

UNIVERSITY OF MUMBAI



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

Program: M.Sc.

Course: Life Sciences

Specialisation:

Aquaculture Technology

M.Sc. Part - II Life Sciences Syllabus

(Aquaculture Biotechnology)

The Academic year 2017-2018

SEMESTER III

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

SEMESTER IV

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

M.Sc. LIFE SCIENCES: SEMESTER – III

PAPER – I(PSLSMBT301): COASTAL AQUACULTURE

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 –VI: **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*. 2nd Ed. Blackwell.

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

PAPER – II (PSLSMBT302): FRESHWATER AQUACULTURE

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 –V: 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*. 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.

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

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 Roughe, 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

Unit II: 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 (GMO) 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, 2nd Edition, 2009.

SEMESTER IV

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

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

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. 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

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

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. *Text Book 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

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 I 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 II 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 (2nd 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