

**Vocational Higher Secondary
Education (VHSE)**

Second Year

AQUA CULTURE

Reference Book - Teachers' Version



Government of Kerala
Department of Education

State Council of Educational Research and Training (SCERT),
KERALA
2016

Foreword

Dear Teachers

This reference book (**Teachers' Version**) is intended to serve as a transactional aid to facilitate classroom transaction and as a ready reference for teachers of Vocational Higher Secondary Schools. It offers some guidelines for the transaction of the course content and for undertaking the practical work listed in the course content. As the curriculum is activity based, process oriented and rooted in constructivism focusing on the realisation of learning outcomes, it demands higher level proficiency and dedication on the part of teachers for effective transaction.

In the context of the Right- based approach, quality education has to be ensured for all learners. The learner community of Vocational Higher Secondary Education in Kerala should be empowered by providing them with the best education that strengthens their competences to become innovative entrepreneurs who contribute to the knowledge society. The change of course names, modular approach adopted for the organisation of course content, work-based pedagogy and the outcome focused assessment approach paved the way for achieving the vision of Vocational Higher Secondary Education in Kerala. The revised curriculum helps to equip the learners with multiple skills matching technological advancements and to produce skilled workforce for meeting the demands of the emerging industries and service sectors with national and global orientation. The revised curriculum attempts to enhance knowledge, skills and attitudes by giving higher priority and space for the learners to make discussions in small groups, and activities requiring hands-on experience.

The SCERT appreciates the hard work and sincere co-operation of the contributors of this book that includes subject experts, industrialists and the teachers of Vocational Higher Secondary Schools. The development of the teachers' version of reference books has been a joint venture of the State Council of Educational Research and Training (SCERT) and the Directorate of Vocational Higher Secondary Education.

The SCERT welcomes constructive criticism and creative suggestions for the improvement of the book.

With regards,

Dr. J. Prasad
Director
SCERT, Kerala

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ABOUT THE COURSE

Aquaculture is the farming of aquatic living things such a fish, shellfish and plants. It refers to the breeding, rearing and harvesting of plants and animals in all types of water environment. According to Food and Agriculture Organisation, aquaculture is defined as the farming of aquatic organisms with some sort of intervention the rearing process to enhance production, such as regular stocking, feeding and protection from predators.

Kerala was a forerunner in marine fish production and foreign exchange earnings through fishery exports even though we have only a lean stretch of land with coast line of 590 km. But now a day due to diminishing capture production from marine sector, Kerala is facing a downfall in fish production and foreign exchange. Only viable alternative to tackle this problem is to cultivate fish by which Kerala can regain its prime position in fisheries sector again. The potential of Kerala in increasing aquaculture production lies greatly in developing and implementing scientific aquaculture practices. However some weaknesses and threats to this sector needs to be addressed like inadequate Human resource development, weak extension activities, depletion of water resources in terms of quality and quantity and unscientific management of fisheries and aquaculture activities. In this context aquaculture course is very promising for fish production as well as for providing employment. For the aspirants of vocational education, aquaculture offer bright future in terms of employment generation and self-employment.

Aquaculture course deals with all relevant topics like basics of morphology and biology of fishes, general farm management measures, different aquaculture systems, culture of commercially important fishes and shell fishes, their hatchery seed production techniques, live and artificial feeding, disease management , ornamental fisheries etc. This curriculum offers skill generation for working in aquaculture sector as well as for entrepreneurship also.

Job Roles (Career Path)

Aquaculture course provides immense job opportunities in various aquaculture industries such as farming and seed production of fin fish, shell fish and ornamental fishes. This curriculum will enable the students to undertake different job roles in Government as well as Private sector. The production cum Training Centre (P.T.C.) and On the Job Training (O.J.T.) will provide hands on practical experience to the students, which will enable them to deal with job situations and have entrepreneurship in the field of Aquaculture. This curriculum is suitable for career enhancement through higher education in Fisheries sector.

Government / Semi Government	Private Sector	Self-Employment
<ul style="list-style-type: none"> • Technical entry cadres in Fisheries Department • Lab Technical Assistant in VHSE Department • Skilled labour in Fisheries Agencies like Matsyafed, ADAK, FIRMA, FFDA, KVK etc. • Field assistant in fisheries research organizations 	<ul style="list-style-type: none"> • Hatchery Assistant • Farm Assistant • Technical assistant in feed mills • Lab assistant in Aquaculture PCR labs • Technical assistant in Ornamental fish farm /Hatchery • Technical assistant in feed marketing 	<p>Entrepreneurship in</p> <ul style="list-style-type: none"> • Fish / Prawn / Shrimp culture • Fish / Prawn / Shrimp Hatcheries • Mussel / Oyster farms • Aqua Shops / Aqua Clinic • Aquarium setting • Ornamental fish farm / hatchery

MAJOR SKILLS AND SUB SKILLS

- Skill in selection and management of carps brood stock
- Expertise in Induced breeding of Carps
- Management of Happa system, Chinese hatchery system and Jar hatchery system
- Expertise in Induced breeding and selective breeding in Tilapia
- Knowledge in seed production of Pearl Spot in captivity
- Expertise in induced breeding of air breathing fishes
- Skill in selection and management of Asian Sea Bass brood stock
- Expertise in larval rearing and seed production of Asian Sea Bass
- Knowledge in seed production of commercially important marine fishes like Cobia and Pompano.
- Skill in packing and transportation of fish seeds
- Expertise in larval rearing and seed production of Penaeid shrimps
- Expertise in live feed culture
- Expertise in Induced maturation and spawning in Penaeid shrimps
- Expertise in selection and transportation of berried female prawns

- Expertise in larval rearing and seed production of Giant Freshwater Prawn
- Skill in packing and transportation of Shrimp seeds and Prawn seeds
- Knowledge in larval rearing and seed production of Crabs
- Knowledge in collection and transportation of Oyster and Mussel spats
- Skill in preparation of Oyster and Mussel ren
- Identification of aquarium fishes and aquarium plants
- Identification of the challenges in conservation of indigenous ornamental fishes
- Expertise in seed production of aquarium fishes
- Expertise in aquarium plant rearing and propagation
- Expertise in installation and usage of aquarium equipment's and accessories.
- Skill in making of glass tank
- Skill in setting up of an aquarium
- Expertise in aquarium management
- Identification of Common Aquarium Fish Diseases and its causative agents
- Knowledge in Quarantine, prophylactic and therapeutic measures against diseases
- Skill in maintenance of brood stock of aquarium fishes

- Skill in breeding of aquarium fishes
- Skill in Nursery rearing aquarium fishes
- Skill in live feed culture for aquarium/ ornamental fishes
- Identification of marine ornamental fishes
- Identification of marine ornamental invertebrates and other marine organisms
- Skill in setting up of marine aquarium
- Skill in maintaining marine aquarium

LEARNING OUTCOMES OF COURSE

After completing the course the learner achieve skills in

- Reproduction in fin fish and shell fish,
- Sexual dimorphism and seed production of fin fish and shell fishes,
- Induced breeding technique of fin fish and shell fishes
- Life feed culture for rearing larvae of fin fish and shell fishes
- packing and transportation of seeds
- Familiarizes ornamental fresh water and marine ornamental fishes
- Familiarizes aquarium plants aquarium equipment's and accessories,
- Glass tank making,
- Common disease in fresh water ornamental fishes,
- Breeding of ornamental fishes,
- setting and management of aquarium

COURSE STRUCTURE

This course consist of four modules		Periods
Module I	: Aquaculture Farm management	340
Module II	: Culture of commercial fin fishes and shell fishes	340
Module III	: Seed production and Hatchery management of fin fishes and shell fishes	340
Module IV	: Ornamental Fisheries and Aquarium Management	340

SYLLABUS

Module III: Seed production and Hatchery management of fin fishes and shell fishes	Periods
3. 1 Introduction to reproduction in fin fishes and shell fishes	30
Factors affecting natural reproduction in fin fishes and shellfishes.	
Physiology of reproduction	
Sexual dimorphism and Hermaphroditism	
Induced breeding	
Fish genetics and selective breeding	
Recent developments	

3.2 Seed production of Carps

80

Commercial carp species and its sexual dimorphism

Natural collection of carp seeds

Induced breeding and larval rearing

Materials and equipments used for Induced breeding

Hatchery system (Happa system, Chinese hatchery system and Jar hatchery system)

3.3 Seed production of Tilapia (GIFT)

15

Sexual dimorphism in Tilapia

Induced and selective breeding in Tilapia

Hormonal sex reversal of Tilapia

Physical, chemical and biological parameters of water for larval rearing

3.4 Seed production of Pearl Spot

15

Sexual dimorphism in Pearl spot

Breeding under captivity/cages

Physical, chemical and biological parameters of water for larval rearing

3.5 Seed production of Air breathing Fishes **15**

Sexual dimorphism in Air breathing fishes

Induced breeding in Air breathing fishes

3.6 Seed production of brackish water and Marine Fishes **15**

Sexual dimorphism in brackish water and marine Fishes

Induced breeding and larval rearing of Asian Sea bass

3.7 Seed production of Penaeid Shrimps **100**

Sexual dimorphism in Penaeid Shrimps

Familiarization of larval stages

Larval rearing techniques

Induced maturation and spawning

Packing and transportation of shrimp seed

3.8 Seed production of Giant Freshwater Prawn **50**

Sexual dimorphism in Giant Freshwater Prawn

Water quality parameters in larval rearing

Larval rearing of Giant Freshwater Prawn

Collection centres of brood stock from wild

3.9 Seed production of Mud Crab

10

Sexual dimorphism in Mud Crab

Water quality parameters

Familiarization of larval stages

Larval rearing techniques

Collection of water crabs for fattening

3.10 Seed collection of Bivalves

10

Commercial bivalve species (Oyster and Mussels)

Collection of Oyster and Mussel spats

Preparation of Oyster Ren and Mussel Ren

Module IV: Ornamental Fisheries and Aquarium Management

4.1 Aquarium fishes

30

Familiarization of aquarium fishes

Classification of aquarium fishes namely Egg Layers (adhesive & non adhesive) and Live bearers

Exotic and indigenous varieties

4.2 Aquarium plants

20

Familiarization of aquarium plants

Aquarium plant rearing and propagation

Aquarium plants and water quality

4.3 Aquarium equipments and accessories

30

Familiarization of Aquarium equipments and accessories

(Aerators, Heaters, Illuminating lamps, Sand filter bed, Submersible pumps and filters
Bio filters, Drift wood, Rock & pebbles)

Principle and functioning of Bio filter

4.4 Making of an aquarium tank **30**

Measurements and cutting of glass pieces for aquarium

Glass tank making tools

Making of glass tank

Acrylic tanks

4.5 Assembling an aquarium **30**

Assembling an aquarium

4.6 Aquarium management **40**

Water quality management

Usage of water test kits to measure chemical parameters

(Dissolved O₂, CO₂, NH₃, NO₂, NO₃, Alkalinity & Acidity)

4.7 Fish Diseases-Quarantine, prophylactic and therapeutic measures **40**

Ichthyophthiriasis

Fin rot and Tail rot

Saprolegniasis

Dropsy

Protozoan infections

4.8 Breeding and seed production of Aquarium fishes

80

Brood stock maintenance

Breeding and spawning

Nursery rearing

Life feed culture

4.9 Marine Aquarium

40

Familiarization of marine ornamental fishes

Familiarization of marine ornamental plants and organisms

Marine aquarium accessories

Water quality management

List of Practical Activities in Module III

- Measurement of physical and chemical and biological parameters of water in larval rearing
- Identification of the commercially important carps and its sexual dimorphism (characters)
- Identification of life stages viz. fertilized egg, spawn, fry, and fingerlings, juvenile and adult
- Familiarization of materials and equipment used for induced breeding
- Demonstration of preparation of Pituitary gland extract
- Methods of injection for induced breeding
- Model preparation of Happa / Chinese hatchery / Jar hatchery
- Demonstration on packing and transportation of seeds
- Identification of species (GIFT) and its sexual dimorphism
- Identification of species (Pearl Spot) and its sexual dimorphism
- Identification of species (Air Breathing Fishes) and its sexual dimorphism
- Identification of species (Sea Bass, Cobia and Pompano) and its sexual dimorphism
- Identification of species (*Penaeus monodon* & *Litopenaeus vannamei*) and its sexual dimorphism
- Measurement of physical and chemical parameters of water
- Identification of larval stages Penaeid shrimp with specimens
- Preparation chart showing larval stages of Penaeid shrimp

- Identification of live feed organisms (*Chaetoceros/ Skeletonema/ Artemia*)
- Simulated experiment on eyestalk ablation with shrimp specimens
- Practical's on shrimp health analysis
- Preparation of lay out of shrimp hatchery
- Identification of species (Giant Freshwater Prawn) and its sexual dimorphism
- Identification of larval stages of Giant Freshwater Prawn with specimens
- Preparation chart showing larval stages of Giant Freshwater Prawn
- Preparation of egg custard for larval rearing of Giant Freshwater Prawn
- Field visit to collection centres of brood stock from wild
- Identification of species (Mud Crab) and its sexual dimorphism
- Identification of larval stages with specimens
- Preparation chart showing larval stages of Mud Crab
- Identification of species (Oyster and Mussels) and its spat with specimens
- Preparation of Oyster and Mussel Ren with live specimen

List of Practical Activities in Module IV

- Familiarization of aquarium fishes with the help of morphological characters and drawing
- Photo-exhibition of aquarium fishes by students
- Familiarization of aquarium plants with the help of morphological characters and drawing
- Photo-exhibition of aquarium plants by students
- Practical on sand planting and propagation of Aquarium plant
- Familiarisation of aquarium equipment's and accessories with Exhibition of the same
- Demonstration of aquarium equipment's and accessories - usage and method of operation
- Practical on setting up of bio filter in an aquarium
- Practical on calculation of measurements of glass pieces for glass tank
- Practical on familiarization of Glass tank making tools
- Practical on making of glass tank
- Practical on setting up of an aquarium
- Identification of symptoms of Fish Diseases with the help of Exhibition of diseased specimens and photos
- Identification of prophylactic and therapeutic agents against ornamental fish diseases (Chemicals, antibiotics and Herbs)
- Practical on breeding of aquarium fishes (Gourami/Fighter fish /Angel fish /Gold fish)

- PTC / practical's on nursery rearing aquarium fishes
- Practical on live feed culture of Infusoria / Artemia / Tubifex / Chironomid larvae / Microworms / Earthworms etc
- Familiarization of marine ornamental fishes
- Familiarization of marine ornamental invertebrates and other marine organisms

LEARNING OUTCOMES

- 3.1.1** Recognizes the factors affecting natural reproduction in fin fish and shell fish.
- 3.1.2** Understands the Physiology of reproduction
- 3.1.3** Understands Sexual dimorphism and hermaphroditism.
- 3.1.4** Understands the basic principles in Fish genetics.
- 3.1.5** Identifies recent developments in seed production
- 3.2.1** Identifies the commercially important carps and it's sexual dimorphism
- 3.2.2** Develops skill in selection and management of carp brood stock
- 3.2.3** Familiarize materials and equipment's used for induced breeding
- 3.2.4** Develops skill in induced breeding technique
- 3.2.5** Identifies the life stages viz. fertilized egg, spawn, fry, fingerlings, juvenile and adult
- 3.2.6** Operates Happa system, Chinese hatchery system and Jar hatchery system
- 3.2.7** Optimises physical, chemical and biological parameters of water.

- 3.3.1 Understands sexual dimorphism in Tilapia
- 3.3.2 Expertise in Induced breeding and selective breeding in Tilapia
- 3.4.1 Understands sexual dimorphism in Pearl spot
- 3.4.2 Understands the methodology of breeding Pearl Spot in captivity
- 3.4.3 Optimizes physical, chemical and biological parameters of water for larval rearing of Pearl Spot
- 3.5.1 Identifies air breathing fishes and its sexual dimorphism
- 3.5.2 Develops skill in induced breeding of air breathing fishes
- 3.5.3 Optimizes physical and chemical and biological parameters of water for larval rearing
- 3.5.4 Acquire skill in packing and transportation of seeds
- 3.6.1 Understands sexual dimorphism in Sea Bass
- 3.6.2 Optimizes physical and chemical and biological parameters of water for larval rearing
- 3.6.3 Acquires expertise in larval rearing of Sea Bass
- 3.6.4 Acquires knowledge in seed production of commercially important marine fishes
- 3.7.1 Identifies species (*Penaeus monodon* & *Litopenaeus vannamei*) and its sexual dimorphism
- 3.7.2 Identifies the larval stages in Penaeid shrimps
- 3.7.3 Optimize physical, chemical and biological parameters of water
- 3.7.4 Acquires expertise in larval rearing techniques
- 3.7.5 Acquires expertise in live feed culture
- 3.7.6 Acquires expertise in Induced maturation and spawning in Penaeid shrimps

- 3.7.7** Acquire skill in packing and transportation of shrimp seeds
- 3.8.1** Identifies species (Giant Freshwater Prawn) and its sexual dimorphism
- 3.8.2** Understand the procedures in brood stock management
- 3.8.3** Optimizes physical and chemical and biological parameters of water for larval rearing
- 3.8.4** Identifies larval stages of Giant Freshwater Prawn
- 3.8.5** Acquires expertise in larval rearing of Giant Freshwater Prawn
- 3.9.1** Identifies species (Mud Crab) and its sexual dimorphism
- 3.9.2** Familiarize larval stages of Crab
- 3.9.3** Optimize physical, chemical and biological parameters of water for larval rearing
- 3.9.4** Acquires expertise in larval rearing techniques
- 3.9.5** Identifies collection centres of water crabs for fattening
- 3.10.1** Identifies species (Oyster and Mussels)
- 3.10.2** Understands the methodology of collection and transportation of Oyster and Mussel spats
- 3.10.3** Develops skill in preparation of Oyster and Mussel ren
- 4. 1.1** Familiarizes ornamental/aquarium fishes
- 4.1.2** Classifies the aquarium fishes into live bearers and egg layers- different types
- 4.1.3** Categorises exotic and indigenous ornamental/ aquarium fishes
- 4.1.4** Identifies the challenges in conservation of indigenous ornamental fishes
- 4.2.1** Familiarizes aquarium plants

- 4.2.2** Develops expertise in aquarium plant rearing and propagation
- 4.2.3** Understands role of aquarium plants in maintaining water quality in aquarium
- 4.3.1** Familiarizes aquarium equipment's and accessories.
- 4.3.2** Understands the use of aerators, heaters, illuminating lamps, sand filter bed, submersible pumps, bio filters in an aquarium
- 4.3.3** Acquires knowledge in principle and functioning of bio filter in an aquarium
- 4.4.1** Understands the measurements and method of cutting glass pieces
- 4.4.2** Familiarizes Glass tank making tools- gun, silicone gel etc
- 4.4.3** Develops skill in making of glass tank
- 4.5.1** Develops skill in setting up of an aquarium
- 4.6.1** Develops expertise in aquarium management
- 4.7.1** Identifies the symptoms of Fish Diseases-Ichthyophthieriasis, Fin rot, Tail rot, Saprolegniasis, Dropsy, Protozoan infections
- 4.7.2** Recognizes the Fish Diseases and its causative agent
- 4.7.3** Understands the Quarantine, prophylactic and therapeutic measures against diseases
- 4.8.1** Develops Skill in maintenance of brood stock of aquarium fishes
- 4.8.2** Develops skill in breeding of aquarium fishes
- 4.8.3** Develops skill in Nursery rearing aquarium fishes
- 4.8.4** Develops skill in live feed culture for aquarium/ ornamental fish breeding
- 4.9.1** Identifies marine ornamental fishes

4.9.2 Identifies marine ornamental invertebrates and other marine organisms

4.9.3 Familiarizes marine aquarium accessories

4.9.4 Develops skill in maintaining marine aquarium

SCHEME OF WORK / YEAR PLAN

MODULE III

SEED PRODUCTION AND HATCHERY MANAGEMENT OF FIN FISHES AND SHELL FISHES

Sl. No.	Month	Units Covered in the Month	Periods
1	June	Introduction to reproduction in fishes and shell fishes	30
2	June/July	Seed production of Carps	80
3	July	Seed production of GIFT	15
4	July	Seed production of Pearl Sport	15
5	August	Seed production of Air breathing fishes	15
6	August	Seed production of Asian Sea bass	15
7	August/September	Seed production of Marine Penaeid Shrimps	100
8	October	Seed production of Fresh Water Prawn	50
9	October	Seed production of Mud Crab	10

10	October	Seed collection of Mussels and oysters	10
		TOTAL	340

MODULE IV

ORNAMENTAL FISHERIES AND AQUARIUM MANAGEMENT

Sl. No.	Month	Units Covered in the Month	Periods
1	November	Aquarium fishes	30
2	November	Aquarium plants	20
3	November/December	Aquarium equipments and accessories	30
4	December	Making of an aquarium glass tank	30
5	December	Assembling an aquarium	30
6	January	Aquarium management	40
7	January/February	Fish Diseases-Prophylactic and therapeutic measures	40
8	February/March	Breeding and seed production of Aquarium fishes	80
9	March	Marine Aquarium	40

		TOTAL	340
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MODULE III

SEED PRODUCTION AND HATCHERY MANAGEMENT OF FIN FISHES AND SHELL FISHES

Units under module III are given below

Unit No.	Name of Units	Periods
1	Introduction to reproduction in fishes and shell fishes	30
2	Seed production of Carps	80
3	Seed production of GIFT	15
4	Seed production of Pearl Spot	15
5	Seed production of Air breathing fishes	15
6	Seed production of Asian Sea bass	15
7	Seed production of Marine Penaeid Shrimps	100
8	Seed production of Giant Freshwater Prawn	50
9	Seed production of Mud Crab	10
10	Seed collection of Mussels and oysters	10
	TOTAL	340

MODULE IV

ORNAMENTAL FISHERIES AND AQUARIUM MANAGEMENT

Units under module IV are given below

Sl. No.	Name of Units	Periods
1	Aquarium fishes	30
2	Aquarium plants	20
3	Aquarium equipments and accessories	30
4	Making of an aquarium glass tank	30
5	Assembling an aquarium	30
6	Aquarium management	40
7	Fish Diseases-Prophylactic and therapeutic measures	40
8	Breeding and seed production of Aquarium fishes	80
9	Marine Aquarium	40
	TOTAL	340

CLASSROOM ACTIVITIES IN GENERAL

- Seminar
- Group discussion
- Quiz
- Preparation of Posters and Charts
- Project and workshops
- Exhibitions
- Multimedia presentation
- Panel discussion
- Interview with invited experts/ farmers in the classroom
- Workshop

PRACTICAL ACTIVITIES IN GENERAL

- Indoor practical work in labs
- Field visits
- Production cum training centre
- On the job training
- Interaction with aquaculture farmers at the farm site
- Curriculum oriented case studies
- Demonstration

OVERVIEW OF THE MODULE III

Module III. Seed production and hatchery management

This module solely deals with seed production of fishes like carps, Pearl spot, GIFT, air breathing fishes and shell fishes like Tiger shrimp, Vannamei shrimp, prawns and bivalves. The module covers the topics like brood stock maintenance, breeding, spawning, larval rearing of fin fishes and shell fishes. Module aim to impart basic knowledge, expertise and skill in various aspects of seed production. It addresses the skill requirements in Induced breeding technique, packing and transportation of seeds. The classroom transaction and practical activities are arranged in such a way that learner acquires knowledge as well as skill from the class room activities and ultimately polish the same through field visit, Production cum Training Centre and On the Job Training programme. The module, in curricular point of view paves the way for skilled manpower required in Aquaculture sector. Ultimately opportunities in this sector can be tapped by the VHSE pass outs.

List of expected skills

- Skill in induced breeding and seed production of fishes
- Skill in breeding and seed production of shell fishes
- Skill in preparation of Oyster and Mussel ren for Culture
- Skill in live feed culture
- Skill in packing and transportation of fin fish seeds and shell fish seeds

Module. III SEED PRODUCTION AND HATCHERY MANAGEMENT OF FIN FISHES AND SHELL FISHES

Unit. 1 Introduction to reproduction in fishes and shell fishes

The unit introduces the module with factors affecting natural reproduction in fin fishes and shellfishes. Before going through the artificial breeding and its techniques, learner get the opportunity to understand the physiology of reproduction, phenomenon like sexual dimorphism, hermaphroditism, fish genetics, selective breeding and recent developments and advancements in seed production.

	IDEAS / CONCEPTS / SKILLS	LEARNING OUTCOMES	SUGGESTED ACTIVITIES	ASSESSMENT
3.1	Introduction			
	Factors affecting natural reproduction in fin fishes and shellfishes.	3.1.1 Recognizes the factors affecting natural reproduction in fin fish and shell fish.	Group discussion on factors affecting reproduction of fin fishes and shell fishes	Report on Group Discussion
	Physiology of reproduction	3.1.2 Understands the Physiology of reproduction	Group discussion on factors affecting reproduction of fin fishes and shell fishes	Assessment of Previous knowledge by Quiz
	Sexual dimorphism, hermaphroditism,	3.1.3 Understands Sexual dimorphism and hermaphroditism.	Identification of sexual dimorphism in fish and Prawn with morphological distinguishing characters and drawings made in record	Practical record
	Fish genetics	3.1.4 Understands the basic principles in Fish genetics. 3.1.5 Identifies recent developments in seed production	Quiz on Fish Genetics Seminar on Recent developments in the field of seed production	Questionnaire and answers Report on seminar

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Additional information

South East Asian countries are the fore-runners in the field of Aquaculture

Assessment Activities

Group discussion on factors affecting reproduction of fin fishes and shell fishes

Identification of male and female fish with morphological distinguishing characters and drawings made in record

Quiz on Fish Genetics

Seminar on Recent developments in the field of seed production

List of items in Portfolio

- Report on Group Discussion
- Assessment of Previous knowledge by Quiz
- Questionnaire and answers
- Report on seminar
- Practical record

Unit. 2 Seed production of Carps

This unit covers the basics of carp seed production. The unit gives emphasis on Induced breeding of Carps through sexual dimorphism in carps, brood stock management, breeding and spawning, larval rearing, packing and transportation. Materials and equipments used for induced breeding, hatchery systems like Happa system, Chinese hatchery system and Jar hatchery system are introduced during this module by practical's, field visits and OJT.

3.2	Seed production of Carps			
	Commercial carp species and its sexual dimorphism	3.2.1 Identifies the commercially important carps and its sexual dimorphism	Identification of male and female fish with morphological distinguishing characters and drawings made in record	Observations in Practical record
	Brood stock management of carps	3.2.2 Develops skill in selection and management of carp brood stock	Group Discussion on Brood stock management Interaction with expert at carp hatchery through OJT/field visit	Report on Group Discussion Report on Field visit/OJT
	Induced breeding and larval rearing	3.2.3 Familiarize materials and equipment's used for induced breeding 3.2.4 Develops skill in induced breeding technique	Familiarization of materials and equipments used for induced breeding through practical/OJT/field visit Interaction with expert at carp hatchery through OJT/field visit	Observations in Practical record Report on Field visit/OJT

			ICT enabled teaching activity on induced breeding in Carps	Report on ICT enabled teaching activity
	Life stages of Carps	3.2.5 Identifies the life stages viz. fertilized egg, spawn, fry, fingerlings, juvenile and adult	Identification of life stages viz. fertilized egg, spawn, fry, fingerlings, juvenile and adult through practical/OJT/field visit	Report on Field visit/OJT
	Hatchery system (Happa system, Chinese hatchery system and Jar hatchery system)	3.2.6 Operates Happa system, Chinese hatchery system and Jar hatchery system 3.2.7 Optimises physical, chemical and biological parameters of water.	Operation of Happa system, Chinese hatchery system and Jar hatchery system at hatchery during OJT/field visit Measure and analyse physical, chemical and biological parameters in larval rearing by field visit/ practical/ OJT	Report on Field visit/OJT Report on Field visit/OJT

Additional information

Hybridization and selective breeding has helped in evolving new strains with improved qualities in Carps

Assessment Activities

Seed production of Carps

Identification of male and female fish with morphological distinguishing characters and drawings made in record

Group Discussion on Brood stock management

Interaction with expert at carp hatchery through OJT/field visit

Familiarization of materials and equipments used for induced breeding through practical/OJT/field visit

Interaction with expert at carp hatchery through OJT/field visit

Identification of life stages viz. fertilized egg, spawn, fry, and fingerlings, juvenile and adult through practical/OJT/field visit

Operation of Happa system, Chinese hatchery system and Jar hatchery system at hatchery during OJT/field visit

Measure and analyse physical, chemical and biological parameters in larval rearing by field visit/ practical/ OJT

List of items in Portfolio

- Report on Group Discussion
- Report on ICT enabled teaching activity
- Report on Field visit/ OJT
- Practical record

Unit.3 Seed production of Tilapia (GIFT)

This unit deals with important topics related such as Sexual dimorphism in Tilapia, Induced and selective breeding in Tilapia, Hormonal sex reversal of Tilapia, Physical, chemical and biological parameters of water for larval rearing. Through this unit student will acquire knowledge, expertise and skill in breeding of a globally cultivated fast growing species.

3.3 Seed production of Tilapia(GIFT)			
Sexual dimorphism in Tilapia	3.3.1 Understands sexual dimorphism in Tilapia	Identification of male and female fish with distinguishing morphological characters and drawings made in record	Practical record / Vocational diary
Induced breeding and selective breeding in Tilapia	3.3.2 Expertise in Induced breeding and selective breeding in Tilapia	Group Discussion on selective breeding and induced breeding ICT enabled teaching activity on induced breeding and selective breeding in Tilapia Simulated practical's on induced breeding of tilapia	Report on Group Discussion Report on ICT enabled teaching activity Practical record

Additional information

Tilapia is the most preferred fish for research and studies because of its adaptive characters

Assessment Activities

Seed production of Tilapia

Identification of male and female fish with distinguishing morphological characters and drawings made in record

Group Discussion on selective breeding and induced breeding

ICT enabled teaching activity on induced breeding and selective breeding in Tilapia

Simulated practical's on induced breeding of tilapia

List of items in Portfolio

- Report on Group Discussion
- Report on ICT enabled teaching activity
- Report on panel discussion
- Report on Field visit/OJT
- Practical record
- Vocational diary

Unit.4 Seed production of Pearl Spot

Pearl spot is highly soted after indigenous food fish which is considered as the state fish of Kerala. High demand for the fish makes seed production of pearl spot important. Here the unit covers Sexual dimorphism in Pearl spot, Breeding of under captivity/cages, Physical, chemical and biological parameters of water suitable for larval rearing and collection of seeds from wild.

3.4 Seed production of Pearl Spot				
	Sexual dimorphism in Pearl spot	3.4.1 Understands sexual dimorphism in Pearl spot	Identification of male and female fish with distinguishing morphological characters and drawings made in record	Observations in Practical record/ Vocational diary
	Breeding under captivity	3.4.2 Understands the methodology of breeding Pearl Spot in captivity	ICT enabled teaching activity on breeding of Pearl spot in captivity	Report on ICT enabled teaching activity
	Physical, chemical and biological parameters of water for larval rearing	3.4.3 Optimizes physical, chemical and biological parameters of water for larval rearing of Pearl Spot	Measure and analyse physical, chemical and biological parameters in larval rearing by field visit/ practical/ OJT	Observations in Practical record/ Vocational diary

Additional information

Breeding of Pearl spot is possible even in Cages by providing a suitable substratum for attaching eggs

Assessment Activities

Seed production of Pearl Spot

Identification of male and female fish with distinguishing morphological characters and drawings made in record

ICT enabled teaching activity on breeding of Pearl spot in captivity

Measure and analyse physical, chemical and biological parameters in larval rearing by field visit/ practical/ OJT

List of items in Portfolio

- Report on ICT enabled teaching activity
- Practical record
- Vocational diary

Unit.5 Seed production of Air breathing Fishes

Air breathing fish culture is gaining importance as they can adapt even the most fluctuating culture atmosphere. The ever depleting water resources in terms of quality and quantity also give immense scope to these fishes in culture scenario. The unit deals with sexual dimorphism in Air breathing fishes and Induced breeding of Air breathing fishes.

3.5 Seed production of Air breathing Fishes				
	Sexual dimorphism in Air breathing fishes	3.5.1 Identifies air breathing fishes and its sexual dimorphism	Identification of male and female fish with distinguishing morphological characters and drawings made in record	Practical record
	Induced breeding in Air breathing fishes	3.5.2 Develops skill in induced breeding of air breathing fishes 3.5.3 Optimizes physical and chemical and biological parameters of water for larval rearing	Measure and analyse physical, chemical and biological parameters in larval rearing by field visit/ practical/ OJT Field visit to hatchery	Observations in Practical record / Vocational diary Report on Field visit
	Packing and transportation of fish seed	3.5.4 Acquire skill in packing and transportation of seeds	Engage in packing process during the Field visit/ OJT in hatchery	Report on Field visit/OJT

Additional information

Air breathing fishes are gaining importance since water resources are depleting in quality and quantity

Assessment Activities

Seed production of Air breathing Fishes

Identification of male and female fish with distinguishing morphological characters and drawings made in record

Measure and analyse physical, chemical and biological parameters in larval rearing by field visit/ practical/ OJT

Field visit to hatchery

Engage in packing process during the Field visit/ OJT in hatchery

List of items in Portfolio

- Report on seminar
- Practical record
- Vocational diary
- Report on Field visit/OJT

Unit. 6 Seed production of Asian Sea bass

As a state is bestowed with vast brackish and marine environments, culture of brackish water and marine fishes has good scope in Kerala. Since there is a clear preference to marine and brackish fishes over freshwater fishes in Kerala, culture of these fishes offer good prospects. This unit highlights sexual dimorphism in brackish water and marine Fishes, induced breeding, management of water quality parameters in larval rearing and also collection of wild seeds.

3.6 Seed production of Asian Sea bass			
Sexual dimorphism in brackish water and marine Fishes	3.6.1 Understands sexual dimorphism in Sea Bass	Identification of male and female fish with distinguishing morphological characters and drawings made in record	Practical Record
Water quality parameters in larval rearing of Sea Bass	3.6.2 Optimizes physical and chemical and biological parameters of water for larval rearing 3.6.3 Acquires expertise in larval rearing of Sea Bass	Measure and analyze physical, chemical and biological parameters in larval rearing by field visit/ practical/ OJT Interaction of students with hatchery expert and training during Field visit /OJT	Observations in Practical record / Vocational diary Report on Field visit/OJT
Seed production of commercially important marine fishes	3.6.4 Acquires knowledge in seed production of commercially important marine fishes (Cobia and Pompano)	Seminar on Seed production of commercially important marine fishes Case study on seed production of any marine fish species (Cobia and Pompano)	Seminar Report Report on case study

Additional information

Cobia and *Pompano* are the two important species with mariculture prospects

Assessment Activities

Seed production of brackish water and Marine Fishes

Identification of male and female fish with distinguishing morphological characters and drawings made in record

Measure and analyse physical, chemical and biological parameters in larval rearing of Asian Sea Bass by field visit/ practical/ OJT

Interaction of students with hatchery expert and training during Field visit /OJT

Seminar on Seed production of commercially important marine fishes

Case study on seed production of any marine fish species (*Cobia* and *Pompano*)

List of items in Portfolio

- Report on seminar
- Report on case study

- Practical record
- Vocational diary

Unit.7 Seed production of Penaeid Shrimps

India is now emerging as prospective shrimp producing nation with Penaeid species namely *Penaeus monodon* and *Litopenaeus vannamei*. This in turn results in huge demand of shrimp seeds. Skilled manpower is still a limiting factor in hatchery sector of shrimp seeds. This unit deeply cover all aspects of seed production of shrimps namely, sexual dimorphism, spawning, familiarization of larval stages, larval rearing, live feed culture, induced maturation and packing of seeds.

3.7 Seed production of Penaeid shrimps				
	Sexual dimorphism in Penaeid Shrimps	3.7.1 Identifies the species(<i>Penaeus monodon</i> & <i>Litopenaeus vannamei</i>) and it's sexual dimorphism	Identification of male and female Shrimps with distinguishing morphological characters and drawings made in record	Observations in Practical record / Vocational diary
	Familiarization of larval stages	3.7.2 Identifies the larval stages in Penaeid shrimps	Identification of larval stages in Penaeid shrimps through microscopic observation during OJT/Field visit Preparation chart showing larval stages of Penaeid shrimp	Observations in Practical record Chart with Larval stages

	Larval rearing techniques	<p>3.7.3 Optimize physical, chemical and biological parameters of water</p> <p>3.7.4 Acquires expertise in larval rearing techniques</p> <p>3.7.5Acquires expertise in live feed culture</p>	<p>Measure and analyse physical, chemical and biological parameters in larval rearing by field visit/ practical/ OJT</p> <p>Interaction of students with hatchery expert and training during Field visit /OJT</p>	<p>Report on Field visit/OJT</p> <p>Report on Field visit/OJT</p>
	Induced maturation and spawning	3.7.6 Acquires expertise in Induced maturation and spawning in Penaeid shrimps	<p>Interaction of students with hatchery expert and training during Field visit /OJT</p> <p>Simulated experiment of eyestalk ablation during practical with specimens</p>	<p>Report on Field visit/OJT</p> <p>Practical record</p>
	Packing and transportation of shrimp seed	3.7.7 Acquire skill in packing and transportation of shrimp seeds	<p>Engage in packing process during the Field visit/ OJT in hatchery</p> <p>Demonstration on packing of live shrimp seeds</p>	<p>Report on Field visit/OJT</p> <p>Report on Demonstration</p>

Additional information

Vannamei shrimp is gaining momentum in Shrimp culture as the single largest species in India with highest production

Assessment Activities

Seed production of Penaeid shrimps

Identification of male and female Shrimps with distinguishing morphological characters and drawings made in record

Identification of larval stages in Penaeid shrimps through microscopic observation during OJT/Field visit

Preparation chart showing larval stages of Penaeid shrimp

Measure and analyse physical, chemical and biological parameters in larval rearing by field visit/ practical/ OJT

Interaction of students with hatchery expert and training during Field visit /OJT

Interaction of students with hatchery expert and training during Field visit /OJT

Simulated experiment of eyestalk ablation during practical with specimens

Engage in packing process during the Field visit/ OJT in hatchery

Demonstration on packing of live shrimp seeds

List of items in Portfolio

- Report on Group Discussion
- Report on ICT enabled teaching activity
- Practical record
- Vocational diary
- Report on Demonstration
- Chart showing larval stages

Unit.8 Seed production of Giant Fresh water Prawn

The Giant Fresh water Prawn widely known as Scampi is facing extinction in natural habitat due human interventions. The seed production of scampi is so significant in terms of huge demand from culture segment and necessity of the replenishment of scampi in natural environment. This unit impart knowledge in sexual dimorphism, breeding, spawning and larval rearing of Scampi in detail.

.8	Seed production of Giant Freshwater Prawn
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	Sexual dimorphism in Giant Freshwater Prawn	3.8.1 Identifies the species(Giant Freshwater Prawn) and it's sexual dimorphism	Identification of male and female Prawns with distinguishing morphological characters and drawings made in record	Practical record
	Brood stock Management of Prawns	3.8.2 Understand the procedures in brood stock management	Mock presentation in procurement of brood stock (Berried Female)	Report on Mock presentation
	Water quality parameters in larval rearing	3.8.3 Optimizes physical and chemical and biological parameters of water for larval rearing	Measure and analyse physical, chemical and biological parameters in larval rearing by field visit/ practical/ OJT	Observations in Practical record / Vocational diary

	Larval rearing of Giant Freshwater Prawn	<p>3.8.4 Identifies larval stages of Giant Freshwater Prawn</p> <p>3.8.5 Acquires expertise in larval rearing of Giant Freshwater Prawn</p>	<p>Identification of larval stages in Giant Freshwater Prawn by microscopic observation during Field visit/ OJT</p> <p>Preparation chart showing larval stages of Prawn</p> <p>Field visit/ OJT in larval rearing of Giant Freshwater Prawn</p> <p>Preparation of Egg Custard Feed during PTC</p>	<p>Practical record</p> <p>Chart with Larval stages</p> <p>Report on Field visit/OJT</p> <p>PTC product</p>
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Additional information

Giant Freshwater Prawn is facing extinction in its natural habitat, Vembanad Lake due to the construction of ‘Thanneermukkam Barrier’ which hinder their catadromous breeding migration

Assessment Activities

Seed production of Giant Freshwater Prawn

Identification of male and female Prawns with distinguishing morphological characters and drawings made in record

Mock presentation in procurement of brood stock (Berried Female)

Measure and analyse physical, chemical and biological parameters in larval rearing of Giant Freshwater Prawn by field visit/ OJT

Identification of larval stages in Giant Freshwater Prawn by microscopic observation during Field visit/ OJT

Preparation chart showing larval stages of Prawn

Field visit/ OJT in larval rearing of Giant Freshwater Prawn

List of items in Portfolio

- Report on Field visit/OJT
- Practical record
- Report on Mock presentation
- Vocational diary
- Chart Drawing on Larval stages
- PTC product

Unit.9 Seed production of Mud Crab

As a highly priced variety crab offers good profitability in its culture. Expertise and skill in Crab seed production is in a growing stage in India. Here the unit gives emphasis on sexual dimorphism, water quality requirements, familiarization of larval stages, larval rearing techniques and packing of seeds. Unit also introduce the method of collection of water crabs for fattening

3.9 Seed production of Mud Crab				
	Sexual dimorphism in Mud Crab	3.9.1 Identifies species(Mud Crab) and it's sexual dimorphism	Identification of male and female crabs with distinguishing morphological characters and drawings made in record	Practical record
	Familiarization of larval stages	3.9.2 Familiarize larval stages of Crab	Identification of larval stages in crab through microscopic observation during OJT/Field visit Preparation chart showing larval stages of crab	Observations in Practical record Chart with Larval stages

Larval rearing techniques	<p>3.9.3 Optimize physical, chemical and biological parameters of water for larval rearing</p> <p>3.9.4 Acquires expertise in larval rearing techniques</p>	<p>Measure and analyse physical, chemical and biological parameters in larval rearing by field visit/ practical/ OJT</p> <p>Interaction of students with hatchery expert and training during Field visit /OJT</p>	<p>Observations in Practical record / Vocational diary</p> <p>Report on Field visit</p>
Collection of water crabs for fattening / culture	3.9.5 Identifies collection centres of water crabs for fattening	With the help of political map of India, students identify the seed collection centres	Mapping of collection centres in Map

Additional information

Larval rearing and seed production of Mud Crab recently got standardized in India.

Assessment Activities

Seed production of Mangrove Crab

Identification of male and female crabs with distinguishing morphological characters and drawings made in record

Identification of larval stages in crab through microscopic observation during OJT/Field visit

Preparation chart showing larval stages of crab

Measure and analyse physical, chemical and biological parameters in larval rearing by field visit/ practical/ OJT

Interaction of students with hatchery expert and training during Field visit /OJT

With the help of political map of India, students identify the seed collection centres

List of items in Portfolio

- Report on Field visit
- Practical record
- Vocational diary
- Chart Drawings of larval stages
- Mapping of collection centres in Map

Unit.10 Seed collection of Mussels and Oysters

Bivalves are variety which have good demand in local as well as in foreign market. At present brackish water resources in Kerala are blessed with spats/seeds of Mussel and Oyster. Hence the unit gives focus on collection techniques of Oyster and Mussel spats. It also covers the identification of commercial species (Oyster and Mussels) and preparation of Oyster Ren and Mussel Ren

3.10 Seed collection of Bivalves				
	Identification of commercially important bivalve species (Oyster and Mussels)	3.10.1 Identifies species (Oyster and Mussels)	Identification of cultivable species of Oyster and Mussels with morphological characters and drawings made	Practical record
	Collection of Oyster and Mussel spats	3.10.2 Understands the methodology of collection and transportation of Oyster and Mussel spats	Interaction of students with mussel farmers during Field visit Panel discussion on collection of oyster and mussel spats. (Like environmental, social, economic etc)	Report on Field visit Report on panel discussion

	Preparation of Oyster Ren and Mussel Ren	3.10.3 Develops skill in preparation of Oyster and Mussel ren	Demonstration in making Mussel/Oyster rens	Report on Demonstration
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Additional information

Mussel and Oysters are natural filtering organisms which can be used in culture systems for improving water quality

Assessment Activities

Seed collection of Bivalves

Identification of cultivable species of Oyster and Mussels with morphological characters and drawings made

Interaction of students with mussel farmers during Field visit

Panel discussion on collection of oyster and mussel spats. (Like environmental, social, economic etc)

Practical experience with farmers in making Mussel/Oyster rens during Field visit

List of items in Portfolio

- Report on panel discussion
- Report on Demonstration
- Practical record
- Mapping of collection centres in Map

List of Extended Activities in Module III

Training and technical assistance in seed production of ornamental fishes can be given to Self Help Groups by the Vocational faculty of the school. Students will be benefitted by associating with programme.

- The schools having Production Cum Training Centres on aquaculture courses can offer short term training programmes. Venue can be offered to various departments for conducting Training Programmes of on fisheries sector will be beneficial to students too. This can be arranged in consultation with heads of concerned departments. By this students will get good exposure. The interaction of students and teachers with the stakeholders will build up confidence.
- Spat collection and ren preparation mentioned in the course can be easily simulated inside the class room will live specimen
- Exposure in the field of Aquaculture can be achieved by arranging visits to Exhibitions on the same too. This will also help the students and teachers in updating knowledge in the field.

OVERVIEW OF THE MODULE IV

Module IV Ornamental Fisheries

Ornamental fish farming and aquarium management is a promising sector in fisheries field. This module includes topics like identification of commercially important fresh water and marine ornamental fishes, importance of conservation of indigenous ornamental fishes, familiarization of important aquarium plants and invertebrates, seed production and disease management. Setting up of aquarium, aquarium management and familiarization of aquarium accessories are also dealt in detail. Marine aquaria, an emerging fast growing segment also finds a place in this module. The learner can go through the module with great enthusiasm, which makes the module attractive to students. Knowledge and skill aimed by the module surely help the learners in finding jobs or to have entrepreneurship in this sector.

Expected Skills

- Identify fresh water and marine ornamental fishes, invertebrates and plants.
- Knowledge in Breeding and seed production of ornamental fishes
- Skill in aquarium setting and management.
- Skill in water quality management.
- Recognition of disease by observing symptoms
- Applying prophylactic and therapeutic measures against diseases
- Skill in packing and transportation of ornamental fishes and organisms

Unit.1 Aquarium fishes

Aquarium keeping is the second largest hobby in the world. Aquarium is the place where fishes, plants, other organisms or objects were exhibited as aquatic habitat for enjoyment. Fishes are main component around which all aquariums exist. Fishes are beautiful, fascinating and relaxing to watch and also enhance the beauty of home or shops. From entrepreneurial point of view familiarisation of ornamental/aquarium fishes are very important. In this unit the learner acquire knowledge in classifying the fishes in to live bearers and egg layers, which is very important prerequisite for seed production of these fishes. Thorough knowledge in exotic and indigenous ornamental fish varieties will help in recognizing the challenges in conservation of indigenous ornamental fishes.

	IDEAS / CONCEPTS / SKILLS	LEARNING OUTCOMES	SUGGESTED ACTIVITIES	ASSESSMENT
4.1	Aquarium fishes			
	Familiarization of ornamental/ aquarium fishes	4.1.1 Familiarises ornamental/aquarium fishes	Familiarization of aquarium fishes with the help of morphological characters and drawing	Practical record
	Classification of aquarium fishes based on nature of reproduction	4.1.2 Classifies the aquarium fishes into live bearers and egg layers- different types	Group Discussion on nature of reproduction in Aquarium fishes Photo-exhibition of aquarium fishes by students	Report on Group Discussion Photo Exhibits Exhibits
	Categorisation of exotic and indigenous ornamental/	4.1.3 Categorises exotic and indigenous ornamental/ aquarium fishes 4.1.4 Identifies the challenges in conservation of	Seminar on exotic and indigenous ornamental/ aquarium fishes Panel discussion on Environmental impacts	Report on Seminar Report on Panel

	aquarium fishes	indigenous ornamental fishes	of Exotic Ornamental Fishes/ Challenges in conservation of indigenous ornamental fishes	Discussion
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Additional information

Aquarium fishes are used to control mosquito by allowing feed their larvae in ditches and swamps

Assessment Activities

Familiarization of aquarium fishes with the help of morphological characters and drawing

Group Discussion on nature of reproduction in Aquarium fishes

Photo-exhibition of aquarium fishes by students

Seminar on exotic and indigenous ornamental/ aquarium fishes

Panel discussion on Environmental impacts of Exotic Ornamental Fishes/Challenges in conservation of indigenous ornamental fishes

List of items in Portfolio

Practical record

Report on Group Discussion

Photo Exhibits

Report on Seminar

Report on Panel discussion

Unit.2 Aquarium plants

Aquarium plants are the main component of an aquarium which gives the aquarium a natural look. Apart from improving the aesthetic

look of aquarium, plants provide oxygen; they absorb the harmful nitrogenous wastes excreted by the fishes and maintain water quality for very existence of fishes. This unit also give awareness on aquarium plants, it's rearing and propagation.

4.2 Aquarium plants				
Familiarization of aquarium plants	4.2.1 Familiarises aquarium plants	Familiarization of aquarium plants with the help of morphological characters and drawing Photo-exhibition of aquarium plants by students	Practical record Photo Exhibits	
Aquarium plant rearing and propagation	4.2.2 Develops expertise in aquarium plant rearing and propagation	Practical/PTC on sand planting and propagation of Aquarium plant	Practical record	
Aquarium plants and water quality of aquarium	4.6.3 Understands role of aquarium plants in maintaining water quality in aquarium	Group Discussion on the role of aquarium plants in maintaining water quality in aquarium	Report on Group Discussion	

Additional information

As in agriculture, tissue culture technique is used for the propagation of aquarium plants

Assessment Activities

Familiarization of aquarium plants with the help of morphological characters and drawing

Photo-exhibition of aquarium plants by students

Practical/PTC on planting and propagation of Aquarium plant

Group Discussion on the role of aquarium plants in maintaining water quality in aquarium

List of items in Portfolio

Practical record

Report on Group Discussion

Photo Exhibits

Unit.3 Aquarium equipments and accessories

Aquarium is an artificial ecosystem created for keeping aquatic organisms. For creating artificial ecosystem suitable equipments are required to maintain the environment stable. Hence familiarization of aquarium equipments such as Aerators, Heaters, Illuminating lamps, Sand filter bed, Submersible pumps, filters, Bio filters are very important.

4.3 Aquarium equipment's and accessories			
Familiarization of aquarium equipment's and accessories.	<p>4.3.1 Familiarizes aquarium equipment's and accessories.</p> <p>4.3.2 Understands the use of aerators, heaters, illuminating lamps, sand filter bed, submersible pumps ,bio filters in an aquarium</p>	<p>Familiarisation of aquarium equipment's and accessories with Exhibition of the same</p> <p>Demonstration of aquarium equipment's and accessories - use and method of operation</p>	<p>Exhibits</p> <p>Report on demonstration</p>

	Principle and functioning of Bio filter	4.3.3 Acquires knowledge in principle and functioning of bio filter in an aquarium	ICT enabled teaching activity on principle and functioning of Bio filter Demonstration on setting up of bio filter in an aquarium	Practical record Vocational Diary
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Additional information

Computerized monitoring of aquariums is in place and such sophisticated instruments are common in foreign countries

Assessment Activities

Aquarium equipments and accessories

Familiarisation of aquarium equipment's and accessories with Exhibition of the same

Demonstration of aquarium equipment's and accessories - use and method of operation

ICT enabled teaching activity on principle and functioning of Bio filter

Practical on setting up of bio filter in an aquarium

List of items in Portfolio

Practical Record

Report on demonstration

Photo Exhibits

Vocational Diary

Unit.4 Making of an aquarium glass tank

Glass is the main component used for making aquarium tank. Here measurements and cutting of glass pieces determines the quality of tank

Familiarisation of glass tank making tools and fixing of glass tank with silicone gel is the prime requisite for aquarium making.

4.4 Making of an aquarium glass tank				
	Measurements and cutting of glass pieces for aquarium glass tank	4.4.1 Understands the measurements and method of cutting glass pieces	Practical on calculation of measurements/cutting of glass pieces for glass tank	Practical Record
	Glass tank making tools	4.4.2 Familiarizes Glass tank making tools- gun, silicone gel etc.	Practical's on familiarization of Glass tank making tools	Practical Record/ Vocational Diary
	Making of a Glass tank	4.4.3 Develops skill in making of glass tank	PTC/ practical on making of glass tank	PTC product

Additional information

Recently acrylic tanks are in place instead of glass tanks. Risk of breakage is so less at the same time the clarity is very high in these tanks

Assessment Activities

Making of an aquarium glass tank

Practical on calculation of measurements/cutting of glass pieces for glass tank

Practical on familiarization of Glass tank making tools

PTC/ practical on making of glass tank

List of items in Portfolio

Practical record
Vocational Diary
PTC product

Unit.5 Assembling an aquarium

Beauty of the aquarium depends on the setting up of the aquarium. Hence sound knowledge in setting an aquarium is important to make an attractive aquarium.

4.5	Assembling an aquarium			
	Assembling an aquarium	4.5.1 Develops skill in assembling an aquarium	Interaction of students with expert with in the class room. PTC/ practical on assembling an aquarium	Report of expert session PTC product

Additional information

Nowadays setting up of paludariums by incorporating aquatic and terrestrial components is becoming popular.

Assessment Activities

Interaction of students with expert in the class room.

PTC/ practical on assembling an aquarium

List of items in Portfolio

Report of expert session

PTC product

Unit.6 Aquarium management

Aquarium is a restricted aquatic environment where several complex processes work to keep the aquarium healthy. It is important to know the aquatic processes going on inside the aquarium and also the interventions to keep it healthy. Hence the scientific study of aquarium maintenance is important. Sound knowledge in water quality management, Usage of water test kits to measure chemical parameters, (Dissolved O₂, CO₂, NH₃, NO₂, NO₃, Alkalinity & Acidity), measurement of physical parameters and assessing biological parameters are essential in management of aquariums.

4.6 Aquarium Management				
	Management of Aquarium	4.6.1 Develops expertise in aquarium management	PTC/ practical on measurement of water quality parameters Compare and analyse water quality parameters through group discussion	Practical record Report on group discussion

Additional information

Unlike individual measurement of water quality parameters there are equipments by which multiple parameters can be measured at a time

Assessment Activities

PTC/ practical on setting up of an aquarium

List of items in Portfolio

PTC product

Practical record

Unit.7 Fish Diseases-Quarantine, prophylactic and therapeutic measures

Being in a restricted environment makes aquarium fishes are vulnerable to diseases. Once disease occurs in tank to one fish then it will spread to other fishes and kill them. To avoid mass mortality it is better to understand the disease symptoms of the disease at the earliest. Quarantine is the most important measure to keep aquarium devoid of diseases. Commonly found fish diseases are Ichthyophthiriasis, Fin rot & Tail rot, Saprolegniasis, Dropsy and Protozoan infections

4.7	Fish Diseases-Quarantine, prophylactic and therapeutic measures			
	Important ornamental fish diseases	4.7.1 Identifies the symptoms of Fish Diseases- Ichthyophthiriasis, Fin rot, Tail rot, Saprolegniasis, Dropsy, Protozoan infections 4.7.2 Recognizes the Fish Diseases and it's causative agent	Identification of symptoms of Fish Diseases with the help of Exhibition of diseased specimens and photos Case study on Diseases occurrence in ornamental fishes from neighbouring states	Practical Record Report on Case study

	Importance of Quarantine, prophylactic and therapeutic measures in aquarium systems	4.7.3 Understands the Quarantine, prophylactic and therapeutic measures against diseases	Group Discussion on Quarantine, prophylactic and therapeutic measures against diseases	Report on group discussion

Additional information

Herbs like Neem, Garlic, Turmeric etc also can be used instead of antibiotic and chemicals in aquarium fishes as well as culture fishes

Assessment Activities

Fish Diseases-Quarantine, prophylactic and therapeutic measures

Identification of symptoms of Fish Diseases with the help of Exhibition of diseased specimens and photos

Seminar on common Fish Diseases and its causative agents

Group Discussion on Quarantine, prophylactic and therapeutic measures against diseases

Familiarization of prophylactic and therapeutic agents against ornamental fish diseases

List of items in Portfolio

- Practical Record
- Report on Group Discussion
- Report on Case study

Unit.8 Breeding and seed production of Aquarium fishes

Breeding of fishes occurs inside the aquarium or such situation is avoided by keeping such brooders separately. It is the best thing for a fish lover to see a fish breeds and give birth to young ones. Breeding behaviour of fishes differ in all respects. But basic knowledge in fish breeding is necessary for an aquarium hobbyist. Seed production of any fish involves brood stock maintenance, breeding, spawning, and nursery rearing

4.8 Breeding and seed production of Aquarium fishes				
	Brood stock maintenance of aquarium fishes	4.8.1 Develops Skill in maintenance of brood stock of aquarium fishes	PTC / practical's on maintenance of brood stock Familiarization of prophylactic and therapeutic agents against ornamental fish diseases	Practical record Practical record

Breeding and spawning of aquarium fishes	4.8.2 Develops skill in breeding of aquarium fishes	PTC / practical's on breeding of aquarium fishes ICT enabled teaching activity on breeding of selected aquarium fishes	Practical record Report on ICT enabled teaching activity
Nursery rearing of aquarium fishes	4.8.3 Develops skill in Nursery rearing aquarium fishes	PTC / practical's on nursery rearing aquarium fishes	Practical record
Live feed culture for aquarium/ ornamental fish breeding	4.8.4 Develops skill in Live feed culture for aquarium/ ornamental fish breeding	Group discussion on importance of live feed culture in seed production of ornamental fishes PTC / Practical's on live feed culture of infusoria/ artemia/ tubifex/ chironomus larvae/ microworms/ earthworms etc	Report on group discussion Practical Record/ PTC product

Additional information

Sea horses are the wonders of animal kingdom where male take care of their young ones in their brood pouch

Assessment Activities

Breeding and seed production of Aquarium fishes

ICT enabled teaching activity on breeding of selected aquarium fishes

PTC / practical's on maintenance of brood stock

PTC / practical's on breeding of aquarium fishes

PTC / practical's on nursery rearing aquarium fishes

PTC / practical's on live feed culture of infusoria/ artemia/ tubifex/ chironomus larvae/ microworms/ earthworms etc

List of items in Portfolio

Report on Group Discussion

Practical record

PTC product

Report on ICT enabled teaching activity

Unit.9 Marine Aquarium

Marine Aquarium is a highly unstable aquatic environment which attracts more attention than freshwater aquarium. Apart from attractive fishes marine aquarium exhibits beautiful marine invertebrates and marine plants. Maintaining water quality is also tough that it requires more sophisticated equipment's also.

4.9 Marine Aquarium				
	Marine ornamental fishes	4.9.1 Familiarizes marine ornamental fishes	Familiarization of marine ornamental fishes	Practical record

	Marine ornamental plants and other organisms	4.9.2 Familiarizes marine ornamental plants and other organisms	Familiarization of marine ornamental plants and other organisms through multimedia CD exhibition.	Report on multimedia CD exhibition
	Marine aquarium accessories	4.9.3 Familiarizes marine aquarium accessories	Workshop on use and method of operation of marine aquarium accessories.	Report on Workshop
	Water quality management	4.9.4 Develops skill in maintaining marine aquarium	PTC on maintenance of marine aquarium Field visit/OJT in marine aquarium	Report on PTC Report on OJT

Additional information

Oceanariums are massive marine aquariums which houses small and large marine organisms which can be viewed through transparent viewing panels

Assessment Activities

Familiarization of marine ornamental fishes

Familiarization of marine ornamental invertebrates and other marine organisms

PTC on managing Marine aquarium

Workshop on use and method of operation of aquarium accessories.

Field visit/OJT on Marine aquarium

List of items in Portfolio

Practical record

Report on Workshop

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List of Extended Activities in Module IV

Farming of ornamental fishes can be arranged in association with Self Help Groups by students.

Give technical assistance to SHG's by students with the help of Vocational faculty of the school.

The schools having Production Cum Training Centres on Ornamental Fishes can offer short term training programmes on Ornamental fisheries to farmers. By this students will get hands on experience in practical aspects. The interaction of students and teachers with the farmers will help them in knowing the latest scenario in the field.

Selected students with aptitude in the field of Ornamental Fishes shall send to commercial farms as apprenticeship trainee

Exposure in the field of Ornamental Fishes can be achieved by arranging visits to Commercial Exhibitions on the same too. This will also help the students and teachers in updating knowledge in the field. By this students will get hands on experience in latest practices.

ON THE JOB TRAINING PROGRAMME

OJT on the Job Training Programme forms an integral part of the vocational curriculum of VHSE in Kerala. It gives a good platform for students to learn the working condition and work culture. OJT help the learners to identify the skill needs of the industry. It is the place where the students acquire and polish their vocational skill. The students will be able to get familiarized with the administrative background of the institution where they undergo training, which will contribute the managerial skill in feature.

Time : One week after each module

Duration : Two weeks per year

On the job training programme can be conducted in Govt. firms/ Semi Govt. firms / Private firms which includes fish farms, shrimp farms, fish hatchery, shrimp hatchery, feed mills, Aquaculture PCR labs, Ornamental fish farm and ornamental fish hatchery.

Possible list of industrial units under Government and Semi Government sector is given below

- Marine Finfish Hatchery, RGCA Pozhiyoor, Trivandrum
- Shrimp Hatchery ADAK, Odayam, Varkala, Trivandrum
- National Fish Seed Farm, Neyyar Dam, Trivandrum
- Matsyafed Shrimp Hatchery, Thirumullavarm, Kollam

- Govt. Shrimp Hatchery, Neendakara, Kollam
- Govt. Fish Hatchery, Thevally, Kollam
- Govt. Fish Farm, Ayiramthungu, Kollam
- Govt. Fish Farm, Edathuva, Alapuzha
- National Fish Seed Farm, Polachira, Thiruvalla
- Govt. Fish Farm, Pannivelichira, Pattanamthitta
- Govt. Fish Farm, Pallam, Kottayam
- RARS, Kumarakom, Kottayam
- Fisheries Station, PuthuvypeErnakulam
- Ornamental Fish Hub, East Kadungallur (Aluva), Ernakulam
- KVK, CMFRI, Njarakkal, Ernakulam
- Marine Ornamental Fish Hatchery, CMFRI, Ernakulam
- Govt. Fish Farm, Njarakkal, Ernakulam
- Govt. Fish Farm, Malippuram, Ernakulam
- Regional Shrimp Hatchery, Asheekode, Thrissur
- Govt. Fish Farm, Poyya, Thrissur

- Indigenous Fish Hatchery, Peechi, Thrissur
- Matsyafed Shrimp Hatchery, Kaippamangalam, Thrissur
- Matsyafed Shrimp Hatchery, Veliyamkode, Malappuram
- Govt. Fish Farm, Parappanagadi, Malapuram
- National Fish Seed Farm, Malampuzha, Palakkad
- Govt. Fish Farm, Meenkara, Palakkad
- Govt. Fish hatchery, Kallanod, Peruvannamuzhi, Kozhikode
- CMFRI, Marine Finfish Hatchery, Westhill, Kozhikode
- Matsyafed Fish hatchery, Mappila Bay, Kannur
- Private Sector Hatcheries

Standard List of tools and TLM

- Fish specimens
- Plant specimen
- Microscope

- Magnifying glass
- Hypodermal syringe
- Catheter
- Feather
- Tissue homogenizer
- Hand centrifuge
- Model of Artemia tank
- Scoop net
- Jar hatchery
- Electro cautery apparatus
- Submersible Pump
- Aerator
- Plankton Counting cell
- Bio filter system
- Aquarium heater
- Illuminating lamp

- Aquarium tank hood
- Silicone gel
- Silicone gel gun
- Glass cutting device
- Glass tank for breeding
- Strainer
- Feed pelletizer
- Steam vessel

Chemicals / Materials

- Lime
- Common salt
- Formaldehyde
- Malachite green
- Methylene blue
- Potassium permanganate
- BKC

- Oxy tetra cycline
- Cyprofloxacin
- Chloramphenicol
- Furazolidone
- Inducement Hormone/Analogue

Models

- Breeding Happa
- Hatching Happa
- Chinese Hatchery
- Model of Artemia tank
- Jar Hatchery
- Multimedia CD's

List of Reference Books

- Encyclopaedia of Aquaculture - Robert R. Stickney
- Fish and Fisheries of India - V.G. Jhingran

- Artificial reef and sea farming technologies - CMFRI Bulletins
- Culture of Brackish water fin fishes and shell fishes - Susheela Jose
- Aquaculture: Principles and practices -TVR Pillai
- Freshwater Aquaculture – Santhanam & Natarajan
- Water quality in warm water fish ponds - Boyd C.E
- Encyclopaedia of Aquaculture - Robert R.Stickney
- Breeding and seed production of fin fish and shell fish – Dr. P.C. Thomas