

Unit 1: Cellular and Molecular Biology

Cell: cell membrane, cytoplasm, endoplasmic reticulum, golgi apparatus, lysosomes, mitochondria, nucleolus, peroxisomes, cytoskeletal systems-microtubules, microfilaments, and intermediate filaments, sub-nuclear structures; Cell division, cell cycle regulation and cell motility (actin- myosin filaments, cilia, flagella); Cell signalling and signal transduction; Active/passive membrane transport; Protein sorting and trafficking; Apoptosis; Genetic material: Structure of DNA & RNA, stereochemistry of bases and secondary structures, alternative forms of DNA structure; Organisation of the nucleic acids: chromatin structure, telomeres; Physico-chemical properties of DNA: T_m, hyperchromicity, kinetic classes, buoyant density, etc.; DNA replication, transcription and translation; Different types of transposons and intervening sequences; Gene structure; Regulation of gene expression in prokaryotes and eukaryotes: operon concept- Lac and Trp operon, post transcriptional gene regulation; Post translational modifications; Epigenetics; Methylation; CRISPER technologies.

Unit 2: Recombinant DNA Technology

Overview; DNA modifying enzymes: Types of restriction endonucleases (Type I, II and III), DNA polymerases, reverse transcriptase, alkaline phosphatases, kinases, exonucleases, ligases, terminal transferases; Isolation and quantitation of proteins and nucleic acids (DNA, RNA and plasmid); Gel electrophoresis techniques; Cloning and expression vectors in prokaryotes and eukaryotes: Plasmids (replication, copy number control and compatibility), phagemids, cosmids, high capacity vectors (eg. BAC), shuttle vectors, adapters, linkers, ligation, transformation and selection; Expression optimization strategies in eukaryotic and prokaryotic hosts; DNA libraries (Genome and cDNA); Screening and characterisation of clones; PCR technique and types; DNA delivery into prokaryotes and eukaryotes; Site directed mutagenesis; Blotting techniques, nucleic acid probes and labelling; Hybridization; Gene expression analysis (RT-PCR, real time PCR); Applications of recombinant DNA technology (DNA vaccines, therapeutics, diagnostics); Bioremediation; Fermentation; Single cell protein; Transgenesis; Safety aspects & regulation of recombinant DNA technology.

Unit 3: Biochemical and Molecular Markers

Type I and Type II markers; Development and applications of allozymes, mtDNA markers, RFLP, RAPD, AFLP, minisatellites, microsatellites and SNPs, ESTs, DNA barcoding; DNA sequencing technologies: Chemical sequencing, chain termination and NGS, application of NGS for developing molecular markers; Whole genome and transcriptome sequencing and their applications; Functional Genomics: Genomic resources in aquaculture species, gene expression pattern during various development stages of fish, genomic responses to stress challenges in fish, functional genomics in fish/shrimp disease control; Nutrigenomics; Metagenomics: Concepts and applications; Protein information resources; Tools in sequence alignment (pairwise and multiple) and sequence retrieval; Primary and secondary structure database, sequence analysis using various *in silico* tools.

Unit 4: Aquaculture and Marine Biotechnology

Transgenesis in fish: Methods of gene transfer in fishes, screening for transgenics, applications of transgenic fishes, transgenic fishes as bioreactors; Basic requirements for animal cell culture technology: Media and supplements, basic aseptic techniques, primary cell culture, cell lines, types of cell lines and their applications, characterization and maintenance of cells; Fish cell line repositories; Stem cells: Stem cell cultures, embryonic stem cells and their applications; Induced pluripotent stem cells and its applications; Bioreactors; Micromanipulation of cells; Seaweed tissue culture; Reproductive biotechnology: Induced breeding by synthetic hormones and analogues; Cryopreservation and revival; Cryopreservation of fish gametes and embryos; Cell viability and cytotoxicity assays; Applications of nanotechnology in fish breeding; Disease diagnostic techniques (PCR, RT-PCR, LAMP); Therapeutics: DNA vaccines, hybridoma technology, monoclonal antibody production and applications; Surrogate broodstock technology; Fuel production from microalgae using biotechnological approaches; Bioactive potential of marine organisms; Bioprospecting and drug from the sea.