# Ph.D (Post Harvest Technology)

## Course Structure – At a Glance

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| **A** | **MAJOR COURSES** | | | **15 Credits** |
| | **A1** | **CORE COURSES** | | 9 Credits |
| 1 | PHT 601 | Principles and Techniques of seafood Analysis | 2+1 | |
| 2 | PHT 602 | Advances in Seafood Processing and Product Development | 2+1 | |
| 3 | PHT 603 | Food safety and Quality Management | 2+1 | |
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| | **A2** | **OPTIONAL COURSES** | | 6 Credits |
| 1 | PHT 604 | Fish Microbiology & Biotechnology | 2+1 | |
| 2 | PHT 605 | Functional properties of fish and shell fish proteins | 2+1 | |
| 3 | PHT 606 | Nutraceuticals of aquatic origin | 1+1 | |
| 4 | PHT 607 | Toxins and Contaminants | 2+1 | |
| 5 | PHT 608 | Applications of nanotechnology in product development | 1+1 | |
| 6 | PHT 609 | Additives in Fish Processing | 1+1 | |
| 7 | PHT 610 | Sensory and Physical Analyses | 2+1 | |
| 8 | PHT 611 | Fishery Industries and The Environment | 1+1 | |
| 9 | PHT 612 | Food Labeling | 1+1 | |
| 10 | PHT 613 | Water Quality Management | 2+1 | |
| **B** | **MINOR COURSES** (Courses outside major discipline / from other relevant disciplines) | | | **8 Credits** |
| **C** | **SUPPORTING COURSES** (Compulsory) | | | **5 Credits** |
| 1 | | | | |
| 2 | | | | |
| | | **Total Course Work Credits** | | **28 Credits** |
| **D** | **DOCTORAL SEMINAR** | | | **2 Credits** |
| 1 | PHT 691 | Doctoral Seminar I | 0+1 | |
| 2 | PHT 692 | Doctoral Seminar II | 0+1 | |
| **E** | **DOCTORAL RESEARCH** | | | **45 Credits** |
| | PHT 699 | Doctoral Research (Semester III) | 0+11 | |
| | PHT 699 | Doctoral Research (Semester IV) | 0+11 | |
| | PHT 699 | Doctoral Research (Semester V) | 0+11 | |
| | PHT 699 | Doctoral Research (Semester VI) | 0+12 | |
| | | **Total PhD Program Credit Hours** | | **75 Credits** |

# POST HARVEST TECHNOLOGY
## Course Contents

**PHT 601 PRINCIPLES AND TECHNIQUES OF SEAFOOD ANALYSIS 2+1**

**Objective** To provide knowledge on various biochemical techniques in fish analysis.

**Theory**

Unit I General principles of separation of micro and macro molecules. Selection of appropriate tools for analysis of fish samples. Outlines of common techniques involved in biochemical analysis.

Unit II Rheology, tribology, TPA. Centrifugation techniques: types of centrifugation (preparative & analytical), concept of Svedberg unit, selecting appropriate rotor, relative centrifugal force.

Unit III Filtration technique: different types of filtration, types of filters and means of using them. Electrophoresis: General principles, types (native and reduced PAGE).

Unit IV IR and FTIR spectrophotometry, spectrofluorimetry, ICP, mass spectrometer.

Unit V Fluorescence microscopy, SEM, TEM, XRD.

Unit VI Chromatographic techniques: general principle, types of chromatography (adsorption, partition, ion-exchange, molecular sieve, affinity, gas chromatography, thin layer chromatography).

**Practical** Characterization of proteins: sarcoplasmic, myofibrillar, stromal; Estimation of proteins-Biuret, Lowry and Dye binding technique. Amino acid analysis, non-protein nitrogen. Extraction and estimation of lipids: measurement of oxidative and hydrolysis of lipids, fatty acid profile. Minerals and heavy metals: estimation by Atomic Absorption spectroscopy. HPLC- determination of histamine. Demonstration of GC-MS-MS.

**PHT 602 ADVANCES IN SEAFOOD PROCESSING AND PRODUCT DEVELOPMENT 2+1**

**Objective** To give a detailed insight into various aspects of advance seafood Processing technologies and product development

**Theory**

Unit I Types of novel processing methods and their applications**:** Supercritical Fluid extraction-SCFX, High-Pressure Processing (HPP); Microwave processing, Accelerated Freeze Drying. Ohmic Heating, Sous-vide technology, pulsed electrical fields (PEF) as a pasteurization technology**,** Ultrasound processing, Ozone/$CO_2$ Processing,

Unit II Hurdle technology: combination with heat, heat and hydrostatic pressure, heat and low pH, heat, NaCl and nitrite, combination with ionising radiation, irradiation and hydrostatic pressure, irradiation and NaCl, irradiation and other adjuncts, heat and irradiation, irradiation and low temperature, low pH and specific acids, low $a_w$ and adjuncts, Modified Atmosphere Packaging; Active and Intelligent Packaging

Unit III Effects of Novel processing techniques on the properties of fish and fishery products

Unit IV Value added products: Present market trends, scope of value addition. Types of value

addition, Important value added products. Constrains in marketing of value added products and developing suitable channels for marketing.

Unit V Fish mince based products: Different types of mince based products and its quality evaluation. Different types of surimi based products and their quality evaluation.

Unit VI Coated products – Principles and type of coating, coating functions, flavorings, seasonings and hydrocolloids in coatings, Fat and oils in coated food and their chemistry, regulatory aspects.

Unit VII products from prawn/shrimp- Nobashi, Barbecue, Sushi, Skewered shrimp mussel and clam meat products; squid products

**Practical** Preparation of extrudates by twine screw extruder. Studying effect of different variables on expansion characteristics and texture profile of extrudates. Effect of microwave cooking on proximate composition, lipid oxidation and texture profile.

Preparation of fish mince, surimi, evaluation of physical and chemical properties, gel strength, colour, formulation of different products; Battered and breaded products from prawns, fish, bivalves, etc., IOF products, fish sausage, burger, fish balls, cutlet, paste.

**Suggested reading**

1. Hall GM. (Ed). 2011. *Fish Processing –sustainability and new opportunities*. Wiley-Blackwell.
2. V. Venugopal (2006) Seafood processing, CRC, Taylor and Francis.

**PHT 603 FOOD SAFETY AND QUALITY MANAGEMENT 2+1**

**Objective**

- To familiarize students with different aspects of quality management systems and evaluation techniques for seafood.
- To teach Seafood Quality Assurance and Quality Assurance Systems.

**Theory**

Unit I The concept of total quality management; The principles of TQM, Zero defect planning, quality circle, quality link, quality culture, statistical quality control. Quality evaluation techniques for seafood: effect of preprocess handling, transport and storage on quality.

Unit II Physical, chemical, bacteriological and Instrumental methods of quality evaluation. Sensory evaluation, validation.

Unit III Quality standards: national and international, seafood quality assurance and quality assurance systems.

Unit IV Good Manufacturing (GMP) and Good Hygiene Practices (GHP): codex guidelines. Concept of HACCP in seafood safety. HACCP team management role and CCPs & implementation procedure for HACCP. ISO 9000 series of standards.

Unit V EU directives and US regulations. QA programme elements.

Unit VI Evaluation of costs and benefits. Management of equipment and supplies.

Unit VII Chemicals: primary standards, reference standards, reference material (RM), Certified Reference Material (CRM) and Standard Reference Material (SRM);

Unit VIII Uncertainty and calculation of uncertainty of measurements, method validation, sample accountability. Sampling plan: probability sampling and non- probability

sampling, method of selection, method of validation, methods to control accuracy and precision.

Unit IX Proficiency and check samples: Intra and inter laboratory test programme, proficiency testing programme. Predictive modeling in quality and safety assurance of fishery products.

**Practical** Developing flow charts and exercises in identification of hazards in processing of fish by different methods. Analysis of physical hazards, study of correction and corrective action. Detection of estimation of important toxic chemicals in food.

**Suggested reading**


1. Gorbutt J. 1997. *Essentials of Food Microbiology*. Arnold Hodder Headline Group.
2. Huss HH. 2003. *Assessment and Management of Seafood Safety and Quality*. FAO Tech. Paper No. 444.
3. Kanduri L & Eckhartt RA. 2002. *Food Safety in Shrimp Processing*. Fishing News Books
4. Kreuzer R. 1971. *Fish Inspection and Quality Control*. Fishing News Books.
5. Shukla RK. 2006. *Total Quality Management Practicing Manager*. New Royal Book


**PHT 604 FISH MICROBIOLOGY & BIOTECHNOLOGY 2+1**

**Objective** To understand the recent trends in microbiology and biotechnology research

**Theory**

Unit I Microbial ecology of food: Pathogens, parasites and zoonoses.

Unit II Pathogen interaction with foods- molecular aspects of attachment, survival, bio-film formation, antimicrobial resistance, microbial control, phage therapy.

Unit III Current research topics in molecular biology of food pathogens, structure-function analysis of microbial toxins, membrane transporters. Co-ordination of virulence gene expression. Genomics of pathogenic bacteria, micro RNA. Application of bioinformatics tools in pathogen research.

Unit IV Recombinant DNA technology applied to food microorganisms- engineering of microorganisms to produce useful metabolites, enzymes, pharmaceuticals, vaccines,

Unit V Molecular biological tools, RT-PCR, microarray, hybridization techniques, next generation sequencing techniques, biosensors.

Unit VI Immunology: immunoglobulins, monoclonal antibodies, application of antigen and antibody reactions, immunomagnetic separation, proteomics and vaccine designing.

**Practical** Molecular biological and Immunological assays for pathogenic bacteria and viruses, construction of recombinant plasmid, recombinant protein expression and purification. Transformation, gene knockout techniques, library construction.

**Suggested reading**


1. Bernard R. Glick, Jack J. Pasternak, Cheryl L. Patten. Molecular Biotechnology: Principles and Applications of Recombinant DNA.
2. Alexander N. Glazer, Hiroshi Nikaido. Microbial Biotechnology: Fundamentals of Applied Microbiology.
3. Garth L. Fletcher, Matthew L. Rise: Aquaculture biotechnology

**PHT 605 FUNCTIONAL PROPERTIES OF FISH AND SHELL FISH PROTEINS 2+1**

**Objective** To provide knowledge on those biochemical properties known to affect product property.

**Theory**

Unit I Definition of functional properties and their importance in proteins from fish. Typical functional properties of proteins in food system.

Unit II Protein structure and function: Protein folding and non-covalent forces stabilizing protein structure with special reference to hydrophobic interactions. Free energy and entropy concept in relation to hydrophobic interaction. Surface hydrophobicity and its relation to functional properties. Estimation of surface hydrophobicity and total hydrophobicity.

Unit III Solubility and water sorption of proteins: Factors affecting protein hydration. Viscosity in relation to protein hydration: Methods of estimating viscosity.

Unit IV Gelation: Definition of gel, mechanism of formation of gel, factors affecting the gel formation. Evaluation of gelling capacity- thermal, rheological and microscopy.

Unit V Surfactant properties: emulsifying and foaming. Importance of emulsifying properties of proteins. Theoretical concept of emulsion capacity and stability. Interfacial properties, adsorption from solution. Methods of estimating surface tension.

Unit VI Emulsion instability: Creaming, sedimentation, aggregation vs Brownian aggregation. DLVO theory, microemulsions. Methods for estimation of emulsion capacity and stability.

Unit VII Macromolecular absorption and different stages of foaming. Foam stability in relation to proteins structure. Foaming ability of different protein systems with case studies.

Unit VIII Denaturation and functionality: Changes in functional properties of proteins as affected by icing, freezing, drying, salting and heating. Modification of proteins for improving functionality- Succinylation and acetylation procedures.

**Practical** Evaluation of different functional properties like water absorption, fat absorption, gelling, emulsification capacity and stability of fish/shell fish proteins. Effect of pH, temperature and ionic strength on various functional properties. Prediction of functional properties using model compounds.

**PHT 606 NUTRACEUTICALS OF AQUATIC ORIGIN 1+1**

**Objective** To teach about compounds of biological importance from the sea

**Theory**

Unit I Nutraceuticals and Functional foods: An overview; Nutritional and functional value of marine proteins, lipids and health benefits of omega-3 fatty acids.

Unit II Functional components from fish processing waste: Extraction and applications of collagen, collagen peptides, gelatin and gelatin hydrolysates, chitosan and glucosamine hydrochloride. Squalene and its clinical significance, carotenoids and their utility.

Unit III Antioxidants from marine sources and antioxidant capacity assays-Ferric Reducing Antioxidant Power Assay, β-carotene bleaching assay, ABTS and DPPH assays.

Unit IV Marine bioactive compounds: Antimicrobial, cytotoxic substances; antiviral and

antitumor compositions; secondary metabolites of corals with therapeutic value.

Unit V Delivery of nutraceuticals: Fortification and encapsulation with marine nutraceuticals, Encapsulating methods (spray drying, freeze drying and liposome entrapment.

Unit VI Macromolecules of marine origin that are used as biopackaging, edible films & coatings and drug delivery systems.

**Practical** Extraction of gelatin, chitin and chitosan and evaluation of their functional properties. Emulsification of fish oil with different emulsifiers, Encapsulation of omega-3 fatty acids by spray drying and freeze drying. Extraction of carotenoids and determination of their antioxidant capacity by Ferric Reducing Antioxidant Power Assay, β-carotene bleaching assay, ABTS and DPPH assays.

**Suggested reading**


1. Vazhiyil Venugopal (2008) Marine Products for Healthcare: Functional and Bioactive Nutraceutical Compounds from the Ocean, CRC Press
2. Vazhiyil Venugopal (2011) Marine Polysaccharides: Food Applications, CRC Press


**PHT 607 TOXINS AND CONTAMINANTS 2+1**

**Objective** To understand various types of toxins and contaminants in seafood, their impact on human health, and the analytical methods to estimate toxins and contaminants in foods.

**Theory**

Unit I Status of food borne diseases. Public health significance of food borne toxins, pathogens. Bacterial toxins, composition and mechanisms.

Unit II Marine bio-toxin- Ciguatoxin, Paralytic shellfish toxins, Diarrhetic shell fish toxins, scomberotoxins, Brevi toxins, etc. Symptoms, treatment, pharmacology and detection.

Unit IV Analytical methods for different types of marine toxins and tolerance limits, stability, bioassays, pharmacology assays, immunoassays, instrumental methods.

Unit V Chemical contaminants of the aquatic environment- heavy metals (Hg, Cd, Pb, Cr, Ni, As etc.), pesticides, PCB, etc. Toxicity and accumulation.

Unit VI Persistent pollutants, toxicity evaluation, measurement of $LC_{50}$ and factors affecting $LC_{50}$. Animal tissue Analysis.

**Practical** Detection of bacterial and fungal toxins. Analysis of heavy metals and pesticides; Biogenic amine estimation.

**Suggested reading**


1. Abigail A. Salyers: Bacterial Pathogenesis: A molecular approach
2. Valtere Evangelista & others: Algal Toxins: Nature, Occurrence, Effect and Detection.
3. J. P. Felix D'Mello: Food Safety: Contaminants and Toxins
4. Vijay K. Juneja, John N. Sofos. Pathogens and Toxins in Foods: Challenges and Interventions

**PHT 608 APPLICATIONS OF NANOTECHNOLOGY IN PRODUCT DEVELOPMENT 1+1**

**Objective** To obtain knowledge about various applications of nanotechnology in fish and fishery products

**Theory**

Unit I Fundamentals of nano science and technology.

Unit II Introduction to nanomaterials and nanofabrication techniques: Nanoparticles, nanocomposites, nanolaminates and nanofibres.

Unit III Nano formulations, nano emulsions and nanoprecipitation methods.

Unit IV Characterization of Nanostructures: Scanning electron microscopy (SEM) and atomic force microscopy (AFM), radiation scattering effects (X-ray, light) and particle size dependent fluorescence

Unit V Nanobiotechnology, nanodelivery systems for bioactive compounds, nanoencapsulation of nutraceuticals.

Unit VI Opportunities for nanomaterials in product development and enhancement.

**Practical** Preparation of nanoparticles loaded with bioactive compounds, size distribution of nanoparticles, characterization of nanoparticles by Scanning electron microscopy (SEM) and atomic force microscopy (AFM), preparation of encapsulates by spray drying.

**Suggested reading**

**PHT 609 ADDITIVES IN FISH PROCESSING 1+1**

**Objective** To familiarize with the use of different additives, their effects, levels and detection

**Theory**

Unit I Importance of food additives in fish processing; Classification of additives- Antioxidants, preservatives, emulsifiers and stabilizers, food colors, flavours, sequestrants, antipacking agents, acids-buffers-bases, humectants, firming and crisping agents, sweeteners, enzymes , nutritive additives, flour and bread additives, cryoprotectants.

Unit II Proteins as food additives. Natural antimicrobials- bacteriocins, natural antioxidants.

Unit III Food additives and hypersensitivity; Risks and benefits of food additives. Health considerations and safety evaluation: acute toxicity, metabolic investigations and toxico kinetics, genotoxicity, reproductive toxicity, sub-acute toxicity, sub¬chronic toxicity, chronic toxicity, carcinogenicity, allergenic effect, allowable daily intake.

Unit IV Laws related to additives, methods of demonstrating safety, GRAS (Generally Recognized as Safe) additives. Problem of adulteration and solution.

Unit V Analysis of food additives.

**Practical** Changes in properties of food due to different food additives; Analysis of food for presence of undesirable food additives.

**Suggested reading**

1. Branen AL, Davidson PM & Salmiven S. 1990. *Food Additives*. Marcel Dekker.
2. Middle KRD & Shubik P. 1989. *International Food Regulation Handbook*. Marcel

Dekker.
3. Rahman MS. 2007. *Handbook of Food Preservation*. 2nd Ed. CRC Press.
4. Sen DP. 2005. *Advances in Fish Processing Technology*. Allied Publ.

**PHT 610 SENSORY AND PHYSICAL ANALYSES 2+1**

**Objective** To obtain expertise in sensory and physical analyses of food product

**Theory**

Unit I Development of sensory testing, human subjects as instruments, conducting a sensory study, sensory attributes and their perception.

Unit II Controls for test room, product & panel, factors influencing sensory verdicts.

Unit III Measuring responses- difference tests, triangle test, Duo-trio, and other tests, attribute difference tests. Concepts of RSM.

Unit IV Determining thresholds, selection and training of panel members.

Unit V descriptive analysis techniques, spectrum descriptive analysis method, affective tests, statistical methods and procedures, guidelines for choice of techniques, guidelines for reporting results;

Unit VI Physical and Mechanical properties of foods: colour, dielectric properties, rheology, viscosity of fluid foods, viscoelastic behaviour, texture measurements.

**Practical** Development of taste panel; Use of different decision making aids; Determining threshold for different additives.

**Suggested reading**

1. Andrew J. Rosenthal . 1999. *Food texture: measurement and perception*. Aspen Publishers. Inc, USA
2. Howard R. Moskowitz. 1987. *Food texture: instrumental and sensory measurement*. Marcel Dekker Inc. USA
3. Howard R. Moskowitz . *Applied sensory analysis of foods*, Volume 1
4. Roland P. Carpenter, David H. Lyon and Terry A. Hasdell. 2000. *Guidelines for sensory analysis in food product development and quality control.* Aspen Publishers
5. Morten Meilgaard, Gail Vance Civille and B. Thomas Carr. 1999. *Sensory evaluation techniques.* Taylor & Francis Inc, CRC Press.
6. Harry T. Lawless and Hildegarde Heymann. 1998. *Sensory evaluation of food: principles and practices.* International Thomson Publishing Services Ltd, Cheriton House, North Way, Andover SP10 5BE, U.K

**PHT 611 FISHERY INDUSTRIES AND THE ENVIRONMENT 1+1**

**Objective** To provide theoretical and practical exposure on Environmental Management Systems in fisheries industry

**Theory**

Unit I Environmental management systems: environmental issues (ozone depletion, global warming, etc.), pollution, long term ecosystem degradation.

Unit II Environmental aspects of fisheries industry, their assessment, impact and control; Sources of environmental concerns (physical, chemical and microbiological); Environmental review of fisheries industry.

Unit III Techniques for the identification of environmental aspects; IS/ISO 14000 and its relevance to environmental management system in fisheries industry: background, policy and planning, implementation, checking and review; International and European laws for environmental protection; National environmental laws.

**Practical** Composition analysis of fish processing waste. Resident time analysis for processing waste at the site of disposal.

**Suggested reading**


1. Anon. 2000. *Manual of Chemical Methods*. 2nd Ed. Bureau of Indian Standards: IS/ISO 14000:1996 on Environmental Management System US-EPA.
2. Cesceri LS. 1998. *Standard Methods for Examination of Water and Waste Water*. APHA.
3. Hurst CJ. 2002. *Manual of Environmental Microbiology*. 2nd Ed. ASM Press.
4. Wise DL. 1994. *Process Engineering for Pollution Control and Waste Minimization*. Marcel Dekker.


**PHT 612** **FOOD LABELING** **1+1**

**Objective** To create basic understanding about labeling of different products, guidelines and enforcement

**Theory**

Unit I Labeling requirements - national and international, legislation on labeling.

Unit II Labeling for product traceability. Components of traceability code – nutrition facts and nutrition labeling, specific requirements of nutrition labeling.

Unit III Food meant for specific age groups and convalescing people. Serving size, calculation of nutrition facts based on nutrient composition and serving size, energy value of foods, EC number.

Unit IV Type of labeling for organic foods, specific foods like organic foods, GM foods, irradiated foods, meat and non-meat foods.

Unit V Label design specification – size, colour, barcoding types.

Unit VI Major nutrients Minor nutrients, Essential nutrients, Function (or note) of nutrients - (providing energy, tissue building).

Unit VII Nutritional research -Nutritional aspects of fish proteins, lipids, vitamins and free minerals.

**Practical** Analysis of major and minor nutrients, calculation of nutrition facts, preparation of labels for typical food items. Analysis for total calorie, calorific value of fats, protein and carbohydrates. PER, BV, NPU analysis of different products.

**Suggested reading**


A Food Labelling Guide; Guidance for Industry (2013) FDA document

**PHT 613 WATER QUALITY MANAGEMENT 2+1**

**Objective** To obtain enough knowledge in all aspects of water quality and its management for processing and drinking purpose.

**Theory**

Unit I Sources of water, types of water: type I, type II, type III, their characteristics; Reagent grade water specifications.

Unit II Water quality criteria: physical factors (colour, odour, taste, turbidity, conductivity, pH and Eh), chemical parameters (physico-chemical parameters in relation to water's natural structure).

Unit III Undesirable substances in drinking water; Parameters concerning toxic substances: toxic metals/metalloids, cyanides, pesticides and related products and polycyclic aromatic hydrocarbons; Organic compounds and their tolerances: polychlorinated biphenyls, pentachlorophenol, 2, 4, 6 trichlorophenol, chlororesorcinol, total nitramine and haloforms in potable water.

Unit IV Microbiological parameters: important pathogenic organisms and their sources, Salmonella, pathogenic Staphylococcus, fecal bacteria, enteroviruses, algae, other organisms.

Unit V Water quality standards: Indian standard, US PHS, EEC, WHO standards.

Unit VI Sources of drinking water. Sources of contamination of drinking water. Ground water contamination. chemical threats to drinking water quality; Primary water quality criteria; Point source and non point source of contamination.

Unit VII Water treatment and disinfection methods: purification and treatment of water, sedimentation, coagulation, sand filtration and lime treatment. Chlorination of water, use of chlorine dioxide ($ClO_2$) ozonization, UV radiation and reverse osmosis: Implications of chlorination & trihalomethane compounds in drinking water.

Unit VIII Examination of water: microbiological examination: frequency, public supply with intermediate storage and without intermediate storage; Examination for undesirable and toxic substances; Method of analysis, sampling, etc.

**Practical** Examination of physical, chemical and microbiological quality of water used in fish processing industry

**Suggested reading**


1. Anon. 2000. *Manual of Chemical Methods*. 2nd Ed. Bureau of Indian Standards: IS/ISO 14000:1996 on Environmental Management System US-EPA.
2. Cesceri LS. 1998. *Standard Methods for Examination of Water and Waste Water*. APHA.
3. Hurst CJ. 2002. *Manual of Environmental Microbiology*. 2nd Ed. ASM Press.
4. Wise DL. 1994. *Process Engineering for Pollution Control and Waste Minimization*. Marcel Dekker