

University of Mumbai



No. AAMS_UGS/ICC/2022-23/ 101

CIRCULAR:-

Attention of the Principals of the Affiliated Colleges, Directors of the Recognized Institutions and the Head of the University Departments in Faculty of Science & Technology is invited to the syllabus uploaded Academic Authority Meetings and Services which was accepted by the Academic Council at its meeting held on June, 2016 relating to the M.Sc. (Life sciences) Specialization in Aquaculture Technology (Sem.III & IV).

They are hereby informed that the recommendations made by the Ad-hoc Board of Studies in **Life Science** at its meeting held on 31st May, 2022 and subsequently passed in the faculty and then by the Board of Deans at its meeting held on 05th July, 2022 vide item No. 6.2 (R) have been accepted by the Academic Council at its meeting held on 11th July, 2022 vide item No. 6.2 (R) and that in accordance therewith, the revised syllabus of M.Sc. (Life sciences) Specialization in Aquaculture Technology (Sem. III & IV) (CBCS), has been brought into force with effect from the academic year 2022-23. (The same is available on the University's website www.mu.ac.in).

MUMBAI – 400 032

11th October, 2022

To

The Principals of the Affiliated Colleges, Directors of the Recognized Institutions and the Head of the University Departments in Faculty of Science & Technology.

A.C/6.2(R) /11/07/2022

No. AAMS_UGS/ICC/2022-23/ 101

11th October, 2022

Copy forwarded with Compliments for information to:-

- 1) The Dean, Faculty of Science & Technology,
- 2) The Chairman, Ad-hoc Board of Studies Life Science,
- 3) The Director, Board of Examinations and Evaluation,
- 4) The Director, Board of Students Development,
- 5) The Director, Department of Life Science ,
- 6) The Co-ordinator, MKCL.

(Dr. Shailendra Deolankar)
I/c. REGISTRAR

py for information and necessary action :-

- 1. The Deputy Registrar, College Affiliations & Development Department (CAD),**
- 2. College Teachers Approval Unit (CTA),**
- 3. The Deputy Registrar, (Admissions, Enrolment, Eligibility and Migration Department (AEM),**
- 4. The Deputy Registrar, Academic Appointments & Quality Assurance (AAQA)**
- 5. The Deputy Registrar, Research Administration & Promotion Cell (RAPC),**
- 6. The Deputy Registrar, Executive Authorities Section (EA)**
He is requested to treat this as action taken report on the conce resolution adopted by the Academic Council referred to the a circular.
- 7. The Deputy Registrar, PRO, Fort, (Publication Section),**
- 8. The Deputy Registrar, Special Cell,**
- 9. The Deputy Registrar, Fort Administration Department (FAD) Record Section,**
- 10. The Deputy Registrar, Vidyanagari Administration Department (VAD),**

Copy for information :-

- 1. The Director, Dept. of Information and Communication Technology (DICT), Vidyanagari,**
He is requested to upload the Circular University Website
- 2. The Director of Department of Student Development (DSD),**
- 3. The Director, Institute of Distance and Open Learning (IDOL Administration Vidyanagari,**
- 4. All Deputy Registrar, Examination House,**
- 5. The Deputy Registrars, Finance & Accounts Section,**
- 6. The Assistant Registrar, Administrative sub-Campus Thane,**
- 7. The Assistant Registrar, School of Engg. & Applied Sciences, Kaly**
- 8. The Assistant Registrar, Ratnagiri sub-centre, Ratnagiri,**
- 9. P.A to Hon'ble Vice-Chancellor,**
- 10. P.A to Pro-Vice-Chancellor,**
- 11. P.A to Registrar,**
- 12. P.A to All Deans of all Faculties,**
- 13. P.A to Finance & Account Officers, (F & A.O),**
- 14. P.A to Director, Board of Examinations and Evaluation,**
- 15. P.A to Director, Innovation, Incubation and Linkages,**
- 16. P.A to Director, Department of Lifelong Learning and Extension (DLLE),**
- 17. The Receptionist,**
- 18. The Telephone Operator,**

Copy with compliments for information to :-

- 19. The Secretary, MUASA**
- 20. The Secretary, BUCTU.**

UNIVERSITY OF MUMBAI



**Revised Syllabus for
M.Sc.**

(LIFE SCIENCES)

Specialization in Aquaculture Technology

**Semester: III & IV
(CBCS)**

(With effect from the academic year 2022-23)

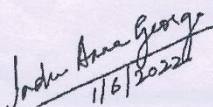
UNIVERSITY OF MUMBAI

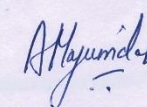


Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course	M.Sc. (Life Sciences) Specialization in Aquaculture Technology
2	Eligibility for Admission	M. Sc. Life Sciences Semester I and II, of University Department of Life Sciences, University of Mumbai.
3	Passing Marks	240/600 every semester.
4	Ordinances / Regulations (if any)	No. PG/ Univ./VCD/ ICC/ 201213/18.
5	No. of Years / Semesters	2 Semesters (Semester III & IV)
6	Level	Certificate/Diploma/UG/ PG
7	Pattern	Semester /Yearly
8	Status	Revised /New /
9	To be implemented from Academic Year	From Academic Year: 2022-2023

Date: 1st June 2022


Signature:
Name: Dr. Indu Anna George
Chairman of BoS of Life Sciences


Signature:
Dr. Anuradha Majumdar
Dean, Science and Technology

M. Sc. LIFE SCIENCES

SEMESTER III & IV

PREAMBLE:

The designers of the Master's Programme in Life Sciences are conscious of the fact that the learners who chose to pursue this programme in Life Sciences are from different disciplines and would need to be familiarized with the scope of Life Sciences. The courses in this programme are common to all learners in the first year (Semester I and II) and they are given a firm and comprehensive foundation in this multidisciplinary subject in this year.

The syllabus of the Semester III and IV of the Masters level in Life Sciences allows the learner to explore the different facets of Life Sciences. The learner has the option to select between the four specializations offered at the Second Year (Semester III and IV) of the programme namely: Biochemistry, Biotechnology, Environmental Biotechnology and Aquaculture Technology which would be awarded on the basis of seats available and merit.

The Semester III would allow the learner to appreciate the finer nuances of the specialization selected which would be detailed in each of the courses (4 theory and 4 practical) specific to that specialization.

The Semester IV gives the learner an opportunity for hands-on extension of the theory that was taught in the preceding semesters and design projects or develop methods that are scientifically relevant or mitigate a social challenge with the appropriate application of the tenets of this discipline through a comprehensive Literature Review (Course 403) and Project (Course 404). The learners would be encouraged to publish the results of their research or present them at relevant platforms such as seminars/ conferences etc.

The learner would earn 48 credits at the end of Semester III and IV (24 credits in each semester) that includes both theory and practical aspects as detailed below. In both semesters, the learner would be exposed to courses that impart core knowledge of the specialization and also expose the learner to skills relevant in that particular specialization. There are about 13 credits (denoted by an Asterix) devoted to this aspect of learning.

Value added courses would also be recommended to the learner as extra but pertinent reading.

The design of the M. Sc. Life Sciences – Specialization Aquaculture Technology course for Semester III and IV have been outlined below:

Dr. Anuradha Majumdar (Dean, Science and Technology)

Prof. Shivram Garje (Associate Dean, Science)

Name of Chairperson (BoS): Dr. Indu Anna George.

Member (BoS): Dr. Nandita Mangalore

Member (BoS): Dr. Hemalata Ramchandran

Member (BoS): Dr. Tejashree Shanbhag

Member (BoS): Dr. Priya Sundarajan.

Member (BoS): Dr. Nilima Gajbhiye

Syllabus framework and details as per University style and template

STRUCTURE FOR THE SEMESTER III AND SEMESTER IV

MASTER'S COURSE IN LIFE SCIENCES – SPECIALIZATION IN AQUACULTURE TECHNOLOGY

SEMESTER III

Theory Credit 4	UNITS				Practical credit 2	
Paper	UT1	UT2	UT3	UT4	P1	P2
PSLSMBT301	Core	Core	Core	Core	2.0 Cr	
PSLSMBT302	Core	Skill*	Skill*	Core	1.0 Cr	1.0* Cr
PSLSMBT303	Core	Core	Core	Skill*	1.5 Cr	0.5* Cr
PSLSMBT304	Skill*	Skill*	Core	Core	1.0 Cr	

Total Credits: 4 x4 = 16; 2 x 4=8; 16 + 8 = 24.

EXAMINATION DETAILS:

Paper	PSLSMBT301			PSLSMBT302			PSLSMBT303			PSLSMBT304		
	Int	Ext	Total	Int	Ext	Total	Int	Ext	Total	Int	Ext	Total
Theory	40	60	100	40	60	100	40	60	100	40	60	100
Practical		50	50		50	50		50	50		50	50
Total Marks			150			150			150			150

Grand Total: 600 marks.

SEMESTER IV

Theory Credit 4	UNITS				Practical credit 2	
Paper	UT1	UT2	UT3	UT4	P1	P2
PSLSMBT401	Core	Core	Core	Core	2.0 C	-
PSLSMBT402	Core	Skill*	Skill*	Core	0.5 + 0.5 C	0.5* + 0.5* C
PSLSMBT403	Skill*	Lit review	Lit review	Lit review	0.5*C	Draft Paper
PSLSMBT404	Skill*	Internship/ Project	Internship /Project	Internship/ Project	Internship /Project	Internship /Project

Examination Details:

Paper	PSLSCMBT401			PSLSCMBT402			PSLSCMBT403			PSLSCMBT404		
	Int	Ext	Total	Int	Ext	Total	Int	Ext	Total	Int	Ext	Total
Theory	40	60	100	40	60	100	40	60	100	40	60	100
Practical		50	50		50	50		50	50		50	50
Total Marks			150			150			150			150

Grand total: 600 marks.

**** Assessment pattern for PSLSCMBT403**

Internal: 10 marks for skill (test); 30 marks from Lit review Thesis submission = 40

External: 15 marks for skill (exam) and 45 marks of Lit review viva (exam) = 60

**** Assessment pattern for PSLSCMBT404**

Practical: 25 marks skill (exam) and 25 marks draft paper (exam) = 50

***** Assessment pattern for PSLSCMBT404**

Internal: 10 marks for skill (test); 30 marks internal assessment of project/ internship by guide = 40

External: 15 marks for skill (exam) and 45 marks for thesis submission = 60

***** Assessment pattern for PSLSCMBT404**

Practical: 50 marks internship/ project viva by external (exam).

UNIVERSITY OF MUMBAI

Syllabus for the M.Sc. Part – II: Life Sciences – Specialization in Aquaculture Technology

Semester III and IV

Choice Based Credit and Grading System

The academic year 2022 - 2023

Program Objectives:

- To expose the learner to various aspects of Aquaculture Technology
- To give an insight in developing skills and knowledge in Aquaculture Technology based research laboratories and industry application

Program Outcome:

The learner will be able to:

- Comprehend various techniques and scope of the discipline.
- Appreciate the applications of Aquaculture Technology in Research labs and industry.
- Increase his/her employability, entrepreneurship and business skill.
- Develop ideas and plans to establish a national & international industrial venture.

SEMESTER III

CODE	UNIT		Credits	Hours
PSLSMBTT301		Aquaculture Principle, Production & Practices	4	60
	I	Scope and Farming Practices of Aquaculture	1	15
	II	Fish Production & Management of Cultivable & Ornamental Fishes	1	15
	III	Pearl/Oyster, Clam & Mussel Culture, Pearl Formation & Management	1	15
	IV	Mariculture and Integrated Aquaculture	1	15
PSLSMBTT302		Aquaculture Development & Management	4	60
	I	Prawn/Shrimp Farming Management & Importance	1	15
	II	Aquatic Plants and their economic importance*	1	15
	III	Practice of Cultivating and Harvesting of Seaweed*	1	15
	IV	Aquafarm Machinery & Management	1	15
PSLSMBTT303		Fish Nutrition and Aquatic Animal Health Management	4	60
	I	Fish Nutrition	1	15
	II	Ornamental Fish Nutrition	1	15
	III	Defense Mechanism in Fish, Shellfish & Disease Diagnostics Tools	1	15
	IV	Vaccines, Disease Prevention and Therapeutics*	1	15
PSLSMBTT304		Value Addition, Biochemical, Biotechnical & Environmental Studies of Aquatic Life	4	60
	I	Value Addition and Fish Processing Technique*	1	15
	II	Biochemical Studies of Aquatic Life*	1	15
	III	Aquaculture & Fishery Biotechnology	1	15
	IV	Environmental Impact on Aquaculture	1	15
PRACTICAL				
PSLSMBTP301		Aquaculture Principle, Production & Practices- Practical	2	60
PSLSMBTP302		Aquaculture Development, Management & Biotechnology - Practical	2	60
PSLSMBTP303		Fish Nutrition and Aquatic Animal Health Management - Practical	2	60
PSLSMBTP304		Value Addition, Biochemical, Biotechnical & Environmental Studies of Aquatic Life - Practical	2	60

SEMESTER IV

CODE	UNIT		Credits	Hours
PSLSMBTT401		Establishment and Management of Fish Farm	4	60
	I	Present Status of Seed Production	1	15
	II	Reproductive biology and induced breeding of Finfish & Shellfish	1	15
	III	Technology of Fishing	1	15
	IV	Shrimp Hatchery Management	1	15
PSLSMBTT402		Genetics, Cell Culture, Nanobiotechnology & Aquarium Management in Aquatic Animals	4	60
	I	Fish Genetics & Cytogenetic	1	15
	II	Fish Cell Culture*	1	15
	III	Nanobiotechnology*	1	15
	IV	Aquarium Management	1	15
PSLSMBTT403		Research Methodology, Scientific Writing and Literature Review		
	I	Research Methodology and Scientific Writing*	4	60
	II	Literature Review	1	15
	III	Literature Review	1	15
	IV	Literature Review	1	15
PSLSMBTT404		Commercially Important Sea Food, Microalgae, Aquatic Waste Products & Use	4	60
	I	Sea Food, Microalgae, Fish Waste Products & Use*	1	15
	II	Internship/Project	1	15
	III	Internship/Project	1	15
	IV	Internship/Project	1	15
PRACTICAL				
PSLSMBTP401		Establishment and Management of Fish Farm- Practical	2	60
PSLSMBTP402		Genetics, Cell Culture, Nanobiotechnology & Aquarium Management in Aquatic Animals - Practical	2	60
PSLSMBTP403		Research Methodology, Scientific Writing and Literature Review - Practical	2	60
PSLSMBTP404		Commercially Important Sea Food, Microalgae, Aquatic Waste Products & Use Project - Internship/Project viva.	2	60

PSLSMBTT 301: Aquaculture Principle, Production & Practices

Course Objectives: Study of aquatic life & its production.

Course Outcomes: Aquaculture management & processing methods will be utilized to strengthen economy.

UNIT I: Scope and Farming Practices of Aquaculture

Introduction of Aquaculture: Concept, Definition and scope of aquaculture; Present status, Problems and scope of fish farming in global and national perspective of Indian aquaculture; Aquaculture research & development in India.

Basic Requirement for Aquaculture: Types of aquaculture practices: Extensive, Intensive, Semi-intensive and Composite culture of fish, Polyculture, Pen and Cage culture.

Aquaculture Productivity: Role of Science and Technology in aquaculture productivity, Economic importance of aquaculture field.

UNIT II: Fish Production & Management of Cultivable & Ornamental Fishes (15 L/ 1 C)

Fish Farming: Cultivable fishes- Major & minor Carps, Magur and Tilapia; Seed production, Nursery management, Pond preparation and stocking, Feeding of fish and water quality management, Recent trends in fish culture, Export of fish & fishery products, Marketing of aquaculture products as emerging opportunities for industry, International quality, Growth & survival of productive fish culture, Industrialization of aquaculture towards blue revolution, Freshwater aquaculture of Gold & Arowana fish.

UNIT III: Pearl/Oyster, Clam & Mussel Culture, Pearl Formation & Management (15 L/ 1 C)

Pearl Farming: Introduction, Basic methods of pearl farming, Physiology of pearl production in Shellfish, Process of pearl culture, Economic importance and marketing of pearl, Processing and quality evaluation of pearls Oyster, Pearl production by tissue culture and mother pearl formation.

Mussel Culture: Introduction, Common species: *Lamellidens marginalis*, *L.corrianus*, Culture practice: Major steps- Collection of mussels, Pre-operative conditioning, Surgery, Post-operative care, Pond culture and harvesting of pearls.

Applications: Pearls as medicine, Cosmetics and Ornaments. Economic importance of pearls.

UNIT IV: Mariculture and Integrated Aquaculture

Mariculture: Introduction, Cultivation of marine organisms, Food and other products obtained by marine organisms, Non-food products produced by mariculture including fish meal, chitin/ chitosan. Mariculture: An overview of marine progress in India.

Integrated Farming Systems: Design, Principle, Global status, Farming practices, Constraints and Integration of aquaculture with agriculture, horticulture and live stock farming; Wastewater-fed aquaculture, Beautification of urban areas, public aquaria.

PSLSMBTP 301: Aquaculture Principle, Production & Practices - Practical

Practicals:

1. Identification of commercially important marine & freshwater Cultivable fishes
2. Estimation of Primary Productivity

3. Production of chitin/ chitosan from shrimp shells or other suitable sources.
4. Identification of commercially important Freshwater Bivalve
5. Identification of commercially important Sea water Oyster
6. Visit to Integrated fish farm.
7. Visit to Sea shore, fish markets & dockyard.

REFERENCES

1. S.D.Tripathi, W.S. Lakra & N.K. Chadha, 2018. Aquaculture in India, Narendra Publishing House
2. Ujwala Jadhav, 2010. Aquaculture Technology and Environment. Publ. PHI Publication
3. S. Ayyappan, 2006. *Handbook of Fisheries and Aquaculture*. ICAR.
4. Pillay T.V.R., 1990. *Aquaculture: Principles and Practices*. Fishing News Books, Cambridge University Press, Cambridge.
5. Pillay T.V.R. & Kutty M.N., 2005. *Aquaculture: Principles and Practices*. 2ndEd. Blackwell
6. Venugopal S., 2005. *Aquaculture*. Pointer Publ.
7. Agarwal S.C., 2008. *A Handbook of Fish Farming*. 2nd Ed. Narendra Publ.House.
8. Beveridge M.C.M. & Mc. Andrew B. J., 2000. *Tilapias: Biology and Exploitations*. Kluwer.

PSLSMBTT 302: Aquaculture Development and Management

Course Objectives: Study of Prawns, Seaweeds and Development & management of Aquatic Life.

Course Outcomes: To get a quality production and processing of aquatic plants, animals and farming knowledge.

UNIT I: Prawn/ Shrimp Farming Management & Importance

Prawn farming: Major types of freshwater Prawn, Freshwater Prawn farming: Culture Practice: Monoculture and polyculture practice of Prawn. Pond preparation: Nursery rearing, Stocking, Feeding and Water quality management, Disease prevention and treatment.

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. Shrimp processing for exports, Economics of shrimp farming.

Soil & Water Quality Management: **Soil:** Physical & chemical properties, Types, Distribution, Suitable soil for aquaculture, pH correction of soil, Management of alkalinity & acidity of soil, Quality monitoring & management. **Water:** Physical & chemical properties, Quality standards, Quality monitoring & management.

UNIT II: Aquatic Plants and their economic importance*

Ornamental Plants: Aquarium plants and aquatic gardens: General types and description of aquarium/ ornamental plants. primary producers, Heterophylly: Temperature, Hormones, Water status. Advantage of growing aquatic plants in fish tanks and aquaria.

Marine Plants – Types, Macro, Micro algae, Phytoplankton and Dinoflagellates.

Bioprospecting of bioactives from aquatic sources: antioxidants, anti-cancer, antibiotic, neurotoxins, phycotoxin etc. with examples) isolated from *Marselia minua*, *Acorus calamus*, *Nymphaea*, *Vallisneria* (antidermatitis), *Marine Dinoflagellates* and Phytoplankton

Cultivation of Aquatic Plants: Traditional methods and Plant tissue culture of aquarium plants, Molecular breeding and cold resistance for aquatic plants.

Dangers of Exotic Aquarium/ Aquatic Plants: Hitchhikers and invasive species.

Plant Aquaculture: Legislation to regulate aquaculture industries and industrial applications.

UNIT III: Practice of Cultivating and Harvesting of Seaweed*

Seaweed Culture: Present status of seaweed culture in India. Site selection, Design of culture ponds and transplanting; Determining growth pattern and environmental monitoring, Problems and prospects. Major seaweed species of commercial importance, Methods of culture,

Post-Harvest Technology: Agar agar, Alginate, Carrageenan production, Chemical composition of Seaweeds; Processing and extraction of agar, Alginic acid, Mannitol and Carrageenan. Uses of agar, Algin, Manitol, Carrageenan and other uses of seaweed. Seaweed cultivation in coastal area of India for small scale fisheries.

UNIT IV: Aquafarm Machinery & Management

Aeration system: Principle, Classification, Aeration process in aqua farm and maintenance, Types of aerators and their application in aqua farms, Operation and maintenance

Filter system: Introduction, Principle of filtration, Types, Rate of filtration, Construction and their maintenance. Advantages & disadvantages.

Pumps: Introduction, Types, Working, Maintenance, Application in aqua farms, Operation and maintenance aspects - Selection of pumps for the aquafarms

Boat: Introduction of different types of Boat & motors.

Feeders: Types & maintenance

PSLSMBTP 302: Aquaculture Development, Management & Biotechnology - Practical

Practicals:

1. Identification of commercially important marine & freshwater Prawn
2. Visit to freshwater Shrimp/Prawn farms
3. Microropagation of aquarium/aquatic plants
 - a. Media preparation
 - b. Shoot culture establishment
 - c. Rooting of the microshoot
 - d. Acclimatization.
4. Aerators & filtration system in aquarium
5. Identification of commercially important freshwater & marine Seaweeds
6. Water Analysis: pH, BOD, COD, Dissolved oxygen, Salinity, Hardness
7. Soil Analysis: pH, soil texture, moisture
8. Chlorophyll estimation from seaweeds

REFERENCES

1. Ujwala Jadhav (2010): Aquaculture Technology and Environment. Publ. PHI Publication
2. S. Ayyappan, 2006. *Handbook of Fisheries and Aquaculture*. ICAR.
3. S.D. Tripathi, W.S. Lakra & N.K. Chadha, 2018. Aquaculture in India, Narendra Publishing House
4. Economics of farm production & management by Raju, V.T., Shankerrao, oxford & ibh, 2017, paperback
5. Faizal Bux and Yusuf Chisti (2016) *Algae Biotechnology: Products and Processes*, Springer.
6. Stengel and Connan (2015) *Natural Products from Marine Algae: Methods and Protocols*. Humana Press
7. Peter Hiscock (2003) *Encyclopedia of Aquarium Plants*, Interpet Publishing.
8. Soil and Water Quality Management for Sustainable Aquaculture Hardcover – 1 October 2010 by R. K Saha (Author)
9. **Design of Water Quality Monitoring Systems 2018 Edition by Robert C. Ward, Wiley**
10. Bird, K.T. and Benson, P.H., 1987. *Seaweed Cultivation for Renewable Resources*. Elsevier Science Publishers, New York. Chapman,
11. A.R.O., 1992. Fourteenth International Seaweed Symposium. Kluwer Academic Press, London
12. Chapman, V. J. and Chapman D. J., 1980. *Seaweed and their uses*. Methuen & Co., London. CMFRI (Central Marine Fisheries Research Institute), 1987.
13. *Seaweed research and utilization in India*. CMFRI Bulletin No. 41, CMFRI, Cochin, India. FAO (Food & Agriculture Organization), 1975
14. Bimal Chandra Mal, 2021. *Aquacultural facilities & equipment*, Elsevier

PSLSMBTT 303: Fish Nutrition and Aquatic Animal Health Management

Course Objectives: To study nutritional value and impact of nutrition on animal development and control of disease management.

Course Outcomes: To get a quality production of disease-free aquatic animals & required nutrition as per demands.

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.

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. Antinutritional factor, Nutrient deficiency and symptoms.

UNIT II: Ornamental Fish Nutrition (15 L/ 1 C)

Food and Feeding Technique: Nutritional requirement, Feed ingredients used and proximate composition, Feed formulation, Pelleted diet preparation, Live-food, feeding of larvae, Storage of prepared feed, Overfeeding and underfeeding.

Feed formulation: Conventional and non-conventional feed stuffs, Feed formulation technology, Growth promoting agents in aqua feed.

UNIT III: Defense Mechanism in Fish, Shellfish & Disease Diagnostics Tools

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.

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 IV: Vaccines, Disease Prevention and Therapeutics*

Disease Prevention and Therapeutics: Vaccines and bacteriocins, Development of vaccines like DNA vaccine, Adjuvant, etc; Disease resistance in fishes.

Fish Diseases: Bacterial, Viral, fungal etc. Administration and mode of action of pathogen specific drugs, Drug resistance, Antiviral drugs, Drug regulation in India, Pharmacokinetics and pharmacodynamics, Immunostimulants.

Antibiotics and Antimicrobial Resistance: History of antibiotics, Classes of antibiotics, Action of antibiotics, Uses and misuse of drugs, AMR, Remedial measures, Alternatives to antibiotics

PSLSMBTP 303: Fish Nutrition and Aquatic Animal Health Management - Practical

Practicals:

1. Moisture and ash content of Feeds/fish
2. Estimation of crude fibre
3. Estimation of vitamin c from feed ingredients
4. Feed preparation.
5. Visit to aquarium/museum
6. Microbial analysis of diseased fish/prawn skin mucus
7. Isolation of microbial DNA from fish pathogens
8. Proximate composition analysis of feed ingredients and feeds

REFERENCES

1. Baton Roughe, De Silva S.S. & Anderson T.A. 1995. *Fish Nutrition in Aquaculture*. Chapman & Hall Aquaculture Series.
2. Halver J. & Hardy R.W. 2002. *Fish Nutrition*. Academic Press.
3. Halver J.E. & Tiews K.T. 1979. *Finfish Nutrition and Fishfeed Technology*. Vols. I, II Heenemann, Berlin.
4. Ujwala Jadhav (2010). *Aquaculture Technology and Environment*. Publ. PHI Publication
5. S. Ayyappan, 2006. *Handbook of Fisheries and Aquaculture*. ICAR
6. Saroj K. Swain, Sarangi N. and Ayyappan S. 2010. *Ornamental Fish Farming* ICAR.
7. Ojha J.S. 2005. *Aquaculture Nutrition and Biochemistry*. Daya Publ.
8. Sindermann C.J. 1990. *Principal Diseases of Marine Fish and Shellfish*. Vols. I, II. 2nd Ed. Academic Press.
9. Felix S., Riji John K, Prince Jeyaseelan M.J. & Sundararaj V. 2001. *Fish Disease Diagnosis and Health Management*. Fisheries College and Research, Institute, T. N. Veterinary and Animal Sciences University. Thoothukkudi.
10. Inglis V., Roberts R.J. & Bromage N.R. 1993. *Bacterial Diseases of Fish*. Blackwell.
11. Iwama G & Nakanishi T. (Eds.). 1996. *The Fish Immune System -Organism, Pathogen and Environment*. Academic Press.
12. Shankar KM & Mohan CV. 2002. *Fish and Shellfish Health Management*. UNESCO Publ.
12. Kimbell E., 1988. *Fundamental of Immunology*.

PSLSMBTT 304: Value Addition, Biochemical, Biotechnical & Environmental Studies of Aquatic Life

Course Objectives: To study skill of value addition and acquire knowledge of Biochemistry, Biotechnology and Environmental Biotechnology

Course Outcomes: Blue revolution and use of aquatic life in studies of different skilled based techniques, uses to develop, increase the application and economy.

UNIT I: Value Addition and Fish Processing Technique*

Value addition: Definition, Shelf life, Entrepreneurship development.

Value Added Fishery Products: Types: Battered and breaded products, minced based products (fish vada, fish cutlet, fish pickle, fish chakli, fish save, etc.), Fermented products.

Colour Enhancement in Fish: Colour enhancers- Carotenoids, Different colour obtained by different pigments.

Fish Preservation Technology: Introduction, Fundamentals, Salting, Drying, Freezing, Curing, smoking, Marinating and fermentation.

Fish Canning: Principles, Changes during canning, Problems related to fish canning. Fish additives and preservatives.

UNIT II: Biochemical Studies of Aquatic Life*

Cell Biology Techniques: Principles, Instrument overview, Applications of flow cytometry, Fluorescence Resonance Energy Transfer (FRET); Surface Plasmon Resonance.

Proteomics: Peptide synthesis and Protein sequencing methods, Detection of post-translation modification of proteins; 2-D gel electrophoresis; Mass spectrometry; X-ray diffraction methods; Static and dynamic light scattering (SLS and DLS); Capillary electrophoresis; Protein chips; Differential scanning calorimetry; Isothermal titration calorimetry.

Genomics: Oligonucleotide synthesis; DNA chips/microarrays; DNA hybridization; DNA sequencing methods; Strategies for genome sequencing; Methods for analysis of gene expression at RNA and protein level; Site directed mutagenesis; Gene knockdown; Differential display; Serial analysis of gene expression (SAGE). Bombay duck & catfish: Protein, Energy nucleic acid, Use of growth hormone for increase production and its effects on consumers.

UNIT III: Aquaculture & Fishery Biotechnology

Biotechnology in aquaculture: Selective breeding, Hybridization, Genetic improvement of brood stock. Natural products from marine organisms (antimicrobial, anticancer and biomedical compounds), Hybridoma technology, Cloning and expression of genes from marine organisms, Genetic improvement of marine organisms and role of genetically engineered organisms. Role of biotechnology in improving aquaculture production.

Biotechnology & Aquaculture Engineering: Application of biotechnology tools to increase the growth rate, Commercial application of fish biotechnology.

Transgenics in Aquaculture: Production of transgenic animals, Intraspecific and interspecific crossbreeding, Genetic conservation, Gene banking and maintaining genetic quality, Genetic improvement of stocks: better taste & higher production.

UNIT IV: Environmental Impact on Aquaculture

Aquatic Ecosystems: Freshwater & Marine Ecosystem- Lotic & Lentic ecosystem
Seas, Oceans, Zonation, Classification of habitat.

Aquatic Pollution: Sources, Types, causes of pollution, effect on aquatic ecosystem; Nature, Microbial changes induced by inorganic and organic pollutants, Pollution abatement measures; Biological indicators of pollution; Standards: National and International; Pollution Control. Greenhouse effect, Acid rain. Sustainability & environmental management of aquaculture, Environmental impact of aquaculture and its assessment. Biological pollution, Algal blooms and their effects on fish production and public health. Role of microorganisms in degradation of pollutants.

Microalgae: For food, Remediation and bioenergy. Microalgae indicator of environmental health. Environmental aspects: Aquatic mosses biofiltration and remediation.

PSLSMBTP 304: Value Addition, Biochemical, Biotechnical & Environmental Studies of Aquatic Life – Practical

Practicals:

1. Preparation of value-added products from low-cost fishes
2. Physico-chemical analysis of fish and fishery product
3. Extraction of protein by Kjeldahl's method/Lowry's method.
4. Extraction of lipid by using Soxhlet/Soxhlet system
5. Amplification of Fish DNA by RAPD
6. Demonstration Proteomic and Genomic techniques.
7. 2-D Gel electrophoresis (Demonstration)
8. Study of differential cell counting by flow cytometry.
9. Study of different aquatic ecosystems
10. Case Study - Acid rain/ rising sea water temperature.

REFERENCES

1. Ranendra K. Majumdar & Amjad K. Balange 2022. Advances in Fish Processing Technologies, CRC Press.
2. Govindan, T. K. 1985. Fish processing technology. Exford & IBH Publishing Co. Pvt. Ltd., New Delhi.
3. Fingerman, M. R., Nagabhushanam and Mary F. T. 1997. Recent advances in Marine Biotechnology (Vol. 1-3). Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
4. Le Gal, Y. and Halvorson, H. O. 1998. New Developments in Marine Biotechnology. Plenum Press, New York.
5. Primrose, S.B. and Twyman, R.M. (2006) Principles of Genetic Manipulation and Genomics. Seventh Edition. Blackwell Publishing, USA.
6. S. Ayyappan, 2006. Handbook of Fisheries & Aquaculture. ICAR.
7. Edward A. Laws, 2000. Aquatic Pollution: An Introductory Text John Wiley & Sons, Inc., New York.
8. Hynes, H. B. N. 1996. The Biology of Polluted waters, Liverpool University Press, Liverpool.
9. Richard, Lloyd, 1989. Pollution and freshwater fish-Fishing News Books, London. Sindermann,
10. C. J. 1976. Ocean Pollution: Effects on Living Resources and Human, CRC Press

11. K. Vijaykumar & B. Vasanthkumar, 2010. Aquatic ecosystem & its management, Daya Publishing House
12. Faizal Bux and Yusuf Chisti (2016) Algae Biotechnology: Products and Processes, Springer.
13. Stengel and Connan (2015) Natural Products From Marine Algae: Methods and Protocols. Humana Press

SEMESTER IV

PSLSMBTT401: Establishment and Management of Fish Farm

Course Objectives: To study production and management of breeding and hatchery techniques.

Course Outcomes: Impart knowledge of beneficial fishes, shrimp hatchery management to startup with an entrepreneurship development.

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

Seed Stocking: Tests for selection of good quality seed, Source & transport of seed, Stocking time and density, Size of stocking, Acclimatization, Estimation of survival rate

Induced spawning: Hypophysation, Cryopreservation technique, Synthetic hormones and Analogues to induced spawning.

UNIT II: Reproductive biology and induced breeding of Finfish & Shellfish

Finfishes & Shellfish (Prawns/Shrimp): Gamete maturation and development: Spermatogenesis and oogenesis, Hormonal pathways and mode of control.

Reproductive biology: Reproductive mechanisms, Age at first maturity; Environmental and endocrine control of reproduction: Reproductive cycles, Factors affecting maturation and spawning, Physiology and techniques of eyestalk ablation.

Induced breeding: Brood stock availability, Methods of natural and artificial fertilization, Evaluation of milt and egg, Egg staging, Stripping and fertilization.

UNIT III: Technology of Fishing

Fishing Technologies: Principles and methods of fish catching, Fishing gears of India, Natural and synthetic materials in fishing gear; Choice of netting materials for different gears; Numbering of yarn; Construction and types of twines and ropes; Different types of floats, Sinkers, Anchors and buoys; Fabrication of fishing gears; Drawing and reading the gear designs; Description and operation of fishing gears - trawls, purse seines, gill nets and lines; Treatment and preservation of fishing gear. Fishing technology and sustainable marine resource management,

UNIT IV: Shrimp Hatchery Management

Shrimp hatchery design and management: Criteria for site selection of hatchery and nursery, Operational management, Broodstock management, Live food production, 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.

PSLSMBTP401: Establishment and Management of Fish Farm - Practical

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. Packing and transportation of cultivable finfish seed
5. Identification of fishing materials
6. Fishing technology as a tool for resource management
7. Visit to different Shrimp hatcheries
8. Visit to fish institutes

REFERENCES

1. FAO. 1992. *Manual of Seed Production of Carps*. FAO Publ.
2. S. Ayyappan, 2006. *Hand Book of Fisheries and Aquaculture*. ICAR.
3. Jhingran V.G. & Pullin R.S.V. 1985. *Hatchery Manual for the Common, Chinese and Indian Major Carps*. ICLARM, Philippines.
4. Jhingran V.G. 1991. *Fish and Fisheries of India*. Hindustan Publ.
5. Pillay T.V.R. & Kutty MN. 2005. *Aquaculture- Principles and Practices*. Blackwell.
6. Thomas P.C., Rath S.C. & Mohapatra K.D. 2003. *Breeding and Seed Production of Finfish and Shellfish*. Daya Publ. AQC
7. FAO. 2007. *Manual for Operating a Small-Scale Recirculation Freshwater Prawn Hatchery*.
8. Von Brandt's, 2005. *Fish Catching Methods of the World*, 4th Edition Book, Wiley-Blackwell
9. Y. Sreekrishna & Latha Shenoy, 2001. *Fishing Gear & Craft Technology*. ICAR
10. Ujwala Jadhav, 2010. *Aquaculture Technology and Environment*. Publ. PHI Publication
11. Chakraborty C & Sadhu A.K. 2000. *Biology Hatchery and Culture Technology of Tiger Prawn and Giant Freshwater Prawn*. Daya Publ. House.
12. Diwan A.D., Joseph S & Ayyappan S. 2008. *Physiology of Reproduction, Breeding and Culture of Tiger Shrimp*. Narendra Publ. House.
13. Brandt. A. V. 1984. *Fish catching methods of the world*. Fishing News Books Ltd., London.
- John, F. 1985. *Design of small fishing vessels*. Fishing News Books Ltd., London.
14. John, S. 1996. *Commercial fishing method - An introduction to vessels and gear*. Fishing News Books Ltd., London
15. Klust, G. 1982. *Netting materials for fishing gear*. FAO fishing manuals West Byfleet survey, Fishing News Books.
16. Shenoy, L. 1988. *Course manual in Fishing Technology*. CIFE, Mumbai.
17. 9. S.S. Khanna, H.R. Singh, *A textbook of Fish Biology & Fisheries*

PSLSMBT402: Genetics, Cell Culture, Nanobiotechnology & Aquarium Management in Aquatic Animals

Course Objectives: To study Genetics, Nanotechnology & their applications in aquaculture.

Course Outcomes: Improved varieties of aquatic animals and getting opportunities in new field of Nanotechnology.

UNIT I: Fish Genetics and Cytogenetic (15 L/ 1 C)

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.

Genetic Markers: Biochemical and molecular genetic markers.

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, R-banding, FISH.

Unit II: Fish Cell Culture*

Steps Involved in Fish Cell Culture: Cell isolation, Cell maintenance in culture, Types of cell (stem cell, precursor cell, differentiated cell), Cell culture type: Primary cell culture, Continuous cell culture, Cell line repository, Cell culture media: Natural and synthetic media. Supplement used in fish cell culture.

Basic Requirement to Established Fish Cell Culture: Laboratory design, Equipment used in fish cell culture: Laminar flow hood/Biosafety Cabinet, Incubator (BOD and CO₂), Sterilizer/Autoclave, Refrigerators and freezers, Hot air oven, Inverted microscope, Centrifuge, Hemocytometer, Water Bath, Osmometer.

Stem Cell Culture: Types of stem cell: Totipotent, Pluripotent, Multipotent and Unipotent, Stem cell line. Applications of stem cell culture.

UNIT III: Nanobiotechnology*

Introduction: Nanoscience, Nanobiotechnology, Nanodevices, Applications in various fields viz. physical & chemical, materials and life sciences, Challenges and opportunities associated with biology at Nanoscale.

Synthesis of Nanomaterials: Chemical, Physical and Biological methods

Properties & Characterization Techniques for Nanomaterial: Optical (UV-Vis/ Fluorescence), X-ray diffraction; Imaging & size (Electron microscopy, Light scattering, Zeta potential), Surface and composition (ECSA, EDAX, AFM/STM)

Application: Nanomaterial in Fisheries and Aquaculture, Nanotechnology in chromosome/genome mapping.

UNIT IV: Aquarium Management

Aquarium Fish Trade: Present status, Potential, Major exporting and importing countries.

Aquarium Keeping: Design and construction of tanks, Heating, Lighting, Aeration and filtration arrangements, Decoration used, Common aquarium plants and their propagation, Health and water quality management, Prophylaxis, Quarantine

Aquarium Species: Freshwater, Marine water and Brackish water fish, Marketing strategy.

Breeding techniques: Reproductive biology, Breeding and rearing of Egg-laying and Live-bearing ornamental fishes, Fecundity of ornamental fishes.

Aquaponics: Introduction, Design, Principle, Components, Fish, plant & water quality, maintenance.

PSLSMBTP402: Genetics, Cell Culture, Nanobiotechnology & Aquarium Management in Aquatic Animals - Practical

Practicals:

1. Isolation of Fish/Shrimp/Bivalve DNA
2. Confirmational analysis of DNA by Agarose gel electrophoresis.
3. Establishment of primary fish cell culture (Demonstration)
4. Study of different equipment used in fish cell culture laboratory.
5. To study different chromosome banding pattern in fish (Demonstration)
6. Study of nanoparticles
 - a. Synthesis of silver nanoparticles
 - b. Spectroscopic characterization
7. Identifications of marine & freshwater Ornamental fishes.
8. Visit to different commercial aquaria.

REFERENCES

1. W.S. Lakra, 2000. Fish Genetics & Biotechnology
2. W.S. Lakra & A. Gopalakrishnan, 2013. Genetics, genetic engineering and biotechnology in fisheries, Indian Council of Agricultural Research
3. Mukunda Goswami & W.S. Lakra, 2012. Fish Cell & Tissue Culture, Narendra Publishing House.
4. Nano: The Essential by T. Pradeep, McGraw Hill Education, N. Delhi; 2. Nanotechnology Principles and Practices by S.K. Kulkarni; 3. Nanotechnology by Booker Boysen
5. Saroj K. Swain, Sarangi N. and Ayyappan S. 2010. Ornamental Fish Farming ICAR.
6. Sylvia Bernstein, 2011. Aquaponic Gardening- A step by step guide to raising.
7. S. Ayyappan, 2006. Handbook of Fisheries and Aquaculture. ICAR.
8. 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)

PSLSMBTT403: Research Methodology, Scientific Writing and Literature Review

- Course Objectives: To study research methods & scientific writing of research.
- Course Outcomes: Develops a scientific insight of a given topic & enhance the research quality.

UNIT I: Research Methodology and Scientific Writing*

Selection of Research Topic: Aim, 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; Systematic review and meta-analysis.

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

Scientific and non-scientific writings: Structures of Research proposals, Synopsis, Dissertations, Thesis, Research paper writings (Abstract, Introduction, Review literature, methodology, Results, Writing skill of Discussions & Conclusion, Summary, Bibliography etc); Presentations: Graphical, Tabular, Animation, Power point

UNIT II: Literature Review:

UNIT III: Literature review:

UNIT IV: Literature Review:

PSLSMBTP403: Research Methodology, Scientific Writing and Literature Review - Practical

Practical:

1. Methods of Sampling.
2. Methods of data collection
3. Data analysis: Central tendency and dispersion.
4. Grant proposal writing.
5. Preparation and submission of a Draft Research/ Review Paper.

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)

PSLSMBTT404: Commercially Important Sea Food, Microalgae, Aquatic Waste Products & Use

Course Objectives:

Study of importance of Sea food (animals & plants), Macroalgae, Fish & their waste products & their commercial use.

Course Outcomes:

Understand the importance of Sea food, Microalgae, Fish and Shellfish commercially, grow ecosystem and economy.

UNIT I: Sea Food, Microalgae, Fish Waste Products & Use*

Sea Food: Introduction, Types, Global status, commercially important Sea food species, Marketing strategy.

Macroalgae: Anti fouling, Bioactives, Nutraceuticals, Skin hydration, Photoprotection benefits, Cosmeceuticals, Marine microalgal biofilms for water treatment and bioenergy, Marine plants as anti-cancer drugs, Antarctica seaweed bioactives, feed & Fertilizer.

Fish Waste: Introduction, Types, Applications. **Recovery of Products from Fish Waste & Use:** Collagen, Gelatin, Glucosamine, Cartilage of Shark, Astaxanthin, Carotenoids, Chitin, Chitosan and Fish meal in products from waste.

UNIT II: Internship/Project 15 L/1C

UNIT III: Internship/ Project 15 L/1C

UNIT IV: Internship/ Project 15 L/1C

PSLSMBTP404: Practical and Internship/ Project

Internship/ Project: Viva.

REFERENCES:

1. Ranendra K. Majumdar & Amjad K. Balange 2022. Advances in Fish Processing Technologies, CRC Press.
2. Gopakumar K. (Ed.). 2002. Text book of Fish Processing Technology. ICAR. 198
3. Elvevoll EO, Fish waste and functional foods, Norwegian College of Fishery Science, Department of Marine Biotechnology, Norway.
4. Wheaton FW & Lawson TB 1985. Processing Aquatic Food Products. John Wiley & Sons.
5. Fereidoon Shahidi 2007, Maximizing the value of marine by products, CRC Press Inc. (Florida)
6. S. Ayyappan, 2006. *Handbook of Fisheries and Aquaculture*. ICAR.
7. Faizal Bux and Yusuf Chisti (2016) *Algae Biotechnology: Products and Processes*, Springer.
8. Stengel and Connan (2015) *Natural Products From Marine Algae: Methods and Protocols*. Humana Press