A Master’s Programme consists of a number of courses. Master’s Programme consists of a set of Core Courses and elective Courses. Core courses are basic courses required for each programme. The number and distribution of credits for core courses will be decided by the faculty.

Elective courses will be suggested by the respective departments, and they may be distributed in III and IV semesters.

A course is divided into five units to enable the students to achieve modular and progressive learning.

SEMESTERS

An academic year is divided into two semesters, Odd Semester and Even Semester. The normal semester periods are:

Odd Semester: July to November (90 Working days)

Even Semester: December to April (90 Working days)

CREDITS

The term credit is used to describe the quantum of syllabus for various programmes and hours of study. It indicates differential weightage given according to the contents and duration of the courses in the curriculum design.
The minimum credit requirement for a two year Master’s Programme shall be 94.

The core courses shall carry 88 credits and the elective courses shall carry 6 credits.

**ELIGIBILITY**

A undergraduate degree in Zoology / B.F.Sc. / Industrial Fish and Fisheries (with Zoology as a subsidiary subject) / Advanced Zoology and Biotechnology with a minimum of 50% of marks in Part III or any other degrees recognized equivalent to Zoology.

[M.Sc. Marine Biology and Oceanography (with B.Sc. Zoology as major) awarded by Annamalai University is equivalent to M.Sc. Zoology (G.O. (Ms.) No. 116 dated 22.07.2014)]

**COURSES**

Each course may consist of lectures / laboratory work / seminar / project work / practical training / report / viva voce etc.

**COURSE WEIGHT**

Core and elective courses may carry different weightage. For example, a course carrying one credit for lectures, will have instruction of one period per week during the semester, if three hours of lecture is necessary in each week for that course then 3 credits will be the weightage. Thus normally, in each of the courses, credits will be assigned on the basis of the lectures / laboratory work and other form of learning in a 15 week schedule:

(i) One credit for each lecture period per week.

(ii) One credit for every three periods of laboratory or practical work per week.

(iii) One credit for 3 contact hours of project work in a week.

(iv) One credit for every two periods of seminar.

**GRADING SYSTEM**

The term Grading System indicates a 10-point scale of evaluation of the performance of students in terms of marks, grade points, letter grade and class.

**DURATION**

The duration for completion of a two year Master’s Programme is four semesters.

**STRUCTURE OF THE PROGRAMME**

The Master’s Programme will consist of:

(i) Core courses which are compulsory for all students.
(ii) Elective courses which students can choose from amongst the courses offered the faculty as well as by Departments of other faculties (Arts, Science, Education and Indian Language).

(iii) The Elective subjects will be allotted by counseling by a committee of the respective Heads of the Departments under the Chairmanship of the Dean of the Faculty.

(iv) Dissertation / Project work / Practical training / Field work can be done in an organization (Government, Industry, Firm, Public Enterprise etc.) approved by the concerned department.

ATTENDANCE

Every teaching faculty handling a course shall be responsible for the maintenance of attendance register for candidates who have registered for the course.

The teacher of the course must intimate the Head of the Department at least Seven Calendar days before the last instruction day in the semester about the attendance particulars of all students.

Each student should fulfil the attendance requirement of 75% as prescribed by the University, to be eligible to appear for the University Examinations.

EXAMINATIONS

The internal assessment for each course carries 25% marks and is based on two sessional tests. The pattern of question paper will be decided by the faculty. The tests are compulsory.

There will be one End Semester Examination (75% marks) of 3 hours duration for each course. The pattern of question paper will be decided by the faculty.

The Internal assessment for each practical course carries 40% of marks while the end semester practical examination of 3 hours duration carries 60% of marks.

EVALUATION

The performance of a student in each course is evaluated in terms of Percentage of Marks (PM) with a provision for conversion to Grade Point (GP). The total performance in each semester will be rated by Grade Point Average (GPA) while the continuous performance from the 2nd Semester onwards will be marked by Overall Grade Point Average (OGPA).

MARKS AND GRADING

A student cannot repeat the assessment of Sessional Test I and Sessional Test II. However, if for any compulsive reason, the student could not attend the test, the prerogative of arranging a special test lies with the teacher in consultation with the Head of the Department.

A student has to secure 50% minimum in the End Semester Examination.
The student who has not secured a minimum of 50% of marks (sessional plus end semester examination) in a course shall be deemed to have failed in that course.

A candidate who has secured a minimum of 50% marks in all the papers prescribed in the programme and earned a minimum of 94 credits will be considered to have passed the Master’s Programme.

**GRADING**

A ten point rating scale is used for the evaluation of the performance of the student to provide letter grade for each course and overall grade for the Master’s Programme.

<table>
<thead>
<tr>
<th>Marks</th>
<th>Grade</th>
<th>Letter grade</th>
<th>Class</th>
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<tr>
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<tr>
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<tr>
<td>80 – 84</td>
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<td>50 – 54</td>
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<tr>
<td>49 or Less</td>
<td>-</td>
<td>F</td>
<td>Fail</td>
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</table>

The successful candidates are classified as follows:

I Class – 60% Marks and above in overall percentage of Marks (OPM).

II Class – 50-59% Marks in overall percentage of marks.

Candidates who obtain 75% and above but below 90% of marks (OPM) shall be deemed to have passed the examination in FIRST CLASS (Distinction) provided he / she passes all the papers prescribed for the programme at the first appearance.

For the Internal Assessment Evaluation, the details shall be as follows:

- Test (2 tests) - 15
- Assignment - 5
- Seminar - 5

Total - 25 Marks

**COURSE – WISE LETTER GRADES**

The percentage of marks obtained by a candidate in a course will be indicated in a letter grade.
A student is considered to have completed a course successfully and earned the credits if he / she secures an overall letter grade other than F. A letter grade F in any course implies a failure in that course. A course successfully completed cannot be repeated for the purpose of improving the Grade point.

The F grade once awarded in the grade card of the student is not deleted even when he / she completes the course successfully later. The grade acquired later by the student will be indicated in the grade sheet of the odd / even semester in which the candidate has appeared for clearance of the arrears.

A student who secures F grade in any course which is listed as a core course has to repeat it compulsorily when the examination is held next. If it is an Elective course, the student has the option to repeat it when it is offered next or to choose a new elective if he / she so desires in order to get a successful grade. When new elective is chosen in the place of failed elective, the failed elective will be indicated as dropped in the subsequent grade card.

If a student secures F grade in the Project Work / Field Work / Practical Work / Dissertation, he / she shall improve it and resubmit it if it involves only rewriting incorporating the clarifications of the evaluators or he / she can re-register and carry out the same in the subsequent semesters for evaluation.
M. Sc. MARINE BIOLOGY & OCEANOGRAPHY  
(M. Sc. BRANCH VII – A)  

CHOICE BASED CREDIT SYSTEM - 2018 – 2019

I SEMESTER  
<table>
<thead>
<tr>
<th>Course Code</th>
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<tbody>
<tr>
<td>MBOC 101</td>
<td>Invertebrates and Prochordates</td>
</tr>
<tr>
<td>MBOC 102</td>
<td>Vertebrates</td>
</tr>
<tr>
<td>MBOC 103</td>
<td>Cytology, Genetics and Immunology</td>
</tr>
<tr>
<td>MBOC 104</td>
<td>Marine Microbiology</td>
</tr>
<tr>
<td>MBOC 105</td>
<td>Physiology and Biochemistry</td>
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<tr>
<td>MBOC 106</td>
<td>Computer Application - I</td>
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<tr>
<td>MBOC 107</td>
<td>Communication Skills</td>
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<td>MBOC 203</td>
<td>Biological oceanography</td>
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<tr>
<td>MBOC 204</td>
<td>Coastal Aquaculture</td>
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<td>MBOC 205</td>
<td>Fisheries Science and Statistics</td>
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<td>MBOP 206</td>
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III SEMESTER  
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<td>MBOC 303</td>
<td>Pollution and Toxicology</td>
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<td>MBOC 304</td>
<td>Ocean Management</td>
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<td>MBOC 305</td>
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IV SEMESTER  
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## M.Sc. Marine Biology & Oceanography

### Credits, Internal Assessment Marks and Endsemester Exam Marks

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<tr>
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Students have to choose courses for 6 credits (2 courses) out of the elective courses offered in other departments / faculties of the University. The elective papers are for students of other departments / faculties of the University.

Credit

<table>
<thead>
<tr>
<th>Credit</th>
<th>Core</th>
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<tbody>
<tr>
<td></td>
<td>88</td>
<td>6</td>
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Suggested Electives

1. Marine Food Technology
2. Ornamental Fish Culture & Aquarium Keeping
3. Molecular Virology
4. Plant and Animal Cell Culture Technology
5. Microbial Technology
6. Bioprocess Engineering & Technology
7. Biostatistics
8. Genomics & Proteomics
9. Vaccines
10. Remote sensing & GIS
I SEMESTER

MBOC 101 – INVERTEBRATES AND PROCHORDATES
(Functional morphology, Palaeontology and Evolution)

Objectives:

In marine & brackish water realm, invertebrate fauna forms a major constituent both in terms of faunal diversity & density. Moreover, many of them stand as economically important both in terms of fishery and byproducts. The ecological role played by invertebrates is manifold. Hence studies pertaining to marine invertebrates is a prerequisite. In this context, the syllabus covers aspects such as classifications/systematics, various aspects of biology with special emphasis on larval development & life history, evolution & palaeontology, adaptive radiation and phylogenetic relationship.

UNIT 1 – Protozoa and Coelenterata

Classification – Morphology – Reproduction - life history and phylogenetic relationships of Protozoa and sponges.


UNIT 2 – Minor phyla

Functional morphology, development and evolution: Nemertinea, Endoprocta, Ectoprocta, Phoronida and Pogonophora.


UNIT 3 – Crustacea and Polychaeta

Crustacea: Classification, comparative morphology, crustacean appendages, larval forms, evolution and palaeontology.


UNIT 4 - Mollusca

Classification, general characters, torsion, palaeontology, phylogenetic relationships and adaptive radiation, reproduction and embrogeny.

UNIT 5 – Echinodermata and Prochordata

Echinodermata – Classification, structure and function, water vascular system, regeneration, reproduction and larval forms.
Prochordata – classification and comparative morphology, reproduction and early development, larval metamorphosis.

**PRACTICAL I : MBOP 108 – Invertebrates and Prochordates**

1. Identification of locally available invertebrate fauna
2. Mounting of gastropod radula
3. Digestive system in gastropods and bivalves
4. Crystalline style of bivalves
5. Identification of sex in crustaceans and molluscs
6. Mouth parts of *Squilla* and *Balanus.*
7. Study of digestive, nervous, reproductive systems and different ovarian maturity stages in Shrimp
8. Appendages of prawns, shrimps and crabs
9. Study of water vascular system, tube feet and Aristotle’s lantern in sea stars

**REFERENCE BOOKS**

MBOC 102 – VERTEBRATES
(Functional morphology, Palaeontology, Developmental Biology and Evolution)

Objectives:

The marine environment is rich not only in the invertebrate fauna but also in the vertebrate faunal resources. Further, the sea water is a good medium that supports life right from its origin from the single celled organism to the multicellular marine mammals. This paper is planned to study the origin and evolution of species and also to understand the reproductive mechanisms in vertebrates.

UNIT 1 – Origin of chordates

Geological time scale – progression of vertebrates through time, chordate features and theories on the origin of chordates.

UNIT 2 – Bony fishes and Amphibia


Origin and distribution of amphibia – anatomical peculiarities and affinities of Urodela and Apoda.

UNIT 3 – Reptiles and Marine birds

Origin of reptiles – adaptive radiation of contemporary reptiles, turtles, amphibian and reptilian features of Seymouria, mammal-like reptiles, rise and fall of dinosaurs including mesozoic marine reptiles.

Mosasaurs, the giant marine lizards. Marine Crocodile: Estuarine/Salt water crocodile, Sea snakes

Importance of marine birds, adaptations to the marine environment, migration.

UNIT 4 – Evolution of Mammals and human


Aquatic adaptations for respiratory and circulatory mechanisms – comparative anatomy of skin derivatives.

UNIT 5 – Developmental Biology

PRACTICAL II : MBOP 109 - Vertebrates

1. Functional morphology of respiratory organs- aquatic animals - gills of cartilagenous and bony fishes
2. Study of important vertebrates specimen representing phylum Pisces to Mammalia
3. Early embryonic developmental stages of fish - Larval stages
5. Baleen plates of whales
6. Osteological observation of fishes and marine mammals
7. Marine turtles
   a. Green turtle
   b. Oliver ridley turtle
   c. Hawksbill turtle
   d. Leathery turtle
   e. Loggerhead turtle
8. Preparation of field report.

REFERENCE BOOKS

MBOC 103  - CYTOLOGY, GENETICS AND IMMUNOLOGY

Objectives :

The paper is aimed at teaching the students of marine biology on varied aspects of cytology, genetics and immunology. The objectives of this paper include the knowledge about the modern trends in cell biology, prospects of chromosomal manipulations and the latest techniques of cytology, genetics and immunological aspects in fish.

UNIT I – Microscopy and cellular organisation

Microscopy - light, phase contrast and interference, darkfield, fluorescence, confocal, electron (TEM and SEM), electron tunneling and atomic force microscopy.

Structural organization of cells-nucleus, ultrastructure of cytoskeleton, microtubules, micro-filaments, mitochondria, endoplasmic reticulum, golgi apparatus, lysosomes and peroxisomes and extracellular matrix – collagen, elastin, fibrilin, fibronectin, laminin and proteoglycans.

UNIT II – Genetic techniques

Principles of genetics, environmental influences, practical applications of genetics – hybridization of fishes, recent trends and techniques in hybridization, selective breeding, cross breeding, development of disease resistance and high quality new strains, transgenic fish production.

Chromosome manipulation –androgenesis, gynogenesis, sex reversal and ploidy. aquaculture applications, Cryopreservation, conservation of germplasm.

UNIT III- Model genetics systems

Model genetic systems – T4 and \( \lambda \) phages; Neurospora; E.coli and Saccharomyces cerevisiae; Drosophila; Zebra fish – advantages.

Normal and transformed cell lines as model genetic systems – advantages.

UNIT IV – Immunology – Invertebrates (Crustaceans)

Non-specific immune response; Immunological factors – humoral and clotting; Cellular components; Chemical constituents – haemocyanin and total protein; Osmality and electrolytes; Glucose and other energy components, acid-base balance, tissue enzymes and hormones.

UNIT V – Immunology – Vertebrates (fish)

Elements of Immunology; Antigen, antigenicity, epitope and haptens; Cells of lymphoretocular system; Antibody production; Immunoglobulins – structure, function, classes, allotypes and isotypes; Innate and acquired immunity; Vaccines; Monoclonal and polyclonal antibodies.
PRACTICAL III : MBOP 110 – Cytology, Genetics and Immunology

1. Demonstration and operation of principles of light, compound, phase contrast and electron microscope
2. Giant chromosomal preparation (Squash)
3. Types of Cells
4. Preparation of stages of cell division
5. Cell organelles (Slides)
6. Fish chromosome mounting
7. Blood cell count and identification of lymphoid cells in blood smears
8. Antigen and antibody reaction & Haemagglutination
9. Immuno electrophoretic techniques
10. ELISA
11. Cell division – Mitosis and Meiosis
12. Calibration and use of Stage and Ocular Micrometers and Measuring microscopic organisms

REFERENCE BOOKS

Objectives

The paper is aimed at teaching the students of marine biology on varied aspects of microbiology. This subject provides a strong foundation for students to build up the knowledge of marine microbes. The objectives of this paper include the knowledge about the biology of microbes and their distribution, ecological role and economic importance.

Unit I - Ecology of marine bacteria

Occurrence and distribution, structure and biology, ecological role, economic significance.

Unit II - Ecology of marine cyanobacteria

Occurrence and distribution, structure and biology, ecological role, economic significance.

Unit III - Ecology of marine actinomycetes

Occurrence and distribution, structure and biology, ecological role, economic significance.

Unit IV - Ecology of marine fungi

Occurrence and distribution, structure and biology, ecological role, economic significance.

Unit V - Ecology of marine viruses

Occurrence and distribution, structure and biology, ecological role, economic significance.

PRACTICAL IV: MBOP 111 – Marine Microbiology

1. Preparation of Media
2. Estimation of bacterial population from marine samples
3. Pure culture techniques
   - Phase streaking
   - Continuous streaking
   - ‘T’ streaking
   - Radial streaking
4. Identification of unknown bacteria
   - Motility of bacteria – hanging drop method/semisolid medium
   - Gram’s staining
   - IMViC
   - Triple sugar iron agar
   - Starch hydrolysis
   - Casein hydrolysis
   - Carbohydrate utilization test
5. Isolation of cyanobacteria
6. Identification of cyanobacteria - morphological
7. Isolation of actinomycetes
8. Identification of actinomycetes – morphological
9. Isolation of fungi from marine samples
10. Identification of fungi – morphological
11. Isolation of bacteriophages
12. One step growth of bacteriophages
13. Preparation of bacteriophage stocks
14. Titration of bacteriophages
15. Purification of phage

REFERENCE BOOKS

MBOC 105 – PHYSIOLOGY AND BIOCHEMISTRY

Objectives:

Study of physiology of marine animals is the fundamental knowledge to culture shrimps, fishes, pearls, oysters etc., because this paper deals with digestive enzymes, ionic regulation, endocrine system, biorhythm etc. This paper also enables to understand physiological mechanism involved in different oceanic environment (cold, warm oceans and deep sea environment).

Study of biochemistry will be helpful to know the structure of proteins, carbohydrates, lipids and vitamins role in physiology.

UNIT 1 – Physiology of Feeding and Respiration

Physiology of feeding, feeding mechanisms, passage of food, digestive enzymes and their role with food habits. Respiratory structures and functions – Accessory respiratory organs, swim/air bladders, factors affecting respiration, structure and function of blood pigments, role of transport of O₂ and CO₂.

UNIT 2 – Osmoregulation and Biorhythms

Physiology of ionic and osmoregulations – ions in body fluids, mechanism of ionic regulation, responses to osmotic conditions, types of osmoregulatory adaptations.

Physiology of rhythms – circadian, tidal and lunar rhythms in marine and estuarine animals, environmental factors responsible for biorhythms, significance of biorhythms. Tidal, vertical and horizontal migration of larvae, larval release rhythm and larval behaviour of crustaceans, crustacean larval phototaxis & its functional significance. Physiology of bioluminescence in marine organisms – its significance.

UNIT 3 – Nervous and Endocrine systems

Physiology of nervous system – autonomic nervous system in elasmobranchs and bony fishes, impulse generation and conduction, interneuronic transmission, integration of information. Physiology of Endocrine system – hormones, neurohormones, hormones of reproduction in finfishes and shell fishes, hormone induced colour change in crustaceans. Moulting in crustaceans.

UNIT 4 – Biomolecules


UNIT 5 – Metabolism and Biosynthesis

PRACTICAL V : MBOP 112 – Physiology and Biochemistry

1. Chromatophore change due to light and dark adaptations in intertidal crabs.
2. Effect of hydrogen ion concentration on amylase activity of the crystalline style from bivalve.
3. Effect of temperature – the rate of particle transport in bivalves
4. Effect of salinity on respiration of fish/bivalve
5. Effect of salinity on osmotic concentration (osmoregulation) of fish.
6. Display of Neuroendocrine organs in a crustacean.
7. Estimation of total protein, carbohydrates, lipids, moisture content, calorific value and ash content.
8. Separation of phospholipid using thin layer chromatography.

REFERENCE BOOKS

MBOC 106 – COMPUTER APPLICATION - I

Objectives:

This course will offer exposure to the hardware, terminology and functions of the personal computer. Hands on experience using popular software will allow exploration and basic introduction to windows and word processing. It also offers internet, web designing and multimedia operations.

UNIT – I


UNIT – II


UNIT – III


Fundamentals of HTML, TCP/IP and E-commerce.

UNIT – IV


UNIT – V


Using Multi Media: Multimedia Interface, Planning and Development of Multimedia projects.
REFERENCE BOOKS

4. James Meade, David Growder, Rhonda Growder – Microsoft DHTML.
MBOC 107 Communication Skills

Unit - I

Process of communication
Concept of effective communication- Setting clear goals for communication; Determining outcomes and results; Initiating communication; Avoiding breakdowns. Creating value in conversation; Barriers to effective communication; Non verbal communication- Interpreting non verbal cues; Importance of body language, Power of effective listening; recognizing cultural differences.

Unit - II

Presentation skills
Formal presentation skills; Preparing and presenting using Over Head Projector, Power Point; Defending Interrogation; Scientific poster preparation and presentation; Participating in group discussions.

Unit - III

Technical Writing Skills
Types of reports; Layout of a formal report; Scientific writing. Problems in the preparation of a scientific document; Plagiarism; Scientific Publication Writing: Elements of a Scientific paper including Abstract, Introduction, Materials and Methods, Results, Discussion, References; Drafting titles and framing abstracts.

Unit - IV

Computing Skills for Scientific Research
Web browsing search engines Hidden Web and its importance in Scientific research; Internet as a medium of interaction of scientists; Effective e-mail strategy using the right tone and conciseness

REFERENCE BOOKS


II Semester

MBOC 201 : PHYSICAL OCEANOGRAPHY

Objectives:

This paper is intended to give students a view to the history and origin of Ocean, the physical properties of seawater and how wind, radiation, gravity, friction and the Earth’s rotation determine the ocean’s temperature, salinity patterns and currents. Some important process we will study include heat budget of the oceans, exchange of heat with the atmosphere and the role of the ocean in climate, surface mixed layer, waves and tides in the Ocean. Students will learn how to explain physical features of the ocean ranging from microscopic turbulence to global circulation, characteristics of estuaries and marine sediments.

In additional to learning facts and concepts, the students should gain some skills such as collection of water and sediment samples from the marine environment for laboratory analysis and they will be able to measure the light, temperature, pressure and current pattern of the ocean waters.

UNIT I - Introduction to Oceanography

History of Oceanography, Origin of Oceans, bottom topography, abyssal hills and plains, submarine canyons & oceanic trenches, underwater volcanoes.

UNIT II - Physical Properties of sea water

Temperature, density, pressure, conductivity, surface tension, viscosity and their interrelationship, temperature distribution in the sea, hot water springs, heat budget of the oceans, Sea level rise and global warming, UV radiation, sound and light in the sea, Pressure.

UNIT III – Dynamics of the ocean

Currents, forces causing surface and deep currents, trade winds and monsoon, wind driven and thermohaline circulation boundary currents, Langumuir circulation, geotropic currents, turbidity currents & up welling. Arctic & Antarctica circulation.

Waves – formation and properties, breakers and surf - internal and standing waves, catastrophic waves, tsunamis or seismic waves, storm waves or surges.

Tides – tide generating forces and theories, types of tides, tidal effects in coastal areas. Utilization of Wave / tide energy

UNIT IV - Estuaries

Origin and classification of estuaries, estuarine circulation, estuarine zonation, lagoons.
UNIT V - Marine sediments

Origin and physical properties of sediments, classification of marine sediments (lithogenous, biogenous, hydrogenous and cosmogenous), distribution and transport of sediments, determination of age of sediments.

Satellite Oceanography

Tsunami warning system in India and other countries. ELNINO, ROV, Surfer, Recent research development in Deep sea Research and Institutions involved.

PRACTICAL VI – MBOP 206 : Physical Oceanography

1. Determination of density of liquids using specific gravity bottle.
2. Measurement of salinity of seawater by refractometer
3. Determination of salinity of seawater by conductivity
4. Determination of salinity of seawater by salinometer
5. Relationship between salinity and density
6. Relationship between salinity and viscosity
7. Determination of surface tension by capillary method
8. Relationship between salinity and surface tension
9. Determination of viscosity by ostwald viscometer
10. Determination of turbidity using turbidity meter,
11. Water sampling Devices:
   a) Mayer’s Water Sampler
   b) Knudsen Water sampler
   c) Nansen Water sampler
   d) Universal Water sampler
   e) Horizontal Water sampler
   f) Bacteriological Water sampler

12. Sediment sampling Devices
   a) Ekman’s Dredge
   b) Petersen grab
   c) Mud snapper
   d) Vertical Gravity Corer
   e) Ooze Sucker

13. Temperature and depth measuring devices
   f) Towing Surface Thermometer
   g) Six’s Maximum and Minimum Thermometer
   h) Reversing Thermometer
   i) Bathythermograph
   j) Fortin’s Barometer

14. Light measuring devices
   a) Secchi Disc
   b) Lux Meter

15. Current measuring devices
   a) Watt’s Current Meter
   b) Direct Reading Current Meter
16. Depth measuring devices
17. Wave and Tide recorder

REFERENCE BOOKS


MBOC 202 – CHEMICAL OCEANOGRAPHY

Objectives:

The ocean is the largest and most complex habitat on our planet and has played a vital role in the development and growth of civilization. Ocean chemistry, i.e. the properties and composition of the substance found in the ocean world is affected by biological, chemical and physical processes. Oceanography is an interdisciplinary science and it is essential to learn the natural chemical processes that take place in the marine environment and also the effect of anthropogenic activity on these natural processes. Therefore this paper on chemical oceanography is essential to understand the basics as it forms a stepping stone for studies of other subjects like fisheries, agriculture and pollution.

UNIT 1 - Introduction to marine chemistry

Ocean as a chemical system, origin of ocean salts, physical and chemical properties of water, structure of water molecules, differences between freshwater and seawater.

UNIT 2 - Chemical composition of seawater

Ionic composition of seawater, major and minor constituents, constancy of ionic composition and factors affecting constancy, major and minor elements, trace elements, their importance and distribution, analytical chemistry of seawater constituents.


UNIT 3 - Dissolved gases

Origin, importance and distribution - Carbon dioxide, oxygen, nitrogen, hydrogen sulphide, noble gases and methane.

UNIT 4 - Organic matter

Dissolved and particulate, sources, classification, composition, estimation, distribution and seasonal variation, ecological significance, growth promoting and growth inhibiting effects & humic substances.

UNIT 5 - Nutrients

Inorganic plant nutrients, origin, role in the fertility of the sea.

Kinds of nitrogen, phosphorus and silicate in the sea, analytical methods, distribution and cycling, N:P ratio and significance.

Mineral wealth of the sea – salts, glauconite, petroleum, phosphorite, manganese nodules, potential and economics of extraction.
PRACTICAL VII - MBOP 207 – Chemical Oceanography

Titrmetric Procedures

1. Salinity
2. Alkalinity
3. Dissolved oxygen
4. Calcium and Magnesium

Colorimetric Procedures of pollutants

5. Bromide, fluoride and iodide
6. Nitrite
7. Nitrate
8. Inorganic phosphate
9. Hydrogen Sulphide
10. Ammonia
11. Organic nitrogen
12. Silicate ( Reactive)
13. Total dissolved phosphorus

REFERENCE BOOKS

MBOC 203 – BIOLOGICAL OCEANOGRAPHY

Objectives :

Sea has in itself quite rich in renewable living resources that supplies food and wealth to the mankind. After depleting the living and non-living resources on the land the attention of the human beings has been turned towards the sea. Further, the sea is serving as a very good living place for the plant and animals ranging from microscopic to macroscopic size of planktonic to nektonic forms. Hence this paper is aimed with the objectives of making the students to learn about the biotic and abiotic components of marine environment, to get knowledge on the importance of plankton vis-à-vis fishery production and creating awareness about the ecological & economic importance seagrasses, seaweeds and mangroves.

UNIT 1 – Marine Biocycle

Sea as a biological environment
       Plankton - classification of plankton based on size, mode of life and habitat.

UNIT 2 – Plankton

       Phytoplankton and zooplankton - methods of collection, estimation of standing crop, Numerical methods, wet and dry weight estimations, plankton volume, settlement and displacement methods, determination of plankton biomass, oxidation as carbon (as organic matter). Inter relationships and vertical migration.

       Adaptations of plankton through structural (Weight, increase of surface area for flotation) and physiological (specific gravity, water content, fat content, mono and divalent ions, and gas vacuoles) mechanisms.

UNIT 3 - Organic production

       Primary and secondary productions, methods of estimation of primary production, factors affecting primary production, spatial and temporal differences in primary and secondary productions, red tide phenomenon its causes and effects.

UNIT 4 – Seaweeds and Seagrasses

       Seaweeds – occurrence and distribution in India, their economic importance. Interaction between reefs and seaweeds.
       Seagrasses – morphological and anatomical adaptations, their ecological role.

UNIT 5 – Mangroves, salt marshes and sand dunes

       Distribution, types, adaptations (morphological, anatomical and physiological), ecological role, uses, need for conservation.
PRACTICAL VIII : MBOP 208 – Biological Oceanography

1. Identification of phytoplankton and zooplankton (diatoms, dinoflagellates, hydromedusae, copepods, pteropods, Chaetognatha, Thaliaceae and larvae of fin and shell fishes).

2. Identification of locally available seaweeds, seagrasses, sand dune spp. and halophytes including mangrove plants / vegetation (herbs, shrubs and woody plants)

3. Primary productivity studies – light and dark bottle method, extraction and identification of plant pigments (chlorophylls) including phaeopigments from water samples of estuary, sea and mangroves (Acetone method)

4. Field collection – submission of herbarium sheets.

REFERENCE BOOKS


MBOC 204: COASTAL AQUACULTURE

Objectives:

The objective of the paper is to teach the post graduate students of coastal aquaculture about biology and culture of fin and shellfishes. Without understanding the biology of cultivable species, culturing them is highly impossible scientifically. Therefore, the present paper deals both biology and culture together. This paper is planned to teach in the lines of understanding the candidate species of important cultivable fin and shellfishes, gaining knowledge in the food and feeding habits and life history of the candidate species, investigating the natural seed potential and artificial fish seed production through hatcheries, farm management and their detailed methods of farming, giving information on market value of fishes and their cost of production and providing scope for employment opportunities in aquaculture activities.

UNIT I – Introduction to coastal aquaculture

Overview – Importance of Coastal aquaculture, global scenario, present status in India - prospects and scope.

UNIT II – Brackishwater farms

Selection of site: topography, water availability and supply, soil conditions. Designing and layout, farm structure and construction.

UNIT III – Biology of important cultivable species

Criteria for choosing cultivable species – fish, crustaceans, molluscs and seaweeds - biological criteria - environmental adaptability - compatibility of species - adaptability to intensive culture - economic criteria - market value - availability in adjacent regions.

UNIT IV – Seed resource survey and Seed & Feed production

Natural seed resources – distribution and abundance, methods of collection and segregation. Artificial seed production - breeding under controlled condition, techniques of induced breeding, larval rearing, packing and transportation.


UNIT V – Culture systems and their management

Culture practices – traditional, extensive, semi – intensive and intensive systems, monoculture and polyculture, raceways, cages, pens, raft and racks.

Culture system management: Pond preparation – production and economics.
Water quality management, Health management: Control of predators, parasites and diseases.


PRACTICAL IX : MBOP 209 – Coastal Aquaculture

1. Field trip to coastal aquaculture farms, hatcheries, raceways and Rack & Raft and procuring plants and Submission of Report
2. Spat collection techniques
3. Dissection of reproductive systems of fish and shrimp.
4. Identification of eggs, larvae, seeds, and juveniles of cultivable species.
5. Seed collection techniques – velon screen, Throw net, other scoop nets
6. Induced breeding and maturation techniques in fishes.
7. Identification of cultivable species of crustaceans, molluscs, finfishes and seaweeds.
8. Identification of live feed (Microalgae, rotifers, copepods and Artemia).
9. Western blotting
10. PCR Demonstration
11. Types of diseases – Observation
12. Identification of different larval stages in shrimps
13. Fabrication of Rack & Raft (floating and fixed), rope culture and spat collectors (rens).

REFERENCE BOOKS
MBOC 205 – FISHERIES SCIENCE AND STATISTICS

Objectives:

There is a theory and science behind fishing. Statistics has been extensively and advantageously used in studying the population of fishes and in finding out the maximum sustainable yield. Knowledge about the general morphology of the fishes, their classification and identification goes a long way in assessing the population of all the organisms. Moreover, information about the biology of the fishes goes a long way in managing the fishery resources and their sustainable utilization. Suitable methods are also to be engaged for their exploitation. As fishes constitute perishable commodity, preservation and processing are also quite essential. Therefore the objective of this paper is to impart knowledge on all the above aspects.

UNIT I – Ecobiology of fishes

General morphology and outline of classification of fishes – major groups of fishes of the world and their characteristics, identification of fishes of Parangipettai.

Basic anatomy of fish – digestive, circulatory, respiratory, nervous and reproductive systems of fish. Maturation and spawning habits of marine fishes – process of maturation, methods to determine spawning, biotic and abiotic factors affecting spawning in fishes. Food and feeding, fecundity and GSI

UNIT II - Population dynamics

Fundamental principles of population dynamics, unit stock, recruitment, growth, mortality, migration, fish tagging and marking. Ecosystem Based Management of Marine fisheries.

UNIT III – Methods of Fishery Survey

Marine fisheries of India, methods of surveying the fishery resources – acoustic method, aerial method (Remote Sensing – PFZ) - survey of fish eggs and larvae, gear selectivity, trawl net and Gill net, mesh size selection

UNIT IV – Crafts and Gears

Principal methods of exploitation of sea fishes – indigenous and modern gears and crafts. Principal methods of fish preservation and processing in India – types of fish spoilage, causative factors. Marketing and economics.

UNIT V – Statistics in fisheries

Sampling techniques – Biometry of fish - Collection and analysis of biological data – mean, median, mode, standard deviation, standard error, coefficient of variation, student ‘t’ test, skewness, kurtosis, chi – square, correlation regression and analysis of variance. Fisheries Statistic Software (ECOPATH, PRIMER, FISH STAT)
PRACTICAL X : MBOP 210 – Fisheries Science and Statistics

1. Identification of common fin and shell fishes of Parangipettai waters.
2. Dissection of 9th and 10th cranial nerves of teleost fishes
3. Food and feeding habits of fishes through Gut content analysis and Digestive system in fishes, Structure of gill filament and gill rakers.
4. Study of food and feeding habits of fishes using gut-content analysis, Dissection and display of digestive system of fishes of different feeding habits.
5. Study of reproductive system of teleost fishes
6. Fecundity estimation and ova – diameter studies, GSI values
7. Life history stages of fishes: eggs and larvae.
8. Morphometric and meristic data of fishes population
9. Collection of cost of different fishes (primary and secondary)and pattern of marketing
10. Economics of fishing of trawler.
11. Growth determination using scales: vertebrates & otoliths
12. Morphometric and meristic characters of a teleost fish
13. Dissection and display of inner ear in a fish, Weberian apparatus in a cat fish
14. Dissection and display of swim bladder of fishes
15. Observation on fish parasites
16. Visits to ice factory and nearby fish processing Units.
17. Methods of sampling and Data collection
18. Calculation of Mean, Mode, Standard Deviation, Standard Error, Co-efficient, Variation
19. Calculation of correlation of co-efficiency & ANNOVA

REFERENCE BOOKS

III Semester
MBOC 301 – MARINE ECOLOGY AND ZOOGEOGRAPHY

Objectives:

The marine biology and zoogeography, the particular topic well growing stage in our country. The knowledge about the marine environment (including the divisions), various ecosystems and biodiversity also informative. Further this paper deals with the population growth density and independent factors, the structure, composition and adaptations of community ecology, besides studying the animal associations and the distribution importance and assessments techniques of marine biodiversity.

UNIT 1 – Classification of Marine Environment


UNIT 2 - Marine ecosystem

Concept - ecosystem structure and function, functional attributes food chain, food web, ecological pyramid, energy flow. recycling of nutrients.

Systems ecology and modeling- System structure, feed-back, loops and types of models, characteristics and behavior of a system. Ecosystem services.

UNIT 3 - Population ecology

Group attributes, population density variation, age structure sex ratio population growth, carrying capacity, dispersal, density dependent and independent factors. prey – predator relationship, Intraspecific & Interspecific competition, survivorship curve, r/k selection,

UNIT 4 - Community ecology

Structure composition and stratification, diversity and stability, concept of niche, edge effect – abundance of diversity, resilience, succession, community-wise adaptation (e.g. fouling and boring community, animal association in the sea).

UNIT 5 - Marine biodiversity

Definition and importance, biodiversity assessment techniques, threats to marine biodiversity, over-exploitation, physical alteration, pollution, alien species. Biosecurity.
PRACTICAL XI: MBOP 306 – Marine Ecology and Zoogeography

1. Population analysis of Cerithidea cingulata, Uca sp.: Quadrante and Transect method
2. Sex ratio of Uca sp.
3. Collection and identification of animal and community studies of different environments
   i) Pelagic
   ii) Muddy shore
   iii) Sandy shore
   iv) Rocky shore
   v) Interstitial
   vi) Oyster bed community
   vii) Phytal faunal community (Seaweed and seagrass).
   viii) Fouling and boring organisms
   ix) Assessment of biodiversity of any one of the above communities


REFERENCE BOOKS

OBJECTIVES:

This paper deals with application of marine biology based on genetical, pharmacological and immunological potential in relation to the instruments used for the application.

UNIT 1 – Tools and Techniques

Introduction to marine biotechnology & genetic engineering

Tools & Techniques: PCR, blotting, Gene probes, gene sequencing: RAPD, RFLP & ELISA

Electrophoresis – Paper, agarose, PAGE, PFGE & Iso – Electric Focusing.

UNIT 2 - Marine Pharmacology

Prospects – Bioactive compounds from marine environment: isolation, purification and identification of compounds.

UNIT 3 – Marine Microbial Technology

Recombinant protein production in microbes; Commercial issues pertaining to the production of recombinant products from microbes; Downstream processing approaches; Industrial microbes as cloning hosts (Streptomyces/Yeast)

UNIT 4 - Bioinformatics

Definition and history

Internet basics: Internet connection, Web browsing and URL; Data bases – Nucleic acid sequence databases (NCBI, EMBL, DDJB), protein sequence database (SWISS – PROT).

Database searching (BLAST); protein prediction – structure and function prediction of proteins.

Molecular visualization and tools for molecular visualization (RASMOL and MOLMOL).
UNIT 5 – Chromatography & Spectroscopy

Chromatography: Principles of paper, thin layer, ion-exchange, affinity, gas-liquid chromatography and HPLC.

Spectroscopy: Absorption and emission principles, UV-vis, Atomic absorption and emission spectrophotometers, fluorescence spectrophotometer, NMR and Mass spectrometer.

PRACTICAL XII : MBOP 307 – Marine Biotechnology, Bioinformatics and Instrumentation

1. Extraction and quantification of Nucleic acid and proteins
2. Electrophoresis – Agarose gel electrophoresis and PAGE.
3. Blotting (Southern & Western) & PCR
4. Tissue culture techniques- Preparation and maintenance of plant and animal cell lines
5. Chromatography
   a. Paper
   b. Column
   c. TLC
6. Basic principles and application of atomic absorption Spectrophotometer, Inductively coupled plasma spectrophotometer, GC, FT-IR, GC-MS, HPLC, UV-Visible spectrophotometer and fluorescence spectrophotometer
7. BLAST search for similar nucleotide sequences
8. Protein secondary structure, tertiary structure and Motifs prediction.
9. Visualizing 3D structure of macromolecules using RASMOL.
10. Isolation and extraction of bioactive compounds from marine organisms

REFERENCE BOOKS

Objectives:

The objective of this course is to provide students with an understanding of the sources, links and biological effects of major classes of pollutants in the marine environment. The course will help prepare students for careers in academic programs, research centers and consulting firms by providing them with an in-depth understanding of causes, consequences and methods of assessment of marine pollution.

UNIT 1 - Basics in Marine Pollution

Marine Pollution – Definition of GESAMP - Major pollutants – sources, transport path, dynamics, monitoring methods, bioindicators, bioaccumulators and hot spots

Toxicology – Lethal and Sub-lethal effects of pollutants to marine organisms bioconcentration, bioaccumulation and biomagnification, methods of toxicity testing, factors influencing toxicity, synergistic and antagonistic effects, role of microcosms & mesocosms.

UNIT 2 - Major Pollutants – Sewage and Detergent

Sewage; industrial, agricultural and domestic discharges. Composition of Sewage - impact on marine environment, treatment methods (primary, secondary and tertiary).

Detergents – composition – eutrophication and ecological significance, interference in the sewage treatment system.

UNIT 3 – Major pollutants – Heavy metals & pesticide

Heavy metal pollution – sources, distribution, fate, toxicity and diseases (Minamata, itai-itai etc.)

Pesticide pollution, classification and composition – sources, transport, distribution, fate and ecological impacts in the marine environment – endocrine disrupters.

UNIT 4 – Major Pollutants - Oil

Oil pollution – composition, sources and fate of spilled oil, biodegradation, biological impact of oil on marine organisms.

Unit 5 – Minor Pollutants

Thermal pollution – sources – waste heat disposal, uses of waste heat, role of biocides (Chlorine), ecological impacts.

Radioactive pollution, sources (natural and artificial), distribution, biological effects of radiation.

Plastics and litter – impact of mining and dredging operations in the marine environment.
PRACTICAL XII : MBOP 308 – Pollution and Toxicology

Analysis and estimation of critical pollutants.

a) Estimation of Ammonia (NH3)
b) Estimation of Hydrogen sulphide (H₂S)
c) Estimation of BOD
d) Estimation of COD
e) Pesticide residues in sea water and selected beeverages
f) Petroleum hydrocarbons in sea water
g) Heavy metals (Cu, Cd, Pb, Hg) in seawater, sediments & animal tissues
h) Preparation of solution (Standard, Normal, Molar) for toxicological studies
i) Methodology of toxicity testing – acute and chronic tests (demonstration)
j) Use of LC₅₀ values – sublethal effects of critical pollutants on fish and shellfish.

REFERENCE BOOKS

MBOC 304: Ocean Management

Objectives:

Students will gain an understanding of the interrelationships between the marine sciences (including the issues, research areas and the scientists) and public policy through exploration of the concepts and implementation processes of integrated coastal and ocean management. Through this effort, students will learn how the needs of the science and the understanding of marine science principles pertaining to the needs of policy development, resource use and regulation/management. The paper will allow the student to synthesize information from a variety of sources and explore some aspect of public policy from the perspective of a marine scientist.

Unit – I: Law of the sea


Role of International, National Agencies and Organizations in Ocean Management

Unit – II: Biodiversity and Conservation


Unit – III: Developmental Activities and Impacts

Coastal zone importance – coastal developmental activities such as mariculture, tourism, shorefront construction and their impacts – global and national coastal problems such as loss of habitat, sea level change, degradation of water quality and fisheries resource depletion.

Unit – IV: Coastal zone management issues

Coastal zone management issues – major ecological, social and economic trend and their importance – coastal zone regulations-91, aquaculture authority bill - CZM programs – Integrated Coastal Zone Management – categorization – coastal management zones - CRZ Notification 2011 - Comparison between developed and developing countries, temperate and tropical countries and their CZM.

Unit – V: Remote sensing & GIS

RS & GIS Technologies – Application in marine resources exploration, satellites and airborne remote sensing, GIS in marine & Coastal zone management – Mapping & monitoring of pollution, changes in Coastal zone. – Application in disaster management – Tsunami types & causes – Post – Tsunami damage assessment and rehabilitation.
REFERENCES BOOKS


MBOC 305 Elective – I

IV SEMESTER

MBOC 401 - Elective – II

MBOC 402 - Project Work
SUGGESTED ELECTIVES

MBOE 01 Marine Food Technology

Unit I

Unit II
Packing – handling fresh fish, frozen packs, IQF, layered and shatter packs. Fishery by – products, cannery waste, feeds, silage, fish gelatin, fish glue, chitin and chitosan, pearl essence, fertilizer.

Unit III

Unit IV

Unit V
Novel product development, marketing and sea food export – MPEDA, marketing, government policies, export finance, economic importance. Novel products – nutrition promotion, consumer studies qualitative and quantitative research methods

REFERENCE BOOKS

MBOE 02. Ornamental Fish Culture & Aquarium Keeping

Unit I

Introduction

Unit II

Culture and hatchery production

Unit III

Designing, Aeration, filtration and lightings
In door and out door aquaria - Tank designs - fabrication - choosing of right tank - Air pumps - filters biofilters - devices - aquarium lights - water quality maintenance - test kits.

Unit IV

Setting up of aquarium
Fresh and marine water set up - aquascaping - adding decorative materials - aquarium plants - community aquarium.

Unit V

Health management
Basic diets - pellet feeds - formulation - Diseases - diagnosis and health management - treatment methods Colour enhancement - induced breeding

REFERENCE BOOKS


MBOE 03. Molecular Virology

Unit I
Economic losses due to important viruses; Types of plant viruses, DNA viruses, RNA viruses, satellite viruses, satellite RNA, satellite DNA, viroids, virusoids; Disease symptoms, local and systemic symptoms, necrosis, hypoplasia, hyperplasia; Vectors for virus transmission; Cell to cell and systemic movement of viruses, plasmodesmata and virus movement.

Unit II
Genome Organization of DNA viruses; Caulimovirus – eg. Cauliflower mosaic virus, Replication of CaMV, Badnavirus – Rice tungro virus (RTBV); Geminiviridae – Bean golden mosaic virus, β- DNAs of geminiviruses, rolling circle replication, Nanovirus – Banana bunchy top virus

Unit III
Genome Organization of positive-stranded RNA viruses – Potyviridae, Potato virusY (PVY), processing of polyprotein, Comoviridae, Citrus triestea virus; Bromoviridae, Alfalfa mosaic virus; Tubirviridae, Tobacco mosaic virus, Replication of TMV, Tobacco rattle virus.

Unit IV
Genome Organization of negative–stranded RNA viruses; Rhabdoviridae, Sonchus yellow net virus; Bunyaviridae, Tomato spotted wilt virus; Tenuivirus, Rice stripe virus; Double-stranded RNA viruses, Reoviridae, Rice dwarf virus.

Unit V
Virus detection and diagnosis; Infectivity assays – Sap transmission, insect vector transmission, agroinfection (using Agrobacterium); Ultracentrifugation, electron microscopy, serological methods, immuneelectrophoresis in gels, direct double-antibody sandwich method, Dot ELISA, Immunosorbent electron microscopy (ISEM), Decoration technique, Polymerase chain reaction; DNA and oligonucleotide microarray; Gene silencing, PTGS & TGS, viral suppressors of gene silencing.

REFERENCE BOOKS


MBOE 04. PLANT AND ANIMAL CELL CULTURE TECHNOLOGY

Unit I

Structure and organization of animal cell - Cell proliferation – Cell differentiation – Cell adhesion – Senescence – Cell transformation

Unit II

Cell culture media: Components, physicochemical properties – Serum: Components, advantages and disadvantages, serum free media – Use of Antibiotics – Primary cell culture: Initiation of cell culture, mechanical and enzymatic disaggregation – Cell lines: Development, characterization, maintenance – Cell separation

Unit III

Adherent & non adherent cell lines – Culture methods – Subculture – Cryopreservation – Contamination in animal cell culture – Quantification and cytotoxicity – Embryonic stem cells – cancer stem cells.

Unit IV

Plant tissue culture – Introduction, cellular totipotency, basic requirements for plant tissue culture laboratory, tissue culture media (constituents and preparations), types of culture – cell, protoplast, callus, suspension culture and its applications.

Unit V

Explant, surface sterilization, plant growth hormones, micropropagation (direct and indirect method), somatic hybridization, plant transformation technique using Agrobacterium tumefaciens, applications of plant tissue culture.

REFERENCE BOOKS


MBOE 05 Microbial Technology

Unit I

Isolation and screening of industrially important microbes; Large scale cultivation of industrial microbes; Strain improvement to improve yield of selected compounds e.g. antibiotics, enzymes or recombinant proteins.

Unit II

Basic principles of bioprocess as applied to selected microbes; Process optimization of selected products.

Unit III

Recombinant protein production in microbes; Commercial issues pertaining to the production of recombinant products from microbes; Downstream processing approaches; Industrial microbes as cloning hosts (Streptomyces/Yeast)

Unit IV

Environmental application of microbes; Ore leaching; Toxic waste removal; soil remediation.

Unit V

Microbial application in food and healthcare industries; Food processing and food preservation; Antibiotics and enzymes of pharmaceutical use.

REFERENCE BOOKS


MBOE 06 Bioprocess Engineering and Technology

Unit I

Basic principle of Biochemical engineering
Isolation, screening and maintenance of industrially important microbes; Microbial growth and death kinetics (an example from each group, particularly with reference to industrially useful microorganisms); Strain improvement for increased yield and other desirable characteristics.

Unit II

Concepts of basic mode of fermentation processes
Bioreactor designs; Types of fermentation and fermenters; Concepts of basic modes of fermentation - Batch, fed batch and continuous; Conventional fermentation v/s biotransformation; Solid substrate, surface and submerged fermentation; Fermentation economics; Fermentation media; Fermenter design- mechanically agitated; Pneumatic and hydrodynamic fermenters; Large scale animal and plant cell cultivation and air sterilization; Upstream processing: Media formulation; Sterilization; Aeration and agitation in bioprocess; Measurement and control of bioprocess parameters; Scale up and scale down process.

Unit III

Downstream processing
Bioseparation - filtration, centrifugation, sedimentation, flocculation; Cell disruption; Liquid-liquid extraction; Purification by chromatographic techniques; Reverse osmosis and ultra filtration; Drying; Crystallization; Storage and packaging; Treatment of effluent and its disposal.

Unit IV

Applications of enzymes in food processing
Mechanism of enzyme function and reactions in process techniques; Enzymic bioconversions e.g. starch and sugar conversion processes; High-Fructose Corn Syrup; Interesterified fat; Hydrolyzed protein etc. and their downstream processing; baking by amylases, deoxygenation and desugaring by glucose oxidase, beer mashing and chill proofing; cheese making by proteases and various other enzyme catalytic actions in food processing.

Applications of Microbes in food process operations and production
Fermented foods and beverages; Food ingredients and additives prepared by fermentation and their purification; fermentation as a method of preparing and preserving foods; Microbes and their use in pickling, producing colours and flavours, alcoholic beverages and other products; Process wastes-whey, molasses, starch substrates and other food wastes for bioconversion to useful products; Bacteriocins from lactic acid bacteria – Production and applications in food preservation.
Unit V

Enzyme kinetics; Two-substrate kinetics and pre-steady state kinetics; Allosteric enzymes; Enzyme mechanism; Enzyme inhibitors and active site determination

Production, recovery and scaling up of enzymes and their role in food and other industries; Immobilization of enzymes and their industrial applications.

REFERENCE BOOKS


MBOE 07 Biostatistics

Unit I
Applications of statistics in biological sciences and genetics; Descriptive statistics; Mean; Variance; Standard deviation and coefficient of variation (CV); Comparison of two CVs; Skewness; Kurtosis

Unit II
Probability – axiomatic definition; Addition theorem; Conditional probability; Bayes theorem; Random variable; Mathematical expectation; Theoretical distributions – Binomial, Poisson, Normal, Standard normal and Exponential distributions; Sampling- parameter, statistic and standard error; Census sampling methods; Probability and non-probability sampling; Purposive sampling; Simple random sampling; Stratified sampling.

Unit III
Testing of hypothesis; Null and alternative hypothesis; Type I and type II errors; Level of significance; Large sample tests; Test of significance of single and two sample means; Testing of single and two proportions - Small sample tests: F-test – testing of single mean; Testing of two sample means using independent t test, paired t test; Chi square test: Test for goodness of fit - association of attributes – testing linkage – segregation ratio.

Unit IV
Correlation – Pearson’s correlation coefficient and Spearman’s rank correlation; Partial and multiple correlation – Regression analysis; Simple linear and non linear regression; Multiple regression.

Unit V
Analysis of variance – definition – assumptions – model; One way analysis of variance with equal and unequal replications; Two way analysis of variance; Non parametric tests – sign test – Mann Whitney ‘U’ test – Kruskal Wallis test.

REFERENCE BOOKS
MBOE 08. Genomics and Proteomics

Unit I

Introduction
Structural organization of genome in Prokaryotes and Eukaryotes; Organelle DNA-mitochondrial, chloroplast; DNA sequencing-principles and translation to large scale projects; Recognition of coding and non-coding sequences and gene annotation; Tools for genome analysis-RFLP, DNA fingerprinting, RAPD, PCR, Linkage and Pedigree analysis-physical and genetic mapping.

Unit II

Genome sequencing projects
Microbes, plants and animals; Accessing and retrieving genome project information from web; Comparative genomics, Identification and classification using molecular markers-16S rRNA typing/sequencing, ESTs and SNPs.

Unit III

Proteomics
Protein analysis (includes measurement of concentration, amino-acid composition, N-terminal sequencing); 2-D electrophoresis of proteins; Microscale solution isoelectricfocusing; Peptide fingerprinting; LC/MS-MS for identification of proteins and modified proteins; MALDI-TOF; SAGE and Differential display proteomics, Protein-protein interactions, Yeast two hybrid system.

Unit IV

Pharmacogenetics
High throughput screening in genome for drug discovery-identification of gene targets, Pharmacogenetics and drug development

Unit V

Functional genomics and proteomics
Analysis of microarray data; Protein and peptide microarray-based technology; PCR-directed protein in situ arrays; Structural proteomics

REFERENCE BOOKS
MBOE 09. Vaccines

Unit I
Innate Immunity; Activation of the Innate Immunity through TLR mediated signaling; Adaptive Immunity; T and B cells in adaptive immunity; Immune response in infection; Protective immune response in bacterial; Viral and parasitic infections; Correlates of protection

Unit II
Vaccination and immune response; Appropriate and inappropriate immune response during infection: CD4+ and CD8+ memory T cells; Memory B cells; Generation and Maintenance of memory T and B cells; Dendritic cells in immune response

Unit III
Adjuvants in Vaccination; Induction of Th1 and Th2 responses by using appropriate adjuvants; Microbial, Liposomal and Microparticles as adjuvant; Chemokines and cytokines; Role of soluble mediators in vaccination; Oral immunization and mucosal Immunity

Unit IV
Conventional vaccines; Bacterial vaccines; Live attenuated and inactivated vaccine; Subunit Vaccines and Toxoids; Peptide Vaccine

Unit V
New Vaccine Technologies; Rationally designed Vaccines; DNA Vaccination; Mucosal vaccination; New approaches for vaccine delivery; Engineering virus vectors for vaccination; Vaccines for specific targets; Tuberculosis Vaccine; Malaria Vaccine; HIV vaccine

REFERENCE BOOKS


MBOE 10: REMOTE SENSING & GIS

Unit – I


Unit – II

Application of remote sensing in the assessment of mangroves, coral reef, seaweed and sea grasses. Ocean Color Monitoring and productivity studies; Sea surface temperature and Oceanographic parameters: eddies, ocean circulation, upwelling and identification of Potential Fishing Zone (PFZ),

Unit- III


Map scanning and digitizing, topology building, editing and cleaning. Data processing: Updation, corrections, modifications, scale change, geometric transformations and map projection transformations, conflation sliver removal, edge matching, interactive graphic editing, rubber sheeting.

Unit- IV

Spatial Analysis, Integration and Modelling: Logic operations, general arithmetic operations, general statistical operations, geometric operations, query and report generation from attribute data, geometric data search and retrieval, classification reclassification, integrated geometry and attributes, overlay, buffer zones, raster data overlay. Definition and concept of Web GIS- advantage and limitations of Web GIS, overview of Web GIS.

Unit V

Applications in Marine sciences: Marine resources exploration, Mapping and Marine Resources information System; GIS in Marine and Coastal Zone Management. Mapping and monitoring of pollution, changes in coastal zones, Applications in Disaster Management: Tsunami – types, causes, RS and GIS applications for post Tsunami damage assessment and rehabilitation. Creating custom GIS Software applications and user interface.
REFERENCE BOOKS


