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

(AquacultureTechnology)

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 inIndia, Species cultured (mussels, oysters, pearl oysters, scallops, clams,cockles, abalones, sea cucumber) distribution, biology, practices followed inIndia.

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, feedand water quality management, disease prevention and treatment; harvestingand handling,problems andprospects.

UNIT IV: Seaweed culture

Seaweed culture: Major seaweed species of commercial importance, methods of culture,
Post- harvest technology i.e. Agar agar, alginate, carageenam production

Practicals:

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

References:

UjwalaJadhav (2010): Aquaculture Technology and Environment. Publ. PHI Publication.
Bardach E.J., Rhyther J.H.& Mc Larney W.O., 1972. *Aquaculture theFarming and Husbandry of Freshwater and Marine Organisms*.John Wiley & Sons.
FAO., 2001. *Planning and Management for Sustainable CoastalAquaculture Development*. FAO Publ.
Gilbert B., 1990. *Aquaculture*. Vol. II. Ellis Horwood.
ICAR. 2006. *Handbook of Fisheries and Aquaculture*. ICAR.
Pillay T.V.R., 1990. *Aquaculture, Principles and Practices*. Fishing NewsBooks.
Pillay T.V.R.&Kutty M.N., 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 farmingin 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, compositefish culture.

UNIT II: Fish Farming
Fish farming: Nursery and grow-out, pond preparation, stocking, feeding andwater quality management in the farming of major and minor carps, magur,tilapia, etc.; stunted seedproduction and culture practice.

UNIT III: Prawn Farming
Freshwater prawn farming: Monoculture practice of prawn in ponds, allmaleculture and its advantages,polyculture with carp. Nursery rearing, sex segregation, pond preparation,stocking, feeding and water quality management, disease prevention andtreatment; harvesting and handling.

UNIT IV: Integrated Farming
Integrated farming systems: Design, farming practices, constraints andeconomics 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, salinityand hardness)
3. Pathogen (Bacterial and fungal) analysis of diseased carps/ prawns
4. Estimation of primary productivity andchlorophyll from water sample
5. Visit to freshwater fish prawn farms

References:

AAHRI. 1998. *Health Management in Shrimp Ponds*. Aquatic Animal Health Research Institute (AAHRI), Department of Fisheries, Thailand.
Agarwal S.C. 2008. *A Handbook of Fish Farming*. 2nd Ed. Narendra Publ. House.
Beveridge M.C.M.& Mc Andrew B.J. 2000. *Tilapias: Biology and Exploitations*. Kluwer.
De Silva S.S. (Ed.). 2001. *Reservoir and Culture Based Fisheries: Biology and Management*. ACAIR Proceedings.
FAO. 2007. *Manual on Freshwater Prawn Farming*.
Midlen& Redding T.A., 1998. *Environmental Management for Aquaculture*. Kluwer.
New MB. 2000. *Freshwater Prawn Farming*. CRC Publ.
Pillay T.V.R. 1990. *Aquaculture: Principles and Practices*. Fishing News

Books, Cambrige University Press, Cambridge.
Venugopal S. 2005. *Aquaculture*. Pointer Publ.
ICAR. 2006. *Handbook of Fisheries and Aquaculture*. ICAR.
UjwalaJadhav (2010): Aquaculture Technology and Environment. Publ. PHI Publication
Welcomme R.L., 2001. *Inland Fisheries: Ecology and Management*. FishingNews Books.

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

UNITI: 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.

UNITII: 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 nonconventional 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.

UNITIV: Larval nutrition

Larval nutrition: Nutritional requirements of fish and shellfishlarvae, quality requirements of larval feeds (particle size, digestibility),natural food and its importance in aquaculture, nutritional quality ofcommonly 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 ingradients
7. Identification of common aquarium fishes
8. Visit to aquarium/museum

References:

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

Cyrino E.P.& Bureau D.& Kapoor B.G., 2008. *Feeding and DigestiveFunctions in Fishes.* Science Publ.

D' Abramo L.R., Conklin D.E.& Akiyama D.M., 1977. *Crustacean Nutrition:Advances in Aquaculture*. Vol. VI. World Aquaculture Society,

Baton Roughe, De Silva S.S.& Anderson T. A. 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 R.W. 2002. *Fish Nutrition*. Academic Press.
Halver J.E.&Tiews K.T., 1979. *Finfish Nutrition and Fishfeed Technology*.Vols. I, II Heenemann, Berlin.
Hertrampf J.W.&Pascual F.P., 2000. Handbook on Ingredients forAquaculture 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 LiveFood for Aquaculture*. FAO Fisheries Tech. Paper 361, FAO.
Lovell R.T., 1998. *Nutrition and Feeding of Fishes*. Chapman & Hall.
New M.B., 1987. *Feed and Feeding of Fish and Shrimp. A Manual on thePreparation and Preservation of Compound Feeds for Shrimp andFish in Aquaculture*. FAO – DCP/REP/87/26.
NRC (National Research Council). 1993. *Nutrient Requirements of Fish*.National Academy Press, Washington.
Ojha J.S., 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 W.V., 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 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 nonscientific 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:

The Oxford Book of Modern Science Writing (Oxford Landmark Science)2009 by Richard Dawkins(Author, Editor).

Writing Science: How to Write Papers That Get Cited and Proposals That Get Funded(2012) by Joshua Schimel(Author).

The Best of the Best of American Science Writing (The Best American Science Writing)2010 by Jesse Cohen(Author)

From Research to ManuscriptA Guide to Scientific Writing (Second Edition) By Katz**,** Michael J. (Springer Publication)

Science Research Writing for Non-Native Speakers of Englishby Hilary Glasman-Deal(Author), Imperial College Press, London, UK

Scientific Writing and Communication by Angellka Hofmann, Oxford University Press (2014)

ISO 9000 quality systems handbook fourth edition by David Hoyle

International standard ISO9001: quality management systems — requirements fifth edition 2015-09-15.

Pharmaceutical quality assurance for students of pharmacy, @nd edition Dec., 2007by Mr. Manohar A. Potdar. NiraliPrakashan.

How to Practice GMPs 7th ed. by P.P. Sharma ,Seventh edition 2015.

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

UNITI: Present status of seed production
Introduction: History, constraints and current status of natural seedcollection 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 ofdifferent synthetic hormones and analogues for induced breeding, Eggstaging, Stripping and fertilization.

UNIT III: Reproductive biology and Induced breeding of Shellfish
Shelfishes(Prawns, Shrimp): Reproductive biology: endocrinology and reproductive mechanisms in prawns, shrimpsetc.Age at first maturity; factors affecting maturation and spawning.

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

UNIT IV: Hatchery
Hatchery design and management: Criteria for site selection of hatchery andnursery, Design and function of incubators, Jar hatchery, Chinese hatcheryand other hatchery systems- design and operation, hatchery protocols, larvalrearing 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 ofcultivable brackishwater finfish
5. Packing and transportation of cultivable finfish seed
6. Visit to different finfish hatcheries

References:

FAO. 1992. *Manual of Seed Production of Carps*. FAO Publ.
ICAR. 2006. *Hand Book of Fisheries and Aquaculture*. ICAR.
Jhingran V.G.&Pullin R.S.V., 1985. *Hatchery Manual for the Common,Chinese and Indian Major Carps*. ICLARM, Philippines.
Jhingran V.G. 1991. *Fish and Fisheries of India*. Hindustan Publ.

Landau M., 1992. Introduction to Aquaculture. John Wiley & Sons.
Mcvey J.P., 1983. *Handbook of Mariculture*. CRC Press.
Pillay T.V.R.&Kutty M.N., 2005. *Aquaculture- Principles and Practices*.Blackwell.
Rath R.K., 2000. *Freshwater Aquaculture*. Scientific Publ.
Thomas P.C., Rath S.C.&Mohapatra K.D., 2003. *Breeding and Seed Production of Finfish and Shellfish*. DayaPubl.**AQC**
CMFRI Bulletin. 1987. National Seminar on Shellfish Resources andFarming.
FAO. 2007. *Manual for Operating a Small Scale Recirculation FreshwaterPrawn Hatchery*.
ICAR. 2006. *Handbook of Fisheries and Aquaculture*. ICAR.
UjwalaJadhav (2010): Aquaculture Technology and Environment. Publ. PHI Publication
Bardach E.J., Rhyther J.H.& Mc Larney WO. 1972. *Aquaculture. TheFarming and Husbandry of Freshwater and Marine Organisms*.John Wiley & Sons.
Chakraborty C.& Sadhu A.K., 2000. *Biology Hatchery and CultureTechnology of Tiger Prawn and Giant Freshwater Prawn*. DayaPubl. House.
Diwan A.D., 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 defensemechanism, immunogenicity, immune cells, immune suppressant, ontogenyof immune system; cellular adaptation, pathogen specificity.

UNIT II: Diagnostics tools
Disease diagnostics tools: Histopathological methods, tools used in differenttypes of PCR, Immunoassay, Biochemical assay, Monoclonal andpolyclonal based antibody assay, Electron microscopy, Serologicaltechniques.

UNIT III: Vaccines
Disease prevention and therapeutics: Vaccines and bactericins, developmentof vaccines like DNA vaccine, adjuvant, etc; Disease resistance in fishes

UNIT IV: Disease prevention and therapeutics
Administration and mode ofaction of pathogen specific drugs, drug resistance, antiviral drugs, drugregulation 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

References:

Andrews C., Excell A.& Carrington N. 1988. The Manual of Fish Health.Salamander Books.
Sindermann C.J., 1990. *Principal Diseases of Marine Fish and Shellfish*.Vols. I, II. 2nd Ed. Academic Press.
Jorge E., Helmut S., Thomas W.& Kapoor B.G., 2008. *Fish Diseases*.Science Publ.
Felix S., Riji John K., Prince Jeyaseelan M.J.&Sundararaj V., 2001. *FishDisease Diagnosis and Health Management*. Fisheries College andResearch, Institute, T. N. Veterinary and Animal SciencesUniversity. Thoothukkudi.
Humphrey J., Arthur J.R., Subasinghe R.P.& Phillips M.J.,2005. *AquaticAnimal Quarantine and Health Certification in Asia.* FAO Publ.
Inglis V., Roberts R.J.&Bromage N.R., 1993. *Bacterial Diseases of Fish*.Blackwell.
Iwama G.& Nakanishi T. (Eds.). 1996. *The Fish Immune System -Organism, Pathogen and Environment*. Academic Press.
Roberts R.J. 2001. *Fish Pathology*. 3nd Ed. W.B. Saunders.
Shankar K.M.& Mohan C.V., 2002. *Fish and Shellfish Health Management*.UNESCO Publ.

Wedmeyer G., Meyer F.P.& Smith L., 1999. *Environmental Stress and FishDiseases*. Narendra Publ. House.
Woo P.T.K.& Bruno D.W. (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 quantitativetraits in fish; chromosomal polymorphism.Non chromosomal inheritance: Mitochondrial inheritance.

Chromosome manipulation: Gynogenesis and Androgenesis; production ofsuper-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 BiofilmVaccines.

Applications of biotechnological tools: Recombinant DNA, Monoclonalantibodies, 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)

References:

Das P.&Jhingran A.G. 1976. *Fish Genetics in India*. Today & TomorrowPubl.

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

Dunham R.A., 2004. *Aquaculture and Fisheries Biotechnology GeneticApproaches*. CABI.

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

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

Padhi B.J.& Mandal R.K., 2000. *Applied Fish Genetics*. Fishing Chimes.

Pandian T.J., Strüssmann C.A.& Marian M.P. 2005. *Fish Genetics andAquaculture Biotechnology*. Science Publ.
Reddy P.V.G.K., 2005. *Genetic Resources of Major Indian Carps*. DayaPubl.
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Sinnot E.W., Dunn L &Dobzansky T., 1989. *Principles of Genetics*. McGraw Hill.
Felix S., 2007. *Molecular Diagnostic Biotechnology in Aquaculture*. DayaPubl. House.
Fingerman M., Nagabhushanam R.& Thompson M.F. 1997. *RecentAdvances in Marine Biotechnology*. Vols. I-III. Oxford & IBH.
Glick B.R.& Pasternak J.J. 1999. *Molecular Biotechnology: Principles andApplications of Recombinant DNA Technology*. ASM Press.
Nagabhushanam R., Diwan A.D., Zahurnec B.J.&Sarojini R., 2004.*Biotechnology of Aquatic Animals*. Science Publ.
Nair P.R., 2008. *Biotechnology and Genetics in Fisheries and Aquaculture*.Dominant Publ.
Pandian T.J., Strüssmann C.A.& Marian M.P., 2005. *Fish Genetics andAquaculture Biotechnology*. Science Publ.
Primrose S.B., 1989. *Modern Biotechnology*. Blackwell.
Ramesh R.C. (Ed.). 2007. *Microbial Biotechnology in Agriculture andAquaculture*. Vol. II. Science Publ.
Reddy P.V.G.K., Ayyappan S., Thampy D.M.&Gopalakrishna., 2005. *TextBook of Fish Genetics and Biotechnology*. ICAR.
Singh B., 2006. *Marine Biotechnology and Aquculture Development*. Daya.Publ. House.
Zhanjiang J.L., 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 drugie Plants, Animals, Microorganisms**;** 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. Preclinical 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

References:

Chemistry of Natural Products by Sujata V. Bhat, B.A. Nagasampagi,Meenakshi Sivakumar (Springer Publication).
Indian Uses of Native Plants by Edith Van Allen Murphey
Plant Taxonomy (2nd Edition) by Sharma
Plant Drug analysis by H. Wagner
Biochemistry and Molecular Biology of *Plants* by Bob B. *Buchanan*
Plant Secondary Metabolites
Volume 1: Biological and Therapeutic Significance
Volume 2: Stimulation, Extraction, and Utilization by Kamlesh Prasad**,**

VasudhaBansalHerbal Cosmetics &Ayurvedic Medicines by P. K. Chattopadhyay
Textbook of Clinical Trials by David Machin, Simon Day, Sylvan Green
Plant Bioactives and Drug Discovery: Principles, Practice, and Perspectives1st Edition Valdir Cechinel-Filho(Author), Wiley Publication.
Drug Discovery from Plants by Angela A. Salim, Young-Won Chin, A. Douglas Kinghorn (Springer publication)
Bioassay Methods in Natural Product Research and Drug Development by Lars Bohlin, Jan G. Bruhn (Springer Publication)
Handbook of Fisheries and Aquaculture. ICAR 2006.
Ornamental Fish Farming ICAR. Saroj K. Swain, Sarangi N. and Ayyappan S., 2010.
Aquarium Fishes. Kingfisher Books by Mills D. 1981.
The Complete Book of the Freshwater Aquarium: A Comprehensive Reference Guide to More Than 600 Freshwater Fish and Plants**b**y Vincent Hargreaves(Author), Thunder Bay Press, San Diego California (2007).
The Inspired Aquarium: Ideas and instructions for living with aquariums by Jeff and Mike Senske Publisher: Quarry Books (2006).
Manual of Fish Health Everything You Need to Know About Aquarium Fish, Their Environment and Disease Preventionby Chris Andrews - Firefly Books Ltd. (2003).
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).
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**			**PSLMBT304**			**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