

ABOUT THE COURSE

Fisheries provides nutritional security to the nation as well as provide employment to about 14 million people in our country. Kerala is the home of more than 10% of the global fish diversity. More over our state was a forerunner in marine fish production and foreign exchange earnings through fishery exports. This sector offers fish which serves as a cheap source of protein in our state. But now a days 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. 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 production techniques, live and artificial feeding, disease management measures, ornamental fisheries etc. This curriculum offers skill generation for working in aquaculture sector as well as for entrepreneurship

FOR JOB ROLES

Aquaculture course provides immense job opportunities in farming and seed production of fin fish, shell fish and ornamental fish farming. This curriculum will enable the students to undertake different job roles in Government as well as Private sector. The production cum Training Centre (PTC) and On the Job Training (OJT) will provide hands on practical experience to the students; which will enable them to have entrepreneurship in the field of Aquaculture. This curriculum is suitable for career enhancement also through finishing schools in Fisheries sector.

Government / Semi Government

- Technical entry cadres in Fisheries Department
- Lab Technical Asst. in VHSE Department
- Skilled labour in Fisheries Agencies like Matsyafed, ADAK, FIRMA, FFDA, KVK etc.
- Field assistant in fisheries research organizations

Private Sector

- Hatchery Assistant
- Farm Assistant

- Technical assistant in feed mills
- Lab assistant in Aquaculture PCR labs
- Technical assistant in Ornamental fish farm / hatchery

Self Employment

Entrepreneurship in

- Fish / Prawn / Shrimp culture
- Fish / Prawn / Shrimp Hatcheries
- Mussel / oyster farms
- Aqua Shops / Aqua Clinic
- Aquarium setting
- Ornamental fish farm / hatchery

Aims of the course

- Measure and analyse water quality parameters in aquaculture systems
- Assist in site selection and construction of aquaculture farms
- Management of fish and shrimp farm
- Assist in management of feed mills
- Assist in the seed production of commercially important fish species
- Assist in the seed production of shrimps and prawns
- Handle fresh water ornamental fish farms and aquariums
- Acquire expertise in aquarium installations
- Acquire expertise in seed production of ornamental fishes

SUBJECT APPROACH

India is the second largest country in aquaculture production. Fisheries sector in India together with agriculture sector contributes a huge chunk to the total GDP of India. The share of inland fisheries and aquaculture has gone up from 46% in the 1980s to over 85% in recent years in total fish production. Especially fresh water aquaculture showed an overwhelming ten fold growth from 0.36 million tonnes in 1980 to 4.03 million tonnes in 2010. Even though aquaculture in India has evolved as a traditional activity now it has grown considerably and now showing an impressive annual growth rate of 6 to 7 percentage.

Fisheries sector play an important role in the economy of our country. In recent years due to many factors marine capture production is going down alarmingly. The only viable alternative to tackle the diminishing

marine production is to culture aquatic organisms in captive environment. Over the years aquaculture has not only led to substantial socio economic benefits such as providing cheap source of protein, generating income, employment and foreign exchange, but also brought vast unutilized and underutilized water resources under culture. But the limiting factor is the skilled man power which can be solved by vocational education.

Vocational education, a dream of Mahatma Gandhi, addresses the problem of massive unemployment among the youth in our country. Among the vocational courses, fisheries courses have great relevance. Being a country with a vast coastline of about 8000 Km, fishing and allied industries play an important role, in providing employment to a vast majority of the population as well as sustaining the economy with the foreign exchange earned from the export of various fisheries products.

Every function in the child's cultural development appears twice: first, on the social level and, later on, on the individual level; first, between people (interpsychological) and then inside the child (intrapychological). The studies conducted by UNESCO and SCERT on the various defects of teacher centered interaction revealed that the knowledge construction within the student will sustain only through interpsychological and intra psychological processes. Thus the learning activities in education process have conceived the new idea of student centered, skill centered and activity oriented educational approach. According to this approach the learning activities should pave way for the construction of knowledge.

Selecting the learning activities one should take into account the nature, mental ability and skills of students. This approach gives emphasis in activities involving problem solving, skill developing and self-studying. It is important that the new educational approach should create opportunities for Individual learning, co-learning and group learning. The issues faced by the aquaculture sector are made known to the learners prior to the learning process. The class room activities are planned for each module in such a way that it suits well for the learning outcome.

Discovery learning

Here the learning takes place in problem solving situations where the learner relies on his own experience and prior knowledge. It is a method of instruction through which students interact with their environment by exploring and manipulating objects, wrestling with questions and controversies, or performing experiments.

Co-operative learning

Cooperative learning is an educational approach which aims to organize classroom activities into academic and social learning experiences. In this method the learners learn by helping each other. The negotiations among peers take place here. For example, if we want to create an awareness among the students about different starting methods, the students can be divided into different groups and a group discussion on the topic can be conducted. The ideas evolved from the discussion can be consolidated and presented in the class by one person from each group.

Collaborative learning

Collaborative learning is a situation in which two or more people learn or attempt to learn something together. Unlike individual learning, people engaged in collaborative learning capitalize on one another's resources and skills (asking one another for information, evaluating one another's ideas, monitoring one another's work, etc.). More specifically, collaborative learning is based on the model that knowledge can be created within a population where members actively interact by sharing experiences.

Interaction with society

Learner is an integral part of the society. The education aims at uplifting the social commitment of the learner. Good interaction of learner with the society during learning process will ensure this aim. In this course OJT, PTC and field visits ensure the social interaction of the learner.

Teaching learning materials

The selection of teaching learning materials for the class room transaction should be based on suitability to the topic, participation of the learner, effectiveness in transaction, cost factor etc. For the course aquaculture use of working models, photo images, multi media CDs internet etc can be used.

Role of learner

The needs of the learner should be reflected in the learning process. Active participation, making use of resources, applying thoughts, making interpretations, drawing inferences, dedication for acquiring expertise or skill are expected from a learner. A congenial atmosphere inside and outside the class room should be ensured by the learner as well as the teacher.

Role of teacher

The teacher's role is redefined nowadays from an actual teacher to one who learns the learners, knows his strength and weakness, arrange the

resources, needs as and when required, create learning situations, learn with the learner, assist or scaffold the learner throughout the learning process, evaluate the learner and equip him further to live in the society.

Role of supporting system

The School Resource Group, Parent Teacher Association, Government and Non-Governmental Organisations are the main supporting systems. A live institution-industrial linkage is also essential in imparting vocational education.

Evaluation

In educational process the evaluation should be systematic, continuous and comprehensive. A good scheme of evaluation can be drawn in such a way that it can measure the skill or expertise acquired by the learner. The aptitude, attitude and approach of the learner should also be assessed for better evaluation.

ICT possibilities

Vocational education is practical oriented, even though time will be a limiting factor for learning processes. Hence the curricular objectives can be achieved by making use of new technologies like ICT enabled education. Making use of multimedia, CDs are helpful in transaction processes inside the classroom which are available through various departments like fisheries department, NGOs etc.

Learning Situations

Aqua-farms and hatcheries are the most suitable areas for skill acquirement. Students can make use of the hands on experience and knowledge of the hatchery technicians and farmers, which are more effective than the classroom situation for the learning process.

Resources

The state of Kerala is endowed with 44 rivers and a long coastline of 590 km providing ample scope for the development of aquaculture. Vocational education requires more practical experience for the students. Other than the school level infrastructure and human resources, the smooth conduct of the course require industrial linkage.

OJT / field visit

More than the class room activities, OJT/Field visits provide the needed practical exposure for the students in an applied field like aquaculture. In Kerala all the V.H.S.E schools which offer aquaculture courses have industrial linkages and they are situated near the coastal areas. The students can utilize the facilities of institutions like CMFRI, CIFT, FIRMA, ADAK, KAVIL, hatcheries and farms of fisheries department.

Inclusiveness

Vocational education is a group activity, where the learners are a heterogeneous mixture of gifted learners, average learners, slow learners and differently abled learners. Our class rooms should ensure the participation of these groups and reap benefit.

SYLLABUS**Module I: AQUACULTURE FARM MANAGEMENT**

1.1 Morphology of Teleost fish.

- Observation and identification
- Biology of Teleost Fish

1.2 Morphology of Penaeid shrimp.

- Observation and identification
- Biology of Shrimp

1.3 Physico-chemical & Biological Parameters of Water

- Physical parameters of water
- Chemical parameters of water
- Biological parameters of water and familiarization of aquatic organisms

1.4 Aquatic Food Web

- Aquatic food webs and pond ecology

1.5 Site selection, design & construction of fish farms

- Criteria for Site Selection
- Aqua farms design
- Legislation

1.6 Components and Accessories of an Aquafarm

- Farm Components
- Farm Accessories

1.7 Management of aqua farms

- Pre stocking management
- Process of stocking
- Post stocking management
- Harvesting of fish

1.8 Familiarization of different aquaculture systems

- Pond culture

- Pen culture
- Cage culture
- Traditional farming systems
- Recirculatory aquaculture systems
- 2.1 Culture of Carps
- 2.2 Culture of Shrimps
- 2.3 Culture of Fresh Water Prawn
- 2.4 Culture of Genetically Improved Farmed Tilapia (GIFT)
- 2.5 Culture of Pearl Spot
- 2.6 Culture of Sea Bass
- 2.7 Culture of Mullet and Milk Fish
- 2.8 Culture of Air breathing fishes
- 2.9 Culture of Mud Crab
- 2.10 Culture of Mussels
- 2.11 New candidate species in aquaculture
- 2.12 Integrated Multitrophic aquaculture (IMTA)

LEARNING OUTCOMES

After the completion of the first 2 modules the learner :

Module : I Aquaculture Farm Management

- 1.1.1 Identifies the morphological characters of teleost fishes
- 1.1.2 Recognises the basics of respiration and reproduction in fishes
- 1.1.3 Identifies different feeding habits of fishes
- 1.2.1 Identifies the morphological characters of Penaeid shrimps
- 1.2.2 Recognises the basics of respiration, reproduction and sexual dimorphism in shrimps.
- 1.2.3 Differentiates between Prawn and Shrimp
- 1.3.1 Measures Physical Parameter and its suitability for aquaculture
- 1.3.2 Measures Chemical Parameter and analyzes its suitability for aquaculture
- 1.3.3 Identifies important planktonic and benthic organisms
- 1.3.4 Examines primary productivity of water body
- 1.4.1 Recognises the importance of food web
- 1.5.1 Identifies the site selection criteria for aquaculture farm

- 1.5.2. Examines the suitability of a site for aquaculture.
- 1.5.3 Identifies the concepts of aqua farm design
- 1.5.4 Identifies the rules and regulations involved in the construction of aquafarms
- 1.6.1 Recognises different components of a fish farm
- 1.6.2 Identifies different farm accessories
- 1.7.1 Identifies common predatory and weed fishes
- 1.7.2 Identifies aquatic weeds and its control
- 1.7.3 Supports pre-stocking management of a farm
- 1.7.4 Develops skill in stocking of seeds
- 1.7.5 Develops skill in feeding
- 1.7.6 Develops skill in sampling and growth assessment
- 1.7.7 Develops skill in prophylactic measures against disease
- 1.7.8 Develops skill in harvesting process
- 1.8.1 Develops expertise in pond based culture
- 1.8.2 Differentiates culture methods in pond
- 1.8.3 Defines the concept of integration of farming system and its advantages
- 1.8.4 Recognises the concept of pen culture
- 1.8.5 Recognises the concept of cage culture
- 1.8.6 Compares and contrasts different traditional farming systems
- 1.8.7 Recognises re-circulatory aquaculture system

Module 2: Culture of Commercial fin fishes and shell fishes

- 2.1.1 Develops expertise in carp culture
- 2.1.2 Differentiates Indian major carps, Chinese carps and common carps
- 2.1.3 Analyses optimum water quality parameters
- 2.2.1 Differentiates different shrimp species
- 2.2.2 Analyses optimum water quality parameters
- 2.2.3 Supports shrimp farm management
- 2.3.1 Identifies the species - *Macrobrachium rosenbergii*
- 2.3.2 Analyses optimum water quality parameters
- 2.3.3 Develops expertise in prawn farm management
- 2.4.1 Identifies the species - GIFT

- 2.4.2 Recognises concept of GIFT
- 2.4.3 Analyses optimum water quality parameters
- 2.4.4 Develops expertise in farming of GIFT
- 2.5.1 Identifies the species - *Etroplus suratensis*
- 2.5.2 Distinguishes the characters of the species and its culture
- 2.5.3 Analyses optimum water quality parameters
- 2.5.4 Develops expertise in doing Pearl Spot Culture
- 2.6.1 Identifies the species - *Lates calcarifer*
- 2.6.2 Distinguishes the characters of the species and its culture
- 2.6.3 Analyses optimum water quality parameters
- 2.6.4 Develops expertise in farming of Sea Bass
- 2.7.1 Identifies the species - *Chanos chanos*, *Mugil cephalus*, *Liza macrolepis*
- 2.7.2 Distinguishes the characters of the species and its culture
- 2.7.3 Analyses optimum water quality parameters
- 2.7.4 Develops expertise in farming of Mullet and Milk fish
- 2.8.1 Identifies the species - *Heteropneustes fossilis*, *Clarias dussumieri*, *Channa sp*
- 2.8.2 Analyses optimum water quality parameters
- 2.8.3 Develops expertise in farming of Air Breathing Fishes
- 2.9.1 Distinguishes the characters of the species (Mud Crab) and its culture
- 2.9.2 Analyses optimum water quality parameters
- 2.9.3 Develops expertise in farming of Mud Crab
- 2.10.1 Identifies the species - *Perna viridis*, *Perna indica*
- 2.10.2 Distinguishes the characters of the species
- 2.10.3 Differentiates on bottom and off bottom culture methods
- 2.10.4 Develops expertise in farming of Mussels
- 2.11.1 Identifies the new candidate species namely *Cobia*, *Pompano* and *Pangassius*
- 2.12.1 Defines the scope & potential of IMTA with Azolla, vegetables, duck, chicken, cattle etc.

SCHEME OF WORK

Module I : Aquaculture Farm Management

Month	Name of Units	Periods
June	Morphology and biology of Teleost fish	10
June	Morphology and biology of Penaeid shrimp	10
June/July	Physico-chemical and biological parameters of water	45
July	Aquatic food web and ecosystem	20
July	Site selection and construction of fish farms	40
August	Components of a fish farm	15
August/ September	Management of fish farm	110
a)	Pre Stocking management	
b)	Stocking	
c)	Post stocking management	
d)	Disease management and prophylactic measures	
e)	Harvest	
October	Aquaculture systems	90
a)	Pond culture	
b)	Cage	
c)	Pen	
d)	Traditional farming systems	
e)	Re-circulatory aquaculture systems	
	TOTAL	340

Module II : Culture of Commercial Fin Fishes and Shell Fishes

Month	Name of Units	Periods
November	Culture of Carps	40
November	Culture of Marine Shrimps	60
a)	Tiger Shrimp	
b)	Vannamei Shrimp	
November	Culture of Fresh Water Prawn	20
December	Culture of GIFT	25

December	Culture of Pearl Sport	20
December	Culture of Sea Bass	20
January	Culture of Milk fish & Mulletts	25
January	Culture of Air breathing fishes	30
January	Culture of Mud Crab	30
February	Culture of Mussels and oysters	30
February	New candidate species in aquaculture	20
February	Integrated multitrophic aquaculture	20
	TOTAL	340

COURSE STRUCTURE

This course consist of four modules

Sl .No	Name of Module	Total periods
I	Aquaculture Farm management	340
II	Culture of commercial fin fishes and shell fishes	340
III	Seed production and Hatchery management of fin fishes and shell fishes	340
IV	Ornamental Fisheries and Aquarium Management	340

CLASS ROOM ACTIVITIES

The following class room activities may be practised

- 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

The following class room activities may be practised

- 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

ON THE JOB TRAINING

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 helps 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 future.

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 include 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, Puthuvype, Ernakulam
- Ornamental Fish Hub, E. 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
- Hatcheries Under Private Sector

Certification of skills in each module

Certification will be based on the following:

- Module 1 : Certificate in Aquaculture Farm management
- Module 2 : Certificate in Culture of commercial fin fishes and shell fishes
- Module 3 : Certificate in Seed production and Hatchery management of fin fishes and shell fishes
- Module 4 : Certificate in Ornamental Fisheries and Aquarium Management

Module I. Aquaculture farm management

The first module aims to introduce the course in general to the students. This module includes objectives like understanding basic principles of aquaculture, familiarization of aqua farm and farm components, familiarization of different culture systems and giving expertise in assisting management of aqua farm.

List of Expected Skills

- Skill in measuring and analyzing physico-chemical parameters of water
- Expertise in assisting site selection and construction of aqua farms
- Expertise in managing aqua farms
- Expertise in harvesting procedure of aqua farm
- Understanding the concepts of pond culture, pen culture, cage culture and other advanced culture systems like RAS

OVERVIEW OF MODULE - 1

Units under module I are given below

Unit No.	Name of Units	Periods
1	Morphology and biology of Teleost fish	10
2	Morphology and biology of Penaeid shrimp	10
3	Physico-chemical and biological parameters of water	45
4	Aquatic food web and ecosystem	20
5	Site selection and construction of fish farms	40
6	Components of a fish farm	15
7	Management of fish farm	110
a)	Pre Stocking management	
b)	Stocking	
c)	Post stocking management	
d)	Disease management and prophylactic measures	
e)	Harvest	

8	Aquaculture systems	90
a)	Pond culture	
b)	Cage	
c)	Pen	
d)	Traditional farming systems	
e)	Re-circulatory aquaculture systems	
	TOTAL	340

Module II. Culture of commercial fin fishes and shell fishes

The second module gives emphasis on culture aspects of commercially important species. It includes culture of fin fishes, shell fishes and other integrated farming systems. This module covers the identification, biology, culture environment, culture method and water quality management for the culture of each species in detail. Through this module the learner will be able to identify the species and get expertise in farming practice.

List of Expected Skills

- Identification of cultivable species
- Optimizing water quality parameter with respect to species
- Familiarization with advanced culture system
- Expertise in farming of Carps, Pearl spot and Penaeid Shrimps
- Expertise in assisting the farming activity of Cobia, Pompano, Seabass, Milkfish, Mulletts, Pangassius, Air breathing fishes and GIFT
- Familiarization with the concept of integrated multitrophic aquaculture

Units under module II are given below

Unit No.	Name of Units	Periods
1	Culture of Carps	40
2	Culture of Marine Shrimps	60
a)	Tiger Shrimp	
b)	Vannamei Shrimp	
3	Culture of Fresh Water Prawn	20
4	Culture of GIFT	25
5	Culture of Pearl Sport	20

6	Culture of Sea Bass	20
7	Culture of Milk fish & Mulletts	25
8	Culture of Air breathing fishes	30
9	Culture of Mud Crab	30
10	Culture of Mussels and oysters	30
11	New candidate species in aquaculture	20
12	Integrated multitrophic aquaculture	20
	TOTAL	340

Module 1 : Aquaculture farm management		Unit : Morphology and biology of Teleost fish (Mullet)	
Ideas/Concepts/Skill	Learning Outcomes	Suggested Activities	Assessment
Morphology of Teleost fish. Observation and identification	<p><i>The learner</i></p> <ul style="list-style-type: none"> 1.1.1 Identifies the morphological characters of teleost fishes 	<ul style="list-style-type: none"> Group discussion on identification of morphological characters viz. body shape, fins, lateral lines, scales etc. Identification of morphological characters with specimen and drawing 	<ul style="list-style-type: none"> Report on Group Discussion Observations in Practical record
Biology of Teleost Fish	<ul style="list-style-type: none"> 1.1.2 Recognises the basics of respiration and reproduction in fishes 1.1.3 Identifies different feeding habits of fishes 	<ul style="list-style-type: none"> Group discussion on respiration, Reproduction (fecundity, Oviparity, Viviparity, Ovo-viviparity) Group discussion on feeding habits (herbivore, Omnivore, Carnivore), Natural food items 	<ul style="list-style-type: none"> Assessment of Previous knowledge by Quiz Class test

Module 1 : Aquaculture farm management		Unit : Morphology and biology of Penaeid Shrimp	
Ideas/Concepts/Skill	Learning Outcomes	Suggested Activities	Assessment
Morphology of Penaeid shrimp. Observation and identification	<p><i>The learner</i></p> <ul style="list-style-type: none"> 1.2.1 Identifies the morphological characters of Penaeid shrimps 	<ul style="list-style-type: none"> Group discussion on identification of morphological characters Identification of morphological characters with specimen and drawings 	<ul style="list-style-type: none"> Report on Group Discussion Observations in Practical record
Biology of Shrimp	<ul style="list-style-type: none"> 1.2.2 Recognises the basics of respiration, reproduction and sexual dimorphism in shrimps. 1.2.3 Differentiates between Prawn and Shrimp 	<ul style="list-style-type: none"> Group discussion on respiration, reproduction - Sexual dimorphism Compare and distinguish sexual dimorphism in Prawn and Shrimp 	<ul style="list-style-type: none"> Report on Group Discussion Drawings of Shrimps and Prawns in Practical record

Module 1 : Aquaculture farm management		Unit : Physico-chemical& Biological Parameters of Water	
Ideas/Concepts/Skill	Learning Outcomes	Suggested Activities	Assessment
Physical parameters of water	<p><i>The learner:</i></p> <ul style="list-style-type: none"> 1.3.1 Measures Physical Parameter and its suitability for aquaculture 	<ul style="list-style-type: none"> Group discussion on Ideal range of physical parameters viz. depth, temperature, transparency, turbidity, colour. Measure and analyze physical parameters by field visit/ practical/ demonstration 	<ul style="list-style-type: none"> Report on Group Discussion Observations in Practical record / Vocational diary
Chemical parameters of water	<ul style="list-style-type: none"> 1.3.2 Measures Chemical Parameter and analyze its suitability for aquaculture 	<ul style="list-style-type: none"> Group discussion on Ideal pH, Salinity Dissolved Oxygen, NH₃, H₂S, Alkalinity, Acidity, Hardness Measure and analyze chemical parameters by field visit/ practical/ demonstration 	<ul style="list-style-type: none"> Report on Group Discussion Observations in Practical record / Vocational diary
Biological parameters of water and familiarization of aquatic organisms	<ul style="list-style-type: none"> 1.3.3 Identifies important planktonic and benthic organisms 1.3.4 Examines primary productivity of water body 	<ul style="list-style-type: none"> Group discussion on Plankton and Benthic organisms of a water body (worms, annelids, mollusc) Collection, quantification and identification of plankton and benthic organisms by field level assessment sample collection and microscopic observation 	<ul style="list-style-type: none"> Report on Group Discussion Observations in Practical record / Vocational diary

Module 1 : Aquaculture farm management		Unit : Aquatic Food Web and Ecosystem	
Ideas/Concepts/Skill	Learning Outcomes	Suggested Activities	Assessment
Aquatic food webs and pond ecology	<p><i>The learner :</i></p> <ul style="list-style-type: none"> 1.4.1 Recognises importance of food web 	<ul style="list-style-type: none"> Seminar on food chains in different water bodies and interaction between them Chart preparation on aquatic food web 	<ul style="list-style-type: none"> Seminar report Charts showing Food web
Criteria for Site Selection	<ul style="list-style-type: none"> 1.5.1 Identifies the site selection criteria for aquaculture farm 1.5.2 Examines the suitability of a site for aquaculture. 	<ul style="list-style-type: none"> Discussion with the help of multimedia about Topography, tidal amplitude, soil quality, water quality, pollution, accessibility, marketability, electricity, legal and socio-economic factors, skilled labour. Field survey of a site for farm construction Measure and analyse soil and water quality parameters Group discussion on wind direction, size and shape of pond, positioning of farm components Visit to aqua farm Layout preparation of Aqua farm 	<ul style="list-style-type: none"> Report on Group Discussion Observations in Vocational diary / Practical record
Aqua farms design	<ul style="list-style-type: none"> 1.5.3 Identifies the concepts of aqua farm design 	<ul style="list-style-type: none"> Group discussion on rules and regulations in obtaining license from authorities for a farm 	<ul style="list-style-type: none"> Report on Group Discussion Lay out preparation in Chart
Legislation	<ul style="list-style-type: none"> 1.5.4 Identifies rules and regulations to be followed in the construction of aquafarms 		<ul style="list-style-type: none"> Report

Module 1 : Aquaculture farm management		Unit : Components and Accessories of an Aquafarm	
Ideas/Concepts/Skill	Learning Outcomes	Suggested Activities	Assessment
Farm Components	<p><i>The learner :</i></p> <ul style="list-style-type: none"> 1.6.1 Recognises different components of a fish farm 	<ul style="list-style-type: none"> Workshop on various types of ponds <ul style="list-style-type: none"> Reservoir, nursery, rearing, production, brood stock maintenance etc. Workshop on cross-section of a bund - wet slope, dry slope, free board, crown, berm, core trench, peripheral bund and partition bund Workshop on feeder canals and drainage canals, effluent treatment systems, bioponds Layout preparation of aqua farm showing Farm components Cross-section of a bund - drawing Calculation of area of ponds 	<ul style="list-style-type: none"> Report on Workshop Observations in Practical record Layout preparation in Chart
Farm Accessories	<ul style="list-style-type: none"> 1.6.2 Identifies different farm accessories 	<ul style="list-style-type: none"> Classroom interaction of students with farmers for familiarization with different farm accessories viz. Sluice Gate, Petty & Para Pumps, Aerators, Check Trays, Cast Net, Harvest Net etc. Field visit to different farm accessories Drawings / Demonstration/ Multimedia/Exhibition on different farm accessories 	<ul style="list-style-type: none"> Observations / Drawings in Practical record Report on Field Visit

Module 1 : Aquaculture farm management			
Unit : Management of aqua farms			
Ideas/Concepts/Skill	Learning Outcomes	Suggested Activities	Assessment
	<p><i>The learner :</i></p> <ul style="list-style-type: none"> 1.7.1 Identifies common predatory and weed fishes 1.7.2 Identifies aquatic weeds and its control 1.7.3 Supports in pre-stocking management of a farm 	<ul style="list-style-type: none"> Group discussion on common fish toxicants and method of eradication Group discussion on common predatory and weed fishes, their effect on aqua culture ponds Group discussion on aquatic weeds and method of eradication Group discussion on liming and ploughing and fertilizer application Group discussion on eradication of aquatic insects (nursery pond) Identification of predatory and weed fishes with specimens Application of fish toxicants and dosage Dosage calculations on liming Preparation of soap oil emulsion by practical experience Using multimedia conduct discussion on process of acclimatization Demonstration of mock stocking 	<ul style="list-style-type: none"> Report on Group Discussion OJT report /field visit report/ Practical record
Pre stocking management			
Process of stocking	<ul style="list-style-type: none"> 1.7.4 Develops skill in stocking of seeds 	<ul style="list-style-type: none"> Group discussion on feeding of fishes / shrimp Group discussion on FCR, Biomass and Carrying capacity 	<ul style="list-style-type: none"> Report on Show Practical record / vocational diary
Post stocking management	<ul style="list-style-type: none"> 1.7.5 Develops skill in feeding 		<ul style="list-style-type: none"> Report on Group Discussion

Module 1 : Aquaculture farm management		Unit : Management of aqua farms	
Ideas/Concepts/Skill	Learning Outcomes	Suggested Activities	Assessment
	<p><i>The learner :</i></p> <ul style="list-style-type: none"> 1.7.6 Develops skill in sampling and growth assessment 1.7.7 Develops skill in prophylactic measures against disease 	<ul style="list-style-type: none"> Group discussion on formulation and preparation of artificial feed Group discussion on maintenance of water quality of pond Group discussion on prophylactic measures and therapeutic measures against disease in general Group discussion on sampling procedure PTC on formulation and preparation of fish feed Practical experience on sampling of fishes during OJT / field visit 	<ul style="list-style-type: none"> Report on Group Discussion Formulated Feed Report on field visit / OJT report
Harvesting of fish	<ul style="list-style-type: none"> 1.7.8 Develops skill in harvesting process 	<ul style="list-style-type: none"> Group discussion on time and schedule of harvest based on demand Group discussion on pre-requisites for harvest (ice, boxes, nets, labour etc.) Practical experience in harvesting by OJT / field visit 	<ul style="list-style-type: none"> Report on Group Discussion OJT Report / practical record

Module 1 : Aquaculture farm management		Unit : Familiarization of different aquaculture systems	
Ideas/Concepts/Skill	Learning Outcomes	Suggested Activities	Assessment
Pond culture	<p><i>The learner :</i></p> <ul style="list-style-type: none"> 1.8.1 Develops expertise in pond based culture 1.8.2 Differentiate culture methods in pond 1.8.3 Defines the concept of integration of farming system and its advantages 	<ul style="list-style-type: none"> Discussion on species combination, stocking density, culture duration, feed production etc. Discussion on monoculture, polyculture, composite fish culture and integrated farming PTC Field visit to a fish pond Chart / model preparation of Integrated farming system 	<ul style="list-style-type: none"> Report on Group Discussion Report on Field visit Chart/ Model
Pen culture	<ul style="list-style-type: none"> 1.8.4 Recognises the concept of pen culture 	<ul style="list-style-type: none"> Discussion on suitable area for pen culture, installation of pen, species cultured, stocking density, feed and production using multimedia Model preparation on Pen 	<ul style="list-style-type: none"> Report on Group Discussion Model
Cage culture	<ul style="list-style-type: none"> 1.8.5 Recognises the concept of cage culture 	<ul style="list-style-type: none"> Discussion on maximum utilization of available area for cage culture, installation of cage, species cultured, stocking density, feed and production using multimedia Model preparation on Cage 	<ul style="list-style-type: none"> Report on Group Discussion Model

Module 1 : Aquaculture farm management		Unit : Familiarization of different aquaculture systems	
Ideas/Concepts/Skill	Learning Outcomes	Suggested Activities	Assessment
Traditional farming systems	<p><i>The learner :</i></p> <ul style="list-style-type: none"> 1.8.6 Compares and contrasts different traditional farming systems 	<ul style="list-style-type: none"> Discussion on comparison between traditional, extensive and scientific farming system Discussion on traditional aquaculture systems in Pokkali, Kari, Kolelands and Kaipad Field visit to a traditional farm 	<ul style="list-style-type: none"> Report on Group Discussion Report on Field visit
Re-circulatory aquaculture systems	<ul style="list-style-type: none"> 1.8.7 Recognizes of re-circulatory aquaculture systems 	<ul style="list-style-type: none"> Discussion on concept of re-circulatory systems PTC on Aquaponics Multimedia show on re-circulatory systems 	<ul style="list-style-type: none"> Report on Group Discussion Participation in group work (PTC)/ Report of the show

List of Practical Activities

- Identification of morphological characters of a typical teleost fish with specimen and drawing.
- Identification of morphological characters of a typical Penaeid shrimp with specimen and drawings
- Compare and distinguish sexual dimorphism in Prawn and Shrimp
- Measure and analyse physical parameters of a pond by field visit/ practical/ demonstration
- Measure and analyse chemical parameters of pond water by field visit/ practical/ demonstration
- Collection, quantification and identification of plankton and benthic organisms by field level assessment , sample collection and microscopic observation
- Chart preparation on aquatic food web
- Field survey of a site for farm construction
- Measure and analyse soil and water quality parameters
- Layout preparation of a fish farm.
- Cross-section of a bund - drawing
- Calculation of area of ponds
- Field visit to any farm for familiarization of farm accessories
- Identification of predatory and weed fishes with specimens
- Application of fish toxicants and dosage
- Dosage calculations on liming
- Preparation of soap oil emulsion by practical experience
- Demonstration of mock stocking of fish seed
- PTC on formulation and preparation of feed
- Practical experience on sampling of fishes during OJT / Field visit
- Practical experience in harvesting by OJT / Field visit
- Field visit to traditional farming systems
- Model preparation of aquaponics

List of Reference Books

- (i) Freshwater Aquaculture - Santhanam & Natarajan
- (ii) Principles of Aquaculture - TVR Pillai
- (iii) Water quality in warm water fish ponds - Boyd C.E
- (iv) Encyclopedia of Aquaculture - Robert R.Stickney

List of tools and TLM

Tools / Instruments

- Thermometer
- PH solution
- Secchi disc
- Salino meter
- Testing kits
- Scale
- Burette and pipette
- Dissolved oxygen bottle
- Conical flask
- Measuring cylinder
- Petri dish
- Feed pelletizer
- Feed emulsifier
- Weighing balance

Chemicals / Materials

- Lime
- Mahua oil cake
- Tea seed cake
- Formaldehyde
- Soap
- Oil
- Feed ingredients

Models

- Sluice Gate
- Cast Net
- Seine Net
- Gill Net
- Bag Net

Module 2: Culture of commercial fin fishes and shell fishes

Ideas/Concepts/Skill	Learning Outcomes	Suggested Activities	Assessment
<p>Culture of Carps</p>	<p><i>The learner :</i></p> <ul style="list-style-type: none"> • 2.1.1 Develops expertise in carp culture • 2.1.2 Differentiates Indian major carps, Chinese carps and common carps • 2.1.3 Analyses optimum water quality parameters 	<ul style="list-style-type: none"> • Interactive discussion on Scientific name of carps varieties, Unique distinguishing characters of Carps and Biology - (Feeding habit, Reproduction, Growth) • Discussion on Water quality requirements (Eg: pH, DO, depth), Composite fish culture in ponds and paddy fields with stocking density, Supplementary feeding, Estimated production with survival rate and Common diseases and prophylactic measures for Carps • Identification of specimens and drawing • Field visit to Farm / OJT / PTC on Artificial feed preparation 	<ul style="list-style-type: none"> • Participation in group discussion • Observations in Practical record • Participation in PTC • Report on field visit / OJT
<p>Culture of Shrimps</p>	<ul style="list-style-type: none"> • 2.2.1 Differentiates different shrimp species • 2.2.2 Analyses optimum water quality parameters • 2.2.3 Supports in shrimp farm management 	<ul style="list-style-type: none"> • Identification of Species - Scientific name- Penaeus monodon, Litopenaeus vannamei, Fenneropenaeus indicus with Unique distinguishing characters & drawings made in record • Discussion on Biology - Feeding habit, Reproduction, Growth (moulting) • Water quality requirements (optimum pH, salinity, DO, depth, transparency, NH₃, H₂S) • Monoculture in farms, re-circulatory aquaculture system (RAS) with stocking density, Supplementary feeding, water exchange and aerators • Estimated production with survival rate, Common diseases and prophylactic measures, • Biosecurity measures and details of Coastal aquaculture authority • Field visit to Farm / OJT 	<ul style="list-style-type: none"> • Observations in Practical record • Report on Group Discussion • Report on field visit / OJT

: Module 2: Culture of commercial fin fishes and shell fishes			
Ideas/Concepts/Skill	Learning Outcomes	Suggested Activities	Assessment
Culture of Fresh Water Prawn	<p><i>The learner :</i></p> <ul style="list-style-type: none"> 2.3.1 Identifies the species 2.3.2 Analyses optimum water quality parameters 2.3.3 Develops expertise in prawn farm management 	<ul style="list-style-type: none"> Identification of specimens (Scientific name - <i>Macrobrachium rosenbergii</i>) and drawing made in record with the help of Unique distinguishing characters Discussion on Biology - Feeding habit, Reproduction, Growth (moulting), differential growth, social hierarchy, territorial nature, cannibalism, Water quality requirements (optimum pH, salinity, DO, depth, transparency, NH₃, hardness), Monoculture, Poly culture with carps, Culture in farms, paddy fields - significance of shelter, stocking density, Feeding, Estimated production with survival rate, Common diseases and prophylactic measures. Field visit to Farm 	<ul style="list-style-type: none"> Observations in Practical record Report on Discussion Report on Field visit
Culture of Genetically Improved Farmed Tilapia (GIFT)	<ul style="list-style-type: none"> 2.4.1 Identifies the species 2.4.2 Recognises concept of GIFT 2.4.3 Analyses optimum water quality parameters 2.4.4 Develops expertise in farming of GIFT 	<ul style="list-style-type: none"> Identification of specimens and drawing made in record with the help of unique distinguishing characters Discussion on Biology (Feeding habit, Reproduction, Growth), Water quality requirements (optimum pH, salinity, DO, depth, NH₃), Monoculture in ponds (>50 cents), Polythene lined ponds, Cage culture, Re-circulatory aquaculture system with stocking density, Feeding, Estimated production with survival rate, Common diseases and prophylactic measures, Biosecurity measures and licensing. R&D-Activities done by RGCA Interactive discussion with experts/farmers inside the class/ at farm site Field visit to Farm 	<ul style="list-style-type: none"> Observations in Practical record Report on Discussion Report on Interactive discussion Report on Field visit

Module 2: Culture of commercial fin fishes and shell fishes

Ideas/Concepts/Skill	Learning Outcomes	Suggested Activities	Assessment
<p>Culture of Pearl Spot</p>	<p><i>The learner :</i></p> <ul style="list-style-type: none"> • 2.5.1 Identifies the species • 2.5.2 Distinguish the characters of the species and its culture • 2.5.3 Analyses optimum water quality parameters • 2.5.4 Develops expertise in doing Pearl Spot Culture 	<ul style="list-style-type: none"> • Identification of specimens (Scientific name - <i>Etropus suratensis</i>) with the help of unique distinguishing characters and drawings made. • Discussion on Biology - Feeding habit, Reproduction, Growth (slow growth rate), Water quality requirements (optimum pH, salinity, DO, depth), Monoculture in ponds, tanks, polythene lined ponds, homestead ponds, pen, cage, Stocking Density, Feeding, Natural Seed Collection, Estimated production with survival rate, Water quality measurement and analysis • Field visit to Farm 	<ul style="list-style-type: none"> • Observations in Practical record • Report on Discussion • Report on Field visit
<p>Culture of Sea Bass</p>	<ul style="list-style-type: none"> • 2.6.1 Identifies the species • 2.6.2 Distinguishes the characters of the species and its culture • 2.6.3 Analyses optimum water quality parameters • 2.6.4 Develops expertise in farming of Sea Bass 	<ul style="list-style-type: none"> • Identification of specimens (Scientific name- <i>Lates calcarifer</i>) with unique distinguishing characters and drawings made in record. • Discussion on Biology - Feeding habit, Reproduction (protandrous hermaphrodite), Growth, Water quality requirements (optimum pH, salinity, DO, NH3), Monoculture in pond, cage, pen - stocking density, Cannibalism and size grading, Feeding- protein requirement, Estimated production with survival rate, Partial and cull harvesting, Common diseases and prophylactic measures, and R & D - Activities done by CIBA • Field visit to Farm 	<ul style="list-style-type: none"> • Observations in Practical record • Report on Discussion • Report on Field visit

Module 2: Culture of commercial fin fishes and shell fishes			
Ideas/Concepts/Skill	Learning Outcomes	Suggested Activities	Assessment
Culture of Mullet and Milk Fish	<p><i>The learner :</i></p> <ul style="list-style-type: none"> 2.7.1 Identifies the species 2.7.2 Distinguishes the characters of the species and its culture 2.7.3 Analyses optimum water quality parameters 2.7.4 Develops expertise in farming of Mullet and Milk fish 	<ul style="list-style-type: none"> Identification of specimens (Scientific name-Chanos chanos, Mugil cephalus, Liza macrolepis) with the unique distinguishing characters and drawings made in records. Discussion on Biology - Feeding habit, Reproduction, Growth, Water quality requirements (optimum pH, salinity, DO, depth), Natural seed collection and nursery rearing, Polyculture and monoculture in ponds -stocking density, Lab-lab, supplementary feeding, Estimated production with survival rate Field visit to Farm /OJT 	<ul style="list-style-type: none"> Observations in Practical record Report on Discussion Report on Field visit/ OJT
Culture of Air breathing fishes	<ul style="list-style-type: none"> 2.8.1 Identifies the species 2.8.2 Analyses optimum water quality parameters 2.8.3 Develops expertise in farming of Air Breathing Fishes 	<ul style="list-style-type: none"> Identification of specimens with distinguishing characters (Scientific name -Heteropneustes fossilis, Clarias dussumieri, Channa sp.) and drawings made in record Discussion on Biology - Feeding habit, Reproduction, Growth, Water quality requirements (optimum pH, salinity, DO, depth, NH3, H2S), Monoculture in tanks, ponds, polythene lined ponds , paddy fields, derelict and sewage waters, homestead ponds - stocking density, Concept of Prey-predator culture (Channa sp. - Tilapia), Feeding, Estimated production with survival rate, Common diseases and prophylactic measures, Seed collection and nursery management. Field visit to farm 	<ul style="list-style-type: none"> Observations in Practical record Report on Discussion Report on Field visit

Module 2: Culture of commercial fin fishes and shell fishes

Ideas/Concepts/Skill	Learning Outcomes	Suggested Activities	Assessment
<p>Culture of Mud Crab</p>	<p><i>The learner :</i></p> <ul style="list-style-type: none"> 2.9.1 Distinguishes the characters of the species and its culture 2.9.2 Analyses optimum water quality parameters 2.9.3 Develops expertise in farming of Mud Crab 	<ul style="list-style-type: none"> Identification of specimens (Scientific name- <i>Squilla olivacea</i>) and drawings made with the help of morphological characters Discussion on Biology Feeding habit, Cannibalism, Reproduction, Growth (moulting), water quality requirements (optimum pH, salinity, DO, depth), Grow out and fattening in ponds, pen, individual chambers - stocking density, Necessity of Fencing, Feeding, Estimated production with survival rate, Common diseases and prophylactic measures and R & D - Activities done by CIBA Field visit to Crab Farm/OJT in Crab farm 	<ul style="list-style-type: none"> Observations in Practical record Report on Discussion Report on Field visit/ OJT
<p>Culture of Mussels and Oysters</p>	<ul style="list-style-type: none"> 2.10.1 Identifies the species 2.10.2 Distinguishes the characters of the species 2.10.3 Differentiates on bottom and off bottom culture methods 2.10.4 Develops expertise in farming of Mussels 	<ul style="list-style-type: none"> Identification of specimens (Scientific name - <i>Perna viridis</i>, <i>Perna indica</i>, <i>Crassostrea madrasensis</i>) and drawings made in record with the help of morphological characters. Discussion on Biology - Geographical Distribution in Kerala, Filter feeding behaviour, Reproduction, Spat, Growth, Water quality requirements - optimum pH, salinity (stenohaline), depth, turbidity, water current, Industrial pollution, On bottom and off bottom (raft, rack) culture - stocking density, Spat collection devices, culture period, Socio-environmental aspects, Depuration with reference to coliforms and estimated production with survival rate Field visit to Mussel Farm OJT in Mussel farm 	<ul style="list-style-type: none"> Observations in Practical record Report on Discussion Report of field visit Vocational diary/OJT report

Module 2: Culture of commercial fin fishes and shell fishes			
Ideas/Concepts/Skill	Learning Outcomes	Suggested Activities	Assessment
New candidate species in aquaculture	<p><i>The learner :</i></p> <ul style="list-style-type: none"> 2.11.1 Identifies the new candidate species namely Cobia, Pompano and Pangassius 	<ul style="list-style-type: none"> Group discussion on new species (Cobia, Pompano and Pangassius) in aquaculture practices. Identification of species Photo-Exhibition 	<ul style="list-style-type: none"> Participation in group discussion Practical record Report on photo exhibition
Integrated Multitrophic aquaculture (IMTA)	<ul style="list-style-type: none"> 2.12.1 Defines the scope & potential of IMTA with Azolla, vegetables, duck, chicken, cattle etc. 	<ul style="list-style-type: none"> Panel discussion on Traditional and Advanced culture systems Field visit to IMTA farm Multimedia on IMTA 	<ul style="list-style-type: none"> Report on Panel discussion Report of field visit Report on multimedia session

List of Practical Activities

- Identification of Carp specimen and drawing
- Field visit, OJT on Carp culture.
- Identification of Shrimp specimen and drawing
- Field visit, OJT on shrimp farming
- Identification of Fresh water prawns specimen and drawing
- Field visit, OJT on freshwater prawn culture
- Identification of GIFT specimen and drawing
- Interactive discussion with experts/farmers
- Field visit, OJT about the farming of GIFT
- Identification of Pearl spot specimen and drawing
- Field visit, OJT about the farming of Pearlsport
- Identification of Cobia specimen and drawing
- Field visit, OJT on Cobia farming
- Identification of Pompano specimen and drawing
- Field visit, OJT on Pompano farming
- Identification of Sea bass specimen and drawing
- Field visit, OJT on Sea bass farming
- Identification of Mullet and Milk fish by specimen observation and drawing
- Field visit, OJT on farming of mullet and Milk fish
- Identification of Pangassius specimen and drawing
- Field visit, OJT on farming of Pangassius
- Identification of air breathing fishes by specimen observation and drawing
- Field visit, OJT on farming of air breathing fishes
- Identification Mud crab specimen and drawing
- Field visit, OJT on farming of Mud crab
- Identification of Mussel specimen and drawing
- Field visit, OJT on Mussel farming
- Identification of common fish and shellfish diseases,

List of Reference Books

- (v) Encyclopedia of Aquaculture - Robert R. Stickney
- (vi) Fish and Fisheries of India - V.G. Jhingran
- (vii) Artificial reef and sea farming technologies - CMFRI Bulletin 48.
- (viii) Culture of Brackish water fin fishes and shell fishes - Susheela Jose

(ix) Aquaculture: Principles and practices of - TVR Pillai

Tools /instruments

- Multimedia CD's
- Specimens of commercially important fish species
- Model of cage
- Model of pen
- Models of rack and raft
- Model of ren
- Model of aquaponic system
- Model of check tray
- Model of aerators
- Cast net
- Model of harvest net

DETAILED UNIT ANALYSIS

Name of Module : Principles of Aquaculture

Name of Unit : Morphology and biology of Teleost Fish

Overview of the Unit :

Selection of fish species for aquaculture is based on its biological features especially growth rate, adaptability to artificial environment, acceptance to artificial feed seed availability etc. Identification of fish species is also important from the process of seed production. Morphological characters of a fish should be thoroughly known for its identification. The biological features of the fish to be cultured should be known to the aqua culturist for the better taming of the fish. Tolerance limits of each species to various physico-chemical parameters, its natural food items as well as its nutritive requirements are important during the culture process. Hence it is a pre-requisite for an aqua-culturist to have sound knowledge in morphology and biology of a fish to be cultured.

Detailing of Activities

Concept : Morphology of Teleost fish (Mullet)

Observation and Identification of Teleost fish

Suggested Activities

- The teacher introduces the concept of morphology of a teleost fish. Then with the help of a fish specimen teacher describe each external features of a fish. Then with the help of a fish specimen teacher describe each external features of a fish.

- Group discussion on identification of morphological characters viz. body shape, fins, scales, lateral line etc.

Practical activity

- Identification of morphological characters with specimens.
- Drawings made in practical record.

Learning outcome

- Understand morphological characters

Discussion points

- What are the external features of a fish?
- How these features help them to lead aquatic life?

Consolidation point

- External morphological characters of fish are suited for living in an aquatic environment.
- External morphological characters are used for identification of a fish?

Concept : **Biology of Teleost fish (Mullet)**

Observation and Identification

Suggested Activities

- The teacher introduces the concept of respiration and Reproduction (Fecundity, Oviparity, Viviparity, Ovo-viviparity)
- Group discussion on respiration, reproduction (terms like fecundity, oviparity, viviparity and ovoviviparity)
- Group discussion on feeding habits (herbivore, Omnivore, Carnivore), Natural food items

Learning outcome

- Understand the basics of respiration and reproduction in fishes
- Understand different feeding habits of fishes

Discussion points

- How do fishes breathe in water?
- How do fishes reproduce?
- What are the food components of a fish?

Consolidation points

- Fishes can breathe by utilizing the oxygen dissolved in water
- Fishes reproduce both by egg laying and giving birth to young ones.
- Some of the fishes feed on microscopic organisms while others thrive on smaller fishes

Repository of Continuous Evaluation Possibilities

a) **Process assessment**

- Participation in group discussion
- Active involvement in practical
- Answering of questions during quiz competition

b) **Portfolio assessment**

- Report on group discussion
- Practical record
- Score card of quiz competition

c) **Unit assessment**

- Oral test
- Unit test
- Quiz
- Preparation of questions and answers

d) **Practical Assessment**

- Practical record
- Vocational diary

e) **Terminal Evaluation Questions**

- Respiration in fishes is carried out by
(gills, air bladder, lungs, heart)
- Fishes which feed on smaller fishes are called as
(Herbivore, Omnivore, Carnivore, Detritivore)
- Fishes in which reproduction is carried out by laying eggs are called as
(oviparity, viviparity, ovoviviparity, ovoidiparity)
- Name the natural food items seen in the bottom of the pond
 - 1) Annelids
 - 2) Worms
 - 3) Molluscs
- Term fecundity refers to _____
(Egg, feed, fin, natural food)
- Pick the odd man out
(Seabass, Catla, Tilapia, Rohu)

- Match the following

	A	B
1	Seabass	Herbivore
2	Tilapia	Planktivore
3	Grass carp	Carnivore
4	Silver carp	Omnivore

- Fishes which feeds on phytoplankton and zooplankton are called as
(Carnivores, Herbivores, Planktivores, Omnivores)
- Identify the fish with the following characters - Uprturned mouth, Feeds on zooplankton, Body deep
(Catla, Rohu, Mrigal)
- Classify the given group of fishes into viviparous and oviparous
(Gold fish, Fighter Fish, Guppy, Angel Fish, Tilapia, Platy, Molly)