Ph.D (Aquatic Animal Health Management): Course Structure – At a Glance

A	**MAJOR COURSES**			**15 Credits**
	A1	**CORE COURSES**		9 Credits
1	AAH 601	Advances in Fish and Shellfish Virology	1+1	
2	AAH 602	Advances in Parasitology	1+1	
3	AAH 603	Advances in Immunology	2+1	
4	AAH 604	Advances in Bacteriology	1+1	
	A2	**OPTIONAL COURSES**		6 Credits
1	AAH 605	Fish Vaccinology	1+1	
2	AAH 606	Biotechnological Tools in Health Management	1+1	
3	AAH 607	Cell culture Techniques	1+1	
4	AAH 608	Nutritional and Toxicity-related Disorders	1+1	
5	AAH 609	Microscopy Techniques	1+1	
6	AAH 610	Aquaculture Medicine	1+1	
B	**MINOR COURSES** (Courses outside major discipline / from other relevant disciplines)			**8 Credits**
C	**SUPPORTING COURSES** (Compulsory)			**5 Credits**
		Total Course Work Credits		**28 Credits**
D	**DOCTORAL SEMINAR**			**2 Credits**
1	AAH 691	Doctoral Seminar I	0+1	
2	AAH 692	Doctoral Seminar II	0+1	
E	**DOCTORAL RESEARCH**			**45 Credits**
	AAH 699	Doctoral Research (Semester III)	0+11	
	AAH 699	Doctoral Research (Semester IV)	0+11	
	AAH 699	Doctoral Research (Semester V)	0+11	
	AAH 699	Doctoral Research (Semester VI)	0+12	
	Total PhD Program Credit Hours			**75 Credits**

AQUATIC ANIMAL HEALTH

Courses and contents

A1 CORE COURSES

AAH 601	**ADVANCES IN FISH AND SHELLFISH VIROLOGY**	**(1+1)**
Objective	To understand recent advances in the field of fish and shellfish virology	
Theory		
Unit I	Molecular virology and pathogenesis of selected viruses infecting fish	
Unit II	Molecular virology and pathogenesis of selected viruses infecting freshwater prawns and shrimp	
Unit III	Recent research advances in antiviral drugs, viral vaccines, emerging viruses and evolution of new viruses	
Practical	Molecular detection and sequence analysis of fish/shellfish viruses; Collection and analysis of molecular information of various viruses using sequence information available on public domain	

AAH 602	**ADVANCES IN PARASITOLOGY**	**(1+1)**
Objective	To understand the recent advances in pathobiology of parasitic infection in fishes and other aquatic organisms. To acquire in-depth knowledge of host-parasite interaction and evolution.	
Theory		
Unit I	Environmental parasitology: Macro-environmental and micro environmental influence on parasite incidence. Ecological parasitology, Manipulative parasites.	
Unit II	Molecular parasitology	
Unit III	DNA taxonomy and barcoding of parasites	
Unit IV	Evolution of parasites; Hyperparasitism. Parasitic adaptation	
Unit V	Antiparasitic drugs applied in aquaculture and their action.	
Unit VI	Fish immunity and parasitic infection (Immune responses against parasites – monogenean, flagellates, ciliates, myxozoans); Immune evasion strategies of parasites. Parasite vaccines; RNA interference and parasites	
Practical	Isolation and culture techniques of parasites. Molecular characterization and diagnosis of parasites. Use of molecular probes for identification of parasites and tracking life stages of parasites. DNA barcoding of parasites; Parasitic survey of selected fishes (case study)	

AAH 603	ADVANCES IN IMMUNOLOGY	2+1
Objective	To learn the recent advances in fish and shellfish immunology	
Theory		
Unit I	Basic Principles & Overview of Immunity; Cardinal signs of immune system.	
Unit II	Cellular Interactions in the Immune System; Mucosal Immunity; Evasion of the Immune Response by Pathogens.	
Unit III	T Cell Activation and differentiation; B Cell Activation and differentiation; Antigen Processing and Presentation.	
Unit IV	Superantigens, DNA vaccines / Recombinant Vectors, Vaccines, Cytokines and therapeutic Uses of Cytokines.	
Unit V	Immunoglobulin Genes; Regulation of Ig Gene Expression.	
Unit VI	Major Histocompatability Complex; Tumor Evasion of Immune Response; Use of Gene-Targeted Knock Out in Immunological Research.	
Unit VII	Classical and alternate Pathway of Complement and their regulation	
Unit VIII	Crustacean immunology	
Practical	Collection, separation and identification of fish leucocytes, Separation of T and B cells, development of anti-T and anti-B antibodies, macrophages, methods of vaccine preparation and techniques of fish immunisation, methods for assessment of efficacy of vaccines. Examination of Hyaline, granular, semi granular cells of shrimps: NBT assay, phagocytic index, ProPo	

AAH 604	ADVANCES IN BACTERIOLOGY	(1+1)
Objective	To understand the intracellular and extracellular life cycle of bacterial pathogens and mechanisms of survival in host cells	
Theory		
Unit I	Pathogenic bacteria and their life cycle, intracellular and extracellular pathogens. Adherence of bacteria to host cells – molecular mechanisms, factors involving adherence	
Unit II	Invasion of host cells, life in phagosome, resistance to intracellular bactericidal molecules, mechanisms of survival in host cells, genes involved and regulation of their expression	
Unit III	Bacterial toxins – Endotoxins, their mode of action. Bacterial toxins – Hemolysins, enterotoxins, pore forming toxins, ion channel blockers, ADP- ribosylating toxins, neurotoxins, their molecular structures, mode of action, genetic control and regulation of expression.	
Unit IV	Host response to bacterial virulence factors – Response to intracellular and extracellular pathogens, cytokines, interlukins, antibodies and other immunological molecules	

Practical	Study of interaction of bacteria with host cells - Estimation of adherence, invasion. Use of erythrocytes to study interaction of bacteria with host cells– assay of hemolytic activity, hemagglutination and its inhibition by mannose, antibodies. Phagocytosis by macrophages and resistance to phagocytosis by pathogens. Assay virulence– LD_{50} – virulence associated enzyme assay – protease, esterase, chitinase. Resistance of virulent bacteria against defence mechanisms of animals – resistance to humoral factors – bactericidins, serum resistance. Specific examples of pathogens: *Aeromonas hydrophila* . Study of A layer protein, extracellular toxic factors. Specific examples of pathogens: Luminous *Vibrio harveyi* for shrimp larvae - study of factor associated with virulence.

A2 OPTIONAL COURSES

AAH 605	**FISH VACCINOLOGY**	**1+1**
Objective	To learn the concepts of vaccination and the latest trends in fish vaccination.	
Theory		
Unit I	General principles of vaccination and vaccination strategies in aquaculture. Influence of environmental parameters on vaccination.	
Unit II	Types of vaccines- killed, live attenuated, synthetic peptide, recombinant, anti-idiotype, DNA and RNAi based vaccines. Monovalent and polyvalent vaccines. Nanoparticle based vaccines.	
Unit III	Vaccine production, quality control, vaccine composition, adjuvants and immunostimulants.	
Unit IV	Immunization against bacterial, viral pathogens and parasites.	
Unit V	Vaccination failure and adverse effects of vaccination.	
Unit VI	Biosafety and regulatory requirements for fish vaccines.	
Practical	Preparation of vaccines; quality control; vaccine administration by different routes; assessment of immune response to vaccination- agglutination test, ELISA, challenge studies; designing of RNAi based vaccines.	

AAH 606	**BIOTECHNOLOGICAL TOOLS IN HEALTH MANAGEMENT**	**1+1**
Objective	To understand the advanced biotechnological tools used for disease diagnosis.	
Theory		
Unit I	Advances in disease diagnostic procedures in aquaculture.	
Unit II	Molecular diagnostic methods such as *in situ* hybridization nucleic acid probe-based diagnosis; Choice and characteristics of probe, Probe labeling	
Unit III	Hybridization: hybridization strategies, factors affecting the rate of hybridization, Immobilization of nucleic acid on filters. Types of hybridization: Southern, Northern, Dot/Slot blot hybridization	
Unit IV	Various types of polymerase chain reaction (PCR) such as conventional one step, nested and semi-nested PCR, RT-PCR, real-time PCR; LAMP etc.	

Unit V	DNA Microarrays : DNA chips, preparations of DNA arrays, label and applications; other related molecular techniques
Unit VI	Antibody-based diagnostics
Practical	Nucleic acid extraction, PCR detection of various pathogens. Monoclonal antibody-based diagnostics. Protein profiling, DNA fingerprinting

AAH 607	**CELL CULTURE TECHNIQUES 1+1**
Objective	To learn cell culture techniques and its applications
Theory	
Unit I	Principles of cell culture; cell culture media and supplements. development of primary cell culture and cell line; maintenance of cell lines. Contamination in cell culture.
Unit II	Characterization, preservation and revival of cell lines.
Unit III	Replication of viruses, host-virus interaction, Isolation and identification of viruses using cell lines; Propagation of viruses using cell lines. Cell transformation and transfection techniques
Unit IV	Application of cell culture in toxicology and vaccine production
Unit V	Hybridoma technology and monoclonal antibody production.
Unit VI	Invertebrate cell culture and its applications
Practical	Media preparation, explant culture, suspension culture, primary cell culture and passaging; Characterization of cell lines (counting, staining), karyotyping, Preservation and revival of cells, viable cell counts, MTT assay. Virus isolation using cell culture. Transfection techniques.

AAH 608	**NUTRITIONAL AND TOXICITY-RELATED DISEASES**	**1+1**
Objective	To understand the impact of nutritional deficiencies and toxic substances on fish health and their remedial measures.	
Theory		
UNIT I	Diseases due to nutritional deficiencies; Anti-nutritional factors in feed ingredients; Toxicity due to pesticides, heavy metals and agrochemicals	
UNIT II	Mycotoxins; Pathology and pathogenesis due to mycotoxins in feedstuffs.	
UNIT III	Phytotoxins in water; its mode of action, tissue responses, toxin manifestations, carcinogenicity, biomagnification and human safety.	
UNIT IV	Fish poisoning and remedial measures	
Practical	On-farm studies on nutritional deficiency diseases; Estimation of mycotoxins in feed; Gross and histopathological changes in different organs due to toxicity.	

AAH 609	MICROSCOPY TECHNIQUES	1+1
Objective	To impart the theoretical and practical knowledge needed to perform microscopical analysis of biological specimens with conventional light, fluorescence, laser scanning confocal and electron microscopy.	
Theory		
UNIT I	Introduction to basic optical theory for conventional light microscopy. General histological specimen preparation techniques and photography.	
UNIT II	Fundamentals of bright field microscopy: Lenses; image formation, diffraction, refraction, dispersion and resolution. Advantages and limitations of Phase Contrast, Differential Interference Contrast (DIC), Dark Field, & Polarized Light Microscopy.	
UNIT III	Fluorescence Microscopy: General Principles; Introduction to fluorescence, Jablonski diagram, filters and sources, fluorophores for fluorescence imaging. Conventional and advanced modern techniques and applications.	
UNIT IV	Confocal Microscopy: Principle of Laser Scanning Confocal Microscopy. Components and foundations of confocal imaging. Advanced Confocal techniques (FRAP, FLIP, FRET and FLIM). Guiding principles for specimen preparation and Imaging.	
UNIT V	Electron microscopy: Introduction to the principles of Electron Microscopy, transmission and scanning electron microscopy, design of the electron microscope. Techniques for biological specimen preparation for TEM, positive and negative staining techniques.	
Practical	Preparation and examination of live and fixed samples for different microscopy and image analysis.	

AAH 610	AQUACULTURE MEDICINE	1+1
Objective	To understand the pharmacokinetics of aquaculture drugs and chemicals	
Theory		
Unit I	Anaesthetics and methods of anaesthetizing fish and shellfish	
Unit II	Different chemicals and drugs used in aquaculture and dosages	
Unit III	Action of different drugs in finfish and shellfish	
Unit IV	Bioaccumulation and toxicity	
Unit V	Antibiotics – use and misuse including development of antibiotic resistant bacteria and their impact on environment and human health	
Unit VI	Use of probiotics and immunostimulants in aquaculture	
Practical	Antibiotic sensitivity test, Estimation of dose Estimation of antibiotic residues Detection of gut colonization by probiotic bacteria	