

Vidyasagar University

Curriculum for B.Sc. Honours in Aquaculture Management [Choice Based Credit System]

Semester-I

Sl.No.	Name of the Subject	Nature	Code	Teaching Scheme in hour per week			Credit	Marks
				L	T	P		
C1	C1T: Taxonomy, Anatomy & Biology of Fin fishes and Shellfishes (Theory)	Core Course-1		4	0	0	6	75
	C1P: Taxonomy, Anatomy & Biology of Fin fishes and Shellfishes (Practical)	Core Course1 [Practical]		0	0	4		
C2	C2T: Capture Fisheries (Theory)	Core Course-2		4	0	0	6	75
	C2P: Capture Fisheries (Practical)	Core Course-2 [Practical]		0	0	4		
GE-1	GE-1	GE					4/5	75
	GE-1	GE					2/1	
AECC	English	AECC					2	20
				Total Credits = 20				

L= Lecture, T=Tutorial, P=Practical

AECC- Ability Enhancement Compulsory Course: English /Modern Indian Language

Interdisciplinary/ Generic Elective (GE) from other Department

[Four papers are to be taken and each paper will be of 6 credits]:[Papers are to be taken from any of the following discipline: Chemistry/Statistics/Computer Sc/Zoology/Mathematics/Botany/

Microbiology/Bio-Technology/Economics

Semester-1

Core Courses

CC-1: Taxonomy, Anatomy & Biology of Fin fishes and Shell fishes

Credits 06

C1 T: Taxonomy, Anatomy & Biology of Fin fishes and Shell fishes (Theory)

(Credits: 4)

1. **Taxonomy of Finfishes and Shellfishes:** Principles of taxonomy, Nomenclature, types. Classification and interrelationships. Criteria for generic and specific identification. Morphological, morphometric and meristic characteristics of taxonomic significance. Method employed in phylogenetic studies. Phylogenetic tree. Fish identification and fish bar-coding. Major taxa of inland and marine fishes (up to order level). Commercially important fishes of the World. Study of external morphology and classification (up to Sub-class) of Crustacea, Bivalvia, Gastropoda and Cephalopoda.
2. **Anatomy of Finfishes and Shellfishes:** Study of internal anatomy of shell fishes and fin fishes having commercial importance. Study of the oral region and associated structures, (teeth, gill rakers, buccopharyngial region, digestive tract), Associated digestive glands (liver, pancreas, gall bladder). Circulatory system, respiratory system, nervous system and urino-genital system/reproductive system of fishes and shellfishes. Osteology of fishes.
3. **Biology of Finfishes and Shellfishes:** Study of food and feeding habits of commercially important fin fishes and shell fishes. Age and growth of commercially important fin fishes and shell fishes. Marking and tagging; Length-weight relationship, respiration, digestion, excretion, osmoregulation and reproductive physiology. Reproductive biology – maturity stages, gonado-somatic index, sex ratio, spawning and fecundity. Eggs and larval stages and developmental biology of finfishes and shellfishes.

C1 P: Taxonomy, Anatomy & Biology of Fin fishes and Shell fishes

(Practical)

Credits 02

1. Collection, preservation and taxonomic study of commercially important Inland and marine finfishes and shellfishes (prawns, crab, lobsters, bivalves, gastropods, cephalopods, echinoderms etc).
2. Study of morphometric and meristic characteristics of collected fishes (finfishes & shellfishes), Study of types of fish scales.
3. Dissection of different finfishes & shellfishes to understand the internal organization of organs
4. Preparation of endoskeleton
5. Analysis of fish gut contents, Study of food and feeding habits of finfishes and shellfishes

6. Classification of maturity stages, estimation of fecundity, identification of eggs and larval stages, study of embryonic and larval development of commercially important finfishes and shellfishes.
7. Tagging and Marking.

CC-2: Capture Fisheries

Credits 06

C2 T: Capture Fisheries (Theory)

Credits 04

1. **Inland Capture Fisheries:** Freshwater fishery regions of the world and their major fisheries, species composition, Global inland fish production statistics. Inland fishery resources of India, Present scenario of inland capture fisheries of India, their potential, problems. Trend of inland capture fish production, Major riverine and estuarine fisheries of India. Fisheries of major rivers/reservoirs/lakes of India. Coldwater fisheries of India.
2. **Marine Capture Fisheries:** Overview of marine fishery resources of the world and India. Classification and definition of fishery zones, offshore and deep sea fisheries of India. The major important fin fish and shell fish resources and their economic management. Major pelagic and demersal fisheries of India. Crafts and gears operated in Indian marine water. Marine fisheries development in India. The concept of total catch and catch per unit effort. Remote sensing potential marine fishing zones (PFZ), EEZ. Conservation of marine fishery resources.

C2 P: Capture Fisheries (Practical)

Credits 02

1. Analysis of species composition of commercial catches at landing and assembly centers, sampling and familiarization of commercially important groups.
2. Study of external morphology, collection, preservation and identifications of prawns, crabs, lobsters, bivalves, gastropods, cephalopods, echinoderms from natural habitats.
3. Observations and experimental operations of selected fishing gears in marine water of India, Maintenance of records on catch statistics and observations.
4. Visit to a fish landing centers, observation and analysis of catches by major craft and gears.
5. Field collection of samples of fishes, crustaceans and molluscs, and their analysis for biological characteristics. Participations in fishing trips and research

GENERIC ELECTIVE (GE)

GE-1 [Interdisciplinary for other department]

GE-I : Fundamentals of Fisheries & Aquaculture **Credits 06**

GE-IT: Fundamentals of Fisheries & Aquaculture (Theory) **Credits: 4**

Fundamentals of Fisheries & Aquaculture:

1. General knowledge about fish.
2. Commercially important freshwater and marine water Fin fishes & Shellfishes, their economic value.
3. Different system of Aquaculture: Extensive, semi-intensive, intensive culture of fish.
4. Non-conventional Aquaculture: Pen-culture, cage-culture, race-way culture, Jhora fisheries.
5. Role of Aquaculture for development.
6. Fisheries co-operatives: Principle of fishermen co-operatives, formation of co-operatives, bylaws, advantage of co-operatives.

GE-I P: Fundamentals of Fisheries & Aquaculture (Practical) **Credits 02**

1. Identification of commercially important freshwater and marine water Finfish & Shellfishes.
2. Study of cultivable species of shellfishes.
3. Collection of predatory and weed fishes.
4. Identification of aquatic weeds.
5. Study of catfishes.

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Semester-II

Sl. No.	Name of the Subject	Nature	Code	Teaching Scheme in hour per week			Credit	Marks
				L	T	P		
C3	C3T: Aquaculture practices	Core Course-3		4	0	0	6	75
	C3P: Aquaculture practices(Practical)	Core Course-3 [Practical]		0	0	4		
C4	C4T: Genetics & Reproduction in fish	Core Course-4		4	0	0	6	75
	C4P: Genetics & Reproduction in fish(Practical)	Core Course-4 [Practical]		0	0	4		
GE-2	GE-2	GE					4/5	75
	GE-2	GE					2/1	
AEC C-2	Environmental Studies	AECC					4	100
				Total Credits = 22				

L= Lecture, T=Tutorial, P=Practical

AECC- Ability Enhancement Compulsory Course: Environmental Studies.

Interdisciplinary/Generic Elective (GE) from other Department

[Four papers are to be taken and each paper will be of 6 credits]:[Papers are to be taken from any of the following discipline: Chemistry/Statistics/Computer Sc/Zoology /Mathematics/Botany/Microbiology/Bio-Technology/Economics

Semester-II

Core Courses

CC-3 : Aquaculture Practices **Credits 06**

C3 T: Aquaculture Practices(Theory) **Credits 04**

1. **Freshwater Aquaculture:** Different freshwater aquaculture systems. Preparation and management of nursery and rearing ponds. Control of aquatic weeds and algal blooms. Monoculture and polyculture of carps, stocking density and ratio, supplementary feeding. Criteria for selection of candidate species for aquaculture. Technology of semi-intensive, intensive and super intensive systems of aquaculture. Aquaculture in running water system, re-circulatory system, cages and pens. Air-breathing fish culture. Culture of coldwater fishes. Culture of freshwater prawns. Definition, history and scope of integrated aquaculture. Principles of organic recycling and detritus food chain. Integration of crop, livestock and fish farming as complimentary activities. Wastewater aquaculture and Paddy-cum fish culture.
2. **Mariculture:** Resource of marine species for shore-based aquaculture and sea farming in India. Cultivable traits of important candidate species of fish and shelfish with notes on their biology (Sea bass, Mullets, Milkfish, Groupers, Tiger shrimp, Mud crab, Mussels, Clams, Oysters etc.). Shore-based aquaculture systems: traditional (Pokkali, Bheries), semi-intensive aquaculture practices of commercially important species. Management of marine fisheries.
3. **Ornamental Fish Culture:** Ornamental fish culture as hobby. Setting up of freshwater and marine aquaria. Selection of suitable species, species combination. Use of natural and artificial aquatic plants and decorative toys. Use of biological filters, aerators, heaters etc. Commercial breeding and culture of ornamental fishes. Methods of production of live and artificial feeds. Common diseases of ornamental fishes and their control. Transport of live ornamental fishes and Aquascaping.

C3 P: Aquaculture Practices (Practical) **Credits 02**

1. Study of cultivable species of fin fishes and shellfishes. Collection and study of predatory fishes, weed fishes. Collection and study of aquatic weed and aquatic insects from fish ponds.
2. Practical experience in the preparation and management of nursery, rearing and stocking tanks. Study of effect of liming, manuring and fertilization of fish ponds and on growth of fishes.
3. Methods of isolation and identification of different live feed organisms. Laboratory scale culture (batch and continuous) of selected live feed organism. Evaluation of live feed organisms. Mass culture of live fish food organisms. Study of algal blooms and their control. Effect of supplementary food on the growth of fishes.

4. Identification of common ornamental fishes and plants. Setting and maintenance of aquaria. Designs and construction of indoor aquaria. Identification of fish diseases and prophylactic measures. Culture of ornamental fishes. Transport of live ornamental fishes.

CC-4 : Genetics & Reproduction in fish **Credits 06**

C4 T: Genetics & Reproduction in fish(Theory) **Credits 04**

1. Fish Genetics and Biotechnology: Principles of genetics; Concepts of biotechnology. Genes and chromosomes, gene interaction. Linkage and crossing over. Chromosome maps, sex determination, chromosomal aberrations. Gene mutation; genome manipulation: gynogenesis, androgenesis, polyploidy. Transgenic fish, Sex-reversal, inbreeding & hybridization.
2. Fish Endocrinology and Reproductive Biology: Modes of reproduction. Secondary sexual characters and maturation process. Different endocrine glands. Ecological and hormonal influence on maturation and spawning; Breeding behavior; Pheromones in fishes. Gametogenesis, Fertilization, Cleavage, Gastrulation, Organogenesis.
3. Breeding and Hatchery Management: Natural breeding and seed production of fishes. Significance of propagation, sexual maturity, season of reproduction, place of propagation, parental care. Types of fish eggs and mechanism of hatching. Riverine spawn collection site, gears used for collection, methods of spawn collection, behavior of spawn in relation to hydrological and hydro-biological factors. Technology of seed production in warm water fishes; brood stock management, techniques of inducing ovulation. Multiple carp spawning. Chinese technique using spawning pool and incubation/hatching pools. Cryopreservation of fish gamete. Breeding technique for Indian major caps and other exotic carps.

C4 P: Genetics & Reproduction in fish(Practical) **Credits 02**

1. Selection of breeders of carps and catfishes. Collection and preservation of pituitary glands in fishes.
2. Preparation and administration of pituitary gland extract. Use of synthetic compounds for induced breeding of fishes. Study of hatchery technology of fishes. Care of eggs, spawn and fry. Identification of eggs and larvae of common cultivable fishes.
3. Detailed study of design and operation of Chinese circular hatchery and funnel shaped hatchery. Study of seed production technology of Indian carps/Cat fishes, Tilapia.
4. Methods of isolation and culture of bacteria and fungus. Identification methods of common bacterial and fungal pathogens of fish.

GENERIC ELECTIVE (GE)

GE-2 [Interdisciplinary for other department]

GE-2: Inland fisheries resources, fish breeding and seed production **Credits 06**

GE-2 T: Inland fisheries resources, fish breeding and seed production(Theory)
Credits 04)

1. Present prospect and problems of Inland fisheries in India.
2. Inland fisheries resources.
3. Freshwater fishery resources of the world and their major fisheries.
4. Different types of fish ponds, criteria for ideal fish culture pond, pre-stocking management of nursery, rearing and stocking ponds.
5. Culture practice of spawn, fry and fingerling in different rearing ponds.
6. Induced breeding of fishes: History of Induced breeding in fish, Bundh breeding, Environmental and hormonal control of fish reproduction, Structure of pituitary gland and its secretion, Use of synthetic hormones, brood fish management, different types of hatchery for IMC breeding.

GE-2 P: Inland fisheries resources, fish breeding and seed production (Practical)
Credits: 02

1. Pituitary gland collection, preservation, preparation of pituitary gland extract for injection.
2. Identification of different life stages of cultivable fish species: spawn, fry, and fingerling.
3. Study of model hatchery.
4. Study of external morphology, collection, preservation and identifications of prawn, crabs, lobsters, bivalves from natural habitats.
5. Study of care of eggs, spawn and fry.

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Semester-III

Course	Course Code	Name of the Subjects	Course Type/ Nature	Teaching Scheme in hour per week			Credit	Marks
				L	T	P		
CC-5		C5T: Fisheries Statistics, Economics and Marketing Management	Core Course - 5	4	0	0	6	75
		C5P: Fisheries Statistics, Economics and Marketing Management (Practical)		0	0	4		
CC-6		C6 T: Aquatic Ecology, Pollution and Biodiversity	Core Course - 6	4	0	0	6	75
		C6 P: Aquatic Ecology, Pollution and Biodiversity (Practical)		0	0	4		
CC-7		C7T: Aquatic Microbiology, Fisheries Biotechnology and Bioinformatics	Core Course - 7	4	0	0	6	75
		C7P: Aquatic Microbiology, Fisheries Biotechnology and Bioinformatics (Practical)		0	0	4		
GE-3	TBD		Generic Elective -3				4/5	75
							2/1	
SEC-1		SEC-1: Ornamental Fish Production and Aquarium Management(Practical) (Practical)	Skill Enhancement Course-1	0	0	4	2	50
Semester Total							26	350

L=Lecture, T= Tutorial, P=Practical, CC = Core Course, GE= Generic Elective, SEC = Skill Enhancement Course, **TBD** = to be decided

Generic Elective (GE) (Interdisciplinary) from other Department [**Four papers are to be taken and each paper will be of 6 credits**]: Papers are to be taken from any of the following discipline: **Chemistry/Statistics/Computer Sc/Zoology/Mathematics/Botany/Microbiology/Bio-Technology/Economics**

Modalities of selection of Generic Electives (GE): A student shall have to choose **04** Generic Elective (GE1 to GE4) strictly from **02** subjects / disciplines of choice taking exactly **02** courses from each subjects of disciplines. Such a student shall have to study the curriculum of Generic Elective (GE) of a subject or discipline specified for the relevant semester.

SEMESTER-III

Core Courses

CC-5: Fisheries Statistics, Economics and Marketing Management	Credits 06
C5T: Fisheries Statistics, Economics and Marketing Management	Credits 04

Theory:

- Fisheries Statistics:** Definition of sample, population in biometry: Frequency distribution, histogram, bar diagram, pie diagram. Measures of central tendencies (Mean, Median and Mode), Dispersion (SD, SE and Variance). Chi squire (X^2) test and Student's t-test. Regression analysis and ANOVA test.
- Fisheries Economics:** Introduction to fisheries economics, basic economic terminologies – micro and macroeconomics, positive and normative economics, environmental economics, resource, scarcity, farm-firm relationships, production Contribution of fisheries sector to the economic development of the country. Micro-economics: theories of demand, supply; market – equilibrium price, consumption, utility, Consumer surplus. Elasticity – price, income, cross, application of elasticity in fisheries managerial decision. Farm production economics – production functions in capture and culture fisheries; Costs and returns –breakeven analysis of fish production system; concepts of externalities and social cost factors of production, marginal cost and return, law of diminishing marginal return, returns to scale, economies of scale and scope, revenue, profit maximization, measurement of technological change, farm planning and budgeting. Significance or importance of marginal cost.
- Marketing Management:** Introduction to marketing management; core marketing concepts: market structure, functions and types, marketing channels and supply chain, marketing margins, marketing environment, marketing strategies, consumer behaviour and marketing research. Fish markets and marketing in India, demand and supply of fish, market structure and price formation in marine and inland fish markets; cold storage and other marketing infrastructure in India; export markets and marketing of fish and fishery products; Trade liberalization and fisheries markets.

C5 P: Fisheries Statistics, Economics and Marketing Management (Practical) Credits 02

1. Draw a histogram, bar diagram, pie diagram, chart etc
2. Collection of data and presentation of data. Testing of Goodness of fit; Chi squire (X^2) test and Student's t-test.
3. Developing questionnaire and conducting market surveys, analysis of primary and secondary data.
4. Exercises on equilibrium price for fish and fishery products; estimation of demand and supply using simple regression.
5. Analysis of credit schemes of banks and the government. Case studies of cooperatives.
6. Visit to co-operative societies, commercial banks and fish markets and organizations dealing with marketing of fish and fishery products.

CC-6 : Aquatic Ecology, Pollution and Biodiversity

Credits: 06

C6 T: Aquatic Ecology, Pollution and Biodiversity

Credits: 04

Theory:

- Aquatic ecology:** Aquatic environment, Flora and fauna: Components of aquatic systems, Aquatic productivity, nutrient cycles, energy flow, food chain. Animal associations: Symbiosis, commensalisms, parasitism, prey-predator relationship, host parasite relationship. Ecological and evolutionary processes. Ecological niches – lagoons, estuaries, mangroves, coral reefs, flood plains, coastal wet lands, bheels, oxbow lakes.
- Aquatic pollution:** Introduction to aquatic pollution, the sources of pollutants, toxic organic compounds and their impacts in the aquatic organisms and the abiotic environment, Classification of pollution physical, chemical and biological classification of water pollution- description of terminologies. Sewage and domestic wastes- composition and pollution effects- sewage treatment and its reuse. Agricultural wastes- organic detritus, nutrients, Adverse effects of oxygen demanding wastes: importance of dissolved oxygen; Oxygen demand; BOD; COD, eutrophication. Different types of aquatic pollution and their impact on aquatic biota.
- Biodiversity:** Definition, concept and types of biodiversity. Aquatic biodiversity-its importance, species diversity, genetic diversity, habitat diversity, diversity indices. Threats to biodiversity- habitat destruction, introduction of exotic species, Conservation of habitats, marine parks and sanctuaries.

C6 P: Aquatic Ecology, Pollution and Biodiversity

Credits 02

Practical:

- Collection of species of fishes and other organisms and studying the assemblages of organisms of rocky, sandy and muddy shores, lentic and lotic habitats.
- Observation of adaptive characters and interrelationships like commensalisms, symbiosis, parasitism and predation.
- Physical characteristics of polluted waters; Colour, Odour, Turbidity. Determination of pH, salinity, alkalinity, hardness, BOD, COD, Hydrogen sulphide, Phosphates, Ammonia, Nitrates, Heavy metals and Oil and grease in water. Determination of pH, conductivity, organic carbon, nitrogen, phosphorus, heavy metals in sediments.
- Methods of pesticide residue analysis in waters and fish tissue; bioassay and toxicity study.
- Working out biodiversity indices.

CC-7: Aquatic Microbiology, Fisheries Biotechnology and Bioinformatics Credits 06

C7T: Aquatic Microbiology, Fisheries Biotechnology and Bioinformatics Credits 04

Theory:

- Aquatic Microbiology:** Introduction and scope of aquatic microbiology, aquatic environment as habitat for microorganisms - bacteria, cyanobacteria, fungi, algae, parasites and viruses; distribution of microorganisms and their biomass in rivers, lakes, sea and sediment. Influence of physical, chemical and biological factors on aquatic microbes. Microbial biofilms. Role of microbes in the production and breakdown of organic matter. Role of microbes in sedimentation and mineralization process. Nutrient cycles-carbon, nitrogen, sulphur, phosphorus, iron, and manganese cycles. Sewage microbiology, self purification in natural waters, sewage treatment, drinking water microbiology, sanitary quality of water for aquaculture, bioremediators.
- Fisheries Biotechnology:** Introduction to Biotechnology –scope and importance in fisheries/aquaculture; Structural organization of prokaryotic and eukaryotic cell. Nucleic acids -structure, function and types, Concepts of gene and genetic code, transcription and translation, mutations and their implications. Post transcriptional modification and RNA processing. Gene regulation and expression in prokaryotes and eukaryotes; DNA sequencing, Operons. Genetic engineering- Restriction enzymes; Gene isolation; Cloning vectors; Probes; Recombinant DNA technology – vaccines. Transgenic fish and Gene transfer technology, Animal Cell Culture, Hybridoma technology. Molecular and immunological techniques – PCR; immunoblotting; ELISA; Principle of hybridization; Northern blotting; Western blotting; Southern blotting; DNA fingerprinting; Restriction fragment length polymorphism., Biosensors.
- Bioinformatics:** Introduction to Bioinformatics; Biological Databases and tools : Introduction; Types of biological databases; Primary and secondary databases; PDB, NCBI, formats and contents; Sequence retrieval, manipulation; Primer design; Restriction mapping; ORF finding; EMBOSS, Molecular visualization Sequence analysis.

C7P: Aquatic Microbiology, Fisheries Biotechnology and Bioinformatics (Practical) Credits 02

- Collection of water and sediment samples for microbiological analysis Isolation, identification and enumeration of various groups of microorganisms from different water bodies including aquaculture systems.
- Study of bacteria involved in nutrient cycles. Biofilms, water testing for potability, enumeration of coliform.
- Study of structure of prokaryote and Eukaryote Cells. Study on Model of protein Synthesis, Study of models r DNA Technology, Cell Culture
- Isolation of Nucleic Acids, Restriction enzymes, Gel Electrophorus, ELISA, DNA sequence analysis and comparison.

GENERIC ELECTIVE (GE)
GE-3[Interdisciplinary for other department]

GE-3: Marine fisheries and oceanography **Credits 06**

GE3 T: Marine fisheries and oceanography **Credits 04**

Theory:

1. **Marine Fisheries:** Classification and definition of fishery zones and fishery resources of world. Overview of marine fisheries resources of the world and India. Major exploited marine fisheries of India, their developmental history and present status. Important pelagic - demersal fish, shellfish and seaweed resources of India. Traditional, motorized and mechanized fisheries according to major gears. Potential marine fishery resources of the India's EEZ. GIS and Remote sensing in marine capture fishery.
2. **Oceanography:** Introduction to Oceanography: classification; expeditions national and international. Earth and the ocean basin, distribution of water and land; relief of sea floor; Major feature of topography and terminology; major divisions. Relief in Indian oceans. Ocean Waves: definition and terms; classification, Difference between surface and long waves; wave theories; surface wave generation; spreading growth; Beaufort Scale; spilling and breaking waves; long waves, Tsunamis, internal waves. Ocean Tides: Definition; Tidal phenomenon, elementary tidal definition; tidal inequalities; tide producing forces types of tides tidal bores, tide prediction. Physical properties of sea water: Salinity and chlorinity; temperature; thermal properties of sea water; Residence time of constituents in seawater. Properties of sea ice; transmission of sound; absorption of radiation; eddy conductivity; diffusivity and viscosity.

GE-3 P: Marine fisheries and oceanography (Practical) **Credits 02**

1. Observation and analysis of catches by major crafts and gears operated in marine fishing.
2. Field collection of fishes, crustaceans, molluscs and seaweeds and record keeping of relevant data.
3. GIS and remote sensing in marine capture fishery.
4. Field visits and operation of oceanographic instruments- Nansen reversing water sampler, Bathythermograph, Grabs, Corers, Current meters, Tidal gauges, Echo-sounder.
5. Measurement of temperature, Transparency, pH. Determination of DO, Salinity, Ammonia, Nitrate, Nitrite, Phosphate and Silicate in sea water

Skill Enhancement Course (SEC)

SEC-1: Ornamental Fish Production and Aquarium Management (Practical)

Credits: 2

1. Identification of freshwater and marine water ornamental fishes and plants.
2. Fabrication of all-glass aquarium. Setting up and maintenance of Aquarium accessories and equipment.
3. Conditioning and packing of ornamental fishes.
4. Preparation of feed. Setting up of breeding tank for live bearers, barbs, goldfish, tetras, chichlids, gouramis, fighters and catfishes.
5. Identification of ornamental fish diseases and prophylactic measures.
6. Conditioning, packing, transport and quarantine methods. Trade regulations and wild life act in relation to ornamental fishes.