DEPARTMENT OF MARINE LIVING RESOURCES

Revised Syllabus

With effect from 2021-2022

Program: M.Sc. Coastal Aquaculture and Marine Biotechnology

ANDHRA UNIVERSITY
Visakhapatnam

DEPARTMENT OF MARINE LIVING RESOURCES, ANDHRA UNIVERSITY

M.Sc. Coastal Aquaculture and Marine Biotechnology-I Semester- Scheme of Examination (With effect from 2021-2022 admitted batches)

Paper No	Paper Title	Maximum Marks			Credits		
		Theory (End exam + Mid)	Practical (Semester end)	Total marks	Theory	Practical	Total
1.1	Oceanography and Marine Biology	80+20	50	150	4	2	6
1.2	Fin Fish Culture	80+20	50	150	4	2	6
1.3	Crustacean Farming	80+20	50	150	4	2	6
1.4	Aquaculture Engineering	80+20	50	150	4	2	6
	Total marks	**400**	**200**	**600**	**16**	**8**	**24**
M.Sc. Coastal Aquaculture and Marine Biotechnology -II Semester							
		Theory (End exam + Mid)	Practical (Semester end)	Total marks	Theory	Practical	Total
2.1	Molluscan & Seaweed Farming	80+20	50	150	4	2	6
2.2	Soil and Water Quality Management in Aquaculture	80+20	50	150	4	2	6
2.3	Seed Production and Hatchery Management	80+20	50	150	4	2	6
2.4	Marine Microbiology	80+20	50	150	4	2	6
	Total marks	**400**	**200**	**600**	**16**	**8**	**24**
M.Sc. Coastal Aquaculture and Marine Biotechnology -III Semester							
		Theory (End exam + Mid)	Practical (Semester end)	Total marks	Theory	Practical	Total
3.1	Biochemistry and Fish Nutrition	80+20	50	150	4	2	6
3.2	Genetics in Aquaculture	80+20	50	150	4	2	6
3.3	Molecular Biology	80+20	50	150	4	2	6
3.4	Marine Pollution and Bio-deterioration	80+20	50	150	4	2	6
3.5	**MOOC-I**						4
	IPR (Value added course)						
	Total marks	**400**	**200**	**600**	**16**	**8**	**28**
M.Sc. Coastal Aquaculture and Marine Biotechnology -IV Semester							
		Theory (End exam + Mid)	Practical (Semester end)	Total marks	Theory	Practical	Total
4.1	Fish Pathology and Immunology	80+20	50	150	4	2	6
4.2	Marine Biotechnology	80+20	50	150	4	2	6
4.3	Bioactive Marine Natural Products	80+20	50	150	4	2	6
4.4	**MOOC-II**						4
4.5	Project	100		100	4	-	4
	Viva-voce		50	50		2	2
	Research Methodology (VAC)						
	Total marks	**400**	**200**	**600**	**16**	**8**	**28**

Programme: M.Sc. Coastal Aquaculture and Marine Biotechnology

Programme Outcome (PO):

PO1. Acquire sound knowledge on oceanography, marine biology, culture of fishes, crustaceans, molluscs and seaweeds, postharvest technology, design and construction of fish/shrimp farms.

PO2. Obtain knowledge on farm management including soil, water and feed. Seed production through induced breeding and operation of fish/shrimp hatcheries and also the basics of marine microbiology.

PO3. Acquire knowledge on aquaculture nutrition, application of genetics in aquaculture, molecular biology, marine pollution and bio-deterioration.

PO4. Acquire knowledge on fish pathology, immunology, bio-technological applications in aquaculture, isolation and purification of bioactive marine natural products.

PO5. Understand the concepts of marine ecology, aquaculture, nutrition for aquaculture species, induced breeding, seed production and pathology through hands on training, field visits and project works.

Programme Specific Outcome (PSO):

PSO1. Able to design and construct fish/ shrimp farm, operation of fish/shrimp hatcheries, management of aquaculture, preparation of supplementary feeds, disease diagnosis and control in aquaculture.

PSO2. Able to apply the principles of genetics and biotechnology in aquaculture and related fields.

PSO3. Acquires integrity, objectivity and disseminate the knowledge for scientific, economic and social benefits leading to National and global development.

Programme Educational Objectives (PEO):

PEO1. Become an entrepreneur in aquaculture and also get employment in aquaculture and its subsidiary industries and aquaculture research institutes.

PEO2. Pursue higher studies in India and Abroad.

M.Sc. Coastal Aquaculture and Marine Biotechnology
First Semester

Course 1.1: Oceanography and Marine Biology

Learning Objectives (LO):

LO1. To impart knowledge in dimensions of oceans, physical parameters of sea, Heat budgets of the oceans, sound and its propagation in the sea.

LO2. To understand chemical parameters of the sea, composition of seawater and brackish water

LO3. To impart knowledge on classification of marine habitats and ecological divisions of the ocean. Ecology of coral reefs and mangrove habitats and Sea-ranching.

LO4. To understand the Law pertaining to the sea, Remote sensing applications in oceanography and marine biology, GIS and its role in oceanography.

LO5. To impart knowledge on National and International Institutes of marine research: NIO, CMFRI, CIFE, CIFT, CIBA, MPEDA, INCOIS and NRSA.

Course Outcome (CO):

CO1. Obtain knowledge on dimensions of oceans, physical parameters of sea, Heat budgets of the oceans, sound and its propagation in the sea.

CO2. Acquire knowledge on chemical parameters of the sea, composition of seawater and brackish water.

CO3. Obtain knowledge on classification of marine habitats and ecological divisions of the ocean. Ecology of coral reefs and mangrove habitats and Sea-ranching.

CO4. Acquire knowledge on Law pertaining to the sea, Remote sensing applications in oceanography and marine biology, GIS and its role in oceanography.

CO5. Obtain knowledge on National and International Institutes of marine research: NIO, CMFRI, CIFE, CIFT, CIBA, MPEDA, INCOIS and NRSA.

Course Specific Outcome (CSO):

CSO1. The student will be able to understand the reasons for climatic changes in day to day life

CSO2. The student will be able to apply the knowledge of oceanography and marine biology to the aquaculture activities to improve yield from aqua farms.

CSO3.The student will have an opportunity to work in the organizations such as NRSA, INCOIS, NIO, IMD as technical person.

Unit - I

Dimensions of oceans; Physical parameters of sea: Tides, waves, light, temperature, currents,density, pressure. Heat budget of the oceans. Sound and its propagation in the sea.

Unit - II

Chemical parameters of the sea: salinity, dissolved oxygen, carbon dioxide, pH, nutrients andtrace elements. Composition of seawater and brackish water.

Unit -III

Classification of marine habitats and ecological divisions of the ocean. Plankton, nekton, benthos and their adaptations, methods of collection

Ecology of coral reefs and mangrove habitats; their special features.

Sea- ranching of economically important marine organisms.

Unit - IV

Law pertaining to the seas: Historical perspectives in International negotiations and settlementsover open seas. Modern law of the sea.
Remote sensing applications in oceanography and marine biology.
Elements of Geographic Information Systems (GIS) and its role in oceanography.

Unit - V

National and International Institutes of marine research: NIO, CMFRI, CIFE, CIFT, CIBA, MPEDA, INCOIS, NRSA.
their affiliation, thrust areas of research, administrative hierarchy, scientist recruitment.
Scripp's Institute of oceanography, Woods Hole Institute of Oceanography, Rosential School of Marine Sciences, Hawaiian Institute of Marine Biology, National Oceanography and atmospheric administration, Plymouth Laboratories.

References

Svedrup et al	The Oceans Prentice	Hall
Tait RV	Elements of marine ecology	Butterworths
Riley & Skirrow	Chemical Oceanography	Academic Press
Newell RC	Biology of intertidal animals	Logos Press
Kinne O (Ed)	Marine ecology	John Wiley & Sons
Mann KH	Ecology of coastal waters	
King CAH	Introd. Phys. & Biol. Oceang.	ELBS

Practical:

1. Determination of Salinity of the sea water sample adopting Harvey's Method
2. Determination of the Dissolved Oxygen concentration in the sea water adopting Winkler's Method
3. Determination of Alkalinity of the sea water sample following Titrimetric Method
4. Determination of pH of sea water sample using a digital pH meter.
5. Identification of Phytoplankton Zooplanktons Nekton, Intertidal and sub-tidal organisms, coral reefs and mangroves.

Course 1.1. Mapping of course outcome with Programme outcome

	CO1	CO2	CO3	CO4	CO5
PO1	✓	✓	✓	✓	✓
PO2					
PO3					
PO4					
PO5					

Course 1.2: Finfish Culture

Learning Objectives (LO):

LO1. To understand the importance and present status of aquaculture in India and abroad.
LO2. To understand the biology and life cycle of important cultivable fish species
LO3. To understand the Design and construction of fish ponds, cages, pens and race-ways.
LO4. To understand the various culture practices of finfish species in coastal waters and their management.
LO5. To understand the methods of harvesting and post-harvesting technology, quality control, marketing and economics.

Course Outcome (CO):

CO1. Obtain knowledge on present status of aquaculture in India and abroad.
CO2. Acquire knowledge on biology and life cycle of important cultivable fish species.
CO3. Obtain knowledge on design of ponds, cages, pens and race-ways for fish culture.
CO4. Acquire knowledge on various culture practices of fish in coastal waters.
CO5. Obtain knowledge on harvesting and post harvesting technology, quality control of fish fishery products.

Course Specific Outcome (CSO):

CSO1. Able to identify the cultivable species of fish.
CSO2. Able to handle the culture of fishes in coastal waters.
CSO2. Employment in coastal aquaculture and its subsidiary industries.

Unit-I

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

Unit-II

Important cultivable finfish species and their biology and life cycle- milkfish, mullets, seabass, yellowtail, pearl spot, grouper, cobia, silver pompano, sea breams, salmon, rabbit fish and tilapia.

Unit-III

Criteria for selection of finfish for aquaculture.
Classification of culture systems: ponds, pens, cages, raceways
Pond preparation and fertilization, eradication of weed and predatory finfishes.

Unit-IV

Monoculture and polyculture: principles and practices. Integrated farming, organic farming and their management.
Culture practices of milkfish, mullets, seabass, cobia and yellowtail.

Unit-V

Harvesting and post-harvesting technology of cultured finfish. Production, quality control, marketing and economics.
Coastal Aquaculture Authority and its role.

References:

Bardach JE et al	Aquaculture	Wiley Interscience
Huet & Timmermans	Textbook of fish culture	FNB
Pillay TVR	Aquaculture: principles and practices	FNB
Santhanam R et al	Coastal aquaculture	CBS

Practical:

1. Fish identification based on morphometric and meristic data.
2. Dissect and display the digestive system of herbivorous and carnivorous fish and reproductive system of fish
3. Important calculations in aquaculture: FCR and FCE, Daily ration of feed, Survival rate, Specific growth rate, Quantifying the seed for transport.
4. Identification:
   A. Cultivable fishes
   B. Predatory and weed fishes
   C. Fertilizers
   D. Supplementary feeds

Course 1.2. Mapping of Course outcome with Programme outcome

	CO1	CO2	CO3	CO4	CO5
PO1	✓	✓	✓	✓	✓
PO2					
PO3					
PO4					
PO5					

Course 1.3: Crustacean Farming

Learning Objectives (LO):

LO1. To know the importance and present status of crustacean farming in India and abroad.
LO2. To understand the biology and life cycle of cultivable crustacean species
LO3. To understand the types supplementary feeds and their formulations.
LO4. To understand various aquaculture practices.
LO5. To understand the culture of prawns, shrimps and crabs lobsters.

Course outcome (CO):

CO1. Obtain knowledge on present status of crustacean farming in India and Abroad.
CO2. Acquire knowledge on biology and life cycle of important cultivable crustacean species.
CO3. Acquire knowledge on preparation of formulated feeds and their applications.
CO4. Obtain knowledge on farming practices i.e. traditional, extensive, semi intensive and ultra-intensive.
CO5. Acquire knowledge on culture of prawns, shrimps and crabs lobsters.

Course Specific Outcome (CSO):

CSO1. Able to formulate nutritionally balanced supplementary feeds.
CSO2. Able to culture prawn, shrimps, crabs and lobsters.
CSO3. Able to get employment in shrimp farming industry.

UNIT I

Scope and importance of crustacean farming. Status of crustacean farming in India and abroad. Production, utilization, emerging trends.

UNIT II

Important cultivable species and their biology - *Penaeus monodon, P. indicus, P. vannamei, P. semisulcatus and Macrobrachium rosenbergii; Scylla serrata* and *Panulirus homarus.*

UNIT III

Supplementary feeding: dry feeds, wet feeds, role of artificial feeds; feed ingredients and nutritional quality. Feed formulations.

UNIT IV

Types of farming practices: Traditional, extensive, semi-intensive, intensive, super- intensive and ultra-intensive. Re-circulatory aquaculture systems and prawn culture in rice fields. Cage culture.

UNIT V

Farming of prawn, shrimp, crab, lobster. Harvesting, handling, post harvesting technology, marketing and economics.

References:

Shigueno K	Shrimp culture of Japan	AITP, Tokyo
Milne PH	Fish & shellfish farming in coastal waters	FNB
McVey JP	Crustacean aquaculture	CRC handbook CRC press
Korringa P	Farming of marine fishes & shrimps	Elseiver
Walne PR	Culture of bivalve mollusks	PNB

Practical:

1. Identification of shrimp upto species level based on morphological characters.
2. Dissect and display the appendages of shrimp and crab.
3. Dissect and display the digestive system of shrimp, crab and lobster
4. Dissect and display the reproductive system of shrimp and squilla.
5. Identification:
   A. Cultivable crustaceans
   B. Larval forms
   C. Shrimp and crab feed

Course 1.3. Mapping of Course outcome with Programme outcome

	CO1	CO2	CO3	CO4	CO5
PO1	✓	✓	✓	✓	✓
PO2					
PO3					
PO4					
PO5					

Course 1.4: Aquaculture Engineering

Learning objectives (LO):

LO1.To understand the general principles of Aquaculture Engineering, Types of soil and their engineering properties.

LO2.To understand computational methods of site measurement, and earth work estimations.

LO3.To acquire knowledge on engineering properties of materials used in Aquaculture, effect of waves and tides on aquaculture installations.

LO4.To acquire knowledge on the design and construction of ponds and hatcheries.

LO5.To understand the basic principles and working mechanisms of water recirculatory systems and other equipment used in Aquaculture.

Course outcomes (CO):

CO1.Able to apply the principles of Aquaculture Engineering in the field

CO2. Able to measure the given site and earth work estimations.

CO3. Able to select suitable materials for aquaculture to withstand the effects of waves and tides.

CO4. Able to design and construct ponds and hatcheries

CO5. Able to apply basic principles and working mechanisms of water recirculatory systems and other equipment used in Aquaculture.

Course Specific Outcomes (CSO):

CO1. Attains the skill in Aquaculture Engineering

CO2. Becomes competent to apply principles of Aquaculture Engineering in the field.

Unit- I

Scope and importance of aquaculture engineering. Origin of soil, Soil profile, Types of soils, properties of soil ; soil texture & structure, soil-water Relationships.

Unit- II

Computation of area by various survey methods (chain, plane table, magnetic compass and leveling. Methods of Earth work estimations (Average depth, Average cross sectional area, Prismoidal and Trapezoidal formulae)

Unit- III

Properties of fluids, computation of time to fill/drain a pond/tank.
Fundamentals of waves & tides and their effects on aquaculture installations.
Engineering properties of materials, Types of materials used in aquaculture.

Unit- IV

Technical considerations in site selection for hatchery/farm/cages
Design and construction of a hatchery (carp/shrimp), pond, cages, pens, raceways.
pumps and aerators (types, selection and positioning).

Unit- V

Filtration of water for aquaculture; water re-circulatory equipments. Different types of feeding equipment, feed control systems, dynamic feeding systems. Working principles of pH meter, salinometer, spectrophotometer, D.O. meter, Secchi disc, heaters, Ozonisers, UV filtration unit.

References:

Lawson TB	Fundm. Aquaculture engineering	CBS
Whaton FW	Aquaculture engineering	John Wiley
Timmon	Aquaculture engineering	Blackwell
Bose & Mitra	Coastal aquaculture engineering	Oxford & IBH
	Punnima Surveying	Laxmi publishers
AGOR	Elements of Civil Engg.	Khanna
BC mal	Soil & Water Conservation Engg.	Kalyani

Practical:

1. Determination of bulk and particulate density of soil
2. Land survey -chain, plane table, magnetic prism, autoleveler
3. Lay-out preparation of fish and shrimp hatchery
4. lay-out preparation of fish/shrimp farm
5. Designs of various monk sluices
6. Numericals on optimal height and width of dikes and earth work

Course 1.4: Mapping of course outcomes with Programme outcomes:

Course Outcomes(CO)	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Programme outcomes(PO)	**PO1**	**PO1**	**PO1**	**PO1**	**PO1**

M.Sc. Coastal Aquaculture and Marine Biotechnology
Second Semester

Course: 2.1. Molluscan and Sea weed farming

Learning Objectives (LO):

LO1. To understand the importance and present status of molluscan farming in India and Abroad.
LO2. To understand the biology and life cycles of cultivable molluscs and sea weeds.
LO3. To understand the various materials used for construction of culture systems.
LO4. To understand the various culture practices of molluscs and sea weeds.
LO5. To understand the methods of harvesting and post-harvesting technology of molluscs and sea weeds.

Course Outcome (CO):

CO1. Acquire knowledge on present status, biology and life cycles of molluscs and sea weeds.
CO2 Gets knowledge on construction of culture systems.
CO3. Acquire knowledge on culture of mussels, oysters, pearl oysters and cephalopods.
CO4. Acquire sound knowledge on culture of agar, algin, carragenen yielding sea weeds.
CO5. Acquire knowledge on post-harvesting technology and preparation of various by-products of molluscs and sea weeds.

Course Specific Outcome (CSO):

CSO1. Able to culture molluscs and sea weeds in coastal waters at commercial scale.
CSO2. Able to prepare various by-products from molluscs and sea weed.
CSO4. Gets employment opportunities in molluscan and sea weed industries.

Unit-I

Present status of molluscan farming.
Biology and Life cycle of cultivable molluscs: mussels, oysters, clams, scallops, cockles and abalones.

Unit-II

Present status of sea weed farming.
Life cycles of sea weeds of commercial importance: *Ulva* sp., *Geledium* sp., *Gracilaria* sp. and *Sargassum* sp. Breed improvement in sea weeds.

Unit-III

Oyster and mussel farming; growth, fattening and greening.
Culture of pearl oyster and pearl production. Culture of clams.
Culture of cephalopods.

Unit-IV

Culture practices of sea weeds in India and abroad. Farming of Agar, Algin, Carrageenan yielding sea weeds and green sea weeds. Integration with other farming systems.

Unit-V

Harvesting, post-harvest technology, quality control, production and economics of molluscans and sea weeds. By-products of molluscans & sea weeds and their uses.

References:

Bardach JE et al	Aquaculture	Wiley Interscience
Pillay TVR	Aquaculture: principles & practices	FNB
Imai T	Aquaculture in shallow seas	Amerind
Stickney RS	Principles of aquaculture	John Wiley
Pillay & Dill	Advances in aquaculture	FAO
Milne PH	Fish and shellfish farming in coastal waters	FNB
Walne PR	Culture of bivalve mollusks	PNB
Santhanam R et al	Coastal Aquaculture	CBS
Korringa P	Farming of the oyster	Elsevier

Practical:

I. Dissections:
1. Digestive system of cephalopods and bivalves
2. Reproductive system of cephalopods and bivalves
3. Gill mounting of molluscans
II. Identification: A. Cultivable Molluscans B. Sea weeds and their by-products, C. Predators D. Models of Culture systems.

Course 2.1. Mapping of Course outcome with Programme outcome

	CO1	CO2	CO3	CO4	CO5
PO1	✓	✓	✓	✓	✓
PO2					
PO3					
PO4					
PO5					

Course 2.2: Soil and water quality management in Aquaculture

Learning Objectives (LO):
LO1: To understand importance of soil and water interactions.
LO2: To understand the role of various nutrients in aquaculture.
LO3: To understand the various fertilizers and their applications.
LO4: To understand the Importance of water treatment devices.
LO5: To understand the importance Aquatic weed management.

Course Outcome (CO):
CO1: Gets knowledge on various parameters of soil and water in aquaculture.
CO2: To monitor and regulate the various standards required for cultivable species in aquaculture.
CO3: Gets knowledge on various fertilizers and manures and their applications.
CO4: Gets knowledge on various devices used in culture systems.
CO5: Gets knowledge on management of aquatic weeds and blooms in culture systems.

Course Specific Outcome (CSO):
CSO1: Able to perform various parameters of soil and water.
CSO2: Gets employment in aquaculture, Labs and in various Fisheries Institutes.

Unit - I

Soil and water interaction: Physico - chemical properties of soil and water
Productivity vs nutrient quality and quantity of soil and water

Unit - II

Aquatic microorganisms and their role in carbon, nitrogen, phosphorus and sulphur cycles and impact on aquatic habitats and species.
Soil and water quality standards in culture systems.

Unit – III

Fertilizers and manures: Different kinds of fertilizers and manures, fertilizer grade, source, rate and frequency of application, Bio-fertilizers, Use of treated sewage for pond fertilization, Ecological changes after fertilization,

Unit – IV

Water treatment: Water filtration and devices, aeration and aerators, chlorination, ozonization and UV radiation; Waste water treatment practices, Waste water discharge standards, sludge disposal.

Unit – V

Primary production, degradation of molecules in aquatic environment.
Eutrophication, Algal bloom control, Aquatic weeds and management.

References:

Adhikari S & Chatterjee DK. 2008. Management of Tropical Freshwater Ponds. Daya Publ.
APHA, AWWA, WPCF. 1998. Standard Methods for the Examination of Water and Wastewater, 20th Ed. American Public Health Association, American Water Works Association, and Water Pollution Control Federation, Washington, D. C.

Boyd, C. E. and Tucker, C. S. 1992. Water Quality and Pond Soil Analyses for Aquaculture, Alabama Agricultural Experimental Station, Auburn University.
Boyd CE. 1979. *Water Quality in Warm Water Fish Ponds*. Auburn University.
ICAR. 2006. *Handbook of Fisheries and Aquaculture*.
ICAR. Parsons TR, Maita Y & Lalli CM. 1984. *A Manual of Chemical and Biological Methods for Seawater Analysis*. Pergamon Press.
Rajagopalsamy CBT & Ramadhas V. 2002. *Nutrient Dynamics in Freshwater Fish Culture System*.
Daya Publ. Sharma LL, Sharma SK, Saini VP & Sharma BK. (Eds.). 2008. *Management of Freshwater Ecosystems*. Agrotech Publ. Academy.

Practical:

1. Determination of soil texture and P^H.
2. Determination of DO, Alkalinity, hardness, transparency and Ammonia of water in culture ponds
3. Estimation of N, P, K in soil
4. Sediment analysis- physical, chemical, bacteriological and mycological
5. Harmful Algal Blooms in culture ponds
7. Numerical on dosage determination of chemicals and other additives in ponds
6. Lime and fertilizer requirement calculations

Course 2.2. Mapping of Course outcome with Programme outcome

	CO1	CO2	CO3	CO4	CO5
PO1					
PO2	✓	✓	✓	✓	✓
PO3					
PO4					
PO5					

Course 2.3: Seed Production and Hatchery Management

Learning Objectives (LO):

LO1. To understand the techniques of brood stock management of finfish/shellfish and production of SPF seed.
LO2. To know the methods of wild seed collection
LO3. To understand the management of fish/shrimp hatcheries..
LO4. To obtain knowledge on live feed, microencapsulated feed for fish/shrimp hatcheries.
LO5. To understand various methods of harvesting, packing and transportation of fish/shrimp seed, testing of their quality and marketing.

Course outcome (CO):

CO1. Obtain knowledge on management of finfish and shellfish brood stock.
CO2. Acquire knowledge on wild seed collection.
CO3. Obtain sound knowledge on management of finfish, shellfish and seaweed hatcheries.
CO4. Acquire knowledge on culture of live feeds and preparation of nutritionally balanced supplementary feeds for hatcheries.
CO5. Obtain knowledge on harvesting, packing and transportation of quality seeds of finfish and shellfish.

Course Specific Outcome (CSO):

CSO1. Able to the finfish and shellfish hatcheries.
CSO2. Gets employment in finfish and shellfish hatcheries.

UNIT I

Brood stock management of finfish and shellfish: Brood stock availability, transport, captive rearing and maturation, nutritional requirements, improvement, SPF and SPR brood stock certification.

UNIT II

Wild seed collection methods - mullets, milkfish, seabass, shrimps, crabs, lobsters, oysters, pearl-oysters, mussels and seaweeds. Induced breeding: Methods of natural and artificial fertilization, synthetic hormones and its analogues, and its applications.

UNIT III

Hatchery management of mullets, milkfish, seabass, shrimps, crabs, lobsters, oysters, pearl-oysters, mussels and seaweeds.

UNIT IV

Nutritional requirements of finfish and shellfish larvae: live feeds - *Spirulina*, micro algae, Artemia and artificial feeds - micro encapsulated feeds, pellets & flakes.

UNIT V

Harvesting, packaging and transport of fish and shrimp seed. Seed quality management: Testing and certification. Marketing and economics of seed production.

References:

Bromage & Roberts Broodstock management and egg and larval quality. Blackwell
Bardach JE et al Aquaculture Wiley Interscience
Pillay TVR Aquaculture: principles & practices FNB

Santhanam R et al	Coastal aquaculture	CBS
Stickney RR	Principles of Aquaculture	John Wiley

Practical:

1. Collection and identification of cultivable Brackish water finfish and shellfish seed- Mullets, milkfish, seabass, shrimps, lobster, crab, mussels, oysters, seaweed
2. Evaluation of milkfish/ mullet/ seabass milt and egg
3. Design and operation of seabass/groupers hatchery
4. Visit to different finfish/shell fish hatcheries
5. Seed packing and transportation
6. Eye stalk ablation technique
7. Culture techniques of micro algae
8. Counting of micro algae cells-Sedzwick's Rafter Cell and Haemocytometer
9. Hatching of Artemia cysts and determination of percentage hatching
10. Identification of live feed organisms.

Course 2.3. Mapping of Course outcome with Programme outcome

	CO1	CO2	CO3	CO4	CO5
PO1					
PO2	✓	✓	✓	✓	✓
PO3					
PO4					
PO5					

Course 2.4: Marine Microbiology

Learning objectives (LO):

LO1.To understand the general principles and working mechanisms of various microscopes .
LO2.To understand the characters and distribution of microbes in the Sea.
LO3.To acquire knowledge on Morphology, isolation, culture, preservation of Microbes.
LO4.To understand the general principles of sterilization and role of microbes in fish preservation.
LO5.To understand the principal aspects of planning and implementation of HACCPs in Marine Food processing industries.

Course outcomes (CO):

CO1.Able to gain knowledge on various microscopes
CO2. Gains knowledge on the distribution of microbes in the Sea.
CO3. Gains knowledge on the isolation, culture and preservation of microbes.
CO4. Gains knowledge on various sterilization methods.
CO5. Able to plan the total management of Sea food processing industries.

Course Specific Outcomes (CSO):

CSO1. Attains the skill in Microbial taxonomy.
CSO2. Becomes competent to undertake Microbiological works in Sea food processing, Aquaculture industry.

Unit- I

Microscopy: Working principles of light, Phase contrast, transmission and scanning electron microscopes.

Unit- II

Microbes in the sea: viruses, bacteria, fungi, microalgae and protozoans and their classification. Microbes in extreme environments and their significance- thermophiles, psychrophiles, halophiles and barophiles.

Unit- III

Viruses: Morphology, isolation, culture and classification. Bacteria: morphology, enumeration, culture, classification and preservation. Culture of Marine Fungi and protozoans.

Unit- IV

Methods of controlling microbes: physical, chemical & chemotherapeutic methods. Sterilization techniques employed in microbiological studies. Micro organisms in frozen, canned and dried products and their control, fish quality and evaluation and different indices of quality.

Unit- V

Concepts of total management in sea food processing, practical aspects of planning and implementing HACCP systems. Hazards in sea foods , risk assessment, . National and International standards – ISO, 9000 series. ISO 22000. Roles of BIS, EIA, EIC, FSSAI. Traceability issues in International trade.

References:

Litchfield CD Marine microbiology Hutchinson & Ross
Pelczar ECS et al Microbiology Tata-McGraw Hill
Dhevendaran K. 2008. *Aquatic Microbiology*. Daya Publ. House.
Frobisher M, Hinsdill RD, Crabtree KT & Goodheart CR. 1974. *Fundamentals of Microbiology*. WB Saunders.
Rheinheimer G. 1992. *Aquatic Microbiology*. John Wiley & Sons.
Stanier R, Ingraham JL & Adelberg EA. 1976. *General Microbiology*. MacMillan.
Vernam AH & Evans M. 2000. *Environmental Microbiology*. Blackwell.

Practical:

1. Sterilization Techniques
2. Preparation of Different Bacterial, Fungal and Protozoal culture media
3. Taxonomical characterization of Bacterial isolates
4. Estimation of total heterophilic Bacterial counts in water and soil sediments
5. Estimation of total Vibrio counts in water and soil sediments
6. Isolation, Culture and identification of fungi, MPN of coliforms and confirmation
7. Antibiotic sensitivity test.

Course 2.4: Mapping of course outcomes with Programme outcomes:

Course Outcomes(CO)	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Programme outcomes(PO)	**PO2**	**PO2**	**PO2**	**PO2**	**PO2**

M.Sc. Coastal Aquaculture and Marine Biotechnology
Third Semester

Course: 3.1: Biochemistry and Fish Nutrition

Learning Objectives (LO):

LO1. To understand structure, functions and metabolism of major classes of biomolecules; structure and functions of biological membranes; Enzymes; Nutritional requirements and Nutritional value of fish.
LO2. To understand Feed formulations: criteria for aquafeed formulation; feed additives.
LO3. To understand types of feeds; experimental diets
LO4. To understand types and functioning of various equipments used in feed manufacture; feed ingredients.
LO5. To understand Quality control procedures in fish feed manufacturing, right from raw materials to finished products; Feed storage; Feed economics and evaluation criteria.

Course Outcome (CO):

CO1. Gets knowledge on major classes of biomolecules and their metabolism; biological membranes; Enzymes and enzymatic actions; Nutritional requirements of cultivable finfish and shellfish
CO2. Gains knowledge on feed formulations
CO3. Acquires knowledge on types of feeds; high energy diet.
CO4. Gains knowledge on functioning of equipments and methods used in feed manufacture; Effects of processing on the nutritional value of feed
CO5. Gains insight into Quality control procedures in fish feed manufacturing.

Course Specific Outcome (CSO):

CSO1. Able to estimate proximate composition of fish/shrimp muscle
CSO2. Able to estimate/determine nutritive value of food fish that helps in making products and by-products, developing processing technology for fish and fish products at both commercial and industrial level
CSO3. Able to determine amount and concentration of ingredients and additives to produce compound feeds that meet the known nutrient requirements of targeted species in aquaculture/fish farming

Unit -I

Carbohydrates, proteins, lipids and their metabolism. Biological membranes: transport of molecules. Enzymes: classification, types, factors affecting enzyme catalysis, control of enzymatic action and immobilization of enzymes.

Unit II

Nutritional requirements of cultivable finfish and shellfish: Nutritional value of commonly used fish as food. Feed formulation: General principles, different steps of feed formulation, Pearson's method, quadratic equation linear programming, and limitations. Computerized least cost formula and criterions for aquafeed formulation. Feed additives - Use of natural and synthetic carotenoids.

Unit III

Texture and size of feed: Dry - pellets, flakes, powdered, micro-encapsulated, micro-bound and micro-coated diets, non-dry, Farm made feeds.

Experimental diets: Reference diet, purified and semi-purified diet, Compact pellet feed, floating and slow sinking pellet feeds, high energy diet, vacuum coating with lipid

Unit IV

Equipment used in feed manufacture - Pulverizer, grinder, mixer, pelletizer, crumbler, drier, Extruder/ Expander, Vacuum coater, fat sprayer in feed manufacture: Grinding, Dosing, Homogenization; Extrusion cooking; Complimentary processes; Drying, crumbling, coating; Use of binders.

Unit V

Effects of processing on the nutritional value of feed: vitamins and trace minerals.
Quality control in fish feed manufacturing, Quality control procedures, raw materials, finished products.
Feed storage: Hydro-stability of feed and their storage; Prevention of spoilage from rancidity, fungus and associated toxins.
Feed economics and evaluation criteria: FCR, AFCR, SGR, PRE, ERE, PER, NPU.

References:

Stryer H Biochemistry
Lehninger AL Principles of biochemistry CBS
Plummer An introduction to practical biochemistry

Practical:

1) Determination of moisture in muscle of fish/shrimp.
2) Estimation of proteins, lipids and carbohydrates in fish/shrimp muscle
3) Different types of pelleted feeds and their proximate analysis.
4) Estimation of maltose by 3, 5- dinitrosalicylate reagent method.
5) Assay of amylase in saliva.
6) Preparation of feed table
7) Visit to feed manufacturing unit

Course 3.1 mapping of course outcomes(COS) with Programme outcomes(POS):

	CO1	CO2	CO3	CO4	CO5
PO1					
PO2					
PO3	✓	✓	✓	✓	✓
PO4					
PO5					✓

Course: 3.2: Genetics in Aquaculture

Learning Objectives (LO):

LO1. To understand Principles of Genetics, probability and modification to Mendelian ratios.
LO2. To understand Chromosome theory of inheritance; Chromosome manipulation; and its applications in aquaculture.
LO3. To understand genome in fishes, germplasm preservation methods
LO4. To understand role of genetics in Aquaculture: hybridization, karyotyping.
LO5. To understand Genetic tools such as allozyme and DNA markers for aquaculture applications

Course Outcome (CO):

CO1. Acquires knowledge on Principles of Genetics, Mendelian inheritance.
CO2. Gains knowledge on Chromosome theory of inheritance; Chromosome manipulation, transgenesis and its applications in aquaculture.
CO3. Gets sound knowledge on fish genome, Sex control, in-vitro fertilization techniques.
CO4. Gains knowledge on role of genetics in Aquaculture
CO5. Gets acquainted with genetic tools for aquaculture applications

Course SpecificOutcome (CSO):

CSO1. Able to identify genes and develop species with improved growth rate, disease resistance, robustness and precisely desired characters to improve aquaculture performance in diverse farming environments
CSO2. Able to control the number and combination of haploid set of chromosomes for improvement of aquaculture traits through sex manipulation.

Unit- I

Principles of Genetics: Mendelian principles, probability of Mendelian inheritance, modification to Mendelian ratios. Chromosome theory of inheritance.

Unit- II

Genetic basis of determination of sex in fin fish and shellfish. Chromosome manipulation: Induction of chromosomal ploidy, polyploidy & aneuploidy, gynogenesis, androgenesis, sex reversal, transgenesis and its applications in aquaculture.

Unit- III

Genome size in fishes, Mechanism of variations in genome size. Sex control and its role in aquaculture, cryopreservation of gametes, in-vitro fertilization, artificial insemination.

Unit- IV

Role of genetics in Aquaculture: Genetic selection, inbreeding, cross breeding, hybridization, karyotyping, heterosis, hybrid vigour, introgression.

Unit- V

Genetic tools for aquaculture applications: DNA markers in stock identification- Allozymes, RFLP, RAPD, AFLP, Microsatellite, ESTs and SNPs, mitochondrial DNA.

References:

Carvalho GR & Pitcher TJ. (Eds.). 1995. *Molecular Genetics in Fisheries*. Chapman & Hall.
Falconer DS & Mackay. 1996. *Introduction to Quantitative Genetics*. 4th Ed. Longman.
Kanakaraj P. 2001. *A Text Book on Animal Genetics*. International Book. Distributing Co.
Nair PR. 2008. *Biotechnology and Genetics in Fisheries and Aquaculture*. Dominant Publ.
Padhi BK & Mandal RK. 2000. *Applied Fish Genetics*. Fishing Chimes.
Pandian TJ, Strüssmann CA & Marian MP. 2005. *Fish Genetics and Aquaculture Biotechnology*. Science Publ.
Purdom CE. 1993. *Genetics and Fish Breeding*. Chapman & Hall.

Reddy PVGK. 2005. *Genetic Resources of Indian Major Carps*. FAO Publ.
Reddy PVGK, Ayyappan S, Thampy DM & Krishna G. 2005. *Text book of Fish Genetics and Biotechnology*. ICAR.
Ryman N & Utter F. (Eds.). 1988. *Population Genetics and Fishery Management*. Washington Sea Grant Programmes, USA.
Tave D. 1996. Genetics for Fish Hatchery Managers. 2nd Ed. AVI Publ.
Thorpe JE, Gall GAE, Lannan JE & Nash CE. (Eds.). 1995. *Conservation of Fish and Shellfish Resources, Managing Diversity*.

Practical:

1. Metaphase plate preparation of fish kidney/spleen
2. Numericals on inbreeding, cross breeding, ploidy and genetic selection
3. Karyotyping
4. Computational tools for RFLP, RAPD, AFLP analysis
5. Numericals on DNA markers
6. Chi- square test for verifying Mendelian ratios
7. Assessment of genetic gain through selection
8. Calculation of selection differential and selection response
9. Estimation of inbreeding and path co-efficient
10. C-banding from heterochromatin
11. G-banding from heterochromatin

Course 3.2 mapping of course outcomes(COS) with Programme outcomes(POS):

	CO1	CO2	CO3	CO4	CO5
PO1					
PO2					
PO3	✓	✓	✓	✓	✓
PO4					✓
PO5					

Course 3.3: Molecular Biology

Learning Objectives (LO):

LO1. To understand cell structure and functions; Cell cycle and regulation; structure, function of biological membranes.
LO2. To understand structure and properties of Nucleic Acids, DNA replication, damage and repair mechanisms.
LO3. To understand mechanism of Transcription, Translation, post transcriptional and post translational modifications
LO4. To understand molecular models of DNA recombination, Types of mutations, and Mutagens
LO5. To understand regulation of gene expression and Environmental regulation of gene expression.

Course Outcome (CO): The student

CO1. Gets knowledge on Cell structure and functioning; Cell cycle; biological membrane
CO2. Acquires knowledge on nucleic acids structure, properties and principal functioning mechanisms of DNA
CO3. Gains knowledge on mechanisms of RNA synthesis, processing and protein synthesis
CO4. Gets knowledge on DNA recombination methods and mutations
CO5. Gains knowledge on Operon concept, and environmental regulation of gene expression.

Course SpecificOutcome (CSO):

CSO1. Able to isolate and quantitate plasmid, genomic DNAs.
CSO2. Able to separate and purify DNA, carryout restriction digestion of DNA and prepare competent cells.
CSO3. Become competent to apply principles and concepts of molecular biology in fisheries as well as aquaculture as the technological developments leading to new genetic approaches are inevitable for sustainable utilization of fisheries.

Unit-I

Cell structure and function in prokaryotes and eukaryotes. Cell cycle and its regulation.
Biological membranes: cell membrane, nuclear membrane, ion transport, Na/K phase, Molecular basis of signal transduction.

Unit-II

Nucleic Acids: Structures of DNA and RNA; Stereochemistry of bases and secondary structures; Chromatin structure; Properties of DNA -Tm, hyperchromicity, kinetic classes, buoyant density. DNA replication: Models of DNA replication in prokaryotes and eukaryotes; Mechanics of DNA replication; DNA methylation, Structure and function of DNA polymerases; Types of priming. Types and mechanisms of DNA damage and Repair

Unit-III

Transcription in Prokaryotes and eukaryotes – enzymes, initiation, elongation and termination. Post transcriptional modifications; Structure and synthesis of rRNA and tRNA. Genetic code, codon bias, types and structures of ribosomes, Wobble hypothesis. Translation in prokaryotes and eukaryotes: initiation, elongation, termination, and posttranslational modifications, concept of polysomes and protein structure.

Unit-IV

DNA recombination: Molecular models - homologous and site-specific recombination, crossing over, Holliday junction, transposition. Types of mutations, Mutagens – nitrous acid, UV, aflatoxin, bleomycin, ethidium bromide.

Unit-V

Regulation of gene expression in prokaryotes and eukaryotes - Operon concept, regulatory sequences and transacting factors. Environmental regulation of gene expression.

References:

Paul J Cell Biology Hinemanu
Friefelder D Microbial genetics
Albert et al Molecular biology of Cells
DeRoberties Cell and molecular biology
Watson et al Molecular biology of the gene B Cummings

Practical:

1. Plasmid DNA and Genomic DNA isolation & quantification: Plasmid mini-preparations
2. Agarose gel electrophoresis
3. Purification of DNA from an agarose gel
4. Restriction digestion of DNA
5. Preparation of competent cells
6. DNA ligation
7. Equipments in molecular biology

Course 3.3 mapping of course outcomes(COS) with Programme outcomes(POS):

	CO1	CO2	CO3	CO4	CO5
PO1					
PO2					
PO3	✓	✓	✓	✓	✓
PO4					
PO5					

Course 3.4: Marine Pollution and Bio-deterioration

Learning Objectives (LO):

LO1. To understand the sources of marine pollution. Toxicity and treatment methods.

LO2. To impart knowledge on oil pollution, thermal and radioactive pollution, solid dumping, mining and dredging operations and their effects on marine ecosystem. Treatment methods

LO3. To study the fouling and boring activities of marine organisms on marine structures, controlling of boring and fouling activities of marine organisms.

LO4.To study the strategies of global environmental methods, the role of biotechnology in mitigating the pollution and management.

LO5. To offer the students opportunity to study the environmental impact assessment-methods; enzymatic removal of hazardous organic substances biological treatment of waste water.

Course Outcome (CO):

CO1. The students will get knowledge about the various types of pollutants, their sources, transport paths, transport agents, their fate in the environment; controlling, monitoring and management methods of all those pollutants.

CO2. The students will get commendable knowledge on the recent topics such as application of biotechnology to mitigate the pollutants generated by industrial activities, to treat the pollutants; EIA methods and enzymatic removal of hazardous substances.

CO3. The knowledge acquired by the students on marine pollution may encourage them to develop, conduct and participate in the programmes against release of pollutants into the coastal environment.

CO4. The student will be aware of the hazardous effects of various pollutants released into the environment and take precautions to keep up his and his family health, which contribute to the health of the society.

CO5. The student may get appointment in the waste water management boards, pollution control boards and also teaching jobs in the higher education institutes.

Course Specific Outcome (CSO):

CSO1. The students will get jobs in the pollution control board, NGOs working on coastal ocean protection and conservation activities.

CSO2. The student will have a thorough understanding about pollutants which are hazardous to the health of humans and can keep up their health, contribute to mitigate the pollution.

CSO3.The student will be motivated to take up higher studies on pollution.

Unit - I

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

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

Unit - II

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

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

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

Unit - III

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

Borers: Effects and control measures.

Corrosion- definition, reactions, classification. Factors and preventive measures.

Unit - IV

Global environmental monitoring methods: status, objectives and limitations.

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

Environment Impact Assessment: Assessment of damage and problems of measuring the impact

Unit - V

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

References:

NielsenSE Tropical pollution

Kinne O Marine Ecology Vol. V John Wiley

Johnson R (Ed) Marine pollution Academic Press

Patin SA Pollution and boil.Resources of oceans Butterworths

Goldberg, E. D. 1974. The Health of the oceans, UNESCO Press. Paris.

Park, P .K, Kester D.R., J.W. Deudall and B.H Ketchum, 1983. Wastes in the Ocean. Vols. 1 to 3. Wiley Interscience Publishers, New York.

Eckenfelder WW. 2000. *Industrial Water Pollution Control*. McGraw Hill.

Gray NF. 2004. *Biology of Wastewater Treatment*. Oxford University Press.

Trivedy RK. 1998. *Advances in Wastewater Treatment Technologies*. Global Science.

Practical:

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

Course 3.4. Mapping of Course outcome with Programme outcome

	CO1	CO2	CO3	CO4	CO5
PO1					
PO2					
PO3	✓	✓	✓	✓	✓
PO4					
PO5					

M.Sc. Coastal Aquaculture and Marine Biotechnology
Fourth Semester

Course 4.1: Fish Pathology and Immunology

Learning objectives (LO):
LO1.To understand the general principles of disease diagnosis and aetiology of various diseases.
LO2.To understand various chemotherapeutic agents and vaccines
LO3. To acquire knowledge on non-specific and specific immune systems
LO4.To understand the general structure and properties of antigens and antibodies
LO5.To understands the concepts of monoclonal antibodies, immune genes and hypersensitivity.

Course outcomes (CO):
CO1.Able to gain knowledge on various diseases in aquaculture
CO2. Gains knowledge on various chemotherapeutic agents used in aquaculture
CO3. Gains knowledge on immune systems
CO4. Gains knowledge on antigens and antibodies
CO5. Gains knowledge on the production of monoclonal antibodies.

Course Specific Outcomes (CSO):
CSO1. Attains full knowledge on pathology and immunology

Unit- I

Introduction to fish pathology, Disease diagnosis: Epidemiology, laboratory studies, microbiological and histopathological studies. Viral, bacterial, fungal, protozoan, nutritional and environmental diseases of fish and shellfish, their control methods.

Unit- II

Chemotherapeutic agents: Types and mode of action. Chemicals, antibiotics, pre & probiotics in disease control. DNA and RNA vaccines. Recombinant vaccines, use of RNA interference. Biosecurity, disease control through environmental management.

Unit- III

Introduction to fish immunology - Historical developments; Phylogeny and ontogeny of immune system, Lymphoid tissues and cellular components of immune system, T and B cells.
Non-specific immune system: Phagocytosis, Complement system - function, components, complement activation.

Unit- IV

Specific defense mechanisms - Memory function and immunological tolerance.
Antigens and antigenicity, antigen processing, super antigens, haptens.
Antibody: Structure, types, theories of antibody formation, regulation of immune response.

Unit- V

Antibody mediated immune response: Polyclonal and monoclonal antibody production and applications. Basic concepts of aptamers, aptabodies and edible antibodies. Immune genes and their regulation, Hypersensitivity reactions; Auto-immune Disorders.
Invertebrate defense mechanisms: quasi immune response.

References:

Schoperclans W Fish diseases Oxian press
Riott I M Essentials of immunology Blackwell

Practical:

Procedure of disease diagnosis,
Tissue fixation, Microtomy and histology of various tissues,
Isolation and identification of pathogenic bacteria/fungi,
Disease diagnosis: Histological techniques for disease diagnosis- Necroscopy, Agglutination test. Identification of various parasites and diseases of fin and shell fishes, PCR, Serological techniques.
Preparation of antigen, rising antibodies, immuno electrophoresis, Isolation from antibody from serum.
NBT and Prophenol Oxidase tests, ELISA, Antibiotic sensitivity test, haematological tests of fish/shrimp.

Course 4.1: Mapping of course outcomes with Programme outcomes:

Course Outcomes(CO)	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Programme outcomes(PO)	**PO4**	**PO4**	**PO4**	**PO4**	**PO4**

Course 4.2: Marine Biotechnology

Learning Objectives (LO):

LO1. To understand scope of marine biotechnology; role of microbes in fermentation, decomposition and recycling processes.
LO2. To understand microbial transformation processes; Gene targeting approaches.
LO3. To understand methods of isolation of DNA, gene modification, blotting techniques.
LO4. To understand sequencing methods of proteins and nucleic acids, Transgenic biology.
LO5. To understand concepts of cell and tissue culture; cell lines, hybridization techniques; Stem cells and their applications in animal health.

Course Outcome (CO):

CO1. Gets knowledge on applications of marine biotechnology and microbial fermentation processes
CO2. Acquires knowledge on microbial transformation and gene targeting approaches.
CO3. Gains knowledge on methods of gene isolation and modification and various hybridization techniques.
CO4. Gets knowledge on various sequencing methods of proteins and nucleic acids and application of biotechnological tools.
CO5. Gets knowledge on cell and tissue culture methods; stemcells and applications.

Course SpecificOutcome (CSO):

CSO1. Able to do microbial transformations and also use microbes to obtain economically and commercially valuable products
CSO2. Able to apply DNA isolation, gene targeting, modifications, blotting and hybridization techniques and methods for improved production performance in aquaculture.
CSO3. Able to use DNA sequencing techniques and PCR to discover novel genetic markers for population studies, DNA barcoding and also in ecotoxicological studies.
CSO4. Able to develop cell lines, carryout various techniques of tissue culture and stem cells for therapy and develop improved varieties with desired characters.

Unit - I

Microbial fermentation, microbes in decomposition and recycling processes, aplications of biofermenters and biofertilizers, microbial transformations. Bioreactors: designing and types of bioreactors.

Unit - II

Gene targeting approaches in biotechnology, isolation of nuclear and extra nuclear DNA; gene modification techniques, Southern, northern and south-western blots, Colony hybridization.

Unit - III

Sequencing methods of proteins and nucleic acids: Sangers, Maxum and Gilbert; NGS, Types of Polymerase Chain Reaction and applications.Transgenic biology, allopheny.

Unit - IV

Cell and tissue culture: primary and secondary cultures, cell lines, callus culture, somaclonal culture, micropropagation, somatic embryogenesis, protoplast fusion, somatic hybridization and cybrids.
Stem cells and their applications in animal health.

Unit -V

Bioinformatics: History, definition, scope and applications, Data base: mining tools; database searching, similarity search, FASTA, BLAST.
Information networks: Gene bank sequence database, EBI-net; NCBI, Genome net, Protein database.
Phylogenetic analysis; Comparative genome analysis; Microarray analysis.

References:

Litchfield CD Marine Micribiology DHR
Bye & Ponnaiah Application of genetics in aquaculture CMFRI
Travan et al Biotechnology Tata-McGraw

Practical:

1. Microbial transformation of yeast/bacteria
2. DNA amplification using Thermocycler (Demo)
3. Horizontal Gel Electrophoresis (Demo)
4. Blotting techniques
5. Isolation of protoplasts from seaweeds and micro propagation.
6. Downloading of PDB IDs of enzymes from Protein Data Bank and structure prediction.

Course 4.2 mapping of course outcomes (COS) with Programme outcomes (POS):

	CO1	CO2	CO3	CO4	CO5
PO1					
PO2					
PO3					
PO4	✓	✓	✓	✓	✓
PO5					

Course 4.3: Bioactive Marine Natural products

Learning objectives (LO):

LO1. To understand principles and working mechanisms of various types of spectrophotometers.
LO2. To understand various separation and characterization techniques.
LO3. To understand antibiotic, antitumor, anti viral, antifouling anti inflammatory compounds of marine origin.
LO4. To gain knowledge on marine toxins and alkaloids.
LO5. To understand basic principles of pharmacology

Course outcomes (CO):

CO1. Gains knowledge on working mechanisms of various spectrophotometers.
CO2. Gains knowledge on various extraction and separation techniques.
CO3. Gains knowledge on Various bio active compounds of marine origin.
CO4. Gains knowledge on marine toxins.
CO5.Gains knowledge on principles of pharmacology.

Course Specific Outcomes (CSO):

CSO1. Gains complete knowledge on bioactive marine natural products
CSO2. Gains knowledge on various extraction, separation and characterization techniques.

UNIT- I

Introduction: Significance of marine natural products. Principle and applications of colorimeter, Flame photometer; Atomic absorption spectrophotometer, Inductively Coupled plasma Spectrophotometer (ICP) in quantification of compounds.

UNIT- II

Isolation techniques: Liquid - liquid extraction, membrane separation methods, chromatography techniques- Paper, Thin layer, Gas and liquid chromatography, HPLC, Ion-Exchange chromatography. Characterization techniques: IR, UV, NMR, Mass Spectroscopy.

UNIT- III

Types of important products: Antibiotic, anti-tumour, tumour-promotor, anti-inflammatory, analgesic, cytotoxic, anti-viral, anti-fouling compounds of marine origin.

UNIT- IV

Marine toxins: Saxitoxin, brevitoxin and ciguatoxin. Marine peptides & alkaloids: pyridoacridine, pyrrolocridine indole, pyrrole, isoquinoline, alkaloids.

UNIT- V

Basic principles of pharmacology: Classification and action of antibiotics and other antimicrobials. Green fluorescent protein from jelly fish and its applications. Pharmaceutical values and drug action.

References:

David HA et al Marine Biotechnology Plenum
Scheur PJ Marine Natural Products Academic
DS Bhakuni DS Rawat Bioactive marine natural products Springer & Anamaya

Practical:

1. Separation of amino acids by paper chromatography
2. Identification of amino acids by paper chromatography
3. Preparation of crude extract by methanol:hexane solvent from molluscs, sponges and mangrove plants
4. Separation of crude extract fractions by column chromatography
5. Separation of fractions/compounds by TLC
6. Testing of Anti-bacterial activity of crude extract
7. Bio - autography testing.
8. Verification of Beer's law in spectrophotometer.
9. Organisms/plants having bioactive importance.

Course 4.3 mapping of course outcomes (COS) with Programme outcomes (POS):

	CO1	CO2	CO3	CO4	CO5
PO1					
PO2					
PO3					
PO4	✓	✓	✓	✓	✓
PO5					