



**BHARATHIDASAN UNIVERSITY, TIRUCHIRAPPALLI – 620 024.**

**B.Sc. **Aquaculture** – Course Structure under CBCS**

**(For the candidates admitted from the academic year 2008-2009 onwards)**

Semester	Part	Course	Title	Instru Hours/ Week	Credit	Exam Hours	Marks		Total
							Int.	Extn.	
I	I	Language Course – I (LC) – Tamil*/Other Languages ** #		6	3	3	25	75	100
	II	English Language Course - I (ELC)		6	3	3	25	75	100
	III	Core Course – I (CC)	Invertebrate & Prochordate Biology.	6	5	3	25	75	100
		Core Course – II (CC)	Practical I-Covering the Core Courses I & III	4	-	***	-	-	-
	III	First Allied Course –I (AC)	Biochemistry for Aquaculture-I	5	4	3	25	75	100
	First Allied Course – II (AC)	Practical	3	-	***	-	-	-	
II	I	Language Course – II (LC) -- Tamil*/Other Languages ** #		6	3	3	25	75	100
	II	English Language Course – II (ELC)		6	3	3	25	75	100
		Core Course – II (CC)	Practical I-Covering the Core Courses I & III	2	4	3	40	60	100
	III	Core Course – III (CC)	Vertebrate Biology	5	5	3	25	75	100
		First Allied Course – II (AC)	Practical	2	2	3	40	60	100
		First Allied Course – III (AC)	Biochemistry for Aquaculture-II	5	4	3	25	75	100
	IV	Environmental Studies		2	2	3	25	75	100
IV	Value Education		2	2	3	25	75	100	
III	I	Language Course – III (LC) – Tamil*/Other Languages ** #		6	3	3	25	75	100
	II	English Language Course - III (ELC)		6	3	3	25	75	100
	III	Core Course – IV (CC)	An Introduction to Genera; Biology and Physiology of Cultivable species.	5	5	3	25	75	100
		Core Course – V (CC)	Practical II–Covering the Core Courses IV & VI	2	-	***	-	-	-

		Second Allied Course – I	Computational and Analytical methods in Aquaculture-I	5	4	3	25	75	100
		Second Allied Course – II	Practical	2	-	***	-	-	-
	IV	Skill Based Elective I		2	2	3	25	75	100
		Non Major Elective I - for those who studied Tamil under Part I a) Basic Tamil for other language students b) Special Tamil for those who studied Tamil upto +2 but opt for other languages in degree programme	Ornamental Fishculture.		2	2	3	25	75
IV	I	Language Course –IV (LC) - Tamil*/Other Languages ** #		6	3	3	25	75	100
	II	English Language Course – IV (ELC)		6	3	3	25	75	100
	III	Core Course – V (CC)	Practical II–Covering the Core Courses IV & VI	2	3	3	40	60	100
		Core Course – VI (CC)	Farm Engineering and Aquaculture techniques.	5	5	3	25	75	100
		Second Allied Course - II	Practical	2	2	3	40	60	100
		Second Allied Course - III	Computational and Analytical methods in Aquaculture-II	5	4	3	25	75	100
	IV	Non Major Elective II - for those who studied Tamil under Part I a) Basic Tamil for other language students b) Special Tamil for those who studied Tamil upto +2 but opt for other languages in degree programme	Freshwater Aquaculture	2	2	3	25	75	100
	IV	Skill Based Elective II		2	2	3	25	75	100
V	III	Core Course – VII (CC)	Farm management and Water qualities studies.	5	5	3	25	75	100
		Core Course – VIII (CC)	Microbial Infections,Disease Diagnosis and Control measures.	5	5	3	25	75	100
		Core Course – IX (CC)	Post harvest Technology.	5	5	3	25	75	100
		Core Course – X (CC)	Practical III covering the core courses VII, VIII & IX	6	4	3	40	60	100

		Major based Elective – I	Microbial Biotechnology	5	5	3	25	75	100
	IV	Skill based Elective –III		2	2	3	25	75	100
		Skill based Elective – IV		2	2	3	25	75	100
VI	III	Core Course – XI (CC)	Fish Nutrition and Feed Management.	5	5	3	25	75	100
		Core Course – XII (CC)	Fishing Gears and Cragfts.	5	5	3	25	75	100
		Core Course – XIII (CC)	Practical IV – Covering the Core Courses XI & XII	6	4	3	40	60	100
		Major based Elective II	Immunology	5	5	3	25	75	100
		Major based Elective III	Aquaculture Biotechnology.	5	5	3	25	75	100
	IV	Skill Based Elective – V		2	2	3	25	75	100
		Skill Based Elective - VI		2	2	3	25	75	100
	V	Extension activities		-	1	-	-	-	-
			Total	180	140				4000

**Note:**

**Internal Marks                  External Marks**

- |   |    |    |
|---|----|----|
| 1. Theory   | 25 | 75 |
| 2. Practical  | 40 | 60 |
| 3. Separate passing minimum is prescribed for Internal and External marks |    |    |

The passing minimum for CIA shall be 40% out of 25 marks [i.e. 10 marks]

The passing minimum for University Examinations shall be 40% out of 75 marks [ i.e. 30 marks]

\* for those who studied Tamil upto +2 (Regular Stream)

\*\* Syllabus for other Languages should be on par with Tamil at Degree level

# those who studied Tamil upto 10<sup>th</sup> or +2, but opt for other languages in degree level under Part I should study special Tamil in Part IV

\*\*\* Examination at the end of the next semester.

Extension activities shall be out side the instruction hours.

## **CORE COURSE I- INVERTEBRATE & PROCHORDATE BIOLOGY**

- UNIT I : Classification, life history and phylogenetic relationship of protozoa and sponges. Coelenterata - polymorphism, life history, theories on coral reefs, distribution. Polychaeta- classification, morphology, reproduction and adaptive radiation.
- UNIT 2: Functional morphology, development and affinity of Nemertinea, Endoprocta, Ectoprocta, Phoronida, Pogonophora and Chaetognatha.
- UNIT 3: Crustacea - classification upto orders, comparative morphology, Type study : *Penaeus monodon*, crustacean appendages, larval forms, evolution.
- UNIT4: Mollusca- classification upto orders, general characters, Type study : *Unio*. Torsion, phylogenetic relationship and adaptive radiation.
- UNIT 5: Echinodermata - Type study : Star fish - water vascular system, larvae : their comparative morphology and evolution.  
Prochordates - Type study : *Amphioxus* - classification and comparative morphology, reproduction and early development, larval metamorphosis of ascidia.

### **TEXT BOOKS**

1. Hyman, L.1967. The invertebrate Zoology, Vols. To VI McGraw Hill Book Co. Ltd., New York.
2. Kaestner, A., 1967. Invertebrate zoology Vols. 1 to III. Wiley Interscience Publishers, New York.
3. Barnes, R.D., 1980. Invertebrate zoology . 4<sup>th</sup> Edition. Saunders College Publishers, Philadelphia.
4. Ruppert, E.E and R.D. Barnes 1994. Invertebrage Zoology. 6<sup>th</sup> Edition. Saunders College Publishers, Philadelphia.

## **CORE COURSE –II PRACTICAL- I (Pertaining to CCI and CCIII)**

01. Identification of coastal invertebrate fauna along Mallapatnam coast.
02. Mounting of gastropod radula, crystalline style.
03. Mouth parts of squilla and prawn.
04. Anatomy of hermit crab, prawn, gastropod and bivalve.
05. Alimentary system of gastropods.
06. Functional morphology of respiratory organs- aquatic animals-gills of shark, mullet and mudskipper.
07. Functional morphology of the integument and its derivatives in different vertebrate groups (skin, scale etc)
08. Spotters: Study of important chordate specimens.(a field trip report has to be submitted separately along with the record note book)
09. Mounting of chick embryo-24,48 and 96 hours of incubation.
10. Spotters: study of various embryonic and post-embryonic stages of chick.

## **FIRST ALLIED COURSE I- (AC) BIOCHEMISTRY FOR AQUACULTURE I**

- Unit 1: Carbohydrates- definition, detailed classification, structure of glucose, biological significance, digestion and absorption,- Methods of estimations- Colorimetric.
- Unit 2: Proteins- definition, Classification and structure(Primary, Secondary, tertiary), Aminoacids-structure, classification(Essential and nonessential, protein and non-protein amino acids.
- Unit 3: Lipids: definition, classification, structure, properties and functions, methods of estimation –Gravimetric.
- Unit 4: Nucleic acids- DNA structure, form and function –RNA types structure and function.
- Unit 5: Vitamins- introduction –fat soluble vitamins(A,D,E&K) water soluble vitamin (B complex &C) sources. Functions and deficiency syndromes of Vitamins.

### **TEXT BOOKS:**

1. Stryer, L.1995 Biochemistry, 4<sup>th</sup> Ed.W.H.Freeman and company , New york.

### **REFERENCES:**

1. Donald voet and Judith voet, 1990. Biochemistry.John Wiley and Sons, New york.
2. Henry, R.Mahler and Eugene, H.Cerdesz, 1966. Biological Chemistry.0 Harper International Edition. New york.
3. Hubert Stryer, 1995. Biochemistry. Freeman and company, New York.
4. Dawnm B.Markus, 19 94. Biochemistry. Harwal publishing, New york.
5. William, J.Marshall and Stephan, K.Bangert, 1995. Clinical Biochemistry metabolic and clinical aspects. Churchill Livingston, New York.

## **FIRST ALLIED COURSE – II (AC)**

### **BIOCHEMISTRY FOR AQUACULTURE PRACTICAL (COURSE I AND III)**

#### **Lab work:**

1. Qualitative analyses – Tests for carbohydrates, proteins, lipids.
2. Quantitative analyses- Estimation of sugars(Benedicts' method) – Estimation of amino acid (Ninhydrin method)- Estimation of ascorbic acid (from biological sample)- Estimation of calcium(from biological sample.)
3. Analysis of urine and demonstration of amino acid estimation.

#### **Text Books:**

1. Stroiv, B.A., Makavora, V.C.1989. Laboratory manual in Biochemistry. MIR Publisher, Moscow.
2. Oser, B.L.Hawks. 1965. Physiological Chemistry, TATA Mc Graw Hill.

## **CORE COURSE III(CC) - VERTEBRATE BIOLOGY**

- UNIT 1: Geological time scale- progression of vertebrates through time, chordate features and theories on the origin and classification of chordates upto classes.
- UNIT 2: Characteristic features of ancestral vertebrates - evolution of jawless and primitive vertebrates. Evolution and adaptive radiation of elasmobranchs and bony fishes.
- UNIT 3: Origin, distribution and adaptive radiation of amphibia.  
Gametogenesis, fertilization, cleavage, development upto gastrulation in amphioxus with special reference to marine vertebrates-embryology of fish, bird and mammal.  
Nuclear transplantation –embryo transplantation techniques, test tube babies, artificial insemination, infertility, Rh factor.
- UNIT 4: Origin of reptiles- adaptive radiation of contemporary reptiles, amphibian and reptilian features of Seymouria, mammal like reptiles, rise and fall of dinosaurs including Mesozoic marine reptiles. Importance of marine birds.
- UNIT 5: General characters of mammals-classification and evolution of monotremes, marsupials and placentals - Aquatic mammals- classification, adaptations and evolution of cetacea and Sirenia.  
Aquatic adaptations of respiratory and circulatory mechanisms-comparative anatomy of skin derivatives.

### **TEXT BOOKS:**

1. Balinsky, B.I., 1970 An introduction to development biology. Philadelphia and London.
2. Berril, N.J., 1971. Developmental Biology, McGraw Hill Book Co., New York.
3. Colbert, E.H., 1970. Evolution of the Vertebrates.
4. Dodson, E.O.1968. Evolution process and products. Eastwest press, New Delhi.
5. Dohzhansky, T., F.T.Ayala, G.L.Stebeinns, and J.Q.Valentini, 1973 Evolution , Surjeet publication ,New Delhi.
6. Goodrich, E.S., 1958, studies on the structure and development of vertebrates vols. I and II. Dover publications inc., New york.
7. Lull, R.S., 1984. Organic Evolution. Seema Publication, New Delhi.
8. Robert, T.Orr, 1976. Vertebrate Biology. W.B.Saunders Company, Philadelphia.
9. Romer, A.S., 1945. Vertebrate Palaeontology. University of Chicago press, Chicago.
10. Verma, P.S., V.K.Agarwal and B.S. Tygi, 1981. Chordate Embryology. S.Chand and Co., New Delhi.
11. Young, J.A., 1981. The life of vertebrates. Oxford University Press, New york.

**FIRST ALLIED COURSE –III(AC)**  
**BIOCHEMISTRY FOR AQUACULTURE II**

- Unit 1: Blood –origin of blood cells, composition characteristics and coagulation.
- Unit 2: Cytochemistry-structure and biochemical composition of cell wall and plasma membrane- fluid mosaic model, trilaminar model. Receptor concept, sodium-potassium pumps.
- Unit 3: Endocrine glands-pituitary, thyroid, parathyroid, pancreas, adrenal, testis and ovary. Hormones- definition, classification, function, diseases associated with deficiency(or) excess of hormones.
- Unit 4: General account of major and accessory pigments. Respiratory pigments, Carotenoids and Chlorophyll.
- Unit 5: Phytohormones and plant's secondary metabolites-structure and function of auxins, gibberellins, cytokinins and abscisic acid, - Alkaloids and flavonoids.

**Text Book:**

1. Stryer, L. 1995 Biochemistry, 4<sup>th</sup> Ed. W.H. Freeman and company, New York.

**Reference:**

1. Donald Voet and Judith Voet, 1990. Biochemistry. John Wiley and Sons, New York
2. Henry, R. Mahler and Eugene, H. Cerdasz, 1966. Biological Chemistry. Harper International Edition. New York.
3. Hubert Stryer, 1995. Biochemistry. Freeman and company, New York.
4. Dawn B. Markus, 1994. Biochemistry. Harwal publishing, New York.
5. William, J. Marshall and Stephan, K. Bangert, 1995. Clinical Biochemistry : Metabolic and Clinical aspects. Churchill Livingstone, New York.

## **CORE COURSE IV AN INTRODUCTION TO GENERAL BIOLOGY AND PHYSIOLOGY OF CULTIVABLE SPECIES**

- Unit 1:** Plankton: Classification, methods of collection, preservation, analysis and biomass of phytoplankton and zooplankton, phytoplankton blooms, primary production.
- Unit 2:** General introduction to seaweeds – criteria for selection of candidate species and candidate seaweed species in India: biology, life history, growth, reproduction of *Ulva*, *Laminaria* and *Gracilaria*.
- Unit 3:** Biology of cultivable mollusks – life history, food and feeding, age and growth and reproduction. Biology of cultivable crustaceans – life history, food and feeding, respiratory structure and functions and blood pigments, age and growth reproduction.
- Unit 4:** Biology of cultivable finfishes – life history, food and feeding, mechanisms, digestive enzyme and their role with food habits. Respiratory structure and functions, blood pigments, their role in transport of oxygen and carbon dioxide – age, growth and reproduction.
- Unit 5:** Physiology of ionic and osmoregulations – ions in body fluids, mechanism of ionic regulation responses to osmotic conditions, types of osmoregulatory adaptations. Physiology of endocrine system – hormones, neurohormones, hormones of reproduction in finfishes and shell fishes.

### **Text books:**

1. Prosser, C.L., 1973. Comparative Animal physiology. Saunder, Philadelphia.
2. Colin Nicol, J.A., 1961. The Biology of Marine Animals. Sir Issac Pitman & Sons Ltd.,
3. Milne, P.H. 1972. Fish and shellfish Farming in the Coastal Waters. Fishing news(Books) London.
4. Champan, V.J. and D.J. Chapman, 1980-. Seaweed and their use. Chapman & Hall, Lodon.
5. S.K. Gupta and P.C. Gupta. General and Applied Ichthyology (Fishes and Fisheries). S.Chand & Co. New Delhi-55.

### **Suggested book for reading:**

1. Shanmugam K., 1990. Fishery Biology and Aquaculture. Leo Pathippagam, Madras, India.
2. Arumugam.N. Aquaculture. saras Publications, Nagercoil.

**CORE COURSE – V PRACTICAL-II AN INTRODUCTION TO GENERAL  
BIOLOGY AND PHYSIOLOGY OF CULTIVABLE SPECIES & FARM  
ENGINEERING AND AQUACULTURE TECHNIQUES**

1. Feeding mechanism in bivalves.
2. Effect of hydrogen ion concentration (pH) on amylase activity of the crystalline style.
3. Effect of temperature on respiration of a fish or a crab.
4. Effect of salinity on respiration of a fish.
5. Hormone study – display of neuroendocrine organs of a crustacean.
6. identification of cultivable species of seaweeds, crustaceans, mollusks and fishes.
7. Identification of phyto and zooplanktons.

## SECOND ALLIED COURSE I COMPUTATIONAL AND ANALYTICAL METHODS IN AQUACULTURE –I

- UNIT:1 Introduction to computers and their applications: Computer system characteristics – Hardware and Software – Types and generations of Computers – Introduction to I/O and storage devices.
- UNIT:2 FORTRAN programming – Basics: Representation of integer and real constants – variable – Expression – Assignment statements – Input/Output statements.
- UNIT:3 FORTRAN Programming: Design control statements – Loops and subscripted variable – Files.
- UNIT:4 Introduction to data processing: records, files – Data collection, preparation, verification, editing and checking – backup and file recovery procedure-sorting, searching and merging.
- UNIT:5 FOXPRO fundamentals and programming; Introduction to FOXPRO environment – Database creation and data insertion, deletion and modification- sorting and indexing, Managing Multiple database –Display of data – Foxpro programming –memory variables – Data, Tie, String and math function –report generation.

### References:

1. Illustrated FOXPRO –Granillo-BPB Publications.
2. Introducing Data processing, N.C.C.Publications.
3. Mastering data processing, J.Bingham, Machmillan Master's Series.
4. Programming in FORTRAN. Rajaraman. Ved.Pentice Hall 1983.
5. Programming with FORTRAN-Seymour Lipschuts and Arthur Poe Schaum series 1982.
6. Computer Today-S.K.Basandra-Galgotia Publications.

**SECOND ALLIED COURSE II – PRACTICAL  
PERTAINING SECOND ALLIED COMPUTATIONAL AND ANALYTICAL  
METHODS IN AQUACULTURE I & II**

**Computational methods in aquaculture:**

Part A-FORTRAN Programming lab

1. Mean, standard deviation and mean deviation.
2. Correlation coefficients
3. Regression coefficients and regression lines
4. Fisher's test
5. Chi-square test.

Part B-FOXPRO

1. Creation of deatabase
2. Updation
3. Sorting
4. Indexing
5. Multiple database
6. Reports generation
- 7.

**Analytical methods in aquaculture**

1. Microscopes – various types.
2. Demonstration of colorimeter, spectrophotometers, gas chromatograph, high performance liquid chromatograph, electrophoresis unit, echosounder, pH meter, oxygen analyzer, salinometer, turbidity meter, water and sediment samplers, photo micrographic equipment.
3. Preparation of tissue blocks, section cutting, fixing and processing and sections, mounting.
4. Preparation of whole mounts.

**CORE COURSE VI**  
**FARM ENGINEERING AND AQUACULTURE TECHNIQUES**

- UNIT 1: Criteria of site selection –principles and procedures of elementary survey – designing and layout of farm, water supply to farm, open water and land based farms, ponds, race ways, pens and saltpan reservoirs.
- UNIT:2 Natural seed resources – seed production –seed grounds –methods of collection of seed for culture practices – quarantining – acclimation of seeds.  
Collection and transportation of brood stock. Breeding under controlled conditions, brood stock management, techniques of induced breeding, hatchery production of seed, components of a hatchery, nursery management.
- UNIT:3 Extensive culture – traditional culture practices – in India and other countries, advantages and disadvantages of extensive semi- intensive and intensive culture. Culture of shrimps. Culture of carp, milk fish and sea bass.
- UNIT:4 Feeding and food utilization, energy metabolism, live and artificial feed. Recent advancement – probiotics – immuno stimulants, aqua mtas, bacteria controlling chemicals.
- UNIT:5 Culture of fresh water prawn *Macrobrachium* spp. and its seed production. Culture of lobsters and crabs – prospects and constraints. Production and economics of aquaculture in extensive and semi-intensive systems.

**References:**

1. Pillay. T.V.R., 1972. Coastal Aquaculture in the indo-pacific Region, Fishing News(Book)Ltd., London.
2. Pillay, T.V.R., 1990. Aquaculture principles and practices. Fishing News (Book) Ltd., London
3. Shigueno, K., 1976. Shrimp culture in Japan. Association for international technical promotion, Tokyo.
4. Bardach, J.E., J.H.Ryther and W.O.McLarney, 1972. Aquaculture:Farming and Husbandry of Freshwater and Marine Organisms. Wiley interscience, New York.

**SECOND ALLIED COURSE III**  
**COMPUTATIONAL AND ANALYTICAL METHODS IN AQUACULTURE II**

- UNIT 1: Minor equipments – water and sediment samplers – Secchi disc, lux meter, turbidity meter, pH meter, oxygen analyzer, refractometer, salinometer, echosounder.
- UNIT 2: Microscopy – light microscope, phase contract , photomicrography, electron microscope.
- UNIT 3: Spectroscopy – absorption and emission principles, colorimeters, spectrophotometers (UV visible, fluorescence, atomic absorption spectrophotometer), inductively coupled plasma spectrometer (ICP).
- UNIT 4: Chromatography-paper, thin layer, gas chromatography, high performance liquid chromatograpohy, electrophoresis.
- UNIT 5: Microtechnique – sliding and rotary microtomes, freezing microtome, specimen fixation, dehydration, embedding and sectioning, staining of sections, whole mount preparation.

**Text books:**

1. Galan W.Ewing, 1988. Instrumental methods of Chemical analysis. McGraw-Hall Book Company.
2. Richard W.Von Norman, 1983. Experimental biology, Prentice –Hall, New york.
3. Skoog, D.A. and J.J.Leary 1992. Principles of instrument analysis. Fourth Edition, Saunders college Publishers, Philadelphia.

## **CORE COURSE VII FARM MANAGEMENT AND WATER QUALITIES STUDIES**

- Unit 1:** Selection of site for a fish farm, purchase of land, registration, registration in MPEDA/BFDA for getting subsidy and technical guidance, getting electric connection and other practical considerations.
- Unit 2:** Soil, Water resources of fish farm -Components of fish farm –design and construction, Water regulating devices. Fertilization of pond, improvement of pond bottom, control of aquatic weeds.
- Unit 3:** Concept of integrated farming – crop, integrating livestock and fish culture – selection of organisms – techniques of farming, management of integrated farming system, benefit, concept of blending culture fisheries, advantages and management.
- Unit 4:** Chemical composition of sea water – ionic composition – major and minor elements – trace elements - difference between fresh and sea water.
- Unit 5:** Water quality management – physico – chemical parameters : nutrients, ammonia, oxygen, pH, hydrogen sulphide and organic matter permissible levels.

### **References:**

1. S.K.Gupta and P.C.Gupta. General and Applied Ichthyology (Fishes and Fisheries). S.Chand &Co.New Delhi-55.
2. Brown, E.E.,1976. World Fish Farming, Cultivation and Economics.
3. Sinha, P.R.R. 1974. Studies in Extension Education.
4. Riley, J.P.and R.Chester, 1971. Introduction to Marine Chemistry. Academic press, London.
5. . Riley, J.P.and G.Skirrow, 1975-1984. Chemical Oceanography, vols.1 to 8. Academic pres, London
6. Strickland, J.D.H and T.R.Parsons, 1972. A practical Handbook of Seawater analysis. Fisheries Board of Canada, Ottawa, Bulletin, 167.
7. Arumugam.N. Aquaculture.saras Publications, Nagercoil.

**CORE COURSE VIII**  
**MICROBIAL INFECTION, DISEASE DIAGNOSIS AND CONTROL MEASURES**

**Unit 1:** General introduction to marine microbiology and pathology - their importance in aquaculture.

**Unit 2:** Study of marine microorganism: methods of collection of water, sediment and fish samples, isolation and culture of bacteria.

**Unit 3:** Disease development: Abiotic and biotic factors important: Diseases of finfish vira, bacterial, fungal, parasitic (protozoan & metazoan) environmental and nutritional diseases.

**Unit 4:** Larval health monitoring with special reference to shrimps. Modern techniques employed in disease diagnosis of cultivable organisms, with reference to microbiology, immunology and PCR).

**Unit 5:** Control of diseases, environmental, physical, chemical and biological methods. Sanitary practices and prophylactic measures – disinfection procedures, water quality standards disease, common chemicals and antibiotics in use, immunization of cultivable organisms.

**References:**

1. Ferguson wood, E.J.,1967. Microbiology of Oceans and Estuaries. Elsevier publishing Co., Amsterdam.
2. Hawker, L.E. and A.h.Linton, 1971. Microorganisms; Function, form and Environment Edward Arnold ltd., London.
3. Sinderman, C.J.and C.V.Lightner, 1988. Disease Diagnosis and control in North American Marine Aquaculture. Elsevier, Amsterdam.
4. Rheinheimer, G., 1980. Aquatic Microbiology John Wiley & Sons.
5. Atlas, R.M.and Bartha, 1997. Microbial Ecology – Fundamentals and applications, Benjamin, Cummings science Publishers.
6. Prescott, L.M.Harley, J.P.and D.A.Klein, 1999. Microbiology, Mc Graw Hill Inc., pp 1962.

## **CORE COURSE IX - POST HARVEST TECHNOLOGY**

- Unit 1: Importance of preservation and processing of cultured organisms, criteria of assessing the freshness of cultured organisms –handling of fresh materials, rigor mortis, quality assurance, HACCP – CONCEPTS – Freezing plants – Hazard Analysis : Identification – Assessment.
- Unit 2: Types of fish spoilage, causative factors – autolytic spoilage, microbial spoilage, oxidative changes.
- Unit 3: Drying and dehydration – conventional and modern method of drying (solar driers), relative merits and demerits.  
Salt curing, pickling and smoking – merits and demerits.
- Unit 4: Freezing and cold storage – various types of freezers, individually quick freezing (IQF), cold storage design and equipments, freeze –drying, canning – history of canning, containers, canning procedures.
- Unit 5: Fishery by –products of commerce – processing of miscellaneous products, fish meal, oil fish protein concentrate, fish waters, ensilage, chitosan etc., development of diversified products.

### **References:**

1. Stans by, M.E., 1963. Industrial fishery technology. Reinhold publishing corporation.
2. Kreuzer, R., 1974, Fishery products. FAO fishing News (Books0 Ltd., England.
3. Govindan, T.K., 1985. Fish processing Technology, Oxford and IBH publishing company private Ltd., New Delhi.
4. Ravindran, K., N.Unnikrishnan Nair, P.A. Panicker and Mary Thomas, Proc. Of the symposium on Harvest and post –Harvest Technology of Fish Society of Fisheries Technologists (India) Cochin.
5. Chandran, K.K., 2000. Harvest Technology of Fish and Fish products. Daya publishing House, New Delhi.

**CORE COURSE X PRACTICAL III –  
FARM MANAGEMENT AND WATER QUALITIES STUDIES MICROBIAL  
INFECTIONS, DISEASE DIAGNOSIS AND CONTROL MEASURES. POST  
HARVEST TECHNOLOGY**

1. Salinity
2. Alkalinity
3. Dissolved oxygen
4. Calcium and magnesium
5. Nitrate
6. Nitrite
7. Reactive phosphorus
8. Particulars phosphorus
9. Sulphide
10. Ammonia
11. Organic nitrogen
12. Silicate
13. Estimation of BOD
14. Estimation of COD
15. Pesticide residues
16. Heavy metals (Cu, Cd, Pb, Hg)
17. Use of LC50 values sublethal effect of critical pollutants to fish and shellfish.
18. Observation of Bacterial, fungal and viral diseases in fin fish and shell fishes.
19. Culture of bacteria from fish samples.
20. Observation of bacterial samples using simple and Gram's staining.
21. Visit to a fish processing industry and observation of fish processing technologies.

## **CORE COURSE XI – FISH NUTRITION AND FEED MANAGEMENT**

- Unit 1: Larval nutrition and growth – digestive process, feeding behavior and its role in larval nutrition Nutrient requirement of larvae. Brood-stock nutrition – effect of dietary quality on reproductive out put and growth.
- Unit 2: Feeding cultivable species- appetite and satiation, factors influencing feeding behaviour, feeding practices in aquaculture weaning. Energetics – Gross Conversion efficiency, the effect of ration on growth.
- Unit 3: Feed in intensive aquaculture – feed development, feed ingredients. Feed types and uses – wet feeds wet and moist formulated feeds, dry feeds, commercial feed types. Feed handling and storage.
- Unit 4: Non-Nutrient diet components-anti metabolites, binders, accidental contaminants, aflatoxins, non-toxic dietary components –Fiber, Ash.Steroids and Steroid – like substances.
- Unit 5: Status of the aquaculture feed industry – Europe, Canada, Japan, Asia and India. Problems of the industry – reducing feed cost. Effect of feeds on the environment.

### **References:**

1. S.S.De Silva and T.A.Anderson, 1995. Fish Nutrition in Aquaculture.
2. Stephen Goddard, 1996. Feed Management in aquaculture. Chapman and Hall, New York.
3. Kitab Mahal, 1999. A text books of fishery science and Indian fisheries, century printers, Allahabad.

## **CORE COURSE XII FISHING GEARS AND CRAFTS**

Unit 1: Statistics on world and Indian fish catches. Indian export of sea food. Fishing gear: Classification, basic principles of fishing gear design construction and operation – Trawls, Purse seine, look and lines, Gill nets, Traps.

Unit 2: Fish detection methods – acoustic fish detection – Echo sounder, Sonar, Net recorder – aerial survey, remote sensing.

Unit 3: Traditional fishing methods – modernization of Indian fisheries – mechanization of boats and the advancement. Fisheries department regulation policy and conventions.

Unit 4: Types of gears used in farm operations. Collection of prawn and fish brooders. Spat collection. Unconventional fishing – Electro –fishing, light fishing.

Unit 5: Fishing Hamlets – Socio-economic problems of fisherman. Principles of public action. Implementation of New Law of the sea. EEZ –Role of fishery scientists – Professional ethics.

### **References:**

1. Maarten B.2001. Marine resource management. Sage Publication Inc. California.
2. M.Shahul Hameed and M.R.Boopendranath, 2000. Modern fishing gear technology. Daya publishing House, New Delhi.
3. William,M,Royce, 1995. Introduction to the practices of fishery science. Academic press. New york.,
4. Kitab Mahal, 1999. A text book of fishery science and Indian fisheries century printers, Allahabad.

**CORE COURSE XIII PRACTICAL IV  
FISH NUTRITION AND FEED MANAGEMENT. FISHING GEARS AND  
CRAFTS.**

Preparation of feed for cultivable species with natural and inorganic ingredients- feed formulation for Prawn and Fishes.

Observation of different craft used for fishing- traditional –mechanised- Raft-Catamaran- Dugout canoe- Simple boats- large boats Masula boat-Mechanized boats – Pictures.

Observation of different gears- Drag nets- seines-beach seine, -Danish seine-Purse seine- Trawls –Beam trawls – Otter trawls. Gill nets- Barrier nets- Cast net- scoop nets- movable traps- Hook and line fish catching device.

Visit to CMFRI, CIBA,

## MAJOR BASED ELECTIVE – I MICROBIAL BIOTECHNOLOGY

Unit 1: Biotechnology – definition – concepts– history and achievements.

Unit 2: Enzyme production technology through microbes. Problems and applications enzyme immobilization and its applications.

Unit 3: Microalgal technology industrial cultivation methods of Spirulina- biotechnology potentials of microalgae – food – feed –fuel production – pharma – ceutically valuable compounds from microalgae.

Unit 4: Principles and applications of recombinant DNA technology and strain improvement (mutational, r-DNA technologies)

Unit 5: Production of biotechnological products. Food – SPC (Algae, yeast. Mushroom) Bio fertilizer (Cyanobacteria, Rhizobia, Azospirillum, Azotobacter, Frankia, VAM). Bioinsecticide (Bacillus thuringiensis) Fuel-ethanol. Pharmaceuticals – antigens, interferons, vaccines, insulin, hormones, gene therapy methods. Hybridomas and monoclonal antibodies.

### References:

1. Desmond, S.T., Nicholl 1994. An invention to genetic engineering. Cambridge press. Old Rw and S.B.Primrose. 1994. Principles of Gene manipulation, 4<sup>th</sup> Blackwell scientific publications, London.
2. Cresswell Rc, Ress, TAV and Shah, N.1989. Algal and Cyanobacterial Biotechnology. Longman scientific and Technical New york.,
3. Prave, P.Paust, V.sittig, W.and sukatasch, D.1987-Fundamentals of Biotechnology. Glick B.R.and Pasternak, JJ.1994. Molecular biotechnology. ASM press. Washington Dc.
4. Watson,J.D.Gilman, M.Witkowski, J.Zoller, M.1992. Recombinant DNA. 2<sup>ND</sup> Ed, Scientific American Books.
5. Lewin, B(2000). Genes VIII. Oxford University Press. Oxford.
6. Balasubramanian. D., Bryce, C.Dharmalingam, K.Green, J.and Jayaraman K.(1996)concepts in Biotechnology, University press, India.
7. Trevan, MD, Boffey, S.Coulding KH & standury, P.1990. Biotechnology. The basic principles Tata MC Graw Hill edition.

## MAJOR BASED ELECTIVE – II IMMUNOLOGY

- Unit1: Introduction: Terminologies – history of immunology – Immunohematology, Blood groups, Blood transfusion – Rh –incompatibilities – immunity-types of immunity-innate and acquired.
- Unit 2: Immune systems: Anatomy of lympho-reticular system-primary lymphoid organ. Secondary lymphoid tissue – Cells of the immune system-detailed aspects of T and B cells-receptors – activation and function.
- Unit 3: Antigens: Types, properties, haptens-adjuvants –vaccines –types-toxoids, antitoxins, Immunoglobulins – structure types and properties. Theories of antibody production.
- Unit 4: Antigen – antibody reactions – in vitro methods, agglutination –precipitation, methods, agglutination –precipitation, complement fixation, Immunofluorescence, ELISA, RIA, in vivo methods: skin tests – immune complex tissue demonstrations.
- Unit:5 Hypersensitivity reactions-antibody mediated, type I anaphylaxis, Type II-Antibody dependent cell cytotoxicity. Type III immune complex reactions – respective disease and immunologic methods of diagnosis –cell mediated immune responses lymphokines, cytokines. Type IV-Hypersensitivity reactions. MHC and transplantation.

### References:

1. Ivan M.Roit 1994. Essential Immunology-Blackwell scientific publications, oxford.  
Donal M.Weir, John, steward 1993. Immunology VII edition. ELBS, Lodon.
2. Richard M.Hyde 1995. Immunology III edition. National Medical series, Williams & Wilkins. Harward publishing company.
4. Janis kuby 1993.Immunology II edition. W.H.Frumen and company, New york.

### Suggested book for reading.

1. William E.Paul 1993. Fundamental immunology. II edition Raven press, New york.
2. Topley & wilsons 1990. Principles of Bacteriology, virology and immunity VIII edition Vol.I General microbiologu and immunity Edward Arnold, London.
3. Helen chapel, Mansel Haeney 1986. Essentials of clinical immunology. ELBS.  
Abul K.Abbas, Andrew H.Lichtman, Jordans. Pobar 1994. Cellular and molecular immunology. II edition W.B.Saunders, U.S.A.

## **MAJOR BASED ELECTIVE – III AQUACULTURE BIOTECHNOLOGY.**

- Unit1: Animal cells – collection and cryopreservation of animal cells, culture media, primary and established cultures. Transformation and genetics of animal cells.
- Unit 2: Kinetics of cell growth –logarithmic and stationery phases, metabolism and growth factors, interaction among cells-cell signaling, signaling pathways, cell proliferation, apoptosis.
- Unit 3: Basic concept-immunoglobulin – types of immunity (innate, acquired)-specific memory. Types of antigens – their structure –preparation of antigens, rising antibodies – handling of animals- adjuvants and their mode of action. Antibodies and immunodiagnosis – ELISA, RIA.
- Unit 4: Introducing DNA into animal cells, injection, viral vectors, tissue culture in biomedical and biochemical research; regulatory proteins, blood products, vaccines and hormones.  
Transgenic animals, fertilization and embryo transfer, foreign gene expression e.g.silkworm and baculoviruses (biocontrol) biotechnology of aquaculture and pest management.
- Unit 5: Mapping and sequencing of genome, Ethical issues in animal biotechnology, management aspects of biotechnology and genetic engineering.

### **References:**

1. Animal Cells; culture and media b D.C. Darling and S.J.Morgan (1994) John Wiley and sons.
2. Advances biotechnology by (Ed) Digmathi et al.(1999) Discovery publishing home, N.Delhi.
3. Gene transfer and expression protocols –Methods in molecular biology Vol7 by (Ed) E.T.Murray (1991) Humana press.
4. Molecular biology of the Gene by J.D.Watson, N.H.Hopkins, J.W.Roberts, J.A.Steitz and A.M.Weiner (1987) Benjamin /Cummons 4<sup>th</sup> Ed.Vol.1 &2
5. Genetic Engineering of animals by (Ed) a.Puhler (1993) VCH Publishers, Weinheim, FRG
6. Recombinant DNA 2 nd by (Ed). J.D.Watson, MGilman,J. Witknowski and M.Zoller (1992) Scientific American Books, NY/
7. Ivan M.Roitt Jonathan Brossoff and david K.Male (1985). Immunology (Glower medical publishing London). First edition.

## **NON MAJOR ELECTIVE I ORNAMENTAL FISHCULTURE.**

### **UNIT – 1**

Importance and scope of ornamental fish culture - Economics. Commercial value and potential, trends in ornamental fish farming in the world and in India. Taxonomy of important freshwater and marine ornamental fish-indigenous and exotic species.

### **UNIT – 2**

Popular ornamental fishes: Beta, Colisa, Macropodus, Trichogaster leeri, T. italics microlepis, Zebra fish.

Gold fish varieties: Koi, Puntius, tetra, Glass fish, cichilids, angel fish, molly, guppy.

Marine species: Hippocampus, scat, Basics on biology, habits (sociability and aggression) and patterns of reproduction.

### **UNIT – 3**

Mass production of fancy fishes Fish farms: Preparations for breeding – breeding behaviour of chosen fishes: carp, fighter fish – induced breeding – food and feeding – live feeds: rotifers, tubifex, artificial feeds.

### **UNIT –4**

Aquarium design, Construction and preparation: size, shape, substrate, ornamental aquatic plants. Construction and functions of Biofilters; aerators – accessories for fish tanks – hood and light, nets, suction tube and maintenance of water quality: controlling ammonia build up, pH, feeding regimes.

### **UNIT –5**

Disease management: Common bacterial, viral fungal, protozoan and crustacean infections. Their treatment and control.

### **References:**

1. Rath, R.K. (2000) Freshwater Aquaculture. Scientific Publishers (India). PO Box:91, Jodhpur.
2. Jhingran, AVG (1991) Fish and Fisheries of India. Hindustan Publishing Co.
3. Baradach, JE, JH Ryther and WO Mc Larney (1972). Aquaculture. The Farming and Husbandry of Freshwater and Marine Organisms. Wiley Interscience, New York.
4. Jameson, J.D. and R.Santhanam (1996). Manual of ornamental fisheries and farming technology. Fisheries College and Research Institute, Thoothukudi.
5. Mitchell Beazley, 1998. The complete guide to tropical aquarium fish care. Read and Consumes Book Ltd., London.
6. Everything for the aquarist. Tetra Werke Publication, West Germany.
7. Jameson, J.D. Alangara Meen Valarpu (in Tamil). National Book House, New Delhi.

## NON MAJOR ELECTIVE II FRESHWATER AQUACULTURE

- Unit-1 : Scope of aquaculture- Fresh water aquaculture practices in India- Cultivable organisms.
- Unit 2: Preparation of fish pond- selection of site- construction of fish farm- liming irrigation-fertilization- water quality management-
- Unit 3 Types of culture- Monoculture- composite fish culture- monosex culture- Pen culture- cage culture- culture in Pokkali fiels - Culture in Bheries.
- Unit 4. Culture of Indian major carps- Tilapia- Fresh water prawn culture. Marketing of fishes- types of fish marketing-
- Unit 5. Integrated fish farming – Paddy cum fish culture- fish cum poultry farming- fish cum dairy farming – fish cum pig farming .

### References:

1. Santhanam.R,N.Sukumaran, P.Natarajan.1990. A Manual of Fresh water Aquaculture. Oxford &IBH publishing.co.P.Ltd.
2. Shanmugam K., 1990. Fishery Biology and Aquaculture. Leo Pathippagam, Madras, India.
3. Arumugam.N. Aquaculture.saras Publications, Nagercoil.
4. Gupta.S.K. and P.C.Gupta. 2006. General and Applied Ichthyology. S.chand &co New Delhi.