Hindi Vidya Prachar Samiti's

Ramniranjan Jhunjhunwala College of Arts, Science and Commerce

(Autonomous College)

Affiliated to University of Mumbai

Syllabus for M.Sc. II

Semester III & IV

Program: M.Sc.

Course: Zoology

Biotechnology and Oceanography & Fishery Sciences

Program Code : RJSPZOOOC

(CBCS 2020-21)

Refer to page no: 03 highlighting component of Internship

DISTRIBUTION OF TOPICS AND CREDITS

M.SC.ZOOLOGY-BIOTECHNOLOGY-OCEANOGRAPHY
SEMESTER III

Course code	Nomenclature	Credits	Topic
RJSPZOOBT305	Paper I : Basics of industrial & environmental biotechnology I	04	1. The implications of recombinant DNA technology of commercial products and microbial synthesis
			2. Large scale culture & production from recombinant microorganisms & genetically engineered animal cells
			3. Medical Biotechnology
			4. Environmental Biotechnology I
RJSPZOOBT306	Paper II: Genetic engineering techniques and its applications-II	04	1. Genome management and analysis
			2. Manipulation of gene expression in prokaryotes
			3.Bioinformatics
			4.Animal biotechnology and human therapies.
RJSPZOOOC307	Paper III: General, physical, chemical and biological oceanography	04	1.General Oceanography.
			2.Physical Oceanography
			3.Chemical Oceanography
			4. Biological Oceanography
RJSPZOOOC308	Paper IV: Environmental And Applied Physiology - I	04	1. Planktology
			2. Fish and Fishery Science
			3. Biotechnology in Fishery and Biometric Studies
			4. Aquaculture
RJSPZOOPBT305	PRACTICAL-I	02	Practicals based on RJSPZOOBT305
RJSPZOOPBT306	PRACTICAL-II	02	Practicals based on RJSPZOOBT306
RJSPZOOPOC307	PRACTICAL-III	02	Practicals based on RJSPZOOOC307
RJSPZOOPOC308	PRACTICAL-IV	02	Practicals based on RJSPZOOOC308

DISTRIBUTION OF TOPICS AND CREDITS

M.SC.ZOOLOGY-BIOTECHNOLOGY-OCEANOGRAPHY
SEMESTER IV

Course code	Nomenclature	Credits	Topic
RJSPZOOBT405	Paper I: Basics of industrial & environmental biotechnology II	04	1. Microbial synthesis of commercial products
			2. Large scale culture & production for industrial biotechnology
			3. Agricultural Biotechnology
			4. Environmental Biotechnology II
RJSPZOOBT406	Paper II Genetic engineering techniques and its applications II	04	1. Genome management
			2. Manipulation of gene expression in eukaryotes.
			3. The human genome project
			4. Regulations and patents in biotechnology.
RJSPZOOOC407	Paper III General, physical, chemical and biological oceanography II	04	1.General Oceanography.
			2.Physical Oceanography
			3.Chemical Oceanography
			4. Biological Oceanography
RJSPZOOOC408	Paper IV Planktology, fish, fishery science and aquaculture II	04	1. Planktology
			2. Fish and Fishery Science
			3. Biotechnology in Fishery and Biometric Studies
			4. Aquaculture
RJSPZOOPBT405	PRACTICAL-I	02	Practicals based on RJSPZOOBT405
RJSPZOOPBT406	PRACTICAL-II	02	Practicals based on RJSPZOOBT406
RJSPZOOPOC407	PRACTICAL-III	02	Practicals based on RJSPZOOOC407
RJSPZOOPOC408	PRACTICAL-IV	02	Practicals based on RJSPZOOOC408

	SEMESTER-III (THEORY)	L	Cr
	Paper- V Basics of Industrial & Environmental Biotechnology I **Paper Code: RJSPZOOBT305**	**60**	**4**
	UNIT I	**15**	
	The implications of recombinant DNA technology of commercial products and microbial synthesis		
1	**1.1. The implications of recombinant DNA technology** 1.1.1 *General account on applications of biotechnology 1.1.2 *Commercialization of biotechnology & biotech companies 1.1.3 Prospects of novel food technology 1.1.4 Economics of microbial biotechnology 1.1.5 Areas of significant public concern: Antibiotic resistance marker gene, transfer of allergies, pollen transfer from GM plants, social, moral & ethical issues associated with GMOs. **1.2. Amino acids & their commercial use** – production strain, process of L-glutamate, L- aspartate, L-phenylalanine, L-tryptophan.		
	UNIT II	**15**	
	Large scale culture & production from recombinant microorganisms & genetically engineered animal cells		
2	**2.1. Large scale culture & production from recombinant microorganisms:** 2.1.1 Batch fermentation 2.1.2 Fed batch fermentation 2.1.3 Continuous fermentation 2.1.4 *Maximizing the efficiency of fermentation process 2.1.5 Harvesting, disrupting & downstream processing **2.2. Large scale culture & production from genetically engineered animal cell cultures:** 2.2.1Design of bioreactors for large scale animal cell culture-Batch, Fed batch 2.2.2 Mammalian cell lines & their characteristics 2.2.3 Media for the cultivation of mammalian cells 2.2.4 *Commercial products produced with mammalian cell culture.		
	UNIT III	**15**	
	Medical Biotechnology		
3	**3.1. Sub-unit vaccines** 3.1.1 *Sub-unit Vaccine production against viruses-Herpes simplex, Bovine foot & mouth disease virus 3.1.2 Peptide vaccines-synthetic drugs (engineered proteins)		

	3.1.3 Genetic immunization-DNA vaccines, Antisense DNA, Therapeutic ribozymes 3.1.4 *Live recombinant vaccines 3.1.5 *Attenuated vaccines against Cholera, Salmonella sp. 3.1.6 Vector vaccines-Vaccine directed against viruses- Rabies virus G-protein, Hepatitis B surface antigen 3.1.7 Anti-idiotypic vaccine for cancer treatment **3.2. Monoclonal antibodies (mAbs) & therapeutic applications:** 3.2.1 mAbs for prevention of rejection of transplanted organs 3.2.2 Treatment of bacterial blood infection 3.2.3 Human monoclonal antibodies 3.2.4 Hybrid human-mouse monoclonal antibodies 3.2.5 HIV therapeutic agents 3.2.6 Anti-tumour antibodies		
	Unit IV	**15**	
	Environmental Biotechnology I		
4	**4.1. Biomass utilization** 4.1.1 Microorganisms in lignocellulose degradation 4.1.2 Isolation of prokaryotic & eukaryotic cellulase gene 4.1.3 Manipulation of cellulase gene 4.1.4 Production of single cell proteins by using biomass as raw material 4.1.5 Commercial production of fructose and alcohol from biomass 4.1.6 Improvements of fructose and alcohol production 4.1.7 Fuel ethanol from biomass **4.2. Bioremediation of aerobic compounds** 4.2.1 Characteristics of xenobiotics in the environment 4.2.2 Characteristics of aerobic microorganisms for degradation of organic pollutants 4.2.3 Genetic engineering of biodegradative pathways- Manipulation by transfer of plasmid, manipulation by gene alteration 4.2.4*Degradation of xenobiotic compounds-petroleum products, n-alkanes, alkenes, cycloaliphatic compounds, aromatic hydrocarbons, polyaromatic hydrocarbons, chlorinated organic compounds (aliphatic & aromatic) ***Marked topics are to be taken for seminar**		

M.Sc-II	Semester III Theory
RJSPZOOBT305 **Paper V** **Basics of Industrial & Environmental Biotechnology- I**	**Course Objectives:** 1. To introduce to the different commercial products of recombinant technology 2. To familiarize the fermentation techniques 3. To understand application in the field of environment and medicine **Learning Outcomes:** 1. Learners will get an idea of various commercial products and its economics. 2. Learners will be able to understand the applications of biotechnology for vaccine production and environmental utility.

	SEMESTER-III (THEORY)	L	Cr
	Paper- VI Genetic Engineering Techniques and Its Applications -II **Paper Code: RJSPZOOBT306**	**60**	**4**
	UNIT I	**15**	
	Genome Management and Analysis		
1	**1.1 The Basic tools of genetic engineering** 1.1.1 Chemical Synthesis of DNA-Oligonucleotide synthesis by Phosphoramidite method, Synthesis of genes 1.1.2*DNA Sequencing -- Maxam-Gilbert method, Sanger's dideoxynucleotide method, By using bacteriophage M13 by Primer walking 1.1.3 Polymerase chain reaction and its advantages **1.2 Cloning Vectors** 1.2.1 *General purpose plasmid vectors (pUC19, pBR322) (Bacterial Vectors) 1.2.2 Bacteriophage and cosmid vectors 1.2.3 Yeast artificial chromosomes (YACs) **1.3 Analysis of genome/proteome** 1.3.1 DNA fingerprinting/physical mapping/pulsed field gel electrophoresis 1.3.2 Analysis of the proteome 1.3.3 Analysis of mRNA transcripts		
	UNIT II	**15**	
	Manipulation of Gene expression in Prokaryotes		
2	**2.1 Promoters of gene expression in prokaryotes** 2.1.1 Prokaryotic gene expression 2.1.2 Isolation of functional promoters 2.1.3 Promoter selection with E.coli plasmid pBR316 2.1.4 *Promoter selection with plasmid pKO1 2.1.5 Gene expression from strong and regulatable promoters **2.2 Expression of cloned genes in prokaryotes** 2.2.1 Increasing protein production and secretion 2.2.2 *Inclusion bodies and fusion proteins 2.2.3 Unidirectional tandem gene arrays 2.2.4 Translation expression vectors 2.2.5 Increasing protein stability.		
	UNIT III	**15**	
	Bioinformatics		
3	3.1 Uses and application of computers in biological science 3.2 *DNA profiling: cDNA and EST's (expressed sequence tags) 3.3 Basic research with DNA microarrays and its application in healthcare 3.4 Biomedical genome research and pharmaco genomics 3.5 *Random amplified polymorphic DNA (RAPD) 3.6 Human genomic variation-SNP's (single nucleotide polymorphisms, SNP's and		

	disease; QTL (quantitative trait loci) and its relation to SNP's 3.7 Satellite DNA and its types		
	Unit IV	**15**	
	Animal biotechnology and Human therapies		
4	**4.1 Animal Biotechnology** 4.1.1 ***Transgenic animals and their applications: Mice as model system for human diseases and as test case model, Cows, pigs, sheep, goats as biopharmaceuticals, Transgenic insects and birds 4.1.2 Recombinant DNA technology to prevent animal diseases 4.1.3 Conservation biology-Embryo transfer 4.1.4 Regulation of transgenic animals and patenting genetically engineered animals **4.2 Human therapies** 4.2.1 Tissue engineering: Skin, liver, pancreas 4.2.2 ***Xenotransplantation 4.2.3 Antibody engineering 4.2.4 Cell adhesion-based therapies: Integrins, Inflammation, Cancer and metastasis 4.2.5 Targeted gene replacement for correcting a mutated gene 4.2.6 Site directed mutagenesis ***Marked topics are to be taken for seminar**		

M.Sc-II	**Semester III Theory**
RJSPZOOBT306 **Paper- VI** Genetic Engineering Techniques and Its Applications -II	**Course Objectives:** 1. To introduce to the concept of genome management. 2. To impart knowledge on gene expression in organisms. 3. To understand computer application. 4. To have insights to treatment strategies. **Learning Outcomes:** 1. Learners will get an idea of different tools of genetic engineering 2. Learners will be well-versed with the computer applications in the field of biotechnology. 3. Learners will be able to understand the applications of biotechnology for treatment of several diseases.

	SEMESTER-III (THEORY)	L	Cr
	Paper- VII GENERAL, PHYSICAL, CHEMICAL AND BIOLOGICAL OCEANOGRAPHY - I **Paper Code: RJSPZOOOC307**	**60**	**4**
	UNIT I	**15**	
	General Oceanography		
1	1.1 Terminology of submarine topography Continental shelf, continental slope, submarine canyons, submarine mountain ranges, Guyots and trenches with special reference to the Indian Ocean and adjacent seas. * 1.2 A general knowledge of typical oceanographic research vessel and its equipments, oceanographic labs and stations of the world and India.		
	UNIT II	**15**	
	Physical Oceanography		
2	2.1 Physical properties of sea water: Salinity, Chlorinity, Temperature, Light, Density, Pressure, Salinity-Temperature- Density relationship (STD) . 2.2 Oceanographic circulation: Ekman spiral, geotropic current, westward intensification with dynamic topography.		
	UNITI III	**15**	
	Chemical Oceanography		
3	* 3.1 Composition of sea water- constancy of its composition and factors affecting the composition, major and minor constituents, trace elements and their biological role. 3.2 Dissolved gases in the sea water and their role in the environment, CO_2 system, dissolved O_2 and oxygen profile, hydrogen sulphide. 3.3 Nutrients in the ocean, their cycles and factors influencing their distribution a) Nitrogen b) Phosphorus c) Silicon.		
	Unit IV	**15**	
	Biological Oceanography		
	*4.1 Sea as a biological environment. *4.2 Division of marine environment. 4.3 a) Marine biotic diversity: Plankton, Nekton, Benthos- brief account Implications of species richness, measuring diversity, quadrant's of species diversity, models explaining diversity gradient.		

	*b) Intertidal organisms and their zonation. 4.4 Effect of physical factors on marine life a) Light: photosynthesis, colouration, structural adaptations, bioluminescence b) Temperature: tolerance, geographical distribution, size, calcium precipitation, metabolism, bipolarity, tropical submergence and periodicity. c) Salinity: tolerance and distribution, size, buoyancy and osmoregulation. d) Currents: role in nutrition, transportation and propogation. *e) Marine bacteria and their role. ***Marked topics are to be taken for seminar**		

M.Sc-II	Semester III Theory
RJSPZOOOC307 Paper VII General, physical, chemical and biological oceanography I	**Course Objectives:** 1. To acquaint learners with the basics of plate tectonics. 2. To introduce the various parameters supporting life 3. To introduce the learners to the basics of marine life. **Learning Outcomes:** 1. Learners will understand the different parameters of life supported by marine ecosystem. 2. Learners will be able to Decipher the relationship between physical, chemical and biological characteristics of the sea .

SEMESTER-III (THEORY)		**L**	**Cr**
Paper- VIII Environmental And Applied Physiology I **Paper Code: RJSPZOOOC308**		**60**	**4**
	UNIT I	**15**	
	Planktology		
1	1.1. Classification of Plankton. Adaptation to planktonic life. Factors influencing the distribution and abundance, plankton bloom, patchiness, vertical distribution and red tide. 1.2. *Diurnal migration of zooplankton. Inter-relationship between phyto and zooplankton.		
	UNIT II	**15**	
	Fish and Fisheries Science		
2	2.1. An overview of fish classification as per Francis Day and FAO. 2.2. a) Major commercial fisheries: Elasmobranchs (shark and ray) Teleosts: Sciaenoids, Indian salmon, Seer fish, Mackerel, Sardine, Carangids, Tuna, Sole fish, Harpodon, Ribbon fish fisheries. b) *Crustacean fisheries: Prawns (penaeid and non penaeid), Shrimps, Lobster and Crab. c) *Molluscan fisheries.		
	UNIT III	**15**	
3.	**Biotechnology in Fishery and Biometric Studies**		
	3.1. Fish stock improvement through selective hybridization. 3.2. Gene transfer technology in fish: General steps for developing transgenic fishes. Gene transfer by microinjection, electroporation, transfer of transgenes by injection with pantropic retroviral viruses, fish antifreeze protein gene, promoter in the production of growth hormone. *Characterization of transgenic fish. (Identification of transgenic fish and expression of transgenes). Gene transfer in common carp and channel fish.		
	UNIT IV:	**15**	
	Aquaculture		
4.	4.1. *History, scope and importance of aquaculture. Aquaculture practices in India. Cultivable organisms for aquaculture and criterion for their selection. 4.2 Different systems of aquaculture such as Pond Culture, Cage Culture, Pen Culture, Running Water Aquaculture, Raft Culture, Aquaranching. 4.3. Impact of aquaculture on environment. ***marked topics are to be taken for seminar**		

M.Sc-II	Semester III Theory
RJSPZOOOC308 Paper VIII Environmental And Applied Physiology I	**Course Objectives:** 1. To acquaint learners with the different aspects of planktology. 2. To impart knowledge on fish biometry. 3. To introduce concepts of aquaculture. **Learning Outcomes:** 1. Learners will understand the different parameters of planktology. 2. Learners will be able to classify different fishes using identification key. 3. Learners will be able to understand the processes involved in aquaculture

	SEMESTER-IV (THEORY)	L	Cr
	Paper- V - Basics of Industrial & Environmental Biotechnology II **Paper Code: RJSPZOOBT405**	**60**	**4**
	UNIT I	**15**	
	Microbial synthesis of Commercial Products		
1	**1.1. Microbial synthesis of commercial products** 1.1.1 Organic acids & their commercial applications – Citric acid, gluconic acid, lactic acid. 1.1.2 Antibiotics – Cloning antibiotic biosynthetic gene by complementation & other methods. Synthesis of novel antibiotics & improving antibiotic production. *Aminoglycosides & their uses 1.1.3 Polysaccharides: Bacterial polysaccharides: General properties & their commercial applications- Dextran, Xanthan, Alginate Genetic engineering for the large scale production of Xanthan gum & its modification. *Marine polysaccharides: General properties & their commercial application- Agar & agarose, Chitosan 1.1.4 Polyesters: Polyhydroxyalkanoates (PHA)-Biosynthesis of PHA, Biopol- commercial biodegradable plastic.		
	UNIT II	**15**	
	Large scale Culture & Production for Industrial biotechnology		
2	**2.1. Biotransformations** 2.1.1 Selection of biocatalyst-screening & use of novel existing biocatalyst 2.1.2 Genetic modification of existing biocatalyst (Indigo biosynthesis) 2.1.3 Biocatalyst immobilization- Methods of immobilization- Cross linking, supported immobilization, adsorption & ionic binding, covalent coupling, lattice entrapment 2.1.4 Immobilized soluble enzymes & suspended cells 2.1.5 Immobilization of multi-enzyme systems & cells 2.1.6 *Immobilized enzyme reactors- Batch reactors, continuous reactors 2.1.7 Analytical enzymes- Enzymes in diagnostic assays: Test strip systems & Biosensors-Electrochemical & optical type		
	UNIT III	**15**	
	Agricultural Biotechnology		
3	**3.1. Agricultural Biotechnology:** 3.1.1 *Nitrogen fixation 3.1.2Nitogenase-Component of nitrogenase; Genetic engineering of nitrogenase cluster 3.1.3 Hydrogenase-Hydrogen metabolism 3.1.4 Genetic engineering of hydrogenase gene 3.1.5 Nodulation-Competition among nodulation organisms,		

	genetic engineering of nodulation gene 3.1.6 Microbial insecticides-Toxins of *Bacillus thuringiensis*, mode of action & use of thuringiensis toxins, thuringiensis toxin gene isolation, genetic engineering of *Bacillus thuringiensis* strains & cloning of thuringio toxin gene. 3.1.7*****Developing insect resistant, virus resistant & herbicide resistant plant 3.1.8 Algal products: Fuels from algae, marine natural products & their medical potential-anticancer, antiviral compounds, antibacterial agents.		
	Unit IV	**15**	
	Environmental Biotechnology II		
4	**4.1. Bioabsorption of metals (Recovery from effluents)** 4.1.1 *****Bioabsorption by fungi, algae, moss & bacteria 4.1.2 Mechanism of bacterial metal resistance & genetic engineering for specific proteins 4.1.3 Bioreactors for bioabsorption-packed bed, fluidized bed, rotating disc, single blanket, sequential reactors 4.1.4 Phytoremediation &its use in biotechnology **4.2. Bioleaching of metals** 4.2.1 Biochemical mechanism of bioleaching 4.2.2 Extraction from mixtures 4.2.3 Types of bioleaching 4.2.4 Methods for bioleaching-Tank & heap bioleaching 4.2.5*****Microorganisms used for bioleaching. ***Marked topics are to be taken for seminar**		

M.Sc-II	Semester IV Theory
RJSPZOOBT405 **Paper V** Basics of Industrial & Environmental Biotechnology II	**Course Objectives:** 1. To introduce to several commercial products of microbial synthesis. 2. To familiarise with applications in industrial, agricultural and environmental fields. **Learning Outcomes:** 1. Learners will get an idea about types of commercial products obtained from microbes. 2. Learners will be able to apply knowledge of biotechnology to industrial, agricultural and environmental sectors.

	SEMESTER-IV (THEORY)	L	Cr
	Paper VI- Genetic engineering techniques and its applications -II **Paper Code: RJSPZOOBT406**	**60**	**4**
	UNIT I	**15**	
	Genome management		
1	**1.1 The Basic tools of genetic engineering** 1.1.1Gene transfer techniques: Protoplast fusion, calcium phosphate, precipitation, electroporation, liposome, ligand mediated, gene gun or biolistic approach, viral mediated 1.1.2 Selection and screening of recombinants 1.1.3 *Nucleic acid probes and hybridization, Southern blotting and Northern blotting 1.1.4 Immunological assays for identification of gene product, Western blot **1.2 Cloning Vectors** 1.2.1 *Retrovirus and SV40 vectors 1.2.2Special purpose vectors- Expression vectors, Secretion vectors, Shuttle or bi-functional vectors, single stranded phage and phagemids		
	UNIT II	**15**	
	Manipulation of Gene expression in Eukaryotes		
2	2.1 Eukaryotic gene expression 2.2 *Introduction of DNA into fungi-yeast and filamentous fungi (fungal transformation) 2.3 Heterologous proteins production in yeast 2.4 Heterologous proteins production in filamentous fungi 2.5 Cultured insect cells expression systems- Baculovirus transfer vector 2.6*Mammalian cell expression systems- Human Papova BK virus shuttle vector.		
	UNIT III	**15**	
	The Human Genome Project		
3	3.1 *The human genome, scope and goals of the project 3.2 Genetic linkage maps, chromosome walking, restriction mapping 3.3 Polymorphic DNA markers 3.4 Restriction fragment length polymorphism (RFLP) and its uses 3.5 Physical maps, Sequence tagged sites 3.6 Integrating genetic linkage and physical maps 3.7 *Mapping human diseases 3.8 Positional cloning: Getting closer to a disease causing gene 3.9 Testing for exons 3.10 Limitations of positional cloning		
	Unit IV	**15**	
	Regulations and Patents in Biotechnology		
4	4.1 Regulating recombinant DNA technology 4.2*Regulatory requirements – safety of genetically engineered foods Chymosin, tryptophan, bovine somatotropin		

	4.3 Regulation environmental release of genetically engineered organism (GEO). Ice minus *Pseudomonas syringae* 4.4 Regulatory agencies and laws for product regulation 4.5 Risk assessment: How much risk? 4.6 *Open field tests of GEO 4.7 Development of policy for Human gene therapy 4.8 Patenting biotechnology inventions a) What constitutes the patent? b) The patent process c) The conditions to be satisfied for an invention to be patentable :Novelty, Inventiveness, Usefulness d) Patenting in different countries, types of inventions that are not patentable in India e) What is Paris convention? Principal features of Paris convention f) Patenting multicellular organisms g) Patenting and fundamental research ***Marked topics are to be taken for seminar**		

	Semester IV Theory
RJSPZOOBT406 **Paper VI** Genetic engineering techniques and its applications -II	**Course Objectives:** 1. To acquaint the learners with the basic tools of genetic engineering. 2. To impart knowledge on gene expression in organisms. 3. To understand the significance of Human Genome Project. **Learning Outcomes:** 1. Learners will get an idea of different gene transfer techniques for genetic engineering. 2. Learners will be able to understand the mechanism of gene expression. 3. Learners will acquire insight of the applications of Human Genome Project for human welfare.

SEMESTER-IV (THEORY)		**L**	**Cr**
Paper- VII GENERAL, PHYSICAL, CHEMICAL AND BIOLOGICAL OCEANOGRAPHY II **Paper Code: RJSPZOOOC407**		**60**	**4**
	UNIT I	**15**	
	General Oceanography		
1.	1.1 Oceanographic instruments: Grab (Peterson and Van veen) for benthos collection, naturalist's dredge (Ekman Sanders deep sea anchor dredge), trawl, plankton nets and continuous plankton sampling system, Reversing Nansen bottles, Reversing thermometer, Salinometer, Secchi disc, Stempel's pipette and dilution jar, underwater photography, remote sensing and satellite imaging, SCUBA apparatus. *1.2 Oceanographic Expeditions**:** Challenger, Indian Ocean and Antarctic. 1.3 Law of sea.		
	UNIT II	**15**	
	Physical Oceanography		
2.	2.1 Vertical circulation**:** wind induced circulation, Thermohaline circulation and upwelling of water. 2.2 Waves: Characteristics of waves, deep water and shallow water waves, transitional waves, wind generated waves, internal waves and Tsunami *2.3 Tides**:** Tides generating forces, equilibrium theory of tides, dynamic theory of tides, tides as a source of power. * 2.4 Currents**:** Types of currents, major currents of the world, Coriolis effect and El Nino effect.		
	UNIT III		
	Chemical Oceanography		
3.	3.1 Impact of anthropogenic activities**:** A) a) Pollution- Domestic sewage, ndustrial/heavy metals. Agricultural- fertilizers and pesticides. b) Oil pollution. c) Ocean dumping. d) Radioactive and Thermal waste. B) Reclamation.		

	UNIT IV		
	Biological Oceanography		
4.	4.1 Resources from the sea: A) Mineral resources: a) Continental margin. b) Deep sea mud oozes and manganese nodules. c) Oil, gas and sulphur deposits and role of ONGC. B) Bioactive compounds from the sea. C) Scientific and economical aspect of seabed exploration and mining. ***marked topics are to be taken for seminar**		

M.Sc-II	**Semester III Theory**
RJSPZOOOC407 Paper VII General, physical, chemical and biological oceanography II	**Course Objectives:** 1. To acquaint learners with the general nature of sea. 2. To introduce the various resources of the ocean **3.** To introduce the learners to the physical, chemical and biological aspects of marine life. **Learning Outcomes:** 1. Learners will Understand the different parameters of Sea supporting life under water. 2. Learners will be able to Decipher the relationship between physical, chemical and biological characteristics off the sea . 3. Learners will be able to understand the impact of anthropogenic factors on sea.

	SEMESTER-IV (THEORY)	L	Cr
	Paper VIII- PLANKTOLOGY, FISH, FISHERY SCIENCE AND AQUACULTURE II **Paper Code: RJSPZOOOC408**	**60**	**4**
	UNIT I	**15**	
	Planktology		
1	1.1. Marine algae and plankton in relation to fisheries. Indicator species 1.2. Methods of collection, preservation and analysis of plankton. 1.3. *Marine Bio-deterioration: Fouling and Boring organisms.		
	UNIT II	**15**	
	Fish and Fisheries Science		
2	2.1. Population Dynamics Abundance in population and fishery. Fishery catches and fluctuation. M.S.Y., Optimum Yield, Age Composition, Population Growth, Population Models. 2.2. *Socio-economics of fishermen.		
	UNIT III	**15**	
	Biotechnology in Fishery and Biometric Studies		
3.	3.1. Statistical methods: Collection of data, Sampling methods, Presentation data, Measurement of central tendancy and dispersion, Frequency distribution, Analysis of variance and co-variance, Correlation regression, Theory of probability, Tests of significance, Chi-square test. 3.2. * Measurement of fish: a) Measurement of length and weight b) Morphometric measurements c) Merestic counts d) Biometric index		
	UNIT IV	**15**	
	Aquaculture		
	4.1. Hatchery and grow out practices for cultivable species of freshwater fishes (Indian major carps and exotic carps) and prawns (*Macrobrachium rosenbergii*), Culture of Air breathing fishes. 4.2. Integrated aquaculture and sewage fed fishery Hatchery and growout practices for the culture of brackish water fishes (*Chanos chanos* and *Lates calcarifer*), Prawns (*Penaeus monodon* and *Penaeus indicus*). 4.3. *Present status of sea farming in India Culture of molluscs, clams, oyster (edible and pearl) and Mussels, Echinoderms (sea cucumber), sea weeds. ***marked topics are to be taken for seminar**		

M.Sc-II	Semester IV Theory
RJSPZOOOC408 Paper VIII Planktology, Fish , fishery science and aquaculture	**Course Objectives:** 1. To introduce to Marine life, biological processes. 2. To elucidate the ecosystem function. 3. To impart mathematical, statistical skills that are useful in oceanography. **Learning Outcomes:** 1. To Provide fundamental knowledge related to marine life. 2. To understand strategies adopted by these groups for survival in marine environment.

SEMESTER-III PRACTICAL	Credits
Biotechnology	
Course Code: RJSPZOOPBT305 and RJSPZOOPBT306	**04**
1)Demonstration of aseptic technique: Work place for aseptic handling, packing glassware (flasks, test tubes, pipettes, petri dishes) for sterilization, aseptic transfer of liquids (pipetting from flask to test tube) 2) Preparation of LB agar plate, slant, butt & demonstration of streaking technique using bacterial culture to obtain isolated colonies. 3) Determination of viable cell count in the given culture of bacteria by dilution & spreading technique. 4) Using mini-prep method isolate plasmid DNA from the given strain of bacteria & show the purity of the isolate by performing agarose gel electrophoresis. 5) To estimate the number of bacteria in the given culture by nephelometry.	
Oceanography and Fishery science	
Course Code: RJSPZOOPOC307	
1) Physical and chemical oceanography: Determination of physico-chemical parameters: a) Salinity (Argentometric and conductivity method) b) Dissolved oxygen, c) Carbon dioxide. d) Nitrates-nitrites. e) Silicates. f) Phosphate-phosphorus. **2) Textural features:** Sediment analysis- size fraction (sand, silt, clay) **3) Identification of foraminiferans and radiolarians from sand.** **4) Estimation of primary productivity by light and dark bottle.** **5) Identification of intertidal organisms:** a) Rocky shore- Patella, Chiton, Fissurella, Mytilus species, *Perna viridis,* Cardium, Balanus, Gorgonids, Littorina and Corals. b) Sandy shore: Solen, Umbonium, Oliva, Pea crab, Fiddler crab, Molluscan shells, Star fish and Balanoglossus. c) Muddy shore: Lingula, Chaetopterus, Arenicola, Tubiculus worm and Mud skipper.	

Course Code: RJSPZOOPOC308

1) Laboratory procedure for quantitative estimation of plankton settling method, wet weight method, weight displacement method, counting method.

2) Identification of Zooplankton permanent slides (Noctiluca, Obelia medusa, Zoea, Zoea porcelina, Copepods, Mysids, Echinoderm larvae, Nauplius, Sagitta, Doliolum, Salpa, Fish eggs and larvae, Jelly fish, Physalia, Porpita)

3) Study of fecundity-maturation studies.

4) Plotting the frequency polygon by ova diameter measurement.

5) Identification and classification of Marine fishes

List of Marine fishes

Elasmobranchs

1. Family- Carcharidae
   Carcharias sps. *Zygaena malleus*
2. Family- Rhinobatidae
   Rhynchobatus djeddensis
3. Family-Trygonidae
   Trygon uarnak

Teleost

4. Family- Percidae
   Lutianus johnii, Therapon sps., *Pristipoma maculatum, Synagris japonicus, Gerres filamentosus*
5. Family- Squamipinnes
   Scatophagus argus
6. Family – Mullidae
   Upenoides vittatus
7. Family- Polynemidae
   Polynemus tetradactylus
8. Family- Sciaenidae
   Pseudosciaena diacanthus, Sciaena sps.
9. Family- Trichuridae
   Trichurus savala/ haumela
10. Family- Carangidae
    Caranx rottleri, Chorinemus toloo
11. Family- Stromatidae
    Pampus chinensis, Pampus argenteus
12. Family- Scombridae
    Rastrelliger kanagurta, Cybium guttatum
13. Family- Trachinidae
    Sillago sihama

	14. Family- Cottidae *Platycephalus punctatus* 15. Family- Gobidae *Periophthalmus* sps., *Boleophthalmus* sps. 16. Family- Sphyraenidae *Sphyraena acutippinis* 17. Family- Mugillidae *Mugil* sps. 18. Family- Gadidae *Bregmaceros* sps. 19. Family- Pleuronectidae *Psettodes erumei, Cynoglossus elongatus* 20. Family- Siluridae *Arius dussumieri* 21. Family- Scopelidae *Saurida tumbil, Harpodon nehereus* 22. Family- Sombresocidae *Belone stongylurus, Hemiramphus* sps. 23. Family- Clupeidae *Pellona feligera, Clupea longiceps* 24. Family- Chirocentridae *Chirocentrus dorab* 25. Family- Muraenesox *Muraenesox* sps. **Note: Minimum number of animals to be used for experiments**	

	Semester III Practical
RJSPZOOPBT305 and RJSPZOOPBT306	**Course Objectives:** • To provide hands-on training in aseptic techniques. • To teach dilution and spreading technique applicable in diagnostic areas. **Learning Outcomes:** • The learner shall acquire the skills of handling glassware and culture in lab. Conditions. • Learners will be trained in several techniques applicable in biotech companies.

M.Sc-II	Semester III PRACTICAL
RJSPZOOPOC307 General, physical, chemical and biological oceanography	**Course Objectives:** 1. To develops concepts about the chemistry of the marine environment. 2. To study the properties and interactions of the substances present in the marine environment. 3. To deals with the Analytical Chemistry of Seawater. **Learning Outcomes:** 1. Learner will develop analytical skills . 2. Learner will understand to use the instruments 3. Learners will understand environment/aquatic systems.

M.Sc-II	Semester III PRACTICAL
RJSPZOOPOC308 **Environmental And Applied Physiology I**	**Course Objectives:** 1. To acquaint learners with the basic of life of the sea. 2. To introduce the various parameters supporting life **3.** To introduce the learners to the basics of marine life. **Learning Outcomes:** 1. Learners will Understand the different parameters of Sea supporting life under water. 2. Learners will be able to understand the relationship between different organisms of the ocean. 3. Learners will be able to understand the processes involved in aquaculture

SEMESTER-IV PRACTICALS	L	Cr
Biotechnology		**04**
Course Code: RJSPZOOPBT405 and RJSPZOOPBT406		
1. Immobilize Yeast cells in calcium alginate & prepare a bioreactor column to demonstrate Invertase activity in the bioreactor column. 2. Restriction-digest the given DNA sample & demonstrate the separation of fragments by performing agarose gel electrophoresis. Interpret the results by comparing with the standard digests provided. 3. Demonstrate the western blotting technique for the given sample of protein. 4. To plot a growth curve for the microorganisms provided. 5. Demonstrate the effect of medium on growth curves of given microorganism, using two different media (minimal & enriched).		
Oceanography and fishery Science		**2**
Course Code- RJSPZOOPOC407		
1) Oceanographic instruments: a) Nansen reversing bottle. b) Deep sea reversing thermometer. c) Bathythermometer. d) Drift bottle. e) Ekman's current meter. f) Secchi disc. g) Plankton nets: Standard net, Hensen net and Clarke Bumpus net. h) Stemple pipette and counting slide. i) Nekton sampling device-trawls. j) Benthic sampling devices-dredges, grabs and corers. **2) Detection of heavy metals:** a) Zinc b) Leadc) Copper. **3) Food and feeding in fish.** **4) Identification of crafts and gears.**		

SEMESTER-IV PRACTICALS	L	Cr
Oceanography and fishery Science		
Course Code- RJSPZOOPOC408		**2**

1) Preparation of Zooplankton mountings.
2) Collection of marine algae and preparation of herbaria (at least five different forms).
3) Biometric studies of fish/ prawn
   A. Study of relationship between total length and standard length/head length/body depth length/body weight.
   B. Calculate correlation (standard length and total length, head length and total length, body depth and total length). Calculate the index values for various relationships.
4) Identification of fouling and boring organisms
   (*Limnoria* sps., *Lepas, Balanus, Caprella, Teredo, Littorina, Crassostrea, Pellaria/ Sertularia*).
5) Identification and classification of fresh water fishes
   (Rohu, Catla, Mrigal, Tilapia, Gourami) and fresh water giant prawn (*Macrobrachium rosenbergii*).
6) Crustacean fishery
   (*Penaeus monodon, P. indicus, M. monoceros, P. stylifera, Solenocera indica, Nematopaleomon, Acetes indicus*).
7) Molluscan fishery
   (*Meretrix, Perna viridis, Katelysia sps., Crassostria sps., Xancus pyrum, Solen kempi, Cuttle fish* and gastropods).
8) Visit to aquaculture centres, boat building yards, processing plants and marine biological institutions (Excursions or study tours)
   Students Activity
   a. Collection of molluscan shells
   b. Preparing herbaria from marine algae (atleast 5)
   c. Preparation of shrimp pickle

Note: Minimum number of animals to be used for experiment.

M.Sc-II	Semester IV Practical
RJSPZOOPBT405 and RJSPZOOPBT406	**Course Objectives:** 1. To provide hands-on training in the setting of a lab-scale bioreactor column. 2. To provide inputs on the blotting techniques and its applications. 3. To understand the growth characteristics of microbes in different media. **Learning Outcomes:** 1. The learner shall be trained in setting a bioreactor column and also understand the industrial applications of the same. 2. Learners will be trained in gel electrophoresis and blotting techniques. 3. Learners will understand the significance of different media in the growth pattern of microbes.

M.Sc-II	Semester IV PRACTICAL
RJSPZOOPOC407 Paper VII General, physical, chemical and biological oceanography II	**Course Objectives:** To provides information on the sampling devices used for collection of marine organisms. To impart skills of identification of biological samples/organisms To provide basic concepts of farming of aquatic organisms. **Learning Outcomes:** Learners develop ability to identify the biological specimens at species level. Learners will know how to take up culture of aquatic organisms.
M.Sc-II	Semester IV PRACTICAL
RJSPZOOPOC408 Paper VIII Planktology, fish, fishery science and aquaculture II	**Course Objectives:** To provides information on the sampling devices used for collection of marine organisms from the environment . To introduce identification of biological samples/organisms **Learning Outcomes:** Learners develop ability to identify the biological specimens at species level. Learners will understand various biological aspects of cultivable species. Learners will understand sight experience of the operation of hatchery and culture systems.

Semester III & IV Biotechnology

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Practicals Paper Pattern

Semester III- Biotechnology Practical V

Total marks- 50

Q1) Determination of viable cell count in the given culture of bacteria by dilution & spreading technique. (DAY 1)
(25)

OR

Q1) Using mini-prep method isolate plasmid DNA from the given strain of bacteria & show the purity of the isolate by performing agarose gel electrophoresis. (DAY 1) (25)

Q2) To estimate the Demonstration of aseptic technique: Work place for aseptic handling, packing glassware (flasks, test tubes, pipettes, petridish) for sterilization, aseptic transfer of liquids (pipetting from flask to (DAY 2)
test tube. (15)

Q3) Viva (05)

Q4) Journal (05)

Biotechnology Practical VI

Total- 50 marks

Q1) Preparation of LB agar plate, slant, butt & demonstration of streaking technique using bacterial culture to obtain isolated colonies. (DAY 1) (25)

Q2) Estimate number of bacteria in given culture of nephelometry. (15)
(DAY 2)

Q3) Viva (05)

Q4) Journal (05)

Practical paper pattern

Semester III Oceanography and Fisheries Practical VII

Total- 50 marks

1. (A) Determination of Physio-chemical parameter salinity/D.O./CO_2 /Nitrates-Nitrites/Silicates/Phosphate-Phosphorus. 10

   OR

   A) Estimation of primary productivity by light and dark bottle. 10

   (B) Foraminiferan and radiolarian shells (any four) 05

2. Minor – Sediment analysis 07

3. Identify and describe (any 6 Intertidal Organism) (6 X 3) 18

4. Viva voce 05

5. Journal 05

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Practical paper pattern

Semester III Oceanography and Fisheries Practical VIII

Total- 50 marks

1. Major

   (A) Fish identification (1 from Elasmobranch, 4 from Teleost) 15
   (B) Fish identification as per Francis day volume 05

2. Minor

   (A) Study of maturity, Plankton settling method/ weight method/ weight displacement method/ counting method and study of fecundity and maturation studies 08

   Or

   Plotting the frequency polygon by ova diameter measurement 08

3. Identification (4 identification 3 marks each) 12

4. Viva voce 05

5. Journal 05

Semester IV

Biotechnology Practical V

Total- 50 marks

Q1) Demonstrate the effect of medium on growth curves of given microorganism, using enriched media. (DAY 1) (25)

OR

Q1) Demonstrate the effect of medium on growth curves of given microorganism, using minimal media. (DAY 1) (25)

Q2) Immobilize Yeast cells in calcium alginate, prepare beads & keep them overnight in activation medium (DAY 1)
(15)

Q3) Viva (05)

Q4) Journal (05)

Biotechnology Practical VI
Total- 50 marks

Q1) Prepare a bioreactor column to demonstrate Invertase activity in the bioreactor column. (DAY 2) (25)

Q2) Restriction-digest the given DNA sample & demonstrate the separation of fragments by performing agarose gel electrophoresis. Interpret the results by comparing with the standard digests provided. (DAY 2) (15)

OR

Q2) Demonstrate the western blotting technique for the given sample of protein. (DAY 2) (15)

Q3) Viva (05)

Q4) Journal (05)

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Practical paper pattern

Semester IV Oceanography and Fisheries Practical VII

Total Marks: 50

1. Major Experiment
   Identification of Oceanographic instrument (3 identification 4 marks each) 12

2. (A) Detection of heavy metals – zinc/ Lead/ Copper 10
   (B) Food and feeding in fish 06

3. Identification (4 identification 3 marks each 2 from crafts & 2 from gears) 12

4. Viva voce 05
5. Journal 05

Practical paper pattern

Semester IV Oceanography and Fisheries Practical VIII

Total Marks: 50

1. Biometric study of fish
   (A) Study of relationship between total length and standard length / head length / body depth length / body weight 04

   (B) Calculate correlation (standard length and total length / head length and total length 03

2. Preparation of zooplankton mounting (5 different mounting of zooplankton) 10

3. Identification (1 from fouling and boring organism, 1 from fresh water fish & fresh water prawn – 1 from crustacean fishery, 1 from molluscan fishery) (4 X 2 marks each) 08

4. (A) Herbarium 05
   (B) Field report (visit to aquaculture centre, boat building yards, processing plants, marine biological Institutions) (Excursion or Study tours) 04

   (C) Collection molluscan shells (5 shells) 04
   (D) Report on shrimp prawn pickle 02

5. Viva voce 05

6. Journal 05