DEPARTMENT OF MARINE LIVING RESOURCES

Revised Syllabus

With effect from 2022-2023

ANDHRA UNIVERSITY
Visakhapatnam

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

Paper No	Paper Title	Maximum Marks			Credits		
		Theory (End exam + Mid+Asgnmt)	Practical (Semester end)	Total marks	Theory	Practical	Total
1.1	Oceanography and Marine Biology	70+20+10	50	150	4	2	6
1.2	Fin Fish Culture	70+20+10	50	150	4	2	6
1.3	Crustacean Farming	70+20+10	50	150	4	2	6
1.4	Aquaculture Engineering	70+20+10	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+Asgnmt)	Practical (Semester end)	Total marks	Theory	Practical	Total
2.1	Molluscan& Seaweed Farming	70+20+10	50	150	4	2	6
2.2	Soil and Water Quality Management in Aquaculture	70+20+10	50	150	4	2	6
2.3	Seed Production and Hatchery Management	70+20+10	50	150	4	2	6
2.4	Marine Microbiology	70+20+10	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+Asgnmt)	Practical (Semester end)	Total marks	Theory	Practical	Total
3.1	Biochemistry and Fish Nutrition	70+20+10	50	150	4	2	6
3.2	Genetics in Aquaculture	70+20+10	50	150	4	2	6
3.3	Molecular Biology	70+20+10	50	150	4	2	6
3.4	Marine Pollution and Bio-deterioration	70+20+10	50	150	4	2	6
3.5	**MOOC-I**						2
	IPR (Value added course)						
	Total marks	**400**	**200**	**600**	**16**	**8**	**26**
M.Sc. Coastal Aquaculture and Marine Biotechnology–IVSemester							
		Theory (End exam + Mid+Asgnmt)	Practical (Semester end)	Total marks	Theory	Practical	Total
4.1	Fish Pathology and Immunology	70+20+10	50	150	4	2	6
4.2	Marine Biotechnology	70+20+10	50	150	4	2	6
4.3	Bioactive Marine Natural Products	70+20+10	50	150	4	2	6
4.4	**MOOC-II**						2
4.5	Project	100		100	4	-	4
	Viva-voce		50	50		2	2
	Research Methodology (VAC)						
	Total marks	**400**	**200**	**600**	**16**	**8**	**26**

M.Sc. coastal Aquaculture and Marine Biotechnology

Course Outcome: To supply trained manpower in the field of Coastal Aquaculture and Marine Biotechnology besides producing entrepreneurs. After completion of the course, the post graduate in Coastal Aquaculture and Marine Biotechnology should be able to

Master the concepts in Oceanography, Marine Biology, Biochemistry, Aquaculture Engineering, Biochemistry,
Molecular biology, Marine Microbiology and Marine Biotechnology.
Apply general principles of Seed production and Hatchery management, Fin Fish, Shellfis culture, and genetics Genetics in Aquaculture.
Practice the techniques of Fish Pathology and immunology to prevent or treat the disease outbreak in Aquaculture systems.

M.Sc. Coastal Aquaculture and Marine Biotechnology
First Semester

Paper 1.1: Oceanography and Marine Biology

Learning Objectives:

To impart knowledge on the various aspects such as temperature, light, salinity, waves, tides as physical parameters and as ecological parameters; heat distribution between continent and oceans, micronutrient distribution, regeneration of nutrients, dissolved oxygen, carbon dioxide and other important gases, their biological importance in the productivity of oceans.

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

Outcome:

The student will get sound knowledge on the above aspects which helps the student understand importance of the physical and chemical properties seawater as ecological parameters and physical parameters to apply the same in the management of culture candidate species when they undertake culture activity.

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

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

Unit - I

Dimensionsofoceans;Physicalparametersofsea:Tides,waves,light,temperature,currents,density, pressure. Heatbudgetofthe oceans.
Soundanditspropagationinthesea.

Unit - II

Chemicalparametersofthesea:salinity,dissolvedoxygen,carbondioxide,pH,nutrientsandtraceelements.Compositionof seawaterandbrackish water.

Unit -III

Classificationofmarinehabitatsandecologicaldivisionsofthe ocean.Plankton,nekton, benthos and theiradaptations, methods of collection
Ecologyofcoralreefsandmangrovehabitats;theirspecialfeatures.Sea-ranchingofeconomicallyimportant marineorganisms.

Unit - IV

Lawpertainingtotheseas:HistoricalperspectivesinInternationalnegotiationsandsettlementsoveropen seas. Modern law ofthe sea.
Remotesensingapplicationsinoceanographyandmarinebiology.
ElementsofGeographicInformationSystems(GIS)anditsroleinoceanography.

Unit - V

NationalandInternationalInstitutes ofmarine 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

Practicals:

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.

Paper 1.2: Finfish Culture

Learning Objectives:

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

To study the biology and life cycle of important cultivable fish species

To study the various materials are required for construction of fish ponds, cages, pens and race-ways

To study the variouspractices for culture of finfish species suitable for coastal aquaculture.

Outcome:

The student can acquire sound knowledge on biology, life cycle of important marine fish species and their culture.

Student can also gain knowledge on management of fish ponds.

Unit-I

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

Unit-II

Importantcultivablefinfishspeciesandtheirbiology 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 foraquaculture.

Classification of culture systems: ponds, pens, cages, raceways

Pondpreparationandfertilization,eradicationofweedand predatoryfinfishes.

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

Practicals:

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

Paper 1.3: Crustacean Farming

Learning Objectives:

To know the status of crustacean farming in India and abroad. To learn the different types of farming practices of crustaceans and types of feed and nutritional quality involved in farming.

Outcome:

To understand the biology and culture of cultivable species of shrimps, crabs and lobsters.

UNIT I

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

UNIT II

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

UNIT III

Supplementaryfeeding:dryfeeds,wetfeeds,roleofartificialfeeds;feed ingredients and nutritionalquality. Nutritional quality and Feed formulations.

UNIT IV

Typesoffarming practices:Traditional,extensive,semi-intensive, intensive, super-intensive and ultra-intensive.Farming of prawn, shrimp, crab, lobster. Harvesting, handling, Marketing and economics.

UNIT V

Culturein Cages,Re-circulatoryaquaculturesystems andRicefields. Types of cages, materialsused for construction of cages.

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

Practicals:

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

Paper 1.4: Aquaculture Engineering

Learning objectives:

To understand the general principles of Aquaculture Engineering including the Soil mechanics, pedology and site survey.

To understand the general principles of fluids, properties of Engineering materials used in the construction of hatchery, farm, raceways, cages and pens.

To understand the fundamentals of waves, tides, water filtration and recirculatory aquaculture systems.

To understand the principles and working mechanisms of pH meter, Salinometer, Spectrophotometer, DO meter, Ozoniser, Pumps, Motors and automated feeding equipment.

Outcome:

After study of the subject the candidate should be able to understand and apply principles of soil engineering, site survey , design and construction of hatchery, farm, cages, pens, raceways and earthwork estimations in Aquafarming.

Unit- I

Scope and importance of aquaculture engineering. Origin of soil, Soil profile,Typesofsoils,properties of soil ;soiltexture&structure,soil-water Relationships.

Unit- II

Computationofareabyvarioussurveymethods(chain,planetable,magnetic compassand leveling. Methods of Earth workestimations (Average depth, Average cross sectional area, Prismoidal and Trapezoidal formulae)

Unit- III

Propertiesoffluids,computationoftimetofill/draina pond/tank.
Fundamentalsofwaves&tides and theireffectsonaquacultureinstallations.
Engineeringpropertiesofmaterials, Typesofmaterialsusedinaquaculture.

Unit- IV

Technicalconsiderationsinsiteselectionforhatchery/farm/cages
Designandconstructionofahatchery(carp/shrimp),pond,cages,pens, raceways.pumpsandaerators (types, selection and positioning).

Unit- V

Filtrationofwaterforaquaculture;waterre-circulatory equipments.Different types of feeding equipment, feed control systems, dynamic feeding systems.Working principles of pH meter, salinometer, spectrophotometer, D.O. meter, Secchidisc,heaters,Ozonisers,UVfiltrationunit.

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

Practicals:

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

M.Sc. Coastal Aquaculture and Marine Biotechnology
Second Semester

Paper 2.1: Molluscan and Seaweed Farming

Learning Objectives:
To study the importance and present status of molluscan and sea weed farming in India and abroad
To study the biology and life cycle of important cultivable molluscan and sea weed species
To study the various materials are required for construction of culture systems
To study the variouspractices for culture of mussels, oysters, pearl oysters, cephalopods and commercially important sea weeds species for coastal aquaculture.

Outcome:
The student can acquire sound knowledge on biology, life cycle of important marine molluscans and sea weed species and their culture. Student can also gain knowledge on post harvesting technology and preparation of various by- products.

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 seaweeds 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 seaweeds in India and abroad. Farming of Agar, Algin, Carrageenan yielding seaweeds and green seaweeds. 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

Practicals:

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.

Paper 2.2: Soil and water quality management in Aquaculture

Learning Objectives:

To understand importance of soil and water interactions.
To study the physic-chemical properties of soil and water.
Importance of nutrients.
Fertilizers and their applications.
Importance of water treatment devices
Aquatic weed management.

Outcome:

To acquire knowledge on various parameters of soil and water in aquaculture.
To monitor and regulate the parameters required for cultivable species in aquaculture.

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 andBiological Methods for Seawater Analysis*. Pergamon Press.
Rajagopalsamy CBT & Ramadhas V. 2002. *Nutrient Dynamics inFreshwater Fish Culture System*.
Daya Publ. Sharma LL, Sharma SK, Saini VP & Sharma BK. (Eds.). 2008. *Management of Freshwater Ecosystems*. Agrotech Publ. Academy.

Practicals:

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

Paper 2.3: Seed production and Hatchery Management

Learning Objective:
To provide knowledge on seed production and hatchery management of fin fish and shell fish.

Outcome:
To understand the basic concepts of brood stock management and seed production of fin fish and shell fish. To learn about the wild seed collection methods and nutritional requirements of larval forms.

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,musselsandseaweeds.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,musselsandseaweeds.

UNIT IV

Nutritional requirements of finfish and shellfish larvae: live feeds - *Spirulina*, micro algae, Artemiaand 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

Practicals:

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.

Paper 2.4: Marine Microbiology

Learning objectives:
To understand the general principles of microscopy, microbiology including the morphology , taxonomy and culture methods of Virus, Bacteria, Virus, Microalgae and Protozoans.
To understand techniques of sterilization, enumeration and preservation of Bacteria.
To understand the importance of pathogenic micro organisms in fish preservation and concepts of quality management in fish processing.

Outcome:
After study of the subject the candidate should be able to understand and apply the concepts in microbiology, fish processing, culture methods and quality management in Aquaculture processing industry.

Unit- I

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

Unit- II

Microbesinthesea:viruses,bacteria,fungi,microalgaeandprotozoans and their classification. Microbes in extreme environments and their significance- thermophiles, psychrophiles, halophiles and barophiles.

Unit- III

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

Unit- IV

Methodsofcontrollingmicrobes:physical,chemical&chemotherapeutic methods. Sterilizationtechniquesemployedinmicrobiologicalstudies.Microorganisms in frozen, canned and dried products and their control, fish quality and evaluation and different indices of quality.

Unit- V

Concepts of total managementin 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 microbiologyHutchinson & 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.

Practicals:

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.

M.Sc. Coastal Aquaculture and Marine Biotechnology
Third Semester

Paper 3.1: Biochemistry and Fish Nutrition

Learning Objective:
To understand the basic principles of biochemistry and fish nutrition, enzymes, basic concepts of feed formulation and different feed processing techniques.

Outcome:
To obtain knowledge on metabolism of macromolecules and interlinking of different energy producing pathways. Nutritional requirements of commercially important finfish and shellfish. Feeding requirement and availability of ingredients for aqua-feeds and different types of equipment used in feed manufacturing. To obtain knowledge on feed processing, storage, economics and evaluation criteria.

Unit -I

Carbohydrates, proteins, lipids and their metabolism.Biological membranes: transport of molecules.Enzymes:classification,types,factorsaffectingenzymecatalysis,control of enzymatic action and immobilization ofenzymes.

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

Practicals:

1) Determinationof 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

Paper3.2: Genetics in Aquaculture

Learning Objectives:

To learn principles of genetics, application of genetics in aquaculture to produce hybrids, sex reversal, chromosomal ploidy, in-vitro fertilization.

To learn various tools for identification of species at molecular level.

Outcome:

Student procure knowledge on application of genetics in fishes and shellfishes to produce high quality species.

Student acquire knowledge on various techniques/ tools for identification of species at molecular level.

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*. 4thEd. 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*.

Practicals:

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

Paper 3.3: Molecular Biology

Learning Objectives:

To understand cell structure and functions in prokaryotes and Eukaryotes including Cell cycle and signal transduction.
To understand structure of Nucleic Acids, their replication, protein synthesis,
To understand molecular models of DNA recombination, mutations, Mutagens, DNA damage and repair.
To understand regulation of gene expression in prokaryotes and eukaryotes.

Outcome:

After study of the subject the candidate should be able to understand and apply principles molecular biology in aquaculture.Molecular biology forms the basis for development of kits for disease diagnosis

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

Practicals:

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

Paper 3.4: Marine Pollution and Bio-deterioration

Learning Objectives:

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

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

Outcome:

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

Unit - I

Sourcesofmarinepollution:dynamics,transportpathsandagents.
Compositionofdomestic,industrialandagriculturaldischarges;theirfateinthemarine environment.Toxicityand treatment methods.

Unit - II

Oilpollution:Sources,compositionanditsfateinmarinehabitats.Toxicityandtreatme ntmethods.
Thermalandradioactivepollution:sources,disposalsystemsofheatedeffluents,effect sandtreatment.
Soliddumping,mininganddredgingoperations:theireffectsonmarineecosystem,ma nagementof solidwaste.

Unit - III

Biofouling and bio-deterioration: Biofilm formation-primary, secondary, tertiary colonizers.Effectsof biofoulingandcontrolmeasures: manual,mechanical, andchemical
Borers:Effectsandcontrolmeasures.
Corrosion-
definition,reactions,classification.Factorsandpreventivemeasure s.

Unit - IV

Globalenvironmental monitoringmethods: status, objectivesand limitations.
Monitoring strategies of marine pollution:critical pathway approach and mass balancing.EnvironmentImpactAssessment:
Assessmentofdamageandproblemsofmeasuringtheimpact

Unit - V

Roleofbiotechnologyinmarine pollution control. Bio-deterioration: Biofilm formation- primary, secondary and tertiary colonization of organisms on marine structures. Enzymatic removal of hazardous substances. Wastesfromfishprocessingunitsandtheirtreatment-removalofnitrogenandphosphorus. 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.

Practicals:

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

M.Sc. Coastal Aquaculture and Marine Biotechnology
Fourth Semester

Paper 4.1: Fish Pathology and Immunology

Learning objectives:

To understand the general principles of pathology , including microbiological, Histopathological, molecular diagnostic methods.
To understand various aetiological agents and their pathogenicity, prophylaxis and treatment methods.
To understand the concepts of immune systems of fish and shrimp.
To understand the action of antibiotics and vaccines in the disease management.

Outcome:

After study of the subject the candidate should be able to understand the Fish pathology in general and prevention ,diagnosis and treatment of diseases in fish in particular.

Unit- I

Introduction to fish pathology, Diseasediagnosis:Epidemiology,laboratorystudies,microbiological and histopathologicalstudies. Viral,bacterial,fungal, protozoan, nutritional and environmental diseases of fish and shellfish, their controlmethods.

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. Basicconcepts 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

Practicals:

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.

Paper 4.2: Marine Biotechnology

Learning Objectives:
To provide knowledge to the student on Microbial fermentation applied in the industries, applicationsofbiofermentersand biofertilizers,microbial transformations, designing the bioreactors; various methods adopted in the genetic engineering; DNA sequencing; tissue culture techniques and bioinformatics.

Outcome:
The student get thorough knowledge on different microial fermentation techniques popularly used in the industry and can serve the pharma industry, sea food industry leather industry, textile industry.
The student will have thorough knowledge in the genetic engineering techniques and can operate high-end instruments such as thermocycler, oxford nanopore, horizontal, vertical gel electrophoresis units.
The student will get knowledge on working with various DNA/ protein databases, can operate various bioinformatics software packages, can conduct *in silico* studies, which are useful to the students when pursued higher studies.

Unit - I

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

Unit - II

Gene targeting approaches in biotechnology, isolation of nuclear and extra nuclear DNA;genemodificationtechniques,Southern,northernandsouth-westernblots,Colonyhybridization.

Unit - III

Sequencing methods of proteins and nucleic acids: Sangers, Maxum and Gilbert; NGS,TypesofPolymeraseChainReactionandapplications.

Transgenicbiology,allopheny.

Unit - IV

Cell and tissue culture: primary and secondary cultures, cell lines, callus culture, somaclonalculture, micropropagation, somatic embryogenesis, protoplast fusion, somatic hybridizationandcybrids.
Stemcellsandtheirapplicationsinanimalhealth.

Unit -V

Bioinformatics:History,definition,scopeandapplications,Database:miningtools;dat abasesearching,similaritysearch,FASTA,BLAST.
Informationnetworks:Genebanksequencedatabase,EBI-net;NCBI,Genome net,Protein database.
Phylogeneticanalysis;Comparativegenomeanalysis;Microarrayanalysis.

References:

Litchfield CD Marine Micribiology DHR

Bye & Ponnaiah Application of genetics in aquaculture CMFRI

Travan et al Biotechnology Tata-McGraw

Practicals:

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.

Paper 4.3: Bioactive Marine Natural products

Learning objectives:

To understand the general principles and techniques of extraction, separation , characterization of Bioactive compounds of marine origin.

To understand the sources and action of various antibiotic, anti tumour, anti inflammatory , anti viral, and anti fouling compounds of marine origin.

To understand basic principles of pharmacology including the action of drugs.

Outcome:

After study of the subject the candidate should be able to extract, separate, characterize the bioactive compounds of marine origin besides conducting bioautographic and pharmacological studies .

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

Typesofimportantproducts:Antibiotic,anti-tumour,tumour-promotor, anti-inflammatory, analgesic, cytotoxic, anti-viral, anti-fouling compounds of marineorigin.

UNIT-IV

Marine toxins: Saxitoxin, brevitoxin and ciguatoxin. Marinepeptides&alkaloids:pyridoacridine,pyrrolocridineindole, 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

Practicals:

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. Bioautography testing.
8. Verification of Beer's law in spectrophotometer.
9. Organisms/plants having bioactive importance.