

**UNIVERSITY OF MUMBAI**



**Syllabus for the M.Sc. Part - II  
[Semester III and IV]**

**Program: M.Sc.**

**Course: Life Sciences**

**Specialization:**

**Aquaculture Technology**

# M.Sc. Part - II Life Sciences Syllabus

(Aquaculture Technology)

The Academic year 2017-2018

## SEMESTER III

COURSE CODE	UNIT	TOPIC HEADINGS	CREDITS	L / WEEK
<b>Paper I</b>	<b>COASTAL AQUACULTURE</b>			
<b>PSLSMBT301</b>	I	<b>Finfish Culture</b>	4	4
	II	<b>Shellfish Culture</b>		4
	III	<b>Shrimp Culture</b>		4
	IV	<b>Seaweed Culture</b>		4
<b>Paper II</b>	<b>FRESHWATER AQUACULTURE</b>			
<b>PSLSMBT302</b>	I	<b>Scope and systems of Aquaculture</b>	4	4
	II	<b>Fish Farming</b>		4
	III	<b>Prawn Farming</b>		4
	IV	<b>Integrated Farming</b>		4
<b>Paper III</b>	<b>NUTRITION, FEED FORMULATION &amp; NON-FOOD AQUACULTURE</b>			
<b>PSLSMBT303</b>	I	<b>Fish Nutrition</b>	4	4
	II	<b>Aquarium</b>		4
	III	<b>Applied Nutrition</b>		4
	IV	<b>Larval Nutrition</b>		4
<b>Paper IV</b>	<b>RESEARCH METHODOLOGY AND QUALITY CONTROL</b>			
<b>PSLSMBT304</b>	I	<b>Research Methodology</b>	4	4
	II	<b>Scientific writing</b>		4
	III	<b>ISO</b>		
	IV	<b>GMP/ GLP</b>		

## SEMESTER IV

<b>COURSE CODE</b>	<b>UNIT</b>	<b>TOPIC HEADINGS</b>	<b>CREDITS</b>	<b>L / WEEK</b>
<b>Paper I</b>	<b>SEED PRODUCTION AND HATCHERY MANAGEMENT</b>			
<b>PSLSMBT401</b>	I	<b>Present status of seed production</b>	4	4
	II	<b>Reproductive biology and Induced breeding of Finfish</b>		4
	III	<b>Reproductive biology and Induced breeding of Shellfish</b>		4
	IV	<b>Hatchery</b>		4
<b>Paper II</b>	<b>AQUATIC ANIMAL HEALTH MANAGEMENT</b>			
<b>PSLSMBT402</b>	I	<b>Defense mechanism in fish and shellfish</b>	4	4
	II	<b>Diagnostics tools</b>		4
	III	<b>Vaccines</b>		4
	IV	<b>Disease prevention and therapeutics</b>		4
<b>Paper III</b>	<b>ADVANCES IN FISH GENETICS AND BIOTECHNOLOGY</b>			
<b>PSLSMBT403</b>	I	<b>Fish genetics</b>	4	4
	II	<b>Cytogenetics</b>		4
	III	<b>Vaccinations and Biotechnological tools in fish genetics</b>		4
	IV	<b>Value addition in aquaculture</b>		4
<b>Paper IV</b>	<b>DRUG DEVELOPMENT AND AQUARIUM MANAGEMENT</b>			
<b>PSLSMBT404</b>	I	<b>Natural products</b>		
	II	<b>Activity Guided Drug Development</b>		
	III	<b>Aquarium management</b>		
	IV	<b>Aquarium species, Breeding &amp; Marketing</b>		

## **M.Sc. LIFE SCIENCES: SEMESTER – III**

### **PAPER – I (PSLSMBT301): COASTAL AQUACULTURE**

#### **Prerequisites:**

#### **Course Objectives:**

- Importance of aquaculture, cultivation of aquaculture, biology and life cycle of different coastal fin fishes and culture practices in advanced manner.
- Study of fin fish seeds and nursery rearing of fin fish and techniques apply to get prospectus in aquaculture industry.
- Study of types of shellfish, marine environment, scope of shell fish, pearl culture as a source of higher income to grow Indian economy at coastal region.
- Practices of pearl formation techniques to grow best quality pearl and its distribution along the world.
- Standardise the different techniques of species culturing in shellfish.
- To get the knowledge of shrimp culture farming and infrastructure requirement.
- Understand the types of intensive aquaculture farming to design and construction of pond.
- Maintenance and management of prawn culture and treatments required during harvesting and handling.
- Study types of Sea weeds found in sea coast, their commercial values and culture practices to get good quality weeds production.

#### **Course Outcomes:**

On the completion of course, learner will be able –

- To study fin fishes as a source of food, medicine and manure in aquaculture industry.
- Valuable pearl production techniques can improve Indian economy as India is well natured with sea coast.
- Importance of various prawn and shrimps culture its scope for export a good quality prawn and other echinoderms species to get foreign currency.
- Sea weed culturing will be a new phenomenon to develop new vision in food formulation and input in medicinal values in commercial values.
- To generate employment in the field of aquaculture and design small scale industries to empower Indian economy and food processing industry to get quality proteinacious food to Indian people.

## **Course Contents**

### **UNIT I: Finfish Culture**

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 etc).

### **UNIT II: Shellfish Culture**

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.

### **UNIT III: Shrimp culture**

Culture of Shrimp farming: systems of farming – extensive, semi-intensive and intensive; site selection, infrastructure requirement, design and construction of pond, stocking, feed and water quality management, disease prevention and treatment; harvesting and handling, Problems and prospects.

### **UNIT IV: Seaweed culture**

Seaweed culture: Major seaweed species of commercial importance, methods of culture, Post harvest technology ie Agar agar, alginate, carrageenan production

### **Practicals:**

1. Identification of common brackish water and marine aquarium fishes
2. Identification of cultivable seaweeds
3. Soil sampling, determination of soil moisture and bulk density,
4. Analyses of mud acidity and soil texture
5. Chlorophyll estimation from seaweeds

### **Suggested Readings**

Ujwala Jadhav (2010): Aquaculture Technology and Environment. Publ. PHI Publication  
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*. 2<sup>nd</sup> Ed. Blackwell.  
Shepherd J & Bromage N. 1990. *Intensive Fish Farming*. B.S.P. Professional Books.

## **PAPER – II (PSLSMBT302): FRESHWATER AQUACULTURE**

### **Prerequisites:**

### **Course Objectives:**

- To acquire the knowledge of present status of aquaculture, its scope in Indian global context and types of aquaculture practices.
- To provide the basic knowledge of freshwater fish culture and to adopt better systematic form technology of fish farming viz. composite fish culture.
- Production of quality seeds and study of various larva in farm rearing in captivity to table size.
- To apply modern tools of research and development including biotechnology for optimizing production and productivity from fisheries to get good quality fishes.
- To design modern infrastructure and different tools and ensure effective management and optimum utilization.
- To provide the basic knowledge of farming prawn culture and use of carp with prawn polyculture practice, stocking and rearing of prawn.
- To adopt latest technology of prawn farming viz. composite prawn culture and produce quality seeds for rearing in captivity to table size for sale to the common men.
- To understand the use and concept related to integrated farming system (IFS) and application of different culture related to animal or agriculture
- IFS systems can reduce operating costs and maximizing the farmer's income, to develop more economic ration for fish from wastes to useful fish protein production and to solve the waste management problem.
- Fish farming along with agriculture together can give the healthy life style and Indian economy.

### **Course Outcomes:**

On the completion of course, learner will be able -

- To modernize the activities relating to fisheries and aquaculture for focused attention and professional management.
- To improve production, processing, storage, transport and marketing of fish products within the country and exporting it.
- To generate substantial employment in fishery sciences.
- To train and self employment to empower women in fishery science to empower nation.
- To enhance contribute of fish towards food and nutritional values added for mankind.

- Freshwater aquaculture (fish-farming, prawn farming) introduced several types of aquaculture systems, understand differences and trade-offs between the systems, Explain the key considerations an aqua culturist must address in their operation.
- To educate rural communities about the nutritional value of fish, prawn sources and methods of aquaculture. Aquaculture technology can empower women's groups to expand and understand the value of fish and prawn production and consumption for their families.
- To produce and provide prawns (juvenile and breeders) to the public and private sectors engaged in activities relating to prawn farming.
- To conduct research to develop new and useful hatchery and pond management techniques and improve existing rearing techniques for higher production or lower operating cost and supply prawn to common men for trading.
- Integrated farming system can help in reducing operating costs and maximizing the farmer's income.
- To provide employment and economic advantages to sustain the economy of rural people.

## **Course Contents**

### **UNIT I: Scope and systems of Aquaculture**

Introduction: Present status, problems and scope of fish farming in global and Indian perspective. 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 II: Fish Farming**

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

### **UNIT III: Prawn Farming**

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

### **UNIT IV: Integrated Farming**

Integrated farming systems: Design, farming practices, constraints and economics of IFS of fish with paddy, cattle, pig, poultry, duck, rabbit, etc. Wastewater-fed aquaculture: Water treatment methods, species selection, culture practices, harvesting and depuration process.

## **Practicals:**

1. Identification of commercially important fresh water finfish/shellfish
2. Water analyses (pH, dissolved oxygen, alkalinity, salinity and hardness)

3. Pathogen (Bacterial and fungal) analysis of diseased carps/ prawns
4. Estimation of primary productivity and chlorophyll from water sample
5. Visit to freshwater fish prawn farms

### **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*. 2<sup>nd</sup> 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.
- UjwalaJadhav (2010): *Aquaculture Technology and Environment*. Publ. PHI Publication
- Welcomme RL. 2001. *Inland Fisheries: Ecology and Management*. FishingNews Books.



## **PAPER – III (PSLSMBT303): NUTRITION, FEED FORMULATION & NON-FOOD AQUACULTURE**

### **Prerequisites:**

### **Course Objectives:**

- To understand the basic requirements of fish nutrition, role of various nutritional components and vitamins in fish diet; nutritional requirement of different stages of growth of the fish.
- To know framing of aquarium and its maintenance, aquatic plants and their growth and propagation methods; water quality management in aquarium and diseases prevention.
- To learn the basic need of feed and feed formulation technology as growth promoting factor, single cell protein (SCP); effect of anti-nutritional factors, feed additives in fish feed and diseases from nutritional deficiency in fish.
- Nutritional requirements of fish and shellfish larval stages and importance of natural live feed/ food organisms along with formulated feed in larval nutrition.

### **Course Outcomes:**

On the completion of course, learner will be able –

- To understand feeding regime and live feed culture methods. Identify feed requirements of fishes and feeding cycles; Regulation of safety, hygiene and sanitation practices during fish feed formulation.
- To maintain aquarium, identification and propagation of common aquarium plants; maintain the aquarium water quality and avoidance of diseases in aquarium.
- To generate employment in different aquaculture industry; To become expert in exporting the aquarium fishes to get foreign currency and grow Indian economy.
- To design and formulate fish feed with different additives for most favourable fish growth and develop a small scale industry.
- Understand the quality requirements of larval feeds and protect fish culture from economic losses.
- Grow aquatic food forming industry along with biotechnology.

## Course Contents

### UNIT I: Fish Nutrition

Fish nutrition: Principles of fish nutrition and terminologies, Role of nutrients: amino acids, fatty acids, proteins, lipids, carbohydrates, vitamins and minerals. Nutritional requirements of cultivable finfish and shellfish: larvae, juveniles and adults.

### UNIT II: Aquarium

Aquarium keeping: Design and construction of tanks, heating, lighting, aeration and filtration arrangements, decoration used, common aquarium plants and their propagation, feed, health and water quality management, prophylaxis, quarantine

### UNIT III: Applied nutrition

Feed formulation: Conventional and non conventional feed stuffs, feed formulation technology, growth promoting agents in aqua feed, single cell protein (SCP), Nutraceuticals, Feed additives (attractants, growth stimulants, probiotics and binders), Antinutritional factor, nutrient deficiency and symptoms.

### UNIT IV: Larval nutrition

Larval nutrition: 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 (bacterioplankton, phytoplankton and zooplankton) and their roles in larval nutrition.

### Practicals:

1. Moisture and ash content of Feeds/fish
2. Estimation of protein from fish/prawn tissue by Folin - Lawry method
3. Estimation of crude protein from feed by Kjeldahl method
4. Lipid content of fish/prawn/feed by Bligh and Dyer method
5. Estimation of crude fibre
6. Estimation of vitamin c from feed ingredients
7. Identification of common aquarium fishes
8. Visit to aquarium/museum

### 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.

ICAR 2006. Handbook of Fisheries and Aquaculture.

Ujwala Jadhav (2010). *Aquaculture Technology and Environment*. Publ. PHI Publication

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

Saroj K. Swain, Sarangi N. and Ayyappan S. 2010. *Ornamental Fish Farming* ICAR.

## **PAPER – IV (PSLSMBT304): Research Methodology and Quality Control**

**Prerequisites:** Students should be able to formulate and write their research proposal. Knowledge of ISO, GLP and GMP is a need of global market.

### **Course Objectives:**

- To understand the different types of research work.
- To present the research work scientifically.
- To acquaint with latest good laboratory practices used in various industries.
- To explain the importance of Quality Management System.

### **Course Outcome:**

On completion of the course, learner will be able to

- Design a research framework.
- Develop soft skills in compilation and presentation of their research work.
- Apply and practice good laboratory practices.

Generate management quality assurance based on ISO tenets.

### **Course Contents**

#### **Unit I: Research Methodology (15L)**

Meaning of Research; Objectives of research, motivation in research; Types of research – Descriptive, Analytical, Applied, Fundamental, Quantitative, Qualitative, Conceptual, Empirical and Other Types of

Research; Research Approaches; Research Methods vs. Methodology; Research and Scientific Method;

Research Process: Steps of research process; Criteria of Good Research; Sampling, Sample size determination, Plan for data collection, Methods of data collection, Plan for data processing and analysis; Ethical considerations during research

#### **Unit II Scientific writing (15L)**

Meaning of Scientific and non scientific writings; Structures of Research proposals, Synopsis, Dissertations, Thesis, Research paper writings (Abstract, Introduction, Review literature, methodology, Results, Discussions, Summary, Conclusion, Bibliography etc);

Presentations: Graphical, Tabular, Animation, Power point etc

#### **Unit III: ISO (15L)**

**Introduction:** Over View of standards in ISO9000 Family

**Key principles:** Key principles of ISO 9000- Quality Management System

**ISO 9001:** Detailed study on ISO 9001:2015 standard, based on a seven principles of quality management, including a strong customer focus, the motivation and implication of top management, the process approach and continual improvement

**Application:** Sector specific Application of ISO 9001- Quality Management System adapted by various industries

## **Unit IV: GMP/ GLP (15L)**

**Introduction:** Good Manufacturing Practices (GMP) and Good Laboratory Practices (GLP) in Pharmaceutical Industries.

Overview of GMPs is enforcement by the U.S. Food Drug Administration (US FDA) under Title 21 CFR

**Documentation requirement** for GMP and GLP

**Case studies for Documentation** related to SOP preparation and CAPA (Corrective action Preventive Action).

## **Practical:**

Review of Literature/ Formulation of research project

## **References:**

1. The Oxford Book of Modern Science Writing (Oxford Landmark Science) 2009 by Richard Dawkins (Author, Editor)
2. Writing Science: How to Write Papers That Get Cited and Proposals That Get Funded (2012) by Joshua Schimel (Author)
3. The Best of the Best of American Science Writing (The Best American Science Writing) 2010 by Jesse Cohen (Author)
4. From Research to Manuscript A Guide to Scientific Writing (Second Edition) By Katz, Michael J. (Springer Publication)
5. Science Research Writing for Non-Native Speakers of English by Hilary Glasman-Deal (Author), Imperial College Press, London, UK
6. Scientific Writing and Communication by Angellka Hofmann, Oxford University Press (2014)
7. ISO 9000 quality systems handbook fourth edition by David Hoyle
8. International standard iso9001 : quality management systems — requirements fifth edition 2015-09-15.
9. Pharmaceutical quality assurance for students of pharmacy, @nd edition Dec.2007.by Mr. manohar a. Potdar. NiraliPrakashan.
10. How to Practice GMPs 7th ed. by P.P. Sharma ,Seventh edition 2015.
11. Hand Book, Good Laboratory Practices: Quality practices for regulated non-clinical research and development, 2<sup>nd</sup> Edition, 2009.

## SEMESTER IV

### PAPER- I (PSLSMBT401): SEED PRODUCTION AND HATCHERY MANAGEMENT

#### Prerequisites:

#### Course Objectives:

- To get the knowledge of aquaculture its history and scope in fish farming.
- Study of the status of fish/fish seed collection and its prospectus in Indian and global economy.
- Various techniques applied in fish breeding to get intensive fish culture and their products
- Types of culture reproduction and hormones pathway to improve intensive culture and polyculture and environment to control reproduction.
- Knowledge of prawn seed production and reproduction and study development biology. Required water quality treatment and management study.
- Prawn farming requirement and types of prawns cultured in captivity, study of factors affecting prawn culture, culture practices to get mature and quality animals to get better yield.

#### Course Outcomes:

On the completion of course, learner will be able –

- To get knowledge of fisheries and its status.
- To know the constrains of fish farming.
- Learning the methods of collection and hatchery seed production of finfish and shellfish.
- Study of reproductive biology and development of animals and its hormonal pathway to get good quality aquatic animals.
- Understanding preservation techniques to get biotechnologically produced fish culture e.g. Cryopreservation.
- To know the use and maintenance of synthetic hormone in aquaculture breeding technique
- Study of biology of prawn and shrimp, their endocrine system to know the important factors responsible for maturation and production.
- Hatchery industry design and management study to get employment in the field of aquaculture technology in commercial use and growing economy.
- Application of aquaculture techniques in rearing, processing, packaging and transportation of fish and fish seed of cultivable aquatic animals.

## **Course Contents**

### **UNIT I: Present status of seed production**

Introduction: History, constraints and current status of natural seed collection and hatchery seed production of Finfishes and shellfishes

### **UNIT II: Reproductive biology and Induced breeding of Finfish**

Finfishes: Gamete maturation and development: Spermatogenesis and oogenesis, Hormonal pathways and mode of control. Environmental and endocrine control of reproduction: Reproductive cycles,

Induced breeding: Brood stock availability, Methods of natural and artificial fertilization, evaluation of milt and egg, cryopreservation technique, use of different synthetic hormones and analogues for induced breeding, Egg staging, Stripping and fertilization.

### **UNIT III: Reproductive biology and Induced breeding of Shellfish**

Shellfishes (Prawns, Shrimp): Reproductive biology: endocrinology and reproductive mechanisms in prawns, shrimps etc. Age at first maturity; factors affecting maturation and spawning.

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

### **UNIT IV: Hatchery**

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.

### **Practicals:**

1. To study histological changes in the liver/gonads of fish
2. Eyestalk ablation technique of shrimp/prawn,
3. Insemination, Cryopreservation of fish and shellfish gametes
4. Collection and identification of cultivable brackish water finfish
5. Packing and transportation of cultivable finfish seed
6. 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**
- 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.
- Ujwala Jadhav (2010): *Aquaculture Technology and Environment*. Publ. PHI Publication
- 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.



## **PAPER- II (PSLSMBT402): AQUATIC ANIMAL HEALTH MANAGEMENT**

### **Prerequisites:**

### **Course Objectives:**

- To get the knowledge of defence mechanism applied in shell fish culture to get rid off from severe diseases and improve immune system.
- Knowledge of diseases diagnosis and use of histopathological methods to get proper treatment.
- Use of different types of PCR and immune assay and biochemical assay and serological techniques.
- Study of vaccines to prevent diseases and development of new vaccine like DNA vaccine, adjuvant to resist fish diseases.
- To know the better administration during drug development, drug regulation and mode of action of pathogen specific drugs.

### **Course Outcomes:**

On the completion of course, learner will be able –

- Knowledge to get rid of different diseases development during fish farming and analysing them according to immune system.
- Observation and study of immune cells and cellular adaptation of specific pathogens defence mechanism.
- Develop the vaccines in aquaculture to resist diseases.
- Knowledge of preventive care to get rid off pathogens of fish and shell fish.
- Increase the level of immunity using different techniques.
- Development and marketing of antiviral drugs development.
- Improvement in pharmacodynamics and immunostimulant technology.

## Course Contents

### UNIT I: Defense mechanism in fish and shellfish

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

### UNIT II: Diagnostics tools

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: Vaccines

Disease prevention and therapeutics: Vaccines and bactericins, development of vaccines like DNA vaccine, adjuvant, etc; Disease resistance in fishes

### UNIT IV: Disease prevention and therapeutics

Administration and mode of action of pathogen specific drugs, drug resistance, antiviral drugs, drug regulation in India, pharmacokinetics and pharmacodynamics, immunostimulants.

## Practicals:

1. Microbial analysis of diseased fish/prawn skin mucus
2. Isolation of microbial DNA from fish pathogens
3. Sandwich ELISA of fish/prawn pathogens
4. Agglutination test
5. Histopathology changes in the organs of diseased fish/prawn

## 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. 2<sup>nd</sup> 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*. 3<sup>rd</sup> 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

## **PAPER- III (PSLSMBT403): ADVANCES IN FISH GENETICS AND BIOTECHNOLOGY**

### **Prerequisites:**

### **Course Objectives:**

- To study the scope of fish genetics to get quality and quantity fish from aquaculture.
- Apply the knowledge of chromosomal manipulation to develop new species and production of super mates and transgenic fish.
- Use of genetic markers in biochemical and molecular study of selective breeding of fish.
- Study of cytology and cytogenetics technology and morphology of fish.
- Recognise the importance of chromosome and sex chromosome study and applications in aquaculture and fisheries
- Develop vaccines and application of vaccines as biotechnical tools.
- Study of cell lines and stem culture in aquatic animal tissue culture using genetic knowledge, additional colour, valuation adapted in ornamental aquatic plant and animal.
- Explanation of nutritional and environmental requirements for cropping, packing and transport of aquatic life.

### **Course Outcomes:**

On the completion of course, learner will be able –

- Advanced techniques and application of genetics manipulation of quality fish development.
- Preparation of vaccines to control aquatic animal disease as precautionary measures.
- Fishery management practices in large scale and development of biotechnological tools to grow fish industry.
- Importance of aquatic fish to study biotechnology and get husbandry in large scale.
- Knowledge of processing and packing and transporting aquatic life to get economical important animal to export and maintain strong economy.

### **Course Contents**

#### **UNIT I: Fish genetics**

Scope of applied fish genetics: Inheritance of qualitative and quantitative traits in fish; chromosomal polymorphism. Non chromosomal inheritance: Mitochondrial inheritance. Chromosome manipulation: Gynogenesis and Androgenesis; production of super-males and transgenic fish.

#### **UNIT II: Cytogenetic**

Genetic markers: Biochemical and molecular genetic markers, selective breeding.

Cytogenetics: Fish cytogenetic techniques, karyological aspects, evolution in chromosome morphology and karyotypes, sex chromosomes in fishes, application of cytogenetics in aquaculture and fisheries management

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

### **UNIT III: Vaccinations and Biotechnological tools in fish genetics**

Vaccination in fishes- DNA vaccines, sub UNIT vaccines and Biofilm Vaccines.

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

### **UNIT IV: Value addition in aquaculture**

Value addition: Colour enhancement; genetic manipulation and production of new strains; hybrids. Ornamental aquatic plants: Propagation methods, nutrient and environmental requirement, cropping methods, packing and transport.

### **Practicals:**

1. Isolation of fish/shrimp DNA
2. Amplification of Fish DNA by RAPD
3. Estimation of Ascorbic acid from seaweeds
4. Amplification of 16s RNA from fish pathogens
5. To study different chromosome banding pattern in fish ( Demonstration)
6. Value addition in low coast fishes (Demonstration)

### **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*. McGraw Hill.

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

Fingerman 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. *TextBook of Fish Genetics and Biotechnology*. ICAR.
- Singh B. 2006. *Marine Biotechnology and Aquaculture Development*. Daya. Publ. House.
- Zhanjiang JL. 2007. *Aquaculture Genome Technologies*. Blackwell.
- Goswami M. and Lakra W. S. 2012. *Cell and Tissue Culture*. ICAR
- Lakra W. S. 2000. *Fish Genetics and Biotechnology*. ICAR.

## **PAPER- IV (PSLSMBT404): Drug Development and Aquarium Management**

### **Prerequisites:**

### **Course Objectives:**

- Study of history and sources of natural drugs founds in aquatic plants and animals.
- Importance and implementation of primary and secondary metabolites.
- Formation of fragrance, pigment, flavours and medicine from the aquatic plants as an important natural product.
- Use of different methods of plant collection and solvent extraction from selective plants.
- Study the methods of identification, isolation and purification of natural products developed from aquatic life.
- To find the medicinal properties and efficient study of antimicrobial, antioxidant, antidiabetic, antiinflammatory effects and its clinical trials.
- To implement new design and construction of tanks along with modern techniques using aeration and filtration as an important arrangement.
- To describe the water quality management and to prevent diseases in aquaculture through prophylaxis and quarantine.

### **Course Outcomes:**

On the completion of course, learner will be able –

- Aquatic plants and animals are natural sources may used as natural drugs.
- Get major sources of carbohydrate and protein from these natural products as a primary and secondary metabolites.
- Formation of industry to get fragrance, pigments, flavour and medicine from these aquatic plant.
- Quality and quantitative purified natural medicines developed as an antimicrobial, antioxidant, antidiabetic, antiinflammatory effects and its clinical trials.
- To maintain aquarium, identification and propagation of common aquarium plants; maintain the aquarium water quality and avoidance of diseases in aquarium.
- To generate employment in different aquaculture industry; To become expert in exporting the aquarium fishes to get foreign currency and grow Indian economy.
- To distinguish freshwater and marine fishes, their marketing strategy, breeding and rearing techniques of freshwater, brackish water and marine ornamental fishes.

## Course Contents

### UNIT I: Natural products

History of natural drugs, Sources of natural drug ie Plants, Animals, Micro organisms; Primary metabolites: carbohydrates, proteins, nucleic acids and lipids and their importance to plants; Secondary metabolites: Types, mechanism of synthesis, Importance in plants and for mankind as fragrance, pigments, flavours and medicines

### UNIT II: Activity Guided Drug Development

Plant collection and Extract preparations: Methods of Plant collection, solvent extraction (cold, hot, critical fluid extraction etc), screening of medicinal properties; Natural products: methods of identification (Qualitative and Quantitative), isolation and purification (Chromatography), Characterization (LC-MS, GC-MS, NMR, XRD, Elemental analysis etc); Bio efficacy studies: *In vitro* testing- Antimicrobial, Antidiabetic, Antioxidant, Antiinflammatory, antilarvicidal etc. Pre clinical and clinical trials.

### UNIT III: Aquarium management (15L)

Aquarium keeping: Design and construction of tanks, heating, lighting, aeration and filtration arrangements, decoration used, common aquarium plants and their propagation, feed, health and water quality management, prophylaxis, quarantine

### UNIT IV: Aquarium species, Breeding & Marketing

Aquarium species: freshwater, marine water and brackish water fish and plants

Aquarium fish trade: Present status, potential, major exporting and importing countries, species wise contribution of freshwater and marine fishes, marketing strategy

Breeding techniques: Reproductive biology, breeding and rearing of freshwater, brackish water, marine ornamental fishes

**Practical:** Research Project

### Suggested Readings

1. Chemistry of Natural Products by Sujata V. Bhat , B.A. Nagasampagi , Meenakshi Sivakumar (Springer Publication)
2. Indian Uses of Native Plants by Edith Van Allen Murphey
3. Plant Taxonomy ( 2<sup>nd</sup> Edition) by Sharma
4. Plant Drug analysis by H. Wagner
5. Biochemistry and Molecular Biology of *Plants* by Bob B. *Buchanan*



6. Plant Secondary Metabolites  
Volume 1: Biological and Therapeutic Significance  
Volume 2: Stimulation, Extraction, and Utilization by **Kamlesh Prasad**,
7. **Vasudha Bansal** Herbal Cosmetics & Ayurvedic Medicines by P. K. Chattopadhyay
8. *Textbook of Clinical Trials* by David Machin, Simon Day, Sylvan Green
9. Plant Bioactives and Drug Discovery: Principles, Practice, and Perspectives 1st Edition Valdir Cechinel-Filho (Author), Wiley Publication.
10. Drug Discovery from Plants By Angela A. Salim, Young-Won Chin, A. Douglas Kinghorn (Springer publication)
11. Bioassay Methods in Natural Product Research and Drug Development By Lars Bohlin, Jan G. Bruhn (Springer Publication)
12. Handbook of Fisheries and Aquaculture. ICAR 2006.
13. Ornamental Fish Farming ICAR. Saroj K. Swain, Sarangi N. and Ayyappan S. 2010.
14. Aquarium Fishes. Kingfisher Books By Mills D. 1981.
15. The Complete Book of the Freshwater Aquarium: A Comprehensive Reference Guide to More Than 600 Freshwater Fish and Plants By Vincent Hargreaves (Author), Thunder Bay Press, San Diego California (2007)
16. The Inspired Aquarium: Ideas and instructions for living with aquariums By Jeff and Mike Senske Publisher: Quarry Books (2006)
17. Manual of Fish Health Everything You Need to Know About Aquarium Fish, Their Environment and Disease Prevention By Chris Andrews - Firefly Books Ltd. (2003)
18. Choosing Fish for Your Aquarium: A complete guide to tropical freshwater brackish and marine fishes By Mary Baily and Gina Sandford, Anness Publishing Ltd. (2000)
19. Aquarium Plants Manual Selecting and Maintaining Water Plants in Large and Small Aquariums By Ines Scheurmann, Barron's Educational Series (September, 1993)

## OVERALL EXAMINATION AND MARKS DISTRIBUTION PATTERN

### SEMESTER III

	COURSE CODE												
Theory	PSLSMBT301			PSLSMBT302			PSLSMBT303			PSLSMBT304			GRAND TOTAL
	Internal	External	Total	Internal	External	Total	Internal	External	Total	Internal	External	Total	
	40	60	100	40	60	100	40	60	100	40	60	100	400
Practicals	PSLSMBP301			PSLSMBP302			PSLSMBP303			PSLSMBP304			
	-	50	50	-	50	50	-	50	50	-	50	50	200

### SEMESTER IV

	COURSE CODE												
Theory	PSLSMBT401			PSLSMBT402			PSLSMBT403			PSLSMBT404			GRAND TOTAL
	Internal	External	Total	Internal	External	Total	Internal	External	Total	Internal	External	Total	
	40	60	100	40	60	100	40	60	100	40	60	100	400
Practicals	PSLSMBP401			PSLSMBP402			PSLSMBP403			PSLSMBP404			
	-	50	50	-	50	50	-	50	50	-	50	50	200