PONDICHERRY UNIVERSITY
SCHOOL OF LIFE SCIENCE

DEPARTMENT OF OCEAN STUDIES AND MARINE BIOLOGY

SYLLABUS

M. Sc., MARINE BIOLOGY (2019 ONWARDS)
Pondicherry University  
School of Life Science  
Department of Ocean Studies & Marine Biology  
Master of Science in Marine Biology

Programme Objectives

The M.Sc., Programme in Marine Biology is conducted to provide the students:

1. Recent development in the field of Marine Biology.
2. Understand the overview structure and function of life in the marine environment.
3. Laboratory course offered for Practical knowledge on identification of various floral and faunal assemblages and their adaptations.
4. Exposure of students through field work involving sample collection, sea water, sediment, biota and short term experiments as dissertations.
5. Creation of a skilled workforce in Marine biology for teaching, research and entrepreneurship.

Programme outcome

1. In depth knowledge on the basic and recent development in the field of Marine Biology.
2. Acquire skill on theoretical and experimental protocols in understanding the marine environment.
3. Possess knowledge for independent thinking, in writing scientific proposal, and its presentation.
4. Man power development for becoming successful researches and academicians.
# M. Sc., Marine Biology Syllabus (2019 – 2020 Academic Year)
## Semester - CBCS Pattern

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Theory / Practical</th>
<th>Assessment</th>
<th>Credit</th>
<th>Total Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Internal</td>
<td>External</td>
<td></td>
</tr>
<tr>
<td>I SEMESTER</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MABO 401</td>
<td>Physical Oceanography</td>
<td>40</td>
<td>60</td>
<td>100</td>
</tr>
<tr>
<td>MABO 402</td>
<td>Chemical Oceanography</td>
<td>40</td>
<td>60</td>
<td>100</td>
</tr>
<tr>
<td>MABO 403</td>
<td>Biological Oceanography</td>
<td>40</td>
<td>60</td>
<td>100</td>
</tr>
<tr>
<td>MABO 404</td>
<td>Marine Ecology</td>
<td>40</td>
<td>60</td>
<td>100</td>
</tr>
<tr>
<td>MABO 405</td>
<td>Lab – I – Physical and Chemical Oceanography</td>
<td>40</td>
<td>60</td>
<td>100</td>
</tr>
<tr>
<td>MABO 406</td>
<td>Lab – II – Biological Oceanography &amp; Marine Ecology</td>
<td>40</td>
<td>60</td>
<td>100</td>
</tr>
<tr>
<td>II SEMESTER</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MABO 411</td>
<td>Marine Invertebrates</td>
<td>40</td>
<td>60</td>
<td>100</td>
</tr>
<tr>
<td>MABO 412</td>
<td>Marine Microbiology</td>
<td>40</td>
<td>60</td>
<td>100</td>
</tr>
<tr>
<td>MABO 413</td>
<td>Physiology and Biochemistry</td>
<td>40</td>
<td>60</td>
<td>100</td>
</tr>
<tr>
<td>MABO 414</td>
<td>Marine Fisheries</td>
<td>40</td>
<td>60</td>
<td>100</td>
</tr>
<tr>
<td>MABO 415</td>
<td>Lab – III – Marine Invertebrates &amp; Marine Microbiology</td>
<td>40</td>
<td>60</td>
<td>100</td>
</tr>
<tr>
<td>MABO 416</td>
<td>Lab IV - Physiology and Biochemistry &amp; Marine Fisheries</td>
<td>40</td>
<td>60</td>
<td>100</td>
</tr>
<tr>
<td>III SEMESTER</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MABO 501</td>
<td>Molecular Genetics</td>
<td>40</td>
<td>60</td>
<td>100</td>
</tr>
<tr>
<td>MABO 502</td>
<td>Aquaculture</td>
<td>40</td>
<td>60</td>
<td>100</td>
</tr>
<tr>
<td>MABO 503</td>
<td>Marine Vertebrates</td>
<td>40</td>
<td>60</td>
<td>100</td>
</tr>
<tr>
<td>MABO 505</td>
<td>Lab – V – Molecular Genetics &amp; Aquaculture</td>
<td>40</td>
<td>60</td>
<td>100</td>
</tr>
<tr>
<td>MABO 521</td>
<td>Soft Core</td>
<td>40</td>
<td>60</td>
<td>100</td>
</tr>
<tr>
<td>MABO 527</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IV SEMESTER</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MABO 511</td>
<td>Ocean Policies and Management</td>
<td>40</td>
<td>60</td>
<td>100</td>
</tr>
<tr>
<td>MABO 512</td>
<td>Marine Biotechnology</td>
<td>40</td>
<td>60</td>
<td>100</td>
</tr>
<tr>
<td>MABO 513</td>
<td>Marine Pollution</td>
<td>40</td>
<td>60</td>
<td>100</td>
</tr>
<tr>
<td>MABO 599</td>
<td>Project</td>
<td>40</td>
<td>60</td>
<td>100</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td>72</td>
</tr>
</tbody>
</table>
MABO - 401; PHYSICAL OCEANOGRAPHY

Course Objective: To understand the physical conditions and processes in the ocean including the motions and physical properties and ocean water.

Pre-requisite: Bachelor’s level course in Life Sciences.

TOTAL CREDIT: 4 TOTAL HOURS: 60

UNIT - I 12 HOURS

UNIT - II 10 HOURS

UNIT - III 14 HOURS

UNIT - IV 12 HOURS

UNIT - V 12 HOURS

Text Books

Reference Books

Course Outcome: Students will know the physical processes of the oceans.
MABO - 402; CHEMICAL OCEANOGRAPHY

Course Objective: To understand the chemical nature of seawater and its function for biological environment.

Pre-requisite: Bachelor’s level course in Life Sciences.

TOTAL CREDIT: 4 TOTAL HOURS: 60

UNIT - I 10 HOURS
Introduction to marine chemistry - ocean as a chemical system - origin of sea salts - properties of water molecules - differences between fresh and seawater.

UNIT - II 13 HOURS
Chemical composition of seawater; ionic - major and minor constituents - constancy of ionic compositions and factors affecting constancy - major and minor elements - trace elements - their importance - distribution. Chemistry of seawater constituents - concept of chlorinity and salinity - methods of collections and measurements of seawater, sediment samples for chemical analysis.

UNIT - III 13 HOURS

UNIT - IV 14 HOURS

UNIT - V 10 HOURS

Text Books

Reference Books

Course Outcome: Student understand the different chemical systems available in the marine waters and its important for the survival of biota.
MABO – 403; BIOLOGICAL OCEANOGRAPHY

**Course Objective:** To understand the diversity of organisms in the ocean and their importance.

**Pre-requisite:** Bachelor’s level course in Life Sciences.

**TOTAL CREDIT: 4**

**TOTAL HOURS: 60**

**UNIT - I**

10 HOURS


**UNIT - II**

15 HOURS


**UNIT - III**

12 HOURS

Organic production - Primary and Secondary production - methods of estimating primary productivity - light and dark bottle method, C\textsuperscript{14}, Pigment analysis, flow cytometer. Factors affecting productivity - productivity in different oceans - CO\textsubscript{2} sequestration. Harmful Algal Blooms (HAB) - Red tide phenomenon - causes and its effects.

**UNIT - IV**

14 HOURS

Productivity - Sea weeds; general structure, types, distribution and economical importance - Mangroves - distribution, adaptation (morphological, anatomical) their importance. Sea grasses - their importance. Salt marshes; occurrence - their importance. Sand dunes; formation - types and their importance. Coral reefs; occurrence - distribution and economic importance.

**UNIT - V**

09 HOURS

Biological resource assessment and management - using remote sensing techniques and Geographical Information System (GIS) for chlorophyll distribution. Critical habitats and biological hot spots.

**Text Books**


**Reference Books**


**Course Outcome:** Students will understand the marine life – flora and fauna in the ocean.
MABO - 404; MARINE ECOLOGY

Course Objective: To understand the marine life habitat - population and interaction among the organisms – adaptation to abiotic and biotic environment.

Pre-requisite: Bachelor’s level course in Life Sciences.

TOTAL CREDIT: 4
TOTAL HOURS: 60

UNIT - I
14 HOURS

UNIT - II
12 HOURS

UNIT - III
12 HOURS
Population ecology; population growth, density variations, concept of carrying capacity. Dispersal, competition, prey-predator relationships, density dependant & density independent factors.

UNIT - IV
12 HOURS

UNIT - V
10 HOURS

Text Books

Reference Books

Course Outcome: Students will understand the Economic importance and Conservation of Marine Ecosystems.
MABO - 405; Lab – I
PHYSICAL OCEANOGRAPHY AND CHEMICAL OCEANOGRAPHY

Course Objective: To understand the practical knowledge on operation of equipments and chemical analysis.

Pre-requisite: Bachelor’s level course in Life Sciences.

TOTAL CREDIT: 2 TOTAL HOURS: 30

1. Navigational Device: Operation and application of GPS.
4. Measuring device - II Wave measurement.
7. Sediment sampling device - I Petersen Grab.
8. Sediment sampling device - II Corer.
11. Determination of Nitrite.
15. Determination of Bicarbonate.

Lab Manuals:


Course Outcome: Students will master the different techniques in physical and chemical oceanography.
MABO - 406; Lab – II  
BIOLOGICAL OCEANOGRAPHY AND MARINE ECOLOGY

Course Objective: To understand the practical knowledge on biological organisms and the functioning in different ecosystem.

Pre-requisite: Bachelor’s level course in Life Sciences.

TOTAL CREDIT: 2  TOTAL HOURS: 30

1. Identification of Phytoplankton; Diatoms and Dinoflagellates.
2. Identification of Zooplankton; Copepods.
3. Identification of Larval forms.
4. Identification of locally available Sea Grasses.
5. Identification of locally available Seaweeds.
6. Identification of locally available Mangroves.
8. Estimation of Primary productivity.

9. Rocky Shore Fauna; Collection and Identification.
10. Sandy Shore Fauna; Collection, Sorting and Identification.
11. Macrofaunal studies in seagrass and mangrove ecosystems.
12. Meiofaunal studies in seagrass and mangrove ecosystems.
16. Foulers and borers: Collection and identifications.

Lab Manuals:


Course Outcome: Students will understand the biology of organisms and their adaptation to the environment.
MABO - 411; MARINE INVERTEBRATES

Course Objective: To understand the Taxonomy, diversity and biology of marine Invertebrates including the prochordates.

Pre-requisite: Bachelor’s level course in Life Sciences.

TOTAL CREDIT: 4

UNIT - I 11 HOURS

UNIT - II 12 HOURS
Taxonomic characters, classification, general morphology of Nemertea, Rotifera, Gastrotricha, Kinorhyncha, Nemotoda, Priapula, Entoprocta, Gnathostomulida and Sipunculiida. Phylum Chaetognatha; characteristics, classification, vertical migration, feeding and digestion.

UNIT - III 13 HOURS
Polychaeta - general morphology, classification, support and locomotion, feeding, reproduction and development - Siboglinidae - Echiuride. Oligochaeta Subphylum Crustacea - characteristics, classification, class Branchiopoda, Malacostraca, Maxillopoda - body plan and appendages, molting, larval forms. Class Pycnogonida and Merostomata - Xiphosura.

UNIT - IV 11 HOURS
Phylum Mollusca - taxonomic history, classification, diversity and distribution, body plan, molluscan shell, torsion, locomotion, cephalopod colouration and ink, feeding - radula - types, sense organs, reproduction and development. Morphological characters and evolutionary relationship of Lophophorates - Ectoprocta, Phoronida and Brachiopoda.

UNIT - V 13 HOURS
Phylum Echinodermata - taxonomic characters and classification - Crinoidea, Asteroidea, Ophiuroidea, Echinoidea, Holothuroidea and sea Daisies - water vascular system, support, locomotion, feeding, reproduction and development, types of larvae, phylogeny. Phylum Hemichordata, Urochordata and Cephalochordata; characteristics, classification.

Text Books

Reference Books

Course Outcome: Students will know about the diversity, distribution and biology of marine Invertebrates and their ecological role in the marine environment.
MABO – 412; MARINE MICROBIOLOGY

Course Objective: To understand the role of microorganism in nutrient cycling and their importance in marine ecosystem.

Pre-requisite: Bachelor’s level course in Life Sciences.

TOTAL CREDIT: 4

TOTAL HOURS: 60

UNIT - I 10 HOURS
Introduction to microbial oceanography: Emergence of the field of microbial oceanography. Marine microorganisms: acinetobacter, cyanobacteria, photoheterotrophic bacteria, heterotrophic bacteria, marine archaea, heterotrophic protists, marine fungi, marine viruses, marine microbial habitats.

UNIT - II 13 HOURS

UNIT - III 13 HOURS

UNIT - IV 12 HOURS

UNIT - V 12 HOURS

Text books

Reference books

Course Objective: students will understand the role of microorganisms in enriching the ocean for life to grow.
MABO – 413; PHYSIOLOGY AND BIOCHEMISTRY

Course Objective: To understand the basic physiological and biochemical processes in organisms.

Pre-requisite: Bachelor’s level course in Life Sciences.

TOTAL CREDIT: 4

UNIT - I

UNIT - II

UNIT - III

UNIT - IV

UNIT - V
Lipids-structure-classification, oxidation of fatty acids - β oxidation, saturated, unsaturated, odd, even chain, Biosynthesis of lipids-synthesis of long chain fatty acids, unsaturated fatty acids, cholesterol - biosynthesis, regulation. Biochemical technique - Centrifugation - types, Chromatography - column, TLC, paper, HPLC.

Text Books

Reference Books

Course Outcome: Students will understand basic physiological and biochemical processes taking place in the organism.
**Course Objective:** To impart basic knowledge on fish biology, taxonomy as well as harvest and post-harvest technology.

**Pre-requisite:** Bachelor’s level course in Life Sciences.

**TOTAL CREDIT:** 4  
**TOTAL HOURS:** 60

**UNIT - I**  
10 HOURS  
Introduction to marine fisheries - history of world and Indian Fisheries sector, Taxonomy and classification of fin and shell fishes with special reference to species of commercial importance.

**UNIT - II**  
12 HOURS  

**UNIT - III**  
12 HOURS  

**UNIT - IV**  
12 HOURS  
Marine fishery resources of India - pelagic, demersal, oceanic and deep-sea. Marine fishery resources of Andaman and Nicobar Islands. Fishery resource potential and present level of exploitation. Exploratory fishery surveys. Ancillary fishery resources - seaweeds, crab, lobsters, chank and bivalves. Socio-economics, extension and planning in fisheries.

**UNIT - V**  
14 HOURS  
Fish handling onboard and landing centers. Fish preservation methods - freezing, drying, salting, smoking and canning. Fishery by products - fish meal, fish oil, fish protein concentrate, chitin, isinglass, shark fin, rays, Surimi and fish minced products.

**Text Books**

**Reference Books**

**Course Outcome:** Students will develop skill to identify fishery resources, learn recent methods used in harvest and post-harvest technology in Marine Fisheries.
MABO - 415; Lab – III
MARINE INVERTEBRATES AND MARINE MICROBIOLOGY

Course Objective: To understand the practical knowledge on identification of marine micro and macro organisms.

Pre-requisite: Bachelor’s level course in Life Sciences.

TOTAL CREDIT: 2 TOTAL HOURS: 30

1. Identification of Polychaetes.
2. Dissection and display of appendages: Decapoda.
3. Dissection of parapodia and seate of polychaetes.
4. Identification of Decapods.
5. Identification of Gastropods.
6. Identification of Bivalves.
7. Identification of Echinoderms.
8. Identification of Nematoda, Nemertea and Sipunculiids.
11. Isolation of bacteria from Seafood.
12. Isolation of pure colonies.
15. Isolation of bacterial DNA.
16. Identification based on 16s RNA.

Lab Manuals:


Course Outcome: Students will be able to understand the identification of marine organisms and their importance in the environment.
MABO - 416; Lab – IV
PHYSIOLOGY AND BIOCHEMISTRY & MARINE FISHERIES

Course Objective: To understand the practical knowledge on physiological, biochemical composition of marine organisms – fishes and their morphology.

Pre-requisite: Bachelor’s level course in Life Sciences.

TOTAL CREDIT: 4 TOTAL HOURS: 30

1. Effect of salinity on oxygen consumption in Fish.
2. Effect of temperature on oxygen consumption in Fish.
5. Estimation of Carbohydrate.
7. Estimation of Lipids.
10. Food and Feeding analysis of Fish.
11. Reproductive Biology of Fish - Maturity stages.
12. Length Weight Relationship of Fish.
13. Identification of common fishing craft and gear.
14. Fish population estimation.
15. Determination of age of fish.
16. Fish byproducts.

Lab Manuals:


2. FAO, 2005, Manuals for Finfish Identification.

Course Outcome: Students will be able to understand physiological and biochemical aspects of marine organisms with special reference to fishes.
SEMESTER - III
MABO – 501; MOLECULAR GENETICS

Course Objective: To understand the basic principles and processes in gene of prokaryotic and eukaryotic organisms in the molecular level.

Pre-requisite: Bachelor’s level course in Life Sciences.

TOTAL CREDIT: 4 TOTAL HOURS: 60

UNIT - I 12 HOURS
General genetics - DNA as genetic material - structure and types of DNA, RNA, Organization of prokaryotic and eukaryotic genomes. Genetics of bacteria and viruses - transformations - conjugation - F+ Hfr - transduction - generalized and specialized, Organelle DNA - chloroplast DNA, mitochondrial DNA.

UNIT - II 13 HOURS
DNA Replication - replication models - role of different enzymes and accessory proteins in prokaryotic and eukaryotic DNA replication - semi conservative, rolling circle, theta replication, Phi x0174, SV40. Mechanism of replications - prokaryotes, eukaryotes.

UNIT - III 11 HOURS
Mutation types, mutagens - physical, chemical-nitrous acid - hydroxylamine - alkylation agents - Intercalating agents and UV - mechanism of mutation - DNA repairs process types, photo reactivation, excision, recombination, SOS, transposons.

UNIT - IV 12 HOURS

UNIT - V 12 HOURS
Regulations of gene expression in prokaryotes - the operon concept: Lac, Trp, positive and negative controls. Eukaryotic regulation: transcriptional, translational level regulations.

Text books

Reference books

Course Outcome: Students will understand basic principles and processes in the genetic level.
MABO – 502; AQUACULTURE

Course Objective: To understand various techniques, developments and prospects in Aquaculture.

Pre-requisite: Bachelor’s level course in Life Sciences.

TOTAL CREDIT: 4 TOTAL HOURS: 60

UNIT - I
Introduction to aquaculture - general principles and present status - scope and importance. World and Indian aquaculture production and trends. General characteristics of major cultivable fin and shellfish of India - estuarine and marine - finfishes (sea bass, groupers, mullets, milkfish etc.); shellfish (shrimps, crabs, lobsters, mussels, oysters, clams). Seaweed culture.

UNIT - II

UNIT - III

UNIT - IV

UNIT - V

Text Books:

Reference Books:

Course Outcome: The students learn basic aquaculture and hatchery practices along with recent developments for implementing in the field.
MABO - 503; MARINE VERTEBRATES

Course Objective: To understand the diversity, distribution and biology of marine vertebrates particularly the reptiles, birds and mammals.

Pre-requisite: Bachelor’s level course in Life Sciences.

TOTAL CREDIT: 4

TOTAL HOURS: 60

UNIT - I 12 HOURS

UNIT - II 11 HOURS

UNIT - III 13 HOURS

UNIT - IV 11 HOURS
Marine mammals - classification and conservation - Indian marine mammals.

UNIT - V 13 HOURS

Text Books

Reference Books

Course Outcome: Students will know about the diversity, distribution and biology of marine Vertebrates (reptiles, birds and mammals) and their ecological role in the marine environment.
Course Objective: To understand the molecular techniques and aquacultural practices.

Pre-requisite: Bachelor’s level course in Life Sciences.

TOTAL CREDIT: 2

1. Extraction of DNA from marine fish.
2. PCR Technique.
3. Study of mitosis from plant tissue.
4. Isolation of chloroplast DNA.
5. Isolation of plasmid.
6. Column Chromatography.
7. Gel Electrophoresis.
8. TLC.

10. Identification of Larval Stages of Shell fish and Fin Fish.
12. Culturable Fish species.
13. Induced Breeding – Thermal Shock.
14. Preparation of Feed.
15. Identification of predators in aquaculture.

Lab Manuals:


2. FAO, 2005, Manuals for Finfish Identification.

Course Outcome: Student will be able to understand various molecular techniques and various aquaculture practices.
## SOFT CORE - MABO - 521 to MABO - 527

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Soft Core</th>
<th>Assessment</th>
<th>Credit</th>
<th>Total Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Internal</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>External</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>III SEMESTER</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MABO 521</td>
<td>Benthic Ecology</td>
<td>40</td>
<td>60</td>
<td>2</td>
</tr>
<tr>
<td>MABO 522</td>
<td>Marine Environmental Impact Assessment</td>
<td>40</td>
<td>60</td>
<td>2</td>
</tr>
<tr>
<td>MABO 523</td>
<td>Marine Ornamental Fishes</td>
<td>40</td>
<td>60</td>
<td>2</td>
</tr>
<tr>
<td>MABO 524</td>
<td>Marine Zooplankton Ecology</td>
<td>40</td>
<td>60</td>
<td>2</td>
</tr>
<tr>
<td>MABO 525</td>
<td>Marine Biodiversity and Conservation</td>
<td>40</td>
<td>60</td>
<td>2</td>
</tr>
<tr>
<td>MABO 526</td>
<td>Marine Organisms Documentation and Submission</td>
<td>40</td>
<td>60</td>
<td>2</td>
</tr>
<tr>
<td>MABO 527</td>
<td>Conservation and Management of Mangrove and Corals</td>
<td>40</td>
<td>60</td>
<td>2</td>
</tr>
</tbody>
</table>

Each student is to select one of the soft core from the above. The soft core course requires a Minimum Five Students to opt for a particular soft core.
MABO – 521; BENTHIC ECOLOGY

Course Objective: To understand the basics on the benthic ecosystem and collection and processing of benthic organisms.

Pre-requisite: Bachelor’s level course in Life Sciences.

TOTAL CREDIT: 2

UNIT - I  6 HOURS
Introduction - benthos - classification - importance - mussel watch program - benthos of coastal waters - deep ocean - mid-ocean ridge community - trophic dynamics - estuarine community - Environmental Impact.

UNIT - II  6 HOURS
Methods of sampling and design of sampling - Sediment analysis - bulk benthic processes - bioturbation - sediment sculpting - animal sediment relationships.

UNIT - III  6 HOURS
Macrofauna techniques - intertidal observation - collection - sampling gear - treatment - sorting of sample.

UNIT - IV  6 HOURS
Meiofauna techniques - sampling - treatment - sorting of samples - extraction - sub-sampling - examination - determination of biomass.

UNIT - V  6 HOURS
Phytobenthos - sampling techniques - separation of live populations - estimation of biomass.

Text Books:

Reference Books

Course Outcome: Student will understand the basics on the benthic ecosystem and their collection and post collection processes of benthic organisms.
MABO - 522; MARINE ENVIRONMENTAL IMPACT ASSESSMENT

Course Objective: To understand the types, procedure and methods of marine Environmental Impact Assessment.

Pre-requisite: Bachelor’s level course in Life Sciences.

TOTAL CREDIT: 2  TOTAL HOURS: 30

UNIT - I  6 HOURS
Introduction - Environmental Impact Assessment (EIA) - types of EIA - rapid EIA - comprehensive EIA - environmental clearance process - coastal regulation zone - baseline studies - collection of primary and secondary data.

UNIT - II  6 HOURS

UNIT - III  6 HOURS
Structure environmental impact assessment - description of project, analysis of alternative site and technology, description of environment - land, water, marine, air, noise and socio-economic occupational health impact. Form I and II.

UNIT - IV  6 HOURS
Anticipated environmental impact and mitigation - Environmental Monitoring Programme - methods and techniques of impact identification and prediction. Risk analysis and disaster management plan - rehabilitation and resettlement action plan - project benefits environmental management plan (EMP).

UNIT - V  6 HOURS

Text Books

Reference Books

Course Outcome: Students will gain knowledge about the types, procedure and methodology of marine EIA in India and will know about the environment clearance, environment management plan, impact identification and prediction.
MABO – 523; MARINE ORNAMENTAL FISHES

Course Objective: To study the importance of marine ornamental fish trade and the methods involved in Aquarium techniques.

Pre-requisite: Bachelor’s level course in Life Sciences.

TOTAL CREDIT: 2  TOTAL HOURS: 30

UNIT - I  8 HOURS
Introduction - marine ornamental fishes - distribution - importance - criteria for selection.

UNIT - II  6 HOURS
Life history traits of marine ornamental fishes - food spectrum - sex ratio - maturation - spawning - fecundity - length-weight relationships - distribution - habitat.

UNIT - III  4 HOURS

UNIT - IV  8 HOURS

UNIT - V  4 HOURS

Text Books

Reference Books

Course Outcome: The students will learn to identify the marine ornamental resources and the aquarium techniques and instrumentation involved.
MABO – 524; MARINE ZOOPLANKTON ECOLOGY

Course Objective: To understand the size and taxonomic composition: holoplankton and meroplankton - developmental biology - their biochemical profile.

Pre-requisite: Bachelor’s level course in Life Sciences.

TOTAL CREDIT: 2  TOTAL HOURS: 30

UNIT - I 6 HOURS
Definition - zooplankton - size - classification - habitat - depth distribution - length of planktonic life.

UNIT - II 6 HOURS
Sampling methods - vertical - horizontal - oblique hauls - quantitative sampling - qualitative sampling - standard sampling - sampling of live plankton for laboratory experiment.

UNIT - III 6 HOURS
Fixation and preservation of samples - storage - labeling - log sheets - splitting - sorting - counting individuals - observation - identification - dissection - staining - mounting technique - identification of species.

UNIT - IV 6 HOURS

UNIT - V 6 HOURS
Rearing and culture - rearing conditions - water quality - physico-chemical parameters - preparation of media - techniques for the culture of feed organisms - phytoplankton - zooplankton.

Text Books

Reference Books

Course Outcome: Students will know the live feed culturing techniques and its application to aquaculture.
MABO – 525; MARINE BIODIVERSITY AND CONSERVATION

Course Objective: To understand the biological diversity in the marine environment and conservation strategies for the protection of biodiversity.

Pre-requisite: Bachelor’s level course in Life Sciences.

TOTAL CREDIT: 2            TOTAL HOURS: 30

UNIT - I                   6 HOURS
Introduction - marine biodiversity - importance - levels of biodiversity - biodiversity indices. Definition of extinction of marine bio-resources - rate of extinction - causes of extinction - island / intertidal biogeography - vulnerability to extinction.

UNIT - II                  6 HOURS

UNIT - III                 6 HOURS
Marine protected areas - designing of protected areas - managing protected areas - restoration ecology.

UNIT - IV                  6 HOURS
Impediments to marine biodiversity conservation - insufficient scientific information - inadequate transfer of information - cultural and biological diversity - differing benefits and costs harming aquatic life - jurisdictional gaps and overlaps - use of marine environment - immunity from public scrutiny - fragmented decision making.

UNIT - V                   6 HOURS

Text Books

Reference Books

Course Outcome: Students will have knowledge on the rules and regulations on conservation of marine biodiversity.
MABO – 526; MARINE ORGANISMS DOCUMENTATION AND SUBMISSION

Course Objective: To understand the procedure of collection, identification of samples and submission.

Pre-requisite: Bachelor’s level course in Life Sciences.

TOTAL CREDIT: 2 TOTAL HOURS: 30

UNIT - I
Field visit - Sampling in local habitats - aquatic - seafood industry - major community types - rocky and sandy intertidal - soft sediment - hard bottom - shallow subtidal. Mangroves - Sea grass - Seaweeds - Coral reef - associates.

UNIT - II
Methods of sampling - collection of organisms using different techniques - Water samplers - Sediment samplers, Multiple nets, Diving systems - SCUBA - ADS (atmospheric diving system). Collection - Identification classification, documentation, preparation of Voucher specimens - herbarium and reporting center of site sampled datasets.

UNIT - III

UNIT - IV
Global marine species assessment (GMSA) - Census Of Marine Life (CoML) - Ocean Biogeographic Information System (OBIS) - CORAL REEFS (Creefs) - Continental Margin Ecosystems of Worldwide Scale (COMARGE) - Census of Diversity of Abyssal Marine Life (CeDAMar) - Census of Marine Zooplankton (CMarZ).

UNIT - V
Global Census of Marine Life on Seamounts (CenSeam) - Chemosynthetic Ecosystem Science (ChEss) - Census of Antarctic Marine Life (CAML) - Arctic Ocean Diversity (ArcOD) - International Census of Marine Microbes (IcoMM) - Future of Marine Animal Populations (FMAP) - History of Marine Animal population (HMAP) - World Register of Marine Species (WORMS).

Text Books

Reference Books

Course Outcome: Students will understand preservation and submission of marine organisms.
MABO – 527; CONSERVATION AND MANAGEMENT OF MANGROVE AND CORALS

Course Objective: To understand the biology of corals and mangroves and its ecosystem function along with the threats and conservation process.

Pre-requisite: Bachelor’s level course in Life Sciences.

TOTAL CREDIT: 2
TOTAL HOURS: 30

UNIT - I 6 HOURS
Mangroves introduction, occurrence distribution and ecology.

UNIT - II 6 HOURS

UNIT - III 6 HOURS
Coral reefs: Introduction; types: distribution and ecology

UNIT - IV 6 HOURS
Coral reefs: monitoring. Floral and faunal association with coral reefs.

UNIT - V 6 HOURS

Text Books


Reference Books


Course Outcome: Student develop the knowledge on the basic research in science with special reference to marine biology.
SEMESTER - IV
MABO – 511; OCEAN POLICIES AND MANAGEMENT

Course Objective: To understand the different principles and management practice of Law of the Ocean and its management practices.

Pre-requisite: Bachelor’s level course in Life Sciences.

TOTAL CREDIT: 4 TOTAL HOURS: 60

UNIT - I 5 HOURS
Major oceans and their wealth: Three-major Oceans - importance. Historical evolution of open ocean as a common heritage of mankind.

UNIT - II 17 HOURS

UNIT - III 13 HOURS

UNIT - IV 10 HOURS

UNIT - V 15 HOURS
Role of National and International agencies and organizations in ocean management Intellectual Property Right (IPR) Ocean policy (India).

Text Books

Reference Books

Course Outcome: Student understand the different process of ocean management practices and its principles at national and international level.
**MABO - 512; MARINE BIOTECHNOLOGY**

**Course Objective:** To understand the application of different techniques and processes involving marine organism and explore their possible utilization.

**Pre-requisite:** Bachelor’s level course in Life Sciences.

**TOTAL CREDIT: 4**

**TOTAL HOURS: 60**

**UNIT - I**
12 HOURS

**UNIT - II**
14 HOURS
Developmental biotechnology; induced breeding, in-vitro fertilization, early embryonic development and developmental processes in marine invertebrates (echinoderms, crustacean, mollusk), biotechnological methods - ELISA, FISH, PCR, Gene probes, dot-immuno binding activity, Principles of cloning - Transgenic Technology, Cryopreservation, Biosafety & Ethics.

**UNIT - III**
10 HOURS
Algal biotechnology - marine algal products and their application in biotechnology, single cell protein. Marine Enzymes and bioreactors.

**UNIT - IV**
12 HOURS
Bioactive marine natural products and their application - introduction to marine natural products.

**UNIT - V**
12 HOURS

**Text Books**

**Reference Books**

**Course Outcome:** Students will understand the development and application of biotechnology of marine organisms.
MABO – 513; MARINE POLLUTION

Course Objective: Types of marine pollution, sources and adverse effects of marine pollution to the marine biota/environment - UN definition and causes of Marine Pollution.

Pre-requisite: Bachelor’s level course in Life Sciences.

TOTAL CREDIT: 4          TOTAL HOURS: 60

UNIT - I  10 HOURS
Marine pollution - definition - role of GESAMP - major pollutant - sources - transport path - dynamics.

UNIT - II  12 HOURS

UNIT - III  14 HOURS

UNIT - IV  12 HOURS

UNIT - V  12 HOURS

Text Books


Reference Books


Course Outcome: Students will understand various techniques involved in marine pollution – protection and various wastes discharged in the marine environment.
MABO - 599; PROJECT

Course Objective: To understand research in short term experiments, sample collection and interpretation.

Pre-requisite: Bachelor’s level course in Life Sciences.

TOTAL CREDIT: 4

TOTAL HOURS: 60

Each Student will be allotted under a Faculty Member and the student will put in 60 hours of research work based on a particular topic. At the end of the semester, this work to be compiled and submitted as a dissertation. This will be evaluated and marks awarded.

Course Outcome: Students on completion of the dissertation will have knowledge on taking up research programmes.