

**Unit 1: Principle of Fish Nutrition**

Nutrients, sources, structure, classification, role/ function and biosynthesis; Metabolism of proteins, carbohydrates and lipids; Essential amino acids, their function and deficiency symptoms; Vitamins and minerals, their role in nutrition and deficiency symptoms; Importance of phospholipids and steroids in fish and crustacean nutrition; Strategies for improvement of carbohydrates utilization in fish; Energy Nutrition: Definition of energy, basic fish bioenergetics, energy partitioning & different forms of energy, energy budget equation, metabolic scope, principles of energy estimation, estimation of gross energy of feed and feed ingredients; Sparing action of nutrients; P:E ratio; Role of nutrients on growth and flesh quality: Concept of growth, growth curve, correlation of growth with body weight and length, biotic and abiotic factors affecting growth, critical nutrients for improving flesh quality; Assessing nutritional requirement of larvae, fingerlings, young fish, grow-out of commercially important finfish and shellfish; Methods and factors affecting nutritional requirements in different life stages of fish and shellfish; Food and feeding habits of fish and shellfish; Nutritive value of live food: Algae, artemia, cladocerans, ostracods, rotifers and copepods; Bio-enrichment of live food; Role of nutrients on reproduction.

**Unit 2: Feed Formulation, Feed Technology and Feeding Management**

Principles and methods of feed formulation; Feed ingredients, classification, evaluation of ingredient quality; Feed additives/supplements: Classification, function, dietary inclusion level; Antinutritional factors and methods of detoxification, permissible level; Types of feed: Farm-made, commercial feed, experimental diets (reference/ basal diet, purified and semi-purified diet), moist, semi-moist, dry, crumble, pellet, sinking, slow sinking, floating, micro-bound, microencapsulated, micro-coated; Feed processing technology: Grinding, dosing/ weighing, homogenization/ mixing, conditioning (steam or extrusion cooking), pellet making, drying, crumbling, coating; high energy feed with vacuum coating of lipid; Equipments used in feed manufacture: Pulverizer/ grinder, mixer, pelletizer/extruder/expander, crumbler, drier, vacuum coater/ fat sprayer; Effect of processing on nutritional value of feeds; Feed and feed ingredients and quality control: Storage methods and monitoring, quality control of feed and ingredients during storage- physical, chemical and biological methods, prevention of spoilage from rancidity, fungus and associated toxins, vectors of fish disease in feed, nutritional value of feed in relation to storage; Economics of feed manufacturing; Fertilization and supplementary feeding, feeding in intensive culture: Feeding methods and devices- broad casting, bag feeding, tray/ basket feeding, raft feeding, box feeding, feeding by demand feeder, automatic feeder, feed blower etc.; Feeding practices: Ration size/feeding rate, feeding frequency, restricted feeding, and mixed feeding; Feeding schedule and Record keeping; Eco-friendly feeds; Legal aspects of feeds; Designer fish production.

### **Unit 3: Nutritional Physiology and Nutrigenomics**

Morphology, anatomy and physiology of various types of fish such as herbivores, planktivores, omnivores, carnivores, detritivores; Nutrient digestion and digestive processes, control and regulation of digestion; Factors affecting feed intake, digestion, absorption, assimilation and digestibility Digestive enzymes in fish: Gastric, pancreatic and intestinal secretions and role of microorganisms in digestion; Transport of nutrients in the body, storage, conversion and utilization; Role of liver and muscles in fat and glycogen storage and release; Digestive hormones, nutrient regulation of endocrine functions; Effects of broodstock diets on eggs and larval quality; Ontogeny of larval digestive physiology; Digestibility: Types, estimation of digestibility of nutrients and energy of feed and feed ingredients, factors affecting digestibility; Nutrigenomics: Definition, classification- transcriptomics, proteomics and metabolomics; Nutrient-gene interaction and expression, reverse transcription and cDNA synthesis, real-time PCR, genetic control on metabolic pathways.

### **Unit 4: Nutrition and Fish Health**

Nutrients and their effects on fish health: Nutritional imbalances, nutritional deficiency, nutrients and immunity, hyper- and hypo-vitaminosis; Dietary lipid and stress tolerance in fish larvae; Myco-toxin in fish feed: Factors favouring mycotoxin production, mycotoxins interactions and pathways, toxins binders, detoxification and amelioration methods; Phytase and phytate in feed ingredients; Role of dietary lipid, vitamin C, vitamin E and carotenoids in stress mitigation and reproductive performance; Nutraceuticals: Role in immunity and disease resistance; Histological features of gut and associated organs during abnormal nutritional conditions.