

**MODEL II
VOCATIONAL
COURSE**

MODEL II B.Sc.PROGRAMME
(VOCATIONAL COURSES)

1. B.Sc. (Aquaculture)

A. VOCATIONAL COURSES (MODEL II)

Semester	Course No.	AQUACULTURE	FOOD MICROBIOLOGY	MEDICAL MICROBIOLOGY
1	I	Principles and Methods in Aquaculture	General Microbiology	Fundamentals of Microbiology
1	II	Hatchery and Culture Techniques	Biological Techniques	Basics of Microbial Physiology & Genetics
1	Practical - I	Principles and Methods in Aquaculture & Hatchery and Culture Techniques	General Microbiology & Biological Techniques	Fundamentals of Microbiology and Basics of Microbial Physiology & Genetics
2	III	Capture Fishery	Microbial physiology & Genetics	Parasitology
2	IV	Biology of Fishes	Applied Microbiology	Medical Virology
2	Practical - II	Capture Fishery & Biology of Fishes	Microbial physiology Genetics & Applied Microbiology	Parasitology & Medical Virology
3	V	Fisheries Environment	Dairy Microbiology	Medical Mycology
3	Practical - III	Fisheries Environment	Dairy Microbiology	Medical Mycology
3	VI	Fish Nutrition	Industrial Microbiology	Diagnostic Microbiology
3	Practical - IV	Fish Nutrition	Industrial Microbiology	Diagnostic Microbiology
4	VII	Reproductive Physiology and Endocrinology	Basic Food Microbiology	Medical Bacteriology
4	Practical - V	Reproductive Physiology and Endocrinology	Basic Food Microbiology	Medical Bacteriology
4	VIII	Microbiology, Pathology and Post Harvest Technology	Food Microbiology and Fermented Food	Clinical Microbiology

4	Practical - VI	Microbiology, Pathology and Post Harvest Technology	Food Microbiology and Fermented Food	Clinical Microbiology
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**b. CONSOLIDATED DISTRIBUTION OF HOURS FOR BSc. (MODEL II
VOCATIONAL COURSES)**

COURSE STRUCTURE

Total Credits 120

Total Instructional Hours 150

3 Vocational Programmes : Aquaculture (A) / Food Microbiology (F)/
Medical Microbiology (M)

SEMESTER I

No	Course Code	Course Title	Course Category	Hrs per week	Credits	Marks ratio	
						Intl	Extl
1		English - 1	Common Course	5	4	1	4
2		Second Language – 1	Common Course	5	4	1	4
3	ZY1CRT01	General perspectives in Science & Protistan Diversity	Core Course I : Theory	2	2	1	4
4		General perspectives in Science & Protistan Diversity	Core Course I : Practical	2	0	0	0
5		Principles and Methods in Aquaculture (A) / General Microbiology (F)/Fundamentals of Microbiology(M)	Vocational Course I : Theory	2	2	1	4
6		Hatchery & Culture techniques (A) / Biological technique (F)/Basics of Microbial physiology & Genetics (M)	Vocational Course II:	2	2	1	4
7		Principles and Methods in Aquaculture, Hatchery and Culture techniques (A)/ General	Vocational Course : Practical	2	0	0	0

		Microbiology and Biological technique (F)/Fundamentals of Microbiology,Basics of Microbial physiology &Genetics(M)					
8		Complementary Course – I	Complementary Course: Theory	3	2		
9		Practical	Practical	2	0		
Total				25 hrs	16		

SEMESTER II

No	Course Code	Course Title	Course Category	Hrs per week	Credits	Marks ratio	
						Intl	Extl
1		English 2	Common Course	5	4	1	4
2		Second Language -2	Common Course	5	4	1	4
3	ZY2CRT02	Animal Diversity- Non Chordata	Core Course II : Theory	2	2	1	4
4	ZY2CRP01	Animal Diversity – Non Chordata	Core Course II : Practical	2	2	1	4
5		Capture Fishery (A) /Microbial physiology & Genetics(F)/Parasitology (M)	Vocational Course III : Theory	2	2	1	4
6		Biology of Fishes (A) / Applied Microbiology (F)/Medical virology(M)	Vocational Course III : Theory	2	2	1	4
7		Capture Fishery &Biology of Fishes(A)/Microbial physiology &Applied Microbiology(F)/Parasitology&MedicalVirology (M)	Vocational Course IV : Practical	2	2	1	4
8		Complementary Course – II	Complementary Course: Theory	3	2		
9		Practical	Practical	2	2		

Total	25 hrs	22	
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SEMESTER III

No	Course Code	Course Title	Course Category	Hrs per week	Credits	Marks ratio	
						Intl	Extl
1		English 3	Common Course	5	4	1	4
2	ZY3CRT03	Animal Diversity – Chordata	Core Course III : Theory	3	3	1	4
3		Animal Diversity- Chordata	Core Course III : Practical	2	0	0	0
4		Fisheries Environment (A) / Dairy Microbiology (F) / Medical mycology(M)	Vocational Course V : Theory	2	2	1	4
5		Fisheries Environment (A) / Dairy Microbiology (F) / Medical mycology(M)	Vocational Course : Practical	3	0	0	0
6		Fish nutrition (A) / Industrial Microbiology (F)/ Diagnostic Microbiology (M)	Vocational Course VI : Theory	2	2	1	4
7		Fish nutrition (A) / Industrial Microbiology (F)/Diagnostic Microbiology	Vocational Course : Practical	3	0	0	0
8		Complementary Course – III	Complementary Course: Theory	3	3	1	4
9		Practical	Practical	2	0	0	0
Total				25 hrs	14		

SEMESTER IV

No	Course Code	Course Title	Course Category	Hrs per week	Credits	Marks ratio	
						Intl	Extl
1		English - 4	Common Course	5	4	1	4
2	ZY4CRT04	Research methodology, Biophysics & Biostatistics	Core Course IV : Theory	3	3	1	4
3	ZY4CRP02	Research methodology, Biophysics & Biostatistics	Core Course IV : Practical	2	2	1	4
4		Reproductive Physiology and Endocrinology (A)/ Medical Bacteriology (M) / Basic Food Microbiology (F)	Vocational Course VII : Theory	2	2	1	4
5		Reproductive Physiology and Endocrinology (A)/ Medical Bacteriology (M) / Basic Food Microbiology (F)	Vocational Course : Practical	3	4	1	4
6		Microbiology , Pathology and Post Harvest Technology (A)/ Clinical Microbiology (M) / Food Microbiology and Fermented Food (F)	Vocational Course VIII : Theory	2	2	1	4
7		Microbiology , Pathology and Post Harvest Technology (A)/ Clinical Microbiology (M) / Food Microbiology and Fermented Food (F)	Vocational Course : Practical	3	4	1	4
8		Complementary Course – IV	Complementary Course: Theory	3	3	1	4
9		Practical	Practical	2	2	1	4
Total				25 hrs	26		

SEMESTER V

No	Course Code	Course Title	Course Category	Hrs per week	Credits	Marks ratio	
						Intl	Extl
1	ZY5CRT05	Environmental Biology & Human rights	Core Course V : Theory	3	3	1	4
2	ZY5CRPO5	Environmental Biology & Human rights	Core Course V : Practical	2	0	0	0
3	ZY5CRT06	Cell Biology & Genetics	Core Course VI : Theory	3	3	1	4
4	ZY5CRPO6	Cell Biology & Genetics	Core Course VI : Practical	2	0	0	0
5	ZY5CRT07	Evolution, Ethology & Zoogeography	Core Course VII : Theory	3	3	1	4
6	ZY5CRPO7	Evolution, Ethology & Zoogeography	Core Course VII : Practical	2	0	0	0
7	ZY5CRT08	Human Physiology, Biochemistry & Endocrinology	Core Course VIII : Theory	3	3	1	4
8	ZY5CRPO8	Human Physiology, Biochemistry & Endocrinology	Core Course VIII : Practical	2	0	0	0
9	ZY5OPT01	1 – Vocational Zoology (Apiculture, Vermiculture, Ornamental fish culture)	Open Courses for other streams (<i>Select any one out of three</i>)	4	3	1	4
	ZY5OPT02	2 – Public health and Nutrition					
	ZY5OPT03	3 – Man, nature & Sustainable Development					
10		Group activity and Field Study - Report to be submitted in 6 th Semester along with Project and Practical Exam		1	0		
Total				25 hrs	15		

Semester VI

No.	Course Code	Course Title	Course Category	Hrs per week	Credits	Marks ratio	
						Intl	Extl
1	ZY6CRT09	Developmental Biology	Core Course IX : Theory	3	3	1	4
2	ZY6CRP09	Developmental Biology	Core Course IX : Practical	2	2	1	4
3	ZY6CRT10	Microbiology & Immunology	Core Course X : Theory	3	3	1	4
4	ZY6CRP10	Microbiology & Immunology	Core Course X : Practical	2	2	1	4
5	ZY6CRT11	Biotechnology, Bioinformatics and Molecular Biology	Core Course XI : Theory	3	3	1	4
6	ZY6CRP11	Biotechnology, Bioinformatics and Molecular Biology	Core Course XI : Practical	2	2	1	4
7	ZY6CRT12	Occupational Zoology (Aquaculture, Apiculture, Vermiculture & Quail farming)	Core Course XII : Theory	3	3	1	4
8	ZY6CRP12	Occupational Zoology (Aquaculture, Apiculture, Vermiculture & Quail farming)	Core Course XII : Practical	2	2	1	4
9	ZY6CBT01	Elective 1: Ecotourism & Sustainable Development	Choice Based Core Elective Courses (<i>Select any one out of four</i>)	4	3	1	4
	ZY6CBT02	Elective 2: Agricultural pest management					
	ZY6CBT03	Elective 3: Vector & Vector borne Diseases					
	ZY6CBT04	Elective 4: Nutrition, Health & life style management					
10	ZY6CRPRP	Project Work	Project	1	2		
11		OJT (On Job Training for 14 days)	OJT		2		
Total				25 hrs	27		

Model II Programmes in Zoology and Core Courses

Instructional Hours, Credit, Total Instructional Hours, University Examination, Weightage Internal and External Evaluation of Core Courses will follow the same pattern as in Model 1 Zoology Programme.

For Vocational Courses also University Examination will be conducted at the end of each Semester for Theory and at the end of even semester for Practical. Duration of examination is 3 hrs and Internal-External marks ratio is 1:4.

The main objective of 'on the job training' is to acquaint the students formally to a real life work place environment. This will help to explore the relationship between knowledge and skill acquired in the college with those required in the working situations. Students are expected to do the OJT in their respective vocational subject related field.

C. SCHEME OF EXAMINATION - VOCATIONAL SUBJECTS

Semester	Course	Weightage ratio			
		Theory		Pract.	
		Ext.	Int.	Ext.	Int.
1	1	4	1	4	1
1	2	4	1		
2	3	4	1		
2	4	4	1		
3	5	4	1	4	1
3	6	4	1		
4	7	4	1	4	1
4	8	4	1		

**i. SCHEME OF EXAMINATION - THEORY
(VOCATIONAL SUBJECT – AQUACULTURE)**

Semester	Code	Course No.	Course	Hrs	Internal External ratio	
					Internal	External
1	ZA1VOT01	1	Principles and Methods in Aquaculture	3	1	4
1	ZA1VOT02	2	Hatchery and Culture Techniques	3	1	4
2	ZA2VOT03	3	Capture Fishery	3	1	4
2	ZA2VOT04	4	Biology of Fishes	3	1	4
3	ZA3VOT05	5	Fisheries Environment	3	1	4
3	ZA3VOT06	6	Fish Nutrition	3	1	4
4	ZA4VOT07	7	Reproductive Physiology and Endocrinology	3	1	4
4	ZA4VOT08	8	Microbiology, Pathology and Post Harvest Technology.	3	1	4

SCHEME OF PRACTICAL

EXAMINATION (AQUACULTURE)

Practical Exams at the end of 2nd & 4th semesters

Semester	Code	Course	Exam duration	Internal External ratio	
				Internal	External
2	ZA2VOP01	Practical 1 & 2 Principles and Methods in Aquaculture, Hatchery and Culture Techniques & Capture Fishery and Biology of Fishes	3 hrs	1	4
4	ZA4VOP02	Practical 3 & 4 Fisheries Environment & Fish nutrition.	3 hrs	1	4
	ZA4VOP03	Practical 5 & 6 Reproductive physiology, Endocrinology & Microbiology, Pathology and Post Harvest	3 hrs	1	4

		Technology			
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**. SCHEME OF DISTRIBUTION OF HOURS AND CREDITS
(VOCATIONAL SUBJECT – AQUACULTURE)**

Semester	Code	Course No.	Title of vocational course	Hrs	Inst. Hrs/Wk	Credit
1	ZA1VOT01	1	Principles and Methods in Aquaculture	36	2	2
1	ZA1VOT02	2	Hatchery and Culture Techniques	36	2	2
1		Practical -1	Principles and Methods in Aquaculture, Hatchery and Culture Techniques.	36	2	0
2	ZA2VOT03	3	Capture Fishery	36	2	2
2	ZA2VOT04	4	Biology of Fishes	36	2	2
2	ZA2VOP01	Practical - 2	Capture Fishery and Biology of Fishes	36	2	2
3	ZA3VOT05	5	Fisheries Environment	36	2	2
3		Practical - 3	Fisheries Environment	54	3	0
3	ZA3VOT06	6	Fish Nutrition	36	2	2
3		Practical - 4	Fish Nutrition	54	3	0
4	ZA4VOT07	7	Reproductive Physiology and Endocrinology	36	2	2
4	ZA4VOP02	Practical – 5	Reproductive Physiology and Endocrinology	54	3	4
4	ZA4VOT08	8	Microbiology, Pathology and Post Harvest Technology.	36	2	2
4	ZA4VOP03	Practical - 6	Microbiology, Pathology and Post Harvest Technology	54	3	4
			TOTAL		32	26

**e. SYLLABUS
(VOCATIONAL SUBJECTS)**

– MODEL II

THEORY & PRACTICAL

1. AQUACULTURE

SEMESTER 1

VOCATIONAL COURSE 1

PRINCIPLES AND METHODS IN AQUACULTURE

36 Hrs
Credits 2

Objectives:

1. To make the student understand the basic concepts of the science and practice of aquaculture.
2. To introduce the student to the diverse practices of culturing of aquatic organisms.
3. To encourage the student to take up aquaculture practices as a vocation.

Module 1

4 Hrs

Scope and importance of Aquaculture. Significance of aquaculture compared to other agricultural systems and commercial fisheries. Types of aquaculture – Freshwater, Brackish water and Mariculture. Shell fish culture, Finfish culture, Monoculture, Polyculture.

Module 2

3 Hrs

Integrated farming – The concept of recycling of organic waste for maximum production. Rice cum fish culture. Culture practices of duck cum fish, poultry cum fish and pig cum fish culture. Sewage fed Fish Culture.

Module 3

7 Hrs

Site selection parameters for a pond site. Soil quality parameters –physical, soil type, porosity, percolation, shear strength, rate of compaction etc. Chemical –salinity, pH, nutrients, toxic gases etc. Water quality parameters-Chemical- salinity, pH, dissolved oxygen, Carbon dioxide, Nutrients, Ammonia. Physical – Temperature, suspended solids, . Biological parameters- presence of juveniles/seedlings, predators/ competitors, plankton, nekton .

Module 4

10 Hrs

Pond construction – Selection of site. Preparation of bunds and dykes. Calculation of earth works, sluice gates- Different types and fixing of sluice gates.**Pond preparation**-Drying, elimination of pests and predators. Preparation of nursery and stocking ponds.Manuring, Production of plankton. Stocking and acclimatization. Use of hapa. Stocking density. Harvesting and Harvesting methods

Module 5

10 Hrs

Fresh water cultivable fishes and their external characters-Indian Major Carps, Catfish, Eel, Tilapia, Etroplus, Trouts, Mahseer, Channa, Clarius, Anabas, Larvivorous and Weed fishes. Cultivable species of crustaceans and mulluscs: Identification and external characters. Shrimp, freshwater prawn, crab, lobster, pearl oyster, edible oyster, mussel and clams.

Module 6

2 Hrs

Brackish water aquaculture-Introduction, the tidal range, salinity and biota.

Major reservoirs of India and their fishery- Constarints in reservoir fisheries.

References

1. R.Santhanam,N.Sukumaran& P. Natarajan, (1990). *Manual of Freshwater Aquaculture*. Oxford &IBH Publishing Co. Pvt. Ltd.
2. R.Santhanam, N.Ramanathan and B. Jegadeesan. (1990). *Coastal Aquaculture in India*. CBS Publishers & distributors, New Delhi.
3. Sugunan.V.V. (1995). *Reservoir Fisheries of India*. FAO Fisheries Technical Paper 345.
4. Ayyappan.S., Jena.J.K., Gopalakrishnan.A. and Pandey.A.K. (2011) *Handbook of Fisheries and Aquaculture*. Indian Council of Agricultural Research.
5. Jhingran.V.G (1991) *Fish and Fisheries of India*. 3rd Edn. Hindustan .Pub. Corp. New Delhi.
6. Marcel Huet. (1971). *Text book of fish culture- Breeding and cultivation of fish*. Fishing News Books Ltd. 23 Rosemount Avenue, West Byfleet , Surrey, England.
7. Pillay.T.V.R and Kutty.M.N. (2005). *Aquaculture – Principles and Practices*. 2nd Edn. Wiley- Blackwell.
8. Boyd.C.E., and Tucker.C.S.(2012). *Pond Aquaculture Water Quality Management*. Springer Science and Business Media.
9. Anand.S. Upadhyaya. (1994). *Handbook on design, construction and Equipments in coastal aquaculture Shrimp Farming*.Allied Publishers Pvt.Ltd., Bombay.
10. Boyd, Claude E and Pillai, V K (1985) *Water Quality Management in Aquaculture*. CMFRI Special Publication, No. 22. CMFRI. Kochi.
11. Marine Products Export Development Authority.(1993). *Handbook on Aquafarming Series. Aquaculture Engineering and Water quality Management*. MPEDA.Kochi.
12. Unnithan.K.Asokakumaran. (1985). *A guide to prawn farming in Kerala*. CMFRI Special publication No.21. Kochi.

13. Santhanam.R., Sukumaran.N and Natarajan.P. (1990). *A Manual of Freshwater Aquaculture*
Oxford &IBH Publishing Co. Pvt. Ltd.
14. Khanna.S.S. (2011). *An introduction to Fishes*. Silver Line Publications.
15. Stickney.R.R.(1994). *Principles of Aquaculture*. John Wiley and sons Inc.
16. Stickney.R.R. (Eds.). (2000). *Encyclopedia of Aquaculture*.Wiley.
17. Wheaton. F.W. (1993). *Aquacultural Engineering*. Krieger Pub.Co.
18. Thomas P.C, Suresh Ch. Rath and Kanta Das Mohapatra. (2003). *Breeding and Seed production of finfish and shellfish*. Daya Publishing House.
19. Talwar.P.K. and Jhungran. A.G.(1991) *Inland fishes of India and adjacent countries*. Vol I and II. Oxford and IBH Pub.Co.
20. Jayaraman. K.C.(1999). *The Freshwater Fishes of the Indian Region*. Narendra Publishing House.
21. Marine Products Export Development Authority.(1993). *Handbook on Aquafarming Series. Freshwater Fishes*. MPEDA.Kochi.
22. Rath.R.K. (1993). *Freshwater aquaculture*. Scientific Publishers.Jodhpur.
23. Marine Products Export Development Authority.(1993). *Handbook on Aquafarming Series. Molluscs*. MPEDA.Kochi.
24. CMFRI (1974). *The commercial molluscs of India*. Bulletin No. 25.CMFRI, Kochi.
25. CMFRI. (2005). *Winter School on Recent advances in Mussel and Edible oyster farming and Marine Pearl production* (Eds: Appukuttan K.K.). CMFRI, Kochi.
26. CMFRI. (1987). *Oyster Culture-Status and Prospects*. Bulletin No: 38. CMFRI, Kochi.
27. CMFRI. (1980). *Coastal aquaculture: Mussel farming: Progress and Prospects*. Bulletin No. 29.CMFRI. Kochi.

SEMESTER I

VOCATIONAL COURSE 2

HATCHERY AND CULTURE TECHNIQUES

36 hrs
Credits 2

Objectives

1. Introduce the student to the culture practices of various indigenous edible and ornamental finfishes and edible shellfishes.
2. To create an understanding of the different technologies of seed production of common cultivable species
3. Introduce the student to various live feeds available for aquatic organisms and understand their culture methods.

Module 1

6 Hrs

Hatchery systems – Different types- fin fish (Carp), Mollusc (Edible oyster)- Seed collection, Spat collectors. Crustacean (Penaeid prawn)- Different Components and operation, Description of Larval stages.

Module 2

8 Hrs

Culture Practices of major groups of finfishes. Indian Major Carps- Nursery, Rearing and stocking ponds. Preparation of ponds. Stocking and post stocking management. Harvesting. Culture of air breathing fishes(eg. Channa) .

Culture of Tilapia and Milk Fish, (Mention lablab and its preparation) production of Monosex in Tilapia.

Culture of Trouts.

Module 3

8 Hrs

Culture of Crustaceans - Penaeid prawns- Seed resources, prawn filtration practices, (Pokkali, Bheries Ghazan lands) ,extensive, semi intensive and intensive, prawn farming.

Crab culture- Crab fattening and growout.

Module 4

8 Hrs

Culture of Bivalve mollusks.- Mussels, Pearl oysters, Edible oysters, Clams. On Bottom and Off bottom culture methods- Stake culture (Bouchot culture), Rack culture (Rack and ren, Rack and tray), Long Line culture and Raft culture.

Module 5

6 Hrs

Culture of ornamental fishes- Types of Aquaria, Aquarium accessories. Setting up and maintenance of Aquaria. Filtration of Aquarium water- Mechanical, Chemical and Biological filtration. Breeding techniques of Aquarium fishes;- gold fish (Egg scatterer) and Fighter fish (Bubble nest builder)

Culture of sea weeds and holothurians.

Culture of live feeds- micro algae, artemia, rotifer, daphnia.

References

1. CMFRI (1996). *Artificial reefs & sea Farming Technologies*. Bulletin No.48. CMFRI.Kochi.
2. John.E.Bardach , John.H.Ryther and William O. McLarney. (1974). *Aquaculture- The farming and Husbandry of freshwater and Marine Organisms*. Wiley Publications.
3. Pillay.T.V.R and Kutty.M.N. (2005). *Aquaculture – Principles and Practices*. 2nd Edn. Wiley- Blackwell.
4. Thomas P.C, Suresh Ch. Rath and Kanta Das Mohapatra. (2003). *Breeding and Seed production of finfish and shellfish*. Daya Publishing House.
5. Axelrod.H.R. (1992). *Breeding of Aquarium Fishes*. TFH Publications.
6. James. P. McVey. (1991). *CRC Handbook of Mariculture*. Vol II. Finfish Culture. CRC Press.
7. James .P.McVey. (1991). *CRC Handbook of Mariculture*.
8. Santhanam.R. Ramanathan N.R. and Jegadeesan.B. (1990). *Coastal Aquaculture in India*.CBS Publishers and Distributors.
9. CMFRI (1980).Bulletin No. 29. *Coastal Aquaculture, Mussel Farming ,Progress and Prospects*. CMFRI, Kochi.
10. Unnithan.K.Asokakumaran. (1985). *A guide to prawn farming in Kerala*. CMFRI Special publication No.21. Kochi.
11. James, D.B., Gandhi A. D., Palaniswamy. N and Rodrigo, Joseph Xavier (1994) *Hatchery Techniques and Culture of the Sea-cucumber Holothuria scabra*. CMFRI Special Publication, 57. CMFRI.Kochi.
12. CMFRI (2005). *Winter School on Recent advances in Mussel and Edible Oyster farming & Pearl Production*. (Eds.) Appukuttan K.K. CMFRI. Kochi.
13. CMFRI.(1987). Bulletin No.38.*Oyster Culture- Status and Prospects*. CMFRI, Kochi.

14. CMFRI (1987). Bulletin No. 39. Pearl Culture. CMFRI. Kochi.
15. Sorgeloos. P. and Kulasekarapandian. S. (1984). Production and use of *Artemia* in Aquaculture .CMFRI Special Publication. No. 15. CMFRI, Kochi.
16. Jhingran. V.G (1991) .*Fish and Fisheries of India*. 3rd Edn. Hindustan .Pub. Corp. New Delhi.
17. Korringa P. (1976). Farming Marine Organisms Low in the food Chain. Elsevier Scientific Publishing Co. Amsterdam, Netherlands.
1. Hatchery Production of Penaeid prawn seed: *Penaeus indicus*
CMFRI Special Publication: No. 23., 41 pp. 1985.
2. Hatchery Manual for The Common, Chinese and Indian major carps
Jhingran .V.G. and R.S.V. Pulin, ICLARM publication.
3. Handbook of Fisheries and Aquaculture
Indian Council of Agricultural Research.
4. Hatchery techniques and culture of the Sea cucumber *Holothuria scabra*
5. Hand book on Indian sea cucumbers.
6. CMFRI Spl Publ: No. 59, 48 pp, 1994 Manual of Freshwater Aquaculture
R. Santhanam, N. Sukumaran & P. Natarajan, (1990)
Oxford & IBH Publishing Co. Pvt. Ltd. 193 pages.
7. Marine shrimp culture- Principles and Practices
Editors : James Lester and Arlo .W. Fast.
8. MPEDA - A Manual on Shrimp Farming
9. MPEDA - Hand book on Shrimp Farming
10. MPEDA- Hand book on Aquafarming- Shrimp Hatchery.
11. Matsya Alankar '99 Souvenir .Department of Fisheries, Government of Kerala & Matsyafed.
12. MPEDA Handbook on Aquafarming Live Feed .
13. Oyster culture: Status and Prospects
CMFRI. Bulletin No: 38, 1987
14. Seaweed resources of India
CMFRI Bulletin, No. 41, 1987

SEMESTER II

VOCATIONAL COURSE 3

CAPTURE FISHERY

36 hrs
Credits 2

Objectives:

1. Introduce the student to the fishery potential of Indian waters- marine and inland.
2. To study the major groups of finfishes and shellfishes contributing to the commercial fishery
3. Introduction to fishing gears and diverse fish catching methods of tropical waters.
4. To develop the concept of fishery as a renewable resource to be managed and study of population dynamics and different management techniques in commercial fisheries.

Module 1

8 Hrs

Commercially important orders, families, genera and species of elasmobranchs and teleost of the Indian region and their identification. Identification of commercially important species of prawn, crab, lobster, bivalve, gastropod and cephalopods.

Module 2

8 Hrs

Craft and gear-Types of fishing craft in India –Traditional, Motorised and Mechanized. Classification of fishing gear. Fishing gear material- Synthetic and natural. Properties of fishing gear, floats, sinkers and accessories. Major fishing gears and their operation. Static gear –Gill nets, Long line and Fish traps. Mobile gear- Drag nets-Trawl nets. Seine nets-Purse seine, Shore seines.

Module 3

6 Hrs

Inland capture fishery resources of India – Riverine fisheries,,Cold water fisheries resources, Lacustrine fisheries (Estuarine or brackish water fisheries and fisheries of fresh water lakes)- Important species and gears.

Module 4

8 Hrs

Marine Fishery Resources of India- Pelagic fishery- Fisheries of oil sardine, lesser sardine, anchovies, mackerel, ribbon fishes. Demersal fisheries. Fisheries of elasmobranchs, Bombay duck, cat fishes, silver bellies, sciaenids, pomfrets, threadfins, threadfin breams and other perches, Flatfishes, Prawns, Lobsters, Crabs, Mussels, Oysters and Clams – Fishing seasons, abundance and major gears for each group.

Module 5

6 Hrs

Fishery management- Concept of population, Yield and Recruitment. Factors affecting fish stocks. Population dynamics. Problems of over fishing- Growth overfishing and Recruitment overfishing.Fishery. Management practices- Input and output controls. Maximum Sustainable Yield.

References

1. Bagenal. Methods for fish production in fresh waters. (IBP Handbook No.3)
2. Bal D.V. and Rao.K.V. 1990. Marine Fisheries of India. Tata Mc Graw-Hill Publishing Company Ltd. New Delhi. 472 pages.
3. CMFRI Bulletin No.47. (1994). Perch Fisheries in India.
4. CMFRI. (2000). Marine Fisheries Research and Management. Ed: V.N.Pillai and N.G.Menon.
5. CMFRI. (2003). Status of exploited Marine Fishery resources of India. 308 pages.
6. CMFRI. 1974. Bulletin No,25. The Commercial mollusks of India.
7. CMFRI. Bulletin No.14. Prawn fisheries of India.1969. 360 pages.
8. Devaraj.M. Fish population Dynamics. Course Manual. CIFE .Mumbai.
9. FAO fisheries technical paper306/1. Per Sparre and Siebren .C. Venema. Introduction to tropical Fish Stock Assessment. Part I – Manual.
10. FAO species identification sheets for the western Indian ocean.
11. Handbook of Fisheries and aquaculture. Indian Council of agricultural research. New Delhi.
12. Jhingran V.G. and K.L.Sehgal. 1968. Coldwater fisheries of India.
13. Jhingran.V.G. 19910 Fish and Fisheries of India. Hindustan Publishing Corporation. Delhi.
14. Khanna .S.S. An Introduction to fisheries. Central Book Depot, Allahabad.
15. Kurien C.V. and Sebastian.V.C.. Prawns and prawn fisheries of India.
16. Michael King. A textbook of Fisheries Assessment and management.
17. Munro.I.S.R. The marine and freshwater fishes of Ceylon. Narendra Publishing House.New Delhi.

18. Sreekrishna.Y. and Latha Shenoy (2001). Fishing gear and craft technology..ICAR. New Delhi.
19. Srivastava.C.B.L (2004). A text book of Fishery Science and Indian Fisheries.Kitab Mahal.
20. Talwar and Kakker. Commercial sea fishes of India.
21. Von Brandt. Fishing gears of the world
22. Website: www.fishbase.org

SEMESTER II

VOCATIONAL COURSE 4

BIOLOGY OF FISHES

**36 hrs
Credits 2**

Objectives:

1. To create an understanding about the morphological and anatomical organization of finfishes and shellfishes.
2. Introduce the student to the basic principles of Taxonomy of cultivable organisms.
3. To have an awareness of the fundamental biological aspects of food and feeding, age and growth and reproductive biology.

Module 1

4 Hrs

Need for taxonomy, binomial nomenclature, Data requirements for classification of fishes, Methods for collection of taxonomic data- Morphologic and Meristic data., Study of external morphology of a typical elasmobranch and a typical teleost, Variations in form and structures used in taxonomic studies.

Module 2

12 Hrs

Internal anatomy of fish- Alimentary canal and associated structures. Gills, Swim bladder, Accessory respiratory organs, Heart and circulatory system, skeletal system (Visceral arches, Vertebral column and skeleton of fins only) Nervous and lateral line system, sense organs (eye, ear, olfactory organs)

Module 3

6 Hrs

Excretion, osmotic and ionic regulation in marine and freshwater fishes. Swimming activity. Types of locomotion- Anguilliform, Carangiform and Ostraciform. Muscles in locomotion. Parental care, Social behaviour- Aggregation and shoaling. Migration of fishes.

Module 4

6 Hrs

Natural food of fishes. Feeding habits and types of feeding in fishes- Carnivorous, Herbivorous and Omnivorous, Predators, Grazers, Suckers, Strainers and parasites.. Feeding habits and method of feeding in prawn, bivalve and cephalopod.

Module 5

8 Hrs

Growth of fishes- Absolute and relative growth, isometric growth and allometric growth. The cube law. Methods for determination of growth checks. Length frequency analysis. Analysis of growth using hard parts like scales, otoliths and vertebrae. Estimation of growth by direct methods. Marking and tagging of fish for growth studies. Methods of studying reproduction- Maturity Stages, Gonadosomatic Index, Ova Diameter Frequency studies. Determination of size at first maturity and spawning season, Fecundity and its determination.

References

1. William.S. Hoar and D.J.Randall. Fish Physiology. Vol II, III, and IX.
2. CMFRI (2005) Winter School on Recent advances in Mussel and Edible Oyster farming & Pearl Production Compiled and edited by Appukuttan K.K.
3. Nikolsky. Ecology of Fishes.
4. Ricker.W.E. Hand book No.3. Methods for assessment of fish production in fresh waters. International Biological Programme. Blackwell scientific publications.
5. Barrington .E.J.W. Invertebrate structure and function.
6. Bensam.P. 1999. Development of Marine Fisheries in India. Daya Publishing House. New Delhi.
7. CMFRI Spl. Publ. No.3. (1978). Summer Institute in Breeding and rearing of marine prawns (129 pages)
8. College of Fisheries , Tuticorin.(2006). Summer School on Advanced Fish taxonomical methods for Fisheries Professionals.
9. George.A. Rounsefell and W.Harry Everhart. Fishery Science. Its methods and applications. John Wiley & Sons Inc.

10. Harry.M.Kyle. The biology of fishes.
11. Jayaram.K.C. (2002). Fundamentals of Fish Taxonomy. Narendra Publishing House . Delhi.
12. Karl.E.Bond. Biology of Fishes.
13. Khanna .S.S. An Introduction to fisheries. Central Book Depot, Allahabad.
14. Kurien C.V. and Sebastian.V.C.. Prawns and prawn fisheries of India.
15. Lagler.K.F., Bardach.J.E. and Miller. Robert.R. Ichthyology. 506 pages.
16. Norman.J.R. A History of fishes. Agro Botanical Publishers.
17. Parihar.R.P. A textbook of Fish Biology and Indian Fisheries.
18. Rajiv Tyagi and Arvind. N. Shukla. Anatomy of Fishes.
19. Srivastava.C.B.L (2004). A text book of Fishery Science and Indian Fisheries. Kitab Mahal.

SEMESTER III

VOCATIONAL COURSE 5

FISHERIES ENVIRONMENT

**36 hrs
Credits 2**

Objectives

1. To study the environment and their effect on fish populations.
2. Study the use of Remote sensing techniques for the assess fish stocks
3. Introduction to the ancillary marine resources like seaweeds, echinoderms and corals.
4. To understand the different techniques and equipments for the study of environmental parameters and different fish finding devices.

Module 1

5 Hrs

Habitat Ecology. Freshwater Habitat- Lentic (Pond, Lake), Lotic (Riffles, Pools). Marine Habitat- Zonation, Biota and adaptations. Principles of limiting factors- Shelford's law of tolerance, Liebig's law of minimum, Combined concept. Ecological succession and Ecological indicators. Photosynthetic and saprophytic food chain.

Module 2

10 Hrs

Basic marine meteorology- weather, air-sea interactions. Monsoons, seasonal changes, Circulation of water masses, Waves, Tides and sediment transportation.

Module 3

7 Hrs

Physical and chemical parameters of Aquatic environments- temperature, salinity, oxygen, nutrition, Microelements and Macroelements. Phytoplankton and primary production- Methods of Estimation (Dark and Light bottle method, C14 Method, Chlorophyll Technique). Estimation of Zooplankton and secondary production.

Module 4

4 Hrs

Ecology of estuaries and mangroves- Soil , Water and Biota. Biogeochemical cycles- Nitrogen, Phosphorus and Sulphur cycle.

Module 5

10 Hrs

Ancillary marine resources-Sea weeds, corals, Echinoderms and their commercial importance. Aquatic pollution- Causes and Remedial Measures. Instruments used for Biological sampling- Plankton International Indian Ocean Expedition Net, Hardy's continuous plankton recorder), Nekton (Isaac Kidd's Midwater trawl), Benthos (Dredges, Grabs, Agassiz trawl). Fish finding devices- Echo sounder, Sonar and net sonde . Remote sensing techniques and application.. Satellite remote sensing of fish stocks- Ocean colour maps, Sea surface Temperature Contour Maps. Potential Fishing Zone (PFZ). Deep Scattering or Sonic Scattering Layer.

References

1. Alan.P.TrUjillo and Harold.V. Thurman. Essentials of oceanography. Prentice Hall Publications
2. Balakrishnan Nair and Thampy. Marine Ecology.
3. CMFRI Bulletin No, 20. (1987)The economic seaweeds of India. 82 pages.
4. CMFRI Spl. Publ. No. 57. (1994). Hatchery techniques and culture of the sea cucumber, *Holothuria scabra*. 40 pages.
5. CMFRI Spl. Publ. No. 59 (1994). A handbook on Indian Sea cucumbers. 47 pages.

6. CMFRI. (1996). Marine Biodiversity Conservation and Management. 205 pages.
7. CMFRI. Bulletin No. 41. (1987). Seaweed Research and Utilisation in India. 116 pages.
8. Laevatsu and Hayes. Fisheries oceanography
9. Nybakken. Marine Biology.
10. Otto Kinne. Elements of ecology.
11. Plaskitt.F.J.W. (1999). Microscopic Freshwater Life. Biotech Books. New Delhi.
12. Santhanam, R., Ramanathan, N., Venketaramanujam.K and Jegatheesan G. 1987. Phytoplankton of the Indian Seas. Daya Publishing House.
13. Sverdrup *et al.* The Oceans.

SEMESTER III

VOCATIONAL COURSE 6

FISH NUTRITION

36 hrs
Credits 2

Objectives:

1. To create an understanding on the nutritional needs of aquatic organisms in culture.
2. To make the student have a basic concept of energy budgeting, food additives and varieties of feed ingredients used in Aquafeeds.
3. To have a basic understanding of the principles of feed formulation and equipments used in feed manufacture.

Module 1

5 Hrs

Digestive system of fish, Digestive Glands and their secretions. Digestive physiology of fish- Digestion of Carbohydrates, Proteins and Fats. Proteins, carbohydrates, fats, vitamins and minerals in fish nutrition- Classification, Structure and functions.

Module 2

8 Hrs

Nutritional Bioenergetics- Gross energy, Digestible energy (Digestibility co-efficient and measurement of digestible energy), Metabolisable energy, Heat increment (Specific Dynamic action) Net energy, Retained energy, Protein utilization. (Protein Efficiency Ratio, Protein

conversion ratio, Productive protein value) .Proximate Analysis- Moisture, Crude protein, Crude Lipid, Crude Fibre, Ash and , Nitrogen free extract- Methods of analysis of each component.

Module 3

8 Hrs

Factors affecting digestibility, Nitrogen balance index, Food additives- Binders, Antioxidants, Chemo-attractants and feeding stimulants, Pigments, Antimicrobial agents and Anabolic agents. Non conventional feed stuffs. Food growth equation. Feed ingredients of plant and animal origin.

Module 4

5 Hrs

Feed preparation techniques. Factors affecting the energy requirement of fish. Non nutrient constituents of the diet. Measurement of calorific value- Component Analysis, Wet oxidation, Bomb Calorimetry. Types of feeds (Wet, Moist and Dry feeds-advantages and disadvantages) Larval feeds- Minced diets, Microparticulate diets, Spray dried diets, Microbound diets, Microcoated diets and Microencapsulated diets.

Module 5

10 Hrs

Growth promoters. Principles of feed formulation (Pearson's Square and Linear programming). Different systems of fish feeding or Fish feeding devices. Equipments used in Feed mills- Weighing Scales, Grinders, Mincers, Mixers, Elevators, Extruders, Coolers/Dryers, Fat sprayer, Crumbler, Sifter and Bag seamer. Food Conversion Ratio and Food efficiency ratio. Economics of feed preparation.

References

1. CMFRI.(1987). *Proceedings of the Summer Institute in Recent Advances in Finfish and Shellfish nutrition*.11-30, May, 1987. CMFRI, Kochi.
2. Das.D. (2005). *Biochemistry*. (Edn.12). Academic Publishers. Calcutta.
3. New.M.B., Tacon. A.G.J. and Csavas.I.(Eds) (1995). FAO Fisheries Technical Paper. 343. *Farm made Aquafeeds*. FAO , Rome.
4. Garrett,R.H. and Grisham, C.M. (2012) *Biochemistry* (Edn.5). Wadsworth Publishing Company.
5. Halver John.E. and Hardy.R.W. (Eds.). (2002). *Fish Nutrition*. Academic Press.
7. Nelson.D.L. and Cox.M.M. (2012). *Lehninger Principles of Biochemistry*. W.H. Freeman.

8. Marine Products Export Development Authority. (1993). *Fish Nutrition*. Handbook on Aquafarming Series. MPEDA. Kochi.
9. Rath.R.K. (1993). *Freshwater aquaculture*. Scientific Publishers.Jodhpur.
10. DeSilva. Sena. S. and Anderson. T.A. (1995). *Fish nutrition in Aquaculture*. Chapman & Hall. London.
11. Tom Lovell. (1998). *Nutrition and Feeding of fish*. Springer.
12. Webster, Carol.D and Chhorn Lim.(2002). *Nutrient requirements and feeding of finfish for Aquaculture*. CABI Publishing.

SEMESTER IV

VOCATIONAL COURSE 7

REPRODUCTIVE PHYSIOLOGY AND ENDOCRINOLOGY

36 hrs
Credits 2

Objectives:

1. To have an understanding of the variety of reproductive techniques in finfishes and shellfishes and the factors controlling reproduction.
2. To study the endocrine and neurosecretory system of finfishes and shellfishes.
3. To understand the principles and techniques of induced breeding, and cryopreservation of fish gametes.

Module 1

6 Hrs

Reproductive systems and Sexual dimorphism in fish, crab and prawn. Types of reproduction- Viviparity, ovoviviparity, oviparity in Teleosts and Elasmobranchs. Classification of maturity stages of ovary and testes in fishes and prawns. Oogenesis and spermatogenesis in fishes. Hermaphroditism- different types. Sex reversal and sex determination in fishes.

Module 2

6 Hrs

Organisation, structure and Functions of Neurosecretory and endocrine systems in fin fishes. Pituitary, Thyroid, Chromaffin tissue, Interrenal tissue, Pancreatic islets, Corpuscles of Stannius, Ultimobranchial Glands, Gonads, Gastro-intestinal Hormones, Pineal organ, Caudal neurosecretory system or Urophysis. Neuroendocrine control of reproduction. Role of Hypothalamus - Pituitary – Gonadal axis in control of maturation in fishes. Gonadotropin releasing hormones, gonadotropins and sex steroids.

Module 3

6 Hrs

Neuroendocrine systems in crustaceans and control of reproduction. Sinus gland complex and X-organs. Pericardial and Post-commisural organs. True Endocrine organs-Y-organs, androgenic gland and Mandibular organs. Hormones produced by the neuroendocrine and true endocrine glands and their role in the control of reproduction and moulting in Crustaceans. Parasitic castration.

Module 4

10 Hrs

Principles of induced maturation and spawning in fishes and crustaceans. Levels of control in induced breeding and maturation in fishes. Environmental control of reproduction in fishes and prawns. Use of hormones and hormone analogues in fishes- Gonadotropin releasing hormones, Gonadotropins and Sex steroids. Methods of hormonal administration. Hypophysation. Linpe Method. Ovaprim. Use of Anaesthetics. Eyestalk ablation- Its principle and application in crustacean hatcheries. Use of hormones for producing monosex population and sex reversal in fishes. Principles and methods of cryopreservation of gametes.

Module 5

8 Hrs

Types of eggs in fishes – Pelagic, Demersal and according to yolk content. Embryonic development- Cleavage, fate map of Blastula, gastrulation- Invagination, Involution, Delamination, Convergence, Epiboly. Hatching , Post Embryonic development and Larval development.

References

1. Subramoniam.T. (1993). *Spermatophores and Sperm Transfer in Marine Crustaceans*. In Blaxter.J.H.S. (Eds). *Advance in Marine Biology*. Vol 29. Academic Press.
3. Tombes. A.S.(1970). *An introduction to Invertebrate endocrinology*. Academic Press.

4. Chondar.S.L. (1980). *Hypophysation of Indian major carps*. Satish Books Enterprise.
5. Harvey.B.J. and Hoar. W.S. (1979). *Induced Breeding in Fish: Theory and Practice*. International Development Research Centre. Canada.
6. Indian National Science Academy. (1978). Symposium on hormonal steroids in fish. New Delhi.
6. Muir.J.F. and Ronald. J.Roberts.(Eds).(1993). *Recent advances in Aquaculture*. Vol. IV. Blackwell Scientific Publications.
7. Jamieson.B.G.M. (1991). *Fish Evolution and Systematics. Evidence from Spermatozoa*. Cambridge University Press.
Chapter 19- Principles of Biological cryopreservation.
Chapter 20- Live preservation of fish gametes.
8. Carl.E.Bond.(1996). *The biology of fishes*.(Edn .2) Saunders College Pub. USA.
9. Highnam.K.C.and Leonard Hill.(1977). The comparative endocrinology of Invertebrates. (Edn.2.). Elsevier.
10. Khanna.S.S. (2011). *An introduction to Fishes*. Silver Line Publications.
11. Kotpal.R.L.(2012). Modern Textbook of Zoology. Invertebrates, and Vertebrates. Rastogi Publications.
12. Lagler.K.F., Bardach.J.E. , Miller. Robert.R, and Dora.R. May Passino.(1977). *Ichthyology*. Wiley.
13. Matty .A.J. (1985).Fish endocrinology. Springer.
14. National Bureau of Fish Genetic Resources. (1986). Genetic improvement of fish stock and resource conservation. Bulletin No.1. NBFGR.
16. Varghese.T.J., Basavaraja.N, Nandeesh.M.C., Kesavanath,P., and Shetty.H.P.C. (1991). *Use of hormones for sex manipulation and growth promotion in cultivable fishes*. In Sinha.V.R.P. and Srivastava.H.C.(Eds). Aquaculture Productivity. Oxford and IBH Publishing company.
17. Talbot. H. Waterman (1960) (Eds). *The Physiology of Crustacea*. Academic Press.
Vol II. Sense organs, Integration and Behaviour.
Vol. I. Metabolism and growth
18. Grizzle, John.M. (2204) *Reproductive Biology (Chapter 6.)* In Tucker.C.S. and Hargreaves.J.A. (Eds). (2004) .Biology and Culture of Channel catfish. Elsevier Publications.
19. Turner, Daniel.C. and Bagnara, Joseph.T.(1971). Edn.5. General Endocrinology. W.B.Saunders and Company.

20. Hoar.W.S. and Randall.D.J. (Eds) Fish Physiology. Academic Press.
 (1969). Vol 2. The Endocrine System.
 (1969). Vol 3. Reproduction and Growth, Bioluminescence, Pigments and Poisons.
 (1983). Vol. 9. Part A. Reproduction, Endocrine tissues and hormones.
 (1983). Vol.9. Part B. Reproductive Behaviour and Fertility control.
21. Hoar.W.S. (1966). General and Comparative Physiology. Prentice-Hall
22. Yadav.B.N. (1995). Fish endocrinology. Daya Books.

SEMESTER IV

VOCATIONAL COURSE 8

MICROBIOLOGY, PATHOLOGY AND POST HARVEST TECHNOLOGY

36 Hrs
Credits 2

Objectives

1. To have a clear understanding of the bacterial fauna associated with fish sanitation.
2. To have a basic idea of the factors associated with fish spoilage and the variety of fish preservation techniques.
3. To clearly understand the symptoms, diagnostic and remedial measures of fish diseases and have an idea of the Critical Control Points in seafood industry.

Module 1

8 Hrs

Bacteriology- Classification of bacteria based on temperature and oxygen requirements, Bacterial growth curve, growth phases Sterilization techniques, preparation of culture media, Estimation of total plate count, Staining techniques (Gram's Staining). Important bacteria of sanitary significance-*Staphylococcus aureus*, *Vibrio cholerae*, *salmonella*. Faecal Indicator organisms- *E.coli* and Faecal streptococcus.

Module 2

8 Hrs

Biochemical composition of fish- Moisture, Protein, Fats, NPN compounds and Minerals. Spoilage of fish - Post mortem changes and Rigor mortis. Causes of spoilage - Enzymatic, microbial, Biochemical (rancidity). Indices of spoilage - organoleptic, chemical (Total Volatile

Basic Nitrogen, Hypoxanthine content, Peroxide value and microbial (direct count and Total Plate Count).

Module 3

8 Hrs

Processing and Preservation of fish – Chilling and Freezing- Slow freezing, and quick freezing-critical temperature. Freezer burn, thawing, drip loss and glazing. Types of Freezers- Plate Freezer, Tunnel (Air Blast) Freezer, Immersion Freezer, Fluidised bed Freezer (IQF), Cryogenic Freezing, Accelerated Freeze drying , Irradiation. Canning- Principle and Procedure. Common defects in canning- Struvite formation, Panelling, Flipper, Springer, Soft swell and Hard swell.

Module 4

6 Hrs

Curing- Types of Curing- Simple, Sun drying, dry and wet curing, Monacuring, Pit Curing, Colombo curing, Smoke curing. Special cured products- Masmine and Marinade. Common defects in curing- Dun, Rust, Pink, Maggots. Value added products. Fishery byproducts- Fish oil, Shark liver oil, Chitin, Chitosan, Isinglass, Fish meal , Shark fin rays.

Module 5

6 Hrs

Diseases of fin fishes and prawns.-Protozoan, Bacterial, viral, fungal, Crustacean, Leech, Helminth diseases. Symptoms and Remedial measures. Nutritional deficiency diseases - Pin head, Rickets, Soft Shell Syndrome, Lipoid hepatic degeneration, Vitaminosis A. Hazard analysis and critical control points in seafood industry.

References

1. Austen. B. (1988). *Marine microbiology*. Cambridge University Press.
2. Balachandran.K.K.(2016). *Post Harvest Technology of Fish and Fish products*. Daya Publishing House. New Delhi.
3. Biswas.K.P. (2014). *Fish processing and Preservation*. Daya Publishing House. New Delhi.
4. Gopakumar.K.(2002) . *Text book of Fish Processing Technology*. Indian Council of Agricultural Research.New Delhi.
5. Govindan T.K. (1986). *Fish Processing Technology*. Oxford and IBH Publishing Company.

6. Ayyappan.S., Jena.J.K., Gopalakrishnan.A. and Pandey.A.K. (2011) *Handbook of Fisheries and Aquaculture*. Indian Council of Agricultural Research.
7. Pelczar.J.Michael Jr., Chan.E.C.S., and Noel.R.Krieg.(1993) *Microbiology*.5th Edn. Tata McGraw- Hill.
8. Ronald J. Roberts. (2012).*Fish Pathology*. 4th Edn.Wiley Blackwell.
9. Srivastava.C.B.L (2006). *A text book of Fishery Science and Indian Fisheries*. Kitab Mahal.
10. Sinderman.C.J.(1990) *Principal diseases of marine fish and shellfish*.Vol 1 &2. Academic Press.
11. Snieszko.S.F. and Herbert.R.Axelrod. (1970). *Diseases of Fishes*. T.F.H.Publications.

AQUACULTURE PRACTICALS

ZA1V02U (P) PRINCIPLES AND METHODS IN AQUACULTURE, HATCHERY AND CULTURE TECHNIQUES

36 hrs

Credit 1

1. Identification and major biological characteristics of cultivable organisms
2. Gut content analysis.
3. Study of common weed and predatory fishes in aquaculture ponds
4. Study of aquatic insects and aquatic weeds.
4. Identification of different larval stages and hatchery operations of prawn
- 6 Setting up and keeping of aquariums
- 7 Visit to carp and prawn hatcheries.

SEMESTER II

ZA2V04U (P) PRACTICAL – II CAPTURE FISHERY & BIOLOGY OF FISHES

36 Hrs

Credit 1

1. Identification of commercially important fishes, crustaceans and molluscs.
2. Fish- Study of external morphology and scales..
3. Dissection of Alimentary canal.
4. Dissecting and identification of internal organs of a fish.
5. Prawn- Study of external morphology and nervous system
6. Gill structure- Herbivorous, carnivorous and omnivorous fishes.
7. Gill structure of a prawn - Dissection
8. Molluscs- Study of morphology, and Dissection of Gills of bivalves
9. Visit to marine fish landing centre.

SEMESTER III

ZA3V05U(P) PRACTICAL – III FISHERIES ENVIRONMENT

54 Hrs

Credit 2

1. Determination of salinity, dissolved oxygen, pH, total alkalinity, hardness, nitrate, nitrite and ammonia and phosphate.
2. Determination of soil pH
3. Study of common marine phytoplankton, zooplankton.
4. Quantitative evaluation of phytoplankton and zooplankton in culture ponds
5. Identification of the common Ancillary Marine Resources – Corals, Sea cucumber and Sea weeds
6. Equipments and Instruments used for the collection of Environmental Data – Plankton samplers and Counters including haemocytometer, Digital pH meter, Salinometer, Spectrophotometer, Colorimeter etc.
7. Study of Ecological sub-divisions of the sea, Principles of Remote sensing and software used (Wikimapia.org)

SEMESTER III

ZA3V06U (P) PRACTICAL – IV FISH NUTRITION

54 Hrs

Credit 2

1. Comparative study of Digestive system of Herbivorous and Carnivorous fishes
2. Qualitative estimation of proteins, Polysaccharides and lipids
3. Formulation of artificial feed for aquarium fishes and prawns with locally available ingredients.
4. Study of identification feed ingredients of plant origin and animal origin (oil cakes and meals eg: Groundnut oil cake, coconut oil cake, Mustard oil cake, Fish meal, Crustacean meals, Molluscan meals, Blood meal etc)
5. Use of Pearson's square method in balancing feed Ingredients.
6. Study of equipments used in feed preparation (Oven, Pelletiser, Feed Press and Die Plate, Extruders etc.)
7. Study of non-conventional feed stuffs eg. Spirulina etc. and Feed Additives (Binders, Antibiotics etc).

SEMESTER IV

ZA4V07U(P) PRACTICAL – V REPRODUCTIVE PHYSIOLOGY AND ENDOCRINOLOGY

54 Hrs

Credit 2

1. Dissection of reproductive organs of Teleost fish.
2. Dissection of reproductive organs of Prawn and Crab.
3. Eyestalk ablation technique and electrocautery apparatus(Demonstration)
4. Methods of hormone injection in fish.
5. Observation of larval and embryonic stages in fish egg development.
6. Estimation of maturity stages and fecundity in fish
7. Equipments used in cryopreservation (Cryocan, French straws etc)

SEMESTER IV

ZA4V08U(P) PRACTICAL – VI MICROBIOLOGY, PATHOLOGY AND POST HARVEST TECHNOLOGY

54 Hrs

Credit

2

1. Sterilisation techniques, preparation of culture media (TGBE and Nutrient Agar Media), nutrient agar slants, staining techniques.(Gram staining)
2. Determination of total plate count
3. Types of bacterial colonies
4. Instruments used in bacteriological Studies (Inoculation chamber, Autoclave, Colony counter etc.)
5. Examination of internal and external organs of diseased fish and shell fishes.
6. Identification of parasites in fishes and shell fishes.
7. Materials used in fish processing and packaging (Cans, Retortable pouches etc.)