

## AQUATIC ANIMAL HEALTH MANAGEMENT

CODE	COURSE TITLE	CREDITS
AAH 501*	VIRAL AND BACTERIAL DISEASES OF FINFISH AND SHELLFISH	2+1
AAH 502*	PARASITIC DISEASES OF FINFISH AND SHELLFISH	2+1
AAH 503*	HEALTH MANAGEMENT IN AQUACULTURE	2+1
AAH 504*	SYSTEMIC FISH PATHOLOGY	2+1
AAH 505	FISH IMMUNOLOGY	2+1
AAH 506	MICROBIOLOGICAL TECHNIQUES	1+1
AAH 507	FISH VIROLOGY AND CELL CULTURE	2+1
AAH 508	CLINICAL PATHOLOGY	1+1
AAH 509	NON-INFECTIOUS AND FUNGAL DISEASES	1+1
AAH 510	AQUATIC ENVIRONMENT AND FISH HEALTH	1+1
AAH 511	DIAGNOSTIC TECHNIQUES	1+1
AAH 591	MASTER'S SEMINAR	1+0
AAH 599	MASTER'S RESEARCH	20
AAH 601**	FISH AND SHELLFISH VIROLOGY	2+1
AAH 602**	ADVANCES IN PARASITOLOGY	2+1
AAH 603**	MOLECULAR MECHANISMS IN DISEASE PROCESS	2+1
AAH 604	CRUSTACEAN PATHOLOGY	1+1
AAH 605	FISH PHARMACOLOGY	2+1
AAH 606	BIOTECHNOLOGICAL TOOLS IN DISEASE DIAGNOSIS	1+1
AAH 607	PUBLIC HEALTH MICROBIOLOGY AND EPIDEMIOLOGY	2+1
AAH 608	MOLECULAR TECHNIQUES IN MICROBIOLOGY	1+1
AAH 609	FISH MYCOLOGY AND VIROLOGY	1+1
AAH 691	DOCTORAL SEMINAR I	1+0
AAH 692	DOCTORAL SEMINAR II	1+0
AAH 699	DOCTORAL RESEARCH	45

\* Compulsory for Master's programme; \*\* Compulsory for Doctoral programme

## Course Contents

### **AAH 501                    VIRAL AND BACTERIAL DISEASES OF FINFISH AND SHELLFISH                    2+1**

#### **Objective**

To impart knowledge of viral and bacterial infections, their replication strategies and pathogenesis in fish and shellfish.

#### **Theory**

##### UNIT I

Virology: virus classification, virus replication, General biology of viral infections. OIE Notifiable diseases.

##### UNIT II

Aetiology, pathogenesis, epidemiology, treatment and control, immunology and molecular biology of viruses/viral diseases of finfishes with emphasis on the following: Epizootic haematopoietic Necrosis (EHN), Infectious Haematopoietic Necrosis (IHN), Oncorhynchus Masou Virus (OMV), Viral Encephalopathy and Retinopathy (VER), Spring Viraemia of Carp (SVC), Viral Haemorrhagic Septicaemia (VHS), Lymphocystis and Infectious Pancreatic Necrosis (IPN).

##### UNIT III

Major viral 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.

##### UNIT IV

Pathogenesis, virulence mechanisms, epidemiology, treatment and control measures of the bacterial diseases of finfish and shell fish with emphasis on Furunculosis, Haemorrhagic septicemia, Columnaris disease, Tail and fin rot, Bacterial gill disease, Vibriosis, Mycobacteriosis, Nocardiosis, Haemophilosis, Edwardsiellosis, enteric red mouth.

##### UNIT V

Bacterial diseases of shellfish such as Vibriosis; Necrotizing hepatopancreatitis, rickettsial diseases, mycobacteriosis.

#### **Practical**

Examination of moribund fish for viral and bacterial diseases; Sampling techniques, culture techniques, bioassay methods; Serological techniques in disease diagnosis, microbial identification.

#### **Suggested Readings**

Austin B & Austin DA. 1993. *Bacterial Fish Pathogens. Disease in Farmed and Wild Fish*. 2<sup>nd</sup> Ed. Ellis Horwood.

Eiras J, Segner H, Wahli T & Kapoor BG. 2008. *Fish Diseases*. Science Publ.

Inglis V, Roberts RJ & Bromage NR. 1993. *Bacterial Diseases of Fish*. Blackwell.

Noga EJ. 1996. *Fish Disease Diagnosis and Treatment*. Mosby-Year Book. Roberts RJ. 2001. *Fish Pathology*. 3<sup>rd</sup> Ed. W.B. Saunders.

Sindermann CJ. 1990. *Principal Diseases of Marine Fish and Shellfish*. Vols. I, II. 2<sup>nd</sup> Ed. Academic Press.

Stoskopf MK. 1993. *Fish Medicine*. WB Saunders.

Wolf K. 1988. *Fish Viruses and Viral Diseases*. Cornell University Press.

### **AAH 502                    PARASITIC DISEASES OF FINFISH AND SHELLFISH 2+1**

#### **Objective**

To comprehend the taxonomy, morphology, pathology and host-parasite relation of common parasites of aquatic organisms and to understand the significance of parasites in fish health.

#### **Theory**

##### UNIT I

Parasite taxonomy and morphology: Protozoan and metazoan parasites of fish and shellfish.

##### UNIT II

Life cycle of fish and shellfish parasites.

##### UNIT III

Parasite pathology: Pathology, treatments and control of the disease caused by protozoan parasites: *Costia necatrix*, *Trypanosoma*, *Trypanoplasma*, *Ichthyophthirius*, Urceolariid ciliates, Microsporidians, Myxozoans.

##### UNIT IV

Parasite pathology: Pathology treatments and control of the disease caused by Metazoan parasites: Trematodes: *Dactylogyrus*, *Gyrodactylus*, *Diplozoan*, *Sanguinicola*, *Neascus cuticola*, Cestodes: *Diphyllbothrium latum*, *Caryophyllaeus*, *Ligula*; Nematodes: *Capillaria*, *Camallanus*.

##### UNIT V

Parasite pathology: Pathology treatments and control of disease caused by Acanthocephalan parasites, Crustacean parasites: *Lernea*, *Argulus*, *Ergasilus*, fish leeches.

#### UNIT VI

Shellfish parasites: Pathology, treatment and control of the disease caused by Microsporidians, Haplosporidians, Ciliates and Cephaline gregarines.

#### **Practical**

Collection and identification of parasites; Preparation of permanent slides, micrometry and diagrams of parasites; Histopathological slide preparation of parasite-infected tissues; Processing for study of helminths and their larval stages; Examination of intermediate host for larval stages; Processing and study of the arthropods and their larval stages; Fixation staining and study of the protozoans; Examination of biopsy material, examination of tissue sections for parasites.

#### **Suggested Readings**

Ferguson HW. (Ed). 2006. *Systemic Pathology of Fish: A Text and Atlas of Normal Tissues in Teleosts and their Responses in Disease*. 2<sup>nd</sup> Ed. Scotian Press.

Lom J & Dykova I. 1992. *Protozoan Parasites of Fishes*. Elsevier.

Noga EJ. 1996. *Fish Disease. Diagnosis and Treatment*. Mosby-Year Book.

Rhode K. 2005. *Marine Parasitology*. Steven Simpson Books. Roberts RJ. 2001. *Fish Pathology*. 3<sup>rd</sup> Ed. WB Saunders.

Sindermann CJ. 1990. *Principal Diseases of Marine Fish and Shellfish*. Vols. I, II. 2<sup>nd</sup> Ed. Academic Press. Stoskopf MK. 1993. *Fish Medicine*. WB Saunders.

Woo PTK & Bruno DW. (Eds.). 1999. *Fish Diseases and Disorders*. CABI.

### **AAH 503**

### **HEALTH MANAGEMENT IN AQUACULTURE**

**2+1**

#### **Objective**

To understand the essential principles of aquatic animal health management, biosecurity and specific issues associated with the system.

To appreciate the significance of national and international instruments in quarantine, disease reporting and surveillance and their application in transboundary movement of aquatic organisms.

#### **Theory**

##### UNIT I

Review of various diseases of finfish and shellfish significant to aquaculture; diagnostic procedures and their application in aquaculture.

##### UNIT II

Disease monitoring, surveillance, epidemiology, quarantine, certification and import risk analysis.

##### UNIT III

Prophylaxis, hygiene and therapy of fish and shellfish diseases.

##### UNIT IV

Commonly used drugs/chemicals in aquaculture, drug delivery.

##### UNIT V

Vaccines and vaccination, probiotics and bioremedial measures; immunostimulants and their role.

##### UNIT VI

Application of health management protocols and biosecurity principles in aquaculture.

##### UNIT VII

Longterm strategy in health management; Advances in disease control and management; Principles of SPF/SPR.

#### **Practical**

Demonstration of different diagnostic tools. Sampling procedures for disease investigation; methods of chemical/drug delivery/application; case study.

#### **Suggested Readings**

David SA, Lee CS & O'Bryen PJ. 2006. *Aquaculture Biosecurity- Prevention, Control and Eradication of Aquatic Animal Diseases*. World Aquaculture Society. Blackwell.

Felix S, Riji John K, Prince Jeyaseelan MJ & Sundararaj V. 2001. *Fish Disease Diagnosis and Health Management*. Fisheries College and Research Institute, T.N. Veterinary and Animal Sciences University. Thoothukkudi.

Humphrey J, Arthur JR, Subasinghe RP & Phillips MJ. 2005. *Aquatic Animal Quarantine and Health Certification in Asia*. FAO.

John P. 1999. *Health Maintenance and Principal Microbial Diseases of Cultured Fishes*. 2<sup>nd</sup> Ed. Blackwell.

Noga EJ. 1996. *Fish Disease. Diagnosis and Treatment*. Mosby-Year Book.

Shankar KM & Mohan CV. 2002. *Fish and Shellfish Health Management*. UNESCO.

Stoskopf MK. 1993. *Fish Medicine*. WB Saunders.

**AAH 504 SYSTEMIC FISH PATHOLOGY**

**2+1**

**Objective**

To understand the various systems of fishes and shrimps with specific reference to their pathological significance.

**Theory**

UNIT I

Introduction: Anatomy and physiology of teleost Integumentary, musculoskeletal, respiratory, circulatory, reticuloendothelial, renal, excretory and digestive systems.

UNIT II

Pathophysiology: Stress and general adaptation syndrome, inflammatory response, necrosis and types, stages.

UNIT III

Integumentary system: Cuticular, epidermal dermal and hypodermal changes, hyperplasia and ulceration.

UNIT IV

Respiratory system: Lamellar oedema, lamellar hyperplasia and lamellar fusion.

UNIT V

Blood vascular system: Pathology of heart, vessels, blood composition, cellular components of blood and haemopoietic tissue.

UNIT VI

Digestive system: Digestive tract and its pathology; hepatic necrosis, lipid infiltration, hepatic granuloma, cirrhosis, pancreatic atrophy, neoplasia; epithelial sloughing of intestine.

UNIT VII

Excretory system: Kidney and its pathology, renal tubules and collecting ducts.

UNIT VIII

Nervous system: Pathology of brain, spinal cord, peripheral nerves, meninges, sense organs.

UNIT IX

Musculoskeletal and Endocrine system: Pathological changes in red and white muscle bone and cartilages. Endocrine systems and pathology.

UNIT X

Systemic pathology in shrimp: Integument, respiratory, digestive and nervous system and its pathology.

**Practical**

Necropsy techniques, Systemic pathology of different organs and their identification.

**Suggested Readings**

Andrews C, Excell A & Carrington N. 1988. *The Manual of Fish Health*. Salamander Books Ltd.

Eiras J, Segner H, Wahli T & Kapoor BG. 2008. *Fish Diseases*. Science Publ.

Ferguson HW. (Ed). 2006. *Systemic Pathology of Fish: A Text and Atlas of Normal Tissues in Teleosts and their Responses in Disease*. 2<sup>nd</sup> Ed. Scotian Press.

Roberts RJ. 2001. *Fish Pathology*. 3<sup>rd</sup> Ed. WB Saunders.

Sindermann CJ. 1990. *Principal Diseases of Marine Fish and Shellfish*. Vols. I, II. 2<sup>nd</sup> Ed. Academic Press.

**AAH 505**

**FISH IMMUNOLOGY**

**2+1**

**Objective**

To teach basic principles of fish and shellfish immunology.

**Theory**

UNIT I

Introduction to fish immunology and terminologies; historical developments; Phylogeny of fish immune system.

UNIT II

Lymphoid tissues and cellular components of immune system.

UNIT III

Non specific humoral and cellular defence mechanisms.

UNIT IV

Specific defence mechanisms; Memory function and immunological tolerance.

UNIT V

Complement system, function, components, complement activation.

UNIT VI

Antigens and antigenicity; structure of antibody. Types of antibodies, Theories of antibody formation, Antibody mediated immune response: general characteristics, immunoglobulin classes, structure and function and

synthesis.

#### UNIT VII

Phagocytic systems; Lymphoid systems; Antigen processing and major histocompatibility complex.

#### UNIT VIII

Cell mediated immune response and its components; Hypersensitivity reactions.

#### UNIT IX

Invertebrate defence mechanisms.

#### **Practical**

Preparation of antigen; Raising of antibodies; Antigen-antibody reactions; Agglutination tests; Precipitation tests: gel diffusion; Immunoelectrophoresis, counter immunoelectrophoresis; Isolation of antibody from serum; ELISA; Western blotting; Isolation of lymphocytes and blastogenesis; Non-specific immune response (NBT and prophenoloxidase).

#### **Suggested Readings**

Ellis AE. 1988. *Fish Vaccination*. Academic Press.

Iwama G & Nakanishi T. 1996. *The Fish Immune System. Organism, Pathogen and Environment*. Academic Press.

Janis K. 1997. *Immunology*. 3<sup>rd</sup> Ed. WH Freeman.

Swain P, Sahoo PK & Ayyappan S. 2005. *Fish and Shellfish Immunology: An Introduction*. Narendra Publ. House.

### **AAH 506**

### **MICROBIOLOGICAL TECHNIQUES**

**1+1**

#### **Objective**

To comprehend different microbiological techniques used in research.

#### **Theory**

##### UNIT I

Techniques in sterilization; Preparation of media. Safety in microbiology laboratory, bio-safety levels.

##### UNIT II

Microscopy: bright field, fluorescence, phase contrast, dark field and electron microscope.

##### UNIT III

Stains, staining and its chemistry.

##### UNIT IV

Isolation and culture of different types of bacteria; Techniques for identification: biochemical, serological and molecular techniques.

##### UNIT V

Techniques for isolation and identification of fungi; Basics of mycological and virological techniques.

#### **Practical**

Practical on microscopic techniques; Antibiotic sensitivity testing; Identification of microorganisms, anaerobic bacteria, mycological and virological techniques.

#### **Suggested Readings**

Chakraborty P. 1995. *A Text Book of Microbiology*. New Central Book Agency.

Criusted J. 1986. *Methods in Microbiology*. Academic Press.

Harry WSJR, Paul JV & John JL. 2000. *Microbes in Action*. Freeman & Co.

James M. 1978. *Modern Food Microbiology*. 2<sup>nd</sup> Ed. D. Van Nostrand Co. Michael J, Pelizar JR & Chan ECS. 1998. *Microbiology*. Tata McGraw Hill.

Paul JH. 2001. *Marine Microbiology - Methods in Microbiology*. Vol. XXX. Academic Press.

Samuel CP & Dunn CG. 1959. *Industrial Microbiology*. McGraw Hill. Silliker JH, Elliof RP, Baired AC & Boyan FL. 1980. *Microbial Ecology of Foods*. Vol. II (ICMSF). Academic Press.

William CF & Westhoff DC. 2000. *Food Microbiology*. Tata Mc Graw Hill.

### **AAH 507**

### **FISH VIROLOGY AND CELL CULTURE**

**2+1**

#### **Objective**

To understand classification and structure of viruses and methods of their culture.

#### **Theory**

##### UNIT I

Recent trends in virus taxonomy, viral structure, viral genetics.

##### UNIT II

Host-virus interaction, viral vectors, bacteriophages, propagation of viruses.

##### UNIT III

Principles of cell culture, development of primary cell culture, maintenance of cell lines.

##### UNIT IV

Scaling up of cell culture, characterization and preservation of cell lines.

## UNIT V

Hybridoma and monoclonal antibody production.

### **Practical**

Virus isolation techniques, virus propagation, viral quantitation, neutralization techniques, electron microscopy, cell culture characterization (counting, staining), karyotyping, cell culture preservation, viable cell counts, MTT assay.

### **Suggested Readings**

Alan C. 2005. *Molecular Virology*. Academic Press.

David MK, Peter MH, Diane EG, Robert AL, Malcolm AM, Bernard R & Stephen ES. 2007. *Fields Virology*. 5<sup>th</sup> Ed. Lippincott Williams & Wilkins.

Dimmock N, Easton A & Leppard K. 2006. *Introduction to Modern Virology*. 6<sup>th</sup> Ed. Blackwell.

Freshney IR. 2005. *Culture of Animal Cells: A Manual of Basic Technique*. 3<sup>rd</sup> Ed. John Wiley & Sons.

John RK & Rosalind GM. 2004. *Finfish and Shellfish Diseases* (Practical Manual). Fisheries College and Research Institute, TANUVAS, Thoothukkudi.

Mothersill C & Austin B. 2000. *Aquatic Invertebrate Cell Culture*. Springer Praxis.

Roberts RJ. 2001. *Fish Pathology*. 3<sup>rd</sup> Ed. WB Saunders.

## **AAH 508**

## **CLINICAL PATHOLOGY**

**1+1**

### **Objective**

To teach methods in clinical pathology of aquatic organisms.

### **Theory**

#### UNIT I

Detailed study of normal and abnormal constituents of blood with reference to pathogenic condition.

#### UNIT II

Stress induced conditions in fishes and their pathology.

#### UNIT III

Physiological effects of stressors on fish, tolerance level (pH, ammonia, oxygen, temperature, handling stress, crowding, transportation, chemicals and bacterial toxins).

#### UNIT IV

Cellular response to stress, response to some specific disease.

### **Practical**

Study of cellular components of blood: T.E.C., D.L.C., T.L.C., haemoglobin, total protein, glucose and other parameters, cholesterol, lipid profile, creatinine, urea and enzymes in blood during disease conditions.

### **Suggested Readings**

Ferguson HW. (Ed.). 2006. *Systemic Pathology of Fish: A Text and Atlas of Normal Tissues in Teleosts and their Responses in Disease*. 2<sup>nd</sup> Ed. Scotian Press.

Noga EJ. 1996. *Fish Disease. Diagnosis and Treatment*. Mosby-Year Book.

Roberts RJ. 2001. *Fish Pathology*. 3<sup>rd</sup> Ed. WB Saunders.

Sindermann CJ. 1990. *Principal Diseases of Marine Fish and Shellfish*. Vols. I, II. 2<sup>nd</sup> Ed. Academic Press.

Stoskopf MK. 1993. *Fish Medicine*. WB Saunders.

Wedmeyer G, Meyer FP & Smith L. 1999. *Environmental Stress and Fish Diseases*. Narendra Publ. House.

Leatherland JF & Woo PTK. 1998. *Fish Diseases and Disorders*. Vol. II. *Non-Infectious Diseases*. CABI.

## **AAH 509**

## **NON-INFECTIOUS AND FUNGAL DISEASES**

**1+1**

### **Objective**

To comprehend the etiology and management of different non-infectious and fungal diseases.

### **Theory**

#### UNIT I

Studies on the causes, pathogenesis, pathology, diagnosis and differential diagnosis of various diseases due to nutritional imbalance and avitaminosis, anorexia, mineral deficiency and toxicity.

#### UNIT II

Metabolic diseases in finfish and shellfish. Genetic diseases and neoplastic lesions.

#### UNIT III

Fungal diseases of finfish and shellfish- External and internal fungal infections.

#### UNIT IV

Epizootic ulcerative syndrome (EUS) in fishes- Etiology, epidemiology, pathogenesis diagnosis and management.

## UNIT V

Fungal diseases of shellfish, larval mycosis, fusarium disease, Crayfish plague.

### **Practical**

Study of gross and histopathological changes due to various metabolic diseases and nutritional disorders. Isolation of fungal pathogens.

### **Suggested Readings**

Leatherland JF & Woo PTK. 1998. *Fish Diseases and Disorders*. Vol. II. *Non-Infectious Diseases*. CABI.

Lim C & Webster CD. 2001. *Nutrition and Fish Health*. Haworth Press. Roberts RJ. 2001. *Fish Pathology*. 3<sup>rd</sup> Ed. WB Saunders.

Stoskopf MK. 1993. *Fish Medicine*. WB Saunders.

## **AAH 510**

## **AQUATIC ENVIRONMENT AND FISH HEALTH**

**1+1**

### **Objective**

To comprehend the basic principles of aquatic animal health management in relation to their environment.

### **Theory**

#### UNIT I

Environmental variables related to fish health; Water quality and sediment characteristics.

#### UNIT II

Nature and type of pollutants. Impact of pollutants on environment and fish health.

#### UNIT III

Biological indicators and indices of water quality. Sanitation in aquaculture systems.

#### UNIT IV

Algal blooms and environmental microflora. Microbial toxins.

#### UNIT V

Probiotics and bioremedial measures. Nitrogen balance in aquatic ecosystem.

### **Practical**

Estimation of major pollutants using spectrophotometry. Hematological, histopathological and biochemical analysis of fish exposed to specific pollutants. Testing the efficacy of aquaculture sanitizers.

### **Suggested Readings**

Braunbeck T, Hinton DE & Streit B. 1998. *Fish Ecotoxicology*. Birkhäuser. Noga EJ. 1996. *Fish Disease. Diagnosis and Treatment*. Mosby-Year Book.

Vernam AH & Evans M. 2000. *Environmental Microbiology*. Blackwell Publ.

Wedemeyer GA. 1996. *Physiology of Fish in Intensive Culture Systems*. Springer.

## **AAH 511**

## **DIAGNOSTIC TECHNIQUES**

**1+1**

### **Objective**

To learn the principles and protocols of diagnostic tests used in the diagnosis of fish diseases.

### **Theory**

#### UNIT I

Common bacterial pathogens of fishes. Handling of diseased fish for bacteriological examination, Withdrawal of blood and materials from internal organs for bacteriological examination. Diagnosis and infection experiments, Cultural and biochemical identification procedures. Mycological techniques.

#### UNIT II

Culture media for isolation of pathogens, non-selective, enriched, enrichment and selective media. Inoculation and purification techniques. Staining methods.

#### UNIT III

Serology of microbial disease – agglutination precipitation and ELISA methods in disease diagnosis. Processing tissue samples for virological examination. Techniques for isolation of viruses. Serological tests for identification of viruses.

### **Practical**

Methods for examination and analysing fish for health certification/diagnosis of disease condition, techniques for sample collection and processing for bacteriological, mycological and virological agents, methods for isolation of various bacterial, fungal and viral pathogens by conventional methods, rapid nucleic acid based methods and serological procedures.

### **Suggested Readings**

de la Maza LM, Pezzlo MT & Baron EJ. 2000. *Diagnostic Microbiology*. 2<sup>nd</sup> Ed. WB Saunders.

Koneman EW. 2005. *Color Atlas and Textbook of Diagnostic Microbiology*. 6<sup>th</sup> Ed. Lippincott Williams & Wilkins.

OIE. 2006. *Manual of Diagnostic Tests for Aquatic Animals*. 5<sup>th</sup> Ed.

**AAH 601****FISH AND SHELLFISH VIROLOGY****2+1****Objective**

To understand the etiology and pathogenesis of common fish and shell fish viral diseases.

**Theory**UNIT I

Molecular virology and pathogenesis of selected viruses infecting fish and shellfish such as IPN, VHS, IHN, VHS.

UNIT II

Nodavirus infection of fish and freshwater prawns, WSSV, YHV.

UNIT III

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 in public domain.

**Suggested Readings**

Alan C. 2005. *Molecular Virology*. Academic Press.

David MK, Peter MH, Diane EG, Robert AL, Malcolm AM, Bernard R & Stephen E S. 2007. *Fields Virology*. 5<sup>th</sup> Ed. Lippincott Williams & Wilkins.

Dimmock N, Easton A & Leppard K. 2006. *Introduction to Modern Virology*. 6<sup>th</sup> Ed. Blackwell.

Flint SJ, Enquist LW, Krug RM, Racaniello VR & Skalka AM. 2000. *Principles of Virology, Molecular Biology, Pathogenesis and Control*. American Society of Microbiology.

Freshney IR. 2005. *Culture of Animal Cells: A Manual of Basic Technique*. 5<sup>th</sup> Ed. John Wiley & Sons.

Roberts RJ. 2001. *Fish Pathology*. 3<sup>rd</sup> Ed. WB Saunders.

**AAH 602****ADVANCES IN PARASITOLOGY****2+1****Objective**

To understand the pathobiology of parasitic infection in fishes.

**Theory**UNIT I

Environmental parasitology: Macro-environmental and micro- environmental influence on parasite incidence.

UNIT II

Host parasite interaction: Pathological changes induced in host due to parasitic infection.

UNIT III

Molecular parasitology; Parasite biochemistry.

UNIT IV

Evolution of parasites; Hyperparasitism.

UNIT V

Antiparasitic drugs applied in aquaculture and their action.

UNIT VI

Parasitic immunity.

**Practical**

Isolation techniques of parasites. Molecular characterization of parasites. Use of molecular probes for identification of parasites and tracking life stages of parasites.

**Suggested Readings**

Lewis EE, Campbell JF & Sukhdeo MVK. 2002. *The Behavioural Ecology of Parasites*. CABI.

Poulin R & Grimes LR. 2007. *Evolutionary Ecology of Parasites*. Princeton University Press.

Theodor VB. 1974. *Biochemistry of Parasites*. 2<sup>nd</sup> Ed. Academic Press.

**AAH 603****MOLECULAR MECHANISMS IN DISEASE PROCESS****2+1****Objective**

To understand the molecular mechanism of common diseases and methods for studying them.

**Theory**UNIT I

Uptake of macromolecules by cells. Viral gene expression. Channelising the cellular events to study the cell viability, cell proliferation, cell lineage.

UNIT II

Biological performance of each cell, i.e., changes in mitochondrial junction, morphology, Ca<sup>+</sup> metabolism, vesicle trafficking; membrane transport system; protein molecule dynamics and expression profile of each cell.



### UNIT III

RNA interfering mechanisms.

#### **Practical**

FISH technique, TUNEL assay, MTT assay, NO assay, COMET assay to detect apoptosis. FRET and FRAP microscopy techniques.

#### **Suggested Readings**

Alan C. 2005. *Molecular Virology*. Academic Press.

David MK, Peter MH, Diane EG, Robert AL, Malcolm AM, Bernard R & Stephen ES. 2007. *Fields Virology*. 5<sup>th</sup> Ed. Lippincott Williams & Wilkins.

Flint SJ, Enquist LW, Kru RM, Racaniello VR & Skalka AM. 2000. *Principles of Virology, Molecular Biology, Pathogenesis and Control*. American Society of Microbiology.

### **AAH 604**

### **CRUSTACEAN PATHOLOGY**

**2+1**

#### **Objective**

To understand the microscopic pathology associated with various diseases of crustaceans.

#### **Theory**

##### UNIT I

Normal histology of different organs of crustaceans with special reference to penaeid shrimp.

##### UNIT II

Major pathogens of commercially important cultured crustaceans with special reference to shrimp and freshwater prawn pathogens: viral, bacterial, fungal and parasites.

##### UNIT III

Biology, morphology, diagnostic methods, clinical signs and symptoms and pathological changes associated with these pathogens.

##### UNIT IV

Bacterial diseases: Vibriosis; necrotizing hepatopancreatitis, rickettsial diseases, mycobacteriosis.

##### UNIT V

Fungal diseases: Larval mycosis, fusarium disease; Parasitic diseases: Microsporidians, Haplosporidians, Ciliates, Cephaline gregarines. Diseases of non infectious etiology: gas bubble disease, hemocytic enteritis.

#### **Practical**

Detailed study on normal histology of different organs/tissues of crustaceans. Diagnostic procedures: field level diagnostic methods (direct microscopic observation, tissue impression, smear and routine staining methods); Histopathology of different diseases of crustaceans. Serological methods; Electron microscopy; Gene probe and dot blot assay; *In-situ* hybridization (ISH) and polymerase chain reaction (PCR).

#### **Suggested Readings**

Bell AT & Lightner DV. 1988. *A Handbook of Normal Penaeid Shrimp Histology*. World Aquaculture Society, Louisiana, USA.

Lightner DV. 1996. *A Handbook of Shrimp Pathology and Diagnostic Procedures for Diseases of Cultured Penaeid Shrimp*. World Aquaculture Society, Louisiana, USA.

### **AAH 605**

### **FISH PHARMACOLOGY**

**2+1**

#### **Objective**

To understand the principles and application of pharmacodynamic compounds applied in aquaculture. To elucidate the pharmacodynamics of important chemicals/drugs applied in aquaculture.

#### **Theory**

##### UNIT I

Introduction to pharmacology, pharmacological terms and definitions, sources of drugs.

##### UNIT II

Principles of drug activity, pharmacokinetics. Absorption, distribution, biotransformation and excretion of drugs.

##### UNIT III

Pharmacodynamics, concept of drug receptor, dose response relationship, half-life and withdrawal period, factors affecting drug effect and dosage, principles of drug safety in terms of species and environment.

#### **Practical**

Antibiogram preparations; Antibiotic residual assays; Studies on histopathological changes caused due to chemotherapy. Important anesthetics and their mode of action.

#### **Suggested Readings**

Brown KMT. 2000. *Applied Fish Pharmacology*. Aquaculture Series 3, Kluwer.

Noga EJ. 1996. *Fish Disease, Diagnosis and Treatment*. Mosby-Year Book.

Richard DH, Mary JM, Richard AH & Pamela CC. 2005. *Pharmacology*. Lippincott Williams & Wilkins.

Stoskopf MK. 1993. *Fish Medicine*. WB Saunders.

**AAH 606  
DIAGNOSIS**

**BIOTECHNOLOGICAL TOOLS IN DISEASE DIAGNOSIS 1+1**

**Objective**

To understand the principles and applications of different 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.

UNIT V

DNA Microarrays: DNA chips, preparations of DNA arrays, label and applications; other related molecular techniques.

UNIT VI

Monoclonal antibody-based diagnostics.

**Practical**

Nucleic acid extraction, PCR detection of various pathogens. Monoclonal antibody-based diagnostic application. Protein profiling, DNA fingerprinting.

**Suggested Readings**

Altman A. 1997. *Agricultural Biotechnology*. CRC Press.

Noga EJ. 1996. *Fish Disease, Diagnosis and Treatment*. Mosby-Year Book.

Sambrook J & Russel D. 2001. *Molecular Cloning*. 3<sup>rd</sup> Ed. Cold Spring Harbour Laboratory.

**AAH 607 PUBLIC HEALTH MICROBIOLOGY AND EPIDEMIOLOGY 2+1**

**Objective**

To learn the zoonotic importance of fish pathogens and toxins produced by aquatic organisms.

**Theory**

UNIT I

Introduction to food-borne diseases – Classification; food-borne infection and intoxication- microorganisms important in food borne diseases and food toxicity – economic importance of food - borne illness.

UNIT II

Factors influencing food-borne disease outbreaks; Sources and transmission of pathogens in foods: human, animal, and environmental reservoirs; crosscontamination; food associations; Microbial detection and indicator organisms: approach and techniques; pathogen indicators; bacteria responsible for food borne infection and intoxication; bacterial toxin and miscellaneous toxic factors; factors affecting toxin production in foods; fungal toxins, aflatoxin, ochratoxin and other fungal toxins; factors affecting fungal toxin production in food; marine toxins PSP, ASP, NSP, ciguatera poisoning and other marine toxins; histamines and other bioamines toxicity.

UNIT III

Zoonoses: Zoonoses of different origins – rare, new, and emerging zoonoses; trematode, cestode and nematode zoonoses; food borne viruses; prevention and control of food toxicity and food-borne diseases. Government Agency and Food Safety Policy: HACCP, Risk Assessment, New pathogens and emerging food borne diseases. Current Food Safety Topic: antibiotic resistance.

**Practical**

Isolation and identification of toxin producing microorganisms and other potent human pathogens in fish and fishery products – detection of toxins using biological and immunological techniques.

**Suggested Readings**

Doyle MP & Buechat LR. 2007. *Food Microbiology*. 3<sup>rd</sup> Ed. ASM Press. Huss HH, Ababouch L & Gram L. 2004. *Assessment and Management of*

*Fish Safety and Quality*. FAO Fisheries Tech. Paper 444. James MJ. 2005. *Modern Food Microbiology*. 7<sup>th</sup> Ed. Springer. FAO. 2004. *Marine Biotoxins Food and Nutrition*. Paper 80.

**Objective**

To understand the molecular techniques used in genetic manipulation.

**Theory**UNIT I

Techniques for isolation of DNA for gram positive bacteria, gram negative bacteria, fungal cells, animal cells, DNA detection, purification, quantification. Plasmid DNA and techniques for isolation and purification of plasmids.

UNIT II

Determination of G+C content of DNA: Chromatographic technique, spectrophotometric method, isopycnic buoyant density gradient centrifugation.

UNIT III

Restriction fragment length polymorphism: Different types of restriction enzymes, their target sites, digestion patterns, chromosomal DNA-RFLP, plasmid DNA, PCR-RFLP, Pulsefield gel electrophoresis and its applications.

UNIT IV

Methods of gene transfer: Transformation, plasmid DNA as cloning vectors, electroporation.

UNIT V

Gene transfer by conjugation: Conjugative plasmids and their application in recombinant DNA technology Gene transfer by transduction: application of bacteriophages in cloning.

**Practical**

Isolation of DNA and RNA; Quantification of DNA and RNA, gene amplification, primer designing, gene cloning-restriction digestion, ligation and transformation, gene sequencing, gene expression, immunoblotting, design and application of gene probes.

**Suggested Readings**

Brown TA. (Ed.). 2002. *Essential Molecular Biology*. Vols. I, II. 2<sup>nd</sup> Ed. Oxford University Press.

Lewin B. 2003. *Gene VIII*. Oxford University Press.

Sambrook J & Russel D. 2001. *Molecular Cloning*. 3<sup>rd</sup> Ed. Cold Spring Harbour Laboratory.

**Objective**

To study the characteristics of fungal and viral agents causing diseases in fish and shellfish and their control measures.

**Theory**UNIT I

Fungi and environment, role of fungi in food processing and aquaculture, the growth of yeasts and molds in fishes – effect of heat, chilling, freezing and chemical preservatives on common fungi associated with fishes. Mycotoxins – source and conditions effecting their production. Techniques for isolation and identification of yeasts and molds.

UNIT II

Virus properties. Viruses associated with fishes and water characteristics. Effect of heat and freezing on food-borne viruses. Techniques for cultivation of viruses, tissue culture.

**Practical**

Isolation and identification of aquatic fungi, fungi involved in food spoilage and diseases, application of fungi, detection of mycotoxins, isolation of viruses using cell culture, molecular identification of viral diseases.

**Suggested Readings**

George P. 1987. *Textbook of Fish Health*. 2<sup>nd</sup> Ed. TFH Publ.

Hoole D, Bucke D, Burgess P & Wellby I. 1991. *Diseases of Carps and Other Cyprinid Fishes*. Wiley-Blackwell.

Roberts RJ. 2001. *Fish Pathology*. 3<sup>rd</sup> Ed. W.B Saunders.

Sindermann CJ. 1990. *Principal Diseases of Marine Fish and Shellfish*. Vols. I, II. 2<sup>nd</sup> Ed. Academic Press.

Woo PTK & Bruno DW. (Eds.). 1999. *Fish Diseases and Disorders*. Vol. III. *Viral, Bacterial and Fungal Infections*. CABI.