuation. Regulation of gene expression at transcription level in eukaryotes: Enhancers, silencers, transcription factors (DNA binding motifs and their role in gene regulatory proteins). Post transcriptional regulation of gene expression: Riboswitches,Alternate splicing, trans splicing, RNA editing, RNA Interference (miRNA, siRNA, piRNA, Fire and Mello Nobel Prize winning experiment). Concept of Transcriptomics and Proteomics. Their application in research and Medical or diagnostics. CRISPR Cas9 Technology: Gene editing. Application of this technology in Medicine.	
Pedagogy:	Lectures/tutorials /online teaching mode/ self-study.	
Learning Outcome:	1. State-of-art knowledge of molecular organisation of chromosomes and genes. 2. 2. Decipher the role of large numbers of molecular events associated with model animal systems and its application in molecular research.	
References /Reading:	1. Clark D, Pazdernik N and McGehee M (2018), Molecular Biology. 3rd Edition, Academic Cell. 2. Davis LG, Dibner MD and Battey JF (1986), Basic Methods in Molecular	

	Biology, Elsevier. 3. Gardner EJ, Simmons MJ and Snustad DP (1991), Principles of Genetics, John Wiley & Sons. 4. Karp G, Iwasa J and Marshall W (2019), Karp's Cell and Molecular Biology, 9th Edition, John Wiley. 5. Krebs JE, Goldstein ES, Kilpatrick ST (2018), Lewin's GENES XII, Jones and Bartlett Learning. 6. Krebs JE, Lewin B, Goldstein ES and Kilpatrick ST (2014), Lewin's Genes XI, Jones and Bartlett Publishers. 7. Malacinski GM (2015), Freifelder's Essentials of Molecular Biology, Narosa Book Distributors Private Limited.