ALAGAPPA UNIVERSITY

(A State University Established in 1985)
Karaikudi - 630003, Tamil Nadu, India

2017 — Accredited with A+ Grade by NAAC (CGPA : 3.64)

2018 — MHRD Govt. of India, UGC — Graded as Category - 1 & Granted Autonomy

2018 — MHRD — Swachh Campus Rank : 4

2019 — nirf NATIONAL INSTITUTIONAL RANKING FRAMEWORK — Rank : 28

2019 — QS — India Rank : 20, BRICS Rank : 104, Asia Rank : 216

DEPARTMENT OF OCEANOGRAPHY AND COASTAL AREA STUDIES

M.Sc., MARINE BIOLOGY (5 YEARS INTEGRATED)

[Choice Based Credit System (CBCS)]

[For the candidates admitted from the academic year 2019 -2020]

Panel of Members-Broad Based Board of Studies

Chairperson **Dr.C.Stella, Professor and Head,** Department of Oceanography and Coastal Area Studies, Alagappa University, Karaikudi. Teaching Experience: 28, Research experience: 40, Area of Research: Biodiversity, Ecology- EIA and Molluscan Taxonomy &Biology.	
Foreign Experts **Dr.Nilmini Viswaprakash,** Assistant Professor for Anatomical Sciences, Cauburn Campus, nviswaprakash@auburn.vcom.edu, Teaching Experience –20 Year, Research Experience-25, Area of Research: Marine Biology.	
Indian Experts **Dr. C. Raghunathan,** Joint Director / Scientist-E, Zoological Survey of India. raghuksc@rediffmail.com, Professional experience: Research – 25 Year, Area of Research: Marine Biology, Zoology and Ecology.	
Dr.Gulab Khedkar, Director, Paul Hebert Centre for DNA Bar-coding and Biodiversity Studies, Dr. Babasaheb Ambedkar Marathwada University, Aurangabad- India (MS). gdkhedkar@gmail.com, Teaching Experience – 20 Year, Research Experience- 27, Area of Research: Molecular genetics and genomics.	
Dr. T. T. Ajith Kumar. Nor, Principal Scientist, ICAR–NBFGR, Peninsular and Marine Fish Genetic Resource Centre, Cochin, ttajith87@gmail.com. Professional experience: 24Years, Area of Research: Aquaculture for conservation and livelihood development.	
Dr. P. Madeswaran, Scientist-G, Ministry of Earth Sciences, National Centre for Coastal Research.Workexperience:30Years,AreaofResearch:CoastalandMarineAreaManagement,	
Expert from Industry **Dr. M. Jaikumar** ,Field Scientist, Sea6 Energy Pvt ltd, Ccamp Lncubator, NCBS –TIFR, GKVK Post, Bellary road, Bangalore - 560065.	

Members **Dr.V. Sugumar**, Assistant Professor in Oceanography and Coastal Area Studies, Alagappa University, Karaikudi, Teaching Experience: 11 years, Research Experience: 15 years, Area of Research: Crustacean Biology, Marine Biomaterial.	
Dr.S.Paramasivam,AssistantProfessorinOceanographyandCoastalAreaStudies,Alagappa University, Karaikudi, Teaching Experience: 11 years, Research Experience: 15 years, Area of Research: Marine Microbiology/Seafoodsafety.	
<u>Alumni</u> **Dr.V.Yoganandan**, Assistant ProfessorDepartment of Marine Science, Bharathidasan University,Tiruchirappalli–620024.yoganandan@bdu.ac.in,TeachingExperience: 10 Years: Research Experience: 15 Years. Area of Research: Paleoceanography/Paleoclimate, Climate change, Biogeochemistry, Climate change impact on Marine environment.	

REGULATIONS AND SYLLABUS

[For the candidates admitted from the academic year 2019 onwards]

1. Programme general objective

ThestudentsintheMarineBiologyprogramattheuniversitywillacquirespecializedanddeep knowledge,relevanttotopicssuchasmarineecology,marinebiology,biogeography,invasionbiology, population genetics, biosystematics and general evolutionary themes based on the marineorganisms.

2. Programme specific objectives

1. To make students learn about the diverse groups of marine organisms, variety of ecosystems and habitats and current events in today's oceans such as overfishing, ocean acidification, restoration and marine protectedareas.
2. The students gain knowledge on ecology and evolution, the marine environment, taxonomic classification of marine organisms, a survey of major marine ecosystems and marineconservation.
3. To increase awareness of anthropogenic impacts in the marine environment and potentialsolutions.

3. ProgrammeOutcome

The graduates of Marine Biology program will:

1. Explain key concepts and terminology in biology/ marinebiology
2. Describe typical marine habitats and associated flora andfauna.
3. Understand interactions between marine organisms and the environment, and adaptations of marineorganisms.
4. Understand the dynamics and structural processes in marine populations andcommunities

4. Eligibility foradmission

A pass in higher Secondary (+2) with Biology (or) Bio-maths (with 50% Marks for others and for SC/ST 45% Mark)

5. Duration ofCourse

The course shall consist of five academic years, divided into ten semesters.

6. TeachingMethods

The classroom teaching would be through conventional lecture, use of OHP, PowerPoint presentation, novel innovative teaching ideas like television, smart board and computer-aided instructions. Periodic field visit enables the student for gathering the practical experience and up to dateindustrialscenario.Studentseminarswouldbearrangedtoimprovetheircommunicativeskills. Inthelaboratory,safetymeasuresinstructionwouldbegivenforthesafehandlingofchemicalsand instruments. The lab experiments shall be conducted with special efforts to teach scientific knowledge among students. The students shall be trained to handle advanced instrumental facilities and shall be allowed to do experiments independently. The periodic test will be conducted for students to assess their knowledge. Slow learners would be identified and will be given special attention by remedial coaching. Major and electives would be held in the Department and for Non-major electives students have to undertake other subjects offered by otherdepartments.

7. Examinations

The examinations shall be conducted separately for theory and practicals to assess the knowledge acquired during the study. There shall be two systems of examinations viz., internal and external examinations. The internal examinations shall be conducted as Continuous Internal Assessment tests I and II (CIA Test I & II). The internal assessment shall comprise of maximum 25 marks for each subject. The following procedure shall be followed for awarding internal marks.

Internal Assessment

Theory paper (Internal Assessment)

Average marks of two CIA test	15 marks
Seminar/group discussion/quiz	5 marks
Assignment/field trip report/case study report.	5 marks
Total	**25 marks**

Practical's (Internal Assessment)

	I to III	IV to V
CIA tests	35 marks	20 marks
Attendance	5 marks	5 marks
Total	**40 marks**	**25 marks**

External Examinations

The external examinations of theory and practicals shall be conducted for three hours duration to each paper at the end of each semester. The external examinations shall comprise of a maximum of 60 and 75 marks for each practical subject. The candidate failing in any subject will be permitted to appear for each failed subject in the subsequent examination. Practical examinations and demonstration of experiments shall be conducted at first, second, and third semester. At the end of the fourth semester, the project work viva-voce examination will be held based on the dissertation report submitted by the student. Two examiners (one internal and one external) will jointly conduct the viva-voce examination for evaluation.

Scheme of External examination

Question paper pattern (Theory)

1. The question paper carries a maximum of 60 and 75marks.
2. The question paper consists of three sections, namely Part-A, B, andC.
3. **Part-A** consists of 10 questions of 2 marks each (10 x 2 = 20 marks) with no choice. The candidate should answer allquestions.
4. **Part-B**consistsof5eitherorchoicequestions.Eachquestioncarries5marks(5x5=25marks).
5. **Part-C** consists of 5 questions. Each question carries 10 marks. The candidate should answer any three questions (10 x 3 = 30marks).

Question paper pattern for IV and V year (Practical) (Maximum 75 marks)

1. MajorPractical 15 Marks
2. MinorPractical 10 Marks
3. Experimentalsetup 5Marks

4. Spotters 25Marks
5. Viva-voce 10Marks
6. PracticalRecordNote 10 Marks

Total 75 Marks

8. Passingminimum

a) For Internal and External Examination, Passing Minimum shall be of 50% (Fifty Percentage) of the maximum marks prescribed for thepaper.

b) In the aggregate (External + Internal), the passing minimum shall be of 50% for each Paper/Practical/Project andViva-voce.

c) Grading shall be based on overall marks obtained (internal +external).

9. Dissertation Work (Maximum Marks:100)

The duration of the Dissertation Work shall be a minimum of three months in the fourth semester.

a) Plan ofwork

Thecandidateshall undergoDissertationWorkduringthefourthsemester.Thecandidateshould prepare a scheme of work for the dissertation and should get approval from the guide. The candidate, after completing the dissertation work, shall be allowed to submit to the university at the end of the fourth semester. If the candidate is desirous of availing the facility from other universities/laboratory,theywill be permittedonlyafter gettingapprovalfromtheguide. In such a case, the candidate shall acknowledge the same in theirdissertation.

b) No. of copies ofdissertation

The candidate should prepare three copies of the dissertation and submit the same for the evaluation of examiners. After evaluation, one copy will be retained in the department library, and the student shall hold one copy.

c) Format to be followed fordissertation

The format /certificate for dissertation to be followed by the student are given below

- Title page
- Certificate
- Acknowledgment
- Content asfollows:

Chapter No	Title	Page No
1	Introduction	
2	Materials and Methods	
3	Results	
4	Discussion	
5	Summary	
6	References	

d) Format of the titlepage

Title of Dissertation

Dissertation submitted in partial fulfilment of the requirement for the degree of Master of Science in Marine Biology(Five Year Integrated) to the Alagappa University, Karaikudi -630003.

By
(Student Name)
(Register Number)
University Logo

Department of Oceanography and Coastal Area Studies
Alagappa University

(A State University Accredited with "A+" grade by NAAC (CGPA: 3.64) in the Third Cycle and Graded as Category-I University by MHRD-UGC, 2019: QS ASIA Rank-216, QS BRICS Rank-104, QS India Rank-20)

Karaikudi - 630003
(Year)

Format of certificate

Certificate

This is to certify that thedissertationentitled_____submitted in partial fulfillment for the requirement of the Degree of Master of Science in Department of Oceanography and Coastal Area Studies to the Alagappa University, Karaikudi is a bonafide record of research work doneby Mr./Mrs_____under my supervision and guidance and that no partofthedissertationhasbeensubmittedfortheawardofdegree,diploma,fellowshiporothersimilar titles or prizes and that the work has not been published in part or in full in any scientific journal or magazines.

e) Dissertationevaluation

Dissertation Work	:	50 Marks
Internal Assessment	:	25 Marks
Viva -voce	:	25 Marks
Total	**:**	**100 Marks**

10. Village Extension Programme(VEP)

The Sivaganga and Ramnad districts are very backward districts where a majority of people lives in poverty. The rural mass is economically and educationally backward. Thus the aim of the introductionofthisVillageExtensionProgrammeistoextendouttoreachenvironmentalawareness, social activities, hygiene, and health to the rural people of this region. The students in their third semesterhavetovisitanyoneoftheadoptedvillageswithinthejurisdictionofAlagappaUniversity and can arrange various programs to educate the rural mass in the following areas for threedays.

1. Environmentalawareness
2. Hygiene andHealth

A minimum of two faculty members can accompany the students and guide them.

11. Maximum duration for completion of thecourse

The maximum period for completion of Degree shall not exceed ten semesters.

12. Commencement of regulation

These regulations shall come into effect from the academic year 2019-2020 for students who are admitted to the first year of the course during the academic year 2019-2020.

13. Industrial visit/Internship/Field/Institutionalvisit:

Students have to undertake an industrial / Internship/Field/ institutional visit/educational tour and have to submit a report for evaluation (Satisfactory / Not Satisfactory).

14. Classification of the successfulcandidate

A candidate who secured not less than 60% of the aggregate marks in the whole examination shallbedeclaredtohavepassedtheexaminationinFirstclass.Allothersuccessfulcandidatesshall be declared to have passed in the Second class. Candidate who obtains 76% of marks in the aggregate shall be deemed to have passed the examination in first class with distinction provide they should have passed all the examination at the firstappearance.

Candidateswhopassedalltheexaminationsprescribedforthecourseinthefirstinstanceandwithin two academic years from the year of admission to the course are alone eligible for university ranking.

A candidate is deemed to have secured the first rank provided if he/she should have passed all the papersinthefirstattemptitselfandshouldhavesecuredthehighestCumulativegradepointaverage (CGPA).

Eachstudentshouldhavetaken**230**creditstocompletethecourse.Eachpapercarries**4/3/2**credits with 50% marks in the university examination and 50% marks inCIA.

Raw score	**Letter Grade**	**Description**	**Grade point**
91 and above	S	First Class-Exemplary	9.01-10
76-90	D	First Class-Distinction	7.51-9.00
61-75	A	First Class	6.01-7.50
56-60	B	Second Class	5.51-6.00
50-55	C	Second Class	5.00-5.50
Below 50	RA	Re-appear	-
I - inadequate attendance; W-withdrawal from the course			

SCHOOL OF MARINE SCIENCES
DEPARTMENT OF OCEANOGRAPHY AND COASTAL AREA STUDIES
ALAGAPPA UNIVERSITY, THONDI CAMPUS
M.Sc. MARINE BIOLOGY (5 YEARS INTEGRATED PROGRAMME)

COURSE CREDIT STRUCTURE

Course			Cr.	Hrs./ Week	Marks		Total
Part	Subject code	Name			Int.	Ext.	
FIRST YEAR FIRST SEMESTER							
I	911T/911F	**Tamil / French – I**	3	3	25	75	100
II	912E	**English – I**	3	3	25	75	100
III	548101	Physical Oceanography	4	4	25	75	100
	548102	Chemical Oceanography	4	4	25	75	100
	548103	Practical – I	3	6	40	60	100
	548104	Practical – II	3	6	40	60	100
	9MB1A1	**Allied – I** – Theory – **Chemistry**	4	4	25	75	100
		Total	**24**	**30**	**--**	**--**	**700**
SECOND SEMESTER							
I	921T/921F	**Tamil / French – II**	3	3	25	75	100
II	922E	**English – II**	3	3	25	75	100
III	548201	Biological Oceanography	3	3	25	75	100
	548202	Ecology and Zoogeography	3	3	25	75	100
	548203	Practical –III	3	6	40	60	100
	9MB2A1	**Allied – II** – Theory – Chemistry	3	3	25	75	100
	9MBP1	**Allied – I** – Practical – Chemistry	3	6	40	60	100
IV		**Environmental Studies**	3	3	25	75	100
		Total	**24**	**30**	**--**	**--**	**800**
SECOND YEAR THIRD SEMESTER							
I	931T/931F	**Tamil / French – III**	3	3	25	75	100
II	932E	**English – III**	3	3	25	75	100
	548301	Invertebrate	3	3	25	75	100
	548302	Vertebrate	3	3	25	75	100
	548303	Practical– IV	3	6	40	60	100
	548304	Practical – V	3	6	40	60	100
	9MB3A2	**Allied – III** – Botany	3	3	25	75	100
	9MB3P2	**Allied – II** – Practical (Botany)			--	--	---
IV		**Non-major Elective – I**	2	3	25	75	100
V		**Extension activities**			100	--	100
		SLC – MOOC	Extra Credit		-	-	-
		Total	**23**	**30**	**--**	**--**	**900**
FOURTH SEMESTER							
I	941T/941F	**Tamil / French – IV**	3	3	25	75	100
II	942E	**English – IV**	3	3	25	75	100

III	548401	Cell and Molecular biology	3	3	25	75	100
	548402	Developmental Biology	3	3	25	75	100
	548403	Practical -VI	3	6	40	60	100
	9MB4A2	**Allied – IV** – Theory (Botany)	3	3	25	75	100
	9MB4P2	**Allied – II** – Practical (Botany)	3	6	40	60	100
		Non-major Elective – II	2	3	25	75	100
		SLC - MOOC	Extra Credit		-	-	-
		Total	**23**	**30**	**--**	**--**	**800**
THIRD YEAR - FIFTH SEMESTER							
III	548501	Biochemistry	5	5	25	75	100
	548502	Coastal and brackish water Aquaculture	5	5	25	75	100
	548503	Practical-VII	3	6	40	60	100
	548504	Practical-VIII	3	6	40	60	100
		Elective	4	4	25	75	100
		Elective	4	4	25	75	100
		Total	**24**	**30**	**--**	**--**	**600**
SIXTH SEMESTER							
III	548601	Animal physiology	5	5	25	75	100
	548602	Fish and Fisheries	5	5	25	75	100
	548603	Practical-IX	4	8	40	60	100
	548604	Practical-X	4	8	40	60	100
		Elective	4	4	25	75	100
		Total	**22**	**30**			**500**
		Grand Total	**140**	**180**			**4300**
FOURTH YEAR-SEVENTH SEMESTER							
Sl.No	**Paper code**	**Course/ Title of the paper**	**Cr.**	**Hrs./ Week**	**External**	**Total**	
1	548701	Immunology	5	5	25	75	100
2	548702	Genetics	5	5	25	75	100
3	548703	Application of Remote sensing &GIS	4	4	25	75	100
4	548704	Practical XI	3	6	25	75	100
5	548705	Practical XII	3	6	25	75	100
6		Elective	4	4	25	75	100
		Total	**24**	**30**			**600**
	EIGHTH SEMESTER						
8	548801	Evolution	4	4	25	75	100
9	548802	Biotechnology	4	4	25	75	100
10	548803	Post-Harvest Technology	4	4	25	75	100
11	548804	Practical XIII	3	6	25	75	100
12	548805	Practical XIV	3	6	25	75	100
13		Elective	3	3	25	75	100
14		Non-Major Elective	2	3	25	75	100
		SLC - MOOC	Extra Credit		-	-	-
		Total	**23**	**30**			**700**
FIFTH YEAR –NINETH SEMESTER							
15	548901	Marine Microbiology	5	4	25	75	100
16	548902	Environmental impact Assessment	5	4	25	75	100

17	548903	Research Methods in Marine Biology	5	4	25	75	100
18	548904	Practical- XV	3	6	25	75	100
19	548905	Practical- XVI	3	6	25	75	100
19		Elective	3	3	25	75	100
20		Non-Major Elective	2	3	25	75	100
		SLC - MOOC	Extra Credit		-	-	-
		Total	**26**	**30**			**700**
TENTH SEMESTER							
21		Elective	2	2	25	75	100
22	548999	Project Work	14	28	50	150	200
		Total Credits	**90**	**120**			**2300**
		TOTAL CREDITS 140+90 =230					**6600**

SCHOOL OF MARINE SCIENCES
Department Of Oceanography And Coastal Area Studies
M.Sc. MARINE BIOLOGY (5 YEARS INTEGRATED PROGRAMME)

Course		Cr.	Hrs./ Week	Marks		Total
Subject code	Title of the paper			Int.	Ext.	
FIRST YEAR - FIRST SEMESTER						
548103	**Practical – I** - Physical Oceanography	3	6	40	60	100
548104	**Practical – II** - Chemical Oceanography	3	6	40	60	100
SECOND SEMESTER						
548203	**Practical –III** - Biological Oceanography& Ecology and Zoogeography	3	6	40	60	100
8MBP1	**Allied – I** – Practical – chemistry	3	6	40	60	100
SECOND YEAR - THIRD SEMESTER						
548303	**Practical– IV** - Invertebrate	3	6	40	60	100
548304	**Practical – V** - Vertebrate	3	6	40	60	100
FOURTH SEMESTER						
548403	**Practical -VI** - Cell and Molecular biology& Developmental Biology	3	6	40	60	100
8MB4P2	**Allied – II** – Practical (Botany)	3	6	40	60	100
THIRD YEAR - FIFTH SEMESTER						
548503	**Practical-VII** - Biochemistry	3	6	40	60	100
548504	**Practical-VIII** - Coastal and brackish water Aquaculture	3	6	40	60	100
SIXTH SEMESTER						
548603	**Practical-IX** - Animal physiology	4	8	40	60	100
548604	**Practical-X** - Fish and Fisheries	4	8	40	60	100
FOURTH YEAR-SEVENTH SEMESTER						
548704	**Practical XI** - Immunology& Genetics	3	6	25	75	100
548705	**Practical XII** - Application of Remote sensing&GIS	3	6	25	75	100
EIGHTH SEMESTER						
548804	**Practical XIII** - Evolution& Biotechnology	3	6	25	75	100
548805	**Practical XIV** - Post-harvest Technology	3	6	25	75	100
FIFTH YEAR –NINETH SEMESTER						
548904	**Practical- XV** - Marine Microbiology&Environmental impact Assessment	3	6	25	75	100
548905	**Practical- XVI** - Research Methods in Marine Biology	3	6	25	75	100
TENTH SEMESTER						
548999	Project Work	14	28	50	150	200

COURSE CREDIT STRUCTURE (PRACTICAL)

M.Sc. MARINE BIOLOGY (5 YEARS INTEGRATED PROGRAM)

SEMSTER– I			
Sub Code: 548101	**Physical Oceanography**	**Credits: 4**	**Hours: 4**
Objectives	• To understand the significance of physical oceanography and meteorology its Physical properties of seawater; Waves, Tides and Currents; Estuaries, Deltas and Coastal Lagoons; Meteorology, Clouds, Precipitation & Air Masses; Monsoons &Cyclones. • To understand the history, ocean studies and types of researchvessels		
Unit -I	**History of Oceanography** Early exploration and Historical review of the Development of Oceanography – Foundation of Modern Oceanography – National Expeditions –Post War Oceanography – Modern Trends.		
Unit-II	**Physical properties of seawater** Units of temperature – Pressure and their changes in the Sea-Density of Sea water - Thermal Properties of seawater - Colligative and other solid suspension properties of sea water-Properties of sea ice-Transmission of sound-Absorption of radiation-Eddy conductivity – Diffusivity-Viscosity.		
Unit-III	**Waves, Tides and Currents** Hydrodynamics, refraction, Wave modification near the coast-Wave height and wave energy – Wave in shallow waters – Internal and standing waves-Energy from waves. Tides – Tidal curves- Dynamic theory of the tide- Tidal currents – Tidal current in coastal areas-Tidal effect in coastal area. Type of currents-Littoral and rib currents-Ekman spiral, Geostrophic current – Boundary current - Western, Eastern and equatorial currents-Thermocline, Temperature and salinity diagram and coastal upwelling.		
Unit-IV	**Estuaries, coastal wetlands and Mud flats** Coastal process and estuaries – The geiod - Eustasy and isotasy – Regional and global effects of sea level changes- Effect of sea level changes on shorelines. Coast and Coastal process - Estuaries-Classification -Type of estuaries - Origin and fate-Estuarine circulation. Global warming - Greenhouse effect - Ozone deflection. ElNino and La Nina - Southern Oscillation - ENSO and its impact on Indian Monsoon. The Geiod - Eustasy and Isostasy.		
Unit -V	**Fundamental Principles of Meteorology**- Indian climatology with special reference to seasonal distribution. Climatic Zones of India. Clouds and their classification. Monsoons & Cyclones: Synoptic features associated with monsoon and tropical cyclones. General Circulation of the atmosphere. SatelliteMeteorology:PolarorbitingandGeostationarysatellites-visibleand infrared radiometers - Multi-scanner radiometers. Identification ofsynoptic systems, fog and sandstorms, detection of cyclones, estimation of SST, cloud top temperatures, winds and rainfall - temperature and humiditysoundings.		

Text Books and Reference

Alan P. Trujillo. (2013). *Essentials of Oceanography (11th ed)*: Pearson.

Bharatdwaj. K. (1993). *Physical Geography-Oceanography*: Discovery Publishing House.

Duxbury,A.C.,Duxbury,A.B.,andSverdrup,K.A.(2000).*AnIntroductiontoTheWorld'sOceans*. UK: Wm. C. Brown Publishers.

Lal. D.S. (2010). *Oceanography.* Allahabad: Sharda Pustak Bhawan.

Matthew Fontaine Maury. (1855). *The Physical Geography of the Sea*. Harper & Brothers.

Natarajan, M., Balasubramanian, T. (2001). *Oceanographic equipments*. ENVIS Centre, CAS in Marine Biology. Annamalai University.

<table>
<tr><td colspan="2">Paul. R. Pinet. (1992). Oceanography - An Introduction to the Planet Oceans. UK: West Publishing Company.
Paul. R. Pinet. (2000). Invitation to Oceanography (2nd ed.). Massachusetts: Jones and Bartlett Publishers.
Robert. H. Stewart. (2008). Introduction to Physical Oceanography: Texas A & M University.
Roland Stull. (2015). Practical meteorology - An algebra-based survey of Atmospheric Sciences.
Vancouver, Canada: The University of British Columbia.</td></tr>
<tr><td>Outcome</td><td> Students able to study of the physical properties and dynamic process of the oceans and also studies the interaction of the ocean with theatmosphere.
 With satellite data, students can able to understand not only how the ocean behavesatagivenpointintime,butalsohowtheoceanchangesandfluctuates.</td></tr>
</table>

Course code :548102	Chemical Oceanography	Credits: 4	Hours: 4
Objectives	▯ The objective of this course is to provide students with an understanding the chemical composition of the oceans and the physical, chemical, and biological processes governing this composition in the past andpresent. ▯ Topics covered include cycling of carbon, nitrogen, phosphorus,silicon, and oxygen, and processes of primary production, export production, remineralization, diagenesis, and air-sea gas exchange.		
Unit -I	**Composition of seawater** Marine Chemistry – Chemical properties of seawater - structure of water molecules. Ionic composition of sea water-Elements present in sea water-Oxidation-Reduction Potential of seawater-Constancy of ionic composition – Factors affecting constancy-Analytical chemistry of seawater constituents – Concept of chlorinity and salinity of seawater-Methods of measurement		
Unit-II	**Dissolved Gases** Basic Concepts-Solubility of gases in seawater Carbon dioxide – Origin-Importance and distribution – CO_2-CO_3 systems. Dissolved oxygen-Origin and factors governing the distribution- BOD and COD – Air and sea gas exchange–Non-reactivegases-Minorreactivegases.Gasesotherthancarbon dioxide and Oxygen-N_2-H_2S, Methane-Noble gases-Their origin-distribution and importance.		
Unit-III	**Trace elements** Concept–Typeofdistribution–Inputsoftraceelementstothecoastalwaters-Cyclingoftraceelementsincoastalwaters.Basicconcepts-Solubilityofgases in seawater Carbon dioxide – Origin-Importance and distribution – CO_2-CO_3 systems. Dissolved oxygen-Origin and factors governing the distribution-BOD and COD -Abundance and residence time- Anoxic Basin-Interaction of major and Minor elements with marineorganisms.		
Unit-IV	**Organic matter** Dissolved and particulate sources classification – Composition-Estimation – Distribution-SeasonalVariation-Ecological processes and significance-Growth promoting and growth inhibitingeffects.		
Unit -V	**Nutrients** Origin-Fertilityofthesea–Nitrogen–Phosphorus–Determination–Cycle-Seasonalvariation–Nitrogen–Phosphorusratio.Silicon:Origin,distribution cycle and theirsignificance.		

Text Books and Reference Books

Diwan, A.,& Arora, D. (1995*). Oceanographic Environment*. Anmol Publications Pvt. Ltd.

Duxbury, A.C., Duxbury, A.B., & Sverdrup, K.A. (2000). *An Introduction to The World's Oceans*. UK: Wm. C. Brown Publishers.

Gianguzza, A., Pelizzetti, E.,& Sammartano, S. (1997). *Marine Chemistry*. Kluwer Academic Publishers.

Millero, F. (1996). *Chemical Oceanography (2nd ed.)*. CRC Press Inc.

Pinet, P. (1992). *Oceanography.* West Publishing Company

Satyanarayana, T. (2007). *Marine Chemistry.* Daya PublishingHouse.

Outcome	▯ Understanding the concept of chemical and physics properties of sea water. Knowledge on the basic structure of water molecules and ioniccomposition. ▯ Gain the knowledge on interaction of major and minor elements with marine organisms.

PRACTICALS – FIRST SEMESTER

Course Code: 548103	PRACTICAL - I	Credits: 3	Hours:6
PHYSICAL OCEANOGRAPHY			
1.	**Water sampling devices:** Mayer's water sampler-Knudsen water sampler – universal water sampler - Nansen water sampler - Horizontal water sampler – Niskin water sampler - Bacteriological water sampler.		
2.	**Light measuring devices:** Secchi disc – Lux meter – Turbidity meter – underwater Photometer.		
3.	**Temperature and pressure measuring devices:** Towing surface thermometer – Six's maximum and minimum thermometer –Reversing thermometer- Bathythermograph – Thermohydrobarograph - Fortin's barometer.		
4.	**Current measuring devices:** Watt's current meter - Direct reading current meter.		
5.	**Bottom sampling devices:** Ekman's dredge - Peterson's grab – Van Veen's grab - Vertical gravity corer - Ooze sucker - Mud snapper - Box corer - Boomerang water sampler, grab and corer.		
6.	**Depth measuring devices** –Echo sounder, Side scan Sonar.		
7.	**Weather Instruments:** Thermometers, Barometers, Humidity Sensors, Wind Speed, Wind Vane, Rain Gauge, Hail Pad, Campbell Stokes Recorder, Hygrometer, Pan evaporation, weather prediction charts of the local region.		

Course Code: 548104	PRACTICALS - II	Credits: 3	Hours:6
CHEMICAL OCEANOGRAPHY			
1.	Determination of Salinity		
2.	Total Alkalinity		
3.	Dissolved oxygen		
4.	BOD		
5.	COD		
6.	pH		
7.	TSS		
8.	TDS		
9.	Calcium and magnesium		
10.	Nitrite		
11.	Nitrate		
12.	Reactive Phosphate		
13.	Particulate Phosphorous		
14.	Sulphide		
15.	Ammonia		
16.	Organic nitrogen		
17.	SiO_2		
18.	Particulate Carbon		
19.	Total Iron		
20.	Total dissolved phosphorous		
21.	Trace Elements		

SECOND SEMESTER

Course Code:548201	BIOLOGICAL OCEANOGRAPHY	Credits: 3	Hours:3
Objectives	▯ The course introduces the students to biological oceanography and explores the interaction between biology, chemistry andphysics. ▯ Thesyllabusisdesignedsuchthatitenablesthestudentstounderstandwhat controls the abundance, kinds, and temporal variations of organisms present in the sea.		
Unit -I	**Sea as biological environment** - divisions of marine environment - pelagic- benthic - coastal - oceanic - zones. Marine diversity - plankton - nekton - benthos – classification - composition**.**		
Unit-II	**PrimaryProductivityofthecoastalEnvironment:Phytoplankton-**Definitionand classification;Methodsofestimationofstandingstockandbiomass-factorsaffecting phytoplankton distribution in the sea; Phytoplankton blooms- Red Tide phenomena andcauses;Harmfulalgalblooms-Phytoplanktonsuccession.Methodsofestimation of Marine Primary Productivity; Factors affecting primary productivity. Regional differenceinprimaryproductioninoceans.PrimaryProductivityintheBayofBengal and the Arabian Sea.		
Unit-III	**SecondaryProductivityofthecoastalEnvironment:Zooplankton-**Definitionand taxonomic classification; Horizontal and Vertical distribution of Zooplankton; Factors affecting the Zooplankton distribution; Concept of indicator species; Zooplankton as bio-indicators; Secondary Productivity:Methods of estimation of secondary production; Factors affecting secondary production, Regional difference in secondary production with special reference to the Bay of Bengal and theArabian Sea. Zooplankton andfisheries.		
Unit-IV	**Coastal Vegetation:** Coastal vegetation: Intertidal, littoral andsublittoral.Seaweeds **-** Occurrence and distribution in India - economic importance. Life cycles of economic important seaweeds. Seagrasses - morphological and anatomical adaptations ecological role. Mangroves **-** distribution, adaptation, conservation and ecologicalrole.Saltmarshandsanddunevegetation-morphological,anatomicaland physiological features, ecological role, uses and conservation.		
Unit -V	**Animal association:**Animal association in the marine environment – Endoceism – Inquilinism- Phoresis – Epizoism-Mutualism Commensalism – Symbiosis-Parasitism.		

Text Books/ Reference Books

Chapman, V.J. and D.J. Chapman. (1980). *Seaweeds and Their Uses.* London: Chapman & Hall Ltd.

Kinne,O.(2004).*MarineEcology.*Comprehensiveintegratedtreatiseonlifeinoceansandcoastalwaters vol (1-5). New York:Wiley-Interscience.

Lali, C., & Parsons, T. (1993). *Biological Ocenaography: An Introduction (2nd ed).* Butterworth Heineman Publications.

Nybakken, J. W. (2001). *Marine Biology – An Ecological Approach.* London: Addison wesley Edu.Pub. Inc.

Sakhare, V., & Jadhav, H. (2017). *Plankton and Fisheries.* Discovery Publishing House Pvt. Ltd.

Outcome	▯ They get knowledge on Plankton and Organic production inocean. ▯ Students will be aware of biomass, growth and productivity of organisms in the marineenvironment.

Course Code:548202	ECOLOGY AND ZOOGEOGRAPHY	Credits: 4	Hours :4
Objectives	To understand the divisions of the marine environment and physico-chemical parameters and adaptations of livingorganisms. To know about the population growth density and independent factors. To understand the structure, composition and adaptations of community ecology, besides studying the animalassociations.		
Unit -I	**Classification of Marine Environment**: Marine environment – Ecological Factors – Light, Temperature, Salinity, Pressure. ClassificationofMarineEnvironment–PelagicEnvironment,Planktonic and Nektonic Adaptations, Benthic Environment – Intertidal, Interstitial and Deep – Sea Adaptation. Other Coastal Environments – Coral reefs, Estuaries, Mangroves, Seagrass Beds, Kelp Forests, Polar Seasand Hydrothermal vent. Marine Zoogeography: Barriers, Centre ofdispersal, Bipolarity, Endemism, Islandfauna.		
Unit-II	**Marine Ecosystem**: Concept - Ecosystem Structure and Function-Functional attributes Food chain, Food – web, Ecological Pyramid, Energy Flow. Recycling of Nutrients. Systems Ecology and Modeling-System Structure, Feed-back, Loops and Types of Models, Characteristics and Behavior of a System. Ecosystem Services.		
Unit-III	**Population Ecology**: Group Attributes, Population Density Variation, Age Structure, Sex Ratio, Population Growth, Carrying Capacity, Dispersal, Density Dependent and Independent Factors. Prey – Predator Relationship, Intra Specific & Inter Specific competition.		
Unit-IV	**Community Ecology**: Structure Composition and Stratification, Diversity and Stability, Concept of Niche, Edge Effect – Abundance of Diversity, Resilience, Succession, Community-wise Adaptation (e.g. Fouling and Boring Community, Animal Association in the Sea).		
Unit -V	**Marine biodiversity**: Definition and Importance, Biodiversity Assessment Techniques, Threats to Marine Biodiversity, Over-Exploitation, Physical Alteration, Pollution, Alien Species.Bio-Security.		

Text Books and Reference Books

Brown, M. (2010). *Ecology (1st ed.).* Apple Academic Press Ltd.

Fennel,W.,&Neumann,P.(2015).*IntroductiontotheModellingofMarineEcosystems(2nd ed.).*Elsevier InternationalInc.

Kritzer, J.,& Sale, P. (2006). *Marine Metapopulations*. Elsevier International Inc.

Kumar, A., &Singh, L. (2006). *Advanced Ecology*. Daya Publishing House.

Mackenzie, A., Ball, A., &Virdee, S. (2001). *Ecology (2nd ed.).* Taylor & Francis Publishers. Nybakken, J.W. (2001). *Marine Biology – An ecological approach (4th ed).* US: Addison Wesley Edu. Pub.

Outcome	Understand the influence of abiotic and biotic factors on marineorganisms and populations. Characteristics of marine organisms andpopulation.

Course Code:548203	PRACTICAL - III	Credits: 3	Hours :6
BIOLOGICAL OCEANOGRAPHY			
1.	Identification of phytoplankton and zooplankton and larval forms.		
2.	Identification of marine algae, seaweeds, seagrasses and holophytes including mangrove plants		
3.	Determination of primary production using light and dark bottle techniques.		
4.	Identification of coastal invertebrates and vertebrates (Medusae, polychaetes, Molluscs,		
5.	Echinoderms, Brachiopod, Phoronids, Chaetognaths, Turtles and marine mammals).		
6.	Mounting - Radulae of gastropod-Mouthparts of Squilla and Balanus-Jaw and cartilage of gastropods-Dissection – Digestive and Nervous system of gastropods		
7.	Animal communities in different biotope-Mud flat-Sandy and rocky shore-Mangrove-Oyster bed		
ECOLOGY AND ZOOGEOGRAPHY			
1	Rocky Shore Fauna		
2	Sandy Shore Fauna.		
3	Seagrass – Macrofauna & Meiofauna		
4	Mangrove associated Macrofauna& Meiofauna		
5	Estimation of Population density in an Ecosystem.		

THIRD SEMESTER

Course Code :548301	INVERTEBRATES	Credits: 4	Hours: 4
Objectives	▯ The syllabus is designed such that the students will learn about the diversityofmarineinvertebrateswith specialemphasisonexamplesfrom India. ▯ Thestudentswillexploretheadaptationsoftheinvertebrategroupstothe marine environment in terms of comparative physiology and body structure.		
Unit -I	**Protozoa and Cnidaria** Classification – Morphology – Reproduction - life history and phylogenetic relationships of Protozoa and sponges. Coelenterate – polymorphism, life history,theoriesoncoralreefs,distribution.Structure,Ecosystem&formation		
Unit-II	**Minor phyla:**Functional morphology, development and evolution: Nemertinea, Endoprocta, Ectoprocta, Phoronida and Pogonophora. Chaetognatha–classification,distribution,morphology,anatomy,embryology and evolution. Brachiopoda- classification, morphology, palaeontology and evolution.		
Unit-III	**Crustacea and Polychaeta:**Classification, comparative morphology, crustacean appendages, larval forms, evolution andpalaeontology. Polychaete – classification, morphology, feeding methods - reproduction and adaptive radiation		
Unit-IV	**Mollusca:**Classification, general characters, torsion, palaeontology, phylogenetic relationships and adaptive radiation, reproduction and embrogeny.		
Unit -V	**Echinodermata and Prochordata :**Echinodermata – Classification, structure and function, water vascular system, larvae, regeneration, reproduction and larval forms.Prochordata – classification and comparative morphology, reproduction and early development, larval metamorphosis.		

Text Books and Reference Books

Barnes, R.D. (1982). *Invertebrate Zoology (4th ed).* Holt saunders International Edn.

Barrington, E.J.W. (1979). *Invertebrate structure and function (2nd ed).* ELBS & Nelson.

EkambaranathaAyyar.,& T.N.Ananthakrishnan. (1992) Manual of Zoology,Vol(1), part I & II, Chennai:S.Viswanathan Pvt. Ltd.

Janakiraman, N.,&PatchiRajan, G. (1992). "*Biodiversity of Invertebrates*". Shri Shanmuga Lakshmi Nilayam, Annamalaiyar Street, Vivekanandhapuram North, Devakottai: Seetha Lakshmi Ganesan Publishers.

Jordan, E.L., & Verma, P.S. (1982). *Invertebrate Zoology.* New Delhi: S.Chand & Co.

Kotpal. R.L., Agarwal, K. S., & Khetarpal. R.P.R. (1989). *Modern text book of Zoology.* Rastogi Publications.

Outcome	▯ Describes the variety of invertebrate organisms and explains their evolutionary origin anddiversification. ▯ Investigate invertebrates in laboratory and field conditions, and identify major taxonomy.Understandtherequirementsforcollectionandshorttermmaintenance of invertebratespecies.

Course Code: 548302	VERTEBRATES	Credits :4	Hours :4
Objectives	The marine environment is rich in different groups of faunal species. Understanding the basic principles of taxonomy is essential for identification of the animalgroups. This paper is to study the principles and classification,taxonomic characteristics, origin, evolution and phylogenetic relationships of different animal phyla.		
Unit -I	**Origin of chordates:**Geological time scale – progression of vertebrates through time, chordate features and theories on the origin of chordates.		
Unit-II	**Bony fishes and Amphibia:**Characteristic features of ancestral vertebrates – classificationandevolutionofjawlessandprimitivevertebrates.Evolutionand adaptiveradiationofelasmobranchsandbonyfishes.Connectinglink(Dipnoi). Origin and distribution of amphibia – anatomical peculiarities and affinitiesof Urodela and Apoda.		
Unit-III	**Origin of reptiles**and birds – adaptive radiation of contemporary reptiles, turtlesand reptilian features of *Seymouria*, mammal like reptiles, rise and fall of dinosaurs including mesozoic marine reptiles. Mosasaurs, the giant marine lizards.Marine Crocodile: Estuarine/Salt water crocodile, Sea snakes.Marine birds, adaptations and migration.		
Unit-IV	**Evolution of Mammals:** General characters of mammals – classification and evolution of monotremes, marsupials and placentals, human evolution,aquatic mammals–classification,adaptationsandevolutionofCetaceaandSirenia. Seals, Walruses and Sea otters. Aquatic adaptations for respiratory and circulatory mechanisms – comparative anatomy of skin derivatives.		
Unit -V	**Developmental Biology of vertebrates:** Fish development – Cleavage - Germ layer formation - Axis formation – Neurulation - Sex determination		

Text Books and Reference Books

Goran E. Nillson. (2010).*Respiratory physiology of vertebrates.* Cambridge University Press.

Stephan, A. Milk. (2012). *Zoology.* UK: McGraw– Hill Education.

Outcome	Acquire knowledge about the geological time scales and theories on the origin of vertebrates.Understand the classification and evolution of jawless and primitive vertebrates and connecting link(Dipnoi). Knowabouttheclassificationsandadaptationsofseasnakes,seaturtles,saltwater crocodiles and marine birds. Recognise the general characteristics of mammals including respiratory, circulatory adaptations of cetaceans and their comparative anatomical skinderivative.

CourseCode: 548303	PRACTICALS- IV	Credits: 3	Hours :6
INVERTEBRATES			
1.	Identification of locally available invertebrate fauna		
2.	Mounting of gastropod radula		
3.	Digestive system in gastropods and bivalves		
4.	Crystalline style of bivalves		
5.	Identification of sex in crustaceans and molluscs		
6.	Mouth parts of *Squilla* and *Balanus*.		
7.	Appendages of prawns, shrimps and crabs		
8.	Study of digestive, nervous, reproductive systems and different ovarian maturity stages in Shrimp		

Course Code: 548304	PRACTICALS- V	Credits: 3	Hours :6
VERTEBRATE			
1.	Bony fishes		
2.	Study of important vertebrates specimen representing phylum Pisces to Mammalia		
3.	Early embryonic developmental stages of fish .- Larval stages		
4.	Mounting of scales of fishes.		
5.	Baleen plates of whales		
6.	Osteological observation of fishes and marine mammals		
7.	Marine turtles		

FOURTH SEMESTER			
Course Code: 548401	**Cell and Molecular Biology**	**Credits:3**	**Hours:3**
Objectives	□ Cell is the fundamental unit of life and the cell is operated under the control of biomolecular synthesis, organizations andfunctions. □ Understanding these aspects is the objective of thispaper		
Unit -I	Microscopy – Principle and Working mechanism of Compound Electron microscopes – SEM, TEM Cytological techniques Fixatives and fixation techniques. Stains and staining techniques. Comparison of Prokaryotic and eukaryotic cells. Ultrastructure and functions of 1. Mesosome 2. Plasma Membrane 3. Golgi complex and Endoplasmic Reticulum		
Unit-II	Mitochondria (glycolysis, kreb's cycle, electron transport system, energy generation summary) Ultrastructure & functions of Ribosomes and Lysosomes. Ultrastructure and functions of Nucleus and nucleolus. Chromosomes: Structure & types and Giant Chromosomes.		
Unit-III	Cell division- Mitosis, Meiosis &their significance. Cancer-Types, properties, causes, treatment and Oncogenes and tumour suppressor genes		
Unit-IV	DNA –Watson and Crick model of DNA, Replication. DNA as the Genetic material (Transformation, Transduction & Conjugation Experiments) RNA – types and structure Bacteriophage.		
Unit -V	Genetic Code – Characters Protein Synthesis – Central dogma, Transcription & Translation. Gene regulation – Lac - Operon model, Types of regulation.		
Text Books and Reference Books Karp, G. (2013). *Cell Biology*: John Wiley & Sons Inc. Prakash Lohar, (2019).*Cell and Molecular Biology*, Chennai: MJP Publishers.			
Outcome	□ Understand the types, principles and mechanisms of different microscopes.Know the organization and functions of mitochondria and other cellorganelles. □ Acquire knowledge about the significance of cell division and significance of mitosis and meiosis. Know the structure and function of DNA and RNA. Aware on the Genetic code including transcription andtranslation.		

Course Code: 548402	Developmental Biology	Credits: 3	Hours: 3
Objectives	• The principal objective is to introduce students to thedevelopmental processes that lead to the establishment of the body plan of vertebrates and the corresponding cellular and geneticmechanisms. • Thiswillallowstudents,atalaterstage,tounderstandorganogenesis and histogenesis, as well as student should be able to indicate the principal historical stages and methodological approaches tothe study of embryonic development and the characteristics of the principal experimental models.		
Unit -I	Gametogenesis – Spermatogenesis and Oogenesis.Fertilization, cleavage and gastrulation		
Unit-II	Development of Eye, Ear, Brain and Heart in frog. Extra embryonic membranes in chick, Placentation		
Unit-III	Organizer concept Amphibian metamorphosis – Biochemical changes and hormonal control, Regeneration types.		
Unit-IV	Hormonal control of Amphibian metamorphosis. Extra-embryonic membranes in chick– Development, Types and Physiology. Placenta in mammals		
Unit -V	Nuclear Transplantation in acetabularia - regeneration – types – regeneration in Amphibians – regeneration in planaria.		

Text Books and Reference

Arumugam, N. (1998). *Developmental Biology.* Saras Publications.

Balinsky, B.I. (1981). *An Introduction to Embryology,* Philadelphia: W.B Saunders Company.

Banerjee, S. (1981). *Development Biology.* New Delhi: Dominant Publishers.

Beril, N.J. (1986). *Developmental Biology.* New Delhi: Tata McGraw- Hill Publishing Ltd.

Berry, A.K. (2007). *An Introduction to Embryology*. New Delhi: Emkay Publications.

Browder, L.N. (1980). *Developmental Biology*. Philadelphia: Saunders College.

Deuchar, E.M.(1976). *Cellular Interaction in Animal Development.* London: Chapman and Hall.

Veer Bala Rastogi. (2010). *Developmental Biology.* Meerut: Kedarnath Ramnath Pulishers.

Outcome	• Understandaboutthefertilization,gametogenesisandoogenesis.Awareaboutthe development of eye, ear and heart, placentation in mammals. Knowledge on concept of amphibianmetamorphosis. • Awareaboutthehormonalcontrolofamphibianmetamorphosis,typesand physiology of placentation in mammals. Understand about the regeneration in amphibians and planarians.

Sub Code: 548403	PRACTICAL – VI	Credits: 3	Hours: 6
CELL AND MOLECULAR BIOLOGY			
1	Principle, working mechanism and care of compound microscope.		
2	Mounting of Mitotic stages in the onion root tip.		
3	Mounting of Meiotic stages from the testis of grasshopper.		
4	Mounting of Giant Chromosomes in Chironomous larva.		
5	Mounting of Squamous epithelial cells from the oral mucosa.		
6	Observation of blood cells in man.		
7	Isolation of DNA from haemolymph and animal tissue.		
8	Plasmid DNA isolation.		
9	Isolation of RNA.		
DEVELOPMENTAL BIOLOGY			
1	Mounting of live sperms of a vertebrate		
2	Observation of eggs – Chick		
3	Cleavage, Blastula, Gastrula stages of Frog		
4	Whole mounting of Chick blastoderm		
5	Slides – 18, 24, 33, 48 & 72 hours chick embryo.		
6	Placenta of Mammals – Pig, sheep, Man & Rabbit		

FIFTH SEMESTER			
Course Code: 548501	**Biochemistry**	**Credits: 5**	**Hours :5**
Objectives	☐ This paper facilitates the students to understand the structure and functions of biomolecules in marine life.		
Unit -I	Bio - Macromolecules as an energy source – Handerson and Hasselbalch equation – Acidbasemaintenanceandtheirsignificance.Chemicalbondsandtheirsignificance. Thermodynamics – laws and theirsignificance.		
Unit-II	Carbohydrates- classification, structure, properties and biological importance of Monosaccharides, Disaccharides and Polysaccharides		
Unit-III	Proteins- Classification and function of Proteins, structural levels of organization. Denaturation and isoelectric point of Proteins. Amino acids: Classification of amino acids, essential amino acids, reactions of amino and carboxyl groups of amino acids		
Unit-IV	Lipids- Classification and properties of lipids. Types of fatty acids – saturated, unsaturated and essential fatty acids. Significance of lipoproteins and phospholipids. Structure, synthesis and biological significance of cholesterol, HDL and LDL.		
Unit -V	Metabolic pathways and Fermentations: Glycolytic pathway, Pentose phosphate pathway (HMP), Tricarboxylic acid cycle, Electron transport chain, Cyt C.Substrate level and oxidative phosphorylation, inhibitors and un-couplers of electron transport chain and function of ATPase (bacterial and mitochondrial), Fermentation- Lactic acid fermentation, Amino acid catabolism- Urea Cycle Deamination and transamination reactions. de novo biosynthesis of purines andpyrimidines, Ribonucleotide reductase and its role in nucleic acid metabolism,Good Laboratory practices		

Text Booksand Reference Books

Donald Voet., & Judith G. Voet. (2004). *Biochemistry (3rd ed).* USA: John Wiley and Sons.

Jeremy, M. Berg., John, L. Tymoczke., and LubertStryer. (2007). *Biochemistry (5th ed),* USA: W.H. Freeman and Company.

Lehninger. (2006). *Principles of Biochemistry (4th ed),* D.L. Nelson and M.M. Cox: Macmillan worth Publishers.

Murray, R.K., Granner, D.K., & Rodwell, V.M. (2006). *Harpers Illustrated Biochemistry (28th ed).* The McGraw-Hill companies Inc.

Thomas, M. Devlin. (2006). *Textbook of Biochemistry with Clinical Correlations (6thed):* John Wiley & Sons Inc.

Trevor Palmer. (2004). *Enzymes- Biochemistry, Biotechnology and Clinical Chemistry.* India: Affiliated Fast – West Press Pvt. Ltd.

Outcome	☐ Students learn about the biological processes which take place in cellsand organisms. ☐ They know the functioning of various body processes and physiology by usesof bio-molecules.

Course Code: 548502	Coastal and Brackish Water Aquaculture	Credits :5	Hours :5
Objectives	▯ The course deals with the importance of coastal aquaculture, natural stock, over fishing, depletion present status, potentialities and socio-economic problems ofaquaculture. ▯ Explains the fish farm design and structure, site selection,technical consideration and topography.		
Unit -I	Introduction: Importance of Coastal aquaculture-Natural Stock-Over fishing-Depletion Present status-Potentialities and socio-economic problems of aquaculture.		
Unit-II	Farm design and structure: Site selection-Technical consideration-Topography-Soil Characteristics - water supply- Pond type – Dyke -Inlet, outlet - Structures, type and Design of supply and drainage canals - Farm design, construction, operation and maintenance- Open sea forming: cages, pens - Raft - Raceways practices.		
Unit-III	Farm Management: Pond management, nursery management-stocking, feedingschedules,waterqualitymanagement-controlofpredators,parasites and disease management – Harvesting-Economics of farming.Seaweed culture-Types of culture-Economic importance of seaweeds.		
Unit-IV	Hatchery Management:An over view of Crustaceans, Fin fishes and Molluscans culture: Present status-Hatchery production: Collection and maintenance of brood stock-induced breeding-mass production of seeds-Types and components of hatchery.		
Unit -V	Feed Formulation - Fisheries extension - Principles and approaches-extension methods- Role of Fisheries extension -Fish Farmers - Development Agency-Brackish Water fish Farmers Development Agency (FFDA & BFFDA) and Non- Governmental Agencies in fisheries development.		

Text Books and Reference Books

Boyd, C., & Tucker, C. (1998). *Pond Aquaculture: Water Quality Management.* Springer International Publishing.

Coche, A. G., & Muir, J. F. (1992). *Pond Construction.* Daya Publishing House.

Dash, M. C., & Patnaik, P. N. (1994). *Brackish Water Prawn Culture.* Palani Paramount Publications.

Gupta, S., Mohapatra, B., & Routray, P. (2008). *Textbook of Breeding and Hatchery Management of Carps.* Narendra Publishing House.

Kannupandi, T., Soundarapandiyan, P., & Anantharaman, P. (2002). *Hatchery manual for Penaeus monodon fabricus*. ENVIS Centre, CAS in Marine Biology, Annamalai University.

Thomas, P. C., Rath, S.,& Mohapatra, K. D. (2013). *Breeding and Seed Production of Finfish and Shellfish.* Daya Publishing House.

Outcomes	▯ Able to identify the potentials and socio-economic issues of aquaculture.Gain knowledge about selection of suitable site for fish farm, design andconstruction. ▯ Accomplish knowledge about water quality, stocking, feed and disease management in aquaculture. Learn about brood stock rearing, induced breeding, hatchery production of fin and shell fish seeds and larvalrearing. ▯ Aware about aquaculture extension, role of government and non government organisation in fisheries and aquaculture extensionactivities.

Course Code:548503	PRACTICAL VII	Credits: 3	Hours :6
BIOCHEMISTRY			
1	Qualitative analysis of carbohydrates		
2	Qualitative analysis of Proteins		
3	Qualitative analysis of lipids		
4	Action of amylase activity in relation to the temperature.		

Course Code:548504	PRACTICAL –VIII	Credits: 3	Hours :6
COASTAL AND BRACKISH WATER AQUACULTURE			
1	Characters of soils, Water Potentials and Water quality		
2	Technique of induced breeding and rearing techniques of prawn, mollusks, fish etc.		
3	Identification of locally available seaweeds.		
4	Fields visits to aquaculture farms – mariculture – seaweed culture.		

SIXTH SEMESTER			
Course Code:548601	**Animal Physiology**	**Credits: 5**	**Hours: 5**
Objectives	▯ The main objective of this paper is to make students study how living organismsworks.Animalphysiologyisascientificdisciplineofthewidest scope andapplication. ▯ The student focus on physiology how organisms,organ systems, organs, cells and biomolecules carry out the chemical and physical functions that exist in a livingsystem.		
Unit -I	Food: Composition, Classification, vitamins Digestion: Types and mechanisms, Digestive enzymes, Absorption and assimilation		
Unit-II	Respiration: Types, Respiratory organs in animals, Mechanism of respiration, Transportation of gases. Circulation: Types, structure and functions heart – Electrocardiograph Blood: Composition, Functions and coagulation mechanism.		
Unit-III	Excretion: Types of nitrogenous wastes, Ammonotelism, Ureotelismand Uricotelism Structure of nephron: Urine formation and composition.Osmoregulation infishes.		
Unit-IV	Nervous System:Structure, types and functions of neurons and Synapses – Mechanism and conduction of nerve impulses – Neuro Muscular junction of fish – Reflex actions. Muscle Physiology Ultrastructure and properties of skeletal muscles, Mechanism & theories of muscle contraction – Kymograph. White and red muscle.		
Unit -V	Chemical co- ordination:Endocrine systems and physiology of marine organism and their significance.Monosex seed production, sex reversal.		

Text Books and Reference Books

Bullock, T.H., Orkand, R.& Grinnel, A. (1977). *Introduction to nervous system.* W.H freeman and Company.

Cooper, J.R., Bloom, F.E., & Roth, R.H. (1990). The *Biochemical basis of neuropharmacology.* Oxford University Press.

Hoar, S. (1975). *General and comparative physiology (2nd ed).* Pentice Hall.

Prosser, C.L. (1991). *Comparative animal physiology (4th ed).* Philadelphia, Saunders Co.

Outcome	▯ By studying this paper, the students can conduct research in a varietyof areas. ▯ These can include reproductive physiology, clinical and molecular endocrinology (dealing with hormones), renal physiology (dealing withthe kidneys), toxicology (the study of poisons) and molecular genetics (the study of hereditary traits).

Course Code: 548602	Fish and Fisheries	Credits :5	Hours: 5
Objectives	▯ The main objective of this course is to make students aware offisheries resources, their biology andmanagement. ▯ To impart the students about the different fishing technologiesand alternative livelihoodoptions.		
Unit -I	**Introduction**: General morphology and outline classification of fishes-major group of fishes of the world and their characteristics-Identification of fishes of Indian waters.		
Unit-II	**Fisheries Biology**: Basic anatomy of fish digestive , respiratory , nervous and reproductive system , Food and feeding habits- Age and growth –Length weight relationship-Maturity and fecundity-Reproduction –Embryonic, larval development and juvenile stages of fin fishes and shell fishes. Migration of fishes-Biotic and abiotic factors affecting spawning in fishes.		
Unit-III	**Population Dynamics:** Theory of fishing-Unit stock-Mortality-Fish tagging and marking-Methods of surveying the fishery resources-Acoustic methods – Aerial methods-Survey of fish eggs and larvae, population analysis.		
Unit-IV	**Study of microbial diseases:** Methods of isolation –culture-Identification of pathogens and disease control. **Microbial quality:** changes during processing and storage. Spoilage of seafood-microbial spoilage, spoilage of fresh and processed seafood - factors affecting spoilage, chemical indices of microbial spoilage, Histamine producers, tetradotoxin, brevitoxin, ciguatera, aflotoxins. Seafood borne human pathogens – bacteria, fungi and viruses. Defects in fish processing technology.		
Unit -V	**Conservation and Management** Principles of conservation andmanagement – Fisheries administration. Protection preservation and impoundment of resources-Fisheryregulation-Organizationinvolvedinfisheriesconservation.		

Text Books and Reference Books

Agarwal, S. C. (2006). *History of Indian Fishery.* Daya Publishing House.

Aravind, N. S. (2013). *Fish and Fisheries.* Discovery Publishing House Pvt. Ltd.

Desai, R. K. (2009). *Fish Management and Aquatic Environment.* A.K. Publications.

Harnell, J. (1995). *Marine Fish Farming for India.* Asiatic Publishing House.

Nelson, J. A. (1992). *Fishes of the world.* John Wiley & Sons, Inc.

Yadav, B. (1997). *Fish & Fisheries.* Daya Publishing House.

Outcome	▯ Students able to classify thefishes. ▯ They obtain knowledge on the techniques of identifyingfishes. ▯ They have sound knowledge on the conservation and management of marine fishery.

Course Code548603	PRACTICAL –IX	Credits :4	Hours: 8
ANIMAL PHYSIOLOGY			
1	Oxygen consumption by a fish.		
2	Study of ciliary activity / heart beat of F W Mussel in relation to the temperature		
3	Preparation of haemin crystals		
4	Osmoregulation – Salt loss & gain in Tilapia fish		
5	Determination of Rf values of amino acid – Paper Chromatography: A] Haemoglobinometer B] Haemocytometer C] Sphygnomanometer D] Kymograph E] pH meter F] Centrifuge G] Electrophoresis		

CourseCode548604	PRACTICAL –X	Credits :4	Hours: 8
FISH AND FISHERIES			
1	Identification of commercially important fin and shell fishes and study of their morphology and classification.		
2	Study of food and feeding habits of fishes.		
3	Observation of fish maturation cycle, larval and juveniles and adult development.		
4	Identification of fish parasites.		
5	Collection of eggs and larvae-collection methods.		
6	Preparation of media-Microbial population enumeration		

SEVENTH SEMESTER			
Course Code: 548701	**Immunology**	**Credits:5**	**Hours: 5**
Objectives	□ To provide students with a foundation in immunologicalprocesses. □ To make students learn about cellular and molecular basis ofimmune system.		
Unit -I	HistoryandscopeofImmunology-Immunity-TypesofImmunity-Innate and acquired, Passive and Active- Lymphoid organs - Primary and secondary lymphoid organs - Thymus, Bone marrow, Bursa of fabricius, Spleen, Tonsil, Lymphnode.		
Unit-II	Immunoglobulin and Immune Diseases-Immunoglobulin - Structure, function and biological properties of Immunoglobulin classes		
Unit-III	Interaction of antigen and anti body- Auto immune diseases – Causes, Classification, Diagnosis and Treatment- Hypersensitivity and its types, Tumour Immunology		
Unit-IV	Lymphocyte and Immune response-Lymphocyte as unit of immune system		
Unit -V	Stem cells, T cells and its types - B cells and macrophages.Immune response: Primary and secondary response - Humoral immune response (B cell activation) - Cell mediated immune response (T cellactivation).		

Text Books and Reference Books

Benjamini, E, Coico, R., & Sunshine, G. (2000). *Immunology – A short course (4th ed).* A John Wiley and Sons, Inc.

Fingerman, M., & Nagabhushanam, R. (2001). *Immunobiology and Pathology*, Vol -5.

Roitt, I. (1984). *Essential immunology (5th ed),* Oxford: Blackwell Scientific publications.

Tizard, R.I. (1983). *Immunology: An introduction.* Philadelphia: Saunders college Publishing.

Outcome	□ The students will be able to describe immunological response and how it is triggered andregulated. □ The students will be able to describe the roles of the immune system in both maintaining health and contributing todisease.

Course Code: 548702	Genetics	Credits:5	Hours:5
Objectives	Survival of any organism depends on mainly genetic systems. Hence, thiscourseisaimedatteachingstudentsonbasicandadvancedconcepts ofgenetics. Students get knowledge on genes, genetic variation, and heredity inorganisms.		
Unit -I	Mendelian Genetics: Monohybrid – laws of dominance & segregation; Dihybrid cross – law of independent assortment – simple mendelian traits in man.		
Unit-II	Interaction of Genes: Complementary, Epistasis – Dominant & Recessive Polygenic Inheritance - Skin colour in man		
Unit-III	Multiple Alleles - Blood groups in man Linkage & Crossing over in Drosophila.		
Unit-IV	Chromosome mapping, Sex-linked inheritance in man – Colour blindness and Haemophilia. Sex Determination – Types, intersexes,Gynandromorph and sex-mosaics		
Unit -V	Inborn Errors of metabolism, Non-disjunction – Syndromes – Klinefelter, Turner, Down, Cri-du-chart. Pedigree analysis, Inbreeding and Out-breeding, Eugenics, Euthenics and Genetic Counselling.		

Text Booksand Reference Books

Gardner, Eeden J. (2001). *Principles of Genetics.* New Delhi: Wiley Eastern Private Limited.

Sinnod, Edward W., Dunn, L. C., & Dolzhansky, Theodosins. *Priciples of Genetics*. New York: Me Graw-Hill.

Tramarin, R.H. (1996). *Principes of Genetics (5th ed).* WCB publishers.

Watson, J.D. (1987). *The molecular biology of the Gene (3rd ed).* W.A. Benjamin. California

Williams S. Klug., Michale., & Cummings, R. (2000). *Concepts of Genetics (6th ed).* Prentice Hall.

Outcome	The students get idea about genetic information to diagnose, treat, prevent and cure manyillnesses. The get idea about genetic problem caused by one or more abnormalities formed in the genome.

Course Code :548703	Application of Remote Sensing & GIS	Credits: 4	Hours: 4
Objectives	▯ The fundamentals of electro-magnetic (EMR) radiation are explained, as are its interactions with Earth's surface andatmosphere. ▯ Thecoursesetoutontoexaminesensorcharacteristics,satelliteorbitsand variouscurrentandfuturemissionsinvolvingarangeofsensorsacrossthe visible, radar and microwave components of thespectrum.		
Unit -I	Remote sensing Definition-Principles and Concepts-Electromagnetic spectrum Electromagnetic energy interaction in the Atmosphere: Absorption, Transmission and Scattering- Electromagnetic spectrum- Electromagnetic energy interaction in the Earth Surface: Vegetation, Soil andWater.		
Unit-II	Define sensors and Platforms-Types of sensors (Active and Passive)-Types of Platforms (Airborne and Space borne)-Aerial camera-Basic principles of Photogrammetry-Aerialphotography missions-Multispectral scanners.		
Unit-III	Introduction of visual image interpretation- Land use, land cover,Geological, SoilandWetlandmapping-ApplicationsofAgricultural,Forestry,Rangeland, WaterresourceandUrbanplanning-PrinciplesofLandformidentificationand Evaluation-Multispectral, Thermal, Hyperspectral and Microwavesensing.		
Unit-IV	Earth observation system (Low, medium, High and Imaging spectrometry systems) Lansatseries,SPOT, IRS, RESURS, ADEOS, JERS, SPIN, IKONOS, QuikBird, OrbView,EROS, NOAA, GOES, DMSP, Seasat, EOS and MODIS-Global Positioning System.		
Unit -V	Basic principles & uses of GIS-Application of GIS in Geology and natural Resource management - Components of GIS-Raster and vector data – DEM-Digital Image Classification-Principle of image classification-image classification process (Supervised, Unsupervised)- Problems in image classification.		

Text Books and Reference Books

Ikeda, M., &Dobson, F. (1995). *Oceanographic Applications of Remote Sensing:* CRC Press.

Malczewski, J. (1999). *GIS and Multicriteria Decision Analysis*: John Wiley & Sons Inc.

Mueller, T., &Sassenrath, G. (2015). *GIS Applications in Agriculture.* CRC Press.

Richards, J., &Jia, X. (2006). *Remote Sensing Digital Image Analysis (4th ed).* Springer International Publishing.

Richards,J.,andJia,X.(1999).*RemoteSensingDigitalImageAnalysis(3rded).*SpringerInternational Publishing.

Singh, S. (1992). *Geomorphology and Remote Sensing in Environmental Management.* Scientific Publishers.

Outcome	
	▯ They can characterize the natural features or physical objects on the soil and wetland. ▯ They get idea about remote sensing platforms and remotesensors ▯ They get knowledge on GIS technology which can be used for scientific investigations, resource management, and developmentplanning.

CourseCode548704	PRACTICAL –XI	Credits: 3	Hours: 6
IMMUNOLOGY			
1	Lymphoid organ in Rat Demonstration only – Model/ chart/ CD Students have to draw the diagram and write detailed account of the lymphoid organs in Rat in the observation note book.		
2	Rh and ABO blood grouping		
3	Spotters**:** a)Stem cells, b)Phagocytes, c)Thymus, d)Bone marrow, e)Spleen, f)Lymph node, g)Immunoglobulin		
4	Double immunodiffusion and radial immunodiffusion (demonstration only).		
GENETICS			
1	Experiments to study Mendel's law using beads.		
2	Observation of minimum 10 Mendelian characters for self & class students.		
3	Observation of Blood group for self & class students		
4	Preparation of Pedigree chart for any two known visible characters for self.		
5	Spotters - Drosophila Cis-Trans linkage types Gynandromorph Syndromes –Down, Turner, Klinefelter & Cri-du-Chart Bacteriophage E.coli. DNA Base pairs Replication tRNA Protein synthesis		

Course Code548705	PRACTICAL-XII	Credits: 3	Hours: 6
APPLICATION OF REMOTE SENSING AND GIS			
1	Preparation of simple Vector map, Topo sheet reading and GPS field survey.		
2	Visual Interpretation of Geomorphic features from the Satellite image and Aerial photographs.		
3	Visit to GIS Centre’		

EIGHTH SEMESTER			
Course Code: 548801	**EVOLUTION**	**Credits :4**	**Hours :4**
Objectives	▯ The principal objective is to create a deep understanding of how evolution works,andgeneralknowledgeaboutthemostimportantresearchquestions in evolutionarybiology. ▯ The subject introduces students to all aspects of evolutionarybiology.		
Unit -I	Origin of life – Theory of special creation – Cosmozoic theory – Theory of spontaneous generation/abiogenesis: Greek philosophers – Thales, Empedocles and Aristotle concepts – Big Bang theory – A. I. Oparin's theory – J.B.S. Haldane's hypothesis – Urey – Miller hypothesis – Coacervation theory.		
Unit-II	Geological time scale: Palaeozoic era: Cambrian period, Ordovician period, Silurian period, Devonian period, Mississippian period, Pennsylvanian period andPermianperiod.Mesozoicera:Triassicperiod,Jurassicperiod,Cretaceous period.Cenozoicera–Paleoceneepoch,Ecoceneepoch,Oligoceneepoch, Miocene epoch, Pliocene epoch, Pleistocene.		
Unit-III	Lamarckism, Neo Lamarckism, Darwinism, Neo Darwinism and Modern Synthetic Theory Fossil and Fossilization, Living fossils, Dating of Fossils, Mesozoic reptiles.		
Unit-IV	Species concept, Isolating mechanisms, Mimicry and colouration. Hardy Weinberg Principle: Gene, Gene pool, Gene and genotypic frequencies and factors affecting H.W. Equilibrium. Evolution of man.		
Unit -V	Fossils and fossilization. Extiniction – causes. Molecular evolution - molecular clocks - systems of classification: cladistics and phenetics - molecular systematics - gene expression and evolution		

Text Books and Reference Books

Barnes, R. S. K. (1999). *Introduction to Marine Ecology*: Blackwell Science.

Bertness, M.D., Gaines, S. D.,& Hay, M.K. (2000). *Marine Community Ecology*: Sinauer Associates.

Jeffery, S. Levinton.(2000). *Marine Ecology, Biodiversity and Function*: Oxford University Press.

Monroe W. Strickberger. (2000). *Evolution.* Jones & Bartlett Learning

Montagu. (1980). *Sociobiology examined.* New York: Oxford University Press.

Moody P.A. (1978). *Introduction to Evolution*. New York, Harper.

Outcome	▯ Understands the process of evolution and Geological time scale.Understandthe Lamarckism, Neo Lamarckism, Darwinism, Neo Darwinism and Modern Synthetic Theory Fossil and Fossilization, Living fossils, Dating of Fossils, Mesozoicreptiles. ▯ Understands the Species concept, Isolating mechanisms, Mimicry and colouration.

Course Code: 548802	Biotechnology	Credits: 4	Hours: 4
Objectives	☐ The principal objective is to prepare students for successful career in industry and research institutes. as well as to provide students with fundamental strength in analysing, designing and solving industry related problems and to develop the ability amongst the students to apply modern bioengineering techniques in industry and research. ☐ To understand the bioactive compounds from marine sources.		
Unit -I	**GeneCloning:**RestrictionenzymeandDNALigation-Cohesiveandbluntend ligation, Linkers, adapters, homopolymer tailing; Transformation– Bacteria-Ca^{2+} mediated, electroporation, lipofection; PEG mediated, gene gun, electroporation, and Mammalian cells- microinjection, transfection methods.Primer design; Fidelity of thermostable enzymes; Chemical synthesis of oligonucleotides; PCR and its optimization; Types of PCR – multiplex, nested,reversetranscriptase,realtimePCR,touchdownPCR,hotstartPCR, colony PCR		
Unit-II	**Marine Microbial Genomics:**Molecular methods of microbial identification; Microbial community structure analysis; Analysis of genomes of cultured marine microorganisms- new generation sequencing technology; Marine metagenomics; Marine genomics – advances and applications; Advances in genomics- introduction to epigenomics, Proteomics of marine organisms; Applications of marine proteomics; Metatrascriptomics and metaproteomics; Advances in marine proteomics.		
Unit-III	**Bioreactor Technology:**Introduction to bioreactors - Types of ideal reactors; Design equation for ideal reactors; Mode of operation of bioreactors- fed-batch and continuous culture, immobilized reactors, solid state fermentation - Bioreactor instrumentation and process control.		
Unit-IV	**Downstream processing:**Downstream processing - Strategies to recover and purify fermentation products - Separation of insoluble products by filtration – Centrifugation - Coagulation and flocculation - Cell disruption – Precipitation – Osmosis – Dialysis - Extraction.		
Unit -V	**Marine Natural Products:**Marine Products: hydrocolloids-agar,agarose, carageenan, alginates, chitosans and chitin. Marine enzymes- Applications of enzyme for fish processing.Marine Lipids application of lipases for modification of fats and oils.Marineflavourants.		

ext Books and ReferenceBooks

Bhakuni, D.S. & Rawat, D.S. (2005). *Bioactive Marine Natural Products.* New Delhi, India: Springer and AnamayaPublishers,

Bhakuni, D.S., & Rawat, D.S. (2005). *Bioactive Marine Natural Products.* New Delhi, India: Springer and AnamayaPublishers'

Brown, T.A. (2000). *Essential Molecular Biology: Vol.(1), A Practical Approach*: Oxford University Press.

Cock,J.M,Tessmar-Raibe,K.,Boyen,C.,&ViardF.(2010).IntroductiontoMarineGenomics:Springer.

Stanbur, P.F., & Allan, W. (1984).*Principles of fermentation technology.* PergamonPress.

Twyman, R.M. (2004). *Principles of Proteomics. Garland Science.* New York: BIOS Scientific Publishers.

Outcome	☐ Understand about techniques and fundamentals behind gene cloning and its application. ☐ Developing marker-assisted selectiontechnologies**.**

Course Code: 548803	Post-Harvest Technology	Credits:4	Hours :4
Objectives	Handling of fish on board and Onshore-Post mortem changes-Transportation-Icing-Principles of mechanical refrigeration-Freezing methods of preservation of fish-Frozen fish products-Spoilage of frozen fish products and methods of prevention of spoilage during frozen storage and frozened by products.		
Unit -I	Handling and transportation – on board and on shore – manufacture, quality and uses of ice for handling, transportation and processing of fish – Refrigerated sea water for fish preservation. Insulated containers for fresh fish transportation.		
Unit-II	Fish processing – post mortem changes–chemical and structural. Chemical changes in lipids, proteins and nucleotides. Changes in pH, bacterial load, sensorychanges,texture,tasteandodour.Factorsaffectingqualityoffish.Pre-treatment of fish washing, gutting, filleting, beheading, peeling,deveining. Steaming of crab.		
Unit-III	Methods of freezing. Processing and packaging, Chemical treatment, antioxidants, cryoprotectants and other additives. Temperature and durationof storageinqualityandshelflife.Processingofcrustaceans,andcephalopods. Sanitation in processing plants and Quality control of fresh and processed fish and fishery products.		
Unit-IV	Packaging and packaging materials – Packaging materials; basic films and laminates, their manufacture and identification; resistance of packaging materials; development of protective packaging for fishery products. Packing of fresh and frozen fish–packaging for transport and shipping. packaging standards for domestic and international trade.		
Unit -V	Seafood quality - Quality assessment in fish and fishery products – Physical, chemical organoleptic and microbiological quality standards. Good manufacturing practices. National and International standards, Codex alimentaris, USFDA and EU regulation for exporttrade		

Text Books and Reference Books

Baishya, D., Deka, M. (2009). *Fish Fermentation.* New India Publishing Agency.

Cutting, C. L. (1999). *Fish Processing and Preservation.* Agro Botanica Publishers

Desai, R. K. (2009). *Fish Management and Aquatic Environment.* A.K. Publications.

Harnell, J. (1995). *Marine Fish Farming for India.* Asiatic Publishing House.

Nettleton, J. A. (1987). *Sea Food and Health.* Van Nostrand Reinhold.

Sinha, P. (2011). *Fish Processing and Preservation.* APH Publishing Corporation

Outcome	Understand about the handling and transport of fish from onboard and fresh fish preservation.Aware about fish processing, chemical, sensory and microbial quality of seafood during processing andstorage. Acquire knowledge about methods of freezing and storage of processed fish.Know about seafood packaging materials and methods of packing and transport.Aware about seafood quality, national and internationalregulatory agencies for quality assurance and monitoring.

CourseCode548804	PRACTICAL –XIII	Credits:3	Hours :6
EVOLUTION			
1	Chart and models: Evolution – Different Geological time scale organisms.		
2	Field study of bivalve and gastropod diversity and computing using PAST online software with discussion.		
BIOTECHNOLOGY			
1	Plasmid DNA isolation and DNA quantitation.		
2	Restriction digestion and mapping of DNA.		
3	Confirmation of DNA by Agarose gel electrophoresis.		
4	DNA Ligation.		
5	Transformation of E.coli with standard plasmids, Calculation of transformation efficiency.		
6	Cloning of genomic DNA in standard plasmid vectors.		
7	Confirmation of the insert, Miniprep of recombinant plasmid DNA.		
8	Polymerase Chain reaction.		
9	RFLP analysis.		
10	BLAST, NCBI.		

CourseCode548805	PRACTICAL- XIV	Credits:3	Hours :6
POST-HARVEST TECHNOLOGY			
1	Observation of fin and shellfish freezing.		
2	Freezing practices with different fish and shell fish products. Organoleptic quality analysis.		
3	Canning of fish and shrimp. Observation of can seaming-estimation of salt content in Cured fish.		
4	Analysis of fish meal-estimation of protein, Lipid and carbohydrates		

NINETH SEMESTER			
Course Code: 548901	**MARINE MICROBIOLOGY**	**Credits: 5**	**Hours: 4**
Objectives	☐ The main objective of this paper is to make students to examine the characteristics of microscopic organisms such as bacteria, viruses, andfungi. ☐ They study the pattern of growth, development, and other characteristics of microorganisms. ☐ The also study the interaction of microorganisms with the environment andalso Industrial productionprocesses.		
Unit -I	Introductionandscope of marine microbiology- Marine microbial habitats: estuaries, mangroves, salt marshes, beach, coastal ecosystems, coral reefs, water column,sedimentsandextermophilesDiversityofmarinemicroorganism-Archaea, bacteria, cyanobacteria, algae, plankton, fungi, viruses andactinomycetes.		
Unit-II	Ecology of coastal microogranisms sampling equipment- water samplers such as Niskin sampler, Hydro-Bios sampler, sediment samplers such as van Veen grabs and corers, multiple plankton net and hand-held plankton net.		
Unit-III	Culturemedia-Typesandpreparationofisolation,purificationandculturemethods for bacteria, algae, actinomycetes and viruses, identification of microbes. Staining methods for different microbes. Control of microorganisms: physical andchemical methods. Microbial identification system Fattyacid analysis genomic sequencing using microbial identification system and16S rRNA sequencehomology.		
Unit-IV	Role of microorganisms - Nutrient cycles- carbon, nitrogen, phosphorous and sulphur cycles in the Coastal under different environments including mangroves.		
Unit -V	Industrialmicrobiology-Fermentation-productionofSinglecellprotein(SCP)from algae and bacteria-product quality and safety. Production of mushroom,probiotics, distilled beverages, exopolysaccarides, biofuels andvinegars.		

Text Books / Reference Books

Arora,D. R., & Bharti Arora. (2007). *Practical Microbiology (2nd ed.).* CBS.

Casida, L.E.J.R. (2019). *Industrial Microbiology.* New Age International Private Limited.

Reed, G. (2004). *Prescott & Dunn's Industrial Microbiology (4th ed.)*. CBS Publishers & Distributors.

Insam, Heribert., & Rangger, Andrea. (1997). *Microbial Communities.* Springer-Verlag Berlin Heidelberg.

Michael, T.,Madigan, John, M.,Martinko, Kelly, S.,Bender, Daniel, H.,Buckley.,& David A. Stahl. (2017). *Brock Biology of Microorganisms, (14th ed).* Pearson Education.

oanne Willey, Linda Sherwood.,& Christopher J. Woolverton. (2017*). Prescott's Microbiology (10th ed).* McGraw-Hill Education.

Pelczar, Jr., & Michael. (2001). *Microbiology (5th ed).* McGraw Hill Education.

Pradipta K. Mohapatra. (2008). *Textbook of Environmental Microbiology.* I K International Publishing House Pvt. Ltd.

Reba Kanungo. (2017). *Ananthanarayan and Paniker's Textbook of Microbiology (10th ed).* Universities Press.

Sharma, P. D. (2005). *Environmental Microbiology.* Alpha Science International Ltd.

Outcome	☐ By studying this paper, the students get opportunities in various fields like healthcare organizations, forensic science laboratories, environmental organizations, higher education institutions, food and drink, publicly funded research organizations, pharmaceuticals and many other industries.

Course Code: 548902	ENVIRONMENTAL IMPACT ASSESSMENT	Credits:5	Hours :4
Objectives	□ Able to understand about the Environmental Impact Assessment (EIA), environmental clearance, coastal regulation zone, baseline studies and collection of primary and secondarydata. □ Knowledgeable to design, site selection, precision, size of samples andappropriatespatialandtemporalreplicationindatacollectionand field observation. Know about marine environment, physical, chemical, biological and sediment logical analysis.		
Unit -I	Introduction - Environmental Impact Assessment (EIA) - types of EIA - rapid EIA - comprehensive EIA - environmental clearance - coastal regulation zone - baseline studies - collection of primary and secondary data.		
Unit-II	Design and sample collection - Site selection - precision - size of samples - variability in biotic communities - appropriate spatial and temporal replication - data collection field observation-air quality		
Unit-III	Marine environment – hydrodynamics (tides - tidal ranges - waves - current velocity) water quality - physical (temperature - salinity - total suspended solids - turbidity) - chemical (pH dissolved oxygen - BOD - nutrient analysis - heavy metals) - biological (Fecal coliforms - phytoplankton - zooplankton - benthos) - sediment quality - sand - silt - clay fraction analysis - wet sieving method - total organic carbon organic matter estimation.		
Unit-IV	Biological indicators - benthic indicators - Marine Biotic Indices - [BENTIX, AMBI, Benthic Quality Index (BQI) - Ecological quality (EcoQ)] - Taxonomic Sufficiency (TS). Prediction of impacts - risk assessment - environmental management - monitoring - preparation of EIA report using computational software. (Field trip data collection - data interpretation).		
Unit -V	Ecological quality measures - univariate measures (species diversity indices) - multivariate measures (Bray-Curtis similarity - multivariate dispersionindices-principalcomponentanalysis-cumulativedominance curves or ABCcurves).		

Text Books and Reference Books

Alongi, D. (1998). *Coastal Ecosystem Processes.* CRC Press LLC.

Brown, M. (2010). *Ecology (1st ed).* Apple Academic Press Ltd.

Diwan, A., &Arora, D. (1995). *Marine Ecology (1st ed.).* Anmol Publications Pvt. Ltd.

Kumar, A.,& Singh, L. (2006). *Advanced Ecology.* Daya Publishing House.

Kumar, H. (1997). *General Ecology.* Vikas Publishing House Pvt. Ltd.

Trivedi, P.,& Raj, G. (1992). *Marine Ecology and Pollution.* Akashdeep Publishing House.

Outcome	□ The students get knowledge on collection of primary and secondary data for environmental Impact Assessment in particular area. □ They get knowledge on marine environment and biologicalindicators.

Course Code: 548903	RESEARCH METHODS IN MARINE BIOLOGY	Credit: 5	Hours:4
Objectives	▯ The primary objective is to develop a research orientation among the students and to familiarize them with the fundamentals of researchmethods. ▯ The course also aims to introduce the students to the basic concepts used in research. This is designed to impart education in the foundational methodsand techniques of academic research.		
Unit -I	Biological literature library search: Abstracting, searching for literature, indexing; manuscriptpreparation,organizationofthepaper–theartofwriting–presentation ofresults–tables–graphs–histogram–relevanttitles,etc.Internetande-journals. Computeraidedtechniquesfordataanalysis,datapresentationandslide preparation.		
Unit-II	Histology: Principles of microtechniques –fixing, embedding, sectioning, staining, differential.Histochemistry:Principlesandpractice.Methodsemployedinanalysis of proximatecomposition.		
Unit-III	Spectroscopy: Principles of biophysical methods, X-ray diffraction, Spectroflurometer, flame photometer, UV-visible, atomic absorption andemission spectrophotometers, NMR and Mass spectrometer. Centrifuge: Principles and applications – Ultra centrifuge (velocity, buoyance and density,gradient centrifugation). pH: Buffers – pH meters – ion, selective electrodes.		
Unit-IV	Chromatography: Principles and Application of Chromatography: Paper, Thin layer, column, Ion Exchange, Gel filtration, Gas Liquid, HPLC and affinity. Electrophoresis: Principles and Application of Electrophoresis: Paper, Agarose, PAGE, SDS PAGE and Iso-Electric focusing. Hybridization, sequencing, PCR, DNA finger printing, screening of genome and cDNA libraries.		
Unit-V	Biostatistics: Collection and analysis of biological data - mean, median, mode Standard deviation, Standard error, Coefficient of variation, Student 't' test, Skewness, Kurtosis, Chi - square, Correlation, Regression and ANOVA. Bioinformatics: Internet - Worldwide Web - Search Engines - their functions. Boolean searching - file formats. Biological data bases - sequence and structure - dateretrieval-searchingsourcedatabases-sequencesimilaritysearches-FASTA and BLAST, CLustalW and Phylip.		

Text Books and Reference Books

Bajpai, P. K. (2006). *Biological Instrumentation and Methodology*. New Delhi: S. Chand & Co. Ltd.

Blum, Deborah., & Mary Knudson. (1997). *A field guide for science writers: the official guide of the National Association of Science Writers.* New York: Oxford University Press.

Comir., & Peter Wood Ford. (1979). *Writing scientific papers in English, London.* Pitman Medical Publishing Co.

Day, R.A. (1994). *How to write and publish a scientific paper.* London: Cambridge University Press.

Milton, J.S. (1992*). Statistical methods in Biological and Health Sciences.* New York: McGraw Hill Inc.

Wilson, & Walker. (2000). *Practical biochemistry - principles and techniques.* Cambridge University Press.

Outcome	▯ Learnstodevelopanunderstandingofthebasicframeworkofresearchprocess, various research designs andtechniques. ▯ Recognizing the various source of information for literature review and data collection. ▯ Understands the ethical dimensions of conductingresearch.

Course Code 548904	PRACTICAL -XV–	Credit: 3	Hours:6
MARINE MICROBIOLOGY			
1	Principles and methods of sterilization.		
2	Direct microscopic observations of bacterial shape – cocci, rods, chains, fungal spores.		
3	Preparation of Media: Nutrient broth, Nutrient agar, plates, slants.		
4	Pure culture technique: Streak plate, spread plate and pour plate methods.		
5	Measurement of size of microbes.		
6	Motility determination – Hanging drop method.		
7	Enumeration of bacterial / yeast cells-viable count (Plate count) Total count (Haemocytometer count).		
8	Isolation and purification of cyanobacteria, actinomycetes, fungi and protozoans.		
9	Staining methods: Simple, Negative, acid fast, Gram staining, spore, Capsule.		
2. **ENVIRONMENTAL IMPACT ASSESSMENT**			
1	Physico- chemical Parameter: water and Sediment sample (Temperature,pH, Conductivity, Light Penetration,Total depth DO, BOD, TDS, Salinity, Nutrients and Heavy metals).		
2	BiologicalParameters:Primaryproductivity,Qualitativeandquantitativeanalysisofmicrobes, plankton and benthiccommunities.		

Course Code 548905	PRACTICAL -XVI–	Credit: 3	Hours:6
RESEARCH METHODS IN MARINE BIOLOGY			
1	Fixation and Preservation of tissue samples		
2	Staining by hematoxylin and eosin		
3	Estimation of proteins, carbohydrates and lipids by UV-Vis Spectroscopy		
4	Separation of amino acids, sugars by Paper Chromatography and Thin layer chromatography		
5	Cell fractionation and organelle isolation by centrifugation		
6	Protein isolation by electrophoresis – Native and SDS PAGE		
7	Isolation and purification of macromolecules by column chromatography		
8	Electrophoretic quality analysis Isolation of DNA and RNA		
9	Western, Southern and northern blotting		
10	Biostatistics a. (Mean, median, mode, standarddeviation). b. Probabilitycalculation. c. Hypothesis testing – Level of Significance – Level of Confidence – pValue.		
11	1. Basic bioinformatic procedures (NCBI and Gen Bankresources) a. Retrieval of Nucleic sequences b. ProteinSequence c. 3D visualization of proteinmolecules		

TENTH SEMESTER			
Course Code : 548999	**Dissertation**	**Credits: 15**	**Hours: 30**
Objectives	Project Dissertation will be carried out by the student themselves with the interest of the student as well as the interest of the faculty with mutual understanding, expertise and interest. The students continuously evaluated the work carried out day to day for furtherevents.Finallythefacultywillbegiveninstructionhowtowritethedissertation with different components, topics and the material, text, problems to be addressed in each assignment title. The dissertation will consist of Introduction, Materials and Methods,ResultsandDiscussion,SummaryandConclusion,References/Bibliography. Of course, appropriate statistical tools must be followed for the assessment of data. A proper preparation of graphs, diagrams and flow charts must be included in the dissertation. Appendix may also be taken into consideration ifnecessary		

ELECTIVE PAPERS

S.No	ELECTIVE PAPERS
1	MARINE BIODIVERSITY AND CONSERVATION
2	COASTAL ZONE MANAGEMENT
3	MARINE RESOURCES
4	MARINE POLLUTION
5	COASTAL DISASTER MANAGEMENT
6	FERMENTATION TECHNOLOGY
7	AQUARIUM KEEPING
8	MARICULTURE
9	MARINE BIOFOULING, PREVENTION AND MANAGEMENT

Course Code : 548E101	MARINE BIODIVERSITY AND CONSERVATION	Credits: 4	Hours: 4
Objectives	• To Protect and restore marine and estuarine ecosystems, Control invasive species, Mitigate the dry land salinity, Promote ecologically sustainable grazing, Minimize impacts of climate change on biodiversity, Maintain and record indigenous peoples' ethnobiological knowledge and Improve scientific knowledge and access to information. • To know the values of marine biodiversity and threats of marine biodiversity and to discuss and debate issue concerning conservationof marinebiodiversity.		
Unit -I	Introduction - Marine Biodiversity - Importance - levels of biodiversity - biodiversity indices. Definition of extinction of marine bio-resources - rate of extinction–causesofextinction-island/intertidalbiogeography-vulnerability to extinction.		
Unit-II	Conservation - essential concepts for small populations - problems of small population-appliedpopulationbiology-establishmentofnewpopulations-ex- situ conservation strategies - conservation categories of species -legal protection of species.		
Unit-III	Marineprotectedareas-designingofprotectedareas-managingprotectedareas - restoration ecology.		
Unit-IV	Impediments to marine biodiversity conservation - insufficient scientific informationinadequatetransferofinformation-culturalandbiologicaldiversity - differing benefits and costs harming aquatic life - jurisdictional gaps and overlaps - use of marine environment - immunity from public scrutiny - fragmented decision making.		
Unit -V	Conservation and sustainable development - traditional societies - Government action local legislation - national laws - National Biodiversity Act and National Biodiversity Authority. International approaches to conservation and sustainable development - On going problems - possible responses - role of conservation biologists.		

Text Books and Reference Books

Dasmann, R. F. (1984). *Environmental Conservation (5th ed).* John Wiley & Sons Inc.

Heywood, V.,& Watson, R. (1995). *Global Biodiversity Assessment.* Cambridge University Press.

Kannaiyan,S.,&Venkatraman,K.(2011).*MarineBiodiversityinIndia.*AssociatedPublishingCompany

Kumar, S. (2009). *Biodiversity, Environment and Sustainable Management (1st ed).* A. K. Publications.

Laladhas, K., Nilayangode, P.,& Oommen, O. (2017). *Biodiversity for SustainableDevelopment.* Springer International Publishing.

Sinha, P. (1998). Biodiversity Depletion: Anmol Publications Pvt. Ltd.

Outcome	• Understanding the marine biodiversity andconservation. • Marine conservation policies andLegislations.

Course Code : 548E102	COASTAL ZONE MANAGEMENT	Credits: 4	Hours: 4
Objectives	A major objective of CZM is to coordinate the initiatives of the various coastal economic sectors (e.g., shipping, agriculture, fisheries) toward long-term optimal socio- economic outcomes, including resolution of conflicts between sectors and arranging beneficialtrade-offs. To gain the knowledge on coastal zone and its importance, variouscoastal ecosystemsanditsvulnerability.TobeabletounderstandtheOceanlaws–Law of thesea		
Unit -I	Definition and Concept: Introduction to Coastal Zone: Environment status of the coastal and marine ecosystems: Estuaries, mangroves, coral reef, lagoon, and wetland-Major threats tocoastal ecosystem-Scientific expeditions for ascertaining the wealth of the sea-Five majorOceans and their relative importance-law of the sea-UNESCO, UNEP, IMO, regional seas programme- Antarctic expedition convention.		
Unit-II	Protected Area Management: Marine biosphere reserves, marine park, biosphere reserve and Sanctuaries-Categories background and basic concepts and applications-strictnature-reserve,nationalpark,naturalmonument-Habitat/species management areas-Protected landscape/seascape-managed resource protected area-Coastal ecosystem-use of Coastal resources-Conservation issueand problems-Species of conservation concern – Recommendation and management practices for future action.		
Unit-III	Natural Hazards and mitigation: Natural hazards, volcanoes, tides, tsunamis, cyclones, storm, Global warming and sea level rice, erosion, emergence and submergence and sub-emergence of coastline-Mitigation. Monitoring strategies of marine pollution: Mitigation - Global warming and Climate change. Role of international and national organizations and role of NGO.		
Unit-IV	Coastal Protection Structures: Bio shields and their impact on coasts, beach stability, ocean and sea beach nourishment; interaction of waves with structures like seawalls, groins, breakwaters, revetments and replantation. Implementationof CRZ regulation and theirProtection		
Unit -V	Managerial organization: Role of national and international agencies and organizations in ocean management. UNESCO, FAO, IMCO, UNEP,UNDP, NIOT, NIO, MOEFs and CPCB, MPEDA.		

Text Booksand Reference Books

Finkl, C. (2013). *Coastal Hazards.* Springer Publications

Lein, J. (2003). *Integrated Environment Planning.* Blackwell Science Ltd

Platzoder, R. (1995). *The 1994 United Nations Convention on the Law of the Sea.* Martinus Nijhoff Publishers.

Rahman, M. H. (2016). *International Law of the Sea*. Atlantic Publishers and Distributors Pvt. Ltd..

Trives, T.,& Pineschi, L. (1997). *The Law of the Sea.* Martinus Nijhoff Publications.

Valiela, I. (2006). *Global Coastal Change.* Blackwell Science Ltd.

Outcome	Learning about coastal zone and itsimportance. Understand the sustainable development of coastal and marineareas. Understand the reduce vulnerability of coastal areas and their inhabitants to natural hazards.

Course Code : 548E103	MARINE RESOURCES	Credits: 4	Hours: 4
Objectives	The marine environment is constituted with a rich resource of chemicals, minerals and biological species. Conservation of the marine resources is essentially important in the context of their increasing exploitation.		
Unit -I	Non-living resources: Ocean resources in coast, shelf, slope and abyssal - Distribution of various kinds particularly in India ocean- Their forms, grade and potentiality- Coastal aquifer its nature, form, migration – Integrated resource management-Preservation and conservation of non-living resources including water-Renewable & non- renewable resources. Resources originated terrigenous, chemogenous, biogenous, allogenic and antigenic.		
Unit-II	Marine minerals: Potential in east and west coasts of India-Mineral resources - Mineral enrichment in the Black sea-Marine phosphorites-Placer minerals-Marine sulfides-Manganese nodules and crusts-Methods in the exploration of seafloor minerals deposits-Methods of exploration in manganese nodules, phospherite and polymetallic sulfides-Sea baulk (non-living resources).		
Unit-III	Fisheryresourcesmanagementanddeep-seafisherypotentialResourcepotential– Resource estimates-Fish resources of Indian EEZ-Reasons for decline in fish production-Profitablevesselmanagementandrequirement–Exploitationofmarine fisheriesresourcesandexports-Exportmanagement.Livingresources:Captures; Sardines, Mackerels, Bombay Duck and Prawn fisheries. Principle methods of exploitation of sea fishes. Indigenous and modern Crafts and Gears.		
Unit-IV	Drugs:Marine drugs– Importance – Sources-Carbohydrate and derivatives-Nitrogenous compounds-Antibiotic compound from marine animals. Bioactive compound – Sources- Natural function -Ecological and distribution in the marine environment.		
Unit -V	Toxin from marine animals: Type of toxins- Functional properties toxin-Venoms-Venom in marine animals: sea snake, fish and mollusks -Pharmacological and toxicological properties- Marine steroids– Types- Marine cartenoids- Sterols of marine invertebrate.		

Text Books and Reference Books

Gautam, A. (1998). *Conservation & Management of Aquatic Resources.* Daya Publishing House.

Madhu, M., Jakhar, P.,& Adhikary, P. (2013). *Natural Resource Conservation*. Satish Serial Publishing House.

Singh, R. (2013). *Fishery Resources.* Pearl Books Publishing.

Teleki, P., Dobson, M.,& Moore, R. (1987). *Marine Minerals.* Reidel Publishing Company.

Thompson,M.,Sarojini,R.,&Nagabushanam,R.(1991).*BioactiveCompoundsfromMarineOrganisms.* Oxford & IBH Publishing Co. Pvt. Ltd.

Yadav, B. N. (1997). *Fish & Fisheries.* Daya Publishing House.

Outcome	Students get idea on fisheries resource management andEEZ. They get awareness about drugs from the marine basedorganisms.

CourseCode 548E104	MARINE POLLUTION	Credits: 4	Hours: 4
Objectives	To gain the knowledge on types, sources and impact of pollution on marineresourc To learn the types of marine pollution monitoring methods, Ocean management an marine pollution abatement programs.		
Unit -I	Marine pollution-definition - role of GESAMP - major pollutant - sources - transport path - dynamics. Toxicology – Lethal and Sub-lethal effects of pollutants to marine organisms bioconcentration, bioaccumulation and biomagnification, methods of toxicity testing, factors influencing toxicity, synergistic and antagonistic effects, role of microcosms & mesocosms.		
Unit-II	Sewage pollution - industrial - agricultural - domestic - impact on marine environment - treatment methods. Detergents - composition – interference with eutrophication - ecological impact. Marine debris - plastics - litter - impact in the marine environment.		
Unit-III	Heavy metal pollution - sources - distribution - fate - analytical approaches. Pesticide pollution - classification - sources - distribution - fate and ecological impacts with special reference to marine fishes, birds and mammals.		
Unit-IV	Oil Pollution - composition - sources - biological impacts on fishes, birds and mammals - treatment techniques - bioremediation. Ballast water and bio-invasion. Aquatic noise. Thermal pollution - sources - uses of waste heat. Role of biocides - chlorine - ecological impacts. Radioactive pollution - sources - natural - artificial-biological effects ofradiation.		
Unit -V	Environmental monitoring methods - critical pollutants - objectives, status, limitations and biological indicators – bioaccumulation – bioconcentration - biomaganification - biotransformation - Mussel watch - water quality assessment. Use of analytical instruments - AAS - ICP - GC.		

Text Books and Reference Books

Chhatwal, G. (1997). *Encyclopaedia of Environmental, Soil and Marine Pollution (1st ed*). Amnol Publications Pvt. Ltd.

Clark, R.B. (1992). *Marine pollution (3rd ed).* Clarendron Press Oxford.

Diwan, A., &Arora, D. (1995). *Marine Pollution (1st ed).* Anmol Publications Pvt. Ltd.

Hammer, M. J. (2006). *Water and Wastewater Technologies.* Prentice Hall of India Pvt. Ltd.

Swarup, R. (1992). *Encyclopaedia of Ecology, Environment and Pollution Control.* Mittal Publications.

Thompson, M., Sarojini, R.,& Nagabushanam, R. (1988). *Marine Bio deterioration.* Oxford & IBH Publishing Co. Pvt. Ltd.

Outcome	Various marine pollutants and its ecologicalimpacts. Impact of mining and dredging of marineenvironment

Course Code : 548E105	COASTAL DISASTER MANAGEMENT	Credits: 4	Hours: 4
Objectives	☐ To understand basic concepts in Disaster Management & mitigation, Definitions and Terminologies used in Disaster Management, Various typesof Disastersthe Challenges posed by Disasters, Impacts of Disasters and Risk Management.		
Unit -I	Definition –Hazards as natural process - Benefits and importance of disasters Nature disaster- creeping disaster- creeping disaster- Death and Damage – Evaluating hazards –Human response to hazards.		
Unit-II	Major threats to coastal ecosystem- Habitat loss- Landslides -Sea level change, Degradation of water quality, Fisheries resource depletion, Earthquakes,Tsunami, Volcanicactivity,Coastalflooding,Cyclones,Erosion,.Seawaterintrusion,Cause and preventive measures. Hazards Relief andmanagement		
Unit-III	Disaster mitigation, actions to reduce risks, the menu of mitigation actions, classification of mitigation measures, Environmental hazards, typology, assessmentandresponse,thestrategies,thescaleofdisaster,vulnerability,disaster trends.		
Unit-IV	Nature, humanity and development, disruption of development by disasters, loss of resources, interruption of programmes, impact on investment and climate, impact on non- formal sector, socio- political destabilization, development as causes of disaster, fundamentals of disaster, causal factor of disasters, characteristics of particular hazards in disaster		
Unit -V	Geohazards, international decade for natural disaster reduction, problems of financing and insurance, tends in climatology, meteorology and hydrology, trends in seismic activities, training of emergency management personnel.		

Text Books and Reference Books

Harsh K Gupta. (2013). *Disaster Management.* Universities Press (India) Pvt. Ltd.

Haruyama, S & Sugai, T. (2016). *Natural Disaster and CoastalGeomorphology*: Springer.

Miguel Esteban, Hiroshi Takagi & Tomoya Shibayama. (2015). *Handbook of Coastal Disaster Mitigation for Engineers and Planners.* Butterworth-Heinemann.

Pranam Dhar. (2011). *Disaster Management and Preventions.* LAP Lambert Academic Publication.

Sinha, P. C. (1998). *Encyclopaedia of Disaster Management (Vol. 1- 4).* Anmol Publications Pvt. Ltd.

Srivasthava H. N. (2009). *Coastal Hazards.* National Book Trust.

Vidyanathan, S. (2011). *An Introduction to Disaster Management.* IKON Books.

Outcome	☐ The Students gets the understanding of the basic concepts in Coastal Disaster Managementanditsmitigations.TheystudydefinitionsandTerminologiesused in DisasterManagement. ☐ They also aware of various types of Disasters and the Challenges posed by Disasters. They are able to understand the Impacts of Disasters and Risk Management strategies.

Course Code : 548E106	FERMENTATION TECHNOLOGY	Credits: 4	Hours: 4
Objectives	☐ Techniques for large-scale production of microbial products. It must both provide an optimum environment for the microbial synthesis of the desired product and be economically feasible on a large scale.		
Unit -I	Fermenter – types and function Fermenters – Basic functions, design and components – asepsis and containment requirements – body construction and temperature control – aeration and agitation systems – sterilization of fermenter, air supply and medium; aseptic inoculation methods – sampling methods, valve systems – a brief idea on monitoring and control devices		
Unit-II	General concepts of industrial microbiology Concepts of basic modes of fermentation - Batch, Fed batch and Continuous fermentation. Bioreactor designs. Primary and secondary screening, Strain development strategies. Scale up of fermentationprocess.Rawmaterialformediapreparation.Harvestingandproduct recovery.		
Unit-III	Downstream processing: Filtration, Cross flow filtration, Flocculation, Whole broth processing, Solvent extraction, Concentration, Centrifugation, Crystallization, Distillation, Adsorption elution, Precipitation and Chromatography		
Unit-IV	Applicationofenzyme:Immobilizationofenzymesandmicrobialcells,Secondary metabolites. Application of enzyme in food industries: enzymes in milk and cheese industry, baking industry, alcoholic beverages (wine andbeer)		
Unit -V	Production of Antibiotics – Penicillin, Enzymes - Amylase. Production of Organic Acids - Acetic acid.		

Text Books and Reference Books

Baishya, D., & Deka, M. (2009). *Fish Fermentation.* New India Publishing Agency.

Cutting, C. L. (1999). *Fish Processing and Preservation.* Agro Botanica Publishers.

Desai, R. K. (2009). *Fish Management and Aquatic Environment.* A.K. Publications.

Harnell, J. (1995). *Marine Fish Farming for India.* Asiatic Publishing House.

Nettleton, J. A. (1987). *Sea Food and Health.* Van Nostrand Reinhold.

Tyagi, N. (2013). *Industrial Microbiology and Biotechnology.* Agrotech Press.

Wiseman, A. (1981). *Topics in Enzymes & Fermentation Biotechnology.* Ellis Horwood Ltd.

Outcome	☐ The students will be able to evaluate factors that contribute in enhancement of cell and product formation during fermentationprocess. ☐ Understand the fermentation techniques andapplications.

Course Code : 548E107	AQUARIUM KEEPING	Credits: 4	Hours: 4
Objectives	The objectives of aquarium are reviewed and the main infrastructure subsystems and operational procedures are described; Know how on aquariumsystemscanalsobeappliedinresearchlaboratoriesofacademic institutions if live organisms have to be kept forexperimentation. Aquarium missions on research, conservation andeducation.		
Unit -I	Introduction to aquarium – types of aquarium – importance of aquarium - Introduction to ornamental aquatic organisms – identification of ornamental fishes – crustaceans - molluscs - ornamental aquatic plants.Status of ornamental fish culture and trade – world and Indian scenario.		
Unit-II	Design and construction aquarium – methods and materials used – setting up of freshwater and marine aquarium - filters and medias used in aquariums – pumps and other equipments – light and its types.		
Unit-III	Care and maintenance of aquarium - criteria for selection of ornamental fishes - water quality management and methods – probiotics – fish food and its type.		
Unit-IV	Diseases of ornamental aquarium fishes - bacterial and fungal diseases – control measures and treatments.		
Unit -V	Brood stock management – breeding of ornamental fishes - Ornamental fish farm and hatchery – design and construction – packaging and transport – economics.		

Text Books and Reference Books

Boyd, C.,& Tucker, C. (1998). *Pond Aquaculture: Water Quality Management.* Springer International Publishing.

Coche, A. G., &Muir, J. F. (1992). *Pond Construction.* Daya Publishing House.

Dash, M. C., &Patnaik, P. N. (1994). *Brackish Water Prawn Culture.* Palani Paramount Publications

Gupta, S., Mohapatra, B., & Routray, P. (2008). *Textbook of Breeding and Hatchery Management of Carps.* Narendra Publishing House.

Sinha, P. (2011). *Fish Processing and Preservation.* APHA Publishing Corporation.

Thomas, P. C., Rath, S., & Mohapatra, K. D. (2013). *Breeding and Seed Production of Finfish and Shellfish.* Daya Publishing House.

Outcome	At the end of the course the students will be able to gain knowledge about aquarium preparation and maintenance and itsidentification. Understand breeding behavior of aquariumfishes.

Course Code : 548E108	MARICULTURE	Credits: 4	Hours: 4
Objectives	The objectives of mariculture are the production of protein rich, nutritive, palatableandeasilydigestiblehumanfoodbenefitingthewholesocietythrough plentiful food supplies at low or reasonablecost. Providing new species and strengthening stocks of existing fish in naturaland man-made water-bodies through artificial recruitment and transplantation. Production of sport fish and support to recreational fishing.		
Unit -I	Importance of Coastal aquaculture-Natural Stock-Over fishing-Depletion-Present status-Potentialities and socio economic problems of aquaculture. History, development and present status of mariculture in India and other countries - importance of mariculture.		
Unit-II	Site selection-Technical consideration-Topography-soil Characteristics - water supply- Pond type: Dyke: Inlet, outlet, -Structures, type and design of supply and drainagecanals-Farmdesign,construction,operationandmaintenance-Opensea forming: cages, pens - Raft - Raceways practices. Site selection and types of materialsusedforopenseafarming-Designandconstructionofopenseafarming structures andcages.		
Unit-III	An over view of Crustaceans, Fin fishes and Molluscans culture: Present status-Hatchery production: Collection and maintenance of brood stock-induced breeding-mass production of seeds-Types and components of hatchery. Pond management, nursery management-stocking, feeding schedules, water quality management-control of predators, parasites and disease management-harvesting.		
Unit-IV	Selection of cultivable species for mariculture, their biology and culture practices of *Chanoschanos, Latescalcarifer, Rachycentroncanadum, Mugil cephalus, Epinephelustauvina and Etroplussuratensis.* - Molluscs: Mussel, Crustaceans: Lobster.		
Unit -V	Engineering aspects of open sea cages – care and maintenance of open sea cages– various Indian and international companies and institutes involved in construction of open sea cages. Economics of farming. Seaweed culture-Types ofculture-Economic importance of seaweeds.Economics of open sea farming - Recent development and future perspective of open sea farming.		

Text Books and Reference Books

Boyd, C., &Tucker, C. (1998). *Pond Aquaculture: Water Quality Management.* Springer International Publishing.

Coche, A. G., &Muir, J. F. (1992). *Pond Construction.* Daya Publishing House.

Dash, M. C.,& Patnaik, P. N. (1994). *Brackish Water Prawn Culture.* Palani Paramount Publications.

Gupta, S., Mohapatra, B., &Routray, P. (2008). *Textbook of Breeding and Hatchery Management of Carps.* Narendra Publishing House.

Sinha, P. (2011). *Fish Processing and Preservation.* APHA Publishing Corporation.

Thomas, P. C., Rath, S.,& Mohapatra, K. D. (2013). *Breeding and Seed Production of Finfish and Shellfish.* Daya Publishing House.

Outcome	They get sound knowledge on selection of species for successfulmariculture. They get advanced idea about open sea cage culture and recenttrends.

Course Code : 548E109	MARINE BIOFOULING, PREVENTION AND MANAGEMENT	Credits: 4	Hours: 4
Unit -I	**Fundamentals of Corrosion:** Basic aspects of Corrosion – Types of Corrosion – Mechanisms of Corrosions – Factors influencing corrosion – Corrosion testing and monitoring – Electrochemical methods, surface analysis		
Unit-II	**Marine Biofouling Basics:**Principle fouling organisms - Micro-fouling - Mechanisms of biofilm formation - Properties of a biofilm -Characteristics of the macro-organisms - Factors influencing biofouling growth - Geographical location - Distance from shore – Depth - Temperature and season - Water current and tidal conditions - Water quality - Other factors.		
Unit-III	**Biofouling Communities:**Bioflims – attached macro-fouling communities – mobile communities – Commensals – Parasites and pathogens.Activities of microorganisms as the driving force for biocorrosion - Sulfate-Reducing Bacteria (SRB)- Metal-Reducing Bacteria (MRB)- Metal-Depositing Bacteria (MDB)- Slime-producing bacteria-Acid-Producing Bacteria (APB)- Fungi.		
Unit-IV	**BiofoulingasaPathway:**Hullfoulingandothershipcomponents–Ports–harbors and marinas - Mariculture – fisheries/fishing and diving equipment – marinedebris – Primary and Secondary pathways. Economic losses caused by biocorrosion.		
Unit -V	**Biofouling Management:** Anti-fouling strategies – anti-fouling systems – Cleaning Programs in the Shipping and aquaculture Industries – Current practice – natural and non-toxic antifoulants – risk analysis – education and training.		

Text Books and Reference Books

Alexander I., &Railkin. (2005). *Marine biofouling: Colonization Processes and Defenses.* Taylor & Francise-Library.

Drane, C.W. (1963).*Chapter on natural waters. "Corrosion", Vol. 1*. Edited by Shrier: George Newness Limited,London.

Lynn Jackson. (2008). *Marine Biofouling and Invasive species: Guideline for Prevention and Management*. Compiled by Lynn Jackson on behalf of The Global Invasive programme and The UNEP Regional Seas Programme.

Peter Maaß & Peter Peißker. (2011). *Handbook of Hot-dip Galvanization*, Weinheim:wiley-vch Verlag GmbH & Co. KGaA.

Volkan Cicek., & Bayan Al-Numan. (2011). *Corrosion Chemistry.* Co-published by John Wiley & Sons, Inc. Hoboken, New Jersey, and Scrivener Publishing LLC, Salem, Massachusetts.

Outcome	Students get idea on biofouling and corrosion mitigationtechniques. They get sound knowledge on macro and micro fouling organisms and its consequences.

CURRICULUM VITAE

Name :**Dr.C.Stella**
Designation :Professor andHead
Address :Department of Oceanography & Coastal Area Studies,
School of MarineSciences
Alagappa University,Karaikudi –630 003
Phone :(+91)9443112812
Email :stella2004@rediffmail.com;stellac@alagappauniversity.ac.in

Educational qualification:

Course	Board/University	Subject	*Division/Grade*
Ph. D	Annamalai University	Marine Biology	Highly Commended
M.Phil.	Annamalai University	Marine Biology	First Class
M.Sc.,	Annamalai University	Marine Biology	First Class
B.Sc.,	Annamalai University	Marine Biology	First Class

Professional experience:
Teaching Experience: 20 years
Research Experience: 25 years

Honours and Awards:

1. Received Cash award for Novel Idea Scheme, Central Electrochemical Research Institute, Karaikudi 1996 – DST, CSIR, andCECRI.
2. Received Second Prize for Young Scientist Award for best paper presentation competition, CSIR Foundation day celebrations on 26.9.1997, CECRI,Karaikudi
3. Received Best Research Advisor Award in Marine science, 7-8th Feb2013.
4. Received Distinguished Faculty Award for the Contribution and Achievement in the Field of Marine Biology- 9th July2016.

Recent publications:

- P De los Ríos, M Kalaiarasi, P Paul, C Lathasumathi, C Stella**(2019)**, Crustaceana Monthly variations in crustacean zooplankton abundances in SundarapandianPattinam and Manamelkudi in the Palk Strait, India (9-10° N, Arabian Sea). 92 (3),295-306.
- P De los Ríos, L Kanagu, C Lathasumathi, C Stella**(2019)** Age and growth of two populations of Pugilinacochlidium (Gastropoda: Melongenidae), from Thondi coast-Palk Bay in Tamil Nadu-South East coast of India.. Brazilian Journal ofBiology.
- P De los Ríos, L Kanagu, C Lathasumathi, C Stella**(2019).** Age and growth of two populations of Pugilinacochlidium (Gastropoda: Melongenidae) from Thondi coast-Palk Bay on the Tamil Nadu-Southeast India coast. Brazilian Journal of Biology
- MariadossKalaiarasi,and**Chelladurai Stella (2017),** Zooplankton in Arabian Sea,India. *Sustainability Agri, Food and Environmental Research* 4(4), 1-12.
- MariadossKalaiarasi, **Chelladurai Stella. (2017).** Key for Microzooplankton Species found in SundaparandianPattinam and Manamelkudi, Tamil Nadu, India (9-10° N, Arabian Sea). *Sustainability Agri, Food and Environmental Research* 4(4), 2017:45-49.
- ChokkalingamLathasumathi, Patricio De Los Ríos Escalante,,MariadossKalaiarasi&**Chelladurai Stella*(2017).**Seasonalvariationofcommunitycompositionofzooplanktoninthe Palkstrait,(9-10 °N, Arabian sea, India).*BulletindelaSociétéRoyaledesSciencesdeLiège*,Vol.86,articles, 2017, p.78 - 87.

TotalCitations	:	682
h-index	:	15
i10 index	:	31

CURRICULUM VITAE

Name :**Dr.NilminiViswaprakash**
Designation :AssistantProfessor
Address : Edward Via College of Osteopathic Medicine,
Clinical AnatomyBuilding
Tuskegge University, 1220 W, Montgomery Rd
Tuskegee, AL 36088, USA
Phone :(334-727-4918)
Email :nviswaprakash@mytu.tuskegee.edu

Educational qualification:

Course	Board/University	Subject	Year	*Division/Grade*
Ph. D	Auburn University	Anatomy and Physiology	2006	Highly Commended
M.Sc.,	Annamalai University	Marine Biology	1990	First Class
B.Sc.,	Madras University	Zoology	1988	First Class

Professional experience:
Teaching Experience: 19 years
Research Experience: 17 years

Honours and Awards:

1. Presidential Graduate Fellowship atAuburnUniversity 2001-2005
2. People's Choice Poster Award at Phi Zeta Honor SocietyResearchForum 2005
3. Outstanding International Graduate Student Award atAuburn University 2005
4. Marshal representing the Veterinary medical school, Auburn Universityatgraduation 2006

Recent publications:

- Kuppurangan, G., Karuppasamy, B., Nagarajan, K., Sekar, R. K., **Viswaprakash, N.** , &Ramasamy, T. (2016) Biogenic synthesis and spectroscopic characterization of silver nanoparticles using leaf extract of Indoneesiellaechioides: in vitro assessment on antioxidant, antimicrobial and cytotoxicity potential Applied Nanoscience 6:973.
- Karuppiah, P., Venkatasamy, V., **Viswaprakash, N.,**&Ramasamy, T. (2015) A statistical approachonoptimizationofexopolymericsubstanceproductionbyHalomonassp.S19andits emulsification activity Bioresources. Bioprocessing 2:48.
- **Viswaprakash, N**., Vaithianathan, T., Viswaprakash, A., Judd, R., Parameshwaran, K. &Suppiramaniam, V. (2015) Insulin treatment restores glutamate (α-amino-3-hydroxy-5-methyl-4-isoxazolepropionic acid) receptor function in the hippocampus of diabetic rats. Journal of Neuroscience Research, 93:1442-1450.
- Geetha, T., Zheng, C., **Vishwaprakash, N.,** Broderick, T. L., &Babu, J. R. (2012) Sequestosome1/p62,aScaffoldingProtein,IsaNewlyIdentifiedPartnerofIRS-1Protein.The Journal of Biological Chemistry, 287(35),29672–29678.
- **Viswaprakash, N.,** Josephson E. M, Dennis J. C, Yilma S., Morrison E. E, Vodyanoy V. J. (2010) Odorant Response Kinetics from Cultured Mouse Olfactory Epithelium at Different Ages in vitro. Cells Tissues Organs;192:361-373.
- **Viswaprakash, N.,** Dennis, J. C., Globa, L., Pustovyy, O., Josephson, E. M., Kanju, P., Morrison, E. E., Vodyanoy V. J. (2009) Enhancement of Odorant-Induced Responses in Olfactory Receptor Neurons by Zinc Nanoparticles. Chemical Senses, Volume 34, Issue 7, Pages 547–557.

CURRICULUM VITAE

Name :**Dr. C.Ragunathan**
Designation :Joint Director/ScientistE
Address :Zoological Survey of India, M-Block, New Alipore, Kolkotta-700053
Phone :(+91) 9434289298
Email :raghuksc@rediffmail.com

Educational qualification:

Course	Board/University	Subject	Year	*Division/Grade*
Ph. D	Annamalai University	Marine Biology	1997	Awarded
M.Sc.	Annamalai University	Marine Biology and Oceanography	1990	First Class
B.Sc.	Aditanar College, Madurai Kamaraj University	Zoology	1988	First Class

Professional experience:

Research Experience: 25 years

Honours and Awards:

- Received 'HIGH PERFORMANCE SCIENTIST OF ZSI – 2011' AWARD conferred by ZSI, HQs, Kolkata on 26th January2012.
- Received 'HIGH PERFORMANCE SCIENTIST OF ZSI – 2012' AWARD conferred by ZSI, HQs, Kolkata on 26th January2013.
- Received a 'CERTIFICATE OF APPRECIATION' from Central Agricultural Research Institute (CARI), ICAR, Port Blair on 23rd June 2013 for the meritoriousservices
- Received a 'CERTIFICATE OF APPRECIATION' from Central Island Agricultural Research Institute (CIARI), ICAR, Port Blair on 23rd June 2014 for the constant support and cooperation for strengthening research, extension and development activities of theinstitute.
- Received an award 'FELLOW OF ANDAMAN SCIENCE ASSOCIATION' conferred by Andaman Science Association, Port Blair on 17th April2015.

Recent publications:

- Dixit, S., Raghunathan, C. and Chandra, K., 2017. New records of sea slugs (Heterobranchia: Opisthobranchia) from India. Proceedings of the International Academy of Ecology and Environmental Sciences, 7(3):47
- Rajeshkumar,S.,Raghunathan,C.andChandra,K.,2016.AdditionalrecordsofOdonata from Andaman & Nicobar Islands, India. Biosystematica, 10(1&2):39-46.
- Dixit, S., Raghunathan, C. and Chandra, K., 2017. Two new Pseudoceros (Polycladida: Pseudocerotidae) and a Prostheceraeus (Polycladida: Euryleptidae) from Andaman and Nicobar Islands, India. Zootaxa, 4269(4):495-512.
- Mondal, J., Raghunathan, C. and Venkataraman, K., 2017. New records of AplousobranchascidianstoIndianwatersfromAndamanIslands.ThreatenedTaxa,9(2): 9874-9880.
- TamalMondal, Raghunathan, C. and Venkataraman, K., 2016. Diversity ofScleractinian Corals in Great Nicobar Island, Andaman and Nicobar Islands, India. Proc. Zool. Soc., 69(2): 205-2016. DOI10.1007/s12595-015-0145-8.

CURRICULUM VITAE

Name :**Dr. G.Khedkar**
Designation :Director
Address :Paul Hebert Centre for DNA Barcoding and Biodiversity Studies, Dr.BabasahebAmbedkarMarathwada University,Aurangabad
Phone : (+91) 9423777971
Email : gdkhedkar@gmail.com

Academic qualification:Ph.D.

Professional experience:
Teaching Experience: 20 years
Research Experience: 27 years

Area of Research: Molecular genetics and genomics.

Recent publications:

1. VikramKhilare,AnitaTiknaik,BharathiPrakash,BalasahebUghade,GaneshKorhale,DineshNalage, Nadeem Ahmed, ChandraprakashKhedkar, GulabKhedkar (2019). Multiple tests on saffron find new adulterant materials and reveal that Ist grade saffron is rare in the market. Food chemistry 272, 635-642.
2. Anita Tiknaik, Amol Kalyankar, Mahesh Shingare, Rahul Suryawanshi, Bharathi Prakash, Tejswini A Sontakke, Dinesh Nalage, RaveendranathanpillaiSanil, GulabKhedkar (2019). Refutation ofmedia reports on introduction of the red bellied piranha and potential impacts on aquatic biodiversity in India.Mitochondrial DNA Part A 30 (4),643-650.
3. B Prakash, I Karunasagar, I Karunasagar, GD Khedkar(2019).Denture wearers show more diversity of lactobacillus spp. Thanklebsiella spp. Compared to non-denture wearers. International Journal of Scientific Research 8(10).
4. G Khedkar, C Khedkar, B Prakash, A Khedkar, D Haymer (2019) DNA barcode-based identification of a suspected tiger skin: A case to resolve mimicry. Forensic Science International: Reports 1, 1000272019.
5. S Abhyankar, K Khobragade, G Khanwelkar, ATiknaik, G Khedkar (2019). Evidence for a species complex in Indialonaganapati (Chydoridae). Mitochondrial DNA Part A 30 (3),457-4652019.
6. BR Ughade, VC Khilare, DM Sangale, GA Korhale, P Ingle, AE Tathe, R Patil, GD Khedkar (2019). A definitive method for distinguishing cultivated onion from its weedy mimic, Asphodelusfistulosus, at multiple developmental stages. Weed Research 59 (1),39-482019.
7. B Prakash, GD Khedkar, SP Akshay RPatil, GD Khedkar I(2019).Newer Aspects of Diagnosis and Treatment of Human Fungal Infection. nt. J. Curr. Microbiol. App. Sci 8 (6),1873-1876.
8. VIswaryaDeepti,SKandula,GDKhedkar(2019).DNAbarcodingoffivespeciesofgroupers(Pisces: Serranidae)offVisakhapatnam,centraleasterncoastofIndia.MitochondrialDNAPartA29(5),659- 663.
9. Nadeem Ahmed, DeepaliSangale, Anita Tiknaik, Bharathi Prakash, RaitujaHange, RavindranathanpillaiSanil, Sajid Khan, GulabKhedkar (2019). Authentication of origin of meat species processed under various Indian culinary procedures using DNA barcoding. Food control 90, 259-265.

TotalCitations	:	302
h-index	:	11
i10 index	:	13

CURRICULUM VITAE

Name :**Dr.Ajith KumarT.T.**
Designation :Principal Scientist & ScientistIn-Charge
Address :PMFGR Center, National Bureau of Fish Genetic Resources, CMFRI Campus, Post Box No- 1603, Ernakulam North P.O., Kochi-682018,Kerala.
Phone :(+91)9443001785
Email :nbfgrcochin@gmail.com

Educational qualification: M. Sc., Ph. D., in Marine Biology

Professional experience:24 years

Current area of Research: Aquaculture for conservation and livelihooddevelopment.

Expertise: Livelihood development to costal & island community.

Honours and Awards:

- Best Researcher- Annamalai University 2008 –2009.
- INSA Fellow –2009.
- K. Chidambaram memorial annual award for the contribution to marine ornamental fish breeding – 2011.
- Prof. M. Aruchami award for the contribution to aquaculture, Clownfish - Kongu Nadu Arts and Science college, Bharathiar University, Coimbatore –2016.
- Member-ExpertcommitteesonInvasiveAlienSpeciesandNormallyTradedCommodities,N.B.A. 2017 – 2019.

Recent publications:

- J.Balamurugan,T.T.AjithKumar,S.Prakash,B.Meenakumari,C.Balasundaram,R.Harikrishnan. 2016. Clove extract: A potential source for stress free transport of fish, Aquaculture, 454:171-175.
- Prakash, S., T. T. Ajith Kumar, R. Bauer, M. Thiel and T. Subramoniam. 2016. Reproductive morphology and mating behavior in the coral reef shrimp Rhynchocinetesdurbanensis Gordon, 1936 (Decapoda: Caridea: Rhynchocinetidae) in India. Journal of Marine Biological Association, UK, 96(6):1331-1440.
- Prakash, S., T. T. Ajith Kumar, T. Subramoniam. 2016. New records of marine ornamental shrimps (Decapoda: Stenopodidea and Caridea) from the Gulf of Mannar, Tamil Nadu, India. Check List, 12(6):1-6.
- Prakash, S., T. T. Ajith Kumar, R. Raghavan, A. Rhyne, M. F. Tlusty and T. Subramoniam. 2017. Marine aquarium trade in India: Challenges and opportunity for conservation and policy. Marine Policy, 77:120-129.
- Marudhupandi,T.,T.T.AjithKumar,S.Prakash,J.BalamuruganandN.B.Dhayanithi.2017.Vibrio parahaemolyticus a causative bacterium for tail rot disease in ornamental fish, Amphiprionsebae. Aquaculture reports, 8:39-44.

Books : 10
Book Chapters: 25
Popular articles : 30

CURRICULUM VITAE

Name :**Dr.P.Madeswaran**
Designation :Scientist-G
Address :Ministry of EarthSciences,
National Centre for Coastal Research (NCCR)
Chennai – 600 100
Phone :(+91) 944 5202984
Email :mades@nccr.gov.in

Educational qualification:

Course	Board/University	Subject	Year	*Division/Grade*
Ph. D	Annamalai University	Marine Biologyand Oceanography	2015	Highly Commended
M.Phil.	Annamalai University	Marine Biologyand Oceanography	1986	First Class
M.Sc.,	Annamalai University	Marine Biologyand Oceanography	1984	First Class

Employment Records:

1. Scientist G, Coordination of Seawater Quality Monitoring (SWQM), National Centre for Coastal Research (NCCR), Ministry of Earth Sciences, Government of India, 2018- tilltoday
2. Scientist-F, Coordination of Seawater Quality Monitoring (SWQM) Programme – National Centre for Coastal Research (NCCR), Ministry of Earth Sciences, Government of India,2014-18
3. Director & Scientist-F, Coordination and Implementation of R&D programme towards conservation and management of marine living resources in Indian Exclusive Economic Zone (EEZ) including maintenance and management of Fishery and Oceanographic Research Vessel (FORV) - SagarSampada. Also represented India in Commission for Conservation of Antarctic Marine Living Resources (CCAMLR), Centre for Marine Living Resources and Ecology (CMLRE), Ministry of Earth Sciences, Kochi,2013-14
4. Scientist-F, Coordination of research programmes on (i) Integrated Coastal and Marine Area Management (ICMAM); (ii) Coastal Ocean Monitoring and Prediction System (COMAPS); (iii) Marine Living Resources (MLR); and (iv) Development of potential Drugs from Ocean (Drugs from Sea). In addition to the above, coordination of international programmes on (i) South Asia Cooperative Environment Programme (SACEP), Colombo, Srilanka; and (ii) Commission for Conservation of AntarcticMarineLivingResources(CCAMLR),Hobart,Australia.MinistryofEarthSciences,NewDelhi, 2008-2009

Major Programs & Achievements:

- Seawater Quality Programme (SWQM) / Coastal Ocean Monitoring and PredictionSystem.
- Marine Research and Development Fund(MRDF)
- Marine Manpower Development Programme(MMDP)
- Assessment of Marine Living Resources in Indian EEZ(MLR)
- Development of potential Drugs from Ocean (Drugs fromSea)
- Outreach programme – seminar, symposia andconference
- National Ocean Information System(NOIS)

Publications:

- 5 publications in national and international referredjournals.
- A status report on, "Seawater quality at selected locations along Indian coast has been released based onthedatacollectedunderCOMAPS/SWQMprogrammeontheoccasionofcelebrationofFoundation Day of Ministry of Earth Sciences on 27th July, 2018 in NewDelhi.

CURRICULUM VITAE

Name :**Dr.M.Jaikumar**
Designation :FieldScientist
Address :CCAMP lncubator, NCBS –TIFR,
GKVK post, Bellaryroad,
Bangalore - 560065.
Phone :(+91)9884742424
Email :jaikumarmarine@gmail.com

Educational qualification:

Course	Board/University	Subject	Year	*Division/Grade*
Ph. D	Andhra University,Visakhapatnam	Marine Biology	2009	Highly Commended
M.Sc.,	Alagappa University	Marine Biology	2002	First Class
B.Sc.,	University of Madras	Microbiology	2000	First Class

Professional experience:

At present working as a Field Scientist in Sea 6 Energy, Pvt Ltd Banglore Located in GKVK Campus, DBT-CCAMPlncubator,NCBS–TIFR,Bengaluru.from(August2015totilldate);Mainresponsibilities: Fieldobservationonmarinestudiesanddevelopingtechnologiesthatallowustogrowseaweedinrougher ocean waters andfisheries.

Worked as a Project Scientist in the division of Ecotoxicology at ICMAM, Ministry of Earth Sciences, Government of India from (November 2012 to July 2015); Main responsibilities: Development of marine water quality criteria for heavy metals by conducting bioassay experiments.

Worked as a Scientist at Aquaculture Foundation of India, Chennai from (February 2010 to November 2012); Main responsibilities: Transfer of knowledge on new fishing technologies to the fishermen populationofTamilNadu,empowerment offisherwomen bytrainingthemonseaweedcultivationat Palk Bay and Mandapam, TamilNadu.

SeniorProjectAssistantatInstituteforOceanManagement,AnnaUniversity,Chennaifrom(May2002to March 2003); Main responsibilities: Digitizing of CRZMaps.

Recent publications:

- P. Karthikeyan, D. Mohan, M. Jaikumar (2015). Growth Inhibition Effect of Organophosphate Pesticide, Monocrotophos on Marine Diatoms. Indian Journal of Geo-Marine Sciences 44(10):516-1520.
- M. Jaikumar, C. Suresh Kumar, Robin. RS, P. Karthikeyan, A. Nagarjuna (2013). Milkfish culture: Alternative revenue for Mandapamfisherfolk, Palk Bay, southeast coast of India. International Journal of Fisheries and Aquaculture Sciences 3(1):31-43.
- P. Karthikeyan, K. Manimaran, P. Sampathkumar, M. Jaikumar, RS. Robin, C. Saravana Kumar, C. Suresh Kumar (2013). In vitro antioxidant activity of marine diatoms. Journal of Environmental Science, Toxicology and Food Technology 5(2):32-37.
- C. Sureshkumar, M. Jaikumar, RS. Robin, P. Karthikeyan, C. Saravana Kumar (2013). Heavymetal concentration of seawater and marine organisms in Ennore creek, southeast coast of India. The Journal of Toxicology and Health 103:192-201.
- Robin RS, Vishnu Vardhan Kanuri, Pradipta R. Muduli, M.Jaikumar, P. Karthikeyan, C. Suresh Kumar, C. Saravana Kumar (2013). Influence of coastal and backwaters coupling on sustenance of highnutrientsandorganicproductionalongthesoutheastArabianSea.MarineScience,3(3):79-90.

CURRICULUM VITAE

Name :**Dr.V.SUGUMAR**
Designation :AssistantProfessor
Address :Department of Oceanography & Coastal Area Studies,
School of Marine Sciences
AlagappaUniversity,Karaikudi –630003
Phone :(+91)9445139906
Email : sugumarv@alagappauniversity.ac.in;crustacealab@gmail.com

Educational qualification:

Course	Board/University	Subject	Year	*Division/Grade*
Ph. D	University of Madras	Zoology	2005	Highly Commended
M.Phil.	University of Madras	Zoology	2001	First Class (Outstanding)
M.Sc.	University of Madras	Zoology	2000	First Class
B.Sc.	University of Madras	Zoology	1998	First Class

Professional experience:

Teaching Experience: 11 years

Research Experience: 14 years

Honours and Awards:

1. Recipient of **Dr. (Mrs) SudhaVaradharajan Memorial Endowment Gold Medal** from Thiru. Surjit Singh Barnala, Governor of Tamil Nadu, for the **"Best Thesis2005"**.
2. **Awarded Research Fellowship** – Department of Ocean Development, Government ofIndia.
3. **Awarded DST – FAST TRACK for Young Scientist**, Government ofIndia.

Recent publications:

- Paneerselvam, R., Anandhan, N., Sivakumar, G., Ganesan, K.P., Marimuthu, T and **Sugumar. V.(2019)**. Role of annealing temperatures on mechanical, optical, electrical and magnetic properties of nanohydroxyapatite biomaterial. ***Journal of Nanoscience and Nanotechnology*** [American Scientific Publishers, USA], 19:4366-4376.

- BeemaMahin, M. I., Saravanan, R. and **Sugumar, V. (2018)**. Isolation, identification and characterization of the bioluminescent bacteria isolated from the blue swimmer crab Portunuspelagicus along Thondi Coast and virulence studies at high temperatures. ***Microbial Pathogenesis***[Elsevier, USA],117:232-236.

- Saravanan, R. and **Sugumar, V. (2018)**. Heavy metal stress induced hyperglycemia in blue swimmer crab, *Portunuspelagicus.**ActaOceanologicaSinica***[Springer, USA], 37 (5);1-7.

TotalCitations	:	136
h-index	:	8
i10 index	:	7

CURRICULUMVITAE

Name :**Dr.S.Paramasivam**
Designation : AssistantProfessor
Address : Department of Oceanography & Coastal Area Studies,
School of MarineSciences
Alagappa University, Karaikudi –630 003
Phone : (+91) 9047733300; Fax : (+91) 4565 225525
Email : drparamsan@gmail.com/psivams@alagappauniversity.ac.in

Educational qualification:

Course	Board/University	Subject	Year	*Division/Grade*
B. Sc.	Barathidasan University	Zoology	1994	First Class
M. Sc.	Annamalai University	Coastal Aquaculture	1996	First Class
Ph.D	Annamalai University	Marine Biology	2003	By thesis

Professional experience: Teaching experience: 11 years; Research experience: 17 years
Honours and Awards:DST-SERB YoungScientistaward : 2012

Recent publications:

- Rosemary,T.;Arulkumar,A.;**Paramasivam,S.**;Mondragon-Portocarrero,A.;Miranda,J.M.**2019**. Biochemical, Micronutrient and Physicochemical Properties of the Dried Red Seaweeds *Gracilaria edulis* and *Gracilariacorticata*. *Molecules*. *24*, 2225. (doi:10.3390/molecules24122225). **Impact Factor: 3.060.**
- Arulkumar,A.,P.Nigariga,S.ParamasivamandR.Rajaram.**2019**.Metalsaccumulationinediblemarine algae collected from Thondi coast of Palk Bay, Southeastern India. Chemosphere. 221:856-862. (doi.org/10.1016/j.chemosphere.2019.01.007). ISSN: 0045-6535, **IF:5.108.**
- Arulkumar A, Paramasivam S, Rameshthangam P, Paramithiotis S. **2019**. Evaluation of psychrophilic, mesophilic, histamine forming bacteria and biogenic amine content in the muscle of mud spiny lobster, *Panuliruspolyphagus* (HERBST, 1793) during ice storage. J. Food Saf. 39 (1):e12582 (doi.org/10.1111/jfs.12582). IF:1.**665.**
- Arulkumar, A., Paramasivam, S. & Miranda, J.M. **2018**. Combined Effect of Icing Medium and Red Alga *Gracilariaverrucosa* on Shelf Life Extension of Indian Mackerel (*Rastrelligerkanagurta*). Food Bioprocess Technol. (doi.org/10.1007/s11947-018-2154-x). pp 1-12. ISSN :1935-5149. **IF-3.032.**
- AbimannanArulkumar, Thomas Rosemary, SadayanParamasivam&RamaswamyBabuRajendran. **2018**. Phytochemical composition, *in vitro* antioxidant, antibacterial potential and GC-MS analysis of red seaweeds (*Gracilariacorticata*and *Gracilaria edulis*) from Palk Bay, India. Journal of Biocatalysis and Agricultural Biotechnology. (doi.org/10.1016/j.bcab.2018.05.008). 15:63-71.ISSN:1878-8181.
- AbimannanArulkumar, AlagusundaramBalamurugan, SadayanParamasivam, PalanivelRameshthangam&Spiros Paramithiotis. **2017**. Physicochemical and Microbiological Changes During Drying of Wolf Herring (*Chirocentrusdorab*) and Coastal Trevally (*Carangoidescoeruleopinnatus*), Journal of Aquatic Food Product Technology, 26:8, 929-939, (doi: 10.1080/10498850.2017.1362683). **IF: 0.682.**
- AbimannanArulkumar, SadayanParamasivam, PalanivelRameshthangam and Mohamed A Rabie. **2017**. Changesonbiogenic,volatileaminesandmicrobialqualityoftheblueswimmercrab (*Portunuspelagicus*) muscle during storage. Journal of Food Science and Technology. (doi: 10.1007/s13197-017-2694-5). 54 (8), 2503-2511. **IF- 1.797**.
- AbimannanArulkumar, SadayanParamasivam and RajendiranRajaram. **2017.**Toxic heavy metals in commercially important food fishes collected from Palk Bay, Southeastern India. Marine Pollution Bulletin. (doi: 10.1016/j.marpolbul.2017.03.045). 119, 454–459. **IF:3.782.**
- AbimannanArulkumar, KaliyanRamachandiran, SadayanParamasivam, PalanivelRameshthangam, Jose Manuel Miranda. **2017**. Effects of turmeric (*Curcumalonga*) on shelf life extension and biogenic amine control of cuttlefish (*Sepiabrevimana*) during chilled storage. *CyTA-Journal of Food*. (doi: 10.1080/19476337.2017.1296495). 15 (3): 441-447. **IF:1.371**
- AbimannanArulkumar, Gunasekaran Karthik, SadayanParamasivam and Mohamed A Rabie. **2017**. HistaminelevelsinIndianFishviaEnzymatic,TLCandHPLCmethodsduringstorage.JournalofFood

Measurement and Characterization.(doi:10.1007/s11694-016-9395-z). 11 (1):281-289. ISSN-2193-4126. **IF: 1.415.**

CumulativeImpactFactor	**:**	**21.912**
TotalCitations	**:**	**221**
h-index:		**6**
i10index	**:**	**4**

CURRICULUM VITAE

Name : **Dr. V.Yoganandan**

Designation :AssistantProfessor
Address :Department of Marine Science
Bharathidasan University
Tiruchirappalli – 620024
Phone :(+91)9486088657
Email : yoganandan1@gmail.com

Academic qualification:Ph.D.

Professional experience:
Teaching Experience: 08 years
Research Experience: 08 years

Membership in Professional and Academic Bodies:

- Life Member: Indian ScienceCongress
- Life Member: PAGES (Past Global Changes) Society ,Switzerland
- Asia Oceania Geosciences Society,Singapore
- Member of Board of Studies for M.Sc.Marine Scienceprogramme
- Department Research Committee member For Ph.D. programme

Recent publications:

A. Sivachandiran, **V. Yoganandan,** K. Selvaraj (2018) Benthic foraminiferal faunal record indicated Paleoclimatic variation in the Southeastern Arabian Sea for 14,430 years B.P. Journal of Coastal Sciences. V. 5, pp 37-45.

K.Selvaraj,J.Pandiyan,**V.Yoganandan,**G.Agoramoorthy(2016).Indiacontemplatesclimate changeconcernsafterfloodsravagedthecoastalcityofChennai.Ocean&CoastalManagement V. 129, pp10-14.

A.Sivachandiran,**V.Yoganandan,**K.Selvaraj(2016)MicrofossilsRecordsofDecadalClimate Variability from the Southeastern Arabian Sea" International workshop on "Connecting Paleo and Modern Oceanographic Data to Understand AMOC over Decades to Centuries" held at boulder, Colorado, USA, During May 23- 25,2016.

A. Sivachandran**V. Yoganandan** and K. Selvaraj, (2015) A High Resolution Planktonic Foraminifer Records of Indian Summer Monsoon Variability from Southeastern Arabian Sea. Proceeding volume of the CLIVAR-ICTP workshop on Decadal Climate Variability and Pridictability held at Trieste, Italy during 16-24 November 2015.

TotalCitations	:	84
h-index	:	05
i10 index	:	04