

ANDHRA UNIVERSITY

M.Sc. FISHERY SCIENCE (Self-Finance)

I – SEMESTER
PAPER – I: LIMNOLOGY (Code No. FS 01)

Unit – I

1. Origin and classification of water bodies – Rivers, lakes and ponds
2. Major rivers and freshwater lakes of India
3. Ecology of ponds, rivers and lakes – Structure and dynamics - energy flow

Unit – II

4. Physical characteristics of water : Temperature, thermal stratification and thermal exchange – light – total hardness – pH.
5. Chemical characteristics of water : Chlorides – dissolved oxygen – alkalinity and acidity.

Unit – III

6. Major groups of organisms in freshwater bodies other than fish
7. Ecological adaptations of freshwater fauna
8. Productivity of water bodies – Primary, secondary, tertiary - Factors affecting primary production

Unit – IV

9. Plankton of freshwater biotopes – Phyto and Zooplankton, their structural dynamics, seasonal variation
10. Plankton sampling: Methods of collection, preservation and identification
11. Benthos of diverse biotopes

Reference Books:

1. Welch, P.S. Limnology. McGrawHill, NY, 1952.
2. Hutchinson, G.E. A Treatise on Limnology, Vols. I & II. John Wiley & Sons, 1957.
3. Ruttner, F. Fundamentals of Limnology. Translated by D.G. Frey and F.E.Fry. University of Toronto Press, 1968.
4. Wetzel, R.G. Limnology. W.B. Saunders Co., 1975.
5. Reid, G.K. & R.D. wood. Ecology of inland waters and Estuaries. Van Nostrand Company, 1976.
6. Cole, C.A. Textbook of Limnology. The C.V. Mosby Co., 1983.

PAPER – II: ESTUARINE AND MARINE BIOLOGY (Code No. FS 02)

Unit – I

1. Estuaries: Origin of estuaries - Structure of an estuary (Physico-chemical Features).
2. Some typical estuarine habitats of India (Hoogly–Matlah, Mahanadi, Godavari, Krishna, Cauvery and West-coast Estuaries).
3. Estuarine food webs.

Unit – II

4. Classification and topography of marine environment and salient features of different zones.
5. Physical environmental factors (temperature, light, pressure, currents, tides and waves)
6. Chemical environmental factors (oxygen, carbon dioxide and carbonates, salinity, pH, nitrogen cycle)

Unit – III :

7. Organic production of the sea: Primary, secondary and tertiary production - factors affecting primary production- Measurement of organic production.
8. Classification of marine organisms and their characteristic features
9. Aquatic Pollution

Unit – IV :

10. Plankton: Estuarine and Marine Phytoplankton and Zooplankton
11. Nekton and their adaptations
12. Benthos: Types of shores (Rocky, Sandy and Muddy shores) and their characteristic features – Fauna and their adaptations

Reference Books:

1. Friedrich, H.: Marine Biology
2. Raymont, J.E.C.: Plankton and productivity in the Oceans, Volume 1.
3. Balakrishna Nair. N. and D.M. Thampy: A text book of Marine ecology
4. Broecker, W.S.: Chemical Oceanography
5. Sverdrup, H.V., M.W., Johnson and R.H. Fleming.: The Oceans - Their physics, chemistry and general biology. Prentice-Hall Inc. 1942.

**PAPER – III: TAXONOMY AND FUNCTIONAL ANATOMY OF SHELL FISH
(Code No. FS 03)**

Unit – I

1. General characters of coelenterates, crustaceans, mollusks and echinoderms
2. Classification of Crustacea up to orders
3. Classification of Mollusca up to sub-class

Unit – II

4. Food, feeding habits and adaptations of cultured crustaceans
5. Food, feeding habits and adaptations of cultured Molluscs
6. Integument and exoskeleton of crustaceans, their structure and functions

Unit – III

7. Respiratory organs in crustaceans and Molluscs
8. Excretion in crustaceans and Molluscs
9. Circulation in crustaceans and Molluscs

Unit – IV

10. Reproductive patterns in crustaceans, reproductive organs, gonad maturity, spawning and fertilization
11. Endocrine organs in crustaceans and their role in reproduction
12. Reproductive patterns in Molluscs, reproductive organs, gonad maturity, spawning and fertilization

Reference Books:

1. Borradile & R.A. Potts. The Invertebrates. Asia Publishing House, 1962.
2. Kaestner, A. Invertebrate Zoology. Vol. I – III, John Wiley & Sons, 1967.
3. Barrington, F.J.W. Invertebrates : Structure and Functions. EIBS, 1971.
4. Kurian, C.V. & V.O. Sabastian. Prawns and Prawn Fisheries of India. Hindustan Pub. Co., 1976.
5. Parker, J. & W.A. Haswell. The Textbook of Zoology. Vol. I. Invertebrates (eds. A.J. Marshall & W.D. Williams), ELBS & McMillan & Co., 1992.

PAPER – IV: TAXONOMY AND FUNCTIONAL ANATOMY OF FIN FISH
(Code No. FS 03)

Unit – I

1. General characters and Classification of fishes up to sub-class
2. Gross external anatomy of fishes: Skin and its derivatives, scales and their significance
3. Major groups of Fishes: Major groups of living Fishes and extinct Fishes – Phylogeny of Fishes

Unit – II

4. Natural food of fishes and feeding habits
5. Feeding adaptations and stimuli for feeding
6. Anatomy and histology of digestive system and physiology of digestion

Unit – III

7. Respiratory organs in fishes – Modification of gills and Tracheae in relation to habit – Structural adaptations of air breathing fishes
8. Nervous system, Sense Organs and Endocrine organs in fishes.

Unit – IV

9. Modes of reproduction, reproductive cycle, gonad maturity stages, spawning seasons and grounds, modes of spawning
10. Environmental factors controlling reproduction and factors affecting development.

Reference Books:

1. Nikolsky, G.V. Ecology of Fishes. Academic Press, NY, 1963.
2. Howar, W.S. & D.J. Randal. Fish Physiology, Vols. 1–4, Academic Press, NY, 1970.
3. Jhingran, V.G. Fish and Fisheries of India. Hindustan Publishing Co., 1975.
4. Norman, J.R. & P.H. Greenwood. A History of Fishes, 3rd Ed. Ernest Benn Ltd., 1975.
5. Fretter, V. & A. Graham. The functional anatomy of vertebrates. Academic Press Inc. (Lon.) Ltd., 1976.
6. Lagler, K.E. et. Al. Ichthyology. John Wiley, 1977.
7. Carl, B.E. Biology of Fishes. Saunders, 1979.
8. Moyle Peterb, Fishes : An Introduction to Ichthyology. Prentice Hall, 1979.
9. Low, M.S. & G.M. Calliet (eds.). Readings in Ichthyology. Prentice Hall, 1979.
10. Meyer & Ashlock. Principles of systematic Zoology.
12. Turnor. Textbook of endocrinology

II – SEMESTER
PAPER – V: ICHTHYOLOGY (Code No. FS 05)

Unit – I

1. Basic fish anatomy – form and function of muscles, gills and gas bladder
2. Skeleton – Endoskeleton – Neurocranium and visceral skeleton

Unit – II

3. Locomotion in fishes: Body form and locomotion, fins and locomotion, swimming and non-swimming locomotion, migration of fishes, anadromous and catadromous migrations
4. Age and growth in fishes: Determination of age, length-weight relationship, annual growth marks, bone marks, determination of growth and factors affecting the age and growth

Unit – III

5. Blood vascular system: Circulation of blood, modification in relation to air breathing
6. Excretion and Osmo-regulation: Structure and function of the excretory organs – Major excretory products of fishes. Osmotic and ionic regulation – acid base balance – Patterns of nitrogen excretion

Unit – IV

7. Genetics and Evolution: Inheritance, sexdetermination, hybridization, mechanism of evolution in fishes.
8. Ecology of Fishes: Introduction – Organic production in aquatic ecosystems – Biogeochemical cycles – Ecological classification of fishes.
9. Parental care in fishes.

Reference Books:

1. Sedgewick. A Student's textbook of Zoology, Vol. I & II.
3. Usinger. General Zoology, Vols. I & II.
6. Marshall & Williams. Textbook of Zoology. Vol.I.
7. Parker and Hasswell. Textbook of zoology, Vertebrates. Vol.II.
8. Barnes. General Zoology
9. Day, F. The fishes of India.
10. S.S. Khanna. An introduction to fishes.
11. K.G. Lagler. Ichthyology.

PAPER – VI: INLAND CAPTURE FISHERIES (Code No. FS 06)

Unit – I: Fish Catch Statistics :

1. A general survey of Inland and Marine fish catches of India and the world (Available Fishing Potential, Estimation of Inland fish catches, Estimation of marine fish landings and Fisheries of different Maritime States)
2. Craft and Gear used in Inland and Marine Fisheries: Traditional and Mechanized Boats and Nets used in catching fish

Unit – II: Freshwater Fisheries :

3. Riverine Fisheries: River systems in India, their ecology and fisheries (Ganga, Brahmaputra, East-Coast River System and West-Coast river system)
4. Reservoir Fisheries: Development, Exploitation and Management of Reservoirs with special reference to India – Dams and their effect on Fish Migration

Unit – III: Estuarine Fisheries :

5. Major estuaries of India and their fisheries (Hoogly – Matlah, Mahanadi, Godavari, Krishna, Cauvery and West-Coast Estuaries).
6. Hilsa fishery – Causes of decline and efforts for revival.

Unit – IV: Brackish water Lake Fisheries:

7. Chilka lake – Fish and fisheries
8. Pulicat lake – Fish and fisheries
9. Kerala back waters – Fish and fisheries

Reference Books:

1. Jhingran, V.G. 1993. Fish and fisheries of India. Hindustan Publishing Corporation (India), New Delhi.
2. Ricker, W.E. 1984. Methods for assessment of fish production in freshwaters. Blackwell Publications.
3. Srivastava, C.B.L., 1985. Textbook of Fishery Science and Indian Fisheries. Kutub Mahal Publications, Allahabad.
4. S.S. Khanna. An introduction to fishes
5. Kurian, C.V. and Sebastian, V.O. 1986. Prawns and prawn fishery of India. Hindustan Publishing Corporation (India), New Delhi.
6. Yadav, B.N. Fish and Fisheries. Daya Publishing House

PAPER – VII : MARINE CAPTURE FISHERIES (Code No. FS 07)

Unit – I: Fisheries of Indian Seas :

1. Marine fish catch in India and fisheries of commercial importance
2. Fishery of: 1) Oil Sardines, 2) Mackerels, 3) Tuna and allied fishes, 4) Seer fish, 5) Flat fishes.

Unit – II: Shell fish fisheries:

3. Fishery of Crustaceans, Mollusks and Edible Oyster
4. Fishery of Seaweed

Unit – III: Fish Population Dynamics:

5. Fish populations and factors affecting the population structures
6. Estimation of fish yield and control of over-fishing

Unit – IV: Preservation and Processing:

7. Different methods of processing and preservation of both Finfish and Shellfish and associated problems
8. Rigor mortis and Post-mortem changes
9. Fish products and by-products

Reference Books:

1. Jhingran, V.G. 1993. Fish and fisheries of India. Hindustan Publishing Corporation (India), New Delhi.
2. Srivastava, C.B.L., 1985. Textbook of Fishery Science and Indian Fisheries. Kutub Mahal Publications, Allahabad.
3. Bal, D.V. and Veerabhadra Rao, K. 1984. Marine Fisheries. IBH Publications
4. Kurian, C.V. and Sebastian, V.O. 1986. Prawns and prawn fishery of India. Hindustan Publishing Corporation (India), New Delhi.

PAPER – VIII: BIOSTATISTICS, POPULATION ECOLOGY AND REMOTE SENSING (Code No. FS 08)

Unit – I

1. Introduction and scope of biostatistics - Concept of sample and Population Sampling methods - Classification and tabulation of data - Frequency distribution - Diagrammatic and graphical presentation.
2. Measures of central tendency: Mean, Median and Mode

Unit – II

3. Measures of dispersion - coefficient of variation - standard deviation - variance - standard error.
4. Analysis of variance – One way ANOVA and two way ANOVA
5. Correlation and Regression

Unit – III

6. Probability – Concept and types of probabilities
7. Distribution – Binomial, Poisson, Normal distribution
8. Tests of significance – Chi-square test and Student's 't' test

Unit – IV

9. Population attributes – Population ecology and dynamics - Demography (including life tables) - Population growth (exponential and logistic patterns and different models)
10. Population Regulation – Population cycles and equilibrium – extrinsic and intrinsic factors – Role of social behavior - Life history strategies – Competition and predation.
11. Remote sensing – its use in identification of the breeding grounds of fishes, fish migrations, capture fishery etc.

Reference Books:

1. Fundamentals of mathematical statistics – Gupta and Kapoor.
2. Fundamentals of Statistics – S.P. Gupta
3. Elementary Statistics – Yule and Kendall
4. Introduction to Biostatistics – Sokal & Rohlf
5. Fundamentals of Biostatistics – By Khan and Khanum

III SEMESTER

PAPER – IX: CONSTRUCTION AND MANAGEMENT OF HATCHERIES AND FISH FARMS (Code No. FS 09)

Unit – I

1. Construction of fish farm: Selection of sites - General considerations - land based and open water farms - quantity and quality of water - Size of the farm unit, division of the farm area - water supply and drainage - Construction of different ponds (Nursery, Rearing and Stocking ponds) - pond structure (size, shape depth etc.).
2. Brackish water pond systems: Introduction, site selection engineering investigations, layout designs, design of water management systems, design of water control structures, viz., sluice gates, peripheral dikes and internal bunds

Unit – II

3. Design, construction and management of Finfish hatcheries
4. Design, construction and management of Prawn Hatcheries

Unit – III

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

Unit – IV

7. Feeding methods: Introduction, different methods of feeding, frequency of feeding, fate of nutrients in feed, water quality and feeding rates
8. Aquatic weeds and their control: Introduction, chemical, biological and mechanical control methods.

Reference Books:

1. Pillay, T.V.R. & 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. Prugim. 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.

PAPER – X: FRESHWATER AQUACULTURE (Code No. FS 10)

Unit – I

1. Basics of aquaculture: Scope and definition, history of aquaculture, origin and growth, General principles underlying the practices of aquaculture, cultivable finfish and shellfish – Productivity of a fishpond.
2. Procurement of Stocking material from natural environment, Bund breeding and Induced breeding - Transportation of fish seed and brood fish (Methods of transporting fish seed – Fingerlings and breeders – Control of mortality and measures for reducing mortality during transportation).

Unit – II

3. Culture of Indian major carps: Major species of carps used for culture, culture systems, spawning and fry production, larval rearing, nursery and grow out pond culture, harvesting and marketing
4. Breeding and culture of exotic carps (grass carp, silver carp, common carp),
5. Polyculture system – Definition and various patterns – Mixed fish farming in India – Composite culture of Indigenous and Exotic fishes.

Unit – III

6. Tilapia culture and Eel culture
7. Culture of air breathing fishes (*Heteropneustus*, *Clarius*, *Channa*, *Anabas*) – Ecology of swamps and their use for culture of air breathing fishes.

Unit – IV

8. Freshwater prawn culture with special reference to *Macrobrachium rosenbergii* – Seed procurement from natural resources, breeding and larval rearing of freshwater prawn hatchery and management, management of culture ponds
9. Integrated fish farming: Paddy cum fish culture, Fish cum livestock, Pig cum fish farming, Duck cum fish farming.
10. Culture of Ornamental fishes.

Reference Books:

1. Bardach, et. Al. Aquaculture – The Farming and Husbandry of Freshwater and Marine Organisms. John Wiley & Sons, NY, 1972.
2. Stickney, R.R. Principles of Water Aquaculture. John Wiley & Sons, NY, 1979.
3. Chondar, C.L. Hypophysation of Indian major carps. Satish Book Enterprise, Agra, 1980.
4. Jhingran, V.G. Fish and fisheries of India. Hindustan Publ. Corporation (India), 1982.
5. Santhanam, R. et. Al. A Manual of Freshwater Aquaculture. Oxford & IBH Publishing Co. Pvt. Ltd., 1987.
6. Pilley, T.V.R. Aquaculture – Principles and Practices. Fishing News (Books) Ltd., London, 1990.
7. Pandey, A.C. Air Breathing Fishes. Reliance Publishing House, New Delhi, 1990.
8. Janardhana Rao, K. & S.D. Tripathi. A Manual of Giant Freshwater Prawn Hatchery. CIFA, Kausalyaganga, Orissa, India, 1993.
9. Iso Matsui. Theory and Practice of Eel Culture. American Publishing Co. Pvt. Ltd., 1980.

PAPER – XI: COASTAL AQUACULTURE (Code No. FS 11)

Unit – I :

1. Brackish water aquaculture: Principles of pond design – Inland and Coastal pond forms, Tank and raceway farms, cage farms, pens – Types of culture systems: Traditional, extensive, modified extensive, semi-extensive, intensive and super-intensive culture of shrimps and their management and economics
2. Water quality management in Aquaculture, Physico-chemical variables: Salinity, temperature, pH, turbidity, BOD, COD, dissolved oxygen, nitrates, phosphates, ammonia, sulphates and silicates

Unit – II :

4. Design and construction of shrimp culture ponds – Liming and fertilization, Seed procurement of shrimps: Natural seed, hatchery reared seed, production and transportation stocking in nursery ponds, rearing and grow-out ponds, pond harvesting.
5. Principles of crab hatchery, brood stock, larval and post-larval management. Packing and transportation of seed - Crab culture: Pond design, management of crab farm. Crab culture and crab fattening process – economics, cage culture and pen culture

Unit – III

8. Principles involved in seed production of lobsters and mussels. Natural resources of shrimp, crab, brackish water fish, oyster and mussel seed
9. Brackish water fish species for culture, management, traditional culture of brackish water fish. Culture of finfish – Sea-bass, milk fish and mullet culture

Unit – IV:

11. Mariculture: Species identification, Lobster culture, Mussel culture, Pearl culture, Oyster culture, Sea-weed culture
12. Feed management – Feeding schedules, protein requirements at different ages of finfish and shellfish, feed formulations, wet feeds and dry feeds

Reference Text Books :

1. Huet, M. Textbook 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 Wiley & Sons, NY, 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 Water Aquaculture. John Wiley & Sons, NY, 1979.

6. Jhingran, V.G. Fish and fisheries of India. Hindustan Publ. Corporation (India), 1982.
7. Kurian, C.V. & V.O. Sabastian. Prawn and Prawn Fisheries of India. Hindustan Publ. Corp. India, 1982.
8. Brown, E.E. World Fish Farming – Cultivation and Economics. AVI Publishing Co. Connecticut, 1983.
9. Huner Jay V. et. Al. Crustacean and Molluse Aquaculture in United States. AVI Publishing Co. Connecticut, 1985
10. Pilley, T.V.R. Aquaculture – Principles and Practices. Fishing News (Books) Ltd., London, 1990.
11. Bose, A.N. Coastal Aquaculture Engineering. Oxford & IBH Publishing Company Pvt. Ltd., 1991.
12. Turcker, C.S. (ed.). Channel Catfish Culture. Elsevier, 1985.
13. Boyd, C.E. Water Quality Management for pond Fish Culture. Elsevier Scientific Publishing Company, 1982.

PAPER – XII : FIN FISH AND SHELL FISH PATHOLOGY (Code No. FS 12)

Unit – I :

1. Introduction : Diseases : Definition, Disease problems in aquaculture, Infectious and non-infectious diseases
2. Viral diseases of fish : Clinical picture, pathology, symptoms and prophylaxis of some common viral diseases – (a) Papillomatosis, (b) Lymphocystis and (c) Infectious pancreatic necrosis
3. Viral diseases of shrimp : Clinical picture, pathology symptoms and prophylaxis of some common viral diseases – (a) *Monodon baculo* virus (MBV), (b) HPV, (c) YHV) Yellow head virus, (d) JHHNV, (e) White spot syndrome.

Unit – II :

4. Bacterial diseases of fish : Etiology clinical symptoms, pathology and prophylaxis of some common bacterial diseases – (a) Bacterial heamorrhagic septicemia, (b) Bacterial cell diseases and (c) Columnaris diseases
5. Bacterial diseases of shrimp : Etiology, clinical symptoms, pathology and prophylaxis of some common bacterial diseases – (a) Vibriosis, (b) Shell diseases, (c) Black spot disease, (d) Red diseases.
6. Fungal diseases of fish : Clinical picture, symptoms and pathology and prophylaxis of fish – (a) Branchiomycosis, (b) Saprolegniasis, (c) EUS
7. Fungal diseases of shrimp : Clinical picture, symptoms and pathology and prophylaxis of fish – (a) Lagenidium, , (b) Fusarium, (c) Larval mycosis

Unit – III :

8. Protozoan diseases :
Protozoan diseases of fish : Clinical picture, pathology, symptoms and prophylaxis of some common diseases – (a) Nodular coccidiosis, (b) Entero coccidiosis, (c) Whirling disease, and (d) Ichthyophthirius
Protozoan diseases of shrimp : Clinical picture, pathology, symptoms and prophylaxis of some common viral diseases
9. Metazoan parasites of fish : Clinical picture, pathology, symptoms and prophylaxis of some common diseases – (a) Monogenetic trematode parasites (*Dactylogyrus*, *Gyrodactylus*, *Diplozoan*), (b) Digenetic trematodes (trematode larval and *Neodiplostomum*), (c) Cestode parasites (*Ligula* and *Dibothriocephalus latus*), (d) Nematodes and fish leeches.
Metazoan parasites of shrimp : Clinical picture, pathology, symptoms and prophylaxis of some common diseases
Crustacean parasites of fish : Clinical picture, pathology, symptoms and prophylaxis of some common diseases – (a) *Argulus*, *Ergasilus* and *Lerneae*

Unit – IV :

10. Environmental induced diseases of fish. Thermal stress, O₂ deficiency, stress due to pH variations; Gas bubble disease
Nutrition deficiency diseases : Avitaminosis, Mineral deficiency, Starvation.

11. Diseases caused by other factors : Hereditary factors, Tumours of hereditary origin, Hydrocoel, Tumours, Benign and Malignant Environmental and nutritional deficiency diseases in shrimps.
12. Management practices in fish and shrimp diseases.

Reference Text Books :

1. Cheng, 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. Textbook 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.
5. Schauperclaus. Fish Diseases. Vol. I & II.
6. Lightner, D.V. Shrimp Disease Diagnosis, 1998.
7. Sinderman. Fish Diseases, Vol. I. Shell Fish Diseases, Vol. II.

IV SEMESTER

PAPER – XIII: FISH IMMUNOLOGY (Code No. FS 13)

Unit – I : Introduction

1. Background and History of Immunology
2. Application to the Fishery Resource
3. Fish Health and Management
4. Lymphoid system: Lymphoid organs and tissues
5. Crustacean immune system

Unit – II : Factors of Immune Response

6. Cellular components of the Immune System
7. Antigen – Haptens : Carriers – adjuvants - Complement – other serum factors
8. Antibody : Structure and function of Ig M_h, its properties and diversity
9. Antigen – Antibody interactions

Unit – III : Immune Response

10. Types of Immune Response in various Representative fish groups
11. Non – Specific and Specific Defense Mechanisms
12. Cell mediated immunity and Humoral immunity
13. Immunotoxicology in Fish – Immuno-suppression & Immuno-modulation in response to various toxicants.

Unit – IV : Immunization and Immuno-diagnostic techniques

14. Immunization: Immunization Procedures and Types of Vaccines and Vaccination programmes for various fish diseases
15. Disease diagnosis using Immuno-diffusion, Agglutination, Blotting techniques and ELISA.
16. Hybridoma Technology : Monoclonal Antibodies and their application in fisheries.

Reference Text Books :

1. Douglas P Anderson : Text Book of Fish Immunology
2. Nandini Shetty. Immunology. Introductory Textbook.
3. Karunasagar, I. Aquaculture and Biotechnology. Oxford-IBH Publishers, New Delhi,
4. Goldsby, R.A., J.K. Thomas and B.A. Barbara.
5. Kubly Immunology. 4th Edition,

PAPER – XIV : FISH PHYSIOLOGY, NUTRITION AND BIOCHEMISTRY
(Code No. FS 14)

Unit – I :

1. Physiological adaptations of fishes and shellfishes with reference to temperature, pressure, Osmo-regulation and pH, Bio-luminescence – electric organs - echolocation
2. Water and electrolyte regulation in freshwater, brackish water and marine environment
3. Biological oxidation, nature of oxidation, reduction reactions, release of energy during oxidation and reduction reactions

Unit – II : Factors of Immune Response

4. Neuro-secretory system of invertebrates with special reference to crustaceans, Molluscs and echinoderms – synthesis of hormones and release, non-neural endocrine glands and neurohemal organs in crustaceans
5. Role of Y- organ and Androgenic gland in crustacean growth and reproduction. Importance of eyestalk ablation. Hormonal control of reproduction in Molluscs and echinoderms.
6. Different endocrine glands of fish – thyroid, adrenal, pituitary and other glands, their structure and physiology

Unit – III :

7. Nutritive value of fish and shellfish – Fish as food, food commodity, nutritive value of fish and shellfish, composition of raw fish & shellfish
8. Nutrition

Unit – IV :

9. Carbohydrates – Chemistry and classification – simple and compound sugars – polysaccharides – Carbohydrate metabolism
10. Proteins – chemistry and classification – simple proteins – fibrous proteins – collagen – elastin and carotenes – Albumins and Globulins – conjugated and nucleoproteins – glycoproteins – nucleotides – purines and pyrimidines
11. Lipids – chemistry and classification – simple lipids – glycerides – fats and waxes – compound lipids – phospholipids – glycol and sphingolipids – fatty acids - cholesterol
12. Enzymes – classification and kinetics

Reference Text Books :

1. Prosser & Brown. Comparative Physiology
2. Hoar. Comparative Physiology
3. Hoar & Randall. Fish Physiology

4. Lockwood. Physiology of Crustacea
5. Watermann. Physiology of Crustacea
6. Leninger. Principles of Biochemistry
7. Harper. Physiological Chemistry
8. Bell Patterson & Smith. Textbook of Physiology & Biochemistry
9. Wilson. Textbook of animal Physiology.

PAPER – XV : GENETICS, MOLECULAR BIOLOGY AND BIOTECHNOLOGY
(Code No. FS 15)

Unit – I :

1. Principles of cell and molecular biology – Cell structure, Structure of DNA & RNA – Composition and properties
2. DNA replication. Transcription in prokaryotes and eukaryotes
3. Gene structure and function – Gene complementation, cistron , mutan, recon, molecular recombination, gene regulation

Unit – II : Factors of Immune Response

4. Principles of genetic engineering – Isolation of DNA & RNA and characterization of DNA, recombinant DNA technology, cloning, plasmids, cosmids, bacteriophages, Transformation, Transduction, in vivo packaging, construction of genomic library
5. Applications of Recombinant DNA technology
6. Molecular hybridization. Labelling of nucleic acids, molecular markers. Amplication of DNA, blotting technique – Southern, Northern and Western blotting, DNA Sequencing

Unit – III :

7. Induced breeding in fish and shellfish. Hypophysation and eyestalk ablation, Chromosome manipulation
8. Animal vaccine development and production – Production of Vaccines (killed & attenuated)

Unit – IV :

9. Application of genetic engineering in fisheries : Genomic manipulation, gene transfer, hybridization, interspecific, intergeneric gynogenesis and androgenesis, polyploidy.
10. Transgenic fish production – Selection of fish species, gene transfer technology – Microinjection technique, electroporation, detection of transgenesis by PCR applications in transgenic fishes and biotechnology.

Reference Text Books :

1. Hopher, B. and Y. Pruginin. Commercial fish farming. John Wiley & Sons Inc., 1981.
2. Jhingran, V.G. Fish and Fisheries of India, 1982.
3. Bhattacharya, S. Hormones in Pisciculture. Biology Education. Vol.9, No.1, pp.31-41, 1992.
4. Subramonium, T. Endocrine regulation of reproduction and molting in crustacean and its importance in shrimp aquaculture development.
5. Summer School Manuals of CIFE. Recent Developments in Biotechnology. CIFE, 1998.
6. Genetics and Biotechnological tools in Aquaculture and Fisheries, CIFE, 1998.

7. I.C.A.R. Biotechnology in Aquaculture – Training Manual. CIKA, Bhubaneswar, 1992.
8. Darnell. Molecular Cell Biology.

**PAPER – XVI : FISHERY EDUCATION, EXTENSION AND ECONOMICS OF
AQUACULTURE (Code No. FS 16)**

Unit – I :

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

Unit – II :

3. Socio-economic conditions of fishermen and fish farmers
4. Fishermen Co-operative Societies

Unit – III :

5. Role of government agencies – Role of NABARD and other central government agencies in the upliftment of fisher folk. Role of state government agencies in various fishery activities – Loans and credits, policies
7. Integrated coastal zone management, ocean policy, role of NGO's CRZ

Unit – IV :

8. Economics of aquaculture
9. Economic viability, data requirement, analysis of data
10. Financial and economic feasibility, risk and insurance

Reference Text 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.

DEPARTMENT OF ZOOLOGY : ANDHRA UNIVERSITY

M.Sc. FISHERY SCIENCE (SELF-FINANCE)

SCHEME OF EXAMINATION

Semester/ Code No. of paper	Title of the Paper	Max. Marks	Sem end	Mid Sem.	No. of periods/ Week
I Semester :					
THEORY :					
FS 01	Limnology	100	85	15	4
FS 02	Estuarine and Marine Biology	100	85	15	4
FS 03	Taxonomy & Functional Anatomy of Shellfish	100	85	15	4
FS 04	Taxonomy & Functional Anatomy of Finfish	100	85	15	4
PRACTICALS :					
FS P 01	Practical-1 : Limnology	50	--	--	3
FS P 02	Practical-2 : Estuarine and Marine Biology	50	--	--	3
FS P 03	Practical-3 : Taxonomy & Functional Anatomy of Shellfish	50	--	--	3
FS P 04	Practical-4 : Taxonomy & Functional Anatomy of Finfish	50	--	--	3
II Semester :					
THEORY :					
FS 05	Ichthyology	100	85	15	4
FS 06	Inland Capture Fisheries	100	85	15	4
FS 07	Marine Capture Fisheries	100	85	15	4
FS 08	Biostatistics, Population Dynamics and Remote Sensing	100	85	15	4
PRACTICALS :					
FS P 05	Practical-5 : Ichthyology	50	--	--	3
FS P 06	Practical-6: Inland Capture Fisheries	50	--	--	3
FS P 07	Practical-7 : Marine Capture Fisheries	50	--	--	3

FS P 08	Practical-8 : Biostatistics, Population Dynamics and Remote Sensing	50	--	--	3
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III Semester :					
THEORY :					
FS 09	Construction and Management of Hatcheries and Fish Farms	100	85	15	4
FS 10	Fresh water Aquaculture	100	85	15	4
FS 11	Coastal Aquaculture	100	85	15	4
FS 12	Finfish and Shellfish Pathology	100	85	15	4
PRACTICALS :					
FS P 09	Practical-09 : Construction and Management of Hatcheries and Fish Farms	50	--	--	3
FS P 10	Practical-10: Freshwater Aquaculture	50	--	--	3
FS P 11	Practical-11 : Coastal Aquaculture	50	--	--	3
FS P 12	Practical-12 : Finfish and Shellfish Pathology	50	--	--	3

IV Semester :					
THEORY :					
FS 13	Fish Immunology	100	85	15	4
FS 14	Fish Pathology, Nutrition and Biochemistry	100	85	15	4
FS 15	Genetics, Molecular Biology and Biotechnology	100	85	15	4
FS 16	Fishery Education, Extension and Economics of Aquaculture	100	85	15	4
PRACTICALS :					
FS P 13	Practical-13 : Fish Immunology	50	--	--	3
FS P 14	Practical-14 : Fish Pathology, Nutrition and Biochemistry	50	--	--	3
FS P 15	Practical-15 : Genetics, Molecular Biology and Biotechnology	50	--	--	3
FS P 16	Practical-16 : Fishery Education, Extension and Economics of Aquaculture	50	--	--	3

M.Sc. FISHERY SCIENCE (SELF-FINANCE)

SYLLABUS FOR PRACTICALS

I SEMESTER :

PRACTICAL – I : LIMNOLOGY (Code FS P 01)

1. Phytoplankton and zooplankton – Identification of major groups up to genus level
2. Estimation of phytoplankton and zooplankton
3. Predaceous freshwater insects
4. Identification of common freshwater benthic organisms
5. Estimation of benthic organisms – Micro, meo and macro benthos
6. Macrophytes in freshwater

PRACTICAL – II : ESTUARINE AND MARINE BIOLOGY (Code FS P 02)

1. Identification of rocky, sandy and muddy shore fauna
2. Phytoplankton and zooplankton estimation
3. Phytoplankton from estuaries
4. Zooplankton from estuaries
5. Phytoplankton and zooplankton from the seawater

**PRACTICAL – III : TAXONOMY AND FUNCTIONAL ANATOMY OF SHELL FISH
(Code FS P 03)**

1. Dissection and display of the visceral organs of freshwater mussels
2. Dissection and demonstration of digestive system of pila
3. Dissection of digestive system of shrimp, prawn and crab
4. Identification and mounting of different appendages of shrimp and prawn
5. Dissection of nervous system of prawn, shrimp and crab
6. Dissection of nervous system of sepia

**PRACTICAL – IV : TAXONOMY AND FUNCTIONAL ANATOMY OF FIN FISH
(Code FS P 04)**

1. Methods of food analysis and a study of the guts in fish with different feeding habits
2. Dissection of digestive system of different cultivable species
3. Dissection of pituitary gland preparation of pituitary extract
4. Dissection of Weberian ossicles in cat fish
5. Lateral line nerve of Trichiurus

M..Sc. FISHERY SCIENCE (SELF-FINANCE)

SYLLABUS FOR PRACTICALS

II SEMESTER :

PRACTICAL – V : ICHTHYOLOGY (Code FS P 05)

1. Identification of fishes with suitable examples from each class
2. Dissection of fish for internal anatomy – External characters. Types of scales, fins, types of teeth, structure of alimentary canal, gill rakers
3. Ecology of fishes – identification characters of pelagic, mid pelagic, benthic and migratory fishes
4. Determination of growth in fish

PRACTICAL – VI : INLAND CAPTURE FISHERIES(Code FS P 06)

1. Identification of freshwater and brackish water fish
2. Observing different boats, nets and other instruments used in fishery
3. Biological analysis of fish samples for gut contents, maturity stages and fecundity
4. Fieldwork : Visit to fish landing and processing centres

PRACTICAL – VII : MARINE CAPTURE FISHERIES (Code FS P 07)

1. Identification of marine fish
2. Observing different boats, nets and other instruments used in fishery
3. Biological analysis of fish samples for gut contents, maturity stages and fecundity
4. Fieldwork : Visit to fish landing and processing centres

PRACTICAL – VIII : BIostatISTICS, POPULATION DYNAMICS AND REMOTE SENSING (Code FS P 08)

Calculation of the following to the given data :

1. Mean, Median, Mode
2. Standard deviation, Standard error
3. Correlation and regression
4. t-test and Chi-square
5. Problems on population dynamics

III SEMESTER :

PRACTICAL – IX : CONSTRUCTION AND MANAGEMENT OF HATCHERIES AND FISH FARMS (Code FS P 09) :

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. Design and estimates of fish and shrimp and prawn hatcheries
4. Design and estimates of cages rafts, race way farm
5. Ash and elemental analysis of soils

PRACTICAL – X : FRESHWATER AQUACULTURE (Code FS P 10) :

1. Analysis of water : Turbidity, pH, Dissolved oxygen, Alkalinity etc.
2. Primary productivity, Estimation by Light and Dark Bottle method
3. Spotters : Cultivable species of finfish and shellfish based on the theory
4. Dissecting out the pituitary gland and preparing the extract
5. Visit to aquaculture farms, finfish and shellfish hatcheries

PRACTICAL – XI : COASTAL AQUACULTURE (Code FS P 11) :

1. Analysis of water : Turbidity, pH, Dissolved oxygen, Alkalinity etc.
2. Primary productivity, Estimation by Light and Dark Bottle method
3. Spotters : Cultivable species of finfish and shellfish based on the theory
4. Dissecting out the pituitary gland and preparing the extract
5. Visit to aquaculture farms, finfish and shellfish hatcheries

PRACTICAL – XII : FINFISH AND SHELLFISH PATHOLOGY (Code FS P 12) :

1. Examination of normal and diseased fish - Thorough examination of external surface
2. Autopsy of the diseased fish
3. Host examination – Collection of parasites
4. Slide preparation - fixing - staining and mounting of parasites
5. Histopathology of organs of diseased fish (Sectioning – Staining and Mounting)
6. Slides of fish parasites (Protozoan – Helminth and Copepod)

IV SEMESTER :

PRACTICAL – XIII : FISH IMMUNOLOGY (Code FS P 13) :

1. Immunization - Routes of Immunization
Preparation of Inoculum
Immunization Schedule
2. Bleeding of Fish - Different methods adopted
3. Blood film preparation (Giemsa Staining)
4. Differential Count of WBC
5. Cell Viability Test
6. Quantification of Antibody - Agglutination, Precipitation
and Immuno - Diffusion

PRACTICAL – XIV : FISH PHYSIOLOGY, NUTRITION AND BIOCHEMISTRY (Code FS P 14) :

1. Qualitative determination of carbohydrates, proteins and lipids. Paper Chromatography
2. Quantitative determination of glucose, glycogen and proteins
3. Demonstration of enzyme action in crustacean hepatopancreas. Estimation of pH in the alimentary canal of fish
4. Experiments on osmosis. Methods in Feed formulations by using different raw materials

**PRACTICAL – XV : GENETICS, MOLECULAR BIOLOGY AND BIOTECHNOLOGY
(Code FS P 15) :**

1. Location of endocrine glands – Fish pituitary, thyroid, adrenals, gonads
2. Isolation and preparation of pituitary gland extract
3. Reproductive systems of selected fish, prawn and crab
4. Nervous and endocrine system of prawn and crab, androgenic gland
5. Eyestalk ablation experiments
6. Estimation of nucleic acids

**PRACTICAL – XVI : FISHERY EDUCATION, EXTENSION AND ECONOMICS OF
AQUACULTURE (Code FS P 16) :**

1. Visiting CIFE, CIFA, FSI etc.,
2. Collecting data of the Fishermen in the nearby fishing villages.
3. Collecting the particulars of Farming practices and its economics.

To

The Registrar,
Andhra University,
Visakhapatnam.

Sir,

I am herewith sending the Syllabus and Scheme for M.Sc. Fishery Science which is going to start from 2006 in the Department of Zoology.

Thanking you,

Yours faithfully,

Encl: As above.

(C. VIJAYA LAKSHMI)