56 FISH GENETICS AND BREEDING

Unit 1: Principles of Fish Genetics and Breeding

History and development of genetics;Mendel inheritance, genetic variation; Multiple factor inheritance; Epistasis; Chromosomal theory of inheritance; Sex determination in fish; Gametogenesis;Linkage and crossing over, DNA as genetic material; Genetic code; DNA replication; DNA and plasmid isolation;Fine structure of chromosomes, chromosomal spread preparation technique and karyotyping, chromosomal aberration, chromosomal banding techniques, chromosomal manipulation; Ploidy induction; Sex reversal; Gynogenesis;Androgenesis.

Unit 2: Population, Quantitative and Conservation Genetics

Genetics of population, gene and genotype frequencies and factors affecting them; Qualitative and quantitative traits of individual and population:Effective population size, estimation of inbreeding, F statistics, Wahlund effect, genetic similarity and Nei's genetic distance, Hardy Weinberg principle; Systematic and dispersive forces changing gene and genotypic forces; Genetic bottleneck and mutation, genetic drift, Founder effect, population mean, variance, heritability, factors affecting heritability; Realized heritability; Limits to selection, asymmetry of response to selection; Evolution and genetic diversity, maintenance of genetic diversity in natural and captive population;Genetic variability and differentiation, equilibrium, null alleles, population genomics, outlier loci and adaptive variation in trait-related genes; Genetic variance components and their estimation; Breeding value and its properties.

Unit 3: Selective Breeding of Aquaculture Species

History of domestication of cultured aquatic species; Stock comparisons methods and mating designs; Genetic basis for selection of fish for breeding;Estimation of breeding values from different methods and source of information; Inbreeding depression and heterosis in aquaculture, managing inbreeding in hatchery population; Cross breeding and hybridization; Genetic gain; Response to selection, methods of selections, aids to selection, mating designs, threshold characters, application of markers QTL and MAS in selection program, selective breeding for ornamentation traits, selection for disease resistance, production of SPF and SPR; Genomic selection; Endocrine control of reproduction in fish and shellfish; Synchronization of spawning; Assessing the gamete quality; Controlled breeding; Genetic aspects of broodstock development and management; Methods of fish identification and pedigree maintenance; Packaging and transportation of fish seed and broodstock; Quarantine procedures; Aquaculture practices for genetically improved stocks; Breeding strategies for threatened species for restocking and live gene bank (LGB);*In situ* and *ex situ* conservation; Conservation and preservation of aquatic species: Issues and strategies;Mutation:Natural and induced;Growth curves; Tagging methods used in fish breeding.

Unit 4: Molecular Genetics and Bioinformatics

Collection and storage of samples for DNA fingerprinting; Isolation and quantification of DNA from different sources; Concept of recombinant DNA techniques cloning and gene mapping;DNA markers in stock identification: Allozymes, RFLP, RAPD, AFLP, microsatellites, ESTs, SNPs, Type I and II markers, mtDNA and nuclear DNA markers, real-time PCR and EST markers, lab assays for markers; Next generation sequencing, applications for species identification, hybridization, stock identification, genetic diversity and conservation, parentage; Linkage and QTL mapping, microarray genes; Transgenics, GMO and biosafety regulations, transgenic containment;Use of biotechnological tools to improve aquaculture production;Data mining tools and techniques, submission of DNA sequences, GenBank sequence database, genome diagnostics, genome and transcriptome analysis, protein information resource, EST database, phylogenetic analysis, microarray informatics;FISH (Florescence in-situ hybridization technique); Geno toxicity (MNT, sister chromosome exchange, comet assay); Synthesis and characterization of nanomaterials, application of nanotechnology in fisheries and aquaculture.