

## Course descriptions for Research Master's Programs

### 1-Aquaculture :

Course code	Course Title	Course Description
111201	<i>Physiology of aquatic animals</i>	Physiology: Comparative physiology of respiratory, digestive, excretory and circulatory respiratory, digestive excretory and circulatory systems; Osmo-regulation; Hormonal control of osmotic and ionic regulation; Organisation of the neurons and neuro-muscular system; Mechanism of neurons coordination; Sense organs - receptor mechanisms and effector systems; Biological rhythms. Ecophysiology - Environmental requirements; effect of salinity, oxygen and other abiotic factors on metabolism, moulting and growth; Effect of environmental factors on acid-base regulation; Biotic interaction; Bioassay and its implication in mariculture. Endocrinology -general morphology, structure and function of neurosecretary system. Reproductive physiology - anatomy of male and female reproductive systems and secondary sexual characters; Process of gametogenesis; neuroendocrine control of reproduction; Hermaphroditism; Parasitic castration.
111202	<i>Aquaculture Nutrition – advanced</i>	Nutritional physiology, principles of nutrition and historical background; Adaptations to various types of feeding in finfish, crustaceans and molluscs; Mechanism of food capture, food ingestion and role of feeding stimulants; Digestion, assimilation and conversion of nutrients; Role of gut microbes in digestion; Nutritional bioenergetics in finfish and shellfish. Nutritional requirements- Gross protein requirements; Nitrogen balance; Essential and non-essential amino acids and their quantitative requirements; Protein quality and sources; Lipids; their functions; Essential fatty acids; Phospholipids and sterol requirements; Protein sparing action of lipids; Negative aspects of lipids; Carbohydrates; Their sources and utilization; Gross energy requirements; factors altering energy requirements; Water and fat soluble vitamins; Their positive functions, deficiency and hyperdosage syndromes, antivitamin factors; Mineral requirements, importance of minerals, recommended dietary allowances, deficiency and hyperdosage syndromes; Nutritional requirements of brood stock; factors influencing nutritional requirements. Feed ingredients and feed technology - classification of feedstuff and international

		<p>feed information system, conventional and non-conventional sources of feed ingredients; Antinutritional factors in feed ingredients, Their effect on finfish and shellfish, Binders, antioxidants, mould inhibitors, Their use in feeds; Anabolic agents in fish and shellfish feed, Feed formulation strategies and methods; Feed manufacture processes; Storage and quality control of feeds; Management of fish feed mills. Larval nutrition - Nutritional requirements of finfish, crustacean and molluscan larvae; Nutritive value of cladocerans and rotifers, their mass culture, Nutritive value of artemia, their mass culture and cyst production; Microdiets for larvae, Recent advances in larval nutrition. Evaluation of feeds: Feeding strategies - Chemical methods of evaluation; Biological methods of evaluation, feed dispensing methods;</p>
<p><b>111203</b></p>	<p><i>Genetic and Breeding of Aquatic Animals</i></p>	<p>Principles of fish genetics: hybridization, sex determination and sex reversal in fishes. Cytogenetics: Chromosomes and genes, karyotyping, mapping, robertsonian rearrangements and banding. Chromosomal engineering: Genome, gynogenesis, androgenesis, polyploidy, production of monosex population and super male by combination of endocrine, sex reversal techniques. Biochemical genetics : Isozymes for genetic characterization. Quantitative genetics: Genotype, phenotype, environment and genotype interactions, Hardy-Weinberger law, variation, heritability, population, effective population size, inbreeding, selective breeding: methods and type of selection, selection response.</p>
<p><b>111204</b></p>	<p><i>Fish diseases - Advanced</i></p>	<p>Causes of diseases: Etiology; Classification of diseases; Role of abiotic and biotic factors; Intrinsic factor such as generic, species and strain; Extrinsic factors - environment and nutritional status. Viral, bacterial and fungal diseases; Diseases caused by protozoans, worms, crustaceans; Environmental and nutritional diseases; Tumours in fishes; toxic diseases and other emerging diseases. `EUS' and other ulcerative dermal necrosis; Gad-bubble diseases; Low temperature diseases; Water-borne irritants; Blue sac, white spot and yolk-sac deformity disease of larvae; Colouration anomalies in cultured marine flat fish; Sunburn and effect of U.V. radiation; Traumatic injuries. Nutritional disease; Deficiencies and imbalances of major dietary components; Toxic components of the diets. Role of stress in disease process and its control measures. Microbial Biotechnology in Fish Pathology: Marine biotechnology origin and prospects in fish Pathology.Recent advancement in detection of pathogens in shellfish and finfish; PCR principle and its application in rapid detection of disease; Use of DNA probes; Tissue cell</p>

		lines for detection of viruses in shrimp; Plasmids and its isolation. Environmental Bio-remediation and disease management. Drugs and chemicals used in Aquaculture: Immunostimulants, Probiotics, DMS, Drugs and Chemicals
111205	<i>Crustacean Nutrition</i>	Feeding strategies for larvae and postlarvae in hatcheries and nurseries; Feed dispensing methods and feeding strategies for crustaceans in intensive and semi-intensive grow out systems; artificial feeding and pond sanitation. evaluation of feeds, chemical methods of evaluation, biological methods of evaluation - PER, BV, NPU, NPR and FCR; Digestibility of feeds in fish and shellfish; Methods of determining digestibility coefficients; Single cell protein in aquaculture feeds; Recent advances in nutrition research.
111206	<i>Feed Additives for aquaculture</i>	Types of feed. Hydro-stability of feed and their storage and prevention of spoilage from rancidity. Feed additives: - Classification, function, and specific use for economic and quality fish and shellfish production. Feed evaluation through the study of growth performance, FCR and PER analysis. Feed additives and feed binders, antinutritional factors and their prevention; Methods of feed formulation, feed processing units and processes, Fortification of micronutrients in larval and brood stock diet, exogenous enzymes in fish feed; Non-nutrient dietary component (Fibre, Ash); Low cost feed development
111207	<i>Metabolism in Aquaculture</i>	Carbohydrate metabolism : Glycolytic pathway, TCA cycle and Pentose phosphate pathways, Gluconeogenesis, Glycogenesis and glycogenolysis. Constraints of carbohydrate utilization in fish, Strategy to enhance carbohydrate utilization. Protein Metabolism: digestion, Absorption, digestibility, Factors affecting protein digestibility Protein energy Inter-relationship (P/E Ratio) ; Both Qualitative and Quantitative, Protein requirement for Maintenance, Growth and Reproduction, Factors affecting protein requirement, Methods of requirement study. Lipid metabolism - biosynthesis and beta oxidation of fatty acids; Sources of lipids and fatty acids, Lipid digestibility, transport storage, mobilization, Protein sparing effect. Requirement study: Qualitative and quantitative requirement of Essential fatty acids, total lipid.
111208	<i>Minerals and Vitamins of Aquaculture Nutrition</i>	Nitrogen balance; Essential and non-essential amino acids and their quantitative requirements; Energy utilization - Sources; Metabolism and calorimetry; Energy- protein rations; Lipids-functions and requirements; Requirements of vitamins and minerals; Larval and roodstock. Nutrition. Food and feeding

		behaviour, feeding strategies, feed delivery systems; Anatomy and physiology of the digestive tract; Mechanisms crustaceans and molluscs; Mechanisms of digestion and absorption; Food assimilation and digestive enzymes; Physiological energetics; Active transport of nutrients and their conversion; Nutritional factors and growth; Environmental factors and growth; Growth rates and models.
111209	<i>Fish Reproduction physiology</i>	Structure and physiology of reproductive system of fin fish and shell fishes. Hormonal control of reproduction in fin fish and shell fishes. Environmental and exogenous hormonal stimuli. Methods of natural and artificial fertilization. Environmental, nutritional and endocrine control of fish reproduction. Improvement of seed quality through stock up gradation Induced breeding by synthetic hormones and its analogues. Bundh breeding and multiple breeding. Parental care of fishes.
111210	<i>Physiology of Marine Larviculture</i>	Larval nutrition - Nutritional requirements of finfish, crustacean and molluscan larvae. Feeding strategies for larvae and postlarvae in hatcheries and nurseries. Comparative physiology of respiratory, digestive, excretory and circulatory respiratory, digestive excretory and circulatory systems; Osmo-regulation; Hormonal control of osmotic and ionic regulation; Organisation of the neurons and neuro-muscular system; Mechanism of neurons co-ordination. Importance of live feed and artificial feed, Different types of feed available for larvae, constraints and scope; Larval gut morphology and mode of nutrition.
111211	<i>Marine fish hatcheries</i>	Formulation and operation of different types of hatcheries. Design and construction of aqua-hatcheries: Carp hatcheries, prawn hatcheries, catfish hatcheries. Induced breeding: spontaneous breeding and hatchery operation, stripping, incubation in different types of hatcheries.. Observation of embryological development stages. Assessment of breeding success and fertilization rate. Professional brood handling, tagging of brood. Seed production out of preserved milt.
111212	<i>Natural food production</i>	Marine bioresources –bioactive compounds from the sea, marine natural products and metabolites. Natural food for different fishes and shellfishes; Necessity of live food for larval development and culture of fish and shell fishes; Culture of different live food organisms; Prospects of live food culture. Nutritive value of live feed.

111213	<i>Viral diseases of Crustacean</i>	Aetiology, pathogenesis, epidemiology, treatment and control, immunology and molecular biology of viruses/viral diseases of shell fish. Major pathogens of commercially important cultured crustaceans with special reference to shrimp and freshwater prawn: viral and bacterial; Biology, morphology, diagnostic methods, clinical signs and pathological changes associated with these pathogens; Viruses: WSSV, YHV, TSV, IHNV, MBV, HPV, BP, BMN, LOVV, GAV, mrNV..
111214	<i>Safe use of wastewater In aquaculture</i>	Established water quality standards for different aspects and for discharge from various sources. Water treatment for, Drinking, industrial & other purposes, Treatment methods for domestic & industrial wastewater treatment methods, Water quality management, Natural processes to remove pollutants. BOD Removal, Types of Biological Processes, Municipal Wastewater
112206	<i>Genetic Engineering</i>	Isolation and analysis of nucleic acids: Isolation of Nuclear DNA, mt DNA, plasmid DNA and mRNA; Restriction mapping, blotting and hybridization, DNA sequencing. Outline of gene manipulation: Enzymes for gene manipulation, Gene cloning, Vectors for cloning, Principle of recombinant DNA techniques, cDNA and DNA probes, Gene libraries; Artificial synthesis of DNA and In-vitro chemical amplification of DNA (PCR), Development of transgenic fish. Manipulation of chromosome sets: Induction of ploidy, Gynogenesis and androgenesis, Genetic control of sex. Cryopreservation of gametes and embryos: Extenders, Cryoprotectants, Equilibration, Thawing, Ice-seeding, Vitrification, Problems and prospects of fish embryo cryopreservation, blastomere isolation and freezing.
112210	<i>Nanobiology</i>	Introduction to Nanobiology, Scale scope and future: How to image nanoscale items, Tools and techniques in Nanoscience. Nano-biology: Food engineering. Engineered Nanoparticles in Consumer Products. Molecular gastronomy of food/food packaging sensors. Bio-mimicry: Material engineering. Tissue engineering. Nanocarriers; Theranostics. Neuro Nano; Blood Brain Barrier. Nano-medicine: Drug delivery, Cancer treatment. NanoSensors, Nano Ethics.
112220	<i>Beneficial Microorganisms applications in Aquaculture</i>	Probiotics, Utilization of Microorganisms for Biopurification of water and Wastewaters, Microbial Production of Polyhydroxyalkanoates for Aquacultural Applications, Bacteriocins Production by LAB, Application of Biofloc in Aquaculture: An Evaluation of Flocculating Activity of Selected Bacteria from Biofloc , Identification and Screening of Bioflocculant-Producing Bacteria, Biopreservation of Seafood by Using Bacteriocins and Bacteriocinogenic Lactic Acid Bacteria as Potential Bio-control Agents.

## 2-Aquatic products Processing & Preservation

<i>Course code</i>	<i>Course Title</i>	<i>Course Description</i>
112201	<i>Seafoods processing technology - advanced</i>	Technological aspects of freezing: Methods of freezing, comparison of various freezing methods, selection of a freezing method, product processing and packaging, chemical treatment prior to freezing, antioxidants, cryoprotectants and other additives, theories of cryoprotection, glazing. Thermal processing of fish products: Mechanism of heat transfer: conduction, convection, radiation and dielectric and microwave heating, unsteady state of transfer, heat resistance of bacteria and spores, decimal reduction time, thermal death time, "Z" and "F" values, heat penetration, cold point, can size, shape, contents etc. on heat penetration, determination of process time. Significance of thermal death curve, graphical, formula, nomogram methods – F0 value, cook value, D value, integrated F value and their inter-relationship. Heat processing and heating equipment, Canning process, steps involved, process flow, additives, HTST processing and aseptic canning, principles and process details, canning machinery and equipment, canning process for fish/shellfish, value added canned products. Irradiation: Radiation sources, units, dose levels radappertization, radacidation, radurization, effects of irradiation on protein, lipids, vitamins, bacteriological aspects, physical properties, shelf life.
112202	<i>Biochemistry - advanced</i>	Sarcoplasmic proteins: Classification, enzymes, hydrolases. Oxidoreductases; Other enzymes, pigments, Heme proteins, Myoglobin, Hemocyanins, parvalbumins, antifreeze proteins. Myofibrillar proteins: Myosin – isolation, sub-unit composition, stability, gelation, actin, allergins, tropomyosin, troponins, paramyosin, connectin. Collagen in fish muscle and skin: location, connective tissue in the muscle, characteristics of seafood collagen, collagen on the quality of seafoods, gaping. Functional properties of seafood proteins: Solubility, emulsification, viscosity, water holding, gelation, texture profile analysis. Denaturation: At high and low temperatures and kinetics, dissociation / aggregation /coagulation etc. reversibility, significance to processing and quality. Hydrolysis and hydrolysates: Process and applications, proteinases. Non-protein nitrogenous compounds: Free amino acids, peptides. Nucleotides, Guanidins, urea, quarternary ammonium compounds etc. TMAO and its decomposition products, demethylase. Seafood lipids: Composition and nutritive value,

		lipid types and their variations, fatty acid composition of fish liver and body oils, lipid fractionation, triglycerides, phospholipids, non-saponifiables including sterols and vitamins. Polyunsaturated fatty acids, prostaglandins, beneficial effects on human health, estimation of lipid fractions, auto-oxidation of fatty acids, pro- and antioxidants, oxidation indices, lipid-protein interactions, oxidized lipids-protein interactions and their impact on quality, rancidity, lipases and phospholipases. Macro and trace elements in fish and shellfish; Minerals of nutritional significance, toxic metals and their harmful effects and metallothionines. Flavour bearing compounds in fish. Nucleotides: Post mortem degradation, K-value Free amino acids, amines, volatile fatty acids, carbonyls, sulphur containing compounds, carotenoids, isoprenoids. Biogenic amines, Aflatoxins in cured fish.
112203	<i>Quality control of fisheries products-advanced</i>	Quality management, total quality concept and application in fish trade. Quality assessment of fish and fishery products - physical, chemical, organoleptic and microbiological. Quality standards. Quality Assurance. Inspection and quality assurance: Fish inspection, process water quality in fishery industry, product quality, water analysis, treatments, chlorination, ozonisation, UV radiation, reverse osmosis, techniques to remove pesticides and heavy metals. Sensory evaluation of fish and fish products, basic aspects, different methods of evaluation, taste panel selection & constitution, statistical analysis
112204	<i>Microbiology of fisheries products</i>	Microorganisms responsible for fish spoilage - their responses to fish processing techniques like chilling, freezing, canning, salting, smoking, drying and fermentation. Special features of psychrophilic, thermophilic and osmophilic bacteria, molds and yeasts. Microbiology of modified atmosphere packaging of fish. Sanitation in fish processing. Pathogens associated with fish, fish processing environments and prevention of contamination. Microbiological aspects of HACCP based fish quality assurance. Rapid and automatic microbiological methods in fish quality assurance.
112209	<i>Extraction methods of active principals</i>	Extraction of collagen from fish processing wastes, Extraction of flavours and pigments and evaluation, extraction of shark liver oil, Extraction of bioactive compounds from seaweeds, microalgae, sponges and test their efficiency microbiology, biochemistry and molecular assays, extraction of agar, alginic acid, mannitol and carrageenan.
		Introduction to Nanobiology, Scale scope and future: How to image nanoscale items, Tools and techniques in Nanoscience. Nano-biology: Food engineering. Engineered Nanoparticles in Consumer Products. Molecular gastronomy of food/food

112210	<i>Nanobiology</i>	packaging sensors. Bio-mimicry: Material engineering. Tissue engineering. Nanocarriers; Theranostics. Neuro Nano; Blood Brain Barrier. Nano-medicine: Drug delivery, Cancer treatment. NanoSensors, Nano Ethics
112211	<i>Additives and preservatives</i>	Introduction to food additives-definition-technical benefits of food additives-intentional and incidental additives. Relationship of great revolutions in history to the development of seafood additives. Basic uses of seafood additives. Intentional additives – use of specific nutrients as seafood additives – Requirements and considerations – minerals. Vitamins, amino acids and nutrient concentrates as additives. Flavors and color as additives. Antioxidants – Mechanism of antioxidants; commercial antioxidants and selections. Analytical methods for antioxidants. Acidulants in food processing; Sequestrants in seafood processing; Polyphosphates in food processing; Starch as an additive; Incidental additives.
112212	<i>Quality control in food processing</i>	Process Control: HAZARD ANALYSIS CRITICAL CONTROLPOINTS, INSPECTION/TEST PLANS. INTRINSIC QUALITY OF SEAFOODS FISH SPOILAGE, MAINTAINING RAW MATERIAL QUALITY, QUALITY ASSESSMENT, CHEMICAL INDICES OF BACTERIAL SPOILAGE, HYGIENIC PRACTICES, CLEAN-UP PROCEDURE, CHLORINATION OF WATER SUPPLIES, BACTERIOLOGICAL INDICATORS OF SEAFOOD PLANT SANITATION AND PRODUCT QUALITY, DEVELOPMENT OF STATISTICAL QUALITY CONTROL, QUALITY IMPROVEMENT-WHAT IS THE CHALLENGE? Quality Management Information System, Quality Cost Accounting, Quality Program Implementation: SYSTEM IMPLEMENTATION, DEVELOPMENT OF PERSONNEL
112213	<i>Contamination of aquatic products</i>	Quality Assurance in Seafood Processing, Organizing for a Quality Program, Finished Product Quality, Process Control, HACCP, Raw Material Quality, Microbiological Indicators and Seafood Processing, Statistical Quality Control, Biological pollution and contamination, Chemical pollution and contamination, Seafood toxicants
112214	<i>Canning technology</i>	Principles of thermal processing Mechanism of heat transfer: conduction, convection, radiation and dielectric and microwave heating, unsteady state transfer, heat resistance of bacteria and spores, decimal reduction time, thermal death time, heat penetration, cold point, can size, shape, contents etc. on heat penetration, determination of process time. Significance of thermal death curve, graphical, formula, nomogram methods - Heat processing and heat equipment, Acidity classification of



		foods - definition of canning, absolute sterility, commercial sterility, pasteurisation Vs sterilization Canning process, steps involved, process flow, additives , HTST processing and aseptic canning , principles and process details , Can manufacture , Canning machinery and equipment , Canning process for fish/shellfish, Value added canned products , Spoilage of canned food.
112215	<i>Packaging technology</i>	Importance of packaging in Fish Processing, Production of kraft paper, Aluminium foil, corrugated fibre board and various flexible plastic films, Laminations and Co-extrusions, properties of various packaging materials.
112216	<i>Biosafety of aquatic products</i>	Seafood safety: microbial hazards, chemical hazards. Seafood and Environmental Toxicant Exposures. Seafood Toxins: Fish Toxins, Other Poisonous Marine Animals, Shellfish Chemical Poisoning, Pathogens Transmitted by Seafood, Laboratory Methodology for Shellfish Toxins, Ciguatera Fish Poisoning, Tetrodotoxin, Epidemiology of Seafood Poisoning, The Medical Management of Seafood Poisoning, Toxicology and Risk Assessment, Nutritional Toxicology, Food Additives, Analysis of Aquatic Contaminants, Agricultural Chemicals, Radioactivity in Food and Water, Food Irradiation, Drug Residues in Foods of Animal Origin, Migratory Chemicals from Food Containers and Preparation Utensils
112217	<i>Organic Physical and sensorial properties of fish</i>	Understanding the concepts of quality and freshness in fish, Different types of physical, chemical, microbiological and sensory changes during chill storage. quality indices for fish, Guidelines for sensory evaluation of fish, Developing a quality index, Keeping fish under different storage conditions, Texture and flavour changes on frozen storage, Pre-freezing factors influencing storage stability, Indicators of deterioration in frozen fish, Multivariate spectrometric methods for determining quality attributes,

### 3-Aquaculture Biotechnology

<i>Course code</i>	<i>Course Title</i>	<i>Course Description</i>
112205	<i>Aquaculture biotechnology</i>	Biotechnology in aquaculture - genetic improvement of brood stock, hybridization, production of transgenic animals, biotechnology in feed development, in water quality management and health management. Natural products such as biomedical, antimicrobial and anticancer compounds from marine organisms, cell and tissue culture, hybridoma technology, cloning and expression of genes from marine organisms, genetic improvement of marine organisms, bioremediation and role of genetically engineered organisms. Role of biotechnology in improving aquaculture production.
112206	<i>Genetic Engineering</i>	Isolation and analysis of nucleic acids: Isolation of Nuclear DNA, mt DNA, plasmid DNA and mRNA; Restriction mapping, blotting and hybridization, DNA sequencing. Outline of gene manipulation: Enzymes for gene manipulation, Gene cloning, Vectors for cloning, Principle of recombinant DNA techniques, cDNA and DNA probes, Gene libraries; Artificial synthesis of DNA and In-vitro chemical amplification of DNA (PCR), Development of transgenic fish. Manipulation of chromosome sets: Induction of ploidy, Gynogenesis and androgenesis, Genetic control of sex. Cryopreservation of gametes and embryos: Extenders, Cryoprotectants,
112207	<i>Food and bioenergy</i>	Introduction to bioenergetics; The energy budget equation, energy flow in fish and shellfish; Gross energy, digestive energy, metabolizable energy, net energy, heat increment; Factor influencing ingestion, absorption, excretion, respiration, and metabolism and their effect. Energy requirement of fish and factors influencing it; Estimation of energy content of feed components based on chemicals composition, indirect and direct method; Relationship between feeding and growth; energy exchange in biological system.
112208	<i>Microbial physiology</i>	Species Concept, Composition and Structure, Growth and Cell Division, Membrane Transport, Metabolism, Gene Regulation, Genomics and Microbial Physiology, Stress Responses, CRISPRs, Horizontal Gene transfer, Biodegradation, Microbes and Metals, Challenges of Extreme Environments.
112210	<i>Nanobiology</i>	Introduction to Nanobiology, Scale scope and future: How to image nanoscale items, Tools and techniques in Nanoscience. Nano-biology: Food engineering. Engineered Nanoparticles in Consumer Products. Molecular gastronomy of food/food packaging sensors. Bio-mimicry: Material engineering. Tissue

		engineering. Nanocarriers; Theranostics. Neuro Nano; Blood Brain Barrier. Nano-medicine: Drug delivery, Cancer treatment. NanoSensors, Nano Ethics.
112218	<i>Environmental biotechnology</i>	Water and Wastewater: Hydrological Cycle, Physical Parameters, Chemical Parameters, Biological Characteristics. Bacterial Metabolism in Wastewater Treatment Systems, Treatment of Wastewater: Water Pollution Control, Wastewater Biology, Secondary Treatment (Biological Treatment): Aerobic and Anaerobic Treatment, Trickling Filters (Aerobic Attached Growth Process), Advantages and Disadvantages of Trickling Filter, Activated Sludge Process, Bioremediation: Contamination of Soil and Ground Water, Bioremediation Systems, Biofiltration. Anaerobic Degradation of Organic Compounds, Industrial Wastewater Sources and Treatment Strategies, Bioreactors, Perspectives of Wastewater, Waste, Off-gas and Soil Treatment.
112219	<i>Cell biology and genetics</i>	STRUCTURE OF PROKARYOTIC AND EUKARYOTIC CELLS:ultrastructure of animal cell; cell differentiation in animal cells. Structural organization of plasma membrane; membrane protein, cytoskeletal proteins; types of cell functions – transport of nutrients, osmosis and active transport. CELL ORGANELLES : Organization and functions of endoplasmic reticulum, golgi complex, lysosomes, mitochondria, ribosomes, nucleus, and vacuoles. CHROMOSOMES : Structural organization, nucleosomes, chromonema, euchromatin, heterochromatin, centromere, kinetochore, telomeric organization. Cell cycle, mitosis and meiosis; cell senescence and death.Phenotype and genotype, chromosomal basis of heredity; Mendel’s laws of inheritance. Random genetic drift, inbreeding, measures to prevent random genetic drift and inbreeding; selective breeding programs - selection of species and traits, choice of breeding strategy, methods of selection and evaluation of selection response, impacts of selective breeding programs on aquaculture productivity.
112220	<i>Beneficial Microorganisms applications in Aquaculture</i>	Probiotics, Utilization of Microorganisms for Biopurification of water and Wastewaters, Microbial Production of Polyhydroxyalkanoates for Aquacultural Applications, Bacteriocins Production by LAB, Application of Biofloc in Aquaculture: An Evaluation of Flocculating Activity of Selected Bacteria from Biofloc , Identification and Screening of Bioflocculant-Producing Bacteria, Biopreservation of Seafood by Using Bacteriocins and Bacteriocinogenic Lactic Acid Bacteria as Potential Bio-control Agents.
112221	<i>Aquatic Biotechnology</i>	Marine organisms as sources of untapped resources. Bioactive compounds from marine organisms (Microorganisms, Sponges,

		<p>Corals, Bryozoans and Tunicates). Seaweeds as a source of polysaccharides. Seaweeds for removal of heavy metal pollutants. Biotechnological applications of extremozymes from extremophilic organisms. Unculturable bacteria, occurrence, characteristics and exploitation. GFP characteristics and applications.</p> <p>Probiotics bacteria and their importance in aquaculture. Vaccines for aquaculture. PCR and other techniques for identification of pathogen in aquaculture. Gene probes and their applications in disease diagnosis. Chromosomal manipulation of commercially important marine organisms. Transgenic fish technology. Transgenic fishes with growth hormone (GH) and antifreeze genes. Transposon in fishes.</p>
112222	<b><i>DNA and genetic analysis</i></b>	<p>DNA, gene, genome and genetic analysis, Recombinant DNA Technology, SNP and microsatellite DNA, PCR and DNA fragment analysis, Gene Expression and Functional Genomics, Knock-out mice and transgenic Animal, microinjection demonstration, Impacts of genetic variations, DNA based genetic analysis and animal breeding, Data analysis and statistical methods, Applications of DNA-based genetic analysis to research.</p>
112223	<b><i>Food biotechnology - advanced</i></b>	<p>Biotechnological applications in food and beverage production. Fermentation technology and management. Biochemistry of fermentation processes. Downstream processing of fermented commodities Advantages and disadvantages of gene-modification technologies in food production. Quality Factors in Preprocessed Food, Food deterioration and its control, Microbial role in food products, Yeast, Bacterial and other microorganisms based process and products. Bioconversion of whey, molasses and starch and other food waste for value addition, Regulatory and Social aspects of Food Biotechnology.</p>
112224	<b><i>Bioethics</i></b>	<p>Principles of bioethics, Environmental Ethics, Human Use of Non-Human Animals: a Biologist's View, Enhancements: genes, drugs, and mind control, Biotechnology and bioethics, Ethics in general: ethics, action and freedom, Ethical Issues in Agriculture and Food Production; Ethics in the context of society: ethics, society and the law; Ethical Issues in Biomedical Science: Genetic Information: Use and Abuse, Cloning of Animals and Humans, Animal Experimentation in Biomedical Research, Crop Biotechnology and Developing Countries.</p>