B.SC.,
MARINE BIOLOGY

SYLLABUS

FROM THE ACADEMIC YEAR
2023-2024

TAMILNADU STATE COUNCIL FOR HIGHER EDUCATION,
CHENNAI – 600 005

LEARNING OUTCOMES-BASED CURRICULUM FRAMEWORK GUIDELINES BASED REGULATIONS FOR UNDER GRADUATE PROGRAMME	
Programme:	**U.G.**
Programme Code:	
Duration:	**3 years [UG]**
Programme Outcomes:	**PO1: Disciplinary knowledge:** Capable of demonstrating comprehensive knowledge and understanding of one or more disciplines that form a part of an undergraduate Programme of study **PO2: Communication Skills:** Ability to express thoughts and ideas effectively in writing and orally; Communicate with others using appropriate media; confidently share one's views and express herself/himself; demonstrate the ability to listen carefully, read and write analytically, and present complex information in a clear and concise manner to different groups. **PO3: Critical thinking:** Capability to apply analytic thought to a body of knowledge; analyse and evaluate evidence, arguments, claims, beliefs on the basis of empirical evidence; identify relevant assumptions or implications; formulate coherent arguments; critically evaluate practices, policies and theories by following scientific approach to knowledge development. **PO4: Problem solving: Capacity** to extrapolate from what one has learned and apply their competencies to solve different kinds of non-familiar problems, rather than replicate curriculum content knowledge; and apply one's learning to real life situations. **PO5: Analytical reasoning**: Ability to evaluate the reliability and relevance of evidence; identify logical flaws and holes in the arguments of others; analyze and synthesize data from a variety of sources; draw valid conclusions and support them with evidence and examples, and addressing opposing viewpoints. **PO6: Research-related skills**: A sense of inquiry and capability for asking relevant/appropriate questions, problem arising, synthesising and articulating; Ability to recognise cause-and-effect relationships, define problems, formulate hypotheses, test hypotheses, analyse, interpret and draw conclusions from data, establish hypotheses, predict cause-and-effect relationships; ability to plan, execute and report the results of an experiment or investigation **PO7: Cooperation/Team work:** Ability to work effectively and respectfully with diverse teams; facilitate cooperative or coordinated effort on the part of a group, and act together as a group or a team in the interests of a common cause and work efficiently as a member of a team **PO8: Scientific reasoning**: Ability to analyse, interpret and draw conclusions from quantitative/qualitative data; and critically evaluate ideas, evidence and experiences from an open-minded and reasoned perspective. **PO9: Reflective thinking**: Critical sensibility to lived experiences, with self awareness and reflexivity of both self and society. **PO10 Information/digital literacy:** Capability to use ICT in a variety of learning situations, demonstrate ability to access, evaluate, and use a variety of relevant information sources; and use appropriate software for analysis of data. **PO 11 Self-directed learning**: Ability to work independently, identify appropriate resources required for a project, and manage a project through to

	completion. **PO 12 Multicultural competence:** Possess knowledge of the values and beliefs of multiple cultures and a global perspective; and capability to effectively engage in a multicultural society and interact respectfully with diverse groups. **PO 13: Moral and ethical awareness/reasoning**: Ability toembrace moral/ethical values in conducting one's life, formulate a position/argument about an ethical issue from multiple perspectives, and use ethical practices in all work. Capable of demonstartingthe ability to identify ethical issues related to one‟s work, avoid unethical behaviour such as fabrication, falsification or misrepresentation of data or committing plagiarism, not adhering to intellectual property rights; appreciating environmental and sustainability issues; and adopting objective, unbiased and truthful actions in all aspects of work. **PO 14: Leadership readiness/qualities:** Capability for mapping out the tasks of a team or an organization, and setting direction, formulating an inspiring vision, building a team who can help achieve the vision, motivating and inspiring team members to engage with that vision, and using management skills to guide people to the right destination, in a smooth and efficient way. **PO 15: Lifelong learning:** Ability to acquire knowledge and skills, including „learning how to learn‟, that are necessary for participating in learning activities throughout life, through self-paced and self-directed learning aimed at personal development, meeting economic, social and cultural objectives, and adapting to changing trades and demands of work place through knowledge/skill development/reskilling.
Programme Specific Outcomes:	**PSO1**: To enable students to apply basic microeconomic, macroeconomic and monetary concepts and theories in real life and decision making. **PSO 2**: To sensitize students to various economic issues related to Development, Growth, International Economics, Sustainable Development and Environment. **PSO 3**: To familiarize students to the concepts and theories related to Finance, Investments and Modern Marketing. **PSO 4**: Evaluate various social and economic problems in the society and develop answer to the problems as global citizens. **PSO 5:** Enhance skills of analytical and critical thinking to analyze effectiveness of economic policies.

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
PSO 1	Y	Y	Y	Y	Y	Y	Y	Y
PSO 2	Y	Y	Y	Y	Y	Y	Y	Y
PSO3	Y	Y	Y	Y	Y	Y	Y	Y
PSO 4	Y	Y	Y	Y	Y	Y	Y	Y
PSO 5	Y	Y	Y	Y	Y	Y	Y	Y

3 – Strong, 2- Medium, 1- Low

Highlights of the Revamped Curriculum:

- Student-centric, meeting the demands of industry & society, incorporating industrial components, hands-on training, skill enhancement modules, industrial project, project with viva-voce, exposure to entrepreneurial skills, training for competitive examinations, sustaining the quality of the core components and incorporating application oriented content wherever required.
- The Core subjects include latest developments in the education and scientific front, advanced programming packages allied with the discipline topics, practical training, devising mathematical models and algorithms for providing solutions to industry / real life situations. The curriculum also facilitates peer learning with advanced mathematical topics in the final semester, catering to the needs of stakeholders with research aptitude.
- The General Studies and Mathematics based problem solving skills are included as mandatory components in the 'Training for Competitive Examinations' course at the final semester, a first of its kind.
- The curriculum is designed so as to strengthen the Industry-Academia interface and provide more job opportunities for the students.
- The Industrial Statistics course is newly introduced in the fourth semester, to expose the students to real life problems and train the students on designing a mathematical model to provide solutions to the industrial problems.
- The Internship during the second year vacation will help the students gain valuable work experience, that connects classroom knowledge to real world experience and to narrow down and focus on the career path.
- Project with viva-voce component in the fifth semester enables the student, application of conceptual knowledge to practical situations. The state of art technologies in conducting a Explain in a scientific and systematic way and arriving at a precise solution is ensured. Such innovative provisions of the industrial training, project and internships will give students an edge over the counterparts in the job market.
- State-of Art techniques from the streams of multi-disciplinary, cross disciplinary and inter disciplinary nature are incorporated as Elective courses, covering conventional topics to the latest - Artificial Intelligence.

ValueadditionsintheRevampedCurriculum:

Semester	Newly introducedComponents	Outcome/ Benefits
I	**Foundation Course** To ease the transition of learningfrom higher secondary to highereducation,providinganoverviewofthepedagogyoflearningLiteratureandanalysingtheworldthroughtheliterarylens givesrisetoanewperspective.	➢ Instill confidenceamongstudents ➢ Createinterestforthesubject
I,II,III,IV	**SkillEnhancementpapers**(Discipline centric /Generic/Entrepreneurial)	➢ Industry readygraduates ➢ Skilledhumanresource ➢ Studentsareequippedwithessentialskillsto makethememployable
		➢ Trainingonlanguageand communicationskillsenablethestudents gain knowledge and exposureinthecompetitiveworld.
		➢ Discipline centric skillwillimprovetheTechnical knowhow ofsolvingreallife problems.
III,IV,V& VI	Electivepapers	➢ Strengthening thedomainknowledge ➢ Introducing thestakeholdersto theState-of Arttechniquesfrom the streamsofmulti-disciplinary,crossdisciplinaryandinterdisciplinarynature ➢ Emerging topics inhigher education/industry/communicationnetwork/healthsectoretc.areintroducedwith hands-on-training.
IV	ElectivePapers	➢ Exposuretoindustrymouldsstudentsintosolutionproviders ➢ GeneratesIndustryready graduates ➢ Employmentopportunitiesenhanced

VSemester	Electivepapers	➢ Self-learning isenhanced ➢ Applicationoftheconcepttorealsituationisconceivedresulting intangibleoutcome
VISemester	Electivepapers	➢ Enriches the studybeyondthe course. ➢ Developingaresearchframework and presenting their independent and intellectual ideas effectively.
ExtraCredits: ForAdvancedLearners/Honorsdegree		➢ Tocatertotheneedsofpeerlearners/research aspirants
SkillsacquiredfromtheCourses	Knowledge, Problem Solving, Analytical ability,ProfessionalCompetency,ProfessionalCommunicationandTransferrable Skill	

Consolidated Semester wise and Component wise Credit distribution

Parts	Sem I	Sem II	Sem III	Sem IV	Sem V	Sem VI	Total Credits
Part I	3	3	3	3	-	-	12
Part II	3	3	3	3	-	-	12
Part III	13	13	13	13	22	18	92
Part IV	4	4	3	6	4	1	22
Part V	-	-	-	-	-	2	2
Total	23	23	22	25	26	21	**140**

***Part I. II, and Part III components will be separately taken into account for CGPA calculation and classification for the under graduate programme and the other components. IV, V have to be completed during the duration of the programme as per the norms, to be eligible for obtaining the UG degree.**

MethodsofEvaluation		
Internal Evaluation	ContinuousInternalAssessmentTest	25 Marks
	Assignments	
	Seminars	
	AttendanceandClassParticipation	
External Evaluation	EndSemesterExamination	75 Marks
	Total	100 Marks
MethodsofAssessment		
Recall(K1)	Simpledefinitions,MCQ,Recallsteps,Conceptdefinitions	
Understand/Comprehend(K2)	MCQ,True/False,Shortessays,Conceptexplanations,Shortsummaryor overview	
Application (K3)	Suggestidea/conceptwithexamples,Suggestformulae, Solveproblems, Observe,Explain	
Analyze(K4)	Problem-solvingquestions,Finishaprocedureinmanysteps,Differentiate	
	betweenvariousideas,Mapknowledge	
Evaluate(K5)	Longer essay/Evaluationessay,Critiqueorjustifywithprosandcons	
Create(K6)	Checkknowledgeinspecificoroffbeatsituations,Discussion,Debatingor Presentations	

B.Sc., MARINEBIOLOGY
Programme Structure

Sem.	Part	Course Code	Courses	Title of the Paper	T/P	Credits	Hrs./ Week	Max. Marks		
								Int.	Ext.	Total
				Semester – I						
I	I	2311T	T/OL	தமிழ் இலக்கிய வரலாறு-I /other Language-I	T	3	6	25	75	100
	II	2312E	E	General English-I	T	3	6	25	75	100
	III	23BMB1C1	CC - I	Fundamentals of Marine Biology	T	5	5	25	75	100
		23BMB1P1	CC - II	Practical - Fundamentals of Marine Biology	P	5	5	25	75	100
			Generic Elective (Allied)– I	Botany/Zoology/Microbiology/ Biotechnology/Chemistry	T	3	3	25	75	100
				Allied Lab	P	2	2	25	75	100
	IV	23BMB1SP	SEC-I	Field Visit (Coastal Ecosystem)	P	2	2	25	75	100
				Library			1			
				Total		**23**	**30**	**175**	**525**	**700**
				Semester – II						
II	I	2321T	T/OL	தமிழ் இலக்கிய வரலாறு-2 /Other Languages-II	T	3	6	25	75	100
	II	2322E	E	General English - II	T	3	6	25	75	100
	III	23BMB2C1	CC – III	Animal Diversity	T	5	5	25	75	100
		23BMB2P1	CC – IV	Practical- Animal Diversity	P	5	5	25	75	100
		--	Generic Elective Allied)– I	Botany/Zoology/Microbiology/ Biotechnology/Chemistry	T	3	3	25	75	100
		--		Allied Lab	P	2	2	25	75	100
	IV	23BMB2SP	SEC-II	Field Report	P	2	2	25	75	100
		--		Library			1			
				Total		**23**	**30**	**175**	**525**	**700**
				Semester – III						
III	I	2331T	T/OL	தமிழக வரலாறும் பண்பாடும் /Other Languages-III	T	3	6	25	75	100
	II	2332E	E	General English– III	T	3	6	25	75	100
	III	23BMB3C1	CC – V	Cell and Developmental Biology	T	4	4	25	75	100
		23BMB3C2	CC – VI	Fishery Biology	T	4	4	25	75	100
		23BMB3P1	CC – VII	Practical -III Cell and Developmental Biology and Fishery Biology	P	3	3	25	75	100
		--	Generic Elective (Allied)– III	Botany/Zoology/Microbiology / Biotechnology/Chemistry	T	3	3	25	75	100
		--		Allied Lab	P	2	2	25	75	100
	IV	233AT/ 23BMB3S1	SEC-III	Adipadai Tamil 1 / Entrepreneurship	T	2	2	25	75	100
				Total		**24**	**30**	**200**	**600**	**800**

Sem.	Part	Course Code	Courses	Title of the Paper	T/P	Credits	Hrs./ Week	Max. Marks		
								Int.	Ext.	Total
Semester – IV										
IV	I	2341T	T/OL	**தமிழும் அறிவியலும்** /Other Languages -IV	T	3	6	25	75	100
	II	2342E	E	General English-IV	T	3	6	25	75	100
	III	23BMB4C1	CC – VIII	Animal Physiology and Biochemistry	T	4	4	25	75	100
		23BMB4C2	CC – IX	Aquaculture	T	3	3	25	75	100
		23BMB4P1	CC - X	Practical -IV Animal Physiology and Biochemistry and Aquaculture	P	2	2	25	75	100
		--	Generic Elective (Allied) – IV	Botany/Zoology/Microbiology/ Biotechnology/Chemistry	T	3	3	25	75	100
		--		Allied Lab	P	2	2	25	75	100
	IV	234AT/ 23BMB4S1	SEC-IV	Adipadai Tamil 2/ Small Business Management	T	2	2	25	75	100
		23BES4	EVS	Environmental Studies	T	2	2	25	75	100
				Total		**24**	**30**	**225**	**675**	**900**
Semester – V										
V	III	23BMB5C1	CC – XI	Marine Pollution	T	4	5	25	75	100
		23BMB5C2	CC – XII	Biodiversity and Conservation	T	4	5	25	75	100
		23BMB5C3	CC – XIII	Seafood Processing Technology	T	4	5	25	75	100
		23BMB5P1	CC – XIV	Practical-V Marine Pollution, Biodiversity and Conservation and Seafood Processing Technology	P	4	4	25	75	100
		23BMB5E1	DSE - I	Marine Resources	T	3	4	25	75	100
		23BMB5E2	DSE - II	Aquarium Fish Keeping	T	3	4	25	75	100
	IV	23BVE5		Value Education	T	2	2	25	75	100
		--		Library			1			
				Total		**24**	**30**	**175**	**525**	**700**
Semester – VI										
VI	III	23BMB6C1	CC – XV	Immunology and Genetics	T	4	4	25	75	100
		23BMB6P1	CC – XVI	Practical-VI Immunology and Genetics	P	3	3	25	75	100
		23BMB6PR	CC – XVII	Project	PR	6	10	25	75	100
		23BMB6E1	DSE - III	Coastal Disaster Management	T	4	6	25	75	100
		23BMB6E2	DSE - IV	Marine Biofouling And Management	T	3	5	25	75	100
	IV	23BMB6S1		Essential Reasoning and Quantitative Aptitude	T	2	2	25	75	100
				Total		**22**	**30**	**100**	**300**	**400**
				Grand total		**140**		**1050**	**3150**	**4200**

- TOL-Tamil/Other Languages,
- E – English
- CC - Core course –Core competency, critical thinking, analytical reasoning, research skill &teamwork
- Generic Elective(Allied)
- SEC-Skill Enhancement Course - Exposure beyond the discipline (Value Education , Entrepreneurship Course, Computer application for Science, etc.,
- FC-Foundation Course
- T/P- T-Theory, P-Practical
- DSE-Discipline Specific Elective

Chairperson details: Dr.E. Kannapiran, DDE, Alagappa University, Karaikudi. Mobile No: 9443602687

SEMESTER-I				
CourseCode:23BMB1C1	Core Course-I	T/P	C	H/W
	FUNDAMENTALS OF MARINE BIOLOGY	T	5	5

Objectives	➢ To study the History of Marine Biology and physical and chemical properties of seawater. ➢ Tounderstandtheprimaryandsecondaryproductivityandcommunityecology.
UNIT-I	History of Marine Biology - Definition, historical and modern developments in Marine Biology and Oceanography – National and International Ocean expeditions, Topography of the oceans; Zonation and its significance.
UNIT-II	Physical properties of seawater –Concept note on temperature, density, viscosity,surfacetension,hydrostaticpressure.Waves:typesofwavesanditsdynamics.Tides:Definition, types, generating force. Wind and Ocean circulation, Currents and its types.
UNIT-III	Chemical properties of seawater: Concept of chlorinity and salinity of seawater;Dissolved gases in seawater: non-reactive gases, minor reactive gases; Elements-majorandminorelements.Organicmatter:DissolvedandParticulateorganicmatter-sources and types; Biogeochemical cycle - carbon, nitrogen, phospohorus, silicateandtheirsignificance.
UNIT-IV	Biological properties of sea: Primary and Secondary Productivity of the coastalenvironment; Phytoplankton and Zooplankton: Classification, distribution, inter-relationship.MeasurementofprimaryandSecondaryproductivity.
UNIT-V	Communityecology– Pelagic,benthic,coralreef,estuaries,seagrass,mangrove,intertidalandDeep-SeaEcology-Animalassociationandtheirassemblages.

ReferencesandTextbooks

Naskar,K.,&Mandal,R.(1999).*EcologyandBiodiversityofIndianMangroves*(Vols.1-2).DayaPublishingHouse.

Nybakken,J.W.,&Mark,D.Bertness.(2004).*MarineBiologyanEcologicalApproach*(6th ed.). Benjamin-CummingsPubCo.

PeterMcRoy,C.,&Helterich,G.(1977).*SeagrassEcosystem:AScientificPerspective*.NewYork :MarcelDekkerInc.

Peter,C.,&Michel,E.H.(2013).*MarineBiology*(9th ed.).McGraw-HillEducation.

Spoel.S.Vander,&Heyman,R.P.(1983).*ComparativeatlasofZooplanktonbiologicalpatternsintheoceans*.Springer-VerlagBerlin.

Sumich,J.L.(1999*).IntroductiontothebiologyofMarineLife*(7th ed.).TheMcGrawHillCompaniesInc.

Sverdrup,H.U.,Honson,M.W.,&Fleming,R.H.(1959).*Theoceanstheirphysics,chemistryandgeneralbiology*.NewJersey:Prentice-HallInc.

Outcomes	Thestudents gain knowledgein history ofMarine biology and Oceanographyfeatures. Thestudentsabletoknowabouttheproductivityofoceanswithcommunityecology.

SEMESTER-I				
Course Code: 23BMB1P1	**Core Practical -I**	**T/P**	**C**	**H/W**
		P	**5**	**5**

FUNDAMENTALS OF MARINE BIOLOGY

1. Marine sampling devices: Water sampling devices- Knudsen water sampler, Light measuring devices - Secchi disc - Turbidity meter, Sediment sampler –- Peterson'sgrab.

2. Chemicalparameters-Salinity,Total alkalinity, Dissolvedoxygen,Nitrite,Nitrate,Phosphateandsilicate.

3. Identificationofphytoplankton,zooplankton,seaweeds,seagrass,benthicfauna.

4. Field visit to near by fish landing centers and different ecosystems.

SEMESTER II				
Course Code	**Core Course - II**	**T/P**	**C**	**H/W**
23BMB2C1	**ANIMAL DIVERSITY**	**T**	**5**	**5**
Objectives	➢ To know the variety of invertebrate and vertebrate organisms and their evolutionary origin and diversification. ➢ To investigate invertebrates and vertebrates in laboratory and field conditions and identify major taxonomy.			
Unit - I	Principles and classification; origin, evolution and interrelationships of invertebrate's Phyla. – interrelationship among the classes with in each invertebrate phylum			
Unit – II	Marine invertebrates and their biology -Classification and biology: Physiology, locomotion, nutrition and reproduction of marine invertebrates - Phylum Porifera, Phylum Cnidaria, Phylum Ctenophora, Phylum Echinodermata. Minor phyla: chaetognatha, brachiopoda, phoronida and pogonophora			
Unit – III	Prochordata, Hemichordata, Urochordata - Principles and classification; origin, evolution and phylogenetic relationships. Comparative morphology, reproductive and early development and larval.			
Unit – IV	General characteristics and outline classification of Phylum Chordata. Origin, evolution and comparative anatomy of vertebrates through geological time scale. Classification of cyclostomes and pisces. Accessory respiratory organ, Classification of Amphibia and reptilia. Metamorphosis, Paedomorphosis, Parental care in Amphibia. Classification of Aves and Mammals. Exoskeleton, and migration in Birds; Principles and aerodynamics of flight. Adaptive radiation in mammals.			
Unit – V	Structure, function and derivatives of integument in amphibian, birds and mammals. Comparative anatomy of stomach; dentition in mammals. Respiratory organs in fish, birds and mammals. General plan of circulation, Comparative account of heart and aortic arches. Succession of kidney in different vertebrate groups. Comparative account of brain in vertebrates; cranial nerves; olfactory and auditory receptors in Vertebrates.			

References and Textbooks

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

Bliss, D. (Ed.). (1983). *Biology of Crustacea* (Vols. 1-10). London: Academic Press.

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

Gurdarshan Singh & Bhaskar, H. (2002). *Advanced Chordate Zoology*. Campus Books.

Jordan, E. L. & Verma, P.S. (1998). *Chordate Zoology*. S. Chand & Co.

Janakiraman, N., & PatchiRajan, G. *Biodiversity of Invertebrates*. Devakottai: Seetha Lakshmi Ganesan Publishers.

Jordan, E. L. & Verma, P.S. (2009). *Invertebrate Zoology* (Revised edition). New Delhi: S. Chand & Co.

Jordan, E. L. & Verma, P.S. (2010). *Vertebrate Zoology*. S. Chand & Company Ltd.

Kotpal, R. L., (2000). *Modern Textbook of Zoology (Vertebrates)*. Global Media Publications.

Sandhu, G.S. & Bhaskar, H. (2004). *Textbook of Chordate Zoology* (Vols. 1-2). Campus Books

Sandhu, G.S. (2005). *Objective Chordate Zoology*. Campus Books.

Outcomes

- The students will learn about the diversity of invertebrates and vertebrates.
- The students will explore the adaptations of the invertebrate and vertebrate groups to the environment in terms of comparative physiology and body structure.

.

SEMESTER II				
Course Code	**Core Practical II**	**T/P**	**C**	**H/W**
23BMB2P1		**P**	**5**	**5**

ANIMAL DIVERSITY

1. Identification selective larval forms through slides
2. Identification of selective protozoan and helminthes of medical importance
3. Dissection and mounting of digestive system, reproductive system of selected invertebrate
4. Comparative anatomy of vertebrates (Fish, Amphibia, Reptiles, birds and mammals) Skeletal system – Girdles only; Digestive system; Respiratory system
5. Comparative anatomy of vertebrates (Fish, Amphibia, Reptiles, birds and mammals) Circulatory system – heart and Aortic arches; Nervous system – Brain; Urinogenital system
6. Dissection of the locally available cultivable fish- Digestive system; Reproductive system; nervous system.

SEMESTER III				
Course Code	**Core Course III**	**T/P**	**C**	**H/W**
23BMB3C1	**CELL AND DEVELOPMENTAL BIOLOGY**	**T**	**4**	**4**

Objectives	➢ To understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles. ➢ To provide a comprehensive understanding of the concepts of early animal development.
Unit - I	Prokaryotic and Eukaryotic cell structure, Ultra-structure and composition of Plasma membrane. Structure and Functions: Endoplasmic Reticulum, Golgi Apparatus, Lysosomes, Mitochondria, Peroxisomes, Centrosome. Nuclear envelope, Nuclear pore complex, Nucleolus; Chromatin: Euchromatin and Heterochromatin
Unit – II	Cell division; mitosis, meiosis. Cell cycle and control in prokaryotes and eukaryotes. Cell death apoptosis. Cell signalling – signal molecules – receptors – signal transduction
Unit – III	Gametogenesis: Spermatogenesis, Oogenesis. Types of eggs, Egg membranes; Fertilization. Planes and patterns of cleavage; Types of Blastula. Fate map. Gastrulation, organogenesis. Embryonic induction and organizers
Unit – IV	Extra-embryonic membranes in Chick; Implantation of embryo in humans, Placenta (Structure, types and functions of placenta). Development of brain and Eye in Chick. Molecular Induction in Brain and Eye development. Organizer concept Amphibian metamorphosis. Hormonal control of Amphibian metamorphosis. Nuclear Transplantation in Acetabularia - Regeneration – types – regeneration in Amphibians and planaria.
Unit – V	*In vitro* fertilization (IVF), Stem cell: Concept of potency, types, markers and applications of stem cell therapy in bone marrow transplantation and cartilage regeneration

References and Textbooks

Alberts, B., Bray, D., Lavis, J., Raff, M., Roberts, K., & Watson, J. (1989). *Molecular biology of the cell* (2nd ed.). New York: Garland publishing Inc.

DeRobertis & DeRobertis (1999). *Cell and Molecular Biology*. Philadelphia: W.B. Saunders Co.

Geoffrey Cooper, M. (2000). *The cell – A molecular approach* (2nd ed.). ASM Press.

Hopper, A. F., & Hart, N. H. (1985). *Foundations of Animal Development*. Oxford: Oxford University Press.

Lewis Wolpert. (2007). *Principles of Development*. Oxford: Oxford University Press.

Rastogi, V.B. (2010). *Introductory Cytology* (9th ed.). New Delhi: Kedarnath Ramnath Publications.

Saunders, J. W. (1982). *Developmental Biology - Patterns, Principles and Problems*. New York: Macmillan Publishing Co.

Scott F. Gilbert. (2006). *Developmental Biology* (8th ed.). INC Publishers

Subramanian, T. (2002). *Developmental Biology*. New Delhi: Alpha Science International Ltd.

Wolpert, L., & Tickle, C. (2011). *Principles of Development* (4th ed.). Oxford: Oxford University Press.
Outcomes: ➢ The students will learn about the basics of cell biology and developmental biology

SEMESTER III				
Course Code	**Core Course IV**	**T/P**	**C**	**H/W**
23BMB3C2	**FISHERY BIOLOGY**	**T**	**4**	**4**
Objectives	➢ To know the basic classification, anatomy age and growth of marine fishes. ➢ To understand the different stages of fishes and fisheries conservation			
Unit - I	Introduction: Brief outline of the classification of fin fish and shell fishes. Major fish group of the world and their characteristics- Distribution of commercially important fishes in Indian waters.			
Unit – II	Morphometric and meristic characters of fishes. Key characters in identification of fishes. Basic anatomy of fish: digestive, respiratory, nervous and reproductive system. Food and feeding habits.			
Unit – III	Age and growth–Length weight relationship. Maturity and fecundity-Reproduction–Embryonic, larval development. Concepts of Maximum Sustainable Yield and Maximum Economic Yield. Under fishing and overfishing.			
Unit – IV	Juvenile stages of fin fishes and shell fishes. Biotic and abiotic factors affecting spawning in fishes. Migration in fishes; Parental care in fishes.			
Unit – V	Fisheries conservation: Definition, Principles of conservation and management – Fishery regulation - Organizations involved in fisheries conservation.			

References and Textbooks

Aravind, N. S. (2013). *Fish and Fisheries*. Discovery Publishing House Pvt. Ltd.
Agarwal, S. C. (2006). *History of Indian Fishery*. Daya Publishing House.
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.

Outcomes	➢ The students able to aware the morphology and anatomy of marine fishes. ➢ The students will be able to understand about the age, growth and juvenile stages and fisheries conservation.

SEMESTER III				
Course Code	**Core Practical III**	**T/P**	**C**	**H/W**
23BMB3P1		**P**	**3**	**3**

CELL AND DEVELOPMENTAL BIOLOGY AND FISHERY 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 Chironomus larva
5. Mounting of Squamous epithelial cells from the oral mucosa
6. Mounting of live sperms of a vertebrate
7. Observation of different types of eggs
8. Slides – Cleavage, Blastula, Gastrula stages of Frog
9. Whole mounting of Chick blastoderm
10. Slides – 18, 24, 33, 48, 72, 96 hours chick embryo.
11. Placenta of Mammals – Pig, sheep, Man & Rabbit

FISHERY BIOLOGY

1. Classical identification of locally available fin and shell fishes.
2. Analysis of food and feeding habits of fishes.
3. Observation of fish maturation cycle, larval, juveniles and adult development.
4. Identification of fish parasites.
5. Methods of eggs and larvae-collection.

SEMESTER IV				
Course Code	**Core Course - V**	**T/P**	**C**	**H/W**
23BMB4C1	**ANIMAL PHYSIOLOGY AND BIOCHEMISTRY**	**T**	**4**	**4**
Objectives	➢ To provide students with a basic understanding of the fundamental processes and mechanisms that serves and controls the various functions of the body. ➢ Students will understand the structures and purposes of basics of macromolecules, membranes, and organelles.			
Unit - I	Nutrition: Types of food, general mechanisms of feeding, transport of food through gut; digestion and digestive enzymes in marine organisms. Food and feeding mechanisms of marine crustaceans, molluscs and fishes.			
Unit – II	Mechanism of Respiration, Respiratory volumes and capacities, transport of Oxygen and Carbon dioxide in blood, Dissociation curves and the factors influencing it, respiratory pigments. Physiology of sense organs in marine fishes: types of organs and functions. Physiology of nervous system: structure and functions.Physiology of endocrine system: hormones; neuro-hormones-controlled, Functions; Growth hormones –moulting process.			
Unit – III	Osmotic regulation and ion regulation: mechanisms and general account. General survey of pigments and colour in marine animals; Colour changes— Chromatophores; Bioluminescence and its biological significance. Endogenous rhythms: Biological clocks; Lunar periodicity. Excretion: Nitrogen excretion, mode of nitrogen excretion and elimination of nitrogenous wastes. Structure of Kidney and its functional unit, Mechanism of urine formation, Regulation of acid base balance.			
Unit – IV	Bio - Macromolecules as an energy source – Handerson and Hasselbalch equation – Acid base maintenance and their significance. Chemical bonds and their significance. Thermodynamics – laws and their significance. Carbohydrates- classification, structure, properties and biological importance of Monosaccharides, Disaccharides and Polysaccharides 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 – V	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			

References and Textbooks

Hoar, S. (1975). *General and Comparative Physiology* (2nd ed.). Printice Hall.

Hoar, W. S. (1983). *General and Comparative Physiology*. Prentice Hall.

Prosser, C. L. (1991). *Comparative Animal Physiology* (4th Ed.). Philadelphia: Saunders Co.

Nagabhushanam, R., Kadarkar, M. S., Sarojini, R. (2002). *Text book of Animal Physiology* (2nd ed.). New Delhi: Oxford and IBH publishing Co. Pvt. Ltd.

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

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

Eckert, R. (2005). *Animal Physiology*. CBS publishers.

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

Mohan P. Arora (2013). *Animal Physiology*. Himalaya Publishing House.

Outcomes	➢ Students will understand the functions of important physiological systems and how these separate systems interact to yield integrated physiological responses. ➢ The students will learn about the basics of biochemistry.

SEMESTER IV				
Course Code 23BMB4C2	**Core Course VI**	**T/P**	**C**	**H/W**
	AQUACULTURE	**T**	**3**	**3**

Objectives	➢ To study about the status of aquaculture and aquafarm design construction and management. ➢ To understand about the fish hatchery and feed formulation.
Unit - I	Introduction: Definition, Importance of Coastal Aquaculture -Status of inland and marine aquaculture in India and world. Socio-economic issues.
Unit – II	Farm design: Site Selection-Topography-Soil Characteristics - water source – Structures and type and drainage canals, Sluice, construction, operation-Seepage, evaporation and their control-Open Sea farming - cage, pen, raft, IMTA.
Unit – III	Fish farm management: nursery and grow out pond management-stocking, feeds, water quality management- Shore based aquaculture system: traditional, semi-intensive, intensive aquaculture practice of commercially important species of fishes - bioflocs and raceways. Fish disease, diagnosis, treatment, management and control - economics of farming. Seaweed culture-Types-economic importance.
Unit – IV	Hatchery Management: Fin and shell fish hatchery, Types of hatcheries, Present Status-Hatchery production: Collection & maintenance of brood stock-induced breeding-mass production of seeds-Types and components of hatchery. Live feed culture.
Unit – V	Feed Formulation - Feed ingredients and nutritive value, feed formulation procedure, microdiets. Fisheries extension: Principles, types and Role-Fish Farmers Development Agency -Brackish Water fish Farmers Development Agency &Role of Non- Governmental Agencies in fisheries development.

References and Textbooks

Pillay, T.V.R. (1990). *Aquaculture Principles & Practices*. London: Fishing News (Books) Limited

Santhanam R., Ramanathan, N., & Jegatheesan, G. (1990). *Coastal Aquaculture in India*. CBS publishers and Distributors.

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

Hertrampft, J. W., & Pascal, F. P. (2000). *Handbook on Ingredients for Aquaculture feeds*. London: Kluwer Academic Publishers.

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

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

Outcomes

- The students will learn the status, potentials and construction and management of aqua farms.
- The students will be able to understand the Hatchery management and feed formulation in aquaculture.

SEMESTER IV				
Course Code	**Core Practical IV**	**T/P**	**C**	**H/W**
23BMB4P1		**P**	**2**	**2**

ANIMAL PHYSIOLOGY AND BIOCHEMISTRY AND AQUACULTURE

1. Oxygen consumption by a fish.
2. Study of ciliary activity / heart beat of Mussel in relation to the temperature
3. Determination of Blood bleeding time and clotting time
4. Preparation of haemin crystals
5. Osmoregulation – Salt loss & gain in fish
6. Determination of R_f values of amino acid – Paper Chromatography
7. Qualitative analysis of carbohydrates
8. Qualitative analysis of Proteins
9. Qualitative analysis of lipids

AQUACULTURE

1. Soil and water quality analysis.
2. Identification of plankton and locally available seaweeds.
3. Field visit to aquaculture farms, Hatchery and seaweed culture sites.
4. Feed formulation, stocking density, FCR

SEMESTER V				
Course Code 23BMB5C1	**Core Course VIII**	**T/P**	**C**	**H/W**
	MARINE POLLUTION	**T**	**4**	**5**
Objectives	➢ To understand about the marine pollution and their classification and origin. ➢ To know thermal, pesticide and heavy metal pollution.			
Unit - I	Marine Pollution - Definition, categories of additions, Pollutant and its classification. Organic wastes – BOD and COD.Origin and transport of organic pollutants to the oceans. Physical, chemical and biological effect on marine organisms- bioaccumulation, biomagnification and biodepuration.			
Unit – II	Sewage Pollution - Definition, sources, nature and their treatment processes with reference to wastes from river run off, agricultural, paper, fertilizer, pulp and soap manufacturing industries. Microplastic pollution: source and effects.			
Unit – III	Thermal Pollution- The status of Indian and Pacific Ocean and seas in the world in relation to pollution. Oil Pollution – types and properties of oil, oil spills, fate of spilled oil on the marine environment - consequences of oil spills and treatment of oil spills.			
Unit – IV	Pesticide pollution - inputs, fate in the sea, factors affecting the bioaccumulation of pesticides - DDT the most widespread molecule - Impact of pesticides on the Environment - Mode of poisoning of pesticides - Methods to minimize pesticide pollution.			
Unit – V	Heavy metal Pollution - Sources, Classification and effects of marine and coastal waters (Hg, Pb, Cd and Fe). Distribution- toxicity and disease - Minamata and Itai itai and their toxic effect – Red tide and ecological significance. Indicator organism - Macro algae, crustaceans and mollusks as indicator organisms. GESAMP.			

References and Textbooks

Andres, H. A., & Jorge, E. (2017). *Marine Pollution and Climate Change*. Taylor &Francis Group.

Aaradhana, S. (2018). *Marine, Nuclear and Thermal Pollution*. Jnanada Prakashan (P&D).

Clark, R. B. (1989). *Marine pollution*. Oxford, New York: Clarendon Press.

Coffield, R. L. (2019). *Saving Our Oceans*. Moonlight Mesa Associates.

Judith S. Weis (2015). *Marine Pollution*. Oxward University Press.

Park, P. K., Kester, D. R., Deudall, J. W. & Ketchum, B. H. (1983).*Wastes in the Ocean*. (Vols. 1-3). New York: Wiley Interscience Publishers.

Ricardo, B. (2018). *Marine Pollution: Sources, Fate and Effects of Pollutants in Coastal Ecosystem*. Elsevier.

Singh, P. (1995). *Environmental Pollution and Management*. Chugh Publications.

Outcomes	➢ Students acquire knowledge about marine pollution and their types and effects. ➢ The students will be able to understand about major types of pollutions such as Thermal, Pesticide and heavy metal pollution.

SEMESTER V				
Course Code	**Core Course IX**	**T/P**	**C**	**H/W**
23BMB5C2	**BIODIVERSITY AND CONSERVATION**	**T**	**4**	**5**

Objectives	➢ To understand about the biodiversity of marine organisms and marine protected areas ➢ To acquire knowledge in issues in marine biodiversity conservation and sustainable development.
Unit - I	Introduction – Definition to Marine Biodiversity - significance - biodiversity indices. Definition of extinction of marine bio-resources – causes and rate of extinction.
Unit – II	Conservation – Definition, essential concepts for small populations - problems of small population - establishment of new populations - conservation categories of species - legal protection of species.
Unit – III	Marine protected areas – Establishment of protected areas – management-restoration.
Unit – IV	Challenges in marine biodiversity conservation – Lack of scientific data and barriers in transfer of information - cultural and biological diversity - differing benefits and costs harming aquatic life - jurisdictional gaps and overlaps - use of marine environment.
Unit – V	Conservation and sustainable development - traditional societies - Government action local legislation - national laws - National Biodiversity Act and National Biodiversity Authority.

References and Textbooks

Bertness, M. D., Bruno, J. F., Silliman, B. R., & Stachowicz, J. J. (Eds.). (2014). *Marine community ecology and conservation*. Sinauer Associates, Inc.

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

Krishnamurthy, K.V. (2004). *An Advanced Text Book of Biodiversity - Principles and Practices*. New Delhi: Oxford and IBH Publications Co. Pvt. Ltd.

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

Kannaiyan, S., & Venkatraman, K. (2011). *Marine Biodiversity in India*. Associated PublishingCompany.

Naskar, K., & Mandal, R. (1999). *Ecology and Biodiveristy of Indian Mangroves*. Daya Publications.

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

Outcomes

- The students understand about importance of marine biodiversity and conservation.
- The students gain knowledge about marine protected areas and sustainable development.

SEMESTER V				
Course Code 23BMB5C3	**Core Course X**	**T/P**	**C**	**H/W**
	SEA FOOD PROCESSING TECHNOLOGY	**T**	**4**	**5**

Objectives	➢ To understand about handling processing and storage of seafoods. ➢ To learn about the export and quality control in seafoods.
Unit - I	Fish Handling transportation - on board and on shore – manufacture and quality of ice for fish storage. Transportation of fish - Refrigerated Sea water - Insulated containers for fresh fish transportation.
Unit – II	Fish processing –Post mortem changes - rigor mortis- autolysis-autooxidation and their role.- Chemical changes (Lipid, protein and nucleotide)-Bacterial load, sensory changes, texture, taste and odour. Factors affecting quality of fish - salting, sun drying, smoking, marinading and fermentation.
Unit – III	Freezing - Processing and packaging, antibiotics and chemicals usage and cryoprotectants. Duration of Storage period -quality and shelf life. Hygienic practice in processing plants. HACCP. Packaging and packaging materials - vacuum packaging, MAP - Packing of fresh and frozen fish – transportation and cold chain-packaging for local consumption and export.
Unit – IV	Canning of fish-general steps in canning-principles-can materials-preparation of raw materials, packing, precooking, exhausting, seaming, retorting, labelling, cooling, labelling and storage. Spoilage of canned foods and preventive measures. Irradiation-Radiation sources and units, dose level-effects of irradiation on protein, vitamin and lipids.
Unit – V	Fish by products and value-added products-fish meal, oil, chitin, chitosan and gelatin etc. Seaweed uses: agar agar, algin, carrageenan. Seafood quality: Quality assessment in fish and fishery products - Quality standards - good manufacturing practices-Codex alimentaris, USFDA and EU regulation for export trade. Role of MPEDA.

References and Textbooks

Balachandran. (2002). *Post - Harvest Technology of Fish and Fish Products*. Daya Publishing House.

Nowak, W. S. W. (1970). *The marketing of shell fish*. London: Fishing News (Books) Ltd.

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

Outcomes	➢ The students will acquire knowledge on seafood handling and processing. ➢ The students will understand about seafood storage, export and quality control.

SEMESTER V				
Course Code	**Core Practical V**	**T/P**	**C**	**H/W**
23BMB5P1		**P**	**4**	**4**

MARINE POLLUTION, BIODIVERSITY AND CONSERVATION AND SEAFOOD PROCESSING TECHNOLOGY

1. BOD, TOC, TDS and TSS
2. Analysis of heavy metals
3. Identification of pollution indicator organisms.

BIODIVERSITY AND CONSERVATION

1. Qualitative and quantitative estimation of Phytoplankton and zooplankton.
2. Structural morphology and physiology of marine fauna and flora.
3. Biodiversity indices-diversity, richnes and eveness.

SEA FOOD PROCESSING TECHNOLOGY

1. Freezing and storage of fish
2. Estimation of salt content in dried fish
3. Sensory evaluation of fish freshness
4. Microbial load in fish samples
5. Proximate compositional analysis of fish
6. Visit to nearby seafood processing unit

Semester - V				
Course Code	**DSE-I**	**T/P**	**C**	**H/W**
23BMB5E1	**MARINE RESOURCES**	**T**	**3**	**4**
Objectives	➢ To understand the marine non-living resources including minerals. ➢ To learn about marine fisheries resources, drug sources and toxin and venoms.			
Unit - I	Marine Non-living resources: Distribution of different kinds of resources-Indian ocean. Integrated resource management-Preservation and conservation of non-living resources-Renewable and non - renewable resources and their origin.			
Unit – II	Marine minerals: Minerals-phosphorites-Placer Minerals-Sulfides-Manganese nodules and cobalt crusts-Methods in the exploration of seafloor minerals deposits.			
Unit – III	Fisheries resources management and deep-sea fisheries. Resource potential-Fish resources of Indian EEZ-Fishery resource depletion. Profitable vessel management. Capture fisheries: Crab, shrimp and fin fishes capture in India. Molluscan fishery and algal resources.			
Unit – IV	Marine drugs: Definition,- Classification based on their pharmacologic actions- Marine bioactive compounds from Seaweeds, Actinomycetes, Sponges, Sea whip, Corals, Tunicates, Molluscs and Fishes: Source organism name and their pharmacologic actions			
Unit – V	Marine biotoxin: Harmful algal bloom Definition- Biotoxin Classification based on their chemical structure- Source and impact. Marine venome: Definition- Stingray, Stonefish, Scorpion fish, Lionfish, Sea urchins, Cone shells and Sea snakes: Venome source organism and their pharmacological effects in brief.			

References and Textbooks

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). *Bioactive Compounds from Marine Organisms*. Oxford & IBH Publishing Co. Pvt. Ltd.

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

Outcomes	➢ The students able to understand the marine minerals and non-living resources. ➢ The students acquire knowledge about marine living resources and drugs from the ocean.

Semester - VI				
Course Code 23BMB5E2	**DSE-II**	**T/P**	**C**	**H/W**
	AQUARIUM FISH KEEPING	**T**	**3**	**4**
Objectives	➢ To elaborate about the importance of aquarium fishes and plants. ➢ To understand the aquarium design and construction and management and hatchery production.			
Unit - I	Introduction to aquarium – types of aquaria – importance of aquarium – exotic and indigenous fishes-Identification of ornamental fishes, crustaceans, molluscs and ornamental aquatic plants and their propagation methods. Aquarium fish culture and trade in India and world.			
Unit – II	Design and construction aquarium– construction of marine and fresh water aquarium-construction materials, Equipment: pumps, filters, aerator and lights.			
Unit – III	Care and maintenance of aquarium - criteria for selection of ornamental fishes - water quality management – Feeds and probiotics.			
Unit – IV	Diseases management – bacterial, fungal and viral diseases –prevention and control.			
Unit – V	Hatchery production – farm and hatchery design and construction - Brooder management. Breeding-Ornamental Fishes, invertebrates and plants -Genetics and Biotechnological application in aquarium fish production- – packaging and transport.			

References and Textbooks

Anderson, C. (2009).*Reef fishes of the Maldives*. Republic of Maldives: Manta Marine Pvt Ltd.

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.

Coleman, N. (2000). *Marine life of the Maldives* (Atoll Editions). Sea Challengers.

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.

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

Outcomes	➢ The students gain knowledge in aquarium construction and management. ➢ The students will earn about selection and hatchery production of aquarium fishers.

SEMESTER VI				
Course Code	**Core Course -XV**	**T/P**	**C**	**H/W**
23BMB6C1	**IMMUNOLOGY AND GENETICS**	**T**	**4**	**4**

Objectives	➢ To identify the cellular and molecular basis of immune responsiveness ➢ To develop and demonstrate an understanding of the structure and function of genes.
Unit - I	History and scope of Immunology - Immunity -Types of Immunity - Innate and acquired, Passive and Active- Lymphoid organs - Primary and secondary lymphoid organs - Thymus, Bone marrow, Bursa of fabricus, Spleen, Tonsil, Lymph node.
Unit – II	Immunoglobulin and Immune Diseases-Immunoglobulin - Structure, function and biological properties of Immunoglobulin classes. Interaction of antigen and antibody- Auto immune diseases – Causes, Classification, Diagnosis &Treatment- Hypersensitivity & its types, Tumour Immunology.
Unit – III	Mendelian Genetics: Monohybrid – laws of dominance & segregation; Dihybrid cross – law of independent assortment – simple mendelian traits in man. Interaction of Genes: Complementary, Epistasis – Dominant & Recessive Polygenic Inheritance - Skin colour in man.
Unit – IV	Multiple Alleles - Blood groups in man Linkage & Crossing over in Drosophila. 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. Pedigree analysis, Inbreeding and Out-breeding, Eugenics, Euthenics and Genetic Counselling.

References and Textbooks

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

Roitt, I. (1984). *Essential Immunology* (5th ed.). Blackwell Scientific publications.

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

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

Fingerman, M., & Nagabhushanam, R. (Eds.). (2001). *Recent advances in marine biotechnology* (Vol. 5: *Immunobiology and Pathology*). Enfield: Science Publishers Inc.

Gardner, E. J.,Simmons, M. J., Snustad D. P. (2006). *Principles of Genetics*. New Delhi: Wiley Eastern Private Limited.

Outcomes	➢ The students know about the principles of Mendelism. Be able to understand multiple allelic inheritance and to describe different types Gene Interactions. Learn the significance of Mitosis and Meiosis, etc. ➢ Student will learn the basic knowledge of immunological processes at a cellular and molecular level.

SEMESTER VI				
Course Code	**Core Practical VI**	**T/P**	**C**	**H/W**
23BMB6P1		**P**	**3**	**3**

Immunology and Genetics

1. Lymphoid organs in Rat Demonstration only – Model/ chart/ CD Students have to draw the diagram
2. Observation of Blood group
3. Double immunodiffusion and radial immunodiffusion (demonstration only).
4. Experiments to study Mendel's law using beads.
5. Observation of Mendelian characters for self & class students.
6. Spotters - Drosophila types, Gynandromorph Syndromes –Down, Turner, Klinefelter.

Semester - VI				
Course Code	**Project**	**T/P**	**C**	**H/W**
23BMB6PR			**6**	**10**

Semester - VI				
Course Code 23BMB6E1	**DSE-III**	**T/P**	**C**	**H/W**
	COASTAL DISASTER MANAGEMENT	**T**	**4**	**6**

Objectives	➢ To learn about the natural hazards, threats and disaster mitigation. ➢ To understand the risk reduction measures and risk management.
Unit - I	Hazards-Definition –Hazards as natural process - Benefits and importance of disasters, Nature disaster- Death and Damage - Evaluating hazards - Human response to hazards.
Unit – II	Major threats to coastal ecosystem- Habitat loss- Landslides -Sea level change, water quality, marine resource depletion, Earthquakes, Tsunami, Volcanic activity, Coastal flooding, Cyclones, Erosion, Sea water intrusion, Causes, preventive measures and early warning systems.
Unit – III	Disaster mitigation and actions to reduce risks- Mitigation actions, types of mitigation measures, Environmental hazards, assessment and response, the scale of disaster. Causes, characteristics and effects of various disasters.
Unit – IV	Nature, humanity and development, interruption of development and programme by disasters, loss of resources, impact on investment and climate.
Unit – V	Geohazards, natural disaster reduction, problems of financing and insurance, tends in climatology, meteorology and hydrology, seismic activities and training for emergency management.

References and Textbooks

Haruyama, S.,&**Sugai,**T. (2016). *Natural Disaster and Coastal Geomorphology*. Springer.

Miguel, E., Hiroshi, T., & Tomoya, S. (2015). *Handbook of Coastal Disaster Mitigation for Engineers and Planners*. Butterworth-Heinemann.

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

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

Vidyanathan, S. (2011). *An Introduction to Disaster Management*. IKON Books. Harsh K Gupta. (2013). *Disaster Management*. Universities Press (India) Pvt. Ltd.

Outcomes	➢ The students gain more knowledge in disaster mitigation assessment. ➢ The students able to understand on disaster risk reduction and management.

Semester - VI				
Course Code 23BMB6E2	**DSE-IV**	**T/P**	**C**	**H/W**
	MARINE BIOFOULING AND MANAGEMENT	**T**	**3**	**5**

Objectives	➢ To learn about the marine corrosion and biofouling. ➢ To understand the process of biofouling and its management.
Unit - I	Corrosion-Definition, basic aspects of corrosion, types, mechanism – corrosion testing and monitoring.
Unit – II	Basics of biofouling**-** Principle, Biofilm, micro and macrofouling organisms –Factors inducing biofouling.
Unit – III	Biofouling Communities–attached macro-fouling communities – mobile communities. Role of microorganisms in biocorrosion.
Unit – IV	Biofouling as a Pathway**:** Ports, harbors, marinas, vessels, Mariculture, fishing and diving equipment. Economic losses and health hazards - imposex.
Unit – V	Biofouling control and Management: Anti-fouling paints and other measures – anti-fouling systems – Cleaning of ships- dry docking, and aquaculture Industries – Current practice – natural and non-toxic antifoulants– education and training.

References and Textbooks

Alexander I. R. (2005). *Marine biofouling: Colonization Processes and Defenses*. CRC Press.

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

Lynn, J. (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, M.,& Peter, P. (2011). *Handbook of Hot-dip Galvanization*. John Wiley & Sons.

Volkan, C.,& Bayan Al-Numan (2011). *Corrosion Chemistry*. Wiley-Scrivener.

Outcomes	➢ The students will gain knowledge about marine corrosion and biofouling organisms. ➢ The students able to understand the biofouling formation, control and management.

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">ESSENTIAL REASONING AND QUANTITATIVE APTITUDE</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">Professional Competency Skill</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">PCS</td><td>Year</td><td>II</td><td>Credits</td><td>2</td><td colspan="2">Course Code</td></tr>
<tr><td>Semester</td><td>IV</td><td colspan="3">23BMB6S1</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td colspan="2">Lecture</td><td colspan="2">Tutorial</td><td>Lab Practice</td><td>Total</td></tr>
<tr><td colspan="2">1</td><td colspan="2">1</td><td>-</td><td>2</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">• Develop Problem solving skills for competitative examinations
• Understand the concepts of averages , simple interest , compound interest</td></tr>
<tr><td colspan="2">UNIT-I:</td><td colspan="6">Quantitative Aptitude: Simplifications=averages-Concepts –problem-Problems on numbers-Short cuts- concepts –Problems</td></tr>
<tr><td colspan="2">UNIT-II:</td><td colspan="6">Profit and Loss –short cuts-Concepts –Problems –Time and work -Short –uts -Concepts -Problems.</td></tr>
<tr><td colspan="2">UNIT-III:</td><td colspan="6">Simple interest –compound interest- Concepts- Prolems</td></tr>
<tr><td colspan="2">UNIT-IV:</td><td colspan="6">Verbal Reasoning : Analogy- coding and decoding –Directions and distance –Blood Relation</td></tr>
<tr><td colspan="2">UNIT-V:</td><td colspan="6">Analytical Reasoning :Data sufficiency
Non-Verbal Reasoning : Analogy ,Classification and series</td></tr>
<tr><td colspan="2">Skills acquired from this course</td><td colspan="6">Studnets relating the concepts of compound interest and simple interest</td></tr>
<tr><td colspan="2">Recommended Text</td><td colspan="6">1.”Quantitative Aptitude” by R.S aggarwal ,S.Chand & Company Ltd 2007</td></tr>
<tr><td colspan="2">Website and e-Learning Source</td><td colspan="6">https://nptel.ac.in</td></tr>
</table>