

M.Sc., AQUACULTURE

I – SEMESTER

PAPER - I: PRINCIPLES OF FRESHWATER BIOLOGY

CODE NO. AC 101

UNIT – I

1. Water as medium; types, states, sources, constituents, physical features and properties
2. Light; factors affecting the availability of light; effects of light on aquatic biota
3. Temperature; sources, measurement; extremes; and distribution in aquatic environment

UNIT – II.

1. Dissolved gases; oxygen and carbon dioxide – sources, reduction, and distribution and factors affecting the distribution
2. Hydrogen ion concentration; concept, acidity, alkalinity and neutrality. Expression of hydrogen ion concentration, substances yielding hydrogen ion to inland waters, range, changes, and buffer effect.
3. Inorganic nutrients; nitrogen, phosphorus, silicon, sulphur and iron in inland waters

UNIT – III.

1. Lacustrine biocoenosis; different types of classification of organisms in water
2. Classification of lentic waters, physical and chemical conditions and faunal characteristics

UNIT – IV

1. Classification of the lotic environment, characteristics of streams, biotic resources with special reference to the Godavari and Krishna riverine systems
2. Productivity : Biological and organic productivity, concepts of productivity, methods for measuring productivity, and classification of freshwater bodies based on productivity

TEXT & REFERENCE BOOKS

1. Welch, P.S. Limnology, McGraw – Hill, New York, 1952
2. Clark, G.L. Elements of Ecology. John Wiley & Sons Inc. New York, 1954
3. Hutchinson, G.E. A Treatise on Limnology Vol - I & Vol – II, John Wiley & Sons, 1957
4. Ruttner, F. Fundamentals of Limnology, Translated by D.G. Frey and F.E. Frey University of Toronto Press, 1968
5. Wetzel, R.G. Limnology, W.B. Saunders Co., 1975
6. Reid, G.K. & R.D. Wood, Ecology of Inland waters and Estuaries. Van Nostrand Co. 1976
7. Cole, C.A. Text Book of Limnology. The C.V. Mosby Co. 1983

M.Sc., AQUACULTURE

I – SEMESTER

PAPER – II: TAXONOMY AND FUNCTIONAL ANATOMY OF FIN FISH

CODE NO. AC 102

UNIT – I

1. Classification of Fishes up to subclass
2. Gross external anatomy of fishes : Skin and its derivatives, scales and their significance

UNIT – II

1. Natural food of fishes and feeding habits
2. Feeding adaptations and stimuli for feeding

UNIT – III

Respiratory organs in fishes

1. Excretion and osmoregulatory mechanisms in fresh, marine and diadromous fishes
2. Endocrine organs in fishes

UNIT – IV

1. Modes of reproduction, reproductive cycle, gonad maturity stages, fecundity, spawning seasons and grounds, modes of spawning
2. Environmental factors controlling reproduction,
3. Factors affecting development
4. Parental care in fishes

TEXT & REFERENCE BOOKS

1. Borradile & R.A. Potts. The Invertebrates. Asia Publishing House, 1962
2. Nikolsky, G.V. Ecology of Fishes. Academic Press, NY., 1963
3. Kaestner, A. Invertebrate Zoology. Vol. I - III. John Willey & Sons, 1967
4. Howar, W.S. & D.J.Randal. Fish Physiology. Vol. 1-4, Academic Press, NY., 1970
5. Barrington, E.J.W. Invertebrates : Structure and Function. ELBS, 1971
6. Jhingran, V.G. Fish and Fisheries of India. Hindustan Publ. Company, 1975.
7. Norman, J.R.& P.H. Greenwood. A History of Fishes. 3rd. ed. Ernest Benn Ltd., 1975
8. Kurian,C.V.& V.O. Sabastian. Prawns and Prawn Fisheries of India. Hindustan Publ. Co., 1976
9. Fretter,V&A.Graham.The Functional Anatomy of Invertebrates.Academic Press Inc.(Lon.) Ltd., 1976
10. Lagler, K.E. et al.. Ichthyology. John Wiley, 1977
11. Carl, B.E. Biology of Fishes. Saunders, 1979
12. Moyle Peterb. Fishes : An Introduction to Ichthyology. Prencice Hall, 1979
13. Low, M.S. & G.M. Calliet (eds). Readings in Ichthyology. Prentice-Hall, 1979
14. Parker, T.J. & W.A. Haswell. The Text Book of Zoology. Vol. I. Invertebrates. (eds. A.J. Marshall & W.D. Willimas), ELBS & McMillan & Co., 1992

M.Sc., AQUACULTURE
I – SEMESTER
PAPER - III : DISEASES OF CULTURE ORGANISMS -1
CODE NO. AC 103

UNIT – I

1. Prophylaxis in fish farm, hygiene and fish farming, therapy and fish farming, techniques of curative baths and techniques of mass injection
2. Fish Immunity : Natural and acquired immunity

UNIT – II

1. Viral Diseases of Fish : Clinical picture, symptoms and prophylaxis of Papillomatosis, Lymphocystis, and Infective Pancreatic Necrosis in fishes
2. Bacterial Diseases of Fish : Clinical picture, symptoms and prophylaxis of Bacterial Hemorrhagic Septicemia, Columnaris Disease, Cold water Disease and Bacterial Gill Disease

UNIT – III

1. Fungal Diseases of Fish : Clinical picture, symptoms and prophylaxis of Branchiomycosis and Saprolegniasis
2. Protozoan Diseases of Fish : Clinical picture, symptoms and prophylaxis of Nodular Coccidiosis in the Intestine of carp, Enterococcidiosis in the carp, Whirling Disease, Chilodonella and Ichthyophthirius

UNIT – IV

1. Helminthiasis in Fish : Diseases produced by Dactylogyrus and Monocoelium, Gyrodactylus, Diplozoon, diseases produced by Caryophyllaeus, Ligula, Schistocephalus, Dibothriocephalus latus, Triaenophorus, diseases caused by Nematodes and fish leeches – clinical picture, symptoms and prophylaxis
2. Crustacean Parasites of Fish : Ergasilus, Lernaea, Achtheres, Sphyrion, Argulus, and Cerripeds – clinical picture, symptoms and prophylaxis

TEXT & REFERENCE BOOKS

1. Chang, T.C. The Biology of Animal Parasites. Saunders, Philadelphia, 1964
2. Reichenbach, H.H. Fish Pathology. T.F.H. (Great Britain) Ltd., England, 1965.
3. Conroy, D.A. & R.L. Herman. Text Book of Fish Diseases. Ibid., 1968
4. Ribelin, W.E. & G. Miguki. The Pathology of Fishes. The Univ. of Wisconsin Press Ltd., Great Russel St., London, 1975

M.Sc., AQUACULTURE
I – SEMESTER
PAPER - IV : FIN FISH CULTURE
CODE NO. AC 104

UNIT-I

1. Biological principles underlying the selection of a species for culture
2. Culture of Major carps:
 - a. Fish seed : Natural resources of major carp seed and collection from natural resources- Bund breeding of carps,
 - b. Induced breeding by Hypophysation and Use of Synthetic hormones
 - c. Design and layout of a fish farm
 - d. Preparation and Management of nursery, rearing and production ponds
3. Concept of Composite fish culture- indigenous and exotic carps and Polyculture

UNIT II

1. Breeding and culture of air-breathing fish – Murrells, catfish and climbing perch
2. Culture of Gourami and Tilapia
3. Culture of Ornamental fish.

UNIT III

1. Culture of Eels
2. Culture of sea bass, *Lates*,
3. Culture of Milk fish, *Chanos* and Mulletts, *Mugil*

UNIT IV

1. Integrated farming : Paddy cum fish culture, Poultry cum fish culture, Dairy cum fish culture, Piggery cum fish culture.
2. Organic aquaculture – Concept, principles and practices
3. Fishing Gear and Craft in Inland water bodies.

TEXT & REFERENCE BOOKS

1. Huet, M. Text Book of fish culture – Breeding and cultivation of fish. Fishing News (Books) Ltd., England, 1972
2. Bardach, et al. Aquaculture – The Farming and Husbandry of freshwater and marine organisms. John Willey & Sons, New York, 1972
3. Chen, T.P. Aquaculture practices in Taiwan. Fishing News (Books) Ltd., England, 1976
4. Takeo Imai, Aquaculture in Shallow Seas – Progress in Shallow Sea Culture. Oxford & IBH., Publ. Co., India, 1977
5. Stickney, R.R. Principles of Warm water Aquaculture. John Willey & Sons, New York, 1979
6. Chondar, C.L. Hypophysation of Indian Major Carps. Satish Book Enterprise, Agra, 1980
7. Iso Matsui. Theory and practice of Eel Culture. Amerind Publishing Co., Pvt. Ltd., 1980
8. Jhingran, V.G. Fish and Fisheries of India. Hidustan Publ. Corporation (India), 1982
9. Brown, E.E. World Fish Farming – Cultivation and Economics. AVI Publishing Co., Connecticut, 1983
10. Santhanam, R. et al. A Manual of Freshwater Aquaculture. Oxford & IBH Publishing Co. Pvt. Ltd., 1987
11. Pillay, T.V.R. Aquaculture – Principles and Practices. Fishing News (Books) Ltd., London, 1990
12. Pandey, A.C. Air Breathing Fishes. Reliance Publishing House, New Delhi, 1990

M.Sc. AQUACULTURE

I - SEMESTER

**PRACTICAL-1. TAXONOMY AND ANATOMY OF FIN FISH & AQUATIC BIOTA
CODE No. AC 105**

1. Identification of freshwater, brackish water and marine cultivable fish
2. Phytoplankton and zooplankton: Identification of major groups up to genus level
3. Predaceous insects and larvae
4. Common benthic organisms
5. Macrophytes
6. Methods of food analysis and a study of the guts in fish with different feeding habits
7. Identification of the stages of maturation; measurements of diameters of intraovarian ova; estimation of fecundity
8. Dissection of pituitary gland and preparation of pituitary extract.
9. Dissection of digestive system of different cultivable fishes
10. Mounting of scales

M.Sc. AQUACULTURE

I - SEMESTER

**PRACTICAL-2. FISH PARASITOLOGY AND PATHOLOGY
CODE No. AC 106**

1. Techniques of diagnosis of disease : external examination of the diseased fish; procedure for rapid killing of fish; exploration of skin smear; exploration of the gill smear; technique of autopsy; inspection of the internal organs; maceration and squash preparation of organs for microscopic observation
2. Post-mortem examination of diseased fish
3. Mounting of some important ecto and endoparasites of fish
4. The techniques employed in sending of fish for analysis of the diseases
5. Identification of Fish Diseases

M.Sc., AQUACULTURE

II – SEMESTER

**PAPER – V : PRINCIPLES OF MARINE AND ESTUARINE BIOLOGY
CODE NO. AC 201**

UNIT – I

1. Classification of the marine environment and salient features of different zones
2. Physical environmental factors – Temperature, Light, Salinity, Pressure; Types of Currents, Tides, Waves

UNIT – II

1. Chemical environmental factors – Oxygen, Carbon dioxide and Carbonates, pH
2. Classification of marine organisms and their characteristic features

UNIT – III

1. Terminology of marine topography – features resulting from unstable formations , features resulting from erosion deposition and biological activity
2. Types of shores – rocky, sandy and muddy shores, their characteristic features, fauna and their adaptations. Zonation in Rocky shores

UNIT – IV

1. Estuaries; origin , types and classification
2. Physical and chemical characteristic of estuaries,. Estuarine fauna and their adaptations.

TEXT & REFERENCE BOOKS

1. Sverdrup, H.V., M.W. Johnson and R.H.Fleming. The Oceans: their physics,chemistry and general biology. Prentice Hall, INC. 1942
2. Reid , G.K. & R.D.Wood. Ecology of Inland waters and Estuaries. Van Nostrand Company, 1976
3. Lewis, J.R. The Ecology of Rocky Shores. The English Universities Press Ltd. London, 1964.
4. Balakrishnan Nair, N, and D.M. Thampi. A Text Book of Marine Ecology. Macmillaan Company of India Ltd., Delhi, 1980.
5. Santhanam, R. and A. Srinivasan. A Manual of Marine Zooplankton. Oxford & IBH Publishing Co. Pvt., Ltd., New Delhi, 1994.

M.Sc., AQUACULTURE

II – SEMESTER

**PAPER – VI : TAXONOMY AND FUNCTIONAL ANATOMY OF SHELL FISH
CODE NO. AC 202**

UNIT – I.

1. Classification of Crustacea up to orders
2. Classification of Mollusca up to Sub-class

UNIT – II

1. Food, feeding habits and adaptations of cultured crustaceans
2. Food, feeding habits and adaptations of cultured molluscs

UNIT –III

1. Respiratory organs in crustaceans
2. Respiratory organs in mollusca
3. Excretion in crustaceans and mollusks

UNIT – IV Reproductive patterns in crustaceans, reproductive organs, gonad maturity, spawning and fertilization

1. Endocrine organs in crustaceans and their role in reproduction
2. Reproductive patterns in molluscs, reproductive organs, gonad maturity, spawning and fertilization

TEXT & REFERENCE BOOKS

1. Borradile & R.A. Potts. The Invertebrates. Asia Publishing House, 1962
2. Nikolsky, G.V. Ecology of Fishes. Academic Press, NY., 1963
3. Kaestner, A. Invertebrate Zoology. Vol. I - III. John Willey & Sons, 1967
4. Howar, W.S. & D.J. Randal. Fish Physiology. Vol. 1-4, Academic Press, NY., 1970
5. Barrington, E.J.W. Invertebrates : Structure and Function. ELBS, 1971
6. Jhingran, V.G. Fish and Fisheries of India. Hindustan Publ. Company, 1975.

7. Norman, J.R. & P.H. Greenwood. A History of Fishes. 3rd. ed. Ernest Benn Ltd., 1975
8. Kurian, C.V. & V.O. Sabastian. Prawns and Prawn Fisheries of India. Hindustan Publ. Co., 1976
9. Fretter, V.& A. Graham. The Functional Anatomy of Invertebrates. Academic Press Inc.(Lon.) Ltd., 1976
10. Lagler, K.E. et al.. Ichthyology. John Wiley, 1977
11. Carl, B.E. Biology of Fishes. Saunders, 1979
12. Moyle Peterb. Fishes : An Introduction to Ichthyology. Prencice Hall, 1979
13. Low, M.S. & G.M. Calliet (eds). Readings in Ichthyology. Prentice-Hall, 1979
14. Parker, T.J. & W.A. Haswell. The Text Book of Zoology. Vol. I. Invertebrates. (eds. A.J. Marshall & W.D. Wllimas), ELBS & McMillan & Co., 1992

M.Sc., AQUACULTURE

II – SEMESTER

PAPER - VII : DISEASES OF CULTURE ORGANISMS -2 CODE NO. AC 203

UNIT - I

1. Ecological diseases produced by physical and chemical factors: Lack of oxygen, gas bubble disease, pH acidosis and alkalosis, intoxications, hydrocyanic acid, free chlorine, metals, phenol, insecticides and temperature disturbances
2. Nutritional diseases of fish : Metabolic disturbances, vitamin deficiencies, bone degeneration, gastritis and enteritis, thyroid disturbances and aflotoxins in feed

UNIT - II

1. Hereditary diseases of fish : Tumors of hereditary origin, hydrocoele and deformities
2. Tumors in Fish : Epitheliomas and fibro-epitheliomas, epithelioma papulosum, papillomas, adenomas, carcinomas, hepatoma and melanomas

UNIT – III

1. Common Viral and Bacterial diseases of Shrimps
2. Fungal and Protozoan diseases of Shrimps

UNIT - IV

1. Biological factors that adversely affect aquaria and their control : Hydras, turbellarians, blue green algae, green algae and diatoms
2. Control and treatment of diseases in fish and shrimp culture ponds – Chemicals, Antibiotics and Drugs.

TEXT & REFERENCE BOOKS

1. Chang, T.C. The Biology of Animal Parasites. Saunders, Philadelphia, 1964
2. Reichenbach, H.H. Fish Pathology. T.F.H. (Great Britain) Ltd., England, 1965.
3. Conroy, D.A. & R.L. Herman. Text Book of Fish Diseases. Ibid., 1968
4. Ribelin, W.E. & G. Miguki. The Pathology of Fishes. The Univ. of Wisconsin Press Ltd., Great Russel St., London, 1975

M.Sc., AQUACULTURE

II – SEMESTER

PAPER – VIII : SHELL FISH AND SEA WEED CULTURE

CODE NO. AC 204

UNIT – I

1. Culture of Indian Marine Shrimps : Seed collection natural resources, identification of post-larvae of penaeid, breeding by eyestalk ablation, hatchery management and larval rearing, stocking and management of production ponds.
2. Culture of Crabs : Seed collection from nature, collection methods, stocking and management of grow out ponds and other culture systems.

UNIT – II

1. Freshwater prawn culture : Seed procurement from natural resources , methods of breeding, larval rearing and management of culture ponds.
2. Culture of Crayfish

UNIT – III

1. Commercially important molluscs of Indian waters
2. Culture of Edible oysters
3. Culture of Pearl oysters and Pearl culture
4. Culture of Clams
5. Freshwater Pearl culture

UNIT – IV

1. Commercially important Sea weeds and their culture techniques.
2. Culture of Live feeds : Algal culture, Artemia culture and Zooplankton culture

TEXT & REFERENCE BOOKS

1. Kurian, C.V. & V.O. Sebastian. Prawn and Prawn fisheries of India . Hindustan Publ. corp. India. 1982
2. Huner Jay V., et al. Crustacean and Mollusc Aquaculture in United States. AVI Publishing Co., Connecticut. 1985
3. Janardhana Rao, K & S.D. Tripathi. A Manual of Giant Freshwater Prawn Hatchery. CIFA, Kausalyaganga , Orissa, India. 1993
4. Huet, M. Text Book of fish culture – Breeding and cultivation of fish. Fishing News (Books) Ltd., England, 1972
5. Bardach, et al. Aquaculture – The Farming and Husbandry of freshwater and marine organisms. John Willey & Sons, New York, 1972
6. Chen, T.P. Aquaculture practices in Taiwan. Fishing News (Books) Ltd., England, 1976
7. Takeo Imai, Aquaculture in Shallow Seas – Progress in Shallow Sea culture. Oxford & IBH., Publ. Co., India, 1977
8. Stickney, R.R. Principles of Warm water Aquaculture. John Willey & Sons, New York, 1979
9. Chondar, C.L. Hypophysation of Indian Major Carps. Satish Book Enterprise, Agra, 1980
10. Iso Matsui. Theory and practice of Eel Culture. Amerind Publishing Co., Pvt. Ltd., 1980
11. Jhingran, V.G. Fish and Fisheries of India. Hindustan Publ. Corporation (India), 1982
12. Brown, E.E. World Fish Farming – Cultivation and Economics. AVI Publishing Co., Connecticut, 1983
13. Santhanam, R. et al. A Manual of Freshwater Aquaculture. Oxford & IBH Publishing Co. Pvt. Ltd., 1987
14. Pillay, T.V.R. Aquaculture – Principles and Practices. Fishing News (Books) Ltd., London, 1990
15. Pandey, A.C. Air Breathing Fishes. Reliance Publishing House, New Delhi, 1990

M.Sc. AQUACULTURE
II - SEMESTER
PRACTICAL-3. MARINE AND ESTUARINE BIOTA AND TAXONOMY AND
ANATOMY OF CULTIVABLE SHELL FISH
CODE No. AC 205

1. Identification and systematics of estuarine and marine shell fish of commercial importance
2. Identification of different stages of shrimp and prawn seed
3. Identification of important cultivable sea weeds
4. Dissection and display of the visceral organs of freshwater mussel
5. Dissection of digestive system of shrimp and prawn
6. Identification and mounting of different appendages of shrimp and prawn

M.Sc. AQUACULTURE
II - SEMESTER
PRACTICAL-4. SHELL FISH DISEASES, MICROTECHNIQUE & VIVA-VOCE
CODE No. AC 206

1. Identification of shrimp and prawn diseases
2. Post-mortem examination of diseased shrimp/prawn
3. Preparation of paraffin blocks and the histology of most important internal organs - skin, gills, heart, spleen, liver, kidney and intestine
4. Mounting of some important ecto and endoparasites of shrimp
5. The techniques employed in sending of shrimp/prawn for analysis of diseases &
6. Viva-voce

M.Sc., AQUACULTURE
III – SEMESTER

PAPER – IX : NUTRITIONAL BIOCHEMISTRY & BIOENERGETICS

CODE NO. AC 301

UNIT – I

1. Classification of organisms based on nutrition; General function of feed nutrients
2. Classification of nutrients; structure and classification of carbohydrates, proteins and lipids.

UNIT - II

1. Energy production in cells - Kreb's citric acid cycle; inter-conversion between carbohydrate, lipid and protein metabolism; Energy from fats and proteins and regulation of lipids and proteins
2. A brief account of the classification of the enzymes and their action

UNIT - III

1. Bioenergetics; Energy values of foods; partitioning of gross energy, energy sources, estimation of caloric needs of fish and factors affecting the energy requirements
2. Feed formulation and evaluation

UNIT – IV

1. Nutritional requirements of fish and shrimp; protein, and lipid requirements.
2. Mineral and vitamin requirements of fish and shrimp.

TEXT & REFERENCE BOOKS

1. Halver, J.E. Fish Nutrition. Academic Press, NY, 1972
2. Hoar, W.& Randal, D.J. Fish Physiology, Vol.I, Acad.Press,NY.
3. Lovell, T. Nutrition and Feeding of Fish. van Nostrand Reinhold, NY., 1989
4. Powar, C.B. Dagainawala, H.F. General Microbiology, Vol.II, Himalaya Publ. House, Delhi., 1991

M.Sc., AQUACULTURE

III – SEMESTER

PAPER – X : DESIGN OF CULTURE SYSTEMS

CODE NO. AC 302

UNIT – I

1. Planning of aquaculture development : Priorities, resources, technology and human resources, legal and environmental factors and organization of aquaculture
2. Selection of sites for aquaculture : General considerations, land based and open water farms, quantity and quality of water, sources of pollution and conflicts

UNIT – II

1. Planning of a freshwater fish farm : Size of the farm unit, division of the farm area, water supply and drainage, construction of the ponds, size, shape and depth of rearing ponds, pond structure; pond bottom, embankments inlets, out lets, mechanical spillway, emergency spillway, fencing
2. Design of brackish water pond systems: Introduction, site selection engineering investigations, layout designs, design of water management systems, design of water control structures viz. sluice gates, design of peripheral dikes and internal bunds.

UNIT – III

1. Design and construction of Fish Hatcheries
2. Design and construction of Prawn hatcheries

UNIT – IV

1. Design and construction of cages and rafts
2. Design and construction of pens and enclosures
3. Design and construction of raceway farms

TEXT & REFERENCE BOOKS

1. Pilley, TVR & W.M.A. Dill. Advances in Aquaculture. Fishing News (Books), Ltd., England, 1979
2. Stickney, R. R. Principles of Warm water Aquaculture. John-Wiley & sons Inc. 1979
3. Hopher, B. & Y. Pruginin. Commercial Fish Farming. John-Wiley & Sons Inc. 1981
4. Boyd, C.E. Water Quality Management for Pond Fish Culture. Elsevier Scientific Publishing Company, 1982
5. Jhingran, V. G. Fish and Fisheries of India. Hindustan Publishing Corporation, India. 1982
6. Turcker C.S. (ed.). Channel Catfish Culture. Elsevier, 1985
7. Bose, A.N. et al. Coastal Aquaculture Engineering. Oxford & IBH Publishing Company, Pvt. Ltd. 1991

M.Sc., AQUACULTURE
III – SEMESTER
PAPER – XI : AQUACULTURE ECONOMICS
CODE NO. AC 303

UNIT – I

1. Introduction : The basis of production, Interrelationships of aquaculture systems.
2. Production Economics :
 - a) Basic economic principles applied to aquaculture production; the input-output relationships, maximum level of input, least-cost combination of inputs, maximum level of out put, combination of products, economies of size.
 - b) Cost-Return Analysis : Production costs; fixed costs, variable costs, gross revenue, economic analysis.
 - c) Partial budget analysis.
 - d) Cash flow analysis.

UNIT - II

1. Marketing Economics : Basic concepts in demand and price analysis; demand, supply and fish prices, elasticity of demand (price elasticity of demand, income elasticity of demand, cross elasticity of demand).
2. Economic feasibility of investment analysis : Methods of feasibility analysis; the pay back period, average rate of return, discounting method, Net Present Value, Benefit - Cost Ratio, Internal Rate of Return.

UNIT - III

1. Economics of carp breeding farm (Unit costs).
2. Economics of carp production farm (Unit costs).

UNIT - IV

1. Farm Management.
2. Economics of a shrimp farm
3. Economics of a freshwater prawn farm

TEXT & REFERENCE BOOKS:

1. Bond, et al. Fish Inspection and Quality Control. Fishing News (Books) England, 1971
2. Allen, et al. Eds). Bio-Economics of Aquaculture, Elsevier, 1984
3. Chaston, I. Business Management in Fisheries and Aquaculture, Fishing News (Books), Ltd., 1984
4. Govindan, T.K. Fish Processing Technology, Oxford-IBH, 1985
5. Meade, J.W. Aquaculture Management Van Nostrand, New York, 1989
6. Hopher, B and Y. Pruginin. Commercial Fish Farming, Wiley-Interscience, 1989
7. Shang, Y.C. Aquaculture Economic Analysis - An Introduction, 1990
8. Pillay, T. V. R. Aquaculture Principles and Practices. Fishing News (Books), Ltd., London, 1990

M.Sc., AQUACULTURE
III – SEMESTER
PAPER – XII : FISH AND SHELL FISH IMMUNOLOGY

CODE NO. AC 304

UNIT – I

1. Introduction to immunology; innate and acquired immunity
2. Immune system in fish; advanced, primitive and unique features; specific and non-specific defence mechanisms
3. Lymphoid system in fish: stem cells, thymus, spleen, head, kidney and other lymph glands; Lymphocyte sub-population in fish
4. Crustacean immune system

UNIT – II

1. Antigen – Types – Haptens, Ag-Ab interactions
2. Immunoglobulin; IgM structure and functional aspects; other Igs; Ig mediated immunity; Diversity
3. Complement system; classical and alternative

UNIT – III

1. Non-Ig mediated Humoral immunity: Antigrowth factors, antienzymes, lysins, complement (Properdin Pathway); Agglutinins and Opsonins
2. Cell mediated immunity : MHC class I & II, Allograft rejection, Anaphylactic hypersensitivity; Delayed type hypersensitivity; Lymphokines
3. Antibody probes in diagnosis of fish diseases and immunodiagnostic kits

UNIT – IV

1. Immunotechnology: Immunodiffusions, Immuno electrophoresis, Radioimmunoassay. ELISA, MLR, Hybridoma Technique, Immunoblotting
2. Concept of immunizing fish : Vaccines and immunostimulants in fish adjuvants; features of vaccine development, vaccine delivery systems, identification of disease problems and potential vaccines; case study describing vaccination for furunculosis; commercial considerations
3. Management of aquaculture practices through immunological approach

TEXT & REFERENCE BOOKS

1. Nandini Shetty. Immunology. Introductory Text Book. New Age International Pvt.,Ltd, Chennai, 2000
2. Karunasagar, I. Aquaculture and Biotechnology. Oxford-IBH Publishers, New Delhi, 1999
3. Goldsby, R.A., J.K. Thomas and B.A. Barbara. Kuby Immunology. 4th Edition, W.H. Freeman & Co. NY, 2000
4. Balasubramanyam, D. et.al. Concepts in Biotechnology. University Press, 1998
5. Kimbell, E. Fundamentals of Immunology. 1988
6. Aruna Bhatia. Manual of Practical Immunology. Palani-Paramount Publications, Chennai

M.Sc., AQUACULTURE
III – SEMESTER
PRACTICAL-5 : BIOCHEMICAL ANALYSIS, BIOENERGETICS, BIOMETRY AND
COMPUTER APPLICATIONS
CODE NO. AC 305

1. Qualitative determination of biochemical constituents like carbohydrates, proteins and lipids
2. Calculation of surface area and caloric needs of fish; calculation of dosages of feed, chemicals, etc. for treatment in culture ponds and cost estimates.
3. Methods of collection and tabulation of data and graphical representation- histogram, polygon, normal curve, pie diagram
4. Calculation of mean, standard deviation and standard error, mode and median
5. Comparison of means of two samples by employing Student's 't' test
6. Computer fundamentals and basic knowledge of hardware and software. Basics of MS-DOS, Word Processing using WordStar and data management using dBASE.

M.Sc., AQUACULTURE
III – SEMESTER
PRACTICAL-6 : DESIGN OF CULTURE SYSTEMS, AQUACULTURE ECONOMICS
AND IMMUNOLOGY
CODE NO. AC 306

1. Design and estimates of area and construction of freshwater fish/shrimp farm
2. Rates of calculation of water flow through pipes of different diameters and of pumps of different HP
3. Estimations and calculations of production costs of fish/shrimp farm
4. Calculation of MIC, MVP, NPV, Benefit Cost Ratio, and IRR
5. Total and differential counts of fish blood
6. Detection of antibodies, antigens through ELISA Test.

M.Sc., AQUACULTURE

IV – SEMESTER

PAPER – XIII : AQUACULTURE MICROBIOLOGY

CODE NO. AC 401

UNIT – I

1. Introduction to micro - organisms; Outlines of the classification and salient features of micro-organisms of medicinal importance.
2. Basic cell structure of prokaryotes and eukaryotes and their distinguishing features. External features and cell division in prokaryotes and eukaryotes

UNIT – II

1. A brief account of the viruses, symmetry, transmission, replication of viruses, laboratory study of viruses.
2. Salient features of free living and parasitic Protozoa
3. A brief account of fungi and slime moulds

UNIT – III

1. Microorganisms in aquatic habitats, microorganisms and pollution, microorganisms in sewage
2. Microorganisms in perishable foods – spoilage of fish meat

UNIT - IV

1. Morphology and classification of bacteria; Cocci and Bacilli; Gram-positive and Gram-negative bacteria; characters of bacterial colonies; major groups of bacteria; Nutrition and growth of bacteria.
2. Basic microbiological techniques; microscopic methods, techniques of sterilization, media preparation, enrichment cultures, isolation and inoculation, direct observation and staining techniques, maintenance and preservation of cultures.

TEXT & REFERENCE BOOKS

1. Gunasekaran, P. Laboratory Manual in Microbiology. New Age International Publishers Ltd., 1995
2. Chakrabarti, C.H. General Microbiology
3. Rao, A.S. Introduction to Microbiology. Printice-Hall, New Delhi, 1997
4. Cheesbrough, M. Medical Laboratory Manual for Tropical Countries. ELBS, 1985
5. Hawker, L.E. & Linton, A.H. Micro-organisms. Arnold, 2nd edition, 1979
6. Williams J. and Shaw, M. Micro-organisms. Bell and Hyman, 1976.

M.Sc., AQUACULTURE
IV – SEMESTER

PAPER – XIV : WATER QUALITY MANAGEMENT IN CULTURE SYSTEMS

CODE NO. AC 402

UNIT – I

1. Fertilization: Introduction, properties of chemical fertilizers, role of inorganic, organic and biofertilizers in aquaculture practices
2. Liming: Introduction, properties of liming materials, effects of liming on pond ecosystem, exchange of acidity and lime requirements, application of liming materials to ponds, acid sulfate soils

UNIT - II

1. Dynamics of dissolved Oxygen : Introduction, diffusion, photosynthesis, respiration, diel changes in dissolved oxygen concentration, oxygen budget of fish ponds; algal die-off, overturns, identification of oxygen problems
2. Aeration : Introduction, principles of aeration, emergency aeration, destratification and practical considerations

UNIT - III

1. Feeding methods : Introduction, different methods of feeding, frequency of feeding, fate of nutrients in feed, water quality and feeding rates.
2. Aquatic plant control : Introduction, chemical, biological and mechanical control methods

UNIT -IV

1. Miscellaneous treatments : Introduction, potassium permanganate, hydrogen peroxide, calcium hydroxide, reduction of pH, control of turbidity, salinity, hardness & chlorides, water exchange, chlorine removal, rotenone, formalin and malachite green, methods of applying chemicals
2. Pollution in relation to aquaculture practices

TEXT & REFERENCE BOOKS

1. Pilley, TVR & W.M.A. Dill. Advances in Aquaculture. Fishing News (Books), Ltd., England, 1979
2. Stickney, R. R. Principles of Warm water Aquaculture. John-Willey & sons Inc. 1979
3. Hopher, B. & Y. Pruginin. Commercial Fish Farming. John-Willey & Sons Inc. 1981
4. Boyd, C.E. Water Quality Management for Pond Fish Culture. Elsevier Scientific Publishing Company, 1982
5. Jhingran, V. G. Fish and Fisheries of India. Hindustan Publishing Corporation, India. 1982
6. Turcker C.S. (ed.). Channel Catfish Culture. Elsevier, 1985
7. Bose, A.N. et al. Coastal Aquaculture Engineering. Oxford & IBH Publishing Company, Pvt. Ltd. 1991

M.Sc., AQUACULTURE
IV – SEMESTER
PAPER – XV : FISHERIES ADMINISTRATION AND POST-HARVEST
TECHNOLOGY
CODE NO. AC 403

UNIT – I

1. Fisheries training and Education in India : Training Institutes, Universities, Research organizations etc.,
2. Institutional funding to fisheries and aquaculture sector.

UNIT – II

1. Socio-economic conditions of fishermen and fish farmers
2. Fishermen co-operative societies.

UNIT – III

1. Composition of fish.
2. Spoilage of fish and shrimp
3. Quality control techniques.

UNIT - IV

1. Methods of preservation and processing : Drying, Salting, Smoking, Iceing, Freezing, Canning, Accelerated freeze drying etc.,
2. Fishery by-products : Fish meal, Fish oils (liver oils and body oils), Fish Manure, Isinglass, Chitin etc.,
3. Biotechniques in post-harvest technology

TEXT & REFERENCE BOOKS:

1. Bond, et al. Fish Inspection and Quality Control. Fishing News (Books) England, 1971
2. Allen, et al. Eds). Bio-Economics of Aquaculture, Elsevier, 1984
3. Chaston, I. Business Management in Fisheries and Aquaculture, Fishing News (Books), Ltd., 1984
4. Govindan, T.K. Fish Processing Technology, Oxford-IBH, 1985
5. Meade, J.W. Aquaculture Management Van Nostrand, New York, 1989
6. Hopher, B and Y. Pruginin. Commercial Fish Farming, Wiley-Interscience, 1989
7. Shang, Y.C. Aquaculture Economic Analysis - An Introduction, 1990
8. Pillay, T. V. R. Aquaculture Principles and Practices. Fishing News (Books), Ltd., London, 1990.

M.Sc., AQUACULTURE
IV – SEMESTER

PAPER – XVI : AQUACULTURE BIOTECHNOLOGY

CODE NO. AC 404

UNIT – I

1. Introduction to Biotechnology : Origin and Definition, a general knowledge of the different areas under biotechnology. (Molecular vectors, Nucleases, Polymerases, Ligases used in gene Cloning)
2. Genetics: A brief introduction of fish cytogenetics ; Selective breeding for improving fish stocks; hybridization in Indian Fishes.
3. Genetic engineering: Androgenesis, Gynogenesis, Polyploidy, Sex reversal, Transgenic fish.

UNIT - II

1. Hormones in fish breeding
2. Hormone regulation of reproduction and molting in important cultivable crustaceans.

UNIT - III

1. Cryopreservation of fish gametes
2. A general knowledge of tissue culture
3. Embryo transfer technology.

UNIT - IV

1. Nitrogen fixation in Aquatic environment and Biofertiizers.
2. Microbial communities in the aquatic environment and their role and importance in Aquaculture
3. Probiotics in Aquaculture.

TEXT & REFERENCE BOOKS

1. Hephher,B.and Y. Pruginin. Commercial Fish Farming. John-Wiley and Sons Inc., 1981
2. Boyd,C.E. Water Quality Management for Pond Fish Culture. Elsevier Scientific Publishing Company, 1982.
3. Jhingran,V.G. Fish and Fisheries of India, Hindustan Publishing Corporation (India), 1982.
4. I.C.A.R. Biotechnology in Aquaculture. Training Manual. C.I.F.A, I.C.A.R. Kausalyaganga, Bhubaneswar, Orissa. 1992
5. Bhattacharya, S. Hormones in Pisciculture. Biology Education, Vol. 9 No.1 pp.31- 41, 1992
6. C.I.F.E. Summer School Manuals of C.I.F.E. Bombay. 1. Recent Developments in Biotechnology : Applications to Aquaculture & Fisheries 1998. Training Manual of C.I.F.E. Bombay. 2. Genetics and Biotechnological Tools in Aquaculture and Fisheries. 1998
7. Subramoniam,T. Endocrine regulation of reproduction and molting in crustacea and its importance in shrimp aquaculture development. Endowment Lecture of Prof. Y.Radhakrishna, Nagarjuna University, 2001.

M.Sc., AQUACULTURE
IV – SEMESTER
PRACTICAL-7 : WATER AND SOIL ANALYSIS, AQUACULTURE MICROBIOLOGY
AND BIOTECHNOLOGY
CODE NO. AC 405

1. Water Analysis: Determination of surface temperature, pH, dissolved oxygen, free carbon dioxide, total alkalinity, total hardness, chlorides, salinity, total dissolved solids, ammonia, phosphates, nitrites, silicates and iron
2. Soil Analysis : Temperature, pH, composition and texture, percentage loss of moisture, percentage loss on ignition, organic matter, soluble chlorides, carbonates, bicarbonates and calcium
3. Standard Plate Count of Bacteria (SPC)
4. Preparation of different types of media for bacterial cultures
5. Observation of chromosomes from fish tissues
6. Observation of meiotic chromosomes from testes

M.Sc., AQUACULTURE
IV – SEMESTER
PRACTICAL-8 : PROJECT WORK, VIVA-VOCE, & FIELD TRIP/EDUCATIONAL
TOUR REPORT
CODE NO. AC 406
