

## M.F.Sc. (Post Harvest Technology)

### Course Structure – At a Glance

<b>A</b>	<b>MAJOR COURSES</b>			<b>20 Credits</b>
	<b>A1</b>	<b>CORE COURSES</b>		<b>12 Credits</b>
1	PHT 501	Low Temperature Preservation of Fish and Shell Fish	2+1	
2	PHT 502	Thermal Processing of Fish and Fishery Products	2+1	
3	PHT 503	Applied Microbiology	2+1	
4	PHT 504	Quality Assurance, Management and Certification	2+1	
	<b>A2</b>	<b>OPTIONAL COURSES</b>		<b>8 Credits</b>
1	PHT 505	Applied Fish Biochemistry	2+1	
2	PHT 506	Value added fish products	2+1	
3	PHT 507	Design, Maintenance of Fish Processing Plants and Instrumentation	1+1	
4	PHT 508	Microorganisms of Public Health Significance	1+1	
5	PHT 509	Fish Byproducts and Waste Utilization	1+1	
6	PHT 510	Molecular Techniques in Seafood Quality Analysis	1+1	
7	PHT 511	Packaging of Fish and Fishery Products	1+1	
8	PHT 512	Fish Processing Technology	2+1	
9	PHT 513	Traditional Fishery Products	1+1	
10	PHT 514	Multivariate Analysis in Food Processing and product development	0+1	
11	PHT 515	Trade Regulations, Certification and documentation in export of fish and fishery products	1+0	
<b>B</b>	<b>MINOR COURSES</b> (Courses outside major discipline / from other relevant disciplines)			<b>9 Credits</b>
<b>C</b>	<b>SUPPORTING COURSES</b> (Compulsory)			<b>5 Credits</b>
1	FST 501	Research Methodology	1+1	
2	FST 502	Statistical Methods	1+2	
		<b>Total Course Work Credit Hours</b>		<b>34 Credits</b>
<b>D</b>	<b>MASTERS' SEMINAR</b>			<b>1 Credit</b>
1	PHT 591	Masters' Seminar I	0+1	
<b>E</b>	<b>FIELD TRAINING</b>			<b>2 credits</b>
1	PHT 551	Field Training Phase I	0+2	
<b>F</b>	<b>MASTERS' RESEARCH</b>			<b>30 Credits</b>
	PHT 599	Masters' Research (Semester III)	0+15	
	PHT 599	Masters' Research (Semester IV)	0+15	
	<b>Total MFSc Program Credit Hours</b>			<b>67 Credits</b>

## POST HARVEST TECHNOLOGY

### Course Contents

**PHT 501                      LOW TEMPERATURE PRESERVATION OF FISH AND SHELLFISH                      2+1**

**Objective**                      To give detailed insight into various aspects of handling, chilling and freezing of seafood

**Theory**

- Unit I      Postmortem changes. Structural and chemical features of fish and shellfish as raw material for processing. Factors affecting quality of fresh fish- intrinsic and extrinsic factors. Handling of fish onboard, landing centres and farm sites-different types of chilling methods, depuration of bivalves.
- Unit II      Chilled storage of fish. Heat load calculation, storage methods- insulated boxes and insulation thickness, different types of ice, physical, chemical, microbiological and sensory changes during chill storage, melanosis and its prevention, iced storage shelf life, cold shock. Transportation- live fish/shell fish, transportation of raw fish to local markets and processing centres, improvements needed in transportation, refrigerated transport systems, classification of transport vehicles, cold chain.
- Unit III      Freezing of fish and shellfish, structure of water and ice, influence of solutes on the structure of water and ice, phase equilibria and freezing curves of pure water and binary solutions, freezing curves for fish, determination of freezing points from time, temperature plots, calculation of freezing time; crystallization, nucleation-homogeneous and heterogeneous nucleation; super cooling, crystal growth, eutectic point, location of ice crystals in tissue, changes during freezing.
- Unit IV      Technological aspects of freezing-methods of freezing (plate freezing, IQF, etc), selection of a freezing method, product processing and packaging, packing of fresh and frozen fish for consumers, modified atmosphere packaging, controlled packaging.
- Unit V      Frozen storage- physical changes, freezer burn and recrystallisation, different types of recrystallisation. Chemical changes in lipids, proteins and nucleotides, freeze denaturation and theories on denaturation, changes in pH, bacterial changes, sensory changes, texture, taste, odour, effect of post-mortem condition on sensory qualities. Prevention of quality loss during frozen storage, treatments prior to freezing, antioxidants, cryoprotectants and other additives, theories of cryoprotection, glazing-importance and methods.
- Unit VI      Cold storage management-arrangements within a cold storage, handling and stacking systems. Time temperature tolerance, temperature and duration of storage on quality and shelf life.

**Practical**                      Chill storage studies. Chemical, physical and sensory analysis, determination of shelf life; Handling of fish, bivalves, prawns, mollusks. Depuration-treatment with chemicals. Evaluation of freshness of fish. Filleting of fish, treatments, glazing, packaging, freezing. Processing of prawns, lobster, squid, cuttle fish, crab etc. in different styles; Packaging

and Freezing. Freezing curve, determination of freezing point. Studies on physical, chemical and sensory changes.

**Suggested reading**

1. Balachandran KK. 2001. Post-harvest Technology of Fish and Fish Products. Daya Publ. House.
2. Clucas IJ. 1981. Fish Handling, Preservation and Processing in the Tropics. Parts I, II. FAO.
3. Gopakumar K. (Ed.). 2002. Text Book of Fish Processing Technology. ICAR.
4. Fennema K, Powrie WD & Marth EH. 1973. *Low Temperature Preservation of Foods and Living Matter*. Marcel Dekker.
5. Hall GM. (Ed). 2011. *Fish Processing –sustainability and new opportunities*. Wiley-Blackwell.
6. Sen DP. 2005. *Advances in Fish Processing Technology*. Allied Publ.
7. Venugopal V. 2006. *Seafood Processing*. Taylor & Francis.

**PHT 502**

**THERMAL PROCESSING OF FISH AND FISHERY PRODUCTS**

**2+1**

**Objective**

- To provide information on various aspects of thermal / heat processing.
- To compare cold sterilization with thermal processing.
- To impart knowledge on various types of packaging techniques and materials used in thermal processing.

**Theory**

- Unit I Principles of thermal processing; 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, Fo value, cook value, D value, integrated F value and their inter-relationship; Heat processing and heating equipment
- Unit II Classification of foods : low acid, medium acid and acidic foods, absolute sterility, statistical sterility, commercial sterility, Pasteurization and sterilization
- Unit III 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; Spoilage of canned food, physical, chemical and microbial, examination of cans and seams, effect of canning on nutrient profile.
- Unit IV Canning plant location: practical considerations, canning plant facilities, layout & design. Flexible packing, retort pouch processing of fish and fishery products principles and techniques; Combination and synergistic effects.

**Practical**

Evaluation of pasteurization and sterilization; Determination of TDT and F value Examination of canned foods, can seams, testing sterility, isolation of *Bacillus* and *Clostridium* spp, spore staining, heat penetration curve and cooling curve, canning

operations for different fish/shellfish products; Double seam profile, Heat Penetration Curve, Fo Value, Z value, process time, canning of table fishes, bivalves, crustaceans in different containers, operation of over pressure autoclaves, Canned culinary preparations; Examination of canned fishery products

**Suggested reading**

1. Hall GM. (Ed). 1992. *Fish Processing Technology*. Blackie.
2. Hersom AC & Hulland ED. 1980. *Canned Foods*. Chemical Publ. Co.
3. Larousse J & Brown BE. 1997. *Food Canning Technology*. Wiley VCH.
4. Venugopal V. 2006. *Seafood Processing*. Taylor & Francis.
5. Warne D. 1988. *Manual on Fish Canning*. FAO Fisheries Tech. Paper 285.
6. Zeathen P. 1984. *Thermal Processing and Quality of Foods*. Elsevier.

**PHT 503**

**APPLIED MICROBIOLOGY**

**2+1**

**Objective**

To teach nature and activity of microbes in fish and fishery products, microbiological spoilage and preservation, various aspects of Industrial microbiology, importance of fermentation.

**Theory**

- Unit I Introductory microbiology- classification, nature and activity of microbes in fish and fishery products; microbiology of marine, brackish and freshwater fish/shell fish, microbiology of spoilage and preservation,
- Unit II Microbial changes during icing, freezing and curing, chemical control of microbial spoilage, effect of preservatives on microflora.
- Unit IV Fermentation: batch wise and continuous; Important fermented products and methods of production: vinegar; screening of microorganisms, detection and assay of products of fermentation, preparation and use of fermentation media, starter culture, preparation and maintenance of stock cultures
- Unit V Production of bacterial enzyme, proteins and other useful products; Immobilization of microbial cells and their use, microbial injury, inactive physiological states, (spores and VBNC), unculturable and uncultured bacteria, identification of unculturable groups.

**Practical**

Staining and microscopy of bacteria, motility; Preparation of culture media, enumeration and isolation of bacteria, identification of bacteria, Sampling for TPC, fresh, iced and frozen fish, selection of bacterial groups in iced fish, isolation of fish spoiling bacteria, enumeration of halophilic bacteria from salted fish, antibiotic sensitivity of bacterial culture; Fermentation by selected microbes; Assay of products formed; Determination of optimum conditions for maximum rate of fermentation; Determination of the effect of certain activities on rate of fermentation.

**Suggested reading**

1. Chakraborty P. 1995. *A Text Book of Microbiology*. New Central Book Agency.
2. Criusted J. 1986. *Methods in Microbiology*. Academic Press.
3. Harry WSJR, Paul JV & John JL. 2000. *Microbes in Action*. Freeman & Co. II (ICMSF). Academic Press.
4. Doyle MP, Beuchat LR & Montville TJ. 1997. *Food Microbiology - Fundamentals and Frontiers*. American Society for Microbiology.

5. Michael J, Pelizar JR & Chan ECS. 1998. *Microbiology*. McGraw Hill.

<b>PHT 504</b>	<b>QUALITY ASSURANCE, MANAGEMENT AND CERTIFICATION</b>	<b>2+1</b>
<b>Objective</b>	<p>To teach various aspects of quality assurance system, quality management and national / international certification system</p> <p>To teach factory sanitation and hygiene, water quality and standards</p> <p>To teach quality affecting parameters</p>	
<b>Theory</b>	<p>Unit I Quality management, total quality concept and application in fish trade.</p> <p>Unit II Quality assessment of fish and fishery products: physical, chemical, organoleptic and microbiological quality standards.</p> <p>Unit III Inspection and quality assurance: fish inspection in India, traceability and authenticity; process water quality in fishery industry, product quality, water analysis, treatments, chlorination, ionization, UV radiation, reverse osmosis, techniques to remove pesticides and heavy metals.</p> <p>Unit IV Sensory evaluation of fish and fish products: basic aspects, different methods of evaluation, taste panel selection &amp; constitution, statistical analysis</p> <p>Unit V Quality problem in fishery products: good manufacturing practices, HACCP and ISO 9000 series of quality assurance system, validation and audit.</p> <p>Unit VI National and international standards, <i>Codex alimentarius</i>, USFDA and EU regulations for fish export trade, IDP and SAT formations in certification of export worthiness of fish processing units, regulations for fishing vessels, pre-processing and processing plants, traceability, EU regulations; ISO22000:2006</p> <p>Unit VII Factory sanitation and hygienization: national and international requirements, SSOP. irradiation: radiation sources, units, dose levels, radiation disinfection, radurization, wholesomeness of irradiated foods, effects of irradiation on protein, lipids, vitamins, bacteriological aspects, physical properties, shelf life.</p> <p>Unit VIII Poisoning by chemicals: heavy metals, pesticides, non-metals, occurrence in food and toxic effects; Biological toxins occurring in seafoods: scombroid poisoning, histamine problem, shellfish poisoning, ciguatera poisoning, puffer fish poison. toxin limits.</p> <p>Unit IX Food laws in India, integrated food law (FSSAI).</p>	
<b>Practical</b>	<p>Evaluation of fish / fishery products for organoleptic, chemical and microbial quality; Methods for analysis for bacterial quality parameters, chemical parameters; Evaluation of sanitary conditions in fish processing units; Analysis of typical hazards; Study of correction and corrective action; Detection and estimation of toxic chemicals in food; SQC –process control charts, variable and attribute control charts, acceptance sampling, sampling by attributes, single and double sampling plans.</p>	
<b>Suggested reading</b>	<ol style="list-style-type: none"> <li>1. Advances in Fish processing Technology, Sen D. P., Pub. Allied Publishers Pvt. Ltd. New Delhi (2005).</li> <li>2. Assessment and Management of Seafood Safety and Quality. (2003) Free amino acids Technical Paper No. 444</li> </ol>	

3. Food borne Disease Handbook. II<sup>nd</sup> Edn. (2001) Vol.4:Seafood and Environmental Toxins, Marcel Dekker Inc New York
4. Handbook of Natural toxins - Vol 3. Marine Toxins and Venom. 1988. Marcel Dekker Inc. New York

**PHT 505                      APPLIED FISH BIOCHEMISTRY                      2+1**

**Objective**                      To impart knowledge on macro and trace constituents and nutritive value of fish.  
    To create basic understanding about toxins and toxic substances and their toxic effects.  
    To give a detailed insight into experimental techniques used in food analysis.

**Theory**

- Unit I    Proteins: classification; structural proteins (actin, myosin, tropomyosin, actomyosin paramyosin), sarcoplasmic proteins (myoalbumin, globulin, hydrolases, oxidoreductases); connective tissue proteins (collagen); pigments, heme proteins, hemocyanins, antifreeze proteins. Functional properties of seafood proteins, solubility, emulsification, viscosity, water holding capacity, gelation. Denaturation of proteins, dissociation, aggregation, coagulation, reversibility and their significance to processing and quality.
- Unit II    Lipids: Composition and nutritive value, lipid types and their variations, fatty acid composition of fish liver and body oils, lipid fractionation, triglycerides, phospholipids. Polyunsaturated fatty acids and their beneficial effects on human health. Auto-oxidation of fatty acids, pro- and anti-oxidants, oxidation indices, lipid protein interactions, oxidized lipids-protein interactions and their impact on quality, rancidity, lipases and phospholipases.
- Unit III    Carbohydrates: Classification and biological significance of carbohydrates, structure and properties of monosaccharides, disaccharides and polysaccharides. Uses of modified starch and other carbohydrates as food additives (as thickening and binding agents). Changes in Carbohydrates during processing and relationship of carbohydrates to food stability, gelatinization
- Unit IV    Seafood flavours: Flavour, taste and odour, chemical basis of flavour perception, volatile fatty acids, influence of processing on flavour. Non-protein nitrogenous compounds: free amino acids, peptides, nucleotides, guanidines, urea, quaternary ammonium compounds.
- Unit V    Fundamental techniques in food analysis: Basic principles of chromatography, TLC, Paper and Liquid Chromatography, HPLC, GC and GC-MS. Principle and applications of Spectrophotometry.

**Practical**                      Protein purification, separation of amino acids by TLC and paper chromatography, enzyme assay by spectrophotometer, amino acid analysis by HPLC, determination of protein carbonyls, extraction of lipids, fractionation of lipids by TLC, fatty acid composition by GC, determination of peroxide value, free fatty acids and TBA. and texture profile analysis

- Suggested reading**
1. Se Kwon Kim (Ed.) ***Marine Cosmeceuticals: Trends and Prospects***, CRC Press, 2011  
    (Contains a chapter on 'Potential uses of collagen, chitin and their derivatives as cosmeceuticals' by V. Venugopal)
  2. Balachandran KK. 2001. *Post Harvest Technology of Fish and Fish Products*. Daya

Publ.

3. Sen DP. 2005. *Advances in Fish Processing Technology*. Allied Publ.

4. Venugopal V. 2006. *Seafood Processing*. Taylor & Francis

**PHT 506                      VALUE ADDED FISH PRODUCTS                      2+1**

**Objective**                      To explain the preparation of products from low cost fish

**Theory**

- Unit I      Protein deficiency and need for fortification of food. Digestibility and nutritive value of fish meat. Overview of value added products: Present market trends, scope of value addition, types of value addition, important value added products.
- Unit II      Minced fish meat: equipment for mince preparation, effect of mincing on physical and chemical properties; Different types of mince-based products. Freeze drying, principles, application of phase rule, triple point of water, sublimation of ice, accelerated freeze drying (AFD), shelf life and specialties of AFD products, machinery and equipment for freeze drying, process flowchart
- Unit III      Surimi: basic concepts, different unit operations. Cryoprotectants in surimi- hypothesis and mechanisms, packaging, freezing and storage. Quality evaluation of surimi, Kamaboko and analogue products.
- Unit IV      Battered and breaded products: present and future market, ingredient for batter system, functionality of corn in coatings, fats and oils, flavourings and seasonings in batter and breading systems, factors affecting performance characteristics of wheat flour batters, hydro-colloids in batter, breading, functional properties and classification, microwavable coated foods, batter and breading process, equipment, application of batters and breading to sea foods, , technique for batter and breading systems
- Unit V      Ready-to-eat and ready-to-cook products- Extruded fish products: Mechanism of extrusion, types of extruders: single screw, twin screw, mechanical and chemical changes during extrusion, parameters affecting quality of extruded product, cook-chill process
- Unit VI      Seaweeds: Resources, global and Indian scenario. Biochemical components in Seaweeds. Edible seaweeds – Nutritive value of seaweeds,  
Products from seaweeds- phycocolloids: agar, alginate, carrageenan- characteristics, application; bioactive molecules, minerals, pigments and their applications.

**Suggested reading**

1. Venugopal V. 2006. *Seafood Processing*. Taylor & Francis.
2. Balachandran KK. 2001. *Post-harvest Technology of Fish and Fish Products*. Daya Publ. House.

**PHT 507                      DESIGN, MAINTENANCE OF FISH PROCESSING PLANTS AND 1+1  
INSTRUMENTATION**

**Objective**                      To expose the students to design, maintenance of fish processing plant, machinery and the instruments used in fish processing plants.

## Theory

- Unit I Plant design: fundamentals of processing plant design, site selection, design and preparation of layout of processing plants, freezing plant, cold storage, canning plant, dryers, etc.
- Unit II Functions and construction of refrigeration system: tests and inspection, operation and handling, pressure-enthalpy (P-H) diagram and basic calculation, application of P-H diagram, size and required power of compressor, maintenance of refrigerating machine, troubles and causes
- Unit III Preventive maintenance of machinery and equipment of fish processing plants, IOF, canning plant, sausage plant, artificial dryers, smoking chambers, etc., safety controls for freezing and canning plant
- Unit IV Effluent treatment: legislation and standards of effluent discharge, water pollution control measures in the food industry, waste water treatment process; Dissolved air floatation, sedimentation, chemical treatment, biological treatment, aeration, carbon adsorption, granular media filtration and sludge handling; Boilers: classification and selection, boiler mounting and accessories
- Unit V Measurement techniques; Sensors, active and passive sensors, characteristic of sensors for the measurement of temperature, relative humidity,  $a_w$  value, gel strength; moisture, freshness, pH, conductivity, DO, redox potential, salinity, air velocity, solar energy and brine concentration
- Unit VI Thermometers: different types of thermometers, characteristics and application
- Unit VII Instrumentation techniques: general configuration of instrumentation system; Instrumentation for measurement of  $a_w$  value, temperature, pH, freshness, gel strength, salinity, brine concentration.

**Practical** Operation and maintenance of machinery and equipment for cold storage plant, freezing plant, canning plant, sausage making, dryers, boilers, etc.; Assembly of a refrigeration unit and charging refrigerant; Measurement of temperature inside cold storage/freezer, fish during freezing and thawing; Estimation of gel strength; Measurement of solar radiation, air velocity, air temperature; Measurement of salinity, conductivity, pH; Estimation of  $a_w$  value.

**Suggested reading**

1. Chupakhim V & Dormenko V. 1985. *Fish Processing Equipments*. MIR Publ.
2. Heid JL & Joslyn MA. 1980. *Food Processing Operations*. AVI Publ. 188
3. Slade FH. 1997. *Food Processing Plants*. Leonard Hill.
4. Wheaton FW & Lawson TB. 1985. *Processing Aquatic Food Products*, John Wiley & Sons.

**PHT 508 MICROORGANISMS OF PUBLIC HEALTH SIGNIFICANCE**

**1+1**

**Objective** To teach in detail about food-borne microorganisms of human health significance, food-borne diseases and their prevention.

## Theory

- Unit I Sources of pathogens in seafood, infection and intoxication; microbial food poisoning, bacteria of public health significance in fish / fishery products / environments.



	Epidemiology.
Unit II	Botulism and staphylococcal food poisoning, organism responsible and their origin, growth and toxin production, nature of toxins, incidence of poisoning, foods involved.
Unit III	The etiology of diseases: Conditions for outbreak & prevention. Food infections by <i>Salmonella</i> , <i>Clostridium perfringens</i> , <i>Vibrio parahaemolyticus</i> , <i>V. vulnificus</i> pathogenic <i>E. coli</i> , <i>Listeria monocytogenes</i> , <i>Campylobacter</i> , <i>Arcobacter</i> ; virulence mechanisms, their sources, incidences, foods involved, , and prevention measures.
Unit IV	Histamine poisoning, Aflatoxins, patulin, ochratoxin and other fungal toxins found in food, toxin producer, source, nature of toxin, toxicity and significance in foods. Virus and some parasites found in foods.
<b>Practical</b>	Laboratory techniques to detect and identify pathogens in fish - <i>E. coli</i> , <i>Staphylococcus aureus</i> , <i>Streptococcus faecalis</i> , <i>Clostridium perfringens</i> , <i>Clostridium botulinum</i> , <i>Salmonella</i> , <i>Listeria</i> , <i>Vibrio cholera</i> , <i>Vibrio parabaemolyticus</i> , <i>V. vulnificus</i> , Animal bio assay of bacterial toxins.
<b>Suggested reading</b>	<ol style="list-style-type: none"> <li>1. Michael P. Doyle ,and ,Robert L. Buchanan. Food Microbiology : Fundamentals and Frontiers, 4th Edition. ASM Press</li> <li>2. Thomas J. Montville , , Karl R. Matthews , and ,Kalmia E. Kniel. Food Microbiology : An Introduction, Third Edition. ASM Press</li> <li>3. J. Hoorfar. Rapid Detection, Characterization, and Enumeration of Foodborne Pathogens. ASM Press.</li> </ol>

**PHT 509 FISH BY-PRODUCTS AND WASTE UTILIZATION 1+1**

**Objective** To teach concepts of utilizing seafood wastes and byproducts from fish and shellfish

**Theory**

- Unit I Overview of fish processing wastes, by catch and its composition. Liquid and solid wastes in fish processing. Bioremediation, anaerobic treatment, production of animal feed, biodiesel.
- Unit II Fish meal: production (dry and wet process), nutritional importance and quality requirements, specifications, packaging and storage. Fish silage: acid silage and fermented silage, advantages over fish meal, nutritional value of silage
- Unit III Fish Oil: Fish body and liver oils, extraction, purification, preservation and storage, industrial and nutritional applications of fish oils; production of concentrates of polyunsaturated fatty acids, preparation of fatty alcohol and amides. extraction of shark liver oil, squalene, shark cartilage; ambergris
- Unit IV Shellfish Waste: sources and composition, conventional uses, , chitin, chitosan, glucosamine hydrochloride, carotenoids from shellfish waste and its applications, production and use of protein isolates from squilla and shrimp waste,
- Unit V Fish protein hydrolysates- production and utilization, biochemical composition and importance in food and nutrition, functional properties of bioactive peptides;
- Unit V Utilization of solid wastes - collagen, gelatin, extraction of enzymes. Recovery of proteins from liquid wastes.

**Suggested** 1. Venugopal, V. Fish industry byproducts as source of enzymes and their applications

- reading** in seafood processing, in '*Fish Processing Byproducts: Quality Assessment and Applications*', Sachindra NM, Mahendrakar NS (Eds), Studium Press LLC, USA. (2014, in press)
2. Elvevoll, E. O., Fish waste and functional foods, Norwegian College of Fishery Science, Department of Marine Biotechnology, Norway. [edele@nfh.uit.no](mailto:edele@nfh.uit.no)
  3. Balachandran KK. 2001. *Post Harvest Technology of Fish and Fish Products*. Daya Publ.
  4. Gopakumar K. (Ed.). 2002. *Text Book of Fish Processing Technology*. ICAR. 198
  5. Wheaton FW & Lawson TB. 1985. *Processing Aquatic Food Products*. John Wiley & Sons.

<b>PHT 510</b>	<b>MOLECULAR TECHNIQUES IN SEAFOOD QUALITY ANALYSIS</b>	<b>1+1</b>
<b>Objective</b>	To teach basic concepts and techniques in molecular biology and immunology	
<b>Theory</b>		
Unit I	Introduction to molecular biology; nucleic acids, structure, replication, translation, transcription, genomes, genes, organization, operons, plasmids, transposons	
Unit II	Enzymes in molecular biology, polymerases, ligases, restriction enzymes, topoisomerases	
Unit III	Molecular methods and their principles, PCR, RT-PCR, hybridization, microarray	
Unit IV	Immunological techniques in pathogen detection; antigen-antibody reactions, Immunoassays-ELISA, FAT; transgenic fish, authenticity testing.	
Unit V	Basic bioinformatics- Introduction, In-Silico DNA and protein analysis, restriction digestion, primer and probe designing, ORF & promoter features, multiple sequence alignment, protein structure prediction, genome comparisons	
<b>Practical</b>	Conventional DNA extraction, Application of PCR for pathogen detection, Probe labeling and Southern hybridization, primer designing, T <sub>m</sub> determination, agarose and protein electrophoresis, cloning of genes, transformation techniques, DNA sequencing. Bioinformatic analysis of DNA and proteins.	
<b>Suggested reading</b>	<ol style="list-style-type: none"> <li>1. J. Hoorfar. Rapid Detection, Characterization, and Enumeration of Foodborne Pathogens. ASM Press</li> <li>2. Helen Kreuzer and Adrienne Massey. Molecular Biology and Biotechnology: A Guide for Students, Third Edition. ASM Press</li> <li>3. C. A. Reddy and others. Methods for General and Molecular Microbiology, Third Edition. ASM Press</li> </ol>	

<b>PHT 511</b>	<b>PACKAGING OF FISH AND FISHERY PRODUCTS</b>	<b>1+1</b>
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**Objective** To learn about different packaging materials, their appropriate use and benefits.

**Theory**

Unit I Food packaging, its purposes and procedures; technological aspects of packaging fishery products; packaging for transport, shipping and institutional supplies; packaging standards for domestic and international trade.

Unit II Packaging materials; basic films and laminates, their manufacture and identification; resistance of packaging materials; development of protective packaging for fishery products.

Unit III Methods of testing for packaging materials for their physical properties; containers and their testing and evaluation; package designs; resistance of packages to hazards in handling; transport and storage.

Unit IV Labeling and printing of packaging materials.

**Practical** Assessment of quality parameters such as moisture permeability, grease resistance, thickness/guage of basic plastic films and laminates. Quality assessment of paper and board and the products prepared from them. Evaluation of packages with regard to the resistance to handling, transportation and storage.

**Suggested reading** T.K Srinivasa Gopal (2009)- Seafood packaging, CIFT publication

**PHT 512 FISH PROCESSING TECHNOLOGY**

**2+1**

**Objective** To give a detailed insight into various aspects of fish processing technology

**Theory**

Unit I Introduction to fish processing:- Importance of fish in human diet; Chemical constituents in fish; Causes of fish spoilage; principles of fish preservation, Importance of processing; Handling of fish and transportation.

Unit II Traditional methods of fish processing:- Icing, Drying, Salting, Smoking, Pickling, Fermentation.

Unit III Use of ice as a cooling medium:- Icing of fish, different types of ice and their manufacture. CSW, RSW. Freezing of fish – slow freezing and quick freezing, freezing curve. Different types of freezers. Quality changes during frozen storage. Theory of freezing damage. Basic refrigeration cycle,

Unit IV Canning: Unit steps in canning and their significance. Retort pouch, Can corrosion, Botulism, spoilage of canned fish.

Unit V Value addition and product development:- Minced based products, coated products, IQF products; Waste utilization: Fish meal, fish oil, Chitin and chitosan

Unit VI Packaging of fish and fishery products:- Packaging materials; basic films and laminates, Technological aspects of packaging fishery products; packing of fresh and frozen fish for consumers; packaging for transport, shipping and institutional supplies;

Unit VII	Quality control during handling and processing; Important pathogenic microbes; Cross contamination; Hygiene in the fish processing factory – the HACCP principle.
<b>Practical</b>	Proximate composition of different fish and fishery products, estimation of alpha amino nitrogen, TMA and TVBN in fresh and dried fish, Determination of available chlorine in bleaching powder/bleach liquor, estimation of salt content in dried fish. Estimation of microbiological parameters in different fish products.
<b>Suggested reading</b>	<ol style="list-style-type: none"> <li>1. Balachandran KK. 2001. <i>Post Harvest Technology of Fish and Fish Products</i>. Daya Publ.</li> <li>2. Gopakumar K. (Ed.). 2002. <i>Text Book of Fish Processing Technology</i>. ICAR. 198</li> <li>3. Sen DP. 2005. <i>Advances in Fish Processing Technology</i>. Allied Publ.</li> <li>4. Venugopal V. 2006. <i>Seafood Processing</i>. Taylor &amp; Francis.</li> <li>5. Wheaton FW &amp; Lawson TB. 1985. <i>Processing Aquatic Food Products</i>. John Wiley &amp; Sons.</li> </ol>

**PHT 513                      TRADITIONAL FISHERY PRODUCTS                      1+1**

**Objective**                      To create understanding on various  
To impart knowledge on changes during storage of products.

**Theory**

- Unit I    Free and bound water in foods, water activity and sorption behaviour of foods, storage characteristics, microbial spoilage, effects of water activity on chemical deterioration, enzymatic reaction, non-enzymatic browning, lipid oxidation, reaction between lipids and proteins, dry fish, control of micro-organisms.
- Unit II    Principles of drying and dehydration: Kinetics of drying, psychometrics, drying calculation, constant rate and falling rate, drying time in air, moisture transport mechanism, natural drying, solar drying and mechanical drying, different types of dryers, tunnel drier, vacuum drier, drum drier, solar drier, etc.
- Unit III    Dehydration of fish products: dehydration ratio, precautions to be taken in fish drying; Denaturation of fish protein
- Unit IV    Cured fish, use of salt, factors affecting salt uptake by fish, lean and fatty fish, whole, gutted or split open, type and size of salt crystals, source of salts and impurities in salts, effect of impurities on salt penetration, temperature of salting; Methods of salting, dry/kench/wet and pickling, brine salting, Colombo curing, specialty of the process. Fermented and marinated products
- Unit V    Spoilage of dried/cured fish, physical, chemical and microbiological changes, methods to prevent/control spoilage, extension of shelf life
- Unit VI    Smoke curing, chemistry of smoke, composition and properties, smoking methods, cold, hot and use of smoke liquids, production of smoke, type of wood used, methods of smoke generation, carcinogens in smoke, smoke kilns. Packaging materials for traditional fishery products.

**Practical**                      Preparation of dried, cured, smoked, marinated and fermented fish products,

**Suggested  
reading**

examination of salt, protein, moisture in dried/cured products, examination of spoilage of dried/cured fish products, marinades, pickles, etc

1. Gopakumar K. (Ed.). 2002. *Text Book of Fish Processing Technology*. ICAR. 198
2. Sen DP. 2005. *Advances in Fish Processing Technology*. Allied Publ.
3. Venugopal V. 2006. *Seafood Processing*. Taylor & Francis.
4. Hall GM. 1992. *Fish Processing Technology*. Blackie.
5. Oefjen G, Wilhelm H & Peter. 2004. *Freeze Drying*. Wiley-VCH GmbH & Co.
6. Sen DP. 2005. *Advances in Fish Processing Technology*. Allied Publ.

**PHT 514**

**MULTIVARIATE ANALYSIS IN FOOD PROCESSING AND PRODUCT  
DEVELOPMENT**

**0+1**

**Objective**

To create practical knowledge about Multivariate Analysis in Food Processing and product development.

**Practical**

Importance of multivariate analysis in optimization of different variables to achieve desired traits in food processing, product development and sensory evaluation. Design and analysis of controlled experiments: Full factorial, Factorial, Central composite and Box-Behnken Designs. Exercises to develop suitable designs for extruded products and antioxidant extractions by using Unscrambler software.

Response surface analysis: Selection of variables, design variables and response variables, selection of samples, modeling the response data using Unscrambler software, checking the predictive ability, response surface plots.

Principal Component Analysis (PCA): Principal components, Bi-linear modeling of one single data matrix X, Score plot, Loading plot and Correlation Loadings.

Regression: Principal component regression (PCR), Multiple linear regression (MLR), Partial Least Squares Regression (PLSR): Modeling Y from the essence of X data set, Calibration and Prediction Models

**Suggested  
reading**

1. Alvin C. Rencher. 2002. *Methods of multivariate analysis*
2. Yiu H. Hui. 2006. *Handbook of food science, technology, and engineering*

**PHT 515      TRADE REGULATIONS, CERTIFICATION AND DOCUMENTATION IN EXPORT      1+0**  
**OF FISH AND FISHERY PRODUCTS**

**Objective**      To create basic understanding about Trade Regulations, Certification and documentation in export of fish and fishery products

**Theory**

- Unit I      Foreign Trade Policy of Fish and Fishery Products in Indian context and world context
- Unit II      Export documentation- certificates of origin, other certificates for Shipment of specific goods, export licenses
- Unit III      Export Certification systems: Consignment-wise, In process Quality, Self Certification, Food safety management system, pre-shipment inspection, voluntary food certification scheme, Sri Lanka Scheme (SLSI), Korea Food Scheme (KFDA)
- Unit IV      Export certification: certificate for export (CFE), health certificate, other certification
- Unit V      Dealing with returned consignments.
- Unit VI      Documentation and verification of export related documents.

**Suggested reading**      1.Shaw, I. C., *Food Safety: The Science of Keeping Food Safe*, 440 pages, Wiley-Blackwell, 2012  
2.James, D., Risks and benefits of seafood consumption, FAO, Globefish Research program, 2013. [www.globefish.org](http://www.globefish.org)