VIKRAMA SIMHAPURI UNIVERSITY
NELLORE- 524324
(Andhra Pradesh, India)

DEPARTMENT OF MARINE BIOLOGY

M.Sc., Marine Biology

Syllabus

(CBCS)

Programme code : MAB

(With effect from AY 2022-23)

Course Duration: 2 Years

VIKRAMA SIMHAPURI UNIVERSITY:: NELLORE
(AP State University)
M.Sc. Marine Biology Syllabus
(For the students admitted during the academic year 2022-23onwards)

First Semester

Components of Study	Course Code	Title of the Course	No. of credits	No. of hours per week	Practical/ Project	Internal Assessment	Semester End Exams	Total
Core	MAB 101	Introduction to Marine Biology	04	06		30	70	100
	MAB 102	Biological Oceanography	04	06		30	70	100
Compulsory Foundation	MAB 103A	Marine Invertebrates	04	06		30	70	100
	MAB 103B	Marine Ecology						
Elective Foundation	MAB 104A	Marine Vertebrates	04	06		30	70	100
	MAB 104B	Principles of Aquaculture						
Life Skill Courses	MABLSC1	Cyber Security	04	05		30*	70*	100*
Practical-I	MAB105P	Lab I: Papers: 101 & 103A/B	04	06	100	00		100
Practical-II	MAB 106P	Lab II: Papers: 102 & 104A/B	04	06	100	00		100
Audit Course -1	MABAUC1	**Value Education/Stress Management**	00	00		50*	00	50*
Sub-total			24	36	200	120	280	600

All core papers are mandatory

Compulsory foundation: Choose one paper
Elective foundation: Choose one paper
Audit Course: 50 marks (Internal: zero credits under self study)
Interested candidates may registered for MOOCS with the approval of the concerned DDC, but it will be considered for the award of the grade as open elective only giving extra credits.
Lab-I: Core course paper-I+ opted Compulsory Foundation course paper
Lab-II: Core course paper-II+ opted Elective Foundation course paper

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Second Semester

Components of Study	Course Code	Title of the Course	No. of credits	No. of hours per week	Practical/ Project	Internal Assessment	Semester End Exams	Total
Core	MAB 201	Physical and Chemical Oceanography	04	06		30	70	100
	MAB 202	Fishery Science	04	06		30	70	100
Compulsory Foundation	MAB 203A	Physiology and Biochemistry	04	06		30	70	100
	MAB 203B	Molecular Biology						
Elective Foundation	MAB 204A	Microbiology and Immunology	04	06		30	70	100
	MAB 204B	Cell Biology						
Life Skill Courses	MABLSC2	Personality enhancement & leadership	00	05		30*	70*	100*
Practical-I	MAB 205P	Lab I: Papers: 201 & 203A/B	04	06	100	00		100
Practical-II	MAB 206P	Lab II: Papers: 202 & 204A/B	04	06	100	00		100
Audit Corse -2	MABAUC2	**Constitution of India/Gender Equality**	00	00		50*	00	50*
Sub-total			24	36	200	120	280	600

All core papers are mandatory
Compulsory foundation: choose one paper
Elective foundation: Choose one paper
Audit Course: 100 marks (Internal: zero credits under self study)
Interested candidates may registered for MOOCS with the approval of the concerned DDC, but it will be considered for the award of the grade as open elective only giving extra credits.
Lab-I: Core course paper-I+ opted Compulsory Foundation course paper
Lab-II: Core course paper-II+ opted Elective Foundation course paper

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III Semester

Components of Study	Course Code	Title of the Course	No. of credits	No. of hours per week	Practical/ Project	Internal Assessment	Semester End Exams	Total
Core	MAB 301	Coastal Aquaculture	04	06		30	70	100
	MAB 302	Marine Pollution and Toxicology	04	06		30	70	100
Generic Elective	MAB 303A	Fish Nutrition and Feed Technology	04	06		30	70	100
	MAB 303B	Marine Biodiversity						
Practical	MAB 304P	Practical: I: Core & Generic Elective	04	06	100			100
Skill Oriented Course	MAB 305 (Mandatory)	Fish Processing Technology (Theory)	04	06		10	40	100
		Practical :II : Fish Processing Technology			50			
Open Elective	MAB 306A	Disaster Management	04	06		30	70	100
	MAB 306B	Ornamental Fish Culture						
	MAB 306C	Aquaculture Biotechnology						
Sub-total			24	36	150	130	320	600

All core papers are mandatory
Generic Electives: choose one paper
Practical I: Core papers and opted Generic Elective paper
Skill Oriented Course is mandatory (it is relevant to society along with practical (Internal: 10 marks; Theory: 40 Marks; Practicals: 50 Marks)
Open Electives are for the students of other Departments.
(Minimum one paper should be opted. Extra credits may be earned by opting more number of open electives depending on the interest of the students through self study only).
Interested candidates may register for MOOCS with the approval of the concerned DDC but it will be considered for the award of the grade as open elective only giving extra credits.

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IV Semester

Components of Study	Course Code	Title of the Course	No. of credits	No. of hours per week	Practical/ Project	Internal Assessment	Semester End Exams	Total
Core	MAB 401	Marine Biotechnology	04	06		30	70	100
	MAB 402	Ocean Management and Remote Sensing	04	06		30	70	100
Generic Elective	MAB 403A	Biostatistics , Bioinformatics and Research Methodology	04	06		30	70	100
	MAB 403B	Tools and Techniques in Biology						
Practical	MAB 404P	Lab I: Core & Generic Elective	04	06	100			100
Multi-disciplinary course/ project work	MAB 405	Project/ Internship (6 weeks) (Submission of Dissertation/Report)	06	06		30	70	100
Open Elective	MAB 406 A	Marine Resources & Conservation	04	06		30	70	100
	MAB 406 B	Disease & Health Management in Aquaculture						
	MAB 406 C	Aquaculture Economics, Extension & Fish Marketing						
Skill enhancement Activity	MAB-SEA1	Educational Tour/Field visit and submission of Report (Visit to Industries/Research Institutes/Aquaculture farms/ Hatecheries /Processing plant /Feed Mill)	02			50		50
	MAB-SEA2	Seminar/ Poster Presentation	04	04		50		50
		Sub-total	**32**	**40**	**100**	**250**	**350**	**700**
		Grand Total Marks	**104**	**148**	**650**	**620**	**1230**	**2500**

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All core papers are mandatory

Generic Electives: choose one paper
Practical II: Core papers and opted Generic Elective paper
Project Work/Internship: Collaboration with various Aqua firms/ companies/industries
Multi-disciplinary course is mandatory. Circle formation with various subjects/Departments of Arts/Department of commerce
Open Electives are for the students of other Departments.
Minimum one paper should be opted. Extra credits may be earned by opting more number of open electives depending on the interest of the students through self study only.
Interested candidates may register for MOOCS with the approval of the concerned DDC but it will be considered for the award of the grade as open elective only giving extra credits.
Value Added Course (VAC) on "MBVAC-01: ORNAMENTAL FISH BREEDING TECHNOLOGY" is offering in the department in the III Semester.

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ROGRAMME OUTCOMES:

PO1: Apply the knowledge of marine biology including with the subject areas of coastal aquaculture, fishery science, marine pollution and toxicology, marine biotechnology in the recent research areas with students in post graduate level.

PO2: Marine biology faculty will continue to review, update and revise the curriculum to ensure the quality of syllabus in commendable level.

PO3: Students graduating Master degree in Marine Biology will be trained to involve in job opportunities in aquaculture/biological sciences related industries and research programmes.

PO4: Marine Biology Master degree graduates will be skilled in advance level of farming, hatchery, feed formulation techniques of aquaculture species and industry orientation.

PO5: Students graduating with Marine Biology master's degree will be able to work as research scientist, R& D experts, Entrepreneur, field experts and teaching positions.

Programme Specific Outcomes:

At the end of the Programme, the student will be able to

PSO1: Understand the knowledge and basic concepts of marine biology and ecology, physical, chemical and biological oceanography.

PSO2: Analyze the relationships among the animals, plants and microorganisms in the marine environment.

PSO3: Perform the different procedures as per the laboratory standards in the areas of marine microbiology, biotechnology, bioinformatics, biostatistics, physiology and biochemistry.

PSO4: Understand the applications of different advanced biological techniques in coastal aquaculture, fishery science and marine biotechnology.

PSO5: Explore the basics of oceans in terms of waves, tides, currents, physical and chemical properties of sea water.

PSO6: Understand about the diversity of marine organisms including marine flora and fauna

PSO7: Impart the knowledge Ocean management and remote sensing, coastal and marine biodiversity. Carryout the various experiments in related to the monitoring marine pollution and toxicology and train the various techniques/instruments.

PSO8: Gain the knowledge related to the molecular biology and immunology by using the tools and techniques to detect the different diseases in aquatic species.

PSO9: Practice the students with proficient in the farming/hatchery operations of cultivable marine organisms and utilization of marine/coastal resources to make as an entrepreneur

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M.Sc. Marine Biology Syllabus

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FIRST SEMESTER

Course Code & Title	22RMAB101: Introduction to Marine Biology		
Programme	Marine Biology	Semester	I
Number of Credits	04	Number of Hours	60
Course Objectives	1. Student will learn about the zonation of the marine environment, its biotic and abiotic factors. 2. Classification and distribution of Phytoplankton and their significance in primary productivity. 3. Zooplankton distribution and relationship between phytoplankton and zooplankton. 4. Deep sea environment and adaptations of deep sea fauna and their ecological factors.		

UNIT	Content	Number of Hours
I	**Marine Environment:** The Sea as biological environment –Classification of the marine environment –biotic and abiotic divisions.	14
II	**Phyto Plankton** : Classification, composition, and adaptations to planktonic life, factors affecting distribution and abundance, Red tide phenomena – causes and effects; biological productivity, primary production – methods of measuring primary production, factors affecting primary production.	16
III	**Zoo Plankton:** Classification, composition, and adaptations; factors affecting distribution and abundance. Phytoplankton, zooplankton relationships, diurnal vertical migrations. Indicator species among zooplankton.	16
IV	**Benthos and Deep Sea**: Benthos-Methods of collection and analysis; benthic communities; Meiobenthos; Deep-Sea- Life and environmental conditions. Adaptations of the deep sea fauna. Marine Bio- deterioration - Fouling and boring organisms.	14

Reference Books

1. Nybakken, J.W. Marine Biology An ecological approach. Harper Collins College Publishers, New York.
2. Fincham, AA. Basic Marine Biology. Cambridge University Press.
3. Sverdrup, HU,MW Johnson and RH Fleming. The oceans, their physics, chemistry and general biology. Prentice Hall, Engel wood cliffs.
4. Boaden, J Sand R. Seed. An Introduction to coastal Ecology, Chapman and Hall, New York.
5. Raymont, JEG. Plankton and Productivity in the Oceans. A Pergmon Press, NewYork.

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	6. Wickstead, JH. An introduction to the study of tropical plankton. Hutchinson 7. Introduction to Marine Biology S.N. Prasad 8. CBL Srivastava A text book of fishery science and Indian fisheries. 9. Jhingran.V.G.1985fishandfisheriesofIndia, Hindusthan publishing corporation, New Delhi. 10. Begon,M.,J.L.HarperandCRTownsend.Ecology,Individuals,Populations and Communities. Blackwell Science, Oxford, UK 11. Koromondy, E.J. Concepts of ecology, Prentice and Hall, New Delhi. 12. Clarke, GL. Elements of Ecology, New York: John wiley and sons 13. Odum, EP., Fundamentals of Ecology. Philadelphia; WB Saunders 14. Krebs, CJ. Ecology. Harper & Row, New York.
Course outcome	On the successful completion of course students will be able to CO1: Understand the basics structure of marine ecosystem and importance of marine environment and its life (Plankton, Fauna etc). CO2: Identify and Classify the Phytoplankton and understand the Significance of the Primary Productivity in the marine environment. CO3: Identify and Classify the Zooplankton and understand the Relationship between Phyto and zooplankton. CO4: Learn the collection of samples and analysis of benthos. Obtain the knowledge of Deep sea life and their adaptations, boring and fouling organisms.

Outcome Mapping:

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO1 5	PSO6	PSO7	PSO8	PSO9
CO1	3	3			3			3	3	3	3			3
CO2	3				3			3	3	3	3			3
CO3	3				3			3			3			
CO4	3							3		3				3

Low:1, Medium:2, High:3

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Course Code & Title	22RMAB102: Biological Oceanography		
Programme	Marine Biology	Semester	I
Number of Credits	04	Number of Hours	60
Course Objectives	1. To know different upwelling regions in the world and its significance in marine ecosystem. 2. To know different types of environmental conditions and their effect on organisms. 3. To understand the classification of flora and fauna in estuaries and their adaptations in estuarine ecosystem. 4. To explain the distribution of mangroves and their ecological significance.		

UNIT	Content	Number of Hours
I	**Upwelling ecosystems:** Major upwelling areas in the world causes and mechanism of upwelling, Biological significance of upwelling – phytoplankton production.	15
II	**Intertidal ecosystems:** Zonation, Environmental conditions-Tides-Temperature-wave action–salinity-other factors- adaptations of intertidal organisms-Rocky – Sandy and Muddy shores.	15
III	**Estuarine ecosystems:** Classification and origin of estuaries, Physical and chemical environmental factors, Flora and fauna of estuaries, Estuarine productivity, adaptations (morphological, anatomical and physiological) ecological role – estuarine food web.	16
IV	**Mangroves, Seagrasses and salt marshes:** Distribution – adaptations (morphological, anatomical and physiological), ecological role, uses, need for conservation. Coral reef biome.	14

Reference Books

1. Wimpenny, R.S., 1966.Plankton of the Sea. Feber and Feber Limited London.
2. Raymont,J.E.G.,1973.Plankton and Productivity in the Oceans Pergamon Press, London.
3. Boney,A.D.,1975.Phytoplankton.Edward,Arnold,London.
4. Chapman,V.J.,1976.Mangrove Vegetation.J .Gramer, Berlin.
5. Chapman, V.J. and D..T.Chapman,1980 .Seaweeds and Their Uses Chapman &Hall London Ltd.
6. Spoel S.Vander and R.P.Heyman, 1983 . Comparative Atlas of Zooplankton Biological Patterns in the Oceans. Springer – Verlag Berlin.
7. Tomilson,P.B.,1986. TheBotany of Mangroves.Cambridge University Press
8. Nyabakken, J.W..1997. MarineBiology – An Ecological Approach .Fourth Edition. Addison 12esley Edu. Pub. Inc.

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	9. Jeffrey S. Levinton. 2001.CD Marine Biology: Function. Biodiversity, Ecologypp.515. 10.Kathiresan ,Kand S.Z. Qasim,2005. Biodiversity of Mangrove Ecosystems. Hindustan Lever Limited.
Course outcome	On the successful completion of course, students will be able to CO1: Understand the mechanism, significance of upwelling and its role in Productivity of the oceans. CO2: Recognize the flora and Fauna of estuaries and their adaptations. CO3: Know the environmental conditions on estuarine organisms Adaptations developed by estuarine organisms to survive in adverse conditions. CO4: Understand the morphology and distribution of organisms in Estuarine ecosystems and their adaptive mechanisms.

Outcome Mapping:

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO5	PSO6	PSO7	PSO8	PSO9
CO1	3				3			3			3	3		
CO2	3				3				3	3	3	3		
CO3	3				3			3	3		3	3		
CO4	3				3			3	3		3	3		

Low:1, Medium:2, High:3

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Course Code & Title	22RMAB103A: Marine Invertebrates		
Programme	Marine Biology	Semester	I
Number of Credits	04	Number of Hours	60
Course Objectives	1. To know general principles of the taxonomy and significance of classification. 2. To understand the functional morphology, development and evolution of minor phyla. 3. To recall crustacean classification, development and life history. 4. To know the classification and general characters of Mollusca and Echinodermata.		

UNIT	Content	Number of Hours
I	**Major Phyla:** General principles of taxonomy – characteristic features of invertebrates, classification up to order level - Protozoa, Porifera, Coelenterata, Annelida, Arthropoda with special reference to Crustacea, Mollusca and Echinodermata.	16
II	**Minor Phyla:** Functional morphology, development and evolution: Nemertinea, Endoprocta, Ectoprocta, Phoronida and Pogonophora; Classification, distribution, morphology, anatomy, and evolution of Chaetognatha and Brachiopoda	14
III	**Crustacea:** Classification, comparative morphology, crustacean appendages, larval forms and their phylogeny, life history of selected species e.g. Penaeids and Brachyurans.	16
IV	**Mollusca & Echinodermata:** Mollusca - Classification, General characters with reference to bivalves and gastropods, Torsion in Gastropoda, Echinodermata - Classification and General characters, Water vascular system, larval forms, their evolutionary significance.	14

Reference Books	1. Hyman, 1967.The Invertebrate Zoology Vols, I to Vl. Mc Graw Hill Book Co. Ltd., New York. 2. Kaestner,A.,1967.Invertebrate Zoology Vols.1toIII. Wiley Inter science Publishers, New York. 3. Barnes,R.D.,1980.Invertebrate Zoology .4thEdition.Saunders College Publishers, Philadelphia. 4. Ruppert, E.E. and R.D.Barnes,1 994. Invertebrate Zoology 6thEdition. Saunders College Publishers, Philadelphia.
Course outcome	On the successful completion of course, students will be able to

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	CO1: Understand the general principles and role of classification in identifying the organisms. CO2: Identify the development and evolution of Minor Phyla organisms. CO3: Identify the larval stages of penaeids and Brachyurans. CO4: Identify the Molluscs and echinoderms, larval forms of the Echinoderms and their evolutionary significance.

Outcome Mapping:

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO1 5	PSO6	PSO7	PSO8	PSO9
CO1	3				3			3	3		3			
CO2	3				3			3	3		3			
CO3	3				3			3	3		3			
CO4	3				3			3	3		3			

Low:1, Medium:2, High:3

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Course Code & Title	22RMAB103B: Marine Ecology		
Programme	Marine Biology	Semester	I
Number of Credits	04	Number of Hours	60
Course Objectives	1. Student will learn about the chemical factors of the marine environment. 2. Identify about the deep sea environment and adaptations of sea fauna and their ecological factors 3. Acquire knowledge related to aquatic environment. 4. Understand the concept of population and community ecology		

UNIT	Content	Number of Hours
I	**Physico – Chemical Properties of the Sea:** Physical Characteristics of the marine environment-Temperature, Temperature-salinity relationship, light, Pressure, Tides, Currents, Waves. Chemical Characteristics of the marine environment-Salinity, Oxygen, carbon dioxide, P^H, Nitrogen, Phosphorus, Calcium, organic matter. Coral reef biome.	16
II	**Population Ecology:** Characteristics of a population-Growth rate, Natality, Mortality. Dispersal, Biotic potential and concept of carrying capacity. Population growth form, Logistic curve. Concept of density dependent and density independent action in population control.	14
III	**Population Interactions:** Negative interactions - Competition, Predation, prey predator relationship, parasitism and parasitic adaptations, antibiosis. Positive interactions: Commensalism, Proto cooperation and mutualism. Ecosystem modelling.	16
IV	**Community Ecology:** Characteristics of a community - Community dominance, species diversity indices, concept of niche, ectones and the concept of edge effect. Ecological succession: Causes, trends and basic types of succession, general process of succession. Hydrosphere and Lithosphere.	14

Reference Books	1.Begon, M., J.L. Harper and CR Townsend. Ecology, Individuals, Populations and Communities. Blackwell Science, Oxford, UK. 2. Koromondy, E.J. Concepts of ecology, Prentice and Hall, New Delhi. 3. Clarke, GL. Elements of Ecology, New York: John wiley and sons. 4. Odum, EP., Fundamentals of Ecology. Philadelphia; WB Saunders. 5. Krebs, CJ. Ecology. Harper & Row, New York. 6. Jorgensen, S.E. Fundamentals of Ecological modelling Elsevier, New York.
Course outcome	On the successful completion of course, students will be able to

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	CO1: Students will know the basics of Marine Ecology and importance of physical and chemical factors. CO2: Students will be able to identify the interactions of population ecology CO3: Learn about the different factors involved in marine ecology. CO4: Describe about the dynamics of population and marine ecology.

Outcome Mapping:

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO1 5	PSO6	PSO7	PSO8	PSO9
CO1	3				3			3	3	3	3			3
CO2	3	3			3			3		3	3			3
CO3	3				3			3	3		3			
CO4	3							3		3				3

Low:1, Medium:2, High:3

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Course Code & Title	22RMAB104A:MarineVertebrates		
Programme	Marine Biology	Semester	I
Number of Credits	04	Number of Hours	60
Course Objectives	1. To study the origin and evolution of species and also classification and comparative morphology of chordates 2. To learn the general characters of bony fishes, marine reptiles, birds and marine mammals and their evolution studies. 3. To obtain knowledge on general characters , classification of marine reptiles and birds 4. To learn the general characters and classification of marine mammals and their adaptations		

UNIT	Content	Number of Hours
I	**Origin of Chordates**: Geological time scale - progression of vertebrates through time, chordate features and theories on the origin of chordates; Prochordata - classification and comparative morphology.	16
II	**Bony Fishes:** Characteristic features and classification of bony fishes and Dipnoi fishes. Classification and evolution of jawless and primitive vertebrates. Evolution and adaptive radiation of elasmobranchs and bony fishes.	16
III	**Marine Reptiles and Birds:** General characters and classification of reptiles, Reptilian features of symuria. Mammal - like reptiles, sea snakes and marine turtles. General characters and classification of Aves, marine birds, migration, aerial adaptations of birds, importance of marine birds.	14
IV	**Marine Mammal:** General characters and classification of mammals – aquatic mammals, adaptations and evolution of cetacea and sirenia ; Adaptations for life in the Sea.	14

Reference Books	1. RobertT.Orr.1976.Vertebrate Biology. W.B. Saunders Company Philadelphiap. 472. 2. Farland,W.N.,Punch,F.H.,Cod,T.J.andHeisser,J.B.,1979. Vertebrate Life-Collier; Macmillan International Edition, Macmillan Publishing Company Inc..New York. 3. Minkoff,E.C.,1983.Evolutionary biology,AddisonWesley shing Company, Massachusetts. 4. Lull.R.S.1984.OrganicEvolution. SeemaPublication,New Delhi. 5. Colbert.Edwin.H.1989. Evolutionofthevertebrates. WileyEasternLtd., New DelhiP.535. 6. Strickberger,W.Monroe,1996. Evolution .Jones and Barlett Publishers .Massachusetts, p.670

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Course outcome	On the successful completion of course, students will be able to CO1: Obtain the Knowledge on Origin of chordates. Identify and classify the Chordates. CO2: Identify and classify the bony fishes and understand the evolution and adaptive radiation of elasmobranchs and bony fishes. CO3: Identify and classify the marine reptiles, birds and mammals. Understand the adaptations of Birds and significance of marine birds. CO4: Identify and classify the marine mammals. obtain the knowledge on adaptations of mammals in the sea.

Outcome Mapping:

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO5	PSO6	PSO7	PSO8	PSO9
CO1	3				3			3	3	3	3			
CO2	3				3			3	3	3	3			
CO3	3				3			3	3	3	3			
CO4	3				3			3	3	3	3			

Low:1, Medium:2, High:3

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Course Code & Title	22RMAB104B: Principles of Aquaculture		
Programme	Marine Biology	Semester	I
Number of Credits	04	Number of Hours	60
Course Objectives	1. To understand the various techniques in aquaculture. 2. Learn the basic aquaculture practices. 3. To obtain the knowledge in related to construction and preparation of culture ponds. 4. How to select the suitable species for aquaculture.		

UNIT	Content	Number of Hours
I	**Introduction & Aquaculture systems/methods:** Introduction to aquaculture: Present status-scope and importance- world and Indian aquaculture production trends; Culture systems/methods: Traditional, extensive, semi - intensive and intensive culture; monoculture, polyculture, composite culture, monosex culture; cage culture, raft culture, culture in re-circulatory systems; sewage – fed fish culture, integrated fish farming.	16
II	**Selection of sites for aquaculture:** Selection of suitable sites for aquaculture practices- Survey and location of suitable site – topography; soil characteristics; soil quality testing; water resources; water quality testing.	16
III	**Construction of culture ponds:** Farm construction-Design and construction of pond, layout and design of aquaculture farm, construction, water intake system, drainage system; aeration and aerators; different accessories used in aquaculture farm;	14
IV	**Selection of species for aquaculture:** Biological characteristics of aquaculture species; economic and market considerations; seed resources, collection and transportation; General characteristics of major cultivable fin fishes & shell fishes of India (sea bass, mullets, milk fish, groupers etc.; shrimps, crabs, oysters, mussels etc.).	14

Reference Books

1. Ayyappan, S., J. K. Jana, A. Gopala krishnan and A. K. Pandey 2006. Handbook of fisheries and aquaculture. Indian Council of Agricultural Research.
2. Bardach, John E. 1997. Sustainable Aquaculture. John Wiley and Sons.
3. Pillay, T. V. R. 2005. Aquaculture Principles and Practices. Blackwell Publishing Ltd.
4. Stickney, 2009. Aquaculture: An Introductory Text. CABI.
5. Pillay, T. V. R. 1993. Aquaculture: Principles and Practices. Fishing News Books. Black Well Scientific Publications.
6. MPEDA, 1991. Hand Book on Shrimp Farming, Kochi, India
7. Coche, A. G. and J. F. Muir. 1996. Pond Construction and Fresh Water Fish Culture – Pond Farm Structures and Layouts – Simple Methods for Aquaculture. FAO. Daya Publishing House, New Delhi.

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	9. Upadhyay, A. S. 1995. A Hand Book on Design, Construction and Equipments in Coastal Aquaculture (Shrimp Farming). Daya Publishing House, New Delhi.
Course outcome	On the successful completion of course, students will be able to CO1: Obtained the knowledge related to different farming practices and culture methods in the aquaculture. CO2: Identify the suitable sites for aqua farming and hatchery construction. CO3: Understand the basics of design and construction of aqua farms CO4: Learn about the selection of suitable species for aquaculture.

Outcome Mapping:

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO1 5	PSO6	PSO7	PSO8	PSO9
CO1	3		3	3	3				3					3
CO2	2								3					3
CO3	3								3					3
CO4	3		2						3					3

Low:1, Medium:2, High:3

PRACTICAL-I: PAPER: 101 & PAPER: 103A/103B

PRACTICAL-II: PAPER: 102 & PAPER: 104A/104B

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PRACTICALS: 22RMAB 101: INTRODUCTION TO MARINE BIOLOGY

1. Enumeration and identification of phytoplankton.
2. Zooplankton species- composition and identification.
3. Primary productivity estimation: Light and dark bottle technique.
4. Estimation of dissolved oxygen by Winkler's method.
5. Estimation of Chlorophyll in the different water samples.
6. Estimation of total alkalinity in the different water samples.
7. Identification of locally available Aquatic weeds
8. Identification of Mangrove plants
9. Field Visit: Observation of shore environment, Collection and analysis of samples and submission of report.

PRACTICALS: 22RMAB 102: BIOLOGICAL OCEANOGRAPHY

1. Identification of Phytoplankton-Diatoms ,Dinoflagellates, Blue green algae
2. Estimation of salinity in different water samples
3. Estimation of transparency in different aquatic bodies.
4. Identification of locally available Seaweeds and Mangrove plants
5. Methods of collection & Identification of sandy shore fauna.
6. Estimation of Total Dissolved organic matter in different water samples
7. Estimationofchlorophyllcontentindifferentmarineandbrackishwatersamples.
8. Identification of rocky, sandy and muddy shore fauna
9. Identification and observation of estuarine flora and fauna
10. Fieldtrip–Observation and Identification of Mangroves near Nellore coast and submission of field report with herbarium sheets.
    b) Visit to sandy shore for observation and identification of fauna

PRACTICALS: MAB 103A: MARINE INVERTEBRATES

1. Identification of selected Invertebrate species.
2. Appendages of Shrimp.
3. Dissection and display of digestive system of Shrimp.
4. Dissection and display of Nervous system of Shrimp.
5. Isolation of X-organ in Shrimp.
6. Identification of coastal invertebrate fauna.
7. Larval stages of Shrimp.
8. Anatomy of gastropod and bivalve.
9. Identification of minor phyla.
10. Mounting of gastropod radula.

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PRACTICALS: MAB 103B: MARINE ECOLOGY

1. Enumeration and identification of phytoplankton.
2. Zooplankton species- composition and identification.
3. Primary productivity estimation: Light and dark bottle technique.
4. Estimation of dissolved oxygen by Winkler's method.
5. Estimation of salinity in different estuarine and coastal waters.
6. Determination of Nitrite, Nitrate and Ammonia in the water samples.
7. Determination of silicates in the water samples.
8. Identification of rocky, sandy, free floating and estuarine fauna.
9. Identification of locally available Aquatic weed sand Mangrove plants
10. Field Visit: Observation of sandy shore environment, Collection of samples and submission of report.

PRACTICALS: MAB 104A: MARINE VERTEBRATES

1. Identification of selected vertebrate species.
2. Dissection and display of digestive system of Fish.
3. Dissection and display of Reproductive system of Fish.
4. Slides of prochordates (Cephalochordata, Hemichordate and Urochordata).
5. Functional morphology of respiratory organs-gills of Fish.
6. Mounting of fish scales.
7. Isolation of fish Swim bladder.
8. Identification of fish tail fins.
9. Identification of different types caudal fins.
10. Fieldtrip – Identification of migratory birds at Pulicot, Nelapattu and submission of report.

PRACTICALS: MAB 104B: PRINCIPLES OF AQUACULTURE

1. Identification of different marine fin fishes
2. Identification of different shell fishes (Shrimps, Crabs etc.)
3. Identification of different fresh water fishes & prawns
4. Estimation of pH in the culture pond soils
5. Estimation of Alkalinity in the culture pond soils
6. Estimation of organic matter in the culture pond soils
7. Estimation of oxygen in shrimp/fish culture pond waters
8. Design and layout of shrimp/fish culture farm
9. Identification/ sketch design of different constructions of culture ponds
10. Field Visit: Visit to shrimp/fish culture ponds for observation of design and construction of culture ponds, drainage, and water distribution system.

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M.Sc. Marine Biology Syllabus

(For the students admitted during the academic year 2022-23onwards)

SECOND SEMESTER

Course Code & Title	**20RMAB 201: Physical & Chemical Oceanography**		
Programme	Marine Biology	Semester	II
Number of Credits	04	Number of Hours	60
Course Objectives	1. To develop the concepts about the chemistry of marine environment that concerns the study of the properties and interactions of substances present in the marine environment. 2. To understand the significance of dissolved gases in the sea transport of marine sediments. 3. To know the biology, geology and chemistry of the ocean, and its imperative to know different physical process. 4. To learn and handling of different types of Oceanographic instruments.		

UNIT	Content	Number of Hours
I	**Chemical composition of seawater**: Ionic composition of seawater, major and minor constituents, trace elements, their importance and distribution; Concept of chlorinity and salinity; Nitrogen, phosphorus and silicon cycles.	14
II	**Dissolved gases & Marine sediments**: Carbon dioxide system in the sea; oxygen in the sea, hydrogen sulphide, noble gases – methane. Origin and physical properties of sediments, classification of marine sediments; distribution and transport of sediments, organic matter in the marine sediments.	16
III	**Ocean dynamics**: Sub marine Topography, Ocean currents, forces causing surface and deep currents, trade winds and monsoon, wind driven and thermohaline circulation, Ekman spiral, waves-Tides.	14
IV	**Oceanographic Instruments**: Oceanographic instruments: Grabs (Petersen, Vanveen, Smith-McIntyre) for benthos collection, naturalist's dredge (Ekman, Sanders deep-sea anchor dredge), Plankton nets, Continuous plankton recorder, Multiple Plankton Sampling System; Reversing Nansen bottles, reversing thermometer, salinometer, bathythermograph, secchi disc, Ekman current meter, echosounders, CTD, underwater photographic equipment, SCUBA apparatus.	16

Reference Books	1. Sverdrup,H.U.,M.W.JohnsonandR.H.Flemming1958.TheOceans –their Physics, Chemistry and General Biology Prentice - Hall Inc. New Jersey. 2. Reading in Earth Sciences (vol.1toIII) 1975. Scientific American Resource Library. W.H. Freeman &Co. 3. McCormick, J.M. and J.V.Thiruvathakal, 1976. Elements of Oceanography. W.B. Saunders, Philadelphia. 4. Neshyba,S.1987. Oceanography: perspectives on a fluid earth. John Wiley &Sons. New York .

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	5. Gross,G".1993.Oceanography: A view of the earth (sixth edition). Prentice-HallInc.. New Jersy. 6. Pickard, G.L. andW.J.Emery,1995. Descriptive Physical Oceanography - an Introduction (fifth edition). Pergamon Press. London. 7. Stowe,K.,1996.ExploringOceanScience.JohnWileySonsInc. 8. HaroldV.Rhurman,1997. Introductory Oceanography. Prentice Hall Inc, New Jersy. 9. Duxbury,A.C., A.B.Duxbury and K.A.Sverdrup, 2000. An Introduction To The World's Oceans. Wm. C. Brown Publishers. 10. Natarajan, M .and T. Balasubramanian, 2001. Oceanographic Equipment's, Annamalai University.
Course outcome	On the successful completion of course, students will be able to CO1: Gettinga larger picture of a coupled ocean-atmosphere CO2: Identify the different process Involved in the controlling the marine ecosystem. CO3: Provide a comprehensive understanding of the properties of sea water CO4: Understand the interactions of the substances present in the marine environment. CO5: Learn about the usage and operation techniques of oceanographic instruments.

Outcome Mapping:

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO5	PSO6	PSO7	PSO8	PSO9
CO1	3				3			3	3		3			
CO2	3				3			3	3		3			
CO3	3				3			3	3		3			
CO4	3				3		3	3			3			
CO5	3	3			3		3				3			

Low:1, Medium:2, High:3

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Course Code & Title	22RMAB202: Fishery Science		
Programme	Marine Biology	Semester	II
Number of Credits	04	Number of Hours	60
Course Objectives	1. To know morphology, Classification and Life history of Indian fishes. 2. To understand the anatomy and reproductive system of Fishes. 3. To know population dynamics. 4. To understand Fishing technology.		

UNIT	Content	Number of Hours
I	**Eco-biology of fishes**: General morphology and classification of fishes – major groups of fishes in the world. General account of life history in Indian fishes: Sea bass, cobia. oil sardines, mackerel.	15
II	**Basic Anatomy and Reproduction 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.	15
III	**Population Dynamics**: Theory of fishing, unit stock, recruitment, growth, mortality, migration, fish tagging and marking. General account of major Marine fisheries of India, survey of fish eggs and larvae, analyzing population features. Length – weight relationship, condition factor.	16
IV	**Fishing Technology:** Principal methods of exploitation of sea fishes - indigenous and modern craft and gear. Evaluation of fishing craft: boat types and their classification; types of boats used in India; maintenance of fishing boats and control of marine fouling: classification of fishing gears; materials used in different types of fishing gear; fishing hooks and baits.	14

Reference Books

1. Lagler, K.F.. J.E. Bardach and R.R. Miller, 1962. Icthyology. John Wiley & Sons Inc., New York.
2. Carl E. Bond, 1979. Biology of Fishes. W.B. Saunders Company, Philadelphia.
3. Jones, E.R.H., 1980. Fish Migration. Edward Arnold Ltd.. London.
4. Bal, D.V. and K.V. Rao. 1990. Marine Fisheries of India. Tata McGraw Hill Publishing Company Limited, New York.
5. King, M., 1995. Fisheries Biology. Assessement and Management. Fishing News Books.
6. Biswas, K.P., 1996. A Text Book of Fish, Fisheries and Technology, II ED. Narendra Publishing House, Delhi. India.

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	7. Srivastava , C.B.L., 1999. Fish Biology. Narendra Publishing House, Delhi. 8. Shanmugam, K., 1990. Fishery Biology and Aquaculture. Leo Pathippagam, Madras, India. 9. Mohan Joseph, M and A.A.Jayaprakash, 2003. Status of Exploited Marine fishery resources of India, 308 pp 10. Dholakia, A.D., 2004. Fisheries and Aquatic resources of India, Daya Publishing House, Delhi.413 pp
Course outcome	At the end of the course the students would be able to CO1: Understand the morphology, Classification and identify the Different stages in the Life history of fishes. CO2: Identify the different systems, organs and their functions of Fishes. CO3: Calculate the length weight relationship in fishes. CO4: Identify the different types of boats and gears .

Outcome Mapping:

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO5	PSO6	PSO7	PSO8	PSO9
CO1	3	3		3		3					3			3
CO2	3	3				3					3			3
CO3	3	3				3		3						3
CO4	3							3	3		3			

Low:1, Medium:2, High:3

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Course Code & Title	20RMAB 203: Physiology and Biochemistry		
Programme	Marine Biology	Semester	II
Number of Credits	04	Number of Hours	60
Course Objectives	1. To know the Digestion and absorption mechanism, respiratory structures and functions. 2. To study endocrine glands and their secretions, osmoregulation mechanism and their adaptations. 3. To know Classification, structure and Functions of biomolecules. Classification and mechanism of enzyme action. 4. To understand the metabolism of carbohydrates, amino acids and fatty acid metabolism.		

UNIT	Content	Number of Hours
I	**Physiology of digestion and Respiration**: Digestion and absorption. Digestive enzymes and their role with food habits. Respiratory structures and functions - factors affecting respiration, structure and function of blood pigments, role of transport of O2 and CO2, Adaptations to hypoxia and anoxia.	15
II	**Endocrine systems and Osmoregulation**: Physiology of Endocrine system - hormones, neuro hormones, hormones of reproduction in fin fishes and shell fishes. Moulting in crustaceans. Physiology of ionic and osmoregulations- ions in body fluids, mechanism of ionic regulation, responses to osmotic conditions, typesof osmoregulatory adaptations	16
III	**Biomolecules:** Major biomolecules – classification, structure and function - carbohydrates, proteins, amino acids, lipids and fatty acids and Nucleic acids - Enzymes - nature, classification and mechanism of action, factors affecting enzyme activity.	14
IV	**Metabolism and Biosynthesis:** Metabolism of carbohydrates - Glycolysis, gluconeogenesis and citric acid cycle. Metabolism of amino acids - Nitrogen transamination, deamination and Urea cycle. Fatty acid metabolism- β – Oxidation.	15

Reference Books

1. ColinNicol,J.A.,1961.The Biology of Marine Animals. Sir Issac Pitman &Sons Ltd., London.
2. Conn,E.E.andP.K.Stumff,1963.Outline of Biochemistry.JohnWiley & Son Inc.,New York and London
3. Vernberg,W.B.andF.J.Vemberg,1972. Environmental Physiology of Marine Animals. Springer Verlag: New York
4. Prosser, C.L.,1973 .Comparative Animal Physiology .Saunder, Philadelphia.
5. Folk.G.E.,1974. Text Book of Environmental Physiology. Leans Fabiger

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	,Philadelphia. 6. Palmer,J .D.,F.A. Brown and L.N.Edmunds,1976.AnIntroductionof Biological Rhythms. Academic Press Inc.. New York. 7. Lehninger ,A. L.,D.L.NelsonandM.M.Cox,1993.PrinciplesofBiochemistry. CBS Publishers & Distributors, New Delhi. 8. Baldwin,E.,1996.DynamicAspectsofBiochemistry.CambridgeUniversitypress. London. P. 554. 9. Denniston,K. J., J.J. Topping and R.L.Caret, 2004. General .Organic and Biochemistry, 880 pp. 10. D. Land M.M.Cox,2005. Lehninger principles of Biochemistry,1119pp. 11. Bio chemistry by AVSS Rama Rao.
Course outcome	On the successful completion of course, students will be able to CO1: Know the Digestion and absorption mechanisms and their significance. Structure and functions of respiratory organs and transport of respiratory gases. CO2: Identify and Isolate the different endocrine glands. Functions of hormones. CO3: Knowing the Osmoregulatory mechanism in fishes. CO4: Understanding the different types of bimolecular and their role in metabolism and classification and mechanism of enzyme action. CO5: Find the metabolism of carbohydrates, amino acids and fatty acids.

Outcome Mapping:

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO5	PSO6	PSO7	PSO8	PSO9
CO1	3	3				3					3	3		
CO2	3	3				3			3			3		
CO3	3					3			3			3		
CO4						3			3			3		

Low:1, Medium:2, High:3

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Course Code & Title	22RMAB203B: Molecular Biology		
Programme	Marine Biology	Semester	II
Number of Credits	04	Number of Hours	60
Course Objectives	1. To provide comprehensive background of Salient features of Nucleic Acids and DNA model to the course learners. 2. To impart detailed understanding of key events of molecular biology comprising of mechanism of DNA Replication, Transcription and Translation in Prokaryotes and Eukaryotes. 3. To provide adequate knowledge about Post Transcriptional Modifications and Processing of Eukaryotic RNA to the course learners. 4. To give detailed explanation of Transcriptional Regulation with examples of lac operon and tryptophan operon in prokaryotic as well as eukaryotic organisms along with key concept of Gene Silencing to the course learners.		

UNIT	Content	Number of Hours
I	**Structure and Functions of Nucleic Acids**: The beginning of Molecular Biology; DNA: A carrier of genetic materials. Double Helical Structure of DNA-Watson-Crick model. Types of DNA- A-, B-, Z-, DNA; Supercoiled DNA, Structure of RNA:Types-tRNA, mRNA & rRNA. Unusual bases of Nucleic Acids. Functions of Nucleic acids. Genetic Code and its features.	14
II	**DNA replication and repair**: Enzymes and Protiensinvolved in DNA. Replication origin and Replication fork.Modelsof Replication.Mechanism of Replication in Eukaryotes. DNA damage and repair -Types of Repair mechanisms.	16
III	**Transcription &Translation**: Genetic code & its features, RNA polymerases. Steps involved in Transcription: Initiation, Elongation &Termination. Post transcriptional modifications. Overview of Translation, Steps involved in Transcription : Initiation, Elongation &Termination. Polysomes. Post translation modifications.	16
IV	**Gene Regulation**: Operon concept,lac operon,tryp operon,Ara Operon.Induction and Repression of Genes.	14

Reference Books	1. Bruce Alberts, Alexander Johnson. Julian Lewis, David Morgan, Martin Raff, Keith Roberts,Peter Walter. 2014. Molecular Biology of Cell. Garland Science publication. 2. Benjamin Lewin, Gene IX, 9th Edition, Jones and Barlett Publishers, 2007. 3. J.D. Watson, N.H. Hopkins, J.W Roberts, J. A. Seitz & A.M. Weiner; Molecular Biology 4. of the Gene, 6Th Edition, Benjamin Cummings Publishing Company Inc, 2007.

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	5. Thomas E. Creighton, Encyclopedia of Molecular Biology, 4 Volume Set 2898 pp, Wiley-Interscience, 1999. 6. Bruce Alberts , Alexander Johnson , Julian Lewis, Martin Raff , Keith Roberts and PeterWalter Molecular Biology of the Cell 1392pp, 2008. 7. Burton E. Tropp. 2012. Molecular Biology - Genes to Proteins. Jones and Bartlett Publishers. 8. David Frifelder. Molecular Biology.2008. Narosa publishing house, New Delhi. 2nd edition. Karp G. Cell and Molecular Biology: Concepts and Experiments. 2010. 6th edition, JohnWiley and Sons. Inc. 9. Introduction to Proteomics: Tools for New Biology Daniel C Liebler 1st Edition New York Humana Press,2001. 10. Discovering Genomics, Proteomics and Bioinformatic A. Malcolm Campbell , Laurie J. Heyer Benjamin Cummings; 2 edition (2006). 11.. Watson JD- Hopokins NH- Roberts JW- Steitz JA- Weiner A.M. 2004. Molecular Biology of Gene) Benjamin / Cummings Publishing Company. 12. George M. Malacinski. 2013. Freifeder's Essentials of Molecular Biology. Norosa PublishingHouse. 13.3. Sambaurthy AVSS. Molecular Biology.2008. Narosa publishing house, New Delhi
Course outcome	CO1 :The students will know the Nucleic Acids and DNA model at end of the course. CO2: The students should be able to explain and summarize the scientific principles of the molecular biology of DNA, RNA and understand the role played in overall functioning of the cell. CO3: Students obtained the knowledge about transcription and translation. CO4:By the end of the course, students will have the necessary learning to radically advance our understanding of life and transform

Outcome Mapping:

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO5	PSO6	PSO7	PSO8	PSO9
CO1	3		2					3	3				3	3
CO2	3		3	2				3	3				3	3
CO3	2		3					3	2				3	2
CO4	3							3	2				2	3

Low:1, Medium:2, High:3

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Course Code & Title	**20RMAB 204: Microbiology and Immunology**		
Programme	Marine Biology	Semester	II
Number of Credits	04	Number of Hours	60
Course Objectives	1. To understand the working principles of different types of Microscopes and study of different groups of Microorganisms- their cultivation, isolation and Identification. 2. To know the collection of Water, sediment and seafood samples. Identification of bacteria 3. To study the fundamental aspects of Immunology like types of Immunity, Immune cells and organs. 4. To know principles of the vaccine and Immunological techniques and their applications in contemporary scenario.		
UNIT	**Content**		**Number of Hours**
I	**Introduction to Microscopy and Marine Microbiology**: Study of cells using Microscopes (Bright-field and Electron microscope).General characters, Morphology and fine structure of bacteria, viruses, fungi, actinomycetis and cyanobacteria		15
II	**Methods in Microbiology**: Methods of studying marine microorganisms - collection of water, sediment and seafood samples, isolation and enumeration of bacteria - total and viable counts, identification of bacteria based on their morphological, physiological and biochemical characteristics.		15
III	**Immunology-fundamental concepts**: Organs and cells of the immune system- primary and secondary lymphoid organs. Immune system in marine invertebrates and vertebrates –specific and nonspecific, immune responses		15
IV	Vaccinology and Immunological Techniques: Vaccine technology -Active and passive immunity; Live, killed, attenuated, sub unit vaccines; recombinant DNA and protein based vaccines; Peptide vaccines, conjugate vaccines .Immunological techniques in the disease diagnosis – monoclonal antibodies and ELISA		15
Reference Books	1. Dube,H.C.,1994.A Text book of Fungi, Bacteria and Viruses, Vikas publishing House. 2. Lederberg,J..1992.Encyclopedia of Microbiology,Vol.1-4.,AcademicPress. 3. Pelzer,M.J.Jr.,Chan,E.C.S, and N.R.Kxeig.1993.Microbiology:Concepts and Applications. McGraw Hill Inc 4. General Microbiology by presscott 5. A Text Book of Microbiology by Anantha Narayana. 6. A text book of Immunology by Nandini settee. 7. Essential Immunology by Roitts 8. Immunology by Tizard Immunology by R. kollmann		
Course outcome	On the successful completion of course, students will be able to CO1: Learn about the basic principles of Microscopy and comparative characteristics of microorganisms like bacteria, viruses, fungi , algae.. CO2: They also understand some of the key fundamentals of Immunology		

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	and advances in Vaccine technology in coordinating with contemporary pandemic diseases like COVID-19 CO3: They will able to analyze and evaluate the efficacy of some important methods in Microbiology and their applications in identification of bacteria. CO4: Students will get awareness on the fundamental aspects of immune system; cell involved and also understands about how the immune system has evolved among different phyla.

Outcome Mapping:

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO5	PSO6	PSO7	PSO8	PSO9
CO1	3					3				3			3	
CO2	3	3				3				3			3	
CO3	3	3	3			3				3			3	
CO4	3		3			3				3			3	

Low:1, Medium:2, High:3

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Course Code & Title	22RMAB204B: Cell Biology		
Programme	Marine Biology	Semester	II
Number of Credits	04	Number of Hours	60
Course Objectives	1. To Know the basic components of Prokaryotic cell and Eukaryotic cells as well as understand and integrate relationship between structure and function at both molecular and cellular levels. 2. To know the structure and functions of cell organelles. 3. To understand the molecular events & regulations of cell cycle. 4. Understand cell signaling and how it regulates cellular functions.		

UNIT	Content	Number of Hours
I	**Introduction to cell:** History of cell Biology. Cell Theories. General Organization of Prokaryotic cell, General Organization of Eukaryotic cell.	14
II	**Cytoskeleton:** Structure of Microtubules and Microfilaments. Microtubular Organelles:cilia, flagella, and centrioles. Bio membranes: Structures and functions of cell membranes and nuclear membranes. Endomembrane system - Endoplasmic reticulum-General Morphology, biogenesis& Functions. Golgi Complex-General Morphology, biogenesis& Functions Cytochemistry& function. Mitochondria-General Morphology, biogenesis& Functions of Lysosomes & Peroxysomes.	16
III	**Overview of the cell cycle:** Mitosis and Meiosis: Regulation functions. Cell Cycle Control System and Cell Cycle Check points. Control of Cell Numbers and Cell Size-Role of Mitogens .Apoptosis - Programmed Cell Death. Biology of Cancer.	15
IV	**General principles of cell signaling:** Cell surface receptors: Types - Ion- Channel- Linked Receptors, G-protein linked receptors, Enzyme-Linked Receptors. Signaling Pathways/cascades-AMP, cAMP&Notch. Secondary messengers	15

Reference Books	
	1. B. Alberts, D. Bray, J. Lowis, K .Roberts and J.D. Watson, 1996. Molecular 2. Biology of the cell. Garland Publishing Inc., New York, 3. Sheller, D.E .Bianchi, 2002. Cell and Molecular biology 4. Cell and Molecular Biology De Robertis, E.D.P. and De Robertis E M F 5. Cell and Molecular Biology Garald Karp J. Wiley & Sons, NY 6. Cell Biology – Structure and Function David E. Sadawa, Jones and Barttett Pub., IND. 7. Cell Biology LabFaxG.B.Dealtry& D. Rickwood Bios Scientific Pub. 8. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology P.S.

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	Verma, V.K. Agarwal S. Chand Pub., N Delhi 9. Cell Growth and Division, A Practical Approach. R. Basega, IRL Press, Oxford Univ. Latest 10.Cell in Development and inheritance EB Wilson MacMilan, NY Latest
Course outcome	On the successful completion of course, students will be able to CO1: Identify and describe basic components of Prokaryotic Cell and Eukaryotic Cells. CO2: The structure and function of cellular compartmentalization. CO3: Understand the cell cycle and its regulation at various check-points. Students will know how cell numbers are maintained at the molecular and cellular levels, and how these processes are deregulated in various diseases. CO4: Understand the general principles of cellular signaling through cell-surface and intracellular receptors.

Outcome Mapping:

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO5	PSO6	PSO7	PSO8	PSO9
CO1	3			3	3	3		3	2				2	2
CO2	2			3	3	2		2	2				3	2
CO3	2			2	3	2		3					3	3
CO4	2			2	3	1		3					2	3

Low:1, Medium:2, High:3

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Course Code & Title	Personality enhancement & Leadership		
Programme		Semester	II
Number of Credits	00	Number of Hours	50
Course Objectives			
UNIT	Content		Number of Hours
I	INTRODUCTION TO PERSONALITY ENHANCEMENT- The concept personality- Dimensions of theories of Freud & Erickson-personality- Significant of personality development. the concept of success and failure: What is Success?- Hurdles in achieving success- Overcoming hurdles- Factors responsible for success- What is failure- Causes of failure- SWOT analyses.		12
II	ATTITUDE & MOTIVATION- Attitude- Concept- Significance- Factors affection attitudes- Positive attitude- advantages- Negative attitude- Disadvantages – ways to development positive attitude-Difference between personalities having positive and negative attitude. Concept of motivation- Significance –Internal and external motives- Importance of self- motivation- Factors leading to de-motivation.		12
III	SELF-ESTEEM- Term self-esteem- Symptoms- Advantages- Do's and Don'ts to develop positive self-esteem- Low self esteem- Symptoms- Personality having low self esteem- Positive and negative self-esteem. Interpersonal Relationships. Defining the difference between aggressive, submissive and assertive behaviours- Lateral thinking.		12
IV	INTRODUCTION TO LEADERSHIP- Definition and meaning, Importance, Leadership and Management, Leader vs Manager, Essential qualities of an effective leader. Theories of Leadershhip: Trait theory, Behavioral theories, Contingency theory.		10
V	LEADERSHIP CHARACERISTICS- Types of Leaders- Importance of Leadership- Leadership Skills- Building and Leading Efficient Teams- Leadership styles: Traditional, Transactional, Transformational, Inspirational and servant leadership and Emerging issues in leadership: Emotional Intelligence and leadership, Trust as a factor, Gender and Leadership. Leadership Qualities of Abraham Lincoln, Mahtma Gandhi, Prakasam pantulu, Dr. B.R. Ambedkar and J.R.D. Tata.		14
Reference Books	1. Girish Batra, Experiments in Leadership,Chennai,NotionPress,2018. 2. Mitesh Khatri, A waken the Leader in You, Mumbai, Jaiko publishing House, 2013. 3. Carnegie Dale, Become an Effective Leader,NewDelhi,Amaryllis,2012. 4. Hall.C.S.Lindzey.G&Campbell,J.B.Theories of personality, JohnWilley & Sons .1998.		

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	5. Organizational Behavior, M.Parikh and R.Gupta, Tata- McGraw-Hill Education Private Limited. 6. Organisational Behaviour, D.Nelson, J.C. Quick and P.Khandelwal, Cengage publication.
Course outcome	

Outcome Mapping:

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO5	PSO6	PSO7	PSO8	PSO9
CO1														
CO2														
CO3														
CO4														

Low:1, Medium:2, High:3

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PRACTICAL-I: PAPER: 201 & PAPER: 203

PRACTICAL-II: PAPER: 202 & PAPER: 204

PRACTICALS: MAB 201: PHYSICAL AND CHEMICAL OCEANOGRAPHY

1. Preparation of charts showing ocean topography with special reference to Indian Ocean and Bay of Bengal.
2. Oceanographic instruments, drawing sketches and familiarization with working.
3. Sediments: Analysis of textural classes.
4. Determination of temperature and pH in different water samples.
5. Estimation of Organic carbon in sediment soils.
6. Estimation of organic matter in different water samples.
7. Estimation of alkalinity in different water and soil samples.
8. Estimation of carbon dioxide in water samples.
9. Estimation of hardness in different water samples.
10. Estimation of Ammonia In different water samples.
11. Estimation of Chlorine content in different water samples.
12. Fieldtrip-observation and Identification of coastal environment near Nellore coast and submission of field report with sketch diagram.

PRACTICALS: MAB 202: FISHERY SCIENCE

1. Identification of common fish and shell fishes in South Andhra Coast.
2. Estimation of Gonado somatic Index(GSI) and fecundity in fishes
3. Determination of age using scale orotolith.
4. Biometric Analysis- morpho metric and meristic
5. Study of external morphology of fin fish and shell fish.
6. Identification of different types of fish scales.
7. Identification of types of fins in fishes
8. Observation of sensory organs in fishes
9. Estimation of gut content analysis in fin fish and shell fishes
10. Fieldtrip: Observation of fishing harbor and identification of different marine fish fauna and preparation of report.

PRACTICALS: MAB 203A: PHYSIOLOGY AND BIOCHEMISTRY

1. Oxygen consumption and metabolic rate in fin fishes.
2. Estimation of haemolymph chlorides with reference to salinity.
3. Effect of eyestalk ablation on oxygen consumption.
4. Quantitative estimation of glucose in blood and haemolymph.
5. Estimation of excretory ammonia with reference to different feeds
6. Estimation of proteins, carbohydrates and lipids in fish tissues
7. Effect size, sex and salinity on oxygen consumption in shell fishes.
8. Estimation of enzymes (amylase, protease and lipase)
9. Dissection : Isolation and identification of pituitary gland in fishes

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PRACTICALS: MAB 203B: MOLECULAR BIOLOGY

1. Quantitative analysis of Nucleic acids.
2. Isolation of DNA
3. Isolation of RNA
4. Estimation of DNA by Diphenylamine method.
5. Estimation of RNA by orcinol method.
6. Plasmid DNA isolation by alkaline lysis method.
7. Purification of DNA from an agarose gel.
8. PCR

PRACTICALS: MAB 204A: MICROBIOLOGY AND IMMUNOLOGY

1. Preparation of solid & liquid media, Differential and Selective media:
2. Isolation of bacteria from seawater/sediments and sea food samples, Serial dilution methods, enumeration plating.-Total and Viable counts
3. Maintenance of organisms: Streaking, slants and stabs cultures
4. Staining of bacteria-Simple staining, Negative staining, Gram's staining.
5. Isolation of Vibrio on TCBS agar
6. Isolation of pathogens from sea foods –Salmonella - shigella spp.
7. Cultivation of fungi: Slide, chunk and cover slip techniques
8. Study of morphology and cultural characteristics-Tease mounts
9. Preparation of cell suspension from fish lymphoid organs.
10. Determination of RBC and WBC count in the blood
11. Detection of antibodies, antigens through enzyme linked immunosorbant assay (ELISA).
12. Antibiotic sensitivity test.

PRACTICALS: MAB 204B: CELL BIOLOGY

1. To study prokaryotic cell by carrying out gram staining.
2. Preparation of cell fixation by using staining.
3. Estimation of Cell Viability & Cell Counting.
4. Preparation of Permanent slide.
5. Preparation of blood smear and differential staining of blood cells.
6. Preparation of divisional stages in Mitosis by the given Samples.
7. Study of divisional stages in Meiosis.
8. Isolation of Mitochondria.
9. Identification of Cell Organelles.

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M.Sc. Marine Biology Syllabus

(For the students admitted during the academic year 2022-23onwards)

THIRD SEMESTER

Course Code & Title	22RMAB301: Coastal Aquaculture		
Programme	Marine Biology	Semester	III
Number of Credits	04	Number of Hours	60
Course Objectives	1. This paper is planned to teach in the line s of understanding the candidate species of important cultivable fin and shell fishes. 2. To gaining knowledge in the food and feeding of cultivable species, artificial seed production through hatchery technology. 3. To acquaint technology related to farm management and their detailed methods of farming, disease and health management of shrimp species.		

UNIT	Content	Number of Hours
I	**Shrimp Hatchery Management**: Importance of Coastal Aqua culture – Global scenario, Present status of shrimp farming in India; natural collection and resources of shrimp seed. Shrimp hatchery management, techniques of induced breeding, larval rearing, packing and transportation. Selection criteria for shrimp seed; seed quality rating.	16
II	**Shrimp culture management**: Culture practices – traditional, extensive, semi- intensive and intensive; culture systems- monoculture and poly culture. Shrimp culture management – pre-stocking, stock and post stocking management – water quality management, feed management. Best management practices (BMP's) in shrimp farming.	14
III	Design and construction of shrimp farms and hatcheries: Selection of site; topography, water availability and supply, soil conditions. Design and layout of shrimp farms – water intake system, Drainage system. Design and construction of shrimp hatcheries; structure and construction, different accessories used in coastal aqua farms and hatcheries.	14
IV	Diseases and health management: Control of predators and parasites. Viral and bacterial diseases in shrimp - cause, symptoms, prophylactic and therapeutic treatments. Nutritional deficiency diseases, environmental stress diseases. Role of probiotics in diseases prevention. Disease diagnosis; microbiological , immunological and molecular diagnosis methods.	16
Reference Books	*1.* Pillay, T.V.R., 1990. Aquaculture - principles and Practices. Fishing News Books. *2.* Samuel Paulraj, 1994. Shrimp Farming Techniques: Problems and Solutions. Palani pub. *3.* Anand S., Upadhyay, 1995. Hand Book on Design, Construction and	

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	Equipments in Coastal Aquaculture. Blackie Academic Pub. 4. Stickney, 1995. Introduction to Aquaculture. John Wiley & Sons, New York. 5. Coche, G. and J.F. Muir, 1996. Simple Methods for Aquaculture Pond Construction for Freshwater Fish Culture : Pond farm structures and layouts. Daya Pub. 6. Conroydas, R. and L. Heruman, 1997. Text Book of Fish Disease. Narendra Pub. 7. John E. Bardach, 1997. Sustainable Aquaculture. John Wiley & Sons, New York. 8. James, W. Meade, 1998. Aquaculture Management, CBS pub., New Delhi. 9. Robert R. Stickney (ed.), 2000. Encyclopedia of Aquaculture. John Wiley and Sons, Inc., New York. 10. Joachim W. Hertrampft and Felicitas Piedad - Pascal, 2000. Hand Book on Ingredients for Aquaculture Feeds. Kluwer Academic Publishers, London
Course outcome	1. Knowledge on various culture practices and intensive management practices of shrimp P.monodon and L.vannamei. 2. Understanding on the culture methods and seed production of important cultivable shrimp species. 3. Learning about various diseases diagnosis and preventive/ treatment measures of disease.

Outcome Mapping:

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO5	PSO6	PSO7	PSO8	PSO9
CO1	3	3		3						3				3
CO2	3	3		3						3		3		
CO3	3	3		3						3				
CO4	3	3		3						3		3		

Low:1, Medium:2, High:3

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Course Code & Title	22RMAB302: Marine Pollution and Toxicology		
Programme	Marine Biology	Semester	III
Number of Credits	04	Number of Hours	60
Course Objectives	To know the key aspects of 1. Marine pollution, its impact on Marine Life, Eutrophication 2. Toxicological aspects associated with Marine life, like testing of toxicity, magnification etc. 3. Explain about the pollution in the marine ecosystem 4. Understand the different metal, thermal and radioactive pollution status of marine environment.		

UNIT	Content	Number of Hours
I	**Marine Pollution & Toxicology** : Marine pollution – definition – major pollutants – sources , transport path , dynamics. Toxicology – lethal and sub lethal effects of pollutants to marine organisms, bio concentrations, bioaccumulation and biomagnifications – methods of toxicity testing, factors influencing toxicity – synergistic and antagonistic effects.	14
II	**Sewage and plastic pollution**: Sewage pollution – industrial, agricultural and domestic, impact on marine environment treatment methods. Eutrophication and ecological significance. Plastics and litter; source and impact in the marine environment.	14
III	**Heavy metal and pesticide pollution** : Heavy metal pollution – sources, distribution , ecological impacts and analytical approaches; pesticide pollution – classification, sources , distribution, and ecological impacts with special reference to marine fishes, birds and mammals.	16
IV	**Oil, Thermal and Radioactive Pollution** : Oil Pollution – composition, sources, biological impacts on fishes, birds, mammals, Treatment techniques. Thermal pollution- sources and ecological impacts. Radio active pollution – sources (natural and artificial) biological effects of radiation.	16

Reference Books	1. Clark R.B 1992. Marine pollution 3rd edition Clavendron, Press Oxford. 2. Williams 1996. Introduction to Marine Pollution Control. John Wiley. 3. Michael J. Kennish 1994. Practical Handbook on Estuarine and Marine Pollution 4. Johnston, R. (ed), 1976. Marine Pollution, Academic Press, London. 5. Goldberg, E. D. 1974. The Health of the oceans, UNESCO Press. Paris. 6. Park, P .K, Kester D.R., J.W. Deudall and B.H Ketchum, 1983. Wastes in the Ocean. Vols. 1 to 3. Wiley Inter science Publishers, New York.
Course outcome	CO1: Students will learn about the impact of Marine Pollution. CO2: Understand about the Marine biota and its significance in the marine Environment. CO3: Learn about the different pollutants disturbing the marine ecosystem.

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	CO4: Identify about the plastic, oil, pesticides and Heavy metals pollution on flora and fauna of Marine environment.

Outcome Mapping:

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO5	PSO6	PSO7	PSO8	PSO9
CO1	3		3				3		3					3
CO2	3		3				3				3			3
CO3		3					3			3	3			
CO4							3		3		3			

Low:1, Medium:2, High:3

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Course Code & Title	22RMAB303A: Fish Nutrition and Feed Technology		
Programme	Marine Biology	Semester	III
Number of Credits	04	Number of Hours	60
Course Objectives	1. To know the nutritional requirement of shell fish, Finfish and significance of live feed in aquaculture 2. To know the food and feeding habits of prawns ,shrimp, fish and crab. 3. To understand feed processing methods and feed quality testing. 4. To know different types of feeding methods		

UNIT	Content	Number of Hours
I	**Fish Nutrition & Live feed culture** : Nutritional requirements, Nutritive needs of fin fish and shell fish with special reference to shrimp, prawn and crab; natural feed and live feed. Spirulina, Azolla; rotifers (Brachionus and moina), copipods and artemia.	16
II	**Food and Feeding habits** : Types of food – basic food , secondary food , incidental food, obligatory food ; feeding habits – detritivores, scavengers, herbivores, omnivores, carnivores, surface feeders, column feeders, bottom feeders ; feeding strategies ; food and feeding habits of prawns, shrimps, crabs and brackish water fishes.	14
III	**Feed production technology** : Suspplimentary feed and formulations; feed ingredients; water stability of feeds ; use of attractants in feeds; feed additives ; binders; processing of feeds (importance of anabolic agents, antioxidants and mould inhibitors; anti nutritional factor) ; determination of proximate composition in feeds; shrimp feed mill design; feed manufacturing, process and preparation protocol.	16
IV	**Feeding and Feed management** : Feeding and shrimp production ; water quality and feeding rates; feeding devises; feeding methods – manual , mechanical and automatic feeding ; relationship between feeding and growth; feed ratio and feeding schedule; check tray monitoring; feed management in shrimp (*Penaeus monodon*, *P. vennamei*).	14
Reference Books	1. Halver, J. E. 1972. Fish Nutrition. Academic Press, New York. 2. Sena, S. De Silva and Trever A. Anderson. Fish Nutrition in Aquaculture, Chapman & Hall London. 1998, p. 319. 3. Lovell, J. 1989. Nutrition and Feeding of Fish. Von Nostrand. 4. MPEDA, 1990. Hand Book on Aquafarming – Live feed. 5. MPEDA, 1990. Hand Book on Aquafarming – Aquaculture feed. 6. MPEDA 1990. Aquaculture Engineering and Water Quality Management. Cochin, India. 7. Pillay, T. V. R. Aquaculture : Principles and Practices. Fishing News	

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	Books. 8. Jhingran, V. G. 1985. Fish and Fisheries of India. Hindustan Publishing Corporation, New Delhi. 9. Boyd, C. E. 1982. Water Quality Management for Pond Fish Culture. Elsevier Science Publishers. 10. Chakroff, M. 1993. Freshwater Fish Pond Culture and Management. Daya Publishing House, New Delhi. 11. Pillay, T. V. R. and W. A. Dill. 1979. Advances in Aquaculture. Fishing News Books Ltd
Course outcome	At the end of the course the students would be able to 1. Understand the nutritional requirement of shellfish , finfish and learn live feed 2. culture 3. Understand the feeding habits of prawns, shrimp, fish and crab. 4. Learn to test the quality of feed and understand feed processing method. 5. Learn feeding schedule and check tray monitoring

Outcome Mapping:

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO5	PSO6	PSO7	PSO8	PSO9
CO1	3	3		3		3								3
CO2	3	3		3		3							3	
CO3	3	3		3		3								3
CO4	3	3		3		3								3

Low:1, Medium:2, High:3

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Course Code & Title	22RMAB303B: MARINE BIODIVERSITY		
Programme	Marine Biology	Semester	III
Number of Credits	04	Number of Hours	60
Course Objectives	1. To know the Marine Biodiversity conservation and significance, 2. To create knowledge about threats to Marine Biodiversity 3. To understand biodiversity conservation strategies, policies and legislations. 4. To understand the marine conservation strategies.		

UNIT	Content	Number of Hours
I	Introduction to Marine Biodiversity: Origin of conservation biology, divisions of biodiversity, Understanding the marine biodiversity and conservation, keystone species, ecosystem functioning, world's marine biological diversity, marine hot spots-cold species, hydrothermal hotspots, marine biosphere reserves and their importance in India, Values of biodiversity-ecological, economic, ethical, and conservation feasibility values.	15
II	Threats to Marine Biodiversity: Species diversity, species richness, species evenneus, factors affecting species diversity. Biodiversity with reference to mangroves and coral reefs. Species extinction vulnerability to extinction, habitat destruction degradation and fragmentation with reference to coral reefs and mangroves, maximum sustainable yield (MSY), alien species, global climate change-coral bleaching	15
III	Conservation Strategies: Importance of conservation, IUCN and their importance, various conservation strategies- germplasm banks, cryptoreservation, marine protected areas, sea ranching, mesh size regulation, TED, fishing holidays, conservation and development at national international level	15
IV	Conservation policies and Legislations : Various legislations and regulations in conservation of marine biodiversity the role of MoEn and Finconservation, NGO's involvement in conservation and various case studies related to coastal marine conservation science and policy with reference to Indian maritime states	15
Reference Books	1. Biodiversity measurement and estimation. Chapman & Hall, 140pp. Qubiroga, H.,2006. 2. Marine biodiversity, SPkringer,353pp. Richard B.Primack., m2002. 3. Essential of conservation biology-32rdedition,simauer assoc.Inc.Pub., USA, 698pp. Ruth,2002. 4. Dynamic modeling for marine conservation. Springer ,446pp, Singh, J.S.,S.P.SinghadS. R. Guptha.,2006.	

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	5. Ecology, Environment and Resource conservation., Anamaya pub., NewDelhi, 688pp.
Course outcome	On the successful completion of course, students will be able to CO1: Understand the Marine Biodiversity Conservation and its significance CO2: Understand and Identify threats to Marine Biodiversity CO3: Know the Biodiversity conservation strategies, polices and Legislations involved in Biodiversity conservation. CO4: Explain the marine conservation strategies.

Outcome Mapping:

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO1 5	PSO6	PSO7	PSO8	PSO9
CO1	3								3	3	3			3
CO2	3								3	3	3			3
CO3	3								3	3	3			3
CO4	3	3							3	3	3			3

Low:1, Medium:2, High:3

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PRACTICAL-I: Core & Generic Elective

22RMAB301P: COASTAL AQUACULTURE

1. Dissection of digestive and reproductive systems of fish and shrimp.
2. Identification of eggs, larvae of cultivable shrimp species.
3. Identification of live feed (rotifers, copepods and artemia).
4. Identification of Commercially important fish and shell fish.
5. External examination of diseased fin fish and shell fish.
6. Isolation of vibrio bacteria from shrimp culture pond water
7. Observation of seed quality in shrimp
8. Estimation of plankton density in shrimp culture ponds
9. Identification of different diseases in shrimp culture ponds
10. Fieldtrip: Observation of shrimp farm and preparation of report by gathering information from the farmer/owner of the farm.

22RMAB302P: Marine Pollution and Toxicology

1. Estimation of LC50 and LD50 values
2. Estimation of BOD
3. Estimation of COD
4. Estimation of Heavy metals/ Pesticide residues.
5. Estimation of antibiotic residues from Marine biota
6. Fieldtrip: Evaluation of pollution status in EEZ of different marine environment

22RMAB303 (A)P: FISH NUTRITION AND FEED TECHNOLOGY

1. Estimation of fiber and ash content in fish feeds.
2. Identification of live feed organisms (Chetoceros, artemea, skeletonetc)
3. Proximate analysis of feeds fish & shrimp (moisture, CHO, protein, fat, ash, Mineral)
4. Estimation of water stability of feeds.
5. Formulation and preparation of artificial feeds for fin fish and shrimps
6. Identification of different feeds used in shrimp /fish farming
7. Assessment of feed quality
8. Fieldtrip: Visit to Shrimp feed mill and quality control lab and preparation of report with observation of different sections in feed mill.

22RMAB 303 (B)P: MARINE BIODIVERSITY

1. Identification of marine bioactive compounds
2. Identification of marine floral communities
3. Identification of marine fauna communities
4. Quantification of faunal changes in marine water
5. Observation of marine biodiversity hotspots
6. Identification of estuarine fauna
7. Identification of different types of mangroves
8. Identification of marine endangered species
9. Environmental impact Assessment of coastal areas
10. Field visit: Visit to various marine ecosystems to study marine biodiversity and to collect specimens.

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Course Code & Title	22RMAB305: Fish Processing Technology		
Programme	Marine Biology	Semester	III
Number of Credits	04	Number of Hours	60
Course Objectives	1. To understand the Biochemical composition as well as the nutritional and medicinal value of shellfish and raw fish. 2. To understand the fish decomposition and post – mortem changes and rigor mortis,causes of spoilage in fishes especially enzymatic spoilage, microbial spoilage,chemical spoilage, and identification and isolation of common bacteria from spoiled fishes. 3. To understand the principle and different types of fish preservation methods and changes during the freezing method of preservation and problems during the storage of fishes. 4. To understand the fish byproducts and their extraction methods from fishes and their uses for humans.		

UNIT	Content	Number of Hours
I	**Biochemical composition of raw fish and shellfish** : The nutritive and medicinal values of fish, protein, fat, carbohydrates, moisture, ash, fish oils, minerals, vitamins etc ; nutritional value of preserved and processed fish.	15
II	**Fish decomposition (Post-mortem changes and Rigor mortis)**: Post- mortem changes and Rigor mortis; decay spoilage of fish – enzymatic spoilage, microbial spoilage, bacterial spoilage, chemical spoilage, factors of fish spoilage; effects of temperature on spoilage; intoxications and food poisoning from fish.	15
III	**Fish preservation** : Principles of preservation; methods of preservation- canning , curing, freezing- techniques of freezing, different types of freezers, changes during freezing and storage of fish; Industrial methods of freezing fish and shell fish; problems in fish preservations; fish preservatives.	16
IV	**Fish byproducts** : Methods of extraction of fish liver oil; processing of fish meal, fish silage, fish sausages, fish manure and guano; Chitosan, chitin , pearl essence, Isinglass, Fish leather, Fish Caviar, Fish Macaroni.	14

Reference Books	1. R.R. Colwell (ed): Biotechnology in Marine Science, 1982. 2. Aitikin, A: Fish handling & processing 2nd edition, Min. Agr. Fish and Food, U.K.,1982. 3. Borgstorm, G. : Fish as Food Vol. I, III and IV, Academic Press, 1961, 1965 4. Brandi, A.V.: Fish catching methods of the World, 3rd edition, Fishing News Books ltd. 1984. 5. Connel, J.J.: Control of Fish Quality, Fishing News Books Ltd., 1975. 6. Sanisburry, J.C.: Commercial Fishing Methods, Fishing News Books Ltd., 1971. 7. C.B.L.Srivastava.: A text book of Fishery Science and Indian Fisheries, Kitab Mahal Agencies, 2002

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Course outcome	By the completion of the course the students should able to – 1. Describe the significance of major nutrients (Proteins, Fats, Carbohydrates, Moisture,) and Minor nutrients (Minerals, Vitamins, Fish oils, and Ash) and Nutritional value of preserved and processed fish. 2. Identify and recognize the difference between fresh fish and spoiled fish and also learned causative agents of fish spoilage (intrinsic and extrinsic factors). 3. Describe canning, curing, freezing, different types of fish preservatives, and problems during fish preservation. 4. Classify the fish byproducts with reference to liver oil fish manure, fish meal, etc and their uses for a human being (pharmacy, hormones, vitamins, and cosmetics, etc).

Outcome Mapping:

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO5	PSO6	PSO7	PSO8	PSO9
CO1	3	3		3		3						3		3
CO2	3	3		3		3						3		
CO3	3	3		3		3						3		
CO4	3	3		3		3						3		

Low:1, Medium:2, High:3

PRACTICAL-II: Fish Processing Technology

1. Assessment of fish freshness by hypoxanthine measurement.
2. Estimation of salt content in dried fish
3. Estimation of moisture content in fish tissues
4. Determination of edible muscle in fish
5. Assessment of freshness for selecting fish
6. Estimation of volatile reducing substances (VRS) in assessment of fish spoilage.
7. Estimationof α–amino nitrogen in spoilage of fish muscle.
8. Isolation of vibrio bacteria from sea foods.
9. Estimationoftotalproteins,carbohydratesandlipidsinfinfishandshellfish samples
10. Fieldtrip:Observationofseafoodprocessingplantandpreparationofreport
11. Fieldtrip: Visit to MPEDA/NACSA and other quality control lab

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Course Code & Title	22RMAB306A: Coastal Disaster Management		
Programme	Marine Biology	Semester	III
Number of Credits	04	Number of Hours	60
Course Objectives	1. To know disaster cycle–risk and vulnerability 2. To study different types of natural and Hydrological hazards 3. To know the principle s of Disaster relief and recovery. 4. To understand planning of Disaster Management.		

UNIT	Content	Number of Hours
I	**Introduction to Disaster Management :** Definition Disaster- Communication and dissemination of disaster of related information land awareness generation : institutional framework and financial management- Disaster cycle- risk and vulnerability- vulnerability Atlas of India	15
II	**Natural and Hydroligical Hazards:** Hazard definition–Types of hazard, Seismic hazard: Earthquake, Landslide, volcano: Coastal hazard : Tsunami, strom surge, Erosion : Hydrological hazards- Floods, Drought. Meteorological hazard: Cyclone: Thunder storms, Lightning, Meteorites, Nature fire hazard.	15
III	**Disaster Relief and Recovery :** Basic principles of disaster recovery: steps for disaster recovery planning: Disaster Recovery among stack holders : organizing disaster recovery team: role of Information Technology in disaster management: Budget for disaster recovery.	15
IV	**Planning of Disaster Management:** Role of Early warning System /(EWS)Disaster Management : Risk assessment : Role of Government agencies for CRZ regulation an implementation of management plans : Early warning system for cyclone, Tsunami, stork surge, earthquake: Studies on impact of long term disasters like Sea level rise, global warnings in peninsular and Island Nations. Mock drill.	15

Reference Books	
	1. Ghosh, G.K. Disaster Management , Macmillan, New Delhi. 2. Sathis Modh, Introduction to disaster management ,Macmillan, New delhi. 3. Sharma, R.K.& Sharma. G2005(ed) Natural disaster APH publishing corporations, Newdelhi. 4. Bryant Edwards 2005: Natural hazard, Cambridge University press UK. 5. Sinha , P.C. 2011. Introduction to disaster Management. Anmol

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	publication. 6. Goesl. S.L. Disaster administration and management, 2007. Deep& Deep publication pvt. Ltd. 7. Srivatsava .H.N and Gupta, G.D. 2006. Management of natural disasters in developing countries. Daya publications. 8. Bryant Edwards 2005.Natural hazard, Cambridge University press UK. 9. UNDRO mitigation natural disaster: Phenomena, effect and options. United Nations, NewYork1991.
Course outcome	On the successful completion of course, students will be able to CO1: Understand the Disaster cycle and risk vulnerability CO2:Underst and the different types of natural and Hydrological hazards CO3:KnowtheprinciplesofDisasterreliefandrecoveryandparticipate in disaster relief Measures CO4: Understand early warning system for disaster and disseminate the information to stack holders.

Outcome Mapping:

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO5	PSO6	PSO7	PSO8	PSO9
CO1	3								3	3	3			3
CO2	3								3	3	3			3
CO3	3								3	3	3			3
CO4	3	3							3	3	3			3

Low:1, Medium:2, High:3

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Course Code & Title	22RMAB306B: Ornamental Fish Culture		
Programme	Marine Biology	Semester	III
Number of Credits	04	Number of Hours	60
Course Objectives	1. To know the ornamental fish culture and their Importance 2. To know the collection of fresh water and marine ornamental fishes, transportation of live ornamental fishes. 3. To understand the setting, construction and maintenance of Aquarium. 4. To know Nutrition and health management of Ornamental fishes.		

UNIT	Content	Number of Hours
I	**Fresh water Ornamental fishes**: Importance of fresh water ornamental fish culture in India; ornamental fisheries –word scenario; Fresh water ornamental species-live bearers, egg layers; Breeding of ornamental fishes-maturation, spawning ,hatching, larval raring; Feeding-larval and adult feeds; Induced breeding in ornamental fishes	14
II	**Marine Ornamental fishes**: Biology of different marine ornamental fishes; methods of collection of marine ornamental fishes; transportation of live marine ornamental fishes-use of sedatives etc.; marine ornamental organisms- lobsters, starfishes, octopus etc.	16
III	**Setting ,construction and maintenance of Aquarium** : Materials used for setting of aquarium- Gravel, pebbles, stones, other materials, aquarium plants; ornamental objects; selection of species for aquarium; Construction- materials used- wooden, metal frames, sealants and gums, aerators, filters, hand nets and other equipments; design and construction of aquarium	15
IV	**Nutritional requirements and health management**: Different kinds of feeds; culture of food organisms; preparation of dry feeds; feeding methods; Common diseases-Viral, bacterial, fungal and external parasitic diseases; prophylactic and therapeutic treatments; chemicals and disinfectants used in aquariums; Aquarium management-cleaning, maintenance of water quality.	15

Reference Books	1. R. Santhanam. 1987. A Manual of Freshwater Aquaculture, Oxford X IBH. 2. V. Satyanarayana. 1996. Fish culture, Narendra Publishing House. 3. P. K. Talwar and A. G. Jhingran 1991. Indian Fishes, Oxford & IBH 4. Q. J. Shammi and S. Bhatnagar. 2002. Applied Fisheries, Agrobios (India) 5. V. K. Dey, 1986. Ornamental Fishes. MPEDA.
Course outcome	On the successful completion of course, students will be able to CO1: Understand the culture technology of the ornamental fishes CO2: Know the collection and transportation of live ornamental fishes.

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	CO3: Handle and setting and maintenance of Aquarium. CO4: Understand the nutritional requirement and health management of different ornamental fishes.

Outcome Mapping:

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO5	PSO6	PSO7	PSO8	PSO9
CO1	3	3		3		3							3	3
CO2	3	3		3		3								3
CO3	3			3		3							3	3
CO4	3			3		3						3	3	3

Low:1, Medium:2, High:3

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Course Code & Title	22RMAB306C: Aquaculture Biotechnology		
Programme	Marine Biology	Semester	III
Number of Credits	04	Number of Hours	60
Course Objectives	To provide an overview of the application of biotechnological tools in aquaculture To learn the technological inventions in health management of fish/shrimp To acquire the knowledge related to nutritional and feed technology in aquaculture To know the knowledge in the applications of biotechnology in fish breeding.		

UNIT	Content	Number of Hours
I	**Genetic Engineering:** ls of genetic engineering: cloning vectors, restriction endonucleases, DNA ligases, topoisomerases, methylases, nucleases, polymerases, reverse transcriptase and their functions; Transgenics: Principles of Transgenic technology and its applications in fisheries; Transgenesis in fish; Biosafty regulations and ethics in transgenesis.	15
II	**Nutritional Biotechnology**: Biofilms, Biofloc, Single cell protein, Bio-encapsulated feeds, Nutraceuticals, Nutrigenomics; Mycotoxins and their effects on feeds; Biotechnological approaches for production of important microalgae; Spirulina culture.	15
III	**Fish breeding Techniques:** Synthetic hormones for induced breeding – GnRH analogue structure and function; Selective breeding for improving fish stocks - hybridization in Indian fishes; Androgenesis; Gynogenesis; Polyploidy and Sex reversal; Cryopreservation of gametes and embryos.	16
IV	**Disease diagnostic techniques:** Disease diagnosis techniques using PCR, ELISA etc. and microbial techniques; Aquaculture Probitics and Prebiotics; immunostimulents.	14

Reference Books

1. Dunham, R. A., (2004) Aquaculture and Fisheries Biotechnology: Genetic Approaches. CABI Publishing, Cambridge, USA. 385 pp.
2. Borowitzka, M.A. & Borowitzka, L.J. (1988) Micro-algal Biotechnology. Cambridge University Press, London, UK, 488 pp.
3. Chen, F. &Jiang, Y. (2001) Algae and their Biotechnological Potential. Springer Netherlands, 306 pp.
4. Gordon R. & Seckbach J. (2012) The Science of Algal Fuels. Springer Netherlands, 506 pp.
5. Lakra. W.S (2004) "Fisheries Biotechnology" Narendra Publishing House, New Delhi, 240 pp.
6. Felix S. 2007. *Molecular Diagnostic Biotechnology in Aquaculture*. Daya Publ. House.
7. Pandian TJ, Strüssmann CA & Marian MP. 2005. *Fish Genetics and Aquaculture Biotechnology*. Science Publications.
8. Singh B. 2006. *Marine Biotechnology and Aquaculture* Development. Daya Publ. House

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Course outcome	On the successful completion of course, students will be able to CO1: Analyze the transgenic technology and its applications in fisheries CO2: Understand the feed technology for manufacturing different types of Feeds used in aquaculture systems. CO3: Identify the Induced breeding technique by using synthetic hormones in fish /shrimp CO4: Acquainted the knowledge related to disease diagnostic techniques in the aquaculture practice

Outcome Mapping:

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO5	PSO6	PSO7	PSO8	PSO9
CO1	3		3	3				3	3				3	3
CO2	3		3	3	3			3	3				3	3
CO3	3		2	3	2			2	2				2	3
CO4	3		2	2				2	2				2	3

Low:1, Medium:2, High:3

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M.Sc. Marine Biology Syllabus

(For the students admitted during the academic year 2022-23onwards)

FOURTH SEMESTER

Course Code & Title	22RMAB401: Marine Biotechnology		
Programme	Marine Biology	Semester	IV
Number of Credits	04	Number of Hours	60
Course Objectives	1. To provide comprehensive background of Salient features of Environment, Aquaculture and marine science course learners. 2. It gives the knowledge on Bioactive products from the marine Organisms. 3. It Ensures the products from from marine Algae . 4. It studies the different types of Marine Enzymes.		

UNIT	Content	Number of Hours
I	**History of Marine Biotechnology:** Biotechnology in marine science. Application in aquaculture, Environment protection and pharmaceuticals, Biofuels, Marine cements, Biominerals, Antifouling Agents.	14
II	**Bioactive Marine Natural Products:** Marine Bioactive Compounds: Isolation Purification and Characterisation of Marine natural Products, source of Marine Bioactive Compounds, Antitumor, Cytotoxic, Anti-inflammatory, Anti-Pyretic, Antiviral	16
III	**Algal Biotechnology:** Production of useful products by Marine Algae, Single Cell Protein (SCP), Agar, Agarose, Carrageen, Alginates, Hydrocolloids, Algal Lipids. Micro algal mass cultivation Technology-Open culture system and photobioreactors. CO_2 Fixation by Micro algae.	16
IV	**Marine Enzymes:** Diversity of Marine enzymes. Oxido-Reductase, Hydrolases, Transferases.Marine Extremophyles as a resource of Biocatalysts. Cellulases, Chitinases, Starch Processings, Proteolytic Enzymes, Lipases, Amides, Polymerases, Ligases	14

Reference Books	1. Italy, E (Eds). 1998, New Developments in Marine Biotechnology, Plenum Pub. Corp. 2. Milton Fingerman and RachakondaNagabhushanam, 1996, Molecular Genetics of Marine Organisms, Science Pub Inc. 3. Y. Le Gal and H.O.Halvorson 1998, New Developments in Marine Biotechnology. Springer. 4. David H. Attaway, 2001. Marine Biotechnology, Volume 1, Pharmaceutical and Bioactive Natural Products. 5. Rita R. Colwell 1984. Biotechnology in the Marine Sciences (Advances in Marine Science & Biotechnology) Wiley Interscience. 6. Scheupr, P.J. (Ed.), 1984. Chemistry of Marine Natural Products, ,Chemical and Biological Perspectives. Vol. I III, Academic Press, New York.
Course outcome	On the successful completion of course, students will be able to CO1: The students gets the knowledge about environment studies of marine biotechnology.

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	CO2: They gain about different types bioactive compounds from marine organisms. CO3: By the end of the course they will get full knowledge on marine algae. CO4: Students knows different types of Enzymes from marine.

Outcome Mapping:

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO5	PSO6	PSO7	PSO8	PSO9
CO1	3	3	3							3		3		
CO2	3	3		3		3				3		3		
CO3		3		3						3		3		
CO4		3		3		3				3		3		

Low:1, Medium:2, High:3

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Course Code & Title	22RMAB402: Ocean Management and Remote Sensing		
Programme	Marine Biology	Semester	IV
Number of Credits	04	Number of Hours	60
Course Objectives	1. Students will be exposed to different satellite data and technology and its application on ocean and coastal studies 2. To study the coastal hazards, risk assessment and disaster management strategies. 3. To study the principles and applications of remote sensing and types of sensors and their applications. 4. To explain about the law of the sea and national, international organizations in ocean management.		

UNIT	Content	Number of Hours
I	**Ocean Management:** Introduction – Law of the Sea- EEZ and its significance – Role of national and International agencies and organizations in ocean management: FAO, UNEP, DOD, UNCED. Major oceans and their importance	14
II	**Coastal Zone Management and Issues:** Coastal zone – definition and importance – Coastal developmental activities: Mariculture, tourism,shore front construction sand their impacts–National and global problems: loss of habitats, sea level change, Coastal Biodiversity – Endangered species, protected areas, Marine Biosphere Reserve, UNCED.	15
III	**Remote Sensing:** Introduction – Basic principles of remote sensing and Aerial Photography - Satellites and airborne remote sensing, Remote sensing techniques for identification of fishing grounds, coastal and ocean resource assessment-Mangroves - coral reefs and other pollution assessment. SST, Phytoplankton assessment	16
IV	**Disaster management:** Communication and dissemination of disaster related information and awareness generation – Disaster cycle – Definition of hazard, risk, vulnerability; Risk assessment .Relief and Response – search and Rescue (SAR) First aid, shelter management, drinking water, electricity; rehabilitation – environmental problem of Rehabilitaiton ; Disaster Recovery.	15

Reference Books

1. Goldberg,E.D..1976. The Health of the Ocean .UNESCOPress. Paris.172pp.
2. Borgese.EM. and N. Ginsburg.1979 -1996. Ocean year books1-12vols. The University of Chicago Press, Chicago.
3. Brian Groom bridge (Ed.)1992. Global Biodiversity –Status of the Earth's Living Resources, Chapman & Hall.

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	4. Jean-Marine Massin.1994.Remote Sensing for the Control of Marine Pollution. Academic Publishers, Plenum Press. 466 pp. 5. Health, A.G.,1995. Water pollution and fish physiology, CRCpress, NewYork, 359pp. 6. Sabins,F.F., 1997.Remot eSensing Principles and Interpretation. Third edition. W.H.Freeman &Company, NewYork.494pp. 7. MarioSoares, 1998.The Ocean our Future –The Report of the Independent World Commission on the Oceans. Cambridge University Press, 248 pp. 8. asim.S.Z.andG.S.Roonwal,1998.India's Exclusive EconomicZone.Omega Scientific Publishers, New Delhi.
Course outcome	CO1: On the successful completion of course, students will be able to CO2: Understand the application of remote sensing in the assessment of marine flora and ocean colour monitoring. CO3: Know the remote sensing technology for identification of fishing grounds in marine environment. CO4: Define about the law of the sea and national and international organizations in ocean management. CO5: Understand the prevalent national and global management practices in disaster management.

Outcome Mapping:

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO5	PSO6	PSO7	PSO8	PSO9
CO1	3		3						3	3				3
CO2	3		3						3	3				3
CO3	3		3						3	3				3
CO4			3				3		3			3		3

Low:1, Medium:2, High:3

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Course Code & Title	22RMAB403A: Research Methodology, Bioinformatics and Biostatistics		
Programme	Marine Biology	Semester	IV
Number of Credits	04	Number of Hours	60
Course Objectives	1. To know meaning and objectives of research, research design and their significance. 2. To understand and analysis of biological databases. 3. To understand the application of statistics in biosciences.		

UNIT	Content	Number of Hours
I	**Research Methodology**: Research Methodology – Meaning, aim and objective of research, Significance of research, Types of research, Research Problem, selecting the problem. Thrust areas in research in Marine Sciences and Technology. Research Design. Sampling- Types of sampling design. Data Collection - Collection of primary data through different methods	14
II	**Bioinformatics:** Introduction – Origin of bioinformatics biological data (genome projects), computer and information technology contributions. Disciplines of bioinformatics – Genomics, transcriptomics, proteomics, functional genomics, structural genomics, metabolomics, pharmacogenomics, structure prediction and drug design. Biological database – Introduction of database (DB), need, organization, search of DB. An over view of biological databases - NCBI, EMBL, DDBJ, SWISS-PROT, PDB, and KEGG.; Sequence analysis - concepts of sequence analysis and their importance. BLAST – blastn, blastp, blastx, tblastx, output analysis matrix BLOSSUM, PAM, e-value.	16
III	**Data Analysis** Collection and Analysis of Biological data – Mean, Median, Mode, Standard Deviation, Standard error, Co efficient of variation, Simple random sampling, Use of random number tables	15
IV	**Biostatistical methods** Student 't' test, Skewness, Kurtosis, Chi-Square test, Z-test, Correlation and Regression, ANOVA, Duncans Multiple Range Test (DMRT).	15

Reference Books	
	1. S.C. Gupta: Fundamentals of Statistics, Himalaya Publishing House Delhi. 2. Gupta &Kapoor: Fundamentals of Mathematical Statistics. S. Chand &Co., New

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	Delhi. 3. Yule & Kendall: Elementary Statistics, Charless Griffin &Co. London
Course outcome	On the successful completion of course, students will be able to CO1: Understand the research problem selection, design of the research work and its significance. CO2: Know the collection and analysis of biological data through statistical tools. CO3: Understand about the different bioinformatic tools for analysis of data. CO3 : Understand the fundamental concepts of biostatistics

Outcome Mapping:

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO5	PSO 6	PSO7	PSO8	PSO9
CO1	3	3	3							3		3		
CO2	3	3	3							3		3		
CO3	3	3	3							3		3		
CO4		3	3							3		3		

Low:1, Medium:2, High:3

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Course Code & Title	22RMAB403B: Tools and Techniques in Biology		
Programme	Marine Biology	Semester	IV
Number of Credits	04	Number of Hours	60
Course Objectives	1. The units of this paper are crucial for implementation of research ideas at molecular level. 2. Here students are taught to deal with different tools and techniques applicable in biological research including various types of microscopes, sterilization & ELISA. 3. To provide adequate knowledge about PCR and Electrophoresis to the course learners. 4. It trains the students in adopting various techniques in biological research		

UNIT	Content	Number of Hours
I	**Basic Instruments and Tools**: Microscopy: Working principles, types and applications of Light and Electron Microscopes: Bright Fields, Fluorescence Phase. Contrast, TEM, SEM & Confocal microscopy. Principle of asepsis and sterilization technique: Autoclave, Hot Air Ovens, laminar air flow Orbital Shakers. Ultramicrotomes, Blotting Techniques-Western, southern & Northern Blotting Techniques. Immunological techniques: ELISA,RIA.	16
II	**Electrophoretic and PCR techniques:** Working principles, basic operation and application of Agarose Gel, polyacrylamide gel electrophoresis, SDS-polyacrylamide gel electrophoresis, 2-D electrophoresis. PCR: Principles, operational procedure types and application. Gel Documentation system.	14
III	**Chromatography & Centrifugation techniques:** Working principles, basic operation and application of Paper, Thin Layer Chromatography. Principles and Application of Column Chromatography- ion exchange, affinity, Gas-Liquid and High Performance Liquid chromatography (HPLC).Working principles, types and Application of preparative and Analytical Centrifuges, Ultracentrifugation.	16
IV	**Spectroscopic and Radio isotopic Techniques:** Principles of Spectroscopy: Beer-Lamberts Law. Operation Procedures, Working Principles and Applications of UV-Visible Spectrophotometer, Atomic Absorption (AAS), NMR, FTIR and X-Ray Crystallography. Principles and Application-Radio Active Decay- Working Principles and applications of GM Counter, Scintillators. Applications of Radio Isotopes in	14

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	Biology.	
Reference Books	1. Freifelder D., Physical Biochemistry, Application to Biochemistry and Molecular Biology.W.H. Freeman and Company, San Fransisco. 2. Wilson, K. and Walker, J. Principles and Techniques of Practical Biochemistry Cambridge, University Press. 3. Holmeand, D. and Peck, H. Analytical Biochemistry. Longman 4. Scopes, R. Protein Purification - Principles and Practices. Springer Verlag. 5. Pattabhi V and Gautham N. Biophysics, Kluwer Academic Publishers. 6. Narayanan P. Essentials of Biophysics, New Age International Pvt Ltd. 7. Volkenshtein, M.V. General Biophysics Academic Press, Inc. 8.Daniel, M. Basic Biophysics for biologists Agrobios. 9.Van, Holde, Johnson, K. E., Cutis, W. and Shing Ho, P. Principles of physical biochemistry, Pearson education Pvt. Ltd	
Course outcome	CO1: Learners will obtain the sterilization techniques and handling of microscope. CO2: Learners will know the PCR nd Electrophoresis. CO3: They gain about different types of Chromatography Techniques. CO4: This significantly enhances the employability of the candidates in Pharmaceutical Industries and Analytical Laboratories and research institutes	

Outcome Mapping:

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO5	PSO6	PSO7	PSO8	PSO9
CO1	3	3	3							3		3		
CO2	3	3		3		3				3		3		
CO3		3		3						3		3		
CO4		3		3		3				3		3		

Low:1, Medium:2, High:3

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MAB 404 P: LAB I: Core & Generic Elective

MARINE BIOTECHNOLOGY

1. Preparation of crude extract by methanol: hexane solvent from molluscs, sponges and mangrove plants.
2. Separation of crude extract fractions by column chromatography.
3. Separation of fractions/compounds by TLC
4. Isolation of protoplasts from seaweeds
5. Production of amylase
6. Estimation of amylase
7. Estimation of Lipase
8. Estimation of protease
9. CO_2 Fixation by Micro algae.
10. Bioactive compounds.

OCEAN MANAGEMENT AND REMOTE SENSING

1. Identification of locally available Macro algae, Seaweeds, Seagrasses and Mangrove.
2. Sediment Analysis estimation of sand, silt and clay percentage in the sediments.
3. Identification of different geomorphic structures
4. Beach Profiling
5. Sediment Analysis: estimation of sand, silt and clay percentage in the sediments
6. Identification of Underwater Geomorphic Structure
7. Study of elements of aerial photographs
8. Hazard identification using digital images.
9. Mapping of Living resources
10. GIS applications in flood hazard.
11. Observation of remote sensing pattern sand flow charts
12. Field Visit : Observation of Beach structure and pollution status/ flora and fauna.

RESEARCH METHODOLOGY, BIOSTATISTICS AND BIOINFORMATICS

1. Methods of sampling and collection of biological data
2. Calculation of mean, median, mode, standard deviation, standard error and co-efficient of variation.
3. Calculation of correlation coefficient values and finding probability values.
4. Calculation of Fvalue and finding out the probability of F value, Regression analysis.
5. Familiarization with windows, UNIX, Internet
6. Use of tools at NCBI, EMBL and SWISSPORT
7. BLAST analysis and FAST Aanalysis
8. Pair wise and Multiple sequence alignment
9. Finding composition of sequence, open reading frames
10. Phylogenetic tree construction
11. PCR Primer designing
12. Preparation of Research proposal.

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TOOLS AND TECHNIQUES IN BIOLOGY

1. Demonstration-Operating Principle of Light, Compound phase contrast microscopy.
2. Blotting techniques-Western
3. Agarose gel electrophoresis.
4. SDS
5. Separation of amino acids by paper chromatography.
6. To identify in given sample by thin layered chromatography.
7. HPLC (Demonstration Only)
8. Separation of crude extract fractions by column chromatography.
9. Verification of Beer-Lambert's law and determination of absorption coefficients.
10. ELISA.
11. Identification of different Tools used in Molecular Biology.

22RMAB 405: Project/ Internship (6 weeks)
(Submission of Dissertation/ Report)

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Course Code & Title	22RMAB406A: Marine Resources & Conservation		
Programme	**Marine Biology**	**Semester**	**IV**
Number of Credits	**04**	**Number of Hours**	**60**
Course Objectives	1. Understand about the different bio-resources in marine environment 2. Learn about the marine resource management 3. Know about different non-living resources of oceans and seas. 4. Understand about the importance of bioactive compounds from marine environment.		
UNIT	**Content**		**Number of Hours**
I	**Ocean Bio-resources:** Renewable resources of the oceans -Seaweeds; Mangroves; Coral reefs; Finfish and shell fish- their occurrence, distribution and importance, exploitation;Indian marine fishes		15
II	**Marine Resource Management:** Conservation of renewable marine resources; Marine conservation Management laws and regulations; Fishery management concepts; non-conventional energy sources: Sea as non-conventional energy source- wave energy, tidal energy, OTEC		15
III	**Non-Living Resources:** Non-renewable resources of the oceans: salt, magnesium, glauconite, phosphorite, manganese nodules etc., and their exploitation		14
IV	**Bioactive substances:** Bioactive marine natural products: Anti-tumour, tumour promoting, anti-inflammatory, cytotoxic, anti-neoplastic and analgesic compounds from the marine organisms		16
Reference Books	1. Naskar, K. 2004. Manual of Indian Mangroves. Daya Publishers, New Delhi. 220 p. Peter, S. (Ed.) 2006. Coral reef fishes: Dynamics and diversity in a complex ecosystem, Academic Press, London. 2. Singh, V.P. and Odaki, K. 2004. Mangrove ecosystem: structure and function. Scientific Publishers, New Delhi: 297 p. 3. Bakus, G.J., 1994. Coral reef ecosystems. Oxford and IBH publishing Company, New Delhi: 232 p. 4. Boyle, G. 2004. Renewable Energy. Oxford University Press, Oxford. 464 p. 5. Norse, E.A. and Crowder, L.B. (Eds.) 2005. Marine Conservation Biology: The Science of Maintaining the Sea's Biodiversity,1st edn., Marine Conservation Biology Institute. Island Press, 496 pp. 6. Day, F. The fishes of India. S.S. Khanna. An introduction to fishes. 7. Michael, R.R. 1997. Fisheries Conservation and Management. Prentice		

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	Hall 8. Chandra, P. 2007. Fishery Conservation Management and Development. SBS Publ. 9. Jhingran, V.G. 1991.Fish and Fisheries of India, Hindustan Publ. Corpn
Course outcome	CO1: To gain knowledge on the estuarine as well as marine fisheries resources of India CO2: To understanding the present level of exploitation of marine resources and to impart knowledge on conservation measures CO3: To provide information on recent methodologies of sustainable exploitation of renewable resources. CO4: To impart the knowledge related to bioactive natural products from marine environment

Outcome Mapping:

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO5	PSO6	PSO7	PSO8	PSO9
CO1	3	3				3			3					3
CO2	3	3				3			3					3
CO3	3	3				3			3					3
CO4		3	3			3			3					3

Low:1, Medium:2, High:3

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Course Code & Title	22RMAB406B: Disease & Health Management in Aquaculture		
Programme	Marine Biology	Semester	IV
Number of Credits	04	Number of Hours	60
Course Objectives	1. Learn about the different bacterial diseases of fin fishes and shellfishes 2. Know about the viral diseases and diagnosis procedures in aquaculture practices. 3. Understand the different disease problems related to external parasitic diseases in aquaculture. 4. To study about the nutritional and environmental disorders in fish and shrimp and other aquatic organisms.		

UNIT	Content	Number of Hours
I	**Bacterial Diseases of finfish & Shellfishes:** Causes, symptoms, diagnosis, prophylactic and therapeutic measures of different bacterial diseases of fish, prawn and shrimp.	15
II	**Viral Diseases of finfish & Shellfishes:** Causes, symptoms, diagnosis, prophylactic measures of different viral diseases of fish, prawn and shrimp	15
III	**Fungal, Protozoan and other parasitic diseases:** Causes, symptoms, diagnosis, prophylactic and therapeutic measures of fungal and protozoan diseases; Diseases caused by isopods and learnea; diseases caused by dactylogyrus and monocoelium; trematode larvae, nematodes and fish leeches – clinical methods, symptoms and prophylaxis treatments	16
IV	**Nutritional & Environmental Stress diseases:** Nutritional deficiency diseases of fish and shrimp: Metabolic disturbances; vitamin deficiency;aflatoxins in feed; Environmental diseases: DO, pH, acidosis and alkalosis problems; gas bubble disease; temperature disturbances	14

Reference Books

1. Roberts R J. 1989. Fish Pathology 2nd edition. Bailliere Tindall London. 467 p
2. Noga E J. 1996. Fish disease, Diagnosis and treatment. Mosby-Year book Inc., St. Louis, Missouri. 367 P.
3. Shaperclaus W. 1991 Fish Diseases- Vol.I& II. Oxonian PressPvt.Ltd
4. Shankar KM & Mohan CV. 2002. Fish and Shellfish Health Management. UNESCO Publications.
5. Johnson SK 1995. Handbook of shrimp diseases. Texas A & M University, Texas

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	6. Lightner D.V., and Redman, R.M. 1998. Shrimp diseases and current diagnostic methods Aquacult., 164 (1-4); 201-220. 7. Wedmeyer G, Meyer FP & Smith L. 1999. Environmental Stress and Fish Diseases. Narendra Publ. House. 8. Sinderman, C.J. 1990. Principal Diseases of Marine Fish and Shellfish. Vol. I, 2nd Ed. Academic Press. ISBN: 9780126458510.
Course outcome	CO1: Acquired the knowledge related to different bacterial diseases and their diagnosis procedures in aquaculture. CO2: Understand the diagnosis techniques and identification of different viral infections in aquaculture practices. CO3: Lean about the disease problems related to external parasites. CO4: Identify about the different nutritional and environmental stress disorders in aquaculture species.

Outcome Mapping:

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO5	PSO6	PSO7	PSO8	PSO9
CO1	3		3	3	2			2	3				3	3
CO2	3		3		3			3	3				3	3
CO3	3		3	3	3			3	3				2	3
CO4	3		3	2	2			2	2				2	3

Low:1, Medium:2, High:3

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Course Code & Title	22RMAB406C: Aquaculture Extension, Economics &Fish Marketing		
Programme	Marine Biology	Semester	IV
Number of Credits	04	Number of Hours	60
Course Objectives	1. Understand the concepts of aquaculture Extension and Economics 2. Describe the role and responsibilities of marketing of fishery products 3. Learn about the knowledge related to Financing of Aquaculture 4. Knowledge on farm management in aquaculture sector		

UNIT	Content	Number of Hours
I	**Aquaculture Extension:** Extension education-objectives and principles; extension strategies and methodologies; Role of extension in community development; Rural development strategies – programmes for weaker sections of the community; fisheries as a tool in rural development; employment generation	14
II	**Economics& Financing of Aquaculture:** Economic viability; assets and liabilities; cost-return analysis; production costs variable and fixed costs; operating income; evaluation of farm performance; sensitivity analysis; minimum farm size; gross revenue; benefit – cost ratio; socio-economic analysis; risk and insurance; Role of banks, central organizations and other funding agencies in the growth and development of aquaculture	16
III	**Farm Management:** Concepts of economic principles of farm management; application of farm management principles in aquaculture; Economics of carp, prawn and shrimp hatcheries and production farms	15
IV	**Fish Marketing:** Economics of fish markets; marketing and resource management; co-operatives and their importance in fish production and marketing; export-oriented growth policies; fisheries projects and fish resources; institutional and management issues; planning and financing schemes for fisheries; legal and environmental issues.	15

Reference Books	1. Kothar, P., 1988. Marketing Management. Prentice Hall, Inc. 2. Allen et. al (Eds). 1984. Bio-Economics of Aquaculture. Elsevier.

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	3. Kothar, P., 1988. Marketing Management. Prentice Hall, Inc. 4. Adivi Reddy, A. 1976. Extension Education. Sree Lakshmi Press, Bapatla, India. 5. Hepher, B. and Pruginin, Y. 1981. Commercial Fish Farming 6. Joshi, M. V., 1996. Economics of Fisheries. Daya Publishing House, New Delhi. 7. Girirappa, S., 1995. The Role of Fisheries in Rural Development. Daya Publishing House, New Delhi. 8. Ray GL. 2006. Extension, Communication and Management. 6th Ed. Kalyani Publ. Delhi. 9. Pillay TVR. 1990. Aquaculture Principles and Practices. Fishing News Books Ltd. London 10. Shang YC. 1990. Aquaculture Economic Analysis - An Introduction. World Aquaculture Society, USA
Course outcome	CO1 Understand about the Aquaculture Economics and Extension activities CO2 Acquire knowledge on Financing of Aquaculture sector CO3Creating awareness on Farm Management in Fishery industry CO4 Learn about the Knowledge related to Marketing of fishery products.

Outcome Mapping:

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO5	PSO6	PSO7	PSO8	PSO9
CO1	3		2	2	3			2	2					3
CO2	3		3	2	2			2	2					2
CO3	2		3	2	1			2	3					2
CO4	2		2	2	2			2	2					2

Low:1, Medium:2, High:3

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22R MAB-SEA1: Educational Tour/ Field Visit and Submission of Report

(Visit to Industries/ Research Institutes/ Aquaculture farms/ Hatcheries/ Processing Plant/ Feed Mill)

Study tour to various marine ecosystems to study marine biodiversity and to collect specimens. Visits to Oceanography and Fisheries Institutes like NIO, CMFRI, CIBA, RGCA, NBFGR, CIFT

Visit to Fish/Shrimp/Crab culture farms and hatcheries; Sea food processing plants; Feed manufacture plants;

Submission of tour/field visit report.

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22R MAB-SEA2: Seminar / Poster Presentation

Model Question paper

M.SC DEGREE EXAMINATIONS, _____, 20___

I/II/III & IV SEMESTER

Branch/Subject: MARINE BIOLOGY

Paper Title:

Time: 3 hrs **Max Marks: 70**

PART- A

Answer any SIX of the following

Each question carries 5 marks

(Marks: 6 x 5 = 30 marks)

1.

2.

3.

4.

5.

6.

7.

8.

PART-B

Answer any ONE question from each unit

Each question carries 10 marks

(Marks: 4 x 10 = 40 marks)

Unit-I

9. (a) or (b)

Unit-II

10. (a) or (b)

Unit-III

11. (a) or (b)

Unit-IV

12. (a) or (b)

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