

DEPARTMENT OF MARINE LIVING RESOURCES

Revised Syllabus

With effect from 2022-2023



ANDHRA UNIVERSITY
Visakhapatnam

DEPARTMENT OF MARINE LIVING RESOURCES, ANDHRA UNIVERSITY
Scheme of Examination (With effect from 2022-2023admitted batches)
M.Sc. Marine Biology and Fisheries-I Semester

| Paper No | Paper Title | Maximum Marks | | | Credits | | |
|--|---|-------------------------------|--------------------------|-------------|-----------|-----------|-----------|
| | | Theory (End exam + Mid+Asgmt) | Practical (Semester end) | Total marks | Theory | Practical | Total |
| 1.1 | Physical and Chemical Oceanography | 70+20+10 | 50 | 150 | 4 | 2 | 6 |
| 1.2 | Biological Oceanography | 70+20+10 | 50 | 150 | 4 | 2 | 6 |
| 1.3 | Marine Ecology | 70+20+10 | 50 | 150 | 4 | 2 | 6 |
| 1.4 | Biostatistics | 70+20+10 | 50 | 150 | 4 | 2 | 6 |
| | Total marks | 400 | 200 | 600 | 16 | 8 | 24 |
| M.Sc. Marine Biology and Fisheries-II Semester | | | | | | | |
| | | Theory (End exam + Mid+Asgmt) | Practical (Semester end) | Total marks | Theory | Practical | Total |
| 2.1 | Estuaries and Coastal Zone Management | 70+20+10 | 50 | 150 | 4 | 2 | 6 |
| 2.2 | Biology of Marine Organisms | 70+20+10 | 50 | 150 | 4 | 2 | 6 |
| 2.3 | Fish Physiology | 70+20+10 | 50 | 150 | 4 | 2 | 6 |
| 2.4 | Fishery Science | 70+20+10 | 50 | 150 | 4 | 2 | 6 |
| | Total marks | 400 | 200 | 600 | 16 | 8 | 24 |
| M.Sc. Marine Biology and Fisheries-III Semester | | | | | | | |
| | | Theory (End exam + Mid+Asgmt) | Practical (Semester end) | Total marks | Theory | Practical | Total |
| 3.1 | Fishing Technology and Fishery Management | 70+20+10 | 50 | 150 | 4 | 2 | 6 |
| 3.2 | Aquaculture | 70+20+10 | 50 | 150 | 4 | 2 | 6 |
| 3.3 | Fish Nutrition and Feed Technology | 70+20+10 | 50 | 150 | 4 | 2 | 6 |
| 3.4 | Marine Pollution & Bio-deterioration | 70+20+10 | 50 | 150 | 4 | 2 | 6 |
| 3.5 | MOOC-I | | | | | | 2 |
| | IPR (Value added course) | | | | | | |
| | Total marks | 400 | 200 | 600 | 16 | 8 | 26 |
| M.Sc. Marine Biology and Fisheries-IV Semester | | | | | | | |
| | | Theory (End exam + Mid+Asgmt) | Practical (Semester end) | Total marks | Theory | Practical | Total |
| 4.1 | Fish Processing Technology | 70+20+10 | 50 | 150 | 4 | 2 | 6 |
| 4.2 | Fishery Economics and Extension | 70+20+10 | 50 | 150 | 4 | 2 | 6 |
| 4.3 | Aquaculture Biotechnology | 70+20+10 | 50 | 150 | 4 | 2 | 6 |
| 4.4 | MOOC-II | | | | | | 2 |
| 4.5 | Project | 100 | | 100 | 4 | - | 4 |
| | Viva-voce | | 50 | 50 | | 2 | 2 |
| | Research Methodology (VAC) | | | | | | |
| | Total marks | 400 | 200 | 600 | 16 | 8 | 26 |

M. Sc., Marine Biology and Fisheries

Course Objectives:

To impart knowledge in various aspects of marine ecosystems and marine fisheries such as physical and chemical parameters, marine ecology, biology of marine organisms, biological oceanography, fisheries science and management, fish processing and preservation, coastal marine pollution, bio-deterioration, culture of marine organisms, application of biotechnology to aquaculture for best culture production of food species.

To produce skilled, technical manpower to serve the fisheries sector, aquaculture sector, marine fisheries and aquaculture research institutes and to the colleges to teach marine biology and fisheries courses

To equip the student with the knowledge and technical strength to undertake entrepreneurship in both capture and culture fisheries, to start NGOs to protect the coastal ocean against release of pollutants, to protect endangered marine organisms, coral reef and mangrove ecosystems.

M.Sc. Marine Biology and Fisheries

First Semester

Paper 1.1: Physical and Chemical Oceanography

Learning Objectives:

To impart knowledge on the various aspects such as temperature, light, salinity, waves, tides, heat distribution between continent and oceans.

To impart knowledge on the micronutrient distribution, regeneration of nutrients, dissolved oxygen, carbon dioxide and other important gases, calcium carbonate precipitation and its biological importance, sea- surface micro-layer its importance in the productivity of oceans.

To give knowledge to the students about the various national and international marine research Institutions

Outcome:

The student will get sound knowledge on the above aspect which helps the student understand importance of the physical and chemical properties seawater, the role of the oceans in keeping the continental climate cool.

The student will get knowledge on the role played by the various properties of seawater on the sustainability of organisms and on the overall productivity of oceans.

The student will be aware of the various marine research institutions in India and abroad to prepare himself to seek a position in the institute or to pursue higher studies.

Unit -I

Dimensions of Oceans, Physical parameters of sea: Temperature, light, waves, currents, upwelling & sinking, density & pressures, tides, sound and its propagation in the sea. Upwelling and Sinking, Heat budget of oceans. Global circulation patterns. Thesea as suitable physical, chemical and biological environment.

Unit - II

Constancy of composition of sea water- salinity, chlorinity, definition and significance. Conservative behaviour of major elements, interaction of trace elements with marine organisms, factors affecting the distribution of trace elements in the sea. Dissolved gases in sea water- basic concepts: Solubility of gases in sea water, air-sea gas exchange, processes affecting their distribution.

Unit-III

Dissolved oxygen in the oceans: Distribution & factors affecting its distribution
Carbon dioxide system: CO₂ equilibrium in the sea water, pH, alkalinity & buffering capacity of seawater, Calcium carbonate precipitation & dissolution phenomenon - its biological importance.

Unit - IV

Micro nutrient elements: N, P, Si in sea water - their forms in sea water, distribution & cycles. N: Pratiol, uptake & regeneration of nutrient elements.
Chemistry of sea surface micro-layer - origin, thickness and collection of surface material, properties of the sea surface micro-layer.

Unit - V

National and International Institutes of marine research.

NIO, CMFRI, CIFE, CIFT, CIBA, MPEDA, INCOIS, NRSA., their affiliation, thrust areas of research, administration hierarchy, scientist recruitment.

Scripps's Institute of oceanography, Woods Hole Institute of Oceanography, Rosenthal School of Marine Sciences, Hawaiian Institute of Marine Biology, National Oceanography and atmospheric administration, Plymouth Laboratories.

References:

- | | | |
|--------------------------------|--|----------------------|
| Riley, JP and Chester R | Introduction to marine chemistry | Academic Press |
| Riley JP and Skirrow, G | Chemical Oceanography (Vol.1,2,3 &8) | Academic Press |
| R.A.Wiley | Sea water: Its composition, properties & behaviour | The open University |
| Broecker and Peng, | Traces in the Sea Lamont-Dohery Geological Observatory, NY | |
| M.E.Q. Pilson | An introduction to the chemistry of the Sea | Cambridge Uni. Press |
| Burton <i>et al.</i>, | Dynamic processes in the chemistry of the upper ocean | Plenum Press |
| D. Satyanarayana | Introduction to marine chemistry. | |

Practicals:

1. Determination of salinity by Harvey's and Kneudson's method
2. Determination of Dissolved Oxygen by titrimetric method
3. Determination of pH by pH meter method
4. Determination of alkalinity by titrimetric method
5. Calculation of tide time and tide height
6. Calculation of density of sea water using salinity and temperature data
7. Identifying the resulting phenomenon (Upwelling/sinking) by observing the vertical temperature cross-section data of a given layer of water column
8. Identification of water mass, determination of stability of water column using temperature and salinity data
9. Equipment : Nansen's water bottle, Niskin's water bottle, Secchi disc, Refractosalinometer, Reversing thermometer

Paper 1.2: Biological Oceanography

Learning Objectives:

To study the Distribution of plankton in the marine environments.

To study the methods of collection of plankton.

To understand marine food chains.

To study the Factors affecting production.

Outcome:

To gain knowledge on identification of various phytoplankton and zooplankton.

Various methods to estimate organic matter and chlorophyll in sea water.

To gain knowledge on collection methods of plankton.

Unit-1

Introduction to plankton: General classification and composition of plankton. Floating mechanism in plankton. Collection of plankton:

Unit- II

General account of instruments and nets employed. Methods of fixation and preservation; Analyses and enumeration of samples. Standing crop estimation methods.

Unit- III

Plankton in relation to fisheries: General account. Distribution of plankton in space and time, Horizontal distribution: neretic and oceanic plankton; geographical distribution and indicators species. Vertical distribution: Vertical migrations, Seasonal changes in plankton. Phytoplankton and Zooplankton relationships.

Unit- IV

Primary and Secondary (zooplankton) production: General account of productivity in different oceans.

Factors affecting primary and secondary production: Nutrients, light, temperature, organic micro-nutrients, inhibitors and grazing. Particulate and dissolved organic matter in the sea.

Unit- V

Red tides and Mass-mortality in the seas. General survey of marine food chains: Pelagic food chains. Pelagic food pyramid and factors affecting its production & stability.

References:

| | | |
|----------------------|--------------------------|----------|
| Angel MV | Biological Oceanography | Methuen |
| Friedrich H | Marine ecology | S & J |
| Raymont JEG | Plankton & Productivity | Pergamon |
| Ekman S | Zoogeography of the sea | S & J |
| Parsons et al | Biological Oceanographic | Pergamon |

Practicals:

1. Identification of Phytoplankton: Diatoms, Flagellates, Dinoflagellates, Coccolithophores and Toxic dinoflagellates
2. Identification of Zooplankton: Holoplankton, Neroplankton, Coastal and Oceanic plankton
3. Analysis and enumeration of Phytoplankton and Zooplankton: Biomass and standing crop estimation
4. Estimation of particulate organic matter in sea water
5. Chlorophyll estimation
6. Plankton nets

Paper 1.3: Marine Ecology

Learning Objectives:

To impart knowledge to the students on the various ecological divisions and habitats of the marine environment. Effects of environmental parameters on the intertidal organisms- rocky shores, rock pool environment, sandy shores and sandy shores. Zonation in the intertidal regions. The Indo-west pacific region-characteristic features and its biodiversity. Characteristic features of coral reefs, mangroves and their importance in supporting biodiversity and protecting coastal zones.

Outcome:

The student will get sound knowledge about the various ecological zones, environmental conditions and the types of organisms/ fisheries of those zones for exploitation.

The student will get good understanding about the role played by marine algae in supporting the phytal fauna there by enriching the benthic and pelagic food chains.

Unit - I

Classification of marine environment. General characters of the primary biotic divisions.

Distribution of shallow water benthic organisms; Fauna of deep sea and hadal regions—their adaptations.

Unit - II

Intertidal Environment: Physico-chemical parameters in the intertidal region: Insolation, desiccation. Types of rocky shores, Rock pool Environment, distribution of life on rocky shore, sandy shore and muddy shore, zonation and adaptations of organisms of rocky shore, sandy shore and muddy shore.

Unit - III

Zoogeography of seas with special reference to Indo-west Pacific region. Ecology of coral reefs and mangrove habitats; their special features. Food chains of coral reef and mangrove ecosystems.

Unit - IV

Larval Ecology: Types of larvae and their distribution.
Chemical communications and settlement of larvae of marine benthic organisms.
Ecological importance and conservation of marine algae. Ecological modelling.

Unit - V

Macro, micro and benthic fauna and their ecology, Benthic and autotrophic production, chemical composition of sediments, aerobic and anaerobic environments, animal-sediment relations.

References:

| | | |
|-----------------------------|----------------------------|----------------|
| Svedrup <i>et al</i> | The Oceans | Prentice Hall |
| Tait RV | Elements of marine ecology | Butterworths |
| Riley & Skirrow | Chemical Oceanography | Academic Press |

Newell RC
Kinne O (Ed)
Marshall NB
Ekman S

Biology of intertidal animals Logos Press
Marine ecology John Wiley & Sons
Aspects of Deepsea Biology Hutchinson
Zoogeography of the sea. Sidgwick & Jackson

Practicals:

1. Representative organisms of rocky shore, sandy shore and muddy shore with special reference to their ecological features, adaptations, economic importance.
2. Larvae of marine benthic organisms.
3. Ecological modelling of ecosystems
4. Analysis of sediment composition analysis
5. Field visit to rocky, sandy and muddy shores.
6. Computational species diversity indices using the data collected from rocky shore/zooplankton sample
7. Instruments: Cores, Grab sampler, dredge.

Paper 1.4: Biostatistics

Learning Objectives: To impart knowledge on basics of biostatistics and applications of statistics in Marine Biology and Fisheries.

Outcome: Student can understand the basic concepts of sample, sampling methods, Collection and classification of data, Representation of biological data both diagrammatic and graphical, measures of central tendency & dispersion, Correlation and regression, Testing of hypothesis and computer applications.

UNIT -I

Introduction to statistics, Sampling and sampling design, Collection of primary and secondary data, Classification and tabulation of data.

UNIT -II

Diagrammatic (one dimensional & two dimensional) representation of data. Graphical representation (Histogram, frequency polygon, frequency curve, and ogive curve) of data, Measures of central tendency (Mean, median and mode).

UNIT -III

Measures of dispersion: standard deviation, standard error, variance, Skewness, kurtosis and moments. Correlation and regression analyses, Probability and distributions.

UNIT -IV

Estimation and testing of hypotheses; Tests of significance: Z test, t test, F test, Chi-square test, ANOVA (one way and two way), ANCOVA, multi-variate analyses. Types of errors & levels of significance.

UNIT -V

Computer applications: Analyses of data using Microsoft Excel in stock assessment, use of virtual population analysis and pedigree analysis and predictive models. Applications of statistics in marine biology and fisheries: data collection analyses.

References:

Arora & Malhan
Ramakrishnan
Gupta SC
Sokal & Rohlf
Jorgenson SE

Biostatistics
Biostatistics
Statistical methods
Biometry
Fundamentals of ecological modelling

Himalaya
Saras
Sultan chand
Freeman
Elsevier

Practicals:

Problems on

- 1) Classification of data.
- 2) Diagrammatic representation & Graphical representation of data.
- 3) Measures of central tendency.
- 4) Measures of dispersion.
- 5) Correlation analysis.
- 6) Probability and distribution.
- 7) Estimation and confidence limits.
- 8) Parametric tests - Z, P, and F
- 9) Analysis of variance.
- 10) Chi-square test.
- 11) Case study on Marine Biological data
- 12) Analysis of secondary data- MS Excel.

M.Sc. Marine Biology and Fisheries
Second Semester

Paper2.1:Estuaries and Coastal Zone Management

Learning Objectives:

To impart knowledge to the students about different types of estuaries in India and abroad. The physico-chemical properties of estuaries, To make the student equip with the knowledge of coastal zone regulations and CZRs with reference to aquaculture, management of estuaries and coastal zones, applying remote sensing methods.

To give knowledge to the student in topics of wild life protection act, marineprotected areas, sanctuaries and biosphere reserve national marine park.

To give students knowledge in the advanced topics such as geographic informationsystemanditsapplicationsin coastal zone management, International law of the seas, international negotiations andsettlements over open seas, conflictmanagement, sharingstocks.

Outcome:

The student will get sound knowledge on the ecology, biodiversity and the importance of estuaries and mangroves of Indian coastal zones, on the coastal zone regulations, IUCN criteria for listing the organisms in the red list, wild-life protection act, MPAs, sanctuaries and biospheres, their role in conserving wild-life, *in-situ* and *ex-situ* conservation methods,on the advanced topics such as GIS, remote sensing, application of those advanced topics in the management of estuaries, mangroves and coastal zones.The student may be encouraged to initiate NGOs to protect marine and wild-life.

Unit – I

Classificationofestuaries: Types of estuaries

Estuarine environment: Physico-chemical properties ofestuaries

Salinity stratification in estuaries

Unit – II

Distributionofestuarineplankton,nektonandbenthos – their adaptations to estuarine life.

Estuarineplants:

Distributionofmangroves. Estuarinebirdsand estuarinefoodweb.

Unit- III

Coastal Zone Management: Coastal resources: finfish, shellfish, non-living Resources and theirmanagement.

CoastalZoneRegulationsinthecontextofaquaculture,suitability,ICZMandestuarine management.Remotesensingapplications in coastal zonemanagement.

Unit - IV

IUCN criteria- Red list, wild life protection act, international treaties and conventions. Marineprotected areas, Sanctuaries and biosphere reserves, Establishment of National Marine parks.Insituandexsitu conservation.

Unit - V

ElementsofGeographic InformationSystemanditsapplicationsinaquaculture.

Law of the Seas. International law of the seas, Historical perspectives, International negotiations and settlements over open seas, conflict management, sharing stocks.

References:

| | | |
|--------------------|------------------------------------|----------------|
| Mc Lusky DS | Ecology of estuaries | Hinmann |
| Green J | Biology of estuarine animals | S & J |
| Carter RWG | Coastal environments | Academic Press |
| Kinne O | Marine Ecology | John Wiley |
| D.K.Pandey, | Fisheries governance & Legislation | NPH |
| H.K.De | In India | |

Practicals:

1. Determination of sediment organic matter
2. Grain size analysis of estuarine sediment using ro-tap sieve shaker
3. Species diversity and ecological modelling of mangrove and estuarine organisms
4. Separation of total suspended matter and plotting with respect to location and tide
5. Typical estuarine and mangrove organisms.

Paper2.2: Biology of Marine Organisms

Learning Objectives:

To provide knowledge to the student about various biological activities of marine organisms such as feeding, respiration, reproduction, reproductive cycles, excretion, circulation, osmoregulation, bioluminescence, pigments, endogenous rhythms.

Outcome:

The student will get a thorough knowledge on the feeding organs, feeding types, digestion, respiration, respiratory organs, reproductive organs, types of reproduction, spawning seasons, GSI, gonad recovery, hermaphroditism, protandry, protogyny, semelparity, iteroparity, factors effecting respiration, reproduction.

The student will be having knowledge to undertake a study on the biology of an individual fish/shellfish of commercial importance in order increase its production through capture or culture.

Unit -1

Marine animal associations: Commensalism, mutualism, Symbiosis, Parasitism and Predator-prey relationships.

Nutrition: Types of food, general mechanisms of feeding, digestion and digestive enzymes. Excretion: Mode of nitrogen excretion and elimination of nitrogenous wastes.

Unit - II

Respiration: Respiratory mechanisms; factors affecting respiration (Salinity, temperature and oxygen tension); Respiratory pigments and their role in transport of gases.

Osmotic regulation and ion regulation: General account and mechanisms.

Unit - III

General survey of pigments and colour in marine animals; Colour changes- Chromatophores; Bioluminescence: luminescent glands and organs; biochemistry of production of light, biological significance.

Unit - IV

Endogenous rhythms: Biological clocks; Lunar periodicity Physiology of sense organs: types of organs and functions. Physiology of nervous system: structure and functions.

Unit - V

General account of reproduction in marine animals: Asexual, hermaphroditism, protandry and protogyny and sex reversal.

Reproductive cycles: maturation and spawning, semelparity, iteroparity. Periodicity of maturation. Factors influencing reproduction.

References:

| | | |
|-----------------------|-------------------------------------|---------------|
| Nicol JAC | The Biology of marine animals | Pitman |
| Prosser CL | Comparative animal physiology | Saunders |
| Barnes RD | Invertebrate zoology | Saunders |
| Newell RC | Biology of intertidal animals | Logos press |
| Newell RC (Ed) | Adaptation to environment | Butterworth |
| Palmer JD | Biological clocks in mar. organisms | Wiley Eastern |

Practicals:

1. Dissection and display of digestive systems of Herbivorous, and Carnivorous Omnivorous shellfish and fin fish.
2. Dissection and display of reproductive system of fish, shrimp, sepia/loligo, cellana, squilla - Dissection
3. Mounting of radula of cellana, nerita
4. Mounting of gills of carnivore and herbivore fishes
5. Determination of gonadal stages and Gonadosomatic Index of fish and shell fish
6. Mouth parts and appendages of shrimp and crab.

Paper 2.3: Fish Physiology

Learning Objectives:

To study the basic physiology of various systems of fish and shellfish and their functions.

Outcome:

Student acquire knowledge on digestive system of fish and their function. Basic mechanism of feed intake and digestion process. Metabolism of different biomolecules. Basic concepts of respiration. Dynamics of cardiovascular system and their respiratory physiology. Basic concepts of reproductive physiology and endocrinology, Moulting and growth.

UNIT -I

Physiology of digestion: Digestion of carbohydrates. Lipids & proteins, digestive enzymes and regulation of their secretions, absorption & assimilation of nutrients, role of hormones in the regulation of digestion.

UNIT -II

Physiology of respiration: definition of respiration, Basal Metabolic Rate (BMR), external respiration, internal respiration, types of respiratory organs, respiratory pigments & their function, respiratory metabolism, energy budget and expenditure in relation to environment conditions & stress. Chloride cells & their role in respiration.

UNIT -III

Cardiovascular system: structure and functions of heart, blood circulation, blood pressure, Composition of blood, heart and cardiac output, structure of blood/haemolymph pigments.

UNIT -IV

Reproductive physiology: development of gonads, oogenesis, spermatogenesis, metabolic changes during oogenesis & spermatogenesis.

UNIT -V

Neuro-hormones, endocrine glands of finfish and shellfish, their role in regulation of reproduction, moulting and growth.

References:

| | | |
|---------------------------|----------------------------|--------------------|
| Bardach JE et al | Aquaculture | Wiley Interscience |
| Conn & Stump | Outlines of Biochemistry | Wiley Eastern |
| Halver JE | Fish nutrition | Academic press |
| Hoar & Randall | Fish physiology (Vol.1-12) | Academic Press |

Practicals:

1. Dissect and display of respiratory, circulatory, reproductive and endocrine systems in shellfish and finfish.
2. Estimation of amylase, protease, lipase, P^H in different parts of GI tract.
3. Extraction & purification of tissue protein and lipids,
4. Estimation of blood glucose, albumin and globulin, Oxygen consumption by fish/shrimp – in relation to pH, temperature and salinity,
5. Histological observations of gonads- shellfish and finfish.
6. Estimation of total protein, lipid profile, creatinine, urea and enzymes in blood.

Paper 2.4: Fishery Science

Learning Objectives:

To classify the fishes and to identify economically important fishes.

To learn the various growth patterns, migratory behaviour's, population dynamics and recruitment of fishes.

To study the life cycle of fishes.

To study the migratory behaviour of fishes, importance of marking of tagging.

Outcome:

Knowledge on identification and classification of fishes and shell fishes up to species level.

Gaining knowledge on life cycles and breeding biology of various groups of fishes. Acquired knowledge on Fish migrations and Population dynamics and their importance in fishery management,

Unit – I

General account of systematic classification of fishes. Classification based on degrees of movement, zones inhabited and manner of reproduction.

Economically important groups of fishes: General and brief account of elasmobranchs, clupeoids, salmonoids, scombroids, gadoids, heterostomata, sciaenids, carangids, trichiurids, catfish, crustaceans and mollusks.

Unit – II

Natural populations or stocks as biological entities: factors limiting abundance of stocks. Criteria for distinguishing units or multi-stock species. Idea of unit stock- its relevance to tropical marine fish. Stock enhancement, strategies like introduction of exotic species, pre and post stocking management, potential risk of stocking.

Unit – III

Population dynamics: recruitment, growth and mortality.

Length-weight relationship, Condition factor. Biomass.

Unit – IV

General account of life history of Indian fishes: oil sardines, Indian shad, mackerel, Bombay duck and Malabar sole.

General account of food and feeding habits of fishes and methods of assessment.

Unit – V

Age determination of fishes. Beverton and Holt yield per recruit model, Biomass- per recruit. General account of movement and migration in fishes: eels, salmon, Indian shad. Marking and Tagging of fishes.

References:

- | | | |
|-------------------------|----------------------------------|--------------------|
| Cushing DH | Fisheries biology Wisconsin | U. Press |
| Cushing DH | Marine ecology & Fisheries | Cambridge U. Press |
| Jhingran VG | Fish and fisheries of India | Hindusthan |
| Nelson JS | Fishes of the world | John Wiley |
| Royce WF | Introduction to fishery sciences | Academic Press |
| Peter B. | An Introduction to Ichthyology, | Prentice Hall. |
| Moyle, Joseph J. | | |
| Cech 1990 | Fishes | |
| Carl E. Bond | Biology of Fishes. | W.B.Saunders |
| Bensam, P., | Development of Marine | Daya Publishing |
| | Fisheries Science in India. | House |

Practicals:

1. Systematic identification of finfish and shellfish upto species level based on morphometric and meristic data
2. Gut content analysis and method of assessment of feeding
3. Estimation of fecundity
4. Length-weight relationship
5. Size at first maturity
6. Age and growth estimation
7. Relative condition factor
8. Problems related to stock assessment

**M.Sc. Marine Biology and Fisheries,
Third Semester**

Paper3.1:Fishing Technology and Fishery Management

Learning Objective:

To study the details about fishing craft and gear and their regulations.

To study the management of fishery resources.

Outcome:

The students acquired knowledge about evolution of fishing craft and gear. Gain knowledge on Materials required for fabrication of craft and gear.

To learn about pelagic, demersal and deep sea fishing.

To obtain knowledge on stock assessment and yield models. To know about the fishing regulations and control measures.

Unit – I

Evolution of Fishing craft: boat types and their classification. Boats used in India.

Evolution of Fishing gear: Classification of fishing gear; Descriptions of hand-line, troll line and pole line. Description, design and fabrication of trawl nets, purse-seine and gill nets.

Unit – II

Pelagic, demersal and deep sea fishing, By catch reduction in trawl fishing, Turtle Excluder Devices.

Stock assessment: Collection of basic data; stock size, yield models (Methods).

Unit – III

Fishing regulations: Potential fishing zones, code of conduct for responsible fishing, duration of fishing output control measures,

Unit – IV

Total available catch, catch quotas, licensing, technical control measures such as size limitations, closed fishing areas, closed seasons, size of nets and mesh size regulations, limited entry.

Unit – V

The effects of exploitation: The over-fishing problem, Management techniques.

Modern navigation equipment life saving devices (Buoy, jacket, raft, SART, EPIRB, SCUBA).

References:

| | |
|----------------------|------------------------------------|
| Aitikin A | Fish handling & processing |
| Baranov F I | Selected works on fishing gear |
| Brandt AV | Fish catching methods of the world |
| Cushing DH | Marine ecology & fisheries |
| Sanisburry JC | Commercial fishing methods |

Practicals:

1. Fishing Crafts: Catamaran, Masula boat, Dugout Canoes, Rampani and Trawler
2. Fishing Gears: Gill net, Purse Seine, Cast net, Ottor Trawl net, Beam trawl net, Hook & Line, Traps, Stake net and Dip net.
3. Mesh size in different fishing gears
4. Fishing gear knots: Square knot, Clove Hitch knot, Fisherman's knot
5. Fishing Gear Material: Nylon, Terylene, Polyethylene, Polypropylene
6. Other Fishing devices: Floats, Sinkers, buoy, raft
7. Length-frequency analysis of marine fishery resources
8. Gear selectivity
9. MSY-Stock recruitment relationship.

Paper 3.2: Aquaculture

Learning Objectives:

To study the importance and present status of aquaculture in India and abroad

To study the various aspects of site selection and construction of fish/ shrimp ponds and hatcheries

To study the various culture systems and practices for culture of various finfish/ shellfish and sea weeds.

Outcome:

The student can acquire sound knowledge on culture of various types fishes, shrimps, molluscs and sea weeds, those have high demand in the domestic as well as foreign market.

Unit-I

Definition and importance of aquaculture. Overview and status of aquaculture in India. Global aquaculture scenario, production, consumption and emerging trends.

Unit-II

Technical and non-technical considerations in site selection: Ecological factors- Type of land and its elevation to that of water source, soil characteristics and suitability, water supply and water quality, climatic conditions; Biological factors; Socio-economic factors; Legal regulations.

Design & construction of ponds, cages, pens, racks, rafts and long lines.

Unit-III

Selection of material and equipment for aquaculture.

Criteria for selection of species for aquaculture: Economical, ecological and Biological characters.

Monoculture, Polyculture, Integrated aquaculture, Integrated multi-trophic aquaculture, Sewage fed farming, Recirculating Aquaculture Systems, Organic farming, Biofloc system.

Unit-IV

Seed production through finfish and shellfish hatcheries.

Culture practices of finfish (carps, milk fish, Pompano and cobia), crustaceans (shrimps and prawns), mollusks (mussels, edible oysters and cephalopods).

Unit-V

Life cycles of seaweeds: *Ulva fasciata*, *Gracilaria corticata* and *Sargassum tenerrimum*. Culture practices of seaweeds in India and Abroad. Farming of Agar, Algin and Carrageenan yielding seaweeds. Breed improvement in Sea weeds.

References:

| | | |
|--------------------------|--|--------------------|
| Bardach JE et al | Aquaculture | Wiley Interscience |
| Pillay & Dill | Advances in aquaculture | FAO |
| Stickney RR | Principles of Warmwater aquaculture | Wiley Interscience |
| Pillay TVR | Aquaculture: principles & practices | FNB |
| Alilis AE | Fish and shellfish pathology | Academic Press |
| Milne PH | Fish & shellfish farming in coastal waters | FNB |
| Stickney RR | Principles of aquaculture | Wiley & sons |
| Imai T | Aquaculture in shallow seas | Amerind |

Practicals:

1. Design and construction of shrimp hatchery
2. Design and construction of fish farm
3. Aquaculture equipment:
Nets (Cast net, Scissor net), Sand filters, FRP-tanks, Harvesting buckets, Secchi disc, P^H meter, Refractometer, Spectrophotometer)
4. General calculations in Aquaculture management:
Survival Rate, Specific growth rate, Quantifying the seed for transport, Calculation of amount of soil required for construction of dike.
5. Identification of Cultivable finfish, Shellfish and Sea weeds.
6. Identification of Predators, weed fishes, aquatic weeds and larval forms.
7. Fertilizers used in aquaculture.

Paper 3.3:Fish Nutrition and Feed Technology

Learning Objectives:

To study the nutritional requirements of fish and shellfish.

Nutritional bioenergetics of fish.

Feed requirements and feed preparations.

Feed formulation and feeding practices

Methods of feeding.

Outcomes:

Student get knowledge on the composition of various feeds of finfish and shell fish.

Student can acquire knowledge on the different types of feeds, their formulation and mode of application to the cultured species.

Unit - I

Fish nutrition: principles of fish nutrition and terminologies, nutritional requirements of cultivable finfish and shellfish: larvae, juveniles and adults

Nutritional biochemistry: classification, structure, quality evaluation of proteins, lipids, carbohydrates, vitamins and minerals.

Unit – II

Nutritional bioenergetics: fish as an open thermodynamic system, energy requirement of fishes, digestible energy , nitrogen balance index , protein sparing effect, optimal foraging theory, mathematical modeling of ingestion, metabolic rate, energy budgets, reproductive energetics in fish and shellfish.

Unit – III

Nutritional pathology: Anti nutritional factors and anti metabolites, microbial toxins, methods of elimination, nutrient deficiency and symptoms.

Unit – IV

Feed Resources: Nutritional value of feed ingredients, feed additives (attractants, growth stimulants, probiotics and binders), high energy feeds, isocaloric diets.

Feed Manufacture: Feed formulation and processing, On-farm feed manufacture, Commercial feed manufacture, Feed storage

Unit –V

Feeding Practices: Supplementary feed–theory and practice, complete diet - theory and practice, Feeding methods and scheduling, ration size, feed performance.

References:

S. Athithan Practical book on fish nutrition and feed technology

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Science Publ.

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Elena M. Nutrition, Physiology and Metabolism in Crustaceans. Science Publishers

Halver J & Hardy RW. Fish Nutrition. Academic Press

Lovell RT. Nutrition and Feeding of Fishes Chapman & Hall
CIFE. 1993. *Training Manual on Culture of Live Food Organisms for AquaHatcheries.*
Hagiwara A, Snell TW, Lubzens E & Tamaru CS. 1997. *Live Food inAquaculture.*
Proceedings of the Live Food and Marine LarvicultureSymposium. Kluwer.
Halver JE & Hardy RW. 2002. *Fish Nutrition.* Academic Press.

Practicals:

1. Quantitative analysis of protein, carbohydrate and lipid from fish feeds.
2. Different types of feeds
3. Feed formulations
4. Calculation of FCR and FCE
5. Calculation of daily ration of feed

Paper 3.4: Marine Pollution and Bio-deterioration

Learning Objectives:

To impart thorough knowledge to the students in marine pollution, sources of pollutants to coastal oceans, transport paths and agents, domestic, industrial and agricultural discharges, composition, fate in the marine environment. Waste water treatment methods.

To study the fouling and boring activities of marine organisms on marine structures, controlling of boring and fouling activities of marine organisms. To study the strategies of global environmental methods.

Outcome:

The students will get knowledge about the various types of pollutants, their sources, transport paths, transport agents, their fate in the environment; controlling, monitoring and management methods of all those pollutants. The students will get commendable knowledge on the recent topics such as application of biotechnology to mitigate the pollutants generated by industrial activities, to treat the pollutants; EIA methods and enzymatic removal of hazardous substances. The knowledge acquired by the students on marine pollution may encourage them to develop, conduct and participate in the programmes against release of pollutants into the coastal environment.

Unit - I

Sources of marine pollution: dynamics, transport paths and agents.

Composition of domestic, industrial and agricultural discharges; their fate in the marine environment. Toxicity and treatment methods.

Unit - II

Oil pollution: Sources, composition and its fate in marine habitats. Toxicity and treatment methods.

Thermal and radioactive pollution: sources, disposal systems of heated effluents, effects and treatment.

Solid dumping, mining and dredging operations: their effects on marine ecosystem, management of solid waste.

Unit - III

Bio-fouling and bio-deterioration: Biofilm formation - primary, secondary, tertiary colonizers. Effects of bio-fouling and control measures: manual, mechanical, chemical and biotechnological.

Borers: Effects and control measures.

Corrosion -

definition, reactions, classification. Factors and preventive measures.

Unit - IV

Global environmental monitoring methods: status, objectives and limitations.

Monitoring strategies of marine pollution: critical pathway approach and mass balancing. Environment Impact Assessment:

Assessment of damage and problems of measuring the impact

Unit - V

Role of biotechnology in marine pollution control. Enzymatic removal of hazardous organic substances. Wastes from fish processing units and their treatment - removal of nitrogen and phosphorus.

Aquatic macrophytes in treatment of waste water.

References:

- Nielsen SE** Tropical pollution John Wiley
Kinne O Marine Ecology Vol. V Academic Press
Johnson R (Ed) Marine pollution Butterworths
Patin SA Pollution and boil.Resources of oceans UNESCO Press. Paris.
Goldberg, E. D. 1974. The Health of the oceans, UNESCO Press. Paris.
Park, P .K, Kester D.R., J.W. Deudall and B.H Ketchum, 1983. Wastes in the Ocean.
Vols. 1 to 3. Wiley Interscience Publishers, New York.
Eckenfelder WW. 2000. *Industrial Water Pollution Control.* McGraw Hill.
Gray NF. 2004. *Biology of Wastewater Treatment.* Oxford University Press.
Trivedy RK. 1998. *Advances in Wastewater Treatment Technologies.* Global Science.

Practicals:

1. Determination of BOD in the polluted sea water sample.
2. Determination of nutrients in the polluted sea water sample: nitrites, nitrates, silicates, phosphates
3. Determination of toxic elements in the polluted sea water sample: ammonia, sulphide
4. Estimation of particulate organic matter in the polluted sea water sample
5. Spotters: Foulers- primary, secondary and tertiary colonizers; Borers

**M.Sc. Marine Biology and Fisheries,
Fourth Semester**

Paper 4.1: Fish Processing Technology

Learning Objectives:

To study the various bacteria found in fresh and processed foods and their impacts,
Various methods of preservation of food products,
Different methods for storage and transportation of fish,
By products of fishery resources, and
Quality control measures in sea food processing plants.

Outcomes:

To have a knowledge on the various bacteria and their isolation techniques.
To gain knowledge on different techniques employed in sea food processing plants.
To acquire knowledge on various methods of preparation of fishery by-products.

Unit – 1

Microbiology of fresh and processed fish: Common bacterial pathogens in fish and fishery products-isolation and identification. Bacteria of sanitary significance.

Unit – II

Handling of fish, Spoilage of fish and shellfish: effect of temperature on fish spoilage; Containers for packaging and transportation of fish
Use of chemical preservatives and irradiation in extending shelf-life of finfish and shellfish: effects of irradiation on protein, fat & vitamin.

Unit – III

Canning: principles of canning; can shapes, canning materials; handling and preparation of fish and shellfish for canning; spoilage of canned fish; chemical and microbiological spoilage and their prevention, process value calculation.
Curing: principles and practices of salting and drying the fish; microwave vacuum drying, pickling; smoking of fish; Spoilage of cured fish.

Unit – IV

Freezing of fish: techniques of freezing; types of freezers; changes during freezing: Crystallization, nucleation, crystal growth, high pressure processing.
Protection of frozen fish: glazing and wrapping; use of anti-oxidants; Thawing of frozen fish; double freezing of fish

Unit – V

Fishery By-products: processing of low cost fish; minced meat, fish oil, fish meal, Fish sausages, isinglass, glues, fish silage, chitosan, chitin, pearlescence; Alginates, agar.
Quality problem in fishery products: good manufacturing practices, HACCP
National and International standards, Food laws in India.

References:

- Aitikin A** Fish handling & processing
Borgstorm G Fish as food Academic press
Connell JJ Advances in fish science & technology FNB
Neha Charan Assessment of fish quality
Anon. 2001. *Food Borne Disease Handbook*. 2nd Ed. Vol. IV. *Seafood and Environmental Toxins*. Marcel Dekker.
Balachandran KK. 2001. *Post Harvest Technology of Fish and Fish Products*. Daya Publ.
Sen DP. 2005. *Advances in Fish Processing Technology*. Allied Publ.
Wheaton FW & Lawson TB. 1985. *Processing Aquatic Food Products*. John Wiley & Sons.
Windsor M & Barlow. 1981. *Introduction to Fishery Byproducts*. Fishing News (Books).

Practicals:

1. Estimation of moisture content in fish and shrimp muscle.
2. Estimation of Total Plate Count (TPC) in water and fish muscle sample.
3. Identification of Gram -ve and Gram +ve bacteria using Gram staining technique.
4. Assessment of freshness of fish and shrimp by using organoleptic characters.
5. Isolation of *Bacillus* and *Clostridium* species from sea food
6. Freezing curve and determination of freezing point
7. Equipments and By-products
8. Visit to processing plant to learn the sanitary conditions to be maintained in fish preservation.

Paper4.2: Fishery Economics and Extension

Learning objectives:

To study the concept of Economics and its impact on fishery industry.

To understand several factors affecting the activities of fisheries and study the relationship between input and output.

To understand cost and profit relationship, promotion of fishery activities and role of several institutions for economic development.

To understand guidelines for promotion of fishery trade and extension in fisheries.

Outcome:

Students will understand the economic aspects of fisheries, make it more profitable and study the socio economic aspects which help in promotion both domestically and internationally.

Understand the market concepts of demand, supply, costs and profit.

Unit-I

Contribution of fisheries to National Economy, Introduction to fisheries economics, Role of economic, technological, social, cultural, political and environmental factors effecting fisheries, Theories of factors of production – Factor-factor, Factor-product, Product-product relationship,

Unit-II

Factors effecting Demand and Supply, Indian marketing environment; Fishery & aquaculture marketing system; Strategies and methods for promoting fisheries development, Cost function and components in fishing effort, Income concepts- factors, BEA, CVP in fisheries, Bio-economic model of the fishery, LPP

Unit-III

Management of fisheries: Regulation of commercial fisheries, Fisheries credit and finance- NABARD, Fisheries cooperatives and Rural development, Risk and un-certainties in fisheries, Fishery resources of India, overfishing and under fishing, open access fisheries,

Unit-IV

Economics of different aquaculture systems. Factors affecting economics of aquaculture, Socio-economic issues in aquaculture development, Domestic and export marketing of fish and fish products, International trade of seafood and trade regulations-WTO, Seafood Export promotion in India-MPEDA.

Unit-V

Extension in Fisheries- Fisheries training and education in India : Training Institutes, Universities, Research Organisations, modes of extension, Interdependence between fisheries and industrial development, Natural Disasters and its coping mechanism

References:

Medwin Gale Economics in Fisheries research

Grafton QR, Kirkley J, Kpmpas T & Squire D Economics for fisheries Management

Cunningham S, Dunn MR & Whitmarsh D, 1985. Fisheries Economics. St. Martin's Press

Dunne EB, 1990. Fisheries Exconomics- An Introduction.

Mansell Publ.

Shang YC, 1981.

Aquaculture Economics. Westview Press.

Shyam S. Salim, RS Birada and SK. Pandey, 2005. Fisheries economics and marketing- An Introduction. CIFE

Practicals:

1. Estimation of different production relationships
2. Farm business analysis- Breakeven , Cost-benefit analysis
3. Mathematical analysis of production relationship
4. Estimation of Physical and economic optimum
5. Estimation of yield gap and factor shares
6. Linear programming- variable resource programming, Variable price programming and optimization techniques.

Paper4.3: Aquaculture Biotechnology

Learning Objectives:

To impart knowledge on application of biotechnology in finfish and shellfish breeding.
To study the application of genetics in aquaculture, culture of live feeds and aquaculture health management.

Outcome:

Student acquire knowledge on breeding technology of finfish and shellfish, cryopreservation of gametes, In-Vitro fertilization.

Student gain knowledge on fish genetics for production of high quality species, culture of live feeds and disease diagnosis and control.

Unit-I

Reproductive Biotechnology: Induced breeding, Egg incubation and Larval rearing. Synthetic hormones for induced breeding - molecular endocrinology with emphasis on use of analogues for breeding like GnRH, pheromones. Cryopreservation, IN VITRO fertilization, artificial insemination.

Unit-II

Principles of genetics: fish cytogenetics; Application of genetics in aquaculture: genetic selection, hybridization, inbreeding, cross-breeding, sex control, polyploidy and transgenesis, methods of gene transfer in fishes, screening, sites, applications. Development of disease-resistant and high quality strains.

Unit-III

Live feed: culture of commercially important micro algal species (*Chaetoceros*, *Skeletonema*, *Isochrysis*, *Tetraselmis*, *Thalassiosira*, *Nannochloropsis*), single cell protein from *Spirulina*, Culture of *Artemia*, rotifers, cladocerans, chironomid larvae.

Unit-IV

Health Management: Viral, bacterial, fungal, parasitic, nutritional and environmental diseases of cultured fish and shellfish. DNA and RNA vaccines, molecular diagnosis of viral diseases, Dot-blot, RAPD, RFLP.

Unit-V

Biotechnological approaches for peptide synthesis. Antimicrobial peptides and their applications. therapeutic proteins. Immunostimulants. anti-oxidants, antibiotics and nutraceuticals. Application of nanotechnology in aquaculture.

References:

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|---------------------------|--------------------------|--------------------|
| Halver JE | Fish Nutrition | Wiley Interscience |
| Hoar & Randall | Fish physiology | Academic Press |
| Bardach JE et al | Aquaculture | Wiley Interscience |
| Conn & Stump | Outlines of biochemistry | Wiley Eastern |
- Italy, E (Eds). 1998, New Developments in Marine Biotechnology, Plenum Pub. Corp.

Milton Fingerman and Rachakonda Nagabhushanam, 1996, Molecular Genetics of Marine Organisms, Science Pub Inc.

Y. Le Gal and H.O.Halvorson 1998, New Developments in Marine Biotechnology. Springer.

Practicals:

1. Pituitary gland isolation and preparation of pituitary gland extract
2. Induced spawning - fish, shrimp, Seaurchins and bivalves
4. Live feed cultures (microalgae)
5. Determination of concentration of microalgal cells in culture flasks using haemocytometer
6. Spotters of live feed organisms:
 - i. Animal live feed
 - ii. Plant live
7. Numericals on inbreeding, cross breeding and polyploidy
7. PCR Demo
8. Dot- Blot Dem.