M.F.Sc. (Fish Biotechnology)

Course Structure – At a Glance

A. MAJOR COURSES **20 Credits**

A1. CORE COURSES 12 Credits

1	FBT 501	Fundamentals of Molecular Biology	2+1
2	FBT 502	Basic Concepts of Cell Biology	2+1
3	FBT 503	Gene Structure and Regulation of Expression	2+1
4	FBT 504	Basic Principles of Genetic Engineering	2+1

A2. OPTIONAL COURSES 8 Credits

1	FBT 505	Molecular and Immunogenetics	2+1
2	FBT 506	Bioinformatics Tools in Genetic Engineering	1+1
3	FBT 507	Cell Culture and Hybridoma Technology	1+1
4	FBT 508	Marine Biotechnology	1+1
5	FBT 509	Aquaculture Biotechnology	2+1

B. MINOR COURSES (Courses from other relevant disciplines) **9 Credits**

C. SUPPORTING COURSES (Compulsory) **5 Credits**

(Course Work Total **34 Credits)**

D. SEMINAR **1 Credits**

E.Skilled training **2 Credits**

F.RESEARCH THESIS **20 Credits**

Total **57 Credits**

Detailed Syllabus - MFSc

FBT501	**FUNDAMENTALS OF MOLECULAR BIOLOGY**	**2+1**
Objective	To provide knowledge of basic molecular processes involving nucleic acids and protein structure, synthesis and maintenance within a living cell.	
Theory		
Unit I	Nucleic Acids: Genetic material, Structures of DNA and RNA; Stereochemistry of bases and secondary structures; Organisation of the nucleic acids - chromatin structure; physico-chemical properties of DNA (Tm, hyperchromicity, kinetic classes, buoyant density etc.	
Unit II	DNA replication: models of DNA replication in prokaryotes and eukaryotes; Mechanics of DNA replication; Enzymes; Structure and function of DNA polymerases; Types of priming.	
Unit III	Transcription: Prokaryotes – bacterial RNA polymerase, initiation, elongation and termination, types of RNA polymerases; Eukaryotes – enzymes and mechanics, post transcriptional modifications; Structure and synthesis of rRNA and tRNA.	
Unit IV	Translation: Genetic code, codon bias, types and structures of ribosomes, tRNA structure, Wobble hypothesis, mechanisms of initiation, elongation, termination, and post-translational modifications in prokaryotes and eukaryotes and the factors involved in various steps, concept of polysomes and protein structure.	
Unit V	DNA recombination: molecular models – homologous and site-specific recombination; crossing over; Holliday junction; transposition.	
Unit VI	Mutations: Types, Mutagens – nitrous acid, UV, aflatoxin, bleomycin, ethidium bromide.	
Unit VII	DNA Repair: Types and mechanisms.	
Practical	Nucleic acid isolation (genomic/plasmid DNA and RNA); Agarose gel electrophoresis; Nucleic acid quantification; Protein purification and separation in polyacrylamide gel electrophoresis (SDS-PAGE); Preparation of competent cells and transformation.	
FBT 502	**BASIC CONCEPTS OF CELL BIOLOGY**	**2+1**
Objective	To outline the basic structure growth and differentiation of prokaryotic and eukaryotic cell, sub cellular components and their function.	
Theory		
Unit I	Prokaryotic and eukaryotic cell architecture: Cell theory; diversity of cell size and shape.	
Unit II	Organization and function of sub-cellular organelles – cell membrane; cytoplasm; endoplasmic reticulum; Golgi apparatus; lysosomes; mitochondria; nucleolus; peroxisomes and sub-nuclear structures.	

Unit III	Principles of membrane transport: Active/passive membrane transport (Case study – Osmoregulation in freshwater and marine fishes) ion channels; carrier proteins; cell signaling.
Unit IV	Cell division: Cell division: Cell cycle and its regulation in *E. coli* and animal cells.
Unit V	Cell motility: actin-myosin filaments; flagella; cilia.
Unit VI	Protein sorting: secretion and targeting; vesicular traffic; endocytosis; exocytosis; protein translocation and secretary pathways.
Practical	Microscopic techniques - bright field, phase contrast and fluorescent microscopy; Microtomy; Sub-cellular fractionation and their functional integrity; Chromosome preparation; Histochemical techniques.

FBT 503	**GENE STRUCTURE AND REGULATION OF EXPRESSION**	**2+1**
Objective	To understand gene structure and regulation of gene expression.	
Theory		
Unit I	Gene structure: Promoters, UTRs, ORFs, exons, introns, termination signal, mono- and polycistronic genes, Gene clustering; Overlapping genes in (Phi X174 virus).	
Unit II	Regulation of gene expression in Prokaryotes: Operon concept (Lac/Trp); SOS response, bidirectional promoters.	
Unit III	Regulation of gene expression in Eukaryotes: DNA protein interactions (zinc fingers, leucine zippers, helix turn helix, Z-DNA); transcription factors, promoters, enhancers, repressors, insulators, attenuators, IRES, alternative splicing.	
Unit IV	RNA in gene regulation: antisense RNA, microRNA, ribozymes.	
Unit V	Case study: Molecular regulation of growth hormone expression in carp/or Molecular regulation of Na^+K^+ ATPase in gills and kidney cells of freshwater and marine fishes.	
Unit VI	Expression analysis – Techniques to test the up and down regulation of specific genes like Microarray and Real time PCR, Droplet digital PCR.	
Unit VII	Epigenetics - DNA methylation, genetic imprinting, histone modifications, chromatin remodeling.	
Practical	Expression studies of a gene controlled by lacZ promoter – Induction, blue/white selection, antibiotic selection, cell extract separation by PAGE and western blotting; lambda plaque formation on E. coli lawn; Separation of gill extract on PAGE and histochemical staining of Na^+ K^+ ATPase of fish kept at different salinities; retrieval of gene information from ensemble and NCBI, BLAST.	

FBT 504	BASIC PRINCIPLES OF GENETIC ENGINEERING	2+1
Objective	To detail the basic steps in recombinant DNA technology and its application in optimization of production, health and environment in fisheries.	
Theory		
Unit I	Recombinant DNA technology: DNA modifying enzymes - types of restriction endonucleases (Type I, II and III), DNA polymerases, alkaline phosphatases, kinases, exonucleases, ligases, terminal transferases; Vectors - plasmids (replication, copy number control and compatibility), phagemids, cosmids, high capacity vectors (eg. BAC), shuttle vectors; Adapters, linkers, ligation, transformation and selection.	
Unit II	Hosts: prokaryotic (selected *E. coli* strains) and eukaryotic (selected yeast strains).	
Unit III	DNA amplification: PCR – principle, optimization, prevention of mispriming and applications; Hot Start, touchdown, gradient PCR; T/A cloning of amplified products; Structure and function of DNA polymerase and reverse transcriptase.	
Unit IV	Genomic DNA library: construction, screening (PFGE) and applications; chromosome walking.	
Unit V	cDNA library: construction, screening (PFGE) and clone characterization.	
Unit VI	Maxam Gilbert and Sanger methods of DNA Sequencing and Edman degradation method for protein sequencing: principle and applications.	
Unit VII	Cloning strategies for prokaryotic and Eukaryotic constructs, *In vitro* transcription, codon optimization, site directed mutagenesis.	
Unit VIII	Nucleic acid hybridization: Southern, Northern and Western blotting; DNA probes and their labeling.	
Unit IX	Antibiotic selection markers- mode of function and resistance mechanism: Tetracyclin, Streptomycin, Chloramphenicol, kanamycin	
Practical	Cloning strategies – insert and vector preparation, ligation, preparation of competent cells, transformation, clone confirmation techniques (horizontal slot lysis/colony PCR); Southern hybridization, probe Labeling methods; Primer designing; DNA sequencing and analysis.	

FBT 505	MOLECULAR AND IMMUNOGENETICS	2+1
Objective	To acquaint the students with concepts and techniques to estimate genomic variation among individuals and populations.	
Theory		
Unit I	Biochemical and molecular markers: Allozyme polymorphism, mtDNA markers, RAPD, RFLP, AFLP Minisatellites and Microsatellites and their development and application.	
Unit II	Whole genome (Nuclear and Mitochondrial) and transcriptome sequencing and their applications.	
Unit III	Gene mapping: linkage maps; FISH, QTL and MAS; SNP discovery, RRL and genomic selection, population genomics.	
Unit IV	Immunogenetics: Molecular biology of Ig synthesis, genetic basis of antibody diversity, humoral B-cell immunoglobulins, T-cell receptors and MHC.	
Practical	Biochemical markers: Allozyme polymorphism. Molecular Markers: RAPD, RFLP, AFLP, Minisatellites and Microsatellites. Interpretation of gels and data analysis and use of software.	

FBT 506	BIOINFORMATICS TOOLS IN GENETIC ENGINEERING	1+1
Objective	To familiarize the students with DNA and protein sequence retrieval and analysis using gene banks and software.	
Theory		
Unit I	Introduction: Computers and biology, bioinformatic resources.	
Unit II	Sequence Alignment: Sequence retrieval from online database, simple pairwise alignment (BLAST) and multiple sequence alignment (CLUSTAL).	
Unit III	Sequence analysis tools: assembly and annotation of automated sequencing reads, identification of *cis* acting regulatory elements, ORF finding, signal sequences in DNA and proteins, data analysis tools for SNP and ESTs.	
Unit IV	Comparative Genomics: patterns and sequence-function relationships, gene prediction; RNA structure prediction.	
Unit V	Phylogeny and evolution: phylogenetic analysis - maximum parsimony, maximum likelihood, Bayesian inference; estimation of divergence time.	
Unit VI	Proteomics: protein information resources, primary and secondary protein databases, analysis packages, predictive methods.	
Practical	Sequence retrieval, sequence submission to NCBI GenBank/BOLD, BLAST analysis, ClustalW, NCBI ORF finder, primer designing software, restriction	

	site identification, plasmid map drawing, PCR primer design, protein structure prediction software, phylogenetic analysis by MrBayes, Phylip and PAUP software.

FBT 507	**CELL CULTURE AND HYBRIDOMA TECHNOLOGY**	**1+1**
Objective	To impart knowledge on cell and tissue culture techniques and their applications.	
Theory		
Unit I	Introduction: Structure and Organization of animal cell; Equipments and materials for animal cell culture technology.	
Unit II	Cell lines and media: Primary and established cell line cultures; media supplements – their metabolic functions; serum & protein free defined media and their application.	
Unit III	Cell culture: Basic techniques of cell culture in vitro; development of primary cultures, cell separation, maintenance of cell lines; biology of cultured cells, transformation and differentiation of cell cultures.	
Unit IV	Characterization of cell lines: measurement of viability and cytotoxicity assays; measuring parameters of growth; karyotyping, isozyme assays, cryopreservation, assessment of contaminants.	
Unit V	Cell cloning: Micromanipulation, cell transformation, application of fish cell culture, scaling-up of cell culture.	
Unit VI	Stem cells: Stem cell cultures, embryonic stem cells and their applications; cell culture based vaccines, organ and histotypic cultures; measurement of cell death; apoptosis; three dimensional culture and tissue engineering.	
Unit VII	Cell hybridization: Somatic cell fusion, hybridoma technology, Production and Application of monoclonal antibodies.	
Practical	Preparation of cell culture medium and membrane filtration, preparation of single cell suspension from spleen and thymus, cell counting and cell viability; macrophage monolayer from PEC and measurement of pathogenicity activity, trypsinization and sub culturing, cryopreservation and thawing; measurement of doubling time, preparation of metaphase chromosome spread from cultured cells, isolation and demonstration of apoptosis of DNA laddering, cell fusion with PEG, monoclonal antibody production, transfection techniques, zebrafish embryo fusion.	
FBT 508	**MARINE BIOTECHNOLOGY**	**1+1**
Objective	To give the students an overview on the potential marine resources for bioactive compounds and their applications.	
Theory		

Unit I	Introduction: Historical background, overview of the present status of marine biotechnology, commercially important and potential species, micro-algae, macro- algae, aquaculture.
Unit II	Marine Resources: biodiversity, marine natural products, valuable chemicals, biomedical, polysaccharides and bioactive compounds from marine organisms, marine organisms as a source of antiviral, anticancer and anti-inflammatory compounds; and commercially important enzymes, Biofuel from micro algae.
Unit III	Environmental Biotechnology: bio-film and bio-remediation, bio-sensors; genetically engineered microbes for pollution control, harmful algal blooms and their molecular identification methods, biofouling and prevention, metagenomics.
Unit IV	Bio-prospecting of genes and allele mining for novel proteins.
Unit V	Large scale production of bioactive compounds and peptides / proteins
Practical	Extraction of bioactive compounds from seaweeds, microalgae, sponges and test their efficiency microbiology, biochemistry and molecular assays, isolation of marine algae, plankton and its culture method, methods for isolation of viable and uncultivable bacteria from sea, recombinant DNA technology to produce commercially important enzymes.

FBT 509	**AQUACULTURE BIOTECHNOLOGY**	**2+1**
Objective	To provide an overview of the application of biotechnological tools in fish breeding, feed, health, processing and other issues in fisheries.	
Theory		
Unit I	Fish Breeding: Synthetic hormones for induced breeding - molecular endocrinology with emphasis on use of analogues for breeding like GnRH, pheromones, growth hormone signal peptide for secretion, biotechnological approaches for peptide synthesis.	
Unit II	Transgenesis: Methods of gene transfer in fishes, single gene traits, screening for transgenics, site of integration, applications, regulation and biosecurity of GMOs, IPR.	
Unit III	Gene Bank and conservation: Cryopreservation of gametes, embryos and stem cells.	
Unit IV	Feed Technology: Nutraceuticals - SCP, prebiotic, symbiotic, probiotic; Nutrient gene interaction; Eco-friendly feed: exogenous enzymes, bio-encapsulated feeds, fatty acid enrichment.	
Unit V	Environment and Health Management: DNA and RNA vaccines, molecular diagnosis of viral diseases, PCR, Dot-blot, ribotyping of pathogenic microbes, RNAi vaccines, Gene Therapy, Biofilms and its impact on health management, immunostimulants, bioremediation of soil and water.	

Unit VI	Algal Biotechnology: Microalgae - biotechnological approaches for the identification and production of commercially important compounds, single cell protein from Spirulina, Microalgae for human nutrition and cosmetics, fish and animal feed.
Unit VII	Post harvest biotechnology: Antibiotic residue detection by ELISA, LC-MS/MS, food adulteration, species detection, fisheries product forensics and traceability; toxins and their detection by biosensors.
Unit VIII	Application of nanotechnology in aquaculture.
Practical	Induced breeding of carps, spirulina culture, identification of selected algae, cryopreservation of gametes, diagnosis of WSSV, micro-encapsulation, ribotyping, HAACP methods, preparation of agar, PCR amplification and cloning of growth hormone gene, transgenesis, chromosomal manipulation-androgenesis, gynogenesis, triploidy, tetraploidy.