

AQUACULTURE

CODE	COURSE TITLE	CREDITS
AQC501*	SUSTAINABLE AQUACULTURE	2+1
AQC502*	SOIL AND WATER QUALITY MANAGEMENT IN AQUACULTURE	2+1
AQC503*	NUTRITION AND FEED TECHNOLOGY	2+1
AQC504*	AQUATIC ANIMAL HEALTH MANAGEMENT	2+1
AQC505	SEED PRODUCTION AND HATCHERY MANAGEMENT OF FINFISHES	2+1
AQC506	SEED PRODUCTION AND HATCHERY MANAGEMENT OF SHELLFISHES	1+1
AQC507	APPLIED GENETICS IN AQUACULTURE	2+1
AQC508	NON-FOOD AQUACULTURE	1+1
AQC509	COASTAL AQUACULTURE	2+1
AQC510	FRESH WATER AQUACULTURE	2+1
AQC511	LARVAL NUTRITION AND CULTURE OF FISH FOOD ORGANISMS	1+1
AQC512	AQUACULTURE ENGINEERING	2+1
AQC591	MASTER'S SEMINAR	1+0
AQC599	MASTER'S RESEARCH	20
AQC601**	ADVANCES IN AQUACULTURE PRODUCTION SYSTEMS	2+1
AQC602**	ADVANCES IN SEED PRODUCTION AND HATCHERY MANAGEMENT	2+1
AQC603**	AQUACULTURE AND ECOSYSTEM MANAGEMENT	2+1
AQC604	AQUATIC ANIMAL HEALTH MANAGEMENT AND QUARANTINE	1+1
AQC605	FISH AND SHELLFISH PHYSIOLOGY AND ENDOCRINOLOGY	1+1
AQC606	ADVANCES IN FISH GENETICS	2+1
AQC607	INTENSIVE FARMING SYSTEMS FOR TILAPIA AND CATFISHES	1+1
AQC608	AQUACULTURE DEVELOPMENT PLANNING AND MANAGEMENT	1+1
AQC609	APPLIED BIOTECHNOLOGY	1+1
AQC691	DOCTORAL SEMINARI	1+0
AQC692	DOCTORAL SEMINARI II	1+0
AQC699	DOCTORAL RESEARCH	45

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

UNIT III

Fertilizers and manures: Different kinds of fertilizers and manures, fertilizer grade, source, rate and frequency of application, Biofertilizers, Use of treated sewage for pond fertilization, Ecological changes taking place after fertilizing, Primary production, degradation of molecules in aquatic environment, Utilization of bioactive compounds by microorganisms.

UNIT IV

Soil and water quality management: Cat clay/pyrite soil, seepage, water treatment, water filtration devices, aeration, chlorination, ozonization and UV radiation, Algal bloom control, eutrophication, Aquatic weed management, Waste water treatment practices, Water quality management in hatcheries, Waste discharge standards, Role of microorganisms in fish production, fish health and fish safety; Microbial load and algal blooms.

Practical

Equipment used in soil and water analysis; Soil sampling, determination of soil moisture and bulk density; pond filling, analyses of mud acidity and soil texture; Measurements of temperature, pH, conductivity, salinity, transparency, turbidity and solids; Analyses of dissolved oxygen, alkalinity and hardness, phosphorus, nitrogen; Estimation of primary productivity and chlorophyll; Application of fertilizers and pond liming; Analysis of toxic elements; Microbial techniques; Visit to effluent treatment plant; Design and operation of biological filters.

Suggested Readings

Adhikari S & Chatterjee DK. 2008. *Management of Tropical Freshwater Ponds*. Daya Publ.

APHA, AWWA, WPCF. 1998. Standard Methods for the Examination of Water and Wastewater, 20th Ed. American Public Health Association, American Water Works Association, and Water Pollution Control Federation, Washington, D. C.

Boyd, C. E. and Tucker, C. S. 1992. Water Quality and Pond Soil Analyses for Aquaculture, Alabama Agricultural Experimental Station, Auburn University.

Boyd CE. 1979. *Water Quality in Warm Water Fish Ponds*. Auburn University. ICAR. 2006. *Handbook of Fisheries and Aquaculture*. ICAR.

Parsons TR, Maita Y & Lalli CM. 1984. *A Manual of Chemical and Biological Methods for Seawater Analysis*. Pergamon Press. Rajagopalsamy CBT & Ramadhas V. 2002. *Nutrient Dynamics in Freshwater Fish Culture System*. Daya Publ.

Sharma LL, Sharma SK, Saini VP & Sharma BK. (Eds.). 2008. *Management of Freshwater Ecosystems*. Agrotech Publ. Academy.

AQC 503

NUTRITION AND FEED TECHNOLOGY

2+1

Objective

To create basic understanding on the nutritional requirements of fish/shellfish and feed manufacture.

Theory

UNIT I

Fish nutrition: Principles of fish nutrition and terminologies, nutritional requirements of cultivable finfish and shellfish: larvae, juveniles and adults.

UNIT II

Nutritional biochemistry: Classification, nutrient quality and evaluation of proteins, lipids and carbohydrates.

UNIT III

Role of nutrients: amino acids, fatty acids, proteins, lipids, carbohydrates, vitamins and minerals.

UNIT IV

Nutritional bioenergetics: Fish as an open thermodynamic system, Energy requirement of fishes, protein to energy ratio, digestible energy, nitrogen balance index, protein sparing effect, high energy feeds, isocaloric diets, Optimal foraging theory, Mathematical modeling of ingestion, Metabolic rate, Energy budgets, Energetic efficiency of fish production.

UNIT V

Nutritional physiology: Digestion, accretions and nutrient flow, Factors affecting digestibility.

UNIT VI

Nutritional pathology: Antinutritional factors and antimetabolites, microbial toxins, methods of elimination, nutrient deficiency and symptoms.

UNIT VII

Feed Resources: Nutritional value of feed ingredients and live feed, Contribution from natural food to nutrient requirements of fish, Feed additives (attractants, growth stimulants and probiotics and binders), and Feed resources assessment.

UNIT VIII

Feed Manufacture: Feed formulation and processing, On-farm feed manufacture, Commercial feed manufacture,

Feed storage.

UNIT IX

Feeding Practices: Supplementary feed–theory and practice, Complete diet - theory and practice, Feeding methods and scheduling, ration size, feed performance and economics.

Practical

Formulation and preparation of a balanced fish feed; Feeding trials; Proximate analysis- moisture, crude protein, crude lipid, ash, acid insoluble ash content of feed; Estimation of crude fibre, nitrogen free extract, calcium and phosphorus content of feed; Estimation of protein and lipid quality; Determination of gross energy content of feed and feed ingredients; Determination of the digestibility of feed using markers; Estimation of FCR from feeding trials and preparation of feeding table; Estimation of growth parameters from feeding trials; Analysis of mycotoxins from feed ingredients/feed; Gut content analysis to study artificial and natural food intake. Visit to feed manufacturing units.

Suggested Readings

ADCP (Aquaculture Development and Co-ordination Programme). 1980. *Fish Feed Technology*. ADCP/REP/80/11. FAO.

Cyrino EP & Bureau D & Kapoor BG. 2008. *Feeding and Digestive Functions in Fishes*. Science Publ.

D' Abramo LR, Conklin DE & Akiyama DM. 1977. *Crustacean Nutrition: Advances in Aquaculture*. Vol. VI. World Aquaculture Society, Baton Rouge.

De Silva SS & Anderson TA. 1995. *Fish Nutrition in Aquaculture*. Chapman & Hall Aquaculture Series.

Elena M. 2003. *Nutrition, Physiology and Metabolism in Crustaceans*. Science Publishers.

Guillame J, Kaushik S, Bergot P & Metallier R. 2001. *Nutrition and Feeding of Fish and Crustaceans*. Springer Praxis Publ.

Halver J & Hardy RW. 2002. *Fish Nutrition*. Academic Press.

Halver JE & Tiews KT. 1979. *Finfish Nutrition and Fishfeed Technology*. Vols. I, II Heenemann, Berlin.

Hertrampf JW & Pascual FP. 2000. *Handbook on Ingredients for Aquaculture Feeds*. Kluwer.

Houlihan D, Boujard T & Jobling M. 2001. *Food Intake in Fish*. Blackwell. Lavens P & Sorgeloos P. 1996. *Manual on the Production and Use of Live Food for Aquaculture*. FAO Fisheries Tech. Paper 361, FAO.

Lovell RT. 1998. *Nutrition and Feeding of Fishes*. Chapman & Hall.

New MB. 1987. *Feed and Feeding of Fish and Shrimp. A Manual on the Preparation and Preservation of Compound Feeds for Shrimp and Fish in Aquaculture*. FAO – ADCP/REP/87/26.

NRC (National Research Council). 1993. *Nutrient Requirements of Fish*. National Academy Press, Washington.

Ojha JS. 2005. *Aquaculture Nutrition and Biochemistry*. Daya Publ.

AQC 504

AQUATIC ANIMAL HEALTH MANAGEMENT

2+1

Objective

To provide holistic knowledge on fish and shellfish pathogens and their control measures.

Theory

UNIT I

Basics of fish and shellfish health management: Host-pathogen-environment relationship, Management of culture systems, Environmental stress.

UNIT II

Defence system in fish and shellfish: Defence systems in fish, innate and acquired immunity, inflammation response to diseases. Antibody and cell mediated immunity in fish and shellfish.

UNIT III

Parasitic and mycotic diseases: General characteristics, Epizootiology, Diagnosis, Life cycle, Prevention and treatment.

UNIT IV

Infectious bacterial and viral diseases: General characteristics, Epizootiology, Diagnosis, Prevention and treatment.

UNIT V

Non-infectious Diseases: Nutritional diseases, water, soil, environmental parameters and their effects on fish health. Disease in hatcheries and grow- out systems.

UNIT VI

Techniques in health management: Microbiological, haematological, histopathological, immunological and molecular techniques. Disease surveillance and reporting.

UNIT VII

Disease control and management: Environment management, chemotherapeutic agents, host management, prophylaxis- vaccines, adjuvants, immunostimulants and probiotics. Use and abuse of antibiotics and chemicals in health management. Fish health and quarantine systems. Seed certification, SPF and SPR stocks - development and applications.

Practical

General procedures for disease diagnosis; Taxonomy and identification of fish parasites; Sampling, preparation of media and culture of pathogenic bacteria; Techniques for bacterial classification; Histological techniques for disease diagnosis; Molecular and immunological techniques; Biochemical tests; PCR; ELISA; Agglutination test; Challenge tests; Purification of virus; Stress related study of fish and shellfish; Disease treatments.

Suggested Readings

Aline W. 1980. *Fish Diseases*. Springer Verlag.

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

Salamander Books.

Austin B & Austin DA. 1987. *Bacterial Fish Pathogens* (Diseases in Farm and Wild). Ellis Harward.

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.

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

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

Roberts RJ. 2001. *Fish Pathology*. 3rd Ed. WB Saunders. Schaperclaus W. 1986. *Fish Diseases*. Vols. I, II. Oxonian Press.

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

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

Walker P & Subasinghe RP. (Eds.). 2005. *DNA Based Molecular Diagnostic Techniques: Research Needs for Standardization and Validation of the Detection of Aquatic Animal Pathogens and Diseases*. FAO Publ.

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

AQC 505 SEED PRODUCTION AND HATCHERY MANAGEMENT OF FINFISHES 2+1

Objective

To learn seed production and hatchery management of commercially important cultivable fin fishes.

Theory

UNIT I

Introduction: History, constraints and current status of natural seed collection and hatchery seed production of fin fishes.

UNIT II

Reproductive biology of fin fishes: Physiology and morphology; Molecular and physiological basis of reproduction, Overview of current developments in reproductive biology.

UNIT III

Gamete maturation and development: Spermatogenesis and oogenesis, Hormonal pathways and mode of control.

UNIT IV

Environmental and endocrine control of reproduction: Reproductive cycles, Seasonality (Photoperiod, change in water quality and quantity, temperature, lunar cycle, etc.), Environmental and exogenous hormonal stimuli.

UNIT V

Induced spawning: Methods of natural and artificial fertilization, GnRH and Linpe models, evaluation of milt and egg, cryopreservation technique, use of different synthetic hormones and analogues for induced spawning, Egg staging, Stripping and fertilization.

UNIT VI

Hatchery technology for different species: Indian major and minor carps, Exotic carps, Catfishes, Tilapia, Masheer, Trout, etc.

UNIT VII

Marine fish seed production: Seabass, milkfish, mullets, sea breams, rabbitfish, grouper, yellowtail, eel, cobia, etc.

UNIT VIII

Hatchery design and management: Criteria for site selection of hatchery and nursery, Design and function of incubators, Jar hatchery, Chinese hatchery and other hatchery systems- design and operation, hatchery protocols, larval rearing stages, rearing technology, packaging and transport of seed.

UNIT IX

Seed supply in aquaculture: Relationship between fry supply and grow-out, Macro-planning of fry production to stimulate grow-out, Marketing and economics of fish seed.

Practical

Study of gonadal development in carps and other cultivable finfishes; Identification of carp and catfish seed; Collection and identification of cultivable brackishwater finfish seed; Packing and transportation of cultivable finfish seed; Induced breeding of fishes through various inducing agents; Evaluation of carp milt and egg; Design and operation of Chinese hatchery; Preparation of brood and larval feed for different cultivable finfish; Rearing of carp spawn and fry; Visit to different finfish hatcheries.

Suggested Readings

FAO. 1992. *Manual of Seed Production of Carps*. FAO Publ. ICAR. 2006. *Hand Book of Fisheries and Aquaculture*. ICAR.
Jhingran VG & Pullin RSV. 1985. *Hatchery Manual for the Common, Chinese and Indian Major Carps*. ICLARM, Philippines.
Jhingran VG. 1991. *Fish and Fisheries of India*. Hindustan Publ. Landau M. 1992. *Introduction to Aquaculture*. John Wiley & Sons.
Mcvey JP. 1983. *Handbook of Mariculture*. CRC Press.
Pillay TVR & Kutty MN. 2005. *Aquaculture- Principles and Practices*. Blackwell.
Rath RK. 2000. *Freshwater Aquaculture*. Scientific Publ.
Thomas PC, Rath SC & Mohapatra KD. 2003. *Breeding and Seed Production of Finfish and Shellfish*. Daya Publ.

AQC 506 SEED PRODUCTION AND HATCHERY MANAGEMENT OF SHELLFISHES

1+1

Objective

To provide overall knowledge of seed production and hatchery management of commercially important cultivable crustaceans and molluscs.

Theory

UNIT I

Introduction: Current status; problems and prospects of shellfishes.

UNIT II

Seed resources: Site selection and techniques of collection; identification and segregation of shellfish seed.

UNIT III

Reproductive biology of shellfishes: Gonad anatomy, endocrinology and reproductive mechanisms in prawns, shrimps, crabs, lobsters, mussels, oysters, scallops and clams; age at first maturity; factors affecting maturation and spawning.

UNIT IV

Broodstock: availability; improvement; nutritional requirements; transport; captive rearing and maturation; induced spawning; physical and chemical inducing agents; physiology and techniques of eyestalk ablation.

UNIT V

Seed production: Seed production of commercially important prawns, shrimps, crabs, lobsters, mussels, edible oysters, pearl oyster, scallops, clams and sea cucumber.

UNIT VI

Hatchery technology and management: Site selection and facilities required; culture and use of different live feed in shellfish hatcheries; larval diseases and their management; different chemicals and drugs used; water quality and feed management; Hatchery standards and biosecurity; sanitary and phytosanitary (SPS) measures; better management practices (BMPs); packaging and transport of seed.

UNIT VII

Economics of seed production.

Practical

Layout and design of prawn and shrimp hatcheries; Study of gonad development in different cultivable crustaceans and molluscs; Collection and identification of shellfish seed; Packing and transportation of shellfish seed; Eyestalk ablation technique; Identification of larval stages of shrimp, prawn, crab, mussel and oyster; Culture techniques of microalgae and other live feed used in shellfish hatcheries; Artemia hatching technique; Visit to different shellfish hatcheries; Economic analysis of shellfish hatcheries.

Suggested Readings

CMFRI Bulletin. 1987. *National Seminar on Shellfish Resources and Farming*.
FAO. 2007. *Manual for Operating a Small Scale Recirculation Freshwater Prawn Hatchery*.
ICAR. 2006. *Handbook of Fisheries and Aquaculture*. ICAR.
Jhingran VG. 1991. *Fish and Fisheries of India*. Hindustan Publ. Corp. Landau M. 1992. *Introduction to Aquaculture*. John Wiley & Sons. Mcvey JP. 1983. *Handbook of Mariculture*. CRC Press.
Pillay TVR & Kutty MN. 2005. *Aquaculture - Principles and Practices*. Blackwell.
Thomas PC, Rath SC & Mohapatra KD. 2003. *Breeding and Seed Production of Finfish and Shellfish*. Daya Publ. House.

AQC 507

APPLIED GENETICS IN AQUACULTURE

2+1

Objective

To impart knowledge on genetic basis of inheritance and breeding plans for commercially important fishes.

Theory

UNIT I

Introduction: Origin and advancement in genetics; physical basis of heredity; genetic correlation, domestication and local adaptation.

UNIT II

Chromosome manipulation: Ploidy induction methods - triploidy and tetraploidy, advantages and disadvantages of polyploids, androgenesis and gynogenesis.

UNIT III

Sex determination: Sex differentiation and sex reversal in fishes, sex control and its role in aquaculture.

UNIT IV

Selection: Scope, application and methods of selection, marker assisted selection-biochemical and molecular markers. Molecular tools for stock differentiation for selection.

UNIT V

Hybridization: Heterosis, hybrid vigour, introgression.

UNIT VI

Inbreeding: Methods of estimation, inbreeding depression and consequences, measures to reduce inbreeding in hatcheries.

UNIT VII

Conservation genetics: Genetic resources of India and conservation, endangered species, cryopreservation of fish gametes.

UNIT VIII

Cytogenetics: Importance and karyotyping.

UNIT IX

Fish breeding: History and advancement of fish breeding, mode of reproduction, basic breeding methods and breeding programmes and goals.

UNIT X

Genetic management strategies: Environmental impacts, Lessons from the green revolution, Bioprospecting, GMOs and their detection.

Practical

Estimation of gene and genotype frequencies; Exercises on Hardy-Weinberg equation; Estimation of inbreeding coefficient; Protocol of androgenesis and gynogenesis; Protocol of cryopreservation of milt; Karyotypic studies; Isolation of DNA from fish blood.

Suggested Readings

Carvalho GR & Pitcher TJ. (Eds.). 1995. *Molecular Genetics in Fisheries*. Chapman & Hall.

Falconer DS & Mackay. 1996. *Introduction to Quantitative Genetics*. 4th Ed. Longman.

Kanakaraj P. 2001. *A Text Book on Animal Genetics*. International Book Distributing Co.

Nair PR. 2008. *Biotechnology and Genetics in Fisheries and Aquaculture*. Dominant Publ.

Padhi BK & Mandal RK. 2000. *Applied Fish Genetics*. Fishing Chimes. Pandian TJ, Strüssmann CA & Marian MP. 2005. *Fish Genetics and Aquaculture Biotechnology*. Science Publ.

Purdom CE. 1993. *Genetics and Fish Breeding*. Chapman & Hall.

Reddy PVGK. 2005. *Genetic Resources of Indian Major Carps*. FAO Publ. Reddy PVGK, Ayyappan S, Thampy DM & Krishna G. 2005. *Text book of Fish Genetics and Biotechnology*. ICAR.

Ryman N & Utter F. (Eds.). 1988. *Population Genetics and Fishery Management*. Washington Sea Grant Programmes, USA.

Tave D. 1996. *Genetics for Fish Hatchery Managers*. 2nd Ed. AVI Publ. Thorpe JE, Gall GAE, Lannan JE & Nash CE. (Eds.). 1995. *Conservation of Fish and Shellfish Resources, Managing Diversity*.

AQC 508

NON-FOOD AQUACULTURE

1+1

Objective

To impart knowledge on ornamental fish production, pearl production, bait fish culture and aquatic ornamental plant propagation.

Theory

UNIT I

Aquarium fish trade: Present status; potential; major exporting and importing countries; species-wise

contribution of freshwater and marine fishes; contribution of culture and capture; marketing strategies; anesthetics, packing and transportation.

UNIT II

Breeding techniques: Reproductive biology, captive breeding and rearing of freshwater, brackishwater, marine ornamental fishes and invertebrates.

UNIT III

Aquarium keeping: Design and construction of tanks; species-wise tank size requirement; heating, lighting, aeration and filtration arrangements; decorations used; common aquarium plants and their propagation; Feed, health and water quality management; prophylaxis; quarantine.

UNIT IV

Value addition: Colour enhancement; genetic manipulation and production of new strains; hybrids; acclimatization strategies for marine ornamental fish to freshwater.

UNIT V

Pearl Production: Overview of pearl trade, pearl oysters and mussels of commercial importance; anatomy, biology and seed production, techniques of implantation, method of rearing and harvesting of pearl, Mable pearl production, processing and quality evaluation of pearls, pearl production by tissue culture.

UNIT VI

Bait fish culture: Scope and importance, bait fish species (minnows, silver heads, etc.), farming practices.

UNIT VII

Ornamental aquatic plants: Propagation methods, nutrient and environmental requirement, cropping methods, packing and transport.

Practical

Identification of common freshwater aquarium fishes and breeding trials of selected freshwater fishes; Identification of common brackish water and marine aquarium fishes; Aquarium fabrication, setting and maintenance; Preparation of powdered and pelleted feed for ornamental fishes; Visit to ornamental fish farms; Study of bacterial, viral, fungal diseases of ornamental fishes and their control; Prophylactic and quarantine measures; Nuclei implantation in pearl oyster; Identification of ornamental aquatic plants.

Suggested Readings

Axelrod HR & Vorderwinkler W. 1978. *Encyclopaedia of Tropical Fishes*. TFH Publ.

Axelrod HR & Sweenen ME. 1992. *The Fascination of Breeding Aquarium Fishes*. TFH Publ.

Axelrod HR. 1967. *Breeding Aquarium Fishes*. TFH Publ. ICAR. 2006. *Handbook of Fisheries and Aquaculture*. ICAR.

Mills D. 1981. *Aquarium Fishes*. Kingfisher Books.

Sanford G & Crow R. 1991. *The Manual of Tank Busters*. Salamander Books.

Saxena A. (Ed.). 2003. *Aquarium Management*. Daya Publ.

Spotte S. 1979. *Fish and Invertebrate Culture*. John Wiley & Sons.

Thabrow De WV. 1981. *Popular Aquarium Plants*. Thornbill Press.

AQC 509

COASTAL AQUACULTURE

2+1

Objective

To gain knowledge in establishing and managing different fish/shellfish farming systems in coastal waters.

Theory

UNIT I

Introduction: An overview of the status of coastal aquaculture; Present trend and scope in India.

UNIT II

Different farming systems: Cage and pen culture – type, site selection, construction, specifications for different species; Raft and rack culture – site selection, design and construction.

UNIT III

Important cultivable finfishes: Distribution, biology, seed collection, nursery rearing, culture techniques, problems and prospects (seabass, milkfish, mullets, pearlspot, sea breams, rabbitfish, grouper, yellowtail, eel, cobia, salmon, flatfish).

UNIT IV

Culture of marine molluscs and echinoderms: Present status and scope in India, Species cultured (mussels, oysters, pearl oysters, scallops, clams, cockles, abalones, sea cucumber) distribution, biology, practices followed in India, farming methods - off-bottom and on-bottom culture; Problems and prospects.

UNIT V

Culture of crustaceans: Shrimp farming: systems of farming – extensive, semi-intensive and intensive; site selection, infrastructure requirement, design and construction of culture systems, pond preparation, stocking, feed and water quality management, disease prevention and treatment; harvesting and handling; freshwater farming of tiger shrimp, shrimp farming in un- drainable ponds, low and zero water exchange systems; Mud

crab fattening, production of soft-shell crabs; Lobster culture; Crayfish culture.

UNIT VI

Seaweed culture: Major seaweed species of commercial importance; methods of culture; farming of agar, algin, carrageenan yielding species; emerging trends in their farming in open seas; Integration with other farming systems.

Practical

Identification of cultivable marine and brackishwater finfish and shellfish; Identification of cultivable seaweeds; Designing of different farming systems – cages, pens, rafts and racks; Visit to coastal aquafarms.

Suggested Readings

Bardach EJ, Rhyther JH & Mc Larney WO. 1972. *Aquaculture the Farming and Husbandry of Freshwater and Marine Organisms*. John Wiley & Sons.

FAO. 2001. *Planning and Management for Sustainable Coastal Aquaculture Development*. FAO Publ.

Gilbert B. 1990. *Aquaculture*. Vol. II. Ellis Horwood.

ICAR. 2006. *Handbook of Fisheries and Aquaculture*. ICAR.

Pillay TVR. 1990. *Aquaculture, Principles and Practices*. Fishing News Books.

Pillay TVR & Kutty MN. 2005. *Aquaculture: Principles and Practices*. 2nd Ed. Blackwell.

Shepherd J & Bromage N. 1990. *Intensive Fish Farming*. B.S.P. Professional Books.

AQC 510

FRESHWATER AQUACULTURE

2+1

Objective

To gain knowledge on fish and prawn farming in different culture systems.

Theory

UNIT I

Introduction: Present status, problems and scope of fish and prawn farming in global and Indian perspective.

UNIT II

Aquaculture systems: Extensive, semi-intensive and intensive culture of fish, Pen and cage culture in lentic and lotic water bodies, polyculture, composite fish culture.

UNIT III

Fish farming: Nursery and grow-out, pond preparation, stocking, feeding and water quality management in the farming of major and minor carps, magur, singhi, murrels, tilapia, pangasius, freshwater turtle, etc.; Stunted seed production and culture practice.

UNIT IV

Freshwater prawn farming: Monoculture practice of prawn in ponds, all- male culture and its advantages, polyculture with carps, prawn farming in inland saline soils. Nursery rearing, sex segregation, pond preparation, stocking, feeding and water quality management, disease prevention and treatment; harvesting and handling.

UNIT V

Integrated farming systems: Design, farming practices, constraints and economics of IFS of fish with paddy, cattle, pig, poultry, duck, rabbit, etc.

UNIT VI

Wastewater-fed aquaculture: Water treatment methods, species selection, culture practices, harvesting and depuration process.

UNIT VII

Economics of different fish farming systems.

Practical

Identification of commercially important cultivable fish and prawn species; Assessment of seed quality- stress test; Calculating carrying capacity of pond and stocking density; Check tray assessment and feed ration calculation; Sampling procedure and growth assessment; Lime and fertilizer requirement calculations; Farm visits; Modeling of different culture systems.

Suggested Readings

AAHRI. 1998. *Health Management in Shrimp Ponds*. Aquatic Animal Health

Research Institute (AAHRI), Department of Fisheries, Thailand. Agarwal SC. 2008. *A Handbook of Fish Farming*. 2nd Ed. Narendra Publ. House.

Beveridge MCM & Mc Andrew BJ. 2000. *Tilapias: Biology and Exploitations*. Kluwer.

De Silva SS. (Ed.). 2001. *Reservoir and Culture Based Fisheries: Biology and Management*. ACAIR Proceedings.

FAO. 2007. *Manual on Freshwater Prawn Farming*.

Midlen & Redding TA. 1998. *Environmental Management for Aquaculture*. Kluwer.

New MB. 2000. *Freshwater Prawn Farming*. CRC Publ.

Pillay TVR. 1990. *Aquaculture: Principles and Practices*. Fishing News Books, Cambridge University Press, Cambridge. Venugopal S. 2005. *Aquaculture*. Pointer Publ.
Welcomme RL. 2001. *Inland Fisheries: Ecology and Management*. Fishing News Books.

AQC 511 LARVAL NUTRITION AND CULTURE OF FISH FOOD ORGANISMS 1+1

Objective

To impart basic understanding of the nutritional requirements of fish/shellfish larvae and knowledge on mass culture and enrichment of live food organisms.

Theory

UNIT I

Larval nutrition: Larval stages, nutritional requirements of fish and shellfish larvae, quality requirements of larval feeds (particle size, digestibility), natural food and its importance in aquaculture, nutritional quality of commonly used fish food organisms, bioenrichment, biofilm/periphyton and its use, culture of single cell proteins and their nutritional quality, formulation and preparation of artificial feeds for larval rearing, microparticulate diets.

UNIT II

Fish food organisms: Bacterioplankton, phytoplankton and zooplankton and their role in larval nutrition.

UNIT III

Mass culture techniques: Methods of collection, maintenance and rearing of fish food organisms, Different media used in culture, Mass culture of fish food organisms and their application in hatcheries, culture of important microalgae, rotifers, artemia, cladocerans, copepods, oligochaetes, nematodes and insect larvae.

Practical

Collection, identification and isolation of live food organisms using various techniques; Preparation of various culture media; Preparation and maintenance of stock microalgal culture; Preparation of artificial feed for rearing finfish and shellfish larvae; Mass culture of microalgae; Mass culture of cladocerans, copepods and rotifers; Culture of *Artemia nauplii*, infusoria – freshwater and marine; Culture of earthworms and chironomid larvae.

Suggested Readings

CIFE. 1993. *Training Manual on Culture of Live Food Organisms for AQUA Hatcheries*. Central Institute of Fisheries Education, Versova, Mumbai.

Finn RN & Kapoor BG. 2008. *Fish Larval Physiology*. Science Publ. Hagiwara A, Snell TW, Lubzens E & Tamaru CS. 1997. *Live Food in Aquaculture*. Proceedings of the Live Food and Marine Larviculture Symposium. Kluwer.

MPEDA. 1993. *Handbook on Aqua Farming - Live Feed. Micro Algal Culture*. MPEDA Publication.

Muthu MS. 1983. *Culture of Live Feed Organisms*. Tech. Paper 14. Summer Institute in Hatchery Production of Prawns Seeds. CMFRI, Cochin.

Ojha JS. 2005. *Aquaculture Nutrition and Biochemistry*. Daya Publ.

Santhanam R, Ramnathan M & Venkataramanujam. 1997. *A Manual of Methods in Plankton*. Fisheries College and Research Institute, Tamil Nadu Veterinary and Animal Sciences University, Tuticorin.

Sorgeloos P & Pandian KS. 1984. *Culture of Live Food Organisms with Special Reference to Artemia Culture*. CMFRI Spl. Publ. No. 15.

Tonapi GT. 1980. *Freshwater Animals of India*. Oxford & IBH.

AQC 512 AQUACULTURE ENGINEERING 2+1

Objective

To learn the basic aspects of successful farm designing for effective management and optimum yield.

Theory

UNIT I

Introduction: Technical components of farm designing, future trends in aquaculture engineering.

UNIT II

Aquaculture facilities: Planning process, site selection and evaluation, design, components and construction of tanks, ponds, cages and hatcheries.

UNIT III

Water intake and outlet: Pipe line, water flow and head loss, pumps.

UNIT IV

Water treatment: Equipment used for water treatment, filters, ultraviolet light, ozone, heating and cooling and other processes of disinfection.

UNIT V

Aeration and oxygenation: Design and fabrication of aerators, oxygen injection system

UNIT VI

Recirculation and water use system: Definition, components and design.

UNIT VII

Feeding system: Different types of feeding equipment, feed control systems, dynamic feeding systems.

UNIT VIII

Instrumentation and monitoring: Instruments for measuring water quality.

Practical

Visit to aqua farms; Contour survey and mappings; Evaluation of performance of seepage controlling devices; Designing of fresh and brackish water fin and shellfish farms; Designing of fresh and brackish water fin and shellfish hatcheries; Estimation of construction cost of FRP and cement hatchery units, inlets, outlets, sluice gate, monks, hatchery sheds, supply channel and drainage systems, gravitational flow; Design and construction of effluent treatment plant for hatchery; Evaluation of capacity of aeration devices.

Suggested Readings

Thomas L. 1995. *Fundamentals of Aquacultural Engineering*. Chapman & Hall.

Wheaton FW. 1977. *Aquacultural Engineering*. John Wiley & Sons. Ivar LO. 2007. *Aquaculture Engineering*. Daya Publ. House.

AQC 601 ADVANCES IN AQUACULTURE PRODUCTION SYSTEMS 2+1

Objective

To impart essential knowledge and skills regarding advanced technologies of different aquaculture production systems.

Theory

UNIT I

An overview of aquaculture production systems: Present status, constraints and future perspectives of aquaculture production systems in India and the world.

UNIT II

Advances in design and construction: Hatcheries; Earthen ponds; Concrete tanks; Pens and cages; Rafts; Racks.

UNIT III

Aquatic plant production systems: Ornamental aquatic plants; microalgae and seaweeds; Long line production system.

UNIT IV

Aquaculture production management: Monitoring of water quality; feeding and monitoring, sampling and harvesting of finfishes and shellfishes.

UNIT V

Advances in farming systems: Enhancing carrying capacity; integrated farming systems; semi-intensive and intensive culture systems; Recirculatory system; Flow-through system.

UNIT VI

Code of conduct for responsible and sustainable aquaculture. Cluster farming, Organic Farming, Satellite Farming and Co-operative farming.

Practical

Soil and water quality monitoring; Basic software packages for designing aquaculture systems; Preparing a model layout for advanced production system; Working out the economic feasibility of construction and maintenance of different fish production systems; Preparation of project proposal for fish production systems.

Suggested Readings

Dubey SK. 2006. *Fish Farming*. Dominant Publ.

Jhingran VG. 1991. *Fish and Fisheries of India*. Hindhustan Publ. Corp.

Pandey N & Davendra SM. 2008. *Integrated Fish Farming*. Daya Publ. House.

Pillay TVR & Kutty MN. 2005. *Aquaculture: Principles and Practices*. 2nd Ed. Blackwell.

Rath RK. 2000. *Freshwater Aquaculture*. Scientific Publ.

Selvamani BR & Mahadevan RK. 2008. *Fish Farming Systems*. Campus Books International.

Shepherd J & Brommage N. 1990. *Intensive Fish Farming*. B.S.P. Professional Books.

Sinha VRP & Ramachandran V. 1985. *Freshwater Fish Culture*. ICAR.

AQC 602 ADVANCES IN SEED PRODUCTION AND HATCHERY MANAGEMENT 2+1

Objective

To impart knowledge of the various requirements for seed production of commercially important finfish and shellfish.

Theory

UNIT I

Reproductive biology of important fishes, crustaceans and molluscs. Anatomy and morphology of

reproductive organs. Reproductive behavior of fishes. Sex determination in fishes.

UNIT II

Reproductive endocrinology: Anatomy and physiology of endocrine glands. Biochemical characteristics of endocrine hormones. Role of endocrine hormone in reproduction.

UNIT III

Broodstock management: Factors affecting the maturation and spawning of fin fishes and shell fishes. Nutritional and environmental requirement for broodstock. Nutritional and environmental manipulation for early maturation. Criteria for the selection of brood stock. Selective breeding strategies; Tagging; Transportation of brood stock. Natural and synthetic anesthetics for transport. Vaccines and therapeutics for health management of broodstock.

UNIT IV

Induced Spawning: Biochemical characteristics of synthetic hormone analogues and their applications. Comparative evaluation of commercially available inducing agents. Artificial insemination in crustaceans and molluscs. Cryopreservation of gametes and embryos.

UNIT V

Seed production and hatchery technology: Advances in seed production of commercially important finfishes and shellfishes. Seed production of ornamental fishes. Artificial propagation of seaweeds.

UNIT VI

Hatchery management: Water quality management in hatcheries - Chemical, Physical and Biological approaches. Nutritional requirement of larvae and post larvae. Live feed culture. Nutritional enrichment of live feed. Formulation of artificial diets. Strategies to control diseases in hatcheries. Diagnosis, quarantine and seed certification. Use of Probiotics and Immunostimulants in hatcheries, SPF and SPR. Effluent treatment in Hatcheries. Seed transportation methods.

Practical

Insemination; Cryopreservation of fish and shellfish gametes; Project preparation for constructing hatchery; Quantitative and qualitative determination of fish gametes like sperm motility, viability, counts; Digital equipments in broodstock management; Methods to identify quality seeds - stress test, microscopic examination.

Suggested Readings

Bardach EJ, Rhyther JH & Mc Larney WO. 1972. *Aquaculture. The Farming and Husbandry of Freshwater and Marine Organisms*. John Wiley & Sons.

Chakraborty C & Sadhu AK. 2000. *Biology Hatchery and Culture Technology of Tiger Prawn and Giant Freshwater Prawn*. Daya Publ. House.

Diwan AD, Joseph S & Ayyappan S. 2008. *Physiology of Reproduction, Breeding and Culture of Tiger Shrimp*. Narendra Publ. House.

Gilbert B. 1990. *Aquaculture*. Vol. II. Ellis Harwood.

Jhingran VG & Pullin RSV. 1985. *Hatchery Manual for the Common, Chinese and Indian Major Carps*. ICLARM, Philippines.

Thomas PC, Rath SC & Mohapatra KD. 2003. *Breeding and Seed Production of Finfish and Shellfish*. Daya Publ. House.

AQC 603

AQUACULTURE AND ECOSYSTEM MANAGEMENT 2+1

Objective

To impart knowledge on interactions between aquaculture and the environment.

Theory

UNIT I

Aquaculture and ecosystem relationship: Ecosystems and productivity, biotic interaction within ecosystems and ecological homeostasis.

UNIT II

Climate: Weather elements of concern in aquaculture, Green house gases, global warming and their impact.

UNIT III

Impact of environment on aquaculture: Raw water source, physical and chemical characteristics, contaminants and pollutants (algae, pathogens, heavy metals, pesticides) and their effect on productivity.

UNIT IV

Impact of aquaculture on environment: Waste water discharge, its quality and quantity; impacts of effluents on ecosystems, chemical degradation of soil and water.

UNIT V

Environment monitoring: Problems and preventive measures of antibiotic and drug residues, salination of soil and water, Eutrophication, Environment impact assessment and environmental audit, Biosensors in aquatic environment, toxicity assessment, Ecolabelling and traceability.

UNIT VI

Environment management: Introduction of exotics and escape of farmed fish, Pathogens in aquatic environment, Safety of aquaculture products, Role of microbes in aquatic environment; assessment of probiotic impact in aquaculture.

Practical

Waste water analysis; Environment impact assessment; Environmental audit; Toxicity assessment studies; Ecolabelling and traceability; Isolation, enumeration and Identification of bacterial population; Physical and chemical characteristics of soil; Design and construction of effluent treatment plant.

Suggested Readings

Holmer M, Black K, Duarte CM, Marba N & Karakassis I. (Eds.). 2008. *Aquaculture in the Ecosystem*. Daya Publ. House.
Lagler KP, Bardach JE, Miller RR & Passino MDR. 1977. *Ichthyology*. John Wiley & Sons.
Midlen & Redding TA. 1998. *Environmental Management for Aquaculture*. Chapman & Hall.
Nikolsky GV. 2008. *The Ecology of Fishes*. Academic Press.
Upadhyay AR. 2004. *Aquatic Plants for the Wastewater Treatment*. Daya Publ. House.

AQC 604 AQUATIC ANIMAL HEALTH MANAGEMENT AND QUARANTINE 1+1

Objective

To impart and update knowledge for combating pathogenic diseases in aquatic environment and its management.

Theory

UNIT I

Advances in Defence mechanism in fish and shellfish: Specific and non-specific defence mechanism, immunogenicity, immune cells, immune suppressant, ontogeny of immune system; cellular adaptation, pathogen specificity.

UNIT II

Disease diagnostics tools: Histopathological methods, tools used in different types of PCR, Immunoassay, Biochemical assay, Monoclonal and polyclonal based antibody assay, Electron microscopy, Serological techniques.

UNIT III

Disease prevention and therapeutics: Vaccines and bactericins, development of vaccines like DNA vaccine, adjuvants, etc; administration and mode of action of pathogen specific drugs, drug resistance, antiviral drugs, drug regulation in India, pharmacokinetics and pharmacodynamics, immunostimulants.

UNIT IV

Quarantine: Biosecurity principles, SPF and SPR, quarantine protocols, and facilities, broodstock and seed quarantine measures, Quarantine of Aquatic Animals and Premises.

Practical

Analysing and reporting legal problems relating to quarantine; Microscopic techniques; Immunisation techniques; Necropsy examination to study internal organs of fish; PCR; ELISA; Agglutination test; Gel electrophoresis; Histopathology; Determination of dosages of chemicals and drugs for treating common diseases.

Suggested Readings

Andrews C, Excell A & Carrington N. 1988. *The Manual of Fish Health*. Salamander Books.
Sindermann CJ. 1990. *Principal Diseases of Marine Fish and Shellfish*. Vols. I, II. 2nd Ed. Academic Press.
Jorge E, Helmut S, Thomas W & Kapoor BG. 2008. *Fish Diseases*. Science Publ.
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 Publ. Inglis V, Roberts RJ & Bromage NR. 1993. *Bacterial Diseases of Fish*. Blackwell.
Iwama G & Nakanishi T. (Eds.). 1996. *The Fish Immune System - Organism, Pathogen and Environment*. Academic Press.
Roberts RJ. 2001. *Fish Pathology*. 3rd Ed. WB Saunders.
Shankar KM & Mohan CV. 2002. *Fish and Shellfish Health Management*. UNESCO Publ.
Wedmeyer G, Meyer FP & Smith L. 1999. *Environmental Stress and Fish Diseases*. Narendra Publ. House.
Woo PTK & Bruno DW. (Eds.). 1999. *Fish Diseases and Disorders*. Vol. III. *Viral, Bacterial and Fungal Infection*. CABI.

AQC 605 FISH AND SHELLFISH PHYSIOLOGY AND ENDOCRINOLOGY 1+1

Objective

To learn functional physiology of fish and shellfish.

Theory

UNIT I

General physiology and endocrinology: Physiology of migration and behaviour, chemical nature of hormones, storage, release and control of hormones, serochemistry, structure and function of neuro-endocrine system, biotic and abiotic factors influencing homeostasis, ecophysiology, endocrine control of growth.

UNIT II

Nutritional and digestive physiology: Mechanism of chemo, electro and mechanoreception, gustation, digestive enzymes and isozymes, nutrient transporters, gut microbial digestion, excretion.

UNIT III

Neurophysiology: Neurosecretory system in fishes, crustaceans and molluscs, neurotransmitters, ecdysis.

UNIT IV

Reproductive physiology: Maturation and spawning, spermatogenesis, oogenesis, yolk formation, mechanism of sex reversal.

UNIT V

Respiratory physiology: Structure and chemical composition of respiratory pigments, gas exchange concept, osmoregulation.

UNIT VI

Stress physiology: stress response, stress hormones, stress adaptation.

Practical

Hormone assay –RIA (Radio Immuno Assay); Dissection of fin and shellfish to study endocrine glands; Histological techniques to study endocrine cells; Identification of moult stages; Serological analysis; Application of Electrocardiogram and respirometer.

Suggested Readings

Adiyodi KG & Adiyodi RG. 1971. *Endocrine Control of Reproduction in Decapod Crustacea*. Biology Reviews. Agarwal NK. 2008. *Fish Reproduction*. APH Publ.

Bell TA & Lightner TA. 1988. *A Handbook of Normal Penaeid Shrimp Histology*. World Aquaculture Society.

Ghosh R. 2007. *Fish Genetics and Endocrinology*. Swastik Publ. & Distr. Hoar WS, Randall DJ & Donaldson EM. 1983. *Fish Physiology*. Vol. IX. Academic Press.

Maria RJ, Augustine A & Kapoor BG. 2008. *Fish Reproduction*. Science Publ.

Matty AJ. 1985. *Fish Endocrinology*. Croom Helm.

Mente E. 2003. *Nutrition, Physiology and Metabolism in Crustaceans*. Science Publ.

Nikolsky GV. 2008. *The Ecology of Fishes*. Academic Press.

Thomas PC, Rath SC & Mohapatra KD. 2003. *Breeding and Seed Production of Finfish and Shellfish*. Daya Publ. House.

AQC 606 ADVANCES IN FISH GENETICS 2+1

Objective

To provide knowledge in genetics for improving qualitative and quantitative traits in fish.

Theory

UNIT I

Scope of applied fish genetics: Inheritance of qualitative and quantitative traits in fish; chromosomal polymorphism.

UNIT II

Non chromosomal inheritance: Mitochondrial inheritance.

UNIT III

Chromosome manipulation: Gynogenesis and androgenesis; production of super-males and transgenic fish.

UNIT IV

Recent trends in Inbreeding and genetic drift: Estimation of genetic parameters.

UNIT V

Selective breeding: Qualitative and quantitative traits for selection, methods of selection- individual selection, mass selection, family selection and combined selection; Designing of breeding programmes.

UNIT VI

Genetic markers: Use of biochemical and molecular genetic markers in hybridization, selective breeding.

UNIT VII

Diallele crossing: Genetic improvement of particular trait (disease resistance) in fish.

UNIT VIII

Chromosome banding techniques: C-banding, G-banding, NOR-banding, FISH.

UNIT IX

Genotoxicity assay: Comet assay, sister chromatid exchange, MNT, etc.

Practical

Chi-square test; Estimation of heritability and repeatability; Assessment of genetic gain through selection; Calculation of selection differential; Calculation of selection response; Estimation of inbreeding coefficient and path coefficient; Karyotypic studies; C-banding (hetero chromatin banding); NOR- banding (nucleolar organizer region banding); G-banding (Giemsa banding); Ploidy determination methods.

Suggested Readings

Das P & Jhingran AG. 1976. *Fish Genetics in India*. Today & Tomorrow Publ.

Douglas T. 1998. *Genetics for Fish Hatchery Managers*. Kluwer.

Dunham RA. 2004. *Aquaculture and Fisheries Biotechnology Genetic Approaches*. CABI.

Malvee S. 2008. *Fish Genetics*. SBS Publ.

Nair PR. 2008. *Biotechnology and Genetics in Fisheries and Aquaculture*. Dominant Publ.

Padhi BJ & Mandal RK. 2000. *Applied Fish Genetics*. Fishing Chimes. Pandian TJ, Strüssmann CA & Marian MP. 2005. *Fish Genetics and Aquaculture Biotechnology*. Science Publ.

Reddy PVGK. 2005. *Genetic Resources of Major Indian Carps*. Daya Publ.

Reddy PVGK, Ayyappan S, Thampy DM & Gopalakrishna. 2005. *Text Book of Fish Genetics and Biotechnology*. ICAR.

Sinnot EW, Dunn L & Dobzansky T. 1989. *Principles of Genetics*. Mc Graw Hill.

AQC 607 INTENSIVE FARMING SYSTEMS FOR TILAPIA AND CATFISHES 1+1

Objective

To learn the techniques of intensive farming of tilapia and catfishes.

Theory

UNIT I

Intensive Farming Systems: Status and future prospectus of catfishes and tilapia in India, Need for intensification, Development of intensive farming. Disease and its control, constraints in intensive farming.

UNIT II

Catfish: Commercially important catfishes, Different culture systems, Means of intensifying catfish culture, polyculture of catfish with other species, Water quality management in catfish culture, feeds and feeding, Economics of culture.

UNIT III

Tilapia: Commercially important tilapia, Different culture systems, Means of intensifying tilapia culture, polyculture of tilapia, Water quality management in tilapia culture, feeds and feeding, Techniques of sex reversal in tilapia, mass production of monosex seed and hybrids, Production of red tilapia, Economics of culture.

Practical

Study of aerators and blowers; Experience in breeding and culture of catfish; Experience in breeding and culture of tilapia; Seed production of catfish and tilapia; Formulation of feeds for catfish and tilapia; Stocking density manipulation and fish production; Economics of intensive farming of catfish and tilapia.

Suggested Readings

Bardach EJ, Rhyther JH & Mc. Larney WO. 1972. *Aquaculture The Farming and Husbandry of Freshwater and Marine Organisms*. John Wiley & Sons.

Beveridge MCM & Mc Andrew BJ. 2000. *Tilapias: Biology and Exploitations*. Kluwer.

Gilbert B. 1990. *Aquaculture*. Vol II. Ellis Harwood.

Jayaram KC. 2006. *Catfishes of India*. Narendra Publ. House.

Pillay TVR. 1990. *Aquaculture, Principles and Practices*. Fishing News Books.

Rath PK. 2000. *Freshwater Aquaculture*. Scientific Publ

AQC 608 AQUACULTURE DEVELOPMENT PLANNING AND MANAGEMENT 1+1

Objective

To understand different aspects of planning and management processes specific to aquaculture development.

To acquire competency to plan, implement, monitor and evaluate aquaculture development programmes.

Theory

UNIT I

Importance, principles and processes in developing aquaculture programmes; Planning for sustainable development; Types of planning; Planning strategies at various levels - Top down and bottom up approaches. Role and relevance of Panchayati Raj institutions in aquaculture development; Plan allocation and performance of FFDA, BFDA and other aquaculture related programmes over the different plan-periods in

India.

UNIT II

Project preparation and project appraisal in terms of social benefit analysis, shadow prices; Project management techniques - PERT and CPM; Logical framework approach (LFA), Stakeholder analysis; Participatory Monitoring and evaluation (PROME); People's participation in aquaculture programmes, significance, importance and approaches .

UNIT III

Critical analysis of aquaculture and rural development programmes; design, operation, institutional mechanism and socio-cultural and economic impact of programmes such as NREGA; labour market relations; Fisheries development *vis-à-vis* fisheries for development; Livelihood Frameworks.

Practical

Need assessment, setting objectives, developing plan of work, Success indicators, Impact assessment of aquaculture development programmes, SWOT analysis; Exercises on PERT and CPM. Fisheries and Aquaculture policies of select countries; Study visits to selected aquaculture project areas – FFDA/ BFDA/ SAUs/ICAR institutes.

Suggested Readings

Agarwal SC. 2004. *Fishery Management*. APH Publ. Corp.

Agarwal SC & Johal S. 2003. *Fishery Development*. Narendra Publ.

Felix S. 2007. *Aquaculture Management Techniques*. Daya Publ. House. Singh B. 2007. *Fishery Management: Planning and Objectives*. Vista International Publ. House.

Sinha VRP. 2005. *Fisheries Research Planning and Management in Developing Countries*. Narendra Publ. House.

AQC 609

APPLIED BIOTECHNOLOGY

1+1

Objective

To learn various biotechnological applications for enhancing production through sustainable eco-friendly culture.

Theory

UNIT I

Introduction: Scope of biotechnology in fisheries and aquaculture research. Transgenics: Principles of transgenic technology and its application in fisheries.

UNIT II

Feed biotechnology: Probiotics, single cell proteins, Nutraceuticals. Recombinant proteins of commercial importance: enzymes, hormones, bioactive compounds, therapeutic proteins.

UNIT III

Biotechnological approaches in environmental management: Bioremediation, biosensors, biofouling, treatment of waste water. Anti microbial Peptides and their applications. Vaccination in fishes- DNA vaccines, sub UNIT vaccines and Biofilm Vaccines.

UNIT IV

Applications of biotechnological tools: Recombinant DNA, Monoclonal antibodies, Cell lines and stem cell culture, DNA markers and MAS. Biotechnological instrumentation in Aquaculture.

Practical

Cell culture and cell lines; Development of hybridoma and production of monoclonal antibodies; Collection, handling and observation of gametes of finfish and shellfish; Preparation of chromosomes from embryos and young fish; Ploidy determination by RBC measurement and chromosome numbers; Gene transfer experiments: northern blotting and southern blotting for integration and expression of transgenes.

Suggested Readings

Felix S. 2007. *Molecular Diagnostic Biotechnology in Aquaculture*. Daya Publ. House.

Ingerman M, Nagabhushanam R & Thompson MF. 1997. *Recent Advances in Marine Biotechnology*. Vols. I-III. Oxford & IBH.

Glick BR & Pasternak JJ. 1999. *Molecular Biotechnology: Principles and Applications of Recombinant DNA Technology*. ASM Press. Nagabhushanam R, Diwan AD, Zahurnec BJ & Sarojini R. 2004.

Biotechnology of Aquatic Animals. Science Publ.

Nair PR. 2008. *Biotechnology and Genetics in Fisheries and Aquaculture*. Dominant Publ.

Pandian TJ, Strüssmann CA & Marian MP. 2005. *Fish Genetics and Aquaculture Biotechnology*. Science Publ. Primrose SB. 1989. *Modern Biotechnology*. Blackwell.

Ramesh RC. (Ed.). 2007. *Microbial Biotechnology in Agriculture and Aquaculture*. Vol. II. Science Publ.

Reddy PVGK, Ayyappan S, Thampy DM & Gopalakrishna. 2005. *Text Book of Fish Genetics and Biotechnology*. ICAR.

Singh B. 2006. *Marine Biotechnology and Aquaculture Development*. Daya Publ. House.