

**Dr.HomiBhabha State University, Mumbai  
The Institute of Science,  
15, Madam Cama Road, Fort,  
Mumbai – 400032**

**ProgrammeM.Sc.  
CourseZoology**

**Syllabus for Semester III**

**(Choice Based Credit System with effect from the academic year 2020-2021)**

# **M.Sc. Zoology Semester III**

## **PREAMBLE**

Master of Science (M.Sc.) in Zoology is a post graduate course of The Institute of Science, affiliated to Dr.HomiBhabha State University, Mumbai.

The prime concern of the department is to develop patterns of teaching in postgraduate education in major fields of zoology like oceanography, endocrinology, molecular biology, Genetic Engineering etc. so as to demonstrate a high standard of education to the postgraduate students in zoology. The vibrancy to synthesize, out of the knowledge gained, and come out with disruptive outcomes, would define the learning outcomes of the future PG students. An attempt is made to elevate the syllabus to International levels, so as to facilitate easier transitions for Post Graduate Courses and Job prospects overseas. As per the Institutional background, being a research institute, this educational experience is imparted in an atmosphere of research to the students.

The class-wise syllabus committees were constituted in accordance with inclusive policy of the BOS, with experienced staff members and providing faculty at large, exposure to work on syllabus and shape the subject which will go a long way ahead in future.

The committee examined the lacunae of the syllabus and after analysing other curricula of existing universities in respective subjects in terms of content, relevance, quality and pattern of teaching and examination has synthesized the present proposal. After guidance from senior faculty, feedbacks from the core faculty, intensive discussions were done and the syllabus was suitably finalized.

The CBCGS pattern provides an opportunity for the students to choose courses from the prescribed courses comprising core, elective/ skill based courses. These elective/skill based courses will help to build a bridge between students and their future mentors from industry.

As per the guide lines of UGC for discontinuation of dissection of live animals in the laboratory experiments in Zoology/ Life Sciences at UG and PG levels, an expert committee was constituted i.e. Institutional animal ethical committee (IAEC) under the purview of Committee for Purpose of Care and Supervision of Experimental Animals (CPCSEA), Reg.no.1961/GO/Re/S/17/CPCSEA dated 25.04.2017 to look into the issue of using minimum bred animals for demonstration by the respective faculty.

In accordance with the deliberations in the meeting, draft syllabus for M.Sc. in Zoology, to be implemented in the Choice based Credit Based Semester and Grading System, was prepared by the committee under the guidance of core committee. The draft was circulated among the heads and senior teachers of the Department of Zoology for approval and suggestions.

## Introduction of the Programme Course

The credit system to be implemented through this curriculum, would allow students to develop a strong footing in the fundamentals and specialize in the disciplines of his/her liking and abilities. The students pursuing this course would have to develop in depth understanding of various aspects of the subject. The working principles, design guidelines and experimental skills associated with the subject such as, Molecular Biology, Animal Physiology, Endocrinology, Oceanography, Genetic Engineering, Ecology etc. However, the intention is to understand the subject of Zoology in the evolving biological paradigm in modern times; where, living beings need to be understood at the level of atomic interactions; and comparative systems of organisms need to be studied through the prism of integrated chemical, physical, mathematical and molecular entities to appreciate the inner working of different organisms at morphological, cellular, molecular, interactive and evolutionary levels. Apart from the classical topics in animal sciences this syllabus covers various topics on courses like Economic Zoology, Presentation skill and Aquaculture to generate employments and entrepreneurship for the students.

This programme through the dissertation work helps the students in understanding the basic principles of nature and also gives hands-on experience to the students on experimenting with nature /animals and thereby enabling the students to develop aptitude for research in various allied fields of animal sciences.

### Learning Outcome:

*Students in this course will be familiar with the wider concepts of Endocrinology, Oceanography, Fishery science, medical endocrinology, Neurobiology, Molecular Biology, Genetic Engineering and Bioinformatics, Physiology, Ecology, etc. Most importantly, students will gain the abilities to work as an independent scientist and researcher.*

The students will be able to solve questions related to oceanography and future of ocean and marine sciences and to communicate them to peers and the public. They will learn the practical and conceptual issues in endocrinology and will learn the quantitative skills in morphological, physiological, hormonal, and molecular techniques in endocrinology. They will learn the main stages of development common to most multicellular organisms and the main endocrine changes that occur during development as a result of cellular behaviour.

Under the Discipline specific electives, the students will learn the insight into fish and fishery science, fish diseases and fish products, including marine hazards. The students will also learn the comparative aspects in invertebrate and vertebrate endocrinology and importance of the male and female reproductive endocrine systems.

In Generic elective, the Economic zoology courses will help the students to gain knowledge regarding the different avenues for entrepreneurship, self-employment, start-ups etc.

Under Ability enhanced courses the students will gain knowledge in presentation skills where in, a student can effectively present his proposals, face interviews confidently and enhance his communication skills. Similarly, the course

based on skill enhancement like Aquaculture will help them to become entrepreneurs in these fields and become self-employed.

## Structure of the M.Sc. Zoology (Semester III)

SEM	Core Courses	DSE/ID/P	GE	AEC	SEC	Non-CGPA Credits	Total Credits
III	MSZOCC301T Molecular Biology	MSZODE301T Physical and Chemical Oceanography Or MSZODE303T Comparative Invertebrate Endocrinology	MSZOG301T Economic Zoology	MSZOAE301T Presentation skills	Nil	MOOCs, CO- /Extra Curricula r Activities etc.	CC: 4*2=8 DE:4*2=8 LB: 1*4 = 4 PR: 1*4=4 GE:2*1=2 AE:2*1=2 <b>Total = 28</b>
	MSZOCC302T Genetic Engineering Techniques and Bio-informatics	MSZODE302T Fish, Fishery Science and Planktology Or MSZODE304T Molecular and Comparative Vertebrate Endocrinology					
	MSZOLB301P Part A- Molecular Biology, Genetic Engineering and Bioinformatics (Based on MSZOCC301 & MSZOCC302)	MSZOLB301P Part B – Oceanography and Fishery Science (Based on MSZODE301 & MSZODE302) Or MSZOLB301P Part C – Endocrinology (Based on MSZODE303 & MSZODE304)					

**Semester III**  
**Scheme of marks**

Sr. No.	Paper	Subject	Credits	Teaching Scheme				Examination Scheme								
				Theory Periods	Practical Periods	Total Periods	Duration in Hrs.	Theory					Practical			
								Maxi. Marks (Theory)	Maxi. Marks (Internal)	Total Marks	Min. Passing Marks	Duration Hrs.	Max. Marks (Practical)	Total Marks	Min. Passing marks	
1	CC301	Molecular Biology	4	4	-	4	4	60	40	100	40	2.5	-	-	-	
2	CC302	Genetic Engineering Techniques and Bio-informatics	4	4	-	4	4	60	40	100	40	2.5	-	-	-	
4	DE301	Physical and Chemical Oceanography	4	8	-	8	8	60	40	100	40	2.5	-	-	-	
5	DE303	Comparative Invertebrate Endocrinology														
6	DE302	Fish, Fishery Science and Planktology	4	8	-	8	8	60	40	100	40	2.5	-	-	-	
7	DE304	Comparative Molecular and Vertebrate Endocrinology														
	LB301	Practical based on CC& DE	4	-	16	16	16	-	-	-	-	-	100	100	40	
	PR301	Project	4	-	16	16	16	-	-	-	-	-	100	100	40	
8	GE	Economic Zoology	2	2	-	2	2	30	20	50	20	1.5	-	-	-	
9	AE	Presentation skills	2	2	-	2	2	30	20	50	20	1.5	-	-	-	
		<b>Total</b>	<b>28</b>	<b>28</b>	<b>32</b>	<b>60</b>	<b>60</b>	<b>300</b>	<b>200</b>	<b>500</b>	<b>200</b>	<b>13</b>	<b>200</b>	<b>200</b>	<b>80</b>	
<b>Grand Total Semester III: 700</b>																

## Syllabus for Semester III

<b>Course Code:</b> <b>MSZOCC301T</b>	<b>Course Title: Molecular Biology</b>	
<b>Course Credit:4</b>	<b>Total contact hours: 60 Hrs</b>	
<b>Learning Objectives:</b>		
<ul style="list-style-type: none"> <li>➤ The learners will be sensitized to the deeper fact through the scale of magnitude from cell to organelles to molecule.</li> <li>➤ They will also have an understanding of various biological processes and their depth in involving different biological molecules.</li> <li>➤ The learners will be exposed to the three major ideas of Mechanism, Cell theory and Evolution which holds molecular biology science together.</li> <li>➤ They will gain knowledge of molecules of life inside cells such as DNA, RNA, Proteins and certain Enzymes.</li> </ul>		
<b>Outcome:</b>		
<ul style="list-style-type: none"> <li>➤ The students can pursue careers in molecular biology focused on the latest developments in cell biology such as Stem cell studies and its utilities.</li> <li>➤ Further the students may participate in Extensive research in molecular biology to develop clones of various animals. And also in studying the evolution of the living world comprising plants and animals.</li> <li>➤ Students will get opportunities in Molecular &amp; Structural Biology Units, Pharma Companies, Molecular Diagnostic Labs, Government hospitals Medical Labs</li> <li>➤ A wide range of job opportunities in the agricultural, medical, pharmaceutical, aquaculture, forensics and environmental science areas are offered.</li> <li>➤ The students can either take up educational assignments or get engaged as research candidates.</li> <li>➤ They can get opportunities in teaching, research fields.</li> </ul>		
<b>Sr. No.</b>	<b>Course Contents (Topics &amp; subtopics)</b>	

<p><b>1</b></p>	<p><b>Unit I: Dynamic organization of cell</b></p> <p><b>1.1 Universal features of cells;</b></p> <p>1.1.1. Cell chemistry and biosynthesis, chemical organization of cells; internal organization of the cell, cytoskeleton.</p> <p>1.1.2. Nuclear compartment: nucleus, nucleolus and chromosomes.</p> <p><b>1.2 Cellular Processes&amp; Cell signalling</b></p> <p>1.2.1. Cellular communication, gap junctions, cell-ECM and cell-cell interactions; cell receptors and trans-membrane signalling; cell motility and migration; extracellular matrix, integrins, neurotransmission and its regulation.</p> <p>1.2.2. Molecular Basis of the Cell and Macromolecular recognition process</p> <p><b>1.3. Membrane Transport and trafficking</b></p> <p>1.3.1. Cell membranes: structure of cell membranes and concepts related to compartmentalization in eukaryotic cells.</p> <p>1.3.2. Molecular mechanisms of membrane transport, nuclear transport, transport across mitochondria and chloroplasts; intracellular vesicular trafficking from endoplasmic reticulum through Golgi apparatus Polysomes/cell exterior.</p>	<p><b>15 Hrs.</b></p>
<p><b>2</b></p>	<p><b>Unit II: Molecular Taxonomy, Proteomics and beyond, Molecular Pathology</b></p> <p><b>2.1. Modes of molecular evolution,</b></p> <p>2.1.1. Neutral theory of Molecular evolution, genetic markers for taxonomic purposes.</p> <p>2.1.2. Comparing total genome by DNA-DNA</p>	<p><b>15 Hrs.</b></p>



	<p>hybridization, comparing DNA sequences. Cladistics, biological identification through DNA barcodes, chromosome painting, establishing molecular homology using protein sequences.</p> <p><b>2.2 Proteomics and beyond:</b></p> <p>2.2.1. Analysis of the transcriptome, Proteomics-Expression analysis &amp; Characterization of proteins, Metabolomics &amp; global biochemical networks.</p> <p>2.2.2. Generation of heat stable, pH stable enzymes, application in vaccine development, drug development, sensor development.</p> <p><b>2.3. Molecular Pathology:</b></p> <p>2.3.1. Rules for nomenclature of mutations &amp; databases of mutations, Loss of function mutations, Gain of function mutations, Molecular pathology from genetic disease.</p> <p>2.3.2. Molecular pathology from disease to gene, Molecular pathology of chromosomal disorders.</p>	
3	<p><b>Unit III: Techniques in Cell Culture</b></p> <p><b>3.1. Isolation of cells and basics of cell culture;</b></p> <p>Observing cells under a microscope, analyzing and manipulating DNA, RNA and proteins</p> <p><b>3.2. Cloning &amp; Selection of specific cell types</b></p> <p>Cloning, somatic cell fusion and HAT selection, Medium suspension fusion, selection of Hybrid clone, production of monoclonal antibodies.</p> <p><b>3.3. Organ Culture</b></p> <p>Culture of embryonic organs, whole embryo culture, culture of adult organs.</p>	15 Hrs.

<b>4</b>	<p><b>UNIT IV: Medical Molecular Biology:</b></p> <p><b>4.1. Molecular biology of Cancer</b>  Activation of oncogenes, Inactivation of tumour suppressor genes, Inappropriate expression of micro RNAs in cancer, Chromosomal rearrangements and cancer.</p> <p><b>4.2. Stem cells &amp; therapeutic cloning</b>  Embryonic stem cells and therapeutic cloning, multi- potent adult stem cells, pluripotent adult stem cells, transgenic stem cells, Regeneration therapy</p> <p><b>4.3. Genes and Human behaviour</b>  Aggressive, impulsive, and violent behaviour, Schizophrenia susceptibility loci.</p>	<b>15 Hrs.</b>
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**Suggested Reading:**

1. Cell and Molecular Biology De Robertis, E.D.P. and De Robertis E M F
2. Cell and Molecular Biology Garald Karp J. Wiley & Sons, NY
3. Cell Biology – Structure and Function David E. Sadawa, Jones and Barttett Pub., IND.
4. Cell Biology LabFaxG.B.Dealtry& D. Rickwood Bios Scientific Pub.
5. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology P.S. Verma, V.K. Agarwal S. Chand Pub., N Delhi
6. Cell Growth and Division, A Practical Approach. R. Basega, IRL Press, Oxford Univ. Latest
7. Cell in Development and inheritance EB Wilson MacMilan, NY Latest.
8. Benjamin Lewin -Gene VI, Gene VII, Gene IX, Gene X Oxford University press
9. David Friefieder -Essentials of Molecular Biology, Jones &Barlett publications

10. J. Kendrew Encyclopedia of Molecular Biology Blackwell Scientific publications.
11. Weaver Molecular Biology
12. J.D. Watson, N.H. Hopkins, J.W. Roberts, et al Molecular Biology of the Gene, Benjamin Cummings publ.co.inc., California
13. J. Darnell. et. al., molecular biology of the cell (2nd edition) Garland Publishing Inc.
14. Meyers R.A (ed)., Molecular biology and biotechnology. VCH publishers NY Inc.
15. Alberts B et. al., Molecular biology of the cell. Garland Publishing Inc
16. Watson J.D., Recombinant DNA.
17. Malacinski; Essentials of Molecular Biology.
18. Stansfield; Molecular and cell biology.
19. Walker Molecular biology and Biotechnology.
20. Brown T.A Essential of Molecular biology Vol 1 and 2 each.
21. Dale Molecular Genetics of Bacter
22. Biological ultrastructure-Arne Engstrom. Academic press inc
23. Transport in Biomembranes-Alexander Gliozzi. RAVCA PRCM NEW YORK
24. Molecular biology – Harvey Lodish. W.H. FREEMAN AND COMPANY NEW YORK
25. Molecular biology, Genes to Proteins- BURTON TROPPE Molecular Cloning- Joseph Sambrook. Cold Spring Harbour Laboratory PRESS. NEW YORK.

<b>Course Code:</b> <b>MSZOCC302T</b>	<b>Course Title: Genetic Engineering Techniques and Bioinformatics</b>
<b>Course Credit:4</b>	<b>Total contact hours: 60 Hrs</b>
<b>Learning Objectives:</b>	
<ul style="list-style-type: none"> <li>➤ The learners will be familiarized with the basic concepts in genetic engineering</li> <li>➤ The learners will be acquainted to versatile tools and techniques employed in genetic engineering and recombinant DNA technology and also will be appraised about the applications in genetic engineering.</li> <li>➤ The learners will be provided with an introduction &amp; importance of bioinformatics</li> <li>➤ They will also learn the the application areas of bioinformatics, with a focus on the topics that will be taught in the course</li> <li>➤ The learners will also be acquainted with the bioinformatics data that is is stored and organised</li> <li>➤ They will also learn the different types of data found at the NCBI and EBI resources and to locate and extract data from key bioinformatics databases and resources.</li> </ul>	
<b>Outcome:</b>	
<ul style="list-style-type: none"> <li>➤ The students will have knowledge of tools and strategies used in genetic engineering.</li> <li>➤ They will have an understanding of applications of recombinant DNA technology and genetic engineering from academic and industrial perspective.</li> <li>➤ They will be able to use and apply the knowledge of genetic engineering in problem solving and in practice.</li> <li>➤ They will gain knowledge to Locate and use the main databases at the NCBI and EBI resources</li> <li>➤ They will know the difference between databases, tools, repositories and will be able to use each one to extract specific information</li> <li>➤ They will be well trained to extract data from specific databases using accessions numbers, gene names etc.</li> </ul>	

Sr. No.	Course Contents (Topics & subtopics)	
1	<p><b>Unit I: Genetic engineering techniques</b></p> <p><b>1.1 The Basic tools of genetic engineering</b></p> <p>1.1.1 Chemical Synthesis of DNA-Oligonucleotide synthesis by Phosphoramidite method, Synthesis of genes</p> <p>1.1.2 *DNA Sequencing -- Maxam-Gilbert method, Sanger's dideoxynucleotide method, By using bacteriophage M13 By Primer walking</p> <p>1.1.3 Polymerase chain reaction and its advantages</p> <p><b>1.2 Cloning Vectors</b></p> <p>1.2.1 *General purpose plasmid vectors (pUC19, pBR322)(Bacterial Vectors)</p> <p>1.2.2 Bacteriophage and cosmid vectors</p> <p>1.2.3 Yeast artificial chromosomes (YACs)</p> <p><b>1.3 Analysis of genome/proteome</b></p> <p>1.3.1 DNA fingerprinting/physical mapping/pulsed field gel electrophoresis</p> <p>1.3.2 Analysis of the proteome</p> <p>1.3.3 Analysis of mRNA transcripts</p>	15 Hrs.
2	<p><b>Unit II: ANIMAL BIOTECHNOLOGY &amp; HUMAN THERAPIES</b></p> <p><b>2.1 Animal Biotechnology</b></p> <p>2.1.1 *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</p> <p>2.1.2 Recombinant DNA technology to prevent animal diseases</p>	15 Hrs.

	<p>2.1.3 Conservation biology-Embryo transfer</p> <p><b>2.2 Human therapies</b></p> <p>2.2.1 Tissue engineering: Skin, liver, pancreas</p> <p>2.2.2 *Xenotransplantation</p> <p>2.2.3 Antibody engineering</p> <p>2.2.4 Cell adhesion based therapies: Integrins, Inflammation, Cancer and metastasis</p> <p>2.2.5 Site specific mutagenesis, PCR in molecular diagnostics, viral and bacterial detection, PCR based mutagenesis.</p>	
<b>3</b>	<p><b>Unit III: BIOINFORMATICS</b></p> <p><b>3.1 Major Bioinformatics resources</b></p> <p>3.1.1 Literature database eg. PUBMED</p> <p>3.1.2 Genome Database at NCBI, EBI, TIGR, SANGER- Viral genomes, Archeal and Bacterial Genomes ,Eukaryotic genomes with special reference to model organisms (yeast, o Drosophila, C.elegans, Rat, Mouse) Human, Plants such as Arabidopsis thaliana, Rice, etc.</p> <p>3.1.3 Nucleic acid: GENBANK, EMBL, DDBJ</p> <p>3.1.4 Protein structure: domains, motifs, databases: NDB, PDB, CCSD.</p> <p>3.1.5 Protein sequence databases: PIR, SWISSPROT, TrEMBL</p> <p><b>3.2 Taxonomy and Phylogeny</b></p> <p>3.2.1 Basic concepts in Systematic, taxonomy and phylogeny</p> <p>3.2.2 Nature of data used in taxonomy and Phylogeny</p> <p>3.2.3 Definition and description of Phylogenetic trees and various methods--Clustering methodUPGMA, Cladistic method - Parsimony</p> <p>3.2.4 Phylogenetic Analysis software Phylip, PAUP.</p>	<b>15 Hrs.</b>

	<p><b>3.3 Approach to gene identification</b></p> <p><b>3.3.1</b> DNA profiling: cDNA and EST's (expressed sequence tags)</p> <p>3.3.2 Basic research with DNA microarrays and its application in Healthcare.</p> <p>3.3.3 Biomedical genome research and pharmacogenomics</p> <p>3.3.4 Random amplified polymorphic DNA (RAPD)</p> <p>3.3.5 Satellite DNA and its types</p>	
4	<p><b>UNIT IV: Genomics and Proteomics</b></p> <p><b>4.1 Genomics</b></p> <p>4.1.1 Nucleotide sequence Databases, its Analysis and Identification</p> <p>4.1.2 Goals of the Human Genome Project, cloning vectors, concept of maps, physical maps, shotgun libraries, DNA polymorphism, nucleotides, DNA sequences.</p> <p>4.1.3 Resource for restriction enzyme (REBASE), similarity search. Various versions of basic BLAST and FASTA, application of Bio Edit.</p> <p>4.1.4 Masking repetitive DNA, database search, codon-bias detection, detecting functional sites in the DNA.</p> <p><b>4.2 Proteomics</b></p> <p><b>4.2.1</b> Protein sequence information, Composition and properties, physicochemical properties based on sequence, sequence comparison,</p> <p>4.2.2 Primary databases, Secondary databases.</p> <p>4.2.3 Pair-wise sequence alignment, Various file formats for bio- molecular sequences</p> <p>4.2.4. Basic Concepts of sequences similarity, Identity and homology ,scoring matrices, PAM250, BLOSUM62, local and global sequence alignment, multiple sequence alignment, ClustalW</p>	15 Hrs.

**Suggested Reading:**

1. Principles of Protein structure, Schultz, G. E., and Schirmer, R. H. Dr. Shakti Sahi
2. Proteomics, Daniel C. Leible
3. Proteins: Structures and Molecular Principles (2d ed.), TE Creighton
4. Computer Fundamentals by Sinha
5. Westhead, D.R., Parish, J.H. & Twyman, R.M., Instant Notes: Bioinformatics, 2002, BIOS
6. Higgs, P.G & Attwood. T.K., Bioinformatics and Molecular Evolution, 2005, Blackwell Publishing
7. Campbell, A.M & Heyer, L.J., Discovering genomics, proteomics and bioinformatics, 2003, Benjamin Cummings
8. Mount, D.W., Bioinformatics sequence and genome analysis, 2nd Ed., 2004 Cold Spring Harbour Laboratory Press.
9. M. Lesk. (2002) Introduction to Bioinformatics Oxford University Press
10. G.B Fogel D.W Corne (2002) Evolutionary Computation in Bioinformatics
11. Proteins: Structures and Molecular Principles (2d ed.), TE Creighton
12. Bioinformatics: Sequence and Genome Analysis, David W. Mount
13. Sequence Analysis in a Nutshell: A Guide to Common Tools and Databases, Scott Markel, Darryl Leon
14. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, Second Edition, Andreas D. Baxevanis, B. F. Francis Ouellette
15. Bioinformatics: Sequence, Structure and Databanks: A Practical Approach (The Practical Approach Series, 236), Des Higgins (Editor), Willie Taylor (Editor)
16. Fundamental Concepts of Bioinformatics, Dan E. Krane Michael L. Raymer
17. Johan E. Smith, Biotechnology, 3rd Edition, Cambridge Univ. Press
18. Colin Rateledge and Bjorn Kristiansen, Basic Biotechnology, 2nd Edition, Cambridge Univ. Press
19. Susan R. Barnum, Biotechnology – An Introduction, Vikas Publishing House



20. Bernard R. Glick and Jack J. Pasternack, *Molecular Biotechnology – Principles and applications of recombinant DNA*, ASM Press, Washington DC.
21. Alexander N. Glazer and Hiroshi Nikaido, *Microbial Biotechnology – Fundamentals of applied microbiology*, W. H. Freeman and Co, New York
22. Indu Shekar Thakur, *Environmental Biotechnology – Basic concepts and applications*, I. K. International Pvt. Ltd, Mumbai, New Delhi
23. R. E. Speir, J. B. Griffiths, W. Berthold (Ed), *Animal Cell Technology – Products of today, prospects of tomorrow*, Butterworth – Heinman Publishers
24. Terence Cartwright, *Animal Cells as Bioreactors*, Cambridge Univ. Press
25. T. A. Brown, *Gene Cloning – An Introduction*, 3rd Edition, Nelson Thornes
26. Bob Old and S. B. Primrose, *Principles of Gene Manipulation*, 5th Edition, Wiley Blackwell Publishers
27. U. Satyanarayan, *Biotechnology*, 2007 Reprint, Uppala Author Publisher Interlink

<b>Course Code:</b> <b>MSZOLB301P</b>	<b>Course Title: Part A: Molecular Biology, Genetic Engineering and Bioinformatics</b> <b>(Practical based on MSZOCC301 &amp; MSZOCC302)</b>
<b>Course Credit:2</b>	<b>Total contact hours: 60 Hrs</b>
<b>Sr. No.</b>	<b>Course Contents (Topics &amp; subtopics)</b>
	<ol style="list-style-type: none"> <li>1. DNA isolation and characterization from Animal cell (goat liver)/ Human Blood (Fresh / Stored / Frozen) /Microbes.</li> <li>2. Isolation of total RNA from Yeast</li> <li>3. DNA Fingerprinting: (Using RAPD techniques)</li> <li>4. Isolation of hepatocytes from goat liver, counting and culturing of hepatocytes</li> <li>5. Identification of sequences using FASTA and BLAST</li> <li>6. Phylogenetic analysis of protein and nucleotide sequences &amp; submission of biological sequences (at least 2 of protein sequences &amp; 2 of nucleotide sequences)</li> <li>7. Study of different Biological databases (esp. the ones given below), Format, their distinguishing features, Uses and Applications: <ol style="list-style-type: none"> <li>a. Sequence databases: EMBL, DDBJ, GenBank, UniProt, PIR, TrEMBL</li> <li>b. Domain database: Prosite, PRINT, Pfam, BLOCK</li> <li>c. Structure database: PDB, protein explorer</li> <li>d. Specialized database: KEGG, PUBMED, OMIM</li> </ol> </li> </ol>

<b>Course Code:</b> <b>MSZODE301T</b>	<b>Course Title: Physical and Chemical Oceanography</b>	
Course Credit:4	Total contact hours: 60 Hrs	
<b>Learning Objectives:</b>		
<ul style="list-style-type: none"> <li>➤ Explores the chemical and geological nature of the oceans. Includes a weekly lab. Prerequisites</li> </ul>		
<b>Outcome:</b>		
<ul style="list-style-type: none"> <li>➤ Use an understanding of waves, tides, and coastal processes to explain the development and functioning of beaches, shorelines, and estuaries.</li> <li>➤ Use an understanding of ocean structure and processes to explain the spatial and temporal distribution of biological productivity in the world ocean.</li> <li>➤ Access ocean science information from a variety of sources, evaluates the quality of this information, and compares this information with current models of ocean processes, identifying areas of congruence and discrepancy.</li> <li>➤ Make field and laboratory-based observations and measurements of ocean materials and marine processes, use scientific reasoning to interpret these observations and measurements, and compare the results with current models of ocean processes identifying areas of congruence and discrepancy.</li> </ul>		
<b>Sr. No.</b>	<b>Course Contents (Topics &amp; subtopics)</b>	
<b>1</b>	<b>Unit I: Physical Oceanography -I</b> <b>2.1 Vertical circulation:</b> wind induced circulation, Ekman spiral, Thermohaline circulation and Upwelling of water. <b>2.2 Waves:</b> Characteristics of waves, deep water and shallow water waves, transitional waves, wind generated waves, internal waves. <b>2.3 Tides:</b> Tides generating forces, equilibrium theory of tides, dynamic theory of tides, tides as a source of power. <b>2.4 Currents:</b> Types of currents, geotropic current, major	<b>15 Hrs.</b>

	currents of the world, Coriolis effect and El Nino effect.	
<b>2</b>	<p><b>Unit II: Physical Oceanography -II</b></p> <p><b>1.1 Physical properties of sea water:</b> Salinity, Chlorinity, Temperature, Light, Density, Salinity-Temperature-Density relationship (STD), Pressure.</p> <p><b>1.2</b> General introduction, Classification, overview of marine and atmospheric hazards.</p> <p>1.3. Tsunami, Cyclones, storm surges, floods.</p> <p>1.4. Coastal vulnerability - shore line changes - landslides – earthquakes</p>	<b>15 Hrs.</b>
<b>3</b>	<p><b>Unit III: Chemical Oceanography - I</b></p> <p><b>3.1 Composition of sea water-</b> constancy of its composition and factors affecting the composition, major and minor constituents, trace elements and their biological role.</p> <p><b>3.2 Dissolved gases</b> in the sea water and their role in the environment, Dissolved O<sub>2</sub> and oxygen profile, hydrogen sulphide.</p> <p><b>3.3 Nutrients in the ocean, their cycles and factors influencing their distribution</b> a) Nitrogen b) Phosphorus c) Silicon.</p>	<b>15 Hrs.</b>
<b>4</b>	<p><b>Unit IV: Chemical Oceanography - II</b></p> <p>4.1 Ocean Carbonate system</p> <p>4.2 Ocean biological Carbon pump</p> <p>4.3 Marine sediment - Classifying Sediments, Lithogenous Sediments, Biogenous Sediments, Hydrogenous</p>	<b>15 Hrs.</b>

Sediments, Cosmogenous Sediments, Sediment Distribution 4.4 Chemical Tracers - Stable Isotopes, Radionuclides, Mass Balance	
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**Suggested Readings:**

1. Svedrup, H. U., Johnson, M. W. and R. H. Fleming (1942). The Oceans: Their Physics, Chemistry and General Biology. *Prentice –Hall Inc.*
2. Harold Thurman, Introductory oceanography, Prentice Hall. London.
3. Qasim S.Z., Glimpses of Indian Ocean, Sangum Bodes Ltd. London. Navya Printers, Hyderabad.
4. R. GordobPirje, Oceanography.
5. P. Michal, Ecological methods for field and laboratory investigations.
6. David Ross, Introduction to Oceanography.
7. Carl Schlipper, Research method in marine biology.
8. D.V. Bal and K.V. Rao, Marine fisheries of India, T-M-H.
9. Russel and Young, The Seas
10. Rilcy, J.P. and R, Chester, Introduction to marine chemistry, Academic Press, London and New Delhi.
11. American Public Health Association-2000.
12. Paul Webb. Introduction to Oceanography, <http://rwu.pressbooks.pub/webboceanography>
13. Carpenter, E.J. and D.G. Capone (1983). Nitrogen in the Marine Environment. Academic Press Inc.
14. Hansell, D.A. and C.A. Carlson (2002). Biogeochemistry of Marine Dissolved Organic matter. Academic Press, Elsevier.
15. Cronan, D.S.(2000). Handbook of Marine Mineral Deposits. CRC Press.
16. Encyclopedia of Disaster Management: P. C. Sinha, Anmol, India, 2002.
17. Environmental Hazards-Assessing Risk and Reducing Disasters: K. Smith, 5th Edn, Routledge, 2009.
18. Global Environmental Change: Past, Present and Future: Karl K. Turekian, Prentice Hall; 1 edition, 1996.

19. Jean Ellis Douglas Sherman (2014). Coastal and Marine Hazards, Risks, and Disasters 1<sup>st</sup> Edition. Elsevier.

Srivastava, H. N. (2009). Coastal Hazards. National Book Trust.

<b>Course Code:</b> <b>MSZODE302T</b>	<b>Course Title: Fish, Fishery Science and Planktology</b>	
Course Credit:4	Total contact hours: 60 Hrs.	
<b>Learning Objectives:</b>		
<ul style="list-style-type: none"> <li>➤ A study of exploited populations of fish and other aquatic organisms. Theory and methods of defining fish growth, survival, mortality, abundance, and community interactions will be emphasized.</li> </ul>		
<b>Outcome:</b>		
<ul style="list-style-type: none"> <li>➤ Explain a conceptual model for the population dynamics of a stock.</li> <li>➤ Estimate abundance from mark-recapture and depletion data.</li> <li>➤ Implement an age-length key.</li> <li>➤ Estimate and interpret mortality from catch-at-age data.</li> <li>➤ Estimate and interpret growth from length-at-age data.</li> <li>➤ Fit and interpret stock-recruitment curves.</li> <li>➤ Compute and interpret length frequency summaries and size structure indices.</li> <li>➤ Compute and interpret condition indices.</li> <li>➤ Describe the components of the fisheries management environment and the relationships between those components.</li> </ul>		
<b>Sr. No.</b>	<b>Course Contents (Topics &amp; Subtopics)</b>	
<b>1</b>	<b>UNIT I: Fish and Fisheries Science:</b> <ol style="list-style-type: none"> <li>1. An overview of fish classification as per Francis Day and FAO.</li> <li>2. a) Major commercial fisheries:</li> </ol>	<b>Hrs.</b> <b>15</b>

	<ul style="list-style-type: none"> <li>• Elasmobranchs (shark and ray).</li> <li>• Teleosts (Sciaenoids, Indian salmon, Seer fish, Mackerel, Sardine, Carangids, Tuna, Sole fish, Harpodon, Ribbon Fishfisheries).</li> </ul> <p>b) Crustacean fisheries:</p> <ul style="list-style-type: none"> <li>• Prawns (penaeid and non penaeid)</li> <li>• Shrimps</li> <li>• Lobster and</li> <li>• Crab.</li> </ul> <p>c) Molluscan fisheries.</p>	
	<p><b>UNIT II: Population Dynamics and Socio-economics of fishermen:</b></p> <ol style="list-style-type: none"> <li>1. Population Dynamics: Abundance in population and fishery, Fishery catches and fluctuation, M.S.Y., Optimum Yield, Age Composition, Population Growth, Population Models.</li> <li>2. Socio-economics of fishermen.</li> <li>3. Role of Co-operative fisheries societies, government agencies in extension programme, Fisheries education, Training and extension, Problems of fisheries.</li> </ol>	<p><b>Hrs.</b> <b>15</b></p>
	<p><b>UNIT III: Fish Growth:</b></p> <ol style="list-style-type: none"> <li>1. Isometric and allometric growth, the cube law, analysis of growth check on hard parts (Scale, otolith, vertebrae).</li> <li>2. Measurement of fish: a) Measurement of length and weight b) Morphometric measurements c) Merestic counts d) Biometric index.</li> <li>3. Marking and tagging of fish for growth studies, length-weight relationship.</li> <li>4. Ponderal index and relative condition factor and</li> </ol>	<p><b>Hrs.</b> <b>15</b></p>

	gonadosomatic index.	
	<p><b>UNIT IV: Plankton- Classification, analysis and Indicator species:</b></p> <ol style="list-style-type: none"> <li>1. Classification of Plankton, Adaptation to planktonic life, Factors influencing the distribution and abundance, plankton bloom, patchiness, vertical distribution and red tide.</li> <li>2. Methods of collection, preservation and analysis of plankton.</li> <li>3. Marine algae and plankton in relation to fisheries:Indicator species.</li> <li>4. Marine Bio-deterioration: Fouling and Boring organisms.</li> </ol>	<p><b>Hrs.</b> <b>15</b></p>
<p><b>Suggested Readings :</b></p> <ol style="list-style-type: none"> <li>1. Svedrup et al., The Oceans.</li> <li>2. Nair N.B. and Thampi D.H., Atextbook of marine ecology, T-M-H.</li> <li>3. Harold Thurman, Introductory oceanography, Prentice Hall. London.</li> <li>4. Qasim S.Z., Glimpses of Indian Ocean, Sangum Bodes Ltd. London. Navya Printers, Hyderabad.</li> <li>5. Michael King, Fisheries Biology assessment and management, Fishing News Publishers, 1995.</li> <li>6. R. GordobPirje, Oceanography.</li> <li>7. Newell and Newell, Marine Plankton.</li> <li>8. Jhingran, Fish and fisheries</li> <li>9. P. Michal, Ecological methods for field and laboratory investigations.</li> <li>10. R.V. Tait, Marine zoology, Oxford press.</li> <li>11. David Ross, Introduction to Oceanography.</li> <li>12. Carl Schlipper, Research method in marine biology.</li> <li>13. B.F. Chapgar, Sea Shore life of India, SIDGWICK and JACKSON, London</li> </ol>		



14. D.V. Bal and K.V. Rao, Marine fisheries of India, T-M-H.
15. Russel and Young, The Seas
16. Kurian and Sebastian, Prawn and prawn fisheries of India.
17. M. Krishna Pillai. Introduction to Planktology, Himalaya Publishing
18. A.A. Fincham. Basic marine biology, British Museum Natural History.
19. LathaShenoy. Course manual in fishing technology, CIFE, Versova, Mumbai.
20. Jefferey F. Raymond, Plankton and productivity, Vol. I and II.
21. J.S.Levington, Marine Biology, Function, biodiversity, ecology. Oxford University Press.
22. Wealth of India, Vol. IV, CSIR Publications.
23. S.P. Biswas, Manual of methods in fish biology, South Asian publishers private Ltd.,New Delhi.
24. J.P. Riley and R, Chester, Introduction to marine chemistry, Academic Press, London andNew Delhi.
25. American Public Health Association-2000.
26. J.V.R. Pillai, Aquaculture principles and plasia, Blackwell Scientific pub.
27. Das P. and Jhingran A.C.G., Fish genetics in India.
28. Colin E. Purdon, Genetics and Fish breeding, Chapman and Hall.
29. Schroder J.J., Genetics and Mutagenesis of fish, Chapman and Hall.
30. P. Bensam. Development of marine fishery sciences in India, Daya publishing House.

<b>Course Code:</b> <b>MSZOLB301P</b>	<b>Course Title:Part B - Oceanography and Fishery Science (Practical based MSZODE301 &amp; MSZODE302)</b>
<b>Course Credit:4</b>	Total contact hours: 60 Hrs.
<b>Sr. No.</b>	<b>Course Contents (Topics &amp; subtopics)</b>
	<ol style="list-style-type: none"> <li>1. Laboratory procedure for quantitative estimation of plankton settling method, wet weight method, weight displacement method, counting method.</li> <li>2. Plotting the frequency polygon by ova diameter measurement</li> <li>3. Morphometric study of fish <ol style="list-style-type: none"> <li>A) Study of relationship between total length and standard length/head length/body depth length/body weight.</li> <li>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.</li> </ol> </li> <li>4. Identification of fouling and boring organisms: (<i>Limnoria</i> sps.,<i>Lepas</i>, <i>Balanus</i>, <i>Caprella</i>, <i>Teredo</i>,<i>Littorina</i>, <i>Crassostrea</i>, <i>Pellaria/ Sertularia</i>).</li> <li>5. Identification and classification of Marine fishes : <p style="text-align: center;"><b>List of Marine fishes –</b></p> <p style="text-align: center;"><b>Elasmobranchs</b></p> <ol style="list-style-type: none"> <li>1. Family- Carcharidae -<i>Zygaena malleus</i></li> <li>2. Family-Rhinobatidae<i>Rhynchobatus djeddensis</i></li> <li>3. Family- Trygonidae-<i>Trygonuarnak</i></li> </ol> <p style="text-align: center;"><b>Teleost</b></p> <ol style="list-style-type: none"> <li>4. Family- Percidae-<i>Lutianus johnii</i>,</li> <li>5. Family- Squamipinnes-<i>Scatophagus argus</i>.</li> <li>6. Family – Mullidae -<i>Upenoides vittatus</i></li> <li>7. Family- Polynemidae<i>Polynemus tetradactylus</i></li> <li>8. Family- Sciaenidae-<i>Pseudosciaenadiacanthus</i>,</li> </ol> </li> </ol>

9. Family- Trichuridae -*Trichurussavala/haumela*
10. Family- Carangidae-*Caranxrottileri*,
11. Family- Stromatidae-*Pampuschinensis*,
12. Family- Scombridae-*Rastrelligerkanagurta*,
13. Family- Trachinidae-*Sillagosihama*.
14. Family- Cottidae-*Platycephaluspunctatus*
15. Family-Gobidae- *Boleophthalmussps.*
16. Family- Sphyraenidae-*Sphyraenaacutippinis*
17. Family- Mugillidae-*Mugilsps.*
18. Family- Gadidae -*Bregmacerossps.*
19. Family- Pleuronectidae-*Cynoglossuselongatus*
20. Family- Siluridae-*Arius dussumieri*
21. Family- Scopelidae-*Harpodonnehereus*
22. Family- Sombresocidae-*Belonestongylurus*,
23. Family- Clupeidae-*Clupealongiceps*
24. Family- Chirocentridae-*Chirocentrusdorab*
- 25. Family- Muraenesox-Muraenesoxsps.**

6. Identification and classification of fresh water fishes:(Rohu, Catla, Mrigal, Tilapia, Gourami) and fresh water giant prawn (*Macrobrachiumrosenbergii*).

7. Crustacean fishery:(*Penaeusmonodon*, *P. indicus*, *M. monoceros*, *P. stylifera*, *Solenoceraindica*,*Nematopaleomon*, *Acetesindicus*).

8. Molluscan fishery: (*Meretrixsps.*,*Pernaviridis*, *Katelysiasps.*, *Crassostriasps.*,*Xancuspyrum*, *Solenkempi*,*Cuttle fish* and gastropods).

**Student Activity:**

- a. Collection, preservation, mounting and identification of Zooplankton (At least 2 slides to be submitted).

**Note:**

- 1. Minimum number of animals to be used for experiments.**

**Visit to aquaculture centre, and Marine Biological Institutions**

	<b>(Excursions or study tours).</b>
<b>Course Code:</b> <b>MSZODE303T</b>	<b>Course Title:Comparative Invertebrate Endocrinology</b>
<b>Course Credit:4</b>	<b>Total contact hours: 60 Hrs</b>

**Learner's Objectives:**

- To learn the basic and advanced endocrine biochemistry, physiology and molecular endocrinology which provide the basis for understanding various aspects of endocrinology.
- To accumulate a critical mass of fundamental aspects of applied and biochemical endocrinology.
- To acquire knowledge and skills necessary for the critical analysis of the endocrine literature.
- To conduct scholarly research in molecular endocrinology and homeostatic metabolism.
- To gain hands on experience in order to acquire the knowledge necessary for the critical analysis of the results of endocrine laboratory tests.

**Outcome**

- The students can pursue careers in endocrinology.
- the student may participate in extensive research in molecular endocrinology and physiology.
- Also, they will get deep knowledge of cardiovascular, respiratory, neurological, hepatobiliary, renal and endocrine homeostasis.
- Students will get wide range of job opportunities in various fields of endocrinology and physiology.

Sr. No.	Course Contents (Topics & subtopics)	
1	<b>Unit I: Invertebrate Endocrine Glands and their Hormones.</b> 1.1. Hormones as chemical messengers in Invertebrates. 1.2. Invertebrate endocrine system; Hormones and their functions in (Coelenterata and Annelida). 1.3. Invertebrate endocrine system; Hormones and their functions in (Arthropoda and Echinodermata). 1.4. Scope and role of invertebrate endocrinology.	<b>15 Hrs.</b>

2	<p><b>Unit II: Endocrine control of reproduction in Invertebrates.</b></p> <p>2.1. Regeneration in coelenterates.</p> <p>2.2. Epitokal metamorphosis in polychaetes.</p> <p>2.3. Reproduction in gastropoda and cephalopoda.</p> <p>2.4. Reproduction in echinodermata.</p> <p>2.5. Differentiation of sex in crustaceans.</p> <p>2.6. Parasitic castration and hermaphroditism.</p>	15 Hrs.
3	<p><b>Unit III: Chemistry of Hormones and Mechanism of Hormone Action.</b></p> <p>3.1. Skeletogenesis in larval sea urchin.</p> <p>3.2. Endocrine and neuroendocrine systems of invertebrate deuterostomes</p> <p>3.3. Juvenile and molting hormones in crustacean.</p> <p>3.4. Use and role of invertebrate models in endocrine disruptor research and testing.</p>	15 Hrs.
4	<p><b>Unit IV: Clinical and Applied Endocrinology.</b></p> <p>4.1. Hormones used in sericulture.</p> <p>4.2. Hormones used in apiculture.</p> <p>4.3. Hormones used in shrimp and prawn culture.</p> <p>4.4. Multiple endocrine syndromes-HRT.</p>	15 Hrs.
<p><b>Suggested Readings:</b></p> <p>1. Comparative Endocrinology of Invertebrates, by Kennetil by Highman and Hill.</p> <p>2. John F- Laycock and Peter H. Wise, Essential of endocrinology.</p> <p>3. Wiliamas R.H.(1974), Textbook of endocrinology, V.Ed. Saunders Press, London.</p> <p>4. Endocrinology- Hadley.</p>		

5. General endocrinology, Bragara and Tumer, W.B.Saunders.
6. General and Comparative endocrinology, by E.J.W.Barrington, Oxford Clarendon Press.
7. Benjamin Levin-Gene VII, Oxford University Press.
8. Lodish et al., Molecular Cell Biology.
9. Anthony W. Norman and Gerald Litwack-Hormones-Academic Press, Inc.
10. Endocrinology, Vol.1-3, by Degroot L.J. et al.
11. An Introduction to Invertebrate Endocrinology by A.S. Tombes.

<b>Course Code:</b> <b>MSZODE304T</b>	<b>Course Title: Molecular and Comparative Vertebrate Endocrinology</b>
<b>Course Credit: 4</b>	<b>Total contact hours: 60 Hrs</b>
<b>Learning Objectives:</b>	
<ul style="list-style-type: none"> <li>➤ To learn the basic and advanced endocrine biochemistry, physiology and molecular endocrinology which provide the basis for understanding various</li> </ul>	

aspects of endocrinology

- To accumulate a critical mass of fundamental aspects of applied and biochemical endocrinology.
- To acquire knowledge and skills necessary for the critical analysis of the endocrine literature.
- To conduct scholarly research in molecular endocrinology and Homeostatic metabolism.
- To gain hands on experience in order to acquire the knowledge necessary for the critical analysis of the results of endocrine laboratory tests.
- The students can pursue careers in endocrinology.
- Further the student may participate in extensive research in molecular endocrinology and physiology.
- Also they will get deep knowledge of cardiovascular, respiratory, neurological, hepatobiliary, renal and endocrine homeostasis.

**Outcome:**

- Students will get wide range of job opportunities in various fields of endocrinology and physiology.

<b>Sr. No.</b>	<b>Course Contents (Topics &amp; subtopics)</b>	
<b>1</b>	<b>Unit I: Phylogeny and Ontogeny of Endocrine Glands.</b> 1.1 Thyroid in class Pisces, Amphibia, Reptilia and Mammals. 1.2 Pancreas in class Pisces, Amphibia, Reptilia and Mammals. 1.3 Adrenals in class Pisces, Amphibia, Reptiles and Mammals.	<b>15 Hrs.</b>



2	<p><b>Unit II: Organization of Endocrine Systems.</b></p> <p>2.1 Endocrine systems and historical perspective</p> <p>2.2 Multidimensional importance of comparative endocrinology</p> <p>2.3 Hypothalamus and its secretions</p> <p>2.4 Vertebrate endocrine glands- structure, hormones and functions of Pituitary, Pineal, Thyroid, Parathyroid and adrenal</p> <p>2.5 Vertebrate endocrine glands- Structure, hormones and functions of Pancreas, Thymus, Testis, Ovary and gastrointestinal tract.</p>	15 Hrs.
3	<p><b>Unit III: Mechanism of Hormone Actions.</b></p> <p>3.1 Hormones those act at the cell surface</p> <p>3.2 Hormones those act on the nuclear receptors</p> <p>3.3 Prostaglandins</p> <p>3.4 Eicosanoids</p>	15 Hrs.
4	<p><b>Unit IV: Physiological Roles of Hormones</b></p> <p>4.1 Secondary messenger system, Pheromones as a diverse group of chemical messengers</p> <p>4.2 Hormones and homeostasis, Neuroendocrine integration in homeostasis.</p> <p>4.3 Hormones and athletic performance</p> <p>4.4 Aging and endocrinology</p>	15 Hrs.
<p><b>Suggested Readings:</b></p> <ol style="list-style-type: none"> <li>1. Barington(1979), Hormones &amp; evolution Vol. I &amp; II, Academic press, New York.</li> <li>2. John F- Laycock and Peter H.Wise, Essential of endocrinology.</li> <li>3. Wiliamas R.H.(1974), Textbook of endocrinology, V.Ed. Saunders Press,</li> </ol>		

London.

4. Endocrinology- Hadley.

5. General endocrinology, Bragara and Tumer, W.B.Saunders.

6. The Physiology of Reproduction, Vol. I & II, E.K. Nobil and J.U.D. Neil, Raven Press, New York. 1988.

7. Benjamin Levin - Gene VII, Oxford University Press.

8. Lodish et al., Molecular Cell Biology.

9. Anthony W. Norman and Gerald Litwack - Hormones - Academic Press. Inc.

<b>Course Code:</b> MSZOLB301P	<b>Course Title: Part C – Endocrinology</b> (Practical based on MSZODE303 & MSZODE304)
<b>Course Credit:</b> 2	<b>Total Contact Hours</b> 60
<b>Sr. No.</b>	<b>Course Contents: Topics and subtopics.</b>
	<ol style="list-style-type: none"><li>1. Study/ Observation of In situ demonstration of Endocrine glands of Crab and Prawn.</li><li>2. Study/ Observation of allectomy in Cockroach.</li><li>3. Study/Observation of effect of eye stalk ablation in Crabs.</li><li>4. Effect of eye stalk ablation on Blood glucose levels in Crabs.</li><li>5. Study/Observation of Reproductive system of Crab (male/female).</li></ol>

<b>Course Code:</b> <b>MSZOG301T</b>	<b>Course Title: Economic Zoology</b>	
Course Credit:2	Total contact hours: 30 Hrs.	
<p><b>Learning Objectives:</b></p> <ul style="list-style-type: none"> <li>➤ To aware the students about economic significance of different types of animals</li> <li>➤ To impart knowledge of useful and harmful animals.</li> <li>➤ To familiarize the students with entrepreneurial opportunities in culture of commercial important animals.</li> <li>➤ To familiarize the students about different house hold pests, stored grain pests, medically important pests and ornamental plant pests and nature of damage by them.</li> </ul>		
<p><b>Outcome:</b></p> <ul style="list-style-type: none"> <li>➤ After completion of course students can think to start their business to obtain useful products from animals by culturing them.</li> <li>➤ Students will get the idea of commercial importance of animals and their byproducts.</li> <li>➤ Students will be able to identify household pests, furniture pests, store grain pests, ornamental plant pests and medically important pests and can avoid economic losses due to them.</li> </ul>		
<b>Sr. No.</b>	<b>Course Contents (Topics &amp;Subtopics)</b>	
<b>1</b>	<p><b>Unit I:</b></p> <ol style="list-style-type: none"> <li>1. Sponge culture and economic importance of sponges.</li> <li>2. Economic importance of corals.</li> <li>3. Economic importance of Annelida and Mollusca.</li> <li>4. Insects of commercial importance : <ol style="list-style-type: none"> <li>1) Honey bee (Apiculture)</li> <li>2) Silkworm</li> </ol> </li> </ol>	<b>Hrs.</b> <b>15</b>

	<p>3) Lac insect ( Lac Culture)</p> <p>5. Economic importance of arachnida and crustacea</p> <p>6. Economic importance of amphibians, reptiles and birds.</p>	
<b>2</b>	<p><b>Unit II:</b></p> <p>1. Wool and fur industry.</p> <p>2. Pharmaceuticals from animals.</p> <p>3. Economic importance of termites</p> <p>4. House hold pests: Cockroach, Cricket, Silverfish, Book louse, Furniture beetle.</p> <p>5. Economic importance of Goat/sheep breeds in meat industry.</p> <p>6. Different government schemes supporting the integrated agricultural business.</p>	<b>15 Hrs.</b>

### **Suggested Readings**

1. Economic Zoology-Shukla and Upadhaya
2. Economic Zoology-P.D.Srivastava
3. Economic Zoology-K.R.Ravindranathan
4. Textbook of Economic Zoology- P.R.Venkitaraman
5. A Handbook on Economic Zoology, Dr JawaidAhsanAndDr.Subhas Prasad Sinha S. ChandGroup.
6. Economic Zoology, G.S Shukla and V. B Upadhyay. Rastoi Publications
7. Encyclopaedia of Economic Zoology, A.A. Khan. Anmol Publications
8. Economic Zoology by. ManjuYadav, Discovery Publishing House Pvt. Limited.
9. Economic Zoology by Malhotra,Prakash, AdhyayanPuhlshers& Distributers
10. A text book of Applied Entomology, vol.2 - K. P. Srivastava, 1996.
11. Agricultural Pests of India and South East Asia – A.S. Atwal, 1993.
12. Beekeeping in India, ICAR, New Delhi, S. Singh, 1975.
13. A handbook of practical Sericulture, CSB, Ullal and Narsimhanna, 1981.
- 14.11. Lac culture in India farm information unit, DEMOFA, New Delhi, S. Krishnaswami,

<b>Course Code:</b> <b>MSZOAE301T</b>	<b>Course Title: Presentation Skills</b>	
Course Credit:2	Total contact hours: 30 Hrs	
<b>Course Objectives:</b>		
<ul style="list-style-type: none"> <li>➤ The Learners will learn the presentation skills which are crucial nowadays.</li> <li>➤ They will learn different traditional and unconventional methods for enhancing and perfecting presentation skills.</li> <li>➤ The learners will learn to structure a presentation, use perfect verbal language and pays significant attention to body language during presentations</li> <li>➤ They will also learn to create and stabilize the relation between the him/her and the audience.</li> </ul>		
<b>Course Outcome:</b>		
<ul style="list-style-type: none"> <li>➤ The students will develop the skills to present oneself in a job interview, which are crucial for the success in society and professional environments.</li> <li>➤ They will be able to present a certain idea or knowledge in the most effective manner to the audience.</li> <li>➤ They will be able to win the audience, by keeping its attention, show emotional intelligence, and manage his /her emotions and to recognize and manage the emotions of the audience.</li> <li>➤ They will develop methods to improve presentation skills necessary for coping with the challenges of the modern requirements to be a successful presenter.</li> </ul>		
<b>Sr. No.</b>	<b>Course Contents (Topics &amp; subtopics)</b>	
<b>1</b>	<b>Unit 1:</b> Introduction, Planning & Structuring of a presentation. 1.1.Key elements of a successful presentation-understandable, memorable and emotional, 1.2. Different types of presentation- Informative,	<b>15 Hrs.</b>

	<p>Demonstrative, Persuasive, Decision making.</p> <p>1.3. Planning- main aim of presentation, planning &amp; deciding on the type of presentation</p> <p>1.4. Structuring - Organizing and gathering presentation material.</p> <p>1.5. Writing of presentation- Introduction, Main content, conclusion, transitions.</p>	
<b>2</b>	<p><b>Unit 2:</b> Preparation, management of presentation</p> <p>2.1. Preparing for presentation—Types of venues, use of visual aids, Flip charts, hand outs.</p> <p>2.2. Use of White boards &amp; Interactive white boards</p> <p>2.3. Computer presentation programmes, videos.</p> <p>2.4. Managing the presentation—communicating with the audience(First impression, Eye contact, body language, Volume, Pace, Voice, Language)</p> <p>2.5 Interacting with audience(dealing with questions). Dealing with nerves(controlling nervousness)</p> <p>2.6. Presentation checklist -Pre-planning, Planning, Practise, Delivery, After delivery.</p>	<b>15 Hrs.</b>
<p><b>Suggested Reading:</b></p> <ol style="list-style-type: none"> <li>1. University of Edinburgh English Language Teaching Centre Improving your Presentation SkillsIndependent Study version.</li> <li>2. Methods for perfecting presentation skills Daniela N. Ilieva- Koleva VUZF University.</li> <li>3. The OCR Guide to Presentation Skills.</li> </ol>		

**Dr.Homi Bhabha State University**  
**The Institute of Science**  
**Madam Cama Road, Mumbai, 400032**  
**M.Sc. Zoology Semester I/II/III/IV (Year) Theory Examination**  
**Subject Code: (CC/ID/SEC/DSE)**  
**Title of Paper: .....**

**Day/Date**

**Time Slot: 2 Hrs.**  
**Total Marks 60**

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**Instructions: i) Attempt all questions**

**ii) Each Questions carry equal marks (12 marks)**

**iii) Draw neat and labeled diagrams wherever necessary.**

Q. 1. (Based on Unit I)		12
	Or	
Q. 1. A. (Based on Unit I)		06
B. (Based on Unit I)		06
Q. 2. (Based on Unit II)		12
	Or	
Q. 2. A. (Based on Unit II)		06
B. (Based on Unit II)		06
Q. 3. (Based on Unit III)		12
	Or	
Q. 3. A. (Based on Unit III)		06
B. (Based on Unit III)		06
Q. 4. (Based on Unit IV)		12
	Or	
Q. 4. A. (Based on Unit IV)		06
B. (Based on Unit IV)		06
Q. 5. Attempt any 04 out of 08 questions based on entire syllabus.		
A.		03
B.		03
C.		03
D.		03
E.		03
F.		03
G.		03
H.		03

**Dr.Homi Bhabha State University**  
**The Institute of Science**  
**Madam Cama Road, Mumbai, 400032**  
**M.Sc. Zoology Semester I/II/III/IV (Year) Theory Examination**  
**Subject Code: (AEC/GE)**  
**Title of Paper: .....**

**Day/Date**

**Time Slot: 1 Hrs.**  
**Total Marks 30**

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**Instructions:** *i) Attempt all questions*  
*ii) Each Questions carry equal marks (12 marks)*  
*iii) Draw neat and labeled diagrams wherever necessary.*

Q. 1. (Based on Unit I)		12
	Or	
Q. 1. A. (Based on Unit I)		06
B. (Based on Unit I)		06
Q. 2. (Based on Unit II)		12
	Or	
Q. 2. A. (Based on Unit II)		06
B. (Based on Unit II)		06
Q. 3. Attempt any 02 out of 04 questions based on entire syllabus.		
A.		03
B.		03
C.		03
D.		03



**Dr.Homi Bhabha State University**  
**The Institute of Science**  
**Madam Cama Road, Mumbai, 400032**  
**M.Sc. Zoology Semester I (Year) Practical Examination**  
**Subject Code: MSZOLB301P**

**Title of Paper: Part A – Molecular Biology, Genetic Engineering and Bioinformatics**  
**Day** **Time Slot: 3 Hrs.**  
**/Date** **Total Marks 50**

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**Q. 1.** Isolate the DNA from the given sample leaf of cabbage / mustard/goat liver/Human Blood (Fresh / Stored / Frozen) / E.coli. 15

Or

**Q. 1.** Perform DNA Fingerprinting by RAPD technique 15

**Q. 2.** Isolate the RNA from the given sample of yeast. 10

Or

**Q. 2.** Isolate hepatocytes from goat liver, and streak for culturing. 10

**Q. 3.** Identify the given unknown sequence with BLAST/FASTA and submit the report to the examiners. 10

Or

**Q. 3.** Perform the Phylogenetic analysis of the given protein /nucleotide sequences and submit the biological sequence to the examiners 10

**Q. 4.** Viva 05

**5.** Journal 10

\*Candidates are required to present certified journal on the day of practical examination.

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**M.Sc. Zoology Semester I (Year) Practical Examination**  
**Subject Code: MSZOLB301P**  
**Title of Paper: Part B – Oceanography and Fishery Science**

Day /Date	Time Slot: 3 Hrs. Total Marks 50
Q. 1. Major	
(A) Fish identification(1 from Elasmobranch, 4 from Teleost)	15
(B)Fish identification as per Francis day volume.	05
Q. 2. Laboratory procedure for quantitative estimation of plankton settling method / wet weight method / weight displacement method / counting method.	08
Or	
Q. 2. Plotting the frequency polygon by ova diameter measurement.	08
Or	
Q. 2. Calculate correlation between standard length and total length / head length and total length / body depth and totallength (from provided data).	
Q.3. Identification and describe.	08
A. Fouling and boring organism,	
B. Crustacean fishery,	
C. Molluscan fishery,	
D. Freshwater fishery	
Q. 4. Zooplankton slide submission. (2 slides)	04
Q.5.	Viva
Voce	05
Journal	05
	Q. 6.

\*Candidates are required to present certified journal on the day of practical examination.

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**M.Sc. Zoology Semester I (Year) Practical Examination**  
**Subject Code: MSZOLB301P**  
**Title of Paper: Part C – Endocrinology**

<b>Day /Date</b>	<b>Time Slot: 3 Hrs. Total Marks 50</b>
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Q. 1. Demonstrate/study any endocrine gland in crab/Prawn. 10

Q. 2. Demonstrate/describe allectomy in Cockroach 10

Q. 3. Demonstrate the effect of eye stalk ablation on blood glucose in crabs. 15

Or

Q. 3. Demonstrate/ observation of male/female reproductive system of crab. 15

Q. 4. Viva voce 05

Q. 5. Journal 10

\*Candidates are required to present certified journal on the day of practical examination.

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**M.Sc. Zoology Semester I (Year) Practical Examination**  
**Subject Code: MSZOPR301P**  
**Title of Paper: Project**

<b>Day /Date</b>	<b>Time Slot: 3 Hrs. Total Marks 100</b>
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Q. 1. Assignment 40

Q. 2. Project proposal A. Submission 40

B. Presentation 20



**Dr. HOMI BHABHA STATE UNIVERSITY, MUMBAI**

**The Institute of Science,**

**15, Madam Cama Road, Fort, Mumbai**

**– 400032**

**Program: M.Sc.**

**Course: Zoology**

**Syllabus for Semester IV**

**(Choice based credit system with effect from the academic  
year 2020-2021)**



## Structure of the M.Sc. Zoology (Sem IV)

SEM	Core Courses	DSE/ID/P	SEC	Non-CGPA Credits	Total Credits
IV	MSZOCC401T Animal Physiology	MSZODE401T General and Biological Oceanography or MSZODE403T Male Reproductive Physiology and Medical Endocrinology	MSZOSE401T  Aquaculture	MOOCs, CO- /Extra- Curricular Activities etc.	CC: 4*2=8 DE:4*2=8  SE:4*1=4 LB: 1*4 = 4 PR:1*4 = 4  <b>Total = 28</b>
	MSZOCC402T Ecology	MSZODE402T Fish Anatomy, Pathology and Fish Processing or MSZODE404T Female Reproductive Physiology and Neurobiology			
	MSZOLB401P Part A – Animal Physiology and Ecology (Based on MSZODE401 & MSZODE402)	MSZOLB401P Part B – Spl. Oceanography and Fishery Science (Based on MSZODE401 & MSZODE402) Or MSZOLB401P Part C – Spl. Endocrinology (Based on MSZODE403 & MSZODE404)			
	MSZOPR401P				

S.no	Paper code	Papers	Units	१	२	३	४	५
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### **Scheme of marking and examination**

								Theory					Practical		
								Maxi. Marks (Theory)	Maxi. Marks (Internal)	Total Marks	Min. Passing Marks	Duration Hrs.	Max. Marks (Practical)	Total Marks	Min. Passing marks
1	CC401	Animal Physiology	4	4	0	4	4	60	40	100	40	2.5	-	-	-
2	CC402	Ecology	4	4	0	4	4	60	40	100	40	2.5	-	-	-
3	DE401	General and Biological Oceanography	4	8	0	8	8	60	40	100	40	2.5	-	-	-
4	DE403	Male Reproductive Physiology and Medical Endocrinology													
5	DE402	Fish Anatomy, Pathology and Fish Processing	4	8	0	8	8	60	40	100	40	2.5	-	-	-
6	DE404	Female Reproductive Physiology and Neurobiology													
7	SE401	Aquaculture	4	4	0	4	4	60	40	100	40	2.5	-	-	-
8	PR401	Oceanography or Endocrinology	8	-	32	32	32	-	-	-	-	-	200	200	80
		<b>Total</b>	28	28	32	60	60	300	200	500	200	12.5	200	200	80
<b>Grand Total Semester IV: 700</b>															





<b>Course Code:</b> <b>MSZOCC401T</b>	<b>Course Title: Animal Physiology</b>	
<b>Course Credit:4</b>	<b>Total contact hours: 60 Hrs.</b>	
<b>Learning Objectives:</b>		
<ul style="list-style-type: none"> <li>➤ The major aims of this course are to provide students with a basic understanding of the fundamental processes and mechanisms that serve and control the various functions of the body.</li> </ul>		
<b>Outcome:</b>		
<ul style="list-style-type: none"> <li>➤ Understand the levels of organization within invertebrates and vertebrates.</li> <li>➤ Understand the function of the main systems that support multicellular life.</li> <li>➤ Relate these processes to the physiological functioning of whole organisms.</li> <li>➤ Understand how animals adapt to their environment Perform a range of laboratory techniques important to the study of cellular / physiological processes; and present and interpret results clearly.</li> </ul>		
<b>Sr. No.</b>	<b>Course Contents (Topics &amp; subtopics)</b>	
<b>1</b>	<b>Unit I: Cellular Physiology :</b> <ol style="list-style-type: none"> <li>1. <b>Biological membranes:</b> Movement of molecules across cell membranes, Osmosis, Body fluids. Oligomeric membrane ionophores and membrane proteins in invertebrate and vertebrates models, LDL as a model recognition site.</li> <li>2. <b>Homeostasis:</b> Positive and negative feedback, General patterns of acclimation, Precht and Prossers pattern of temperature tolerance, Temperature regulation in animals living in high and low temperatures, Role of brown fat in temperature regulation.</li> <li>3. <b>Osmoregulation:</b> Concepts of osmoregulation, Osmoregulation in animals of aquatic and terrestrial environments. Excretory patterns and osmoregulation. Role of</li> </ol>	<b>Hrs.</b> <b>15</b>

	renal and extra renal tissues in osmoregulation.	
	<p><b>Unit II: System Physiology:</b></p> <ol style="list-style-type: none"> <li>1. Blood and body Fluids: Blood and its components, Heart cycle, Electrical Properties of the heart, ECG, Control of cardiac output. Vascular system, Regulation of arterial blood pressure.</li> <li>2. Respiration: Gas exchange and mechanism of respiration in invertebrates and vertebrates oxygen curves and control of respiration.</li> <li>3. Gastrointestinal system: Motility, secretion and absorption of nutrients, carbohydrate, protein and fat digestion. Role of dietary fiber in digestion. Nutritional disorders. Ruminant and non-ruminant digestive patterns, Endoparasitism with reference to appendicitis.</li> </ol>	<b>Hrs. 15</b>
	<p><b>Unit III: Physiology of high altitude:</b></p> <ol style="list-style-type: none"> <li>1. Effects of acute exposure to high altitude, to Respiratory changes, Physiological polycythemia, Exercise at high altitude.</li> <li>2. Stress physiology–basic concept of stress &amp; strain, strain resistance, stress avoidance and tolerance</li> <li>3. Neuroendocrine &amp; physiological responses to stress in animals. Hormesis, relevance of stress specificity.</li> </ol>	<b>Hrs. 15</b>

	<p><b>Unit IV: Exercise Physiology:</b></p> <ol style="list-style-type: none"> <li>1. Physiology of Exercise, Circulatory changes in muscular exercise, Blood pressure during exercise, Respiratory responses to exercise.</li> <li>2. Types of exercise, Response of muscle to exercise Endocrine response to exercise. Fatigue- induced biochemical and physiological changes.</li> <li>3. Role of Meditation, Yoga and their effects.</li> </ol>	<p><b>Hrs.</b> <b>15</b></p>
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**Suggested Readings :**

1. Eckert, Marsall; Animal Physiology Mechanism and Adaptations, 2002.
2. Eckert & Randall; Animal Physiology (CBS), 2nd Ed, 2000.
3. Ganong; Review of Medical Physiology (21st Ed.), Lang Medical Publications, 2003.
4. Gordon M; Animal Physiology, Macmillan & Co.; First edition (1972).
5. Guyton and Hall; Text Book of Medical Physiology (10th Ed.), (W.B. Saunders), 2001.
6. A.C. Guyton ; Human Physiology, Saunders Company London, Toronto.
7. Heil E and Joets N.; Physiology, ( Oxford University Press) 1982.
8. Hill R.W ; Comparative Physiology of Animals, Sinauer Associates) Third edition.
9. Hoar W.S.; General and Comparative Physiology, ( Prentice – Hall) 1983
10. Houssay, Human Physiology, McGraw Hill Books Company, Second edition.
11. Hutchinson; Hunter and Bomford, Hutchinson's Clinical Methods, (Lippincott).
12. Hurst J.W et al (eds); The Heart 7th ed. New York McGraw- Hill Book Co. 1990.
13. Keel et al: Samson Wright's Applied Physiology (13th Ed.), Oxford Press, 1989.

14. Mill Peter J.; Comparative Neurobiology (Ed. Harbord London)
15. Murray et al; Harper's Illustrated Biochemistry (26th Ed.), Appleton & Lange, 2003.
16. Philips JG.; Environmental Physiology, (Blackwells)  
Prosser C.L.; Comparative Animal Physiology(WB Saunders Company)
17. Randall D, Burggren W and French K, Eckert Animal Physiology, WH Freeman and Co, New York.
18. Shepherd G.M.;Neuro Biology, New York Oxford University Press 1987.
19. Smith, Patterson; Text Book of Physiology (ELBS, Read & Scratched) 1988, 11th Ed.
20. West: Best and Taylor's Physiological Basis of Medical Practice (11th Ed.), (Williams and Wilkins) 1981.
21. Wilson J.A., Principles of Animal Physiology (McMillan, N.Y) 2nd edition. Withers P, Comparative Animal Physiology, Saunders College Publications.

<b>Course Code:</b> <b>MSZOCC402T</b>	<b>Course Title: Ecology</b>	
<b>Course Credit:4</b>	<b>Total contact hours: 60 Hrs.</b>	
<b>Learning Objectives:</b>		
<ul style="list-style-type: none"> <li>➤ TO understand concepts of ecology</li> <li>➤ To understand interactions and effect of environmental factors on each other.</li> <li>➤ To aware about population ecology and current status of forest ecosystem of country!</li> </ul>		
<b>Outcome:</b>		
<ul style="list-style-type: none"> <li>➤ Fundamental knowledge about the three E's of sustainability: environment, economics and equity.</li> <li>➤ Communication abilities to share information with technical and non-technical audiences.</li> <li>➤ Methodological training for generating and analyzing data needed to investigate, explain and mitigate ecological issues and problems.</li> <li>➤ Critical thinking skills for understanding and confronting problems that involve the intersection between the natural and human worlds at multiple scales.</li> </ul>		
<b>Sr. No.</b>	<b>Course Contents (Topics &amp; subtopics)</b>	
<b>1</b>	<b>Unit I: Ecological Concepts.</b> 1.1 Basic concepts and scope of Ecology 1.2 Multidisciplinary nature and relevance-Ecosystem concept. 1.3 Organization and significance-Biosphere concept. 1.4 Organization and significance-Cybernetic nature of ecosystems.	Hrs. 15

	1.5 Ecological Succession: Types and Patterns of succession, Climax.	
	<p><b>Unit II: Factors affecting ecosystem.</b></p> <p>2.1 Major environmental factors (biotic and abiotic) influencing organisms in various ecosystems.</p> <p>2.2 Concept of limiting factors;</p> <p>2.2.1 Liebig's law of the minimum</p> <p>2.2.2 Shelford law of tolerance</p>	Hrs. 15
	<p><b>Unit III: Community ecology.</b></p> <p>3.1 Community concept; Individualistic and organismic nature of communities</p> <p>3.2 Qualitative and quantitative characters of community</p> <p>3.3 Types of Ecological niche</p> <p>3.4 Methods of studying vegetation</p> <p>3.5 Diversity Index: Simpson's, Shannon and Pielouseveness</p>	Hrs. 15
	<p><b>Unit IV: Forest and forest environment.</b></p> <p>4.1 Structure of forest ecosystem</p> <p>4.2 Forest microclimate</p> <p>4.3 Forest types of India with special reference to Western ghat and North East India</p> <p>4.4 Forest and Tree cover of India</p>	Hrs. 15

	4.5 Sampling designs in forest inventory	
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### **Suggested Readings:**

1. Ambasht R. S. and Ambasht, N. K. (2008) Text Book of Plant Ecology (15th edn.). CBS Publishers and Distributers, New Delhi. Colbert, E.M. (1996)
2. Evolution of the Vertebrates: A History of Backboned Animals through Times. Wiley Eastern Ltd., New Delhi. Dobzhansky, T. (1973)
3. Genetics and the Origin of Species. Oxford & IBH Publishing Co. Gupta, P.K. (1990)
4. Cytology, Genetics, Evolution and Ecology. Rastogi Publications, Meerut. Kormondy, E. J. (1996)
5. Concepts of Ecology (4th edn.). Prentice-Hall of India Pvt. Ltd. Krebs, C. J. (1985)
6. Ecology: The Experimental Analysis of Distribution and Abundance. Harper and Row, New York. Lull, R.S. (1976)
7. Organic Evolution. (revised edn.) Suma Publications, Delhi. Odum, E.P. and Barrett, G.W. (2005)
8. Fundamentals of Ecology (5th edn.). Thompson. Singh, J.S; Singh, S.P. and Gupta S.R. (2014)
9. Ecology, Environmental Science and Conservation. S.Chand& Company Pvt.Ltd. New Delhi.
10. Brewer, R. (1994) Principles of Ecology. Saunders College Publishing, London. Chiras, D.D. (2012)
11. Environmental Science (9th edn.). Jones and Barlett Learning. Dash, M.C. and Dash, S.P. (2009)
12. Fundamentals of Ecology (3rd edn.). Tata McGraw-Hill Publishing Co., New Delhi. Nobel, B.J. and Wright, R.T. (1995)
13. Environmental Science. Prentice Hall. Santra, S.C. (2005)
14. Environmental Science (2nd edn.). Central Book Agency, Calcutta

<b>Course Code:</b> MSZOLB401P	<b>Course Title: Part A- Animal Physiology and Ecology (Practical based on MSZOCC401 &amp; MSZOCC402:)</b>	
<b>Course Credit:2</b>	<b>Total contact hours: 60 Hrs</b>	
<b>Sr. No.</b>	<b>Course Contents (Topics &amp; subtopics)</b>	
<b>1</b>	<ol style="list-style-type: none"> <li>1. Study of blood pressure, pulse rate and breathing rate during rest and exercise.</li> <li>2. Measurement of ascorbic acid in blood and urine.</li> <li>3. Effect of pH, temperature and incubation on human salivary amylase activity.</li> <li>4. Determination of protein, glucose in Urine from normal and diabetic patient.</li> <li>5. Determination of organic matter present in sediment.</li> <li>6. Estimation of primary productivity by light and dark bottle.</li> <li>7. <b>Textural features:</b> Sediment analysis- size fraction (sand, silt, clay)</li> <li>8. To calculate the relative density of species by using square quadrat method.</li> </ol>	

<b>Course Code:</b> <b>MSZODE401T</b>	<b>Course Title: General and Biological Oceanography</b>	
Course Credit:4	Total contact hours: 60 Hrs	
<b>Course objectives:</b>		
<ul style="list-style-type: none"> <li>➤ To understand what controls the abundances, kinds, and temporal variation of organisms in the sea.</li> <li>➤ Teaching programs are oriented toward a mechanistic understanding of processes.</li> <li>➤ To this end we employ a variety of approaches including field observations, laboratory experiments and theoretical models.</li> </ul>		
<b>Course Outcomes:</b>		
<ul style="list-style-type: none"> <li>➤ Students should be able to provide major definitions and explain key concepts in the field of biological oceanography by their own words.</li> <li>➤ Students should gain knowledge on important ocean environments and ecosystems and should train to describe the key role of the oceans in the earth's environment.</li> <li>➤ Students should be aware of the impact of biotic and abiotic factors on marine organisms</li> </ul>		
<b>Sr. No.</b>	<b>Course Contents (Topics &amp; subtopics)</b>	
<b>1</b>	<p><b>Unit I: Ocean topography and Remote sensing</b></p> <p><b>1.1 Terminology of submarine topography:</b> Continental shelf, continental slope, Continental Rise, submarine canyons, Sea Fans, submarine mountain ranges, Reefs, Guyots and trenches with special reference to the Indian Ocean and adjacent seas.</p> <p>1.2 A general knowledge of typical oceanographic research vessel and</p>	<b>15 Hrs.</b>

	<p>its equipment, oceanographic labs and stations of the world and India.</p> <p>1.3 Introduction to Remote Sensing &amp; Satellites Electro-magnetic Radiation, Concept of Remote Sensing, Types of Remote Sensing, Polar orbital &amp; Geostationary satellites, Sensors and platforms.</p>	
<b>2</b>	<p><b>Unit II: Oceanographic tools</b></p> <p><b>2.1 Oceanographic instruments:</b></p> <p>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, SCUBA apparatus.</p> <p><b>2.2 Oceanographic Expeditions:</b> Challenger, Indian Ocean and Antarctic.</p> <p><b>2.3 Laws of sea.</b></p>	<b>15 Hrs.</b>
<b>3</b>	<p><b>Unit III: Biological Oceanography - I</b></p> <p><b>3.1 Sea as a biological environment.</b></p> <p><b>3.2 Division of marine environment.</b></p> <p><b>3.3</b> a) Marine biotic diversity: Plankton, Nekton, Benthos- brief account, Implications of species richness, measuring diversity, quadrants of species diversity, models explaining diversity gradient.</p> <p>b) Intertidal organisms and their zonation.</p> <p><b>3.4 Effect of physical factors on marine life</b></p> <p>a) Light: photosynthesis, coloration, structural adaptations, bioluminescence.</p>	<b>15 Hrs.</b>

	<p>b) Temperature: tolerance, geographical distribution, size, calcium precipitation, metabolism, bipolarity, tropical submergence and periodicity.</p> <p>c) Salinity: tolerance and distribution, size, buoyancy and osmoregulation.</p> <p>d) Currents: role in nutrition, transportation and propagation.</p> <p>e) Marine bacteria and their role.</p>	
<b>4</b>	<p><b>UNIT IV: Biological Oceanography - II</b></p> <p><b>4.1 Resources from the sea:</b></p> <p>4.1.1 Mineral resources:</p> <p>a) Continental margin.</p> <p>b) Deep sea mud oozes and manganese nodules.</p> <p>c) Oil, gas and Sulphur deposits and role of ONGC.</p> <p>4.1.2 Bioactive compounds from the sea.</p> <p>4.1.3 Scientific and economical aspect of seabed exploration and mining.</p>	<b>15 Hrs.</b>

**Suggested Reading:**

1. Svedrup et al., The Oceans.
2. Nair N.B. and Thampi D.H., A textbook of marine ecology, T-M-H.
3. Harold Thurman, Introductory oceanography, Prentice Hall. London.
4. Qasim S.Z., Glimpses of Indian Ocean, Sangum Bodes Ltd. London. Navya Printers, Hyderabad.
5. R. GordobPirje, Oceanography.
6. Newell and Newell, Marine Plankton.
7. P. Michal, Ecological methods for field and laboratory investigations.
8. R.V. Tait, Marine zoology, Oxford press.
9. David Ross, Introduction to Oceanography.
10. Carl Schlipper, Research method in marine biology.
11. B.F. Chapgar, Sea Shore life of India, SIDGWICK and JACKSON, London
12. Russel and Young, The Seas
13. M. Krishna Pillai. Introduction to Planktology, Himalaya Publishing
14. A.A. Fincham. Basic marine biology, British Museum Natural History.
15. Latha Shenoy. Course manual in fishing technology, CIFE, Versova, Mumbai.
16. Jefferey F. Raymond, Plankton and productivity, Vol. I and II.
17. J.S. Levington, Marine Biology, Function, biodiversity, ecology. Oxford University Press.
18. Wealth of India, Vol. IV, CSIR Publications.

<b>Course Code:</b> MSZODE402T	<b>Course Title: Fish Anatomy, Pathology and Fish Processing</b>	
<b>Course Credit:4</b>	<b>Total contact hours: 60 Hrs.</b>	
<b>Learning Objectives:</b>		
<ul style="list-style-type: none"> <li>➤ This course aimed to understand fish anatomy</li> <li>➤ This course aimed to understand fish pathology and its management</li> <li>➤ This course also highlights various fish processing technologies</li> </ul>		
<b>Outcome:</b>		
<ul style="list-style-type: none"> <li>➤ After completing the course: Students will be able to understand anatomy and physiology of fish.</li> <li>➤ Students will also able to identify health status of fish and their diseases causing agents.</li> <li>➤ Students will also be learned to manage fish diseases from range of pathogenic infections.</li> <li>➤ Students will also be learned fish processing techniques, handling of processed fishes.</li> </ul>		
<b>Sr. No.</b>	<b>1.Course Contents (Topics &amp; subtopics)</b>	
<b>1</b>	<p><b>Unit I: Fish anatomy:</b></p> <ol style="list-style-type: none"> <li>1. Morphology of skin, coloration, scales, mouth, jaws, teeth, fin and fin rays and their taxonomic importance.</li> <li>2. Internal anatomy of a typical elasmobranch and Teleost fish: Alimentary canal and associated structure, Respiratory and accessory respiratory organs, Heart and circulatory system, Reproductive system, sense organs, Lateral line system, skeletal system.</li> </ol>	<b>Hrs.</b> <b>15</b>

2	<p><b>Unit II: Fish Pathology</b></p> <p><b>Causative agents, symptoms, prophylaxis and histopathological studies of diseases. Biology, morphology and clinical signs associated with pathogen.</b></p> <p><b>3.1. Protozoan Disease:</b></p> <p>3.1.1. Brackish water and marine water finfish – White spot disease <i>Ichthyophthirius multifiliis</i></p> <p>3.1.2. Shellfishes - Dermo Disease of Oysters</p> <p>3.1.3. Crustaceans – <i>Zoothamnium rigidium</i> infection in prawn</p> <p><b>3.2. Viral Disease:</b></p> <p>3.2.1. Brackish water and/or marine water finfish - Infectious pancreatic necrosis virus (IPNV)</p> <p>3.2.2. Shellfishes - <i>Tellina Virus</i></p> <p>3.2.3. Crustaceans - White Spot Syndrome Virus (WSSV) in shrimps</p> <p><b>3.3. Bacterial Disease:</b></p> <p>3.3.1. Brackish water and marine water finfish - <i>Black Gill Disease</i></p> <p>3.3.2. Shellfishes - Vibrosis</p> <p>3.3.3. Crustaceans - Rickettsial diseases in shrimp</p> <p><b>3.4. Fungal Disease:</b></p> <p>3.4.1. Brackish water and marine water finfish - <i>Ichthyophonus</i></p> <p>3.4.2. Shellfishes - <i>Dermocystidium marinum</i> infection in Oyster</p> <p>3.4.3. Crustaceans – <i>Saprolegnia parasitica</i> infection in prawn</p>	15 Hrs.
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	<p><b>UNIT III : Fish health and Disease Management</b></p> <p><b>4.1. Fish Health</b></p> <p>4.1.1. Definition of health and disease in fish.</p> <p>4.1.2. Predisposing factors, biotic and abiotic factors,</p> <p>4.1.3. Stress and general adaptation syndrome.</p> <p>4.1.4. Role of physical (injuries, health, cold) chemical (pH, salinity, toxins, ammonia, nitrogenous waste, endogenous chemical metabolites, free radicals, oxidants) soil and water parameters in fish health.</p> <p>4.1.5. Host-pathogen-environment interaction,</p> <p>4.1.6. Toxins and nutritional factors in disease process.</p> <p><b>4.2. Disease Management</b></p> <p>4.2.1. Principles of disease diagnosis, epidemiological and clinical diagnosis,</p> <p>4.2.2. Microbiological and post mortem examination of fin fishes in brackish water and marine water environment.</p> <p>4.2.3. Environmental impact of disease management.</p> <p>4.2.4. Aquaculture medicines and its importance in fisheries.</p> <p>4.2.5. Rules and regulation for use of aquaculture medicine.</p>	<p><b>15 Hrs.</b></p>
	<p><b>UNIT IV : Fish Spoilage, Processing and Fish products:</b></p> <p><b>1. Fish spoilage:</b> Criteria for freshness of fish, study of post mortem changes (Rigor mortis, Bacterial spoilage and Chemical spoilage).</p> <p><b>2. Preservation and processing:</b> Principles and methods</p>	<p><b>15 Hrs.</b></p>

with reference to: Drying, Salting, Smoking, Canning, Refrigeration and freezing.

**3. Fishery products and by-products:**

3.1 Fish body oil, Fish liver oil, Fish meal, Isinglass, Fish protein concentrate, Fish glue and Fish manure.

3.2 Fish silage: Acid silage and fermented silage, advantages over fish meal, nutritional value of silage.

3.3 Fish hydrolysates: Production and utilization, biochemical Composition and importance in food and nutrition.

3.4 Miscellaneous by-products and recent advances.

**Suggested Reading:**

1. Jhingran, Fish and fisheries
2. Fisheries technology - Balchandran
3. General topics in fishery by Ravi Reddy, Mohan Babare, Ramraopatil.
4. Fisheries-Its methods and applications by Rounsfell G.A. and W.H. Everhart
5. Manual of methods in fish biology by S.P. Biswas
6. Inland fishes of India and adjacent countries (vol.I,II) by Talwar P.K.andA.G.Jhingran.
7. Fisheries Ecology by Pitcher T.J. and P.J.T. Hart.
8. Fish stock assessment : A manual of basic methods.
9. Manual of methods of fisheries biology, Pisciculture by Laevastu T.
10. History of fishes by Norman
11. Fish and fisheries by B.N. Yadav.
12. Proceedings of the symposium on living resources of the seas around
13. Biswas K.P. Fish Processing and Preservation. Daya Pub. House. 14.Govindan T.K. Fish Processing Technology. Oxford & IBH Pub. Co.
14. Badapanda K.C. Fish processing and preservation technology. Narendra

Publishing House.

15. Brody, J Fishery products technology, West port
16. Burgess, G.H.S et al. Fish handling and processing HMSO London
17. Kreuzer, R. Freezing and irradiation of fish. Fishing News., London
18. Kreuzer, R. Ed Fish inspection and quality control. Fishing News New England
19. Kreuzer, R. (Ed) Fishery products. Fishing News England.
20. Greensmith, M Practical Dehydration. Food Trade Press.
21. Govindan T.K. Fish processing technology. IBH, New Delhi.
22. Windsor, M. and Barlow, Introduction to fishery by-products. Fishing News
23. Charles Cutting, L., Fish processing and preservation. AGRO Botanical Publishers (India).
24. Gopalkumar K. Fish Packaging Technology – Materials and Methods.
25. Connell, J.J. (Ed.). 1980. Advances in Fishery Science and Technology. Fishing News Books
26. Limited. England.
27. Wheaton, F.W. and Lawson, T.B. 1985. Processing Aquatic Food Products. Wiley and Interscience Publishers.
28. Borgstrom, G. 1962. Fish as Food. Vol 1 - 4. Academic Press. New York.
29. Saccharow, S. and Griffin, R.C. 1980. Principles of Food Packaging – 2nd Edition. AVI Publishing Company, Connecticut.
30. Noga, Edward J. (2010). Fish disease: diagnosis and treatment / Second Edition Edward J. Noga.—2nd ed. A John Wiley & Sons, Inc., Publication.
31. John A. Plumb and Larry A. Hanson (2011). Health maintenance and principal: microbial diseases of cultured fishes / 3rd ed. John A. Plumb and Larry A. Hanson. A John Wiley & Sons, Ltd., Publication.
32. Woo, P.T.K. (2006). Fish diseases and disorders.- Volume 1: Protozoan and Metazoan Infections-2nd ed. CAB International.
33. Frederick S.B. Kibenge and Marcos G. Godoy (2016). Aquaculture Virology. Academic Press, Elsevier, UK.
34. Ronald J. Roberts (2012). Fish pathology / edited by Ronald J. Roberts. – 4th

ed. A John Wiley & Sons, Ltd., Publication.

35. ICAR(1998). Methods for Diagnosis and Treatment of Fish Disease. Bull. no.

84. *Central Inland Capture Fisheries Research Institute. Barrackpore.*

36. Pillai, T.V.R. and M.N. Kutty (2005). Aquaculture Principles and Practices. 2<sup>nd</sup>

Eds. Blackwell publishing Ltd.

<b>Course Code:</b> MSZOLB401P	<b>Course Title: Part B- Oceanography and Fishery Science(Practical based on MSZODE401&amp; MSZODE402)</b>
<b>Course Credit:2</b>	<b>Total contact hours: 60 Hrs</b>
<b>Sr. No.</b>	<b>Course Contents (Topics &amp; subtopics)</b>
	<p>1) Determination of physico-chemical parameters of marine water sample:</p> <ol style="list-style-type: none"> <li>1) Salinity (Argentometric and conductivity method)</li> <li>2) Dissolved oxygen,</li> <li>3) Carbon dioxide.</li> <li>4) Nitrates-nitrites.</li> <li>5) Silicates.</li> <li>6) Phosphate-phosphorus.</li> </ol> <p>2) Detection of heavy metals from water sample:</p> <ol style="list-style-type: none"> <li>a. Zinc</li> <li>b. Lead</li> <li>c. Copper</li> </ol> <p>3)<b>Oceanographic instruments:</b> a) Nansen reversing bottle. b) Deep sea reversing thermometer. c) Bathythermometer. d) Drift bottle.</p> <ol style="list-style-type: none"> <li>e) Ekman's current meter. f) Secchi disc. g) Plankton nets: Standard net, Hensen net and Clarke Bumpus net. h) Stemple pipette and</li> </ol>

	<p>counting slide. i) Nekton sampling device-trawls. j) Benthic sampling devices-dredges, grabs and corers.</p> <p><b>4.Study of fish diseases: 1. Protozoan Diseases.2.Bacterial Diseases 3.Viral Diseases.4.Fungal Diseases</b></p> <p><b>Student Activity:</b></p> <p>b. Collection of marine algae and preparation of herbaria (at least five different forms).</p> <p><b>c. Visit to fish processing unit and submission of report</b></p>
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<b>Course Code:</b> <b>MSZODE403T</b>	<b>Course Title</b> Male Reproductive Physiology and Medical Endocrinology
<b>Course Credit:4</b>	<b>Total contact hours: 60 Hrs.</b>

<p><b>Learning Objectives:</b></p> <ul style="list-style-type: none"> <li>➤ The course is designed to develop deep understanding on Male Reproductive Physiology and Medical Endocrinology.</li> <li>➤ This course on ‘Male Reproductive Physiology and Medical Endocrinology’ helps to understand how Male Reproductive Physiology and Medical Endocrinology in animals work at all levels, ranging from individual cells to the whole integrated organism.</li> </ul>
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<p><b>Outcomes:</b></p> <ul style="list-style-type: none"> <li>➤ After going through this course on ‘Male Reproductive Physiology and Medical Endocrinology’, the students have a good understanding of how Male Reproductive Physiology in animals work and how these animals’ biology is influenced by the hormones.</li> <li>➤ The students will be able to explore an original query in ‘Male Reproductive Physiology and Medical Endocrinology’.</li> </ul>
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Sr. No.	Course Contents (Topics & subtopics)	
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1	<p><b>Unit: I</b></p> <p><b>Gonadal differentiation</b></p> <p>1.1 Sexual differentiation: Genetic sex- gonadal sex- somatic sex</p> <p>1.2 Differentiation of testis and Ovary: Morphological and hormonal aspects</p> <p>1.3 Development abnormalities of male sex organs: genetic and endocrine aspects</p> <p>1.4 Hypothalamo- hypophyseal- gonadal axis</p>	15 Hrs.
2	<p><b>Unit: II</b></p> <p><b>Male reproductive system</b></p> <p>2.1 Structure of male reproductive system</p> <p>2.2 Testicular events and biosynthesis of testosterone</p> <p>2.3 Biochemistry of semen</p> <p>2.4 Sterility, its causes and control</p>	15 Hrs.
3	<p><b>Unit: III</b></p> <p><b>Medical Endocrinology - I</b></p> <p>3.1 Artificial insemination</p> <p>3.2 <i>In vitro</i> fertilization and embryo transfer</p> <p>3.3 GIFT (Gamete intra-fallopian transfer)</p>	15 Hrs.

<b>4</b>	<p><b>Unit: IV</b></p> <p><b>Medical Endocrinology - II</b></p> <p>4.1 Fertility control – Contraception: Natural and chemical methods, Oral contraception and Surgical methods</p> <p>4.2 Growth Hormones related to human development</p> <p>4.3 Production of insulin and growth hormones as Pharmaceuticals</p>	<b>15 Hrs.</b>
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### **Suggested Reading Reference**

#### **Books:**

1. Comparative Vertebrate Endocrinology by P.J.Bentley, Cambridge Univ. Press.
2. General and Comparative Endocrinology by E.J.W. Barrington, Oxford Clarendan Press
3. Endocrinology Vol.1-3 by DeGroot L.J.et.al.
4. Text Book of Endocrine Physiology by C.R.Martin, Oxford Univ.Press, New York.
5. Text Book of Endocrinology by Turner and Bagnara (W.B.Saunders).
6. Vertebrate Endocrinology by Mc.Hadley.
7. Text Book of Comparative Endocrinology by Gorbman A, and Bern H.A., John Harley and Sous, New York.
8. Essential Endocrinology by JoenLaycock and Peter Louise Oxford Univ. Press.
9. A Text Book of Medical Physiology by A. C. Guyton.
10. Text Book of Endocrinology by R.H.Williams (W.B.Saunders).

<b>Course Code:</b> MSZODE404T	<b>Course Title</b> Female Reproductive Physiology and Neuroendocrinology
<b>Course Credit:4</b>	<b>Total contact hours: 60 Hrs.</b>
<b>Learning Objectives:</b>	
<ul style="list-style-type: none"> <li>➤ The course is designed to develop deep understanding on Female Reproductive Physiology and Neuro endocrinology.</li> <li>➤ This course on ‘Female Reproductive Physiology and Neuroendocrinology’ helps to understand how Female Reproductive Physiology and Neuro endocrinology in animals work at all levels, ranging from individual cells to the whole integrated organism.</li> </ul>	
<b>Outcome:</b>	
<ul style="list-style-type: none"> <li>➤ After going through this course on ‘Female Reproductive Physiology and Neuroendocrinology’, the students have a good understanding of how Female Reproductive Physiology and Neuroendocrinology in animals work and how these animals’ biology is influenced by the hormones.</li> <li>➤ The students will be able to explore an original query in ‘Female Reproductive Physiology and Neuroendocrinology’.</li> </ul>	



Sr. No.	Course Contents (Topics & subtopics)	Hrs. 15
1	<p><b>Unit: I</b></p> <p><b>Female Reproductive Physiology - I</b></p> <p>1.1 Structure of female reproductive system</p> <p>1.2 Folliculogenesis</p> <p>1.3 Ovulation</p> <p>1.4 Luteinization</p> <p>1.5 Implantation and role of hormones during pregnancy</p>	Hrs. 15
2	<p><b>Unit: II</b></p> <p><b>Female Reproductive Physiology - II</b></p> <p>2.1 Estrous cycle</p> <p>2.2 Menstrual cycle</p> <p>2.3 Menopause</p> <p>2.4 Endocrinology of implantation</p> <p>2.5 Parturition</p>	Hrs. 15
3	<p><b>Unit: III</b></p> <p><b>Neuroendocrinology-I</b></p> <p>1.1 Varieties and distribution of neurons</p> <p>1.2 Structural characteristics of neurons</p> <p>1.3 Neurophysiology: electrical properties of neurons and propagation of nerve impulses</p> <p>1.4 Neuromodulation: neurotransmitter versus neuropeptides</p>	Hrs. 15

<b>4</b>	<p><b>Unit: IV</b></p> <p><b>Neuroendocrinology-II</b></p> <p>1.1 Neuroendocrine regulation of immune system</p> <p>1.2 Stress hormones and immune responses</p> <p>1.3 Regulation of systemic homeostasis by nervous and immune system interactions.</p> <p>1.4 Neuroendocrine disorders: genetic versus environmental cause</p> <p>1.5 Introduction to Electrophysiology</p>	<b>Hrs. 15</b>
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**Suggested Reading:**

1. Comparative Vertebrate Endocrinology by P.J.Bentley, Cambridge Univ. Press.
2. General and Comparative Endocrinology by E.J.W. Barrington, Oxford Clarendan Press
3. Endocrinology Vol.1-3 by DeGroot L.J.et.al.
4. Text Book of Endocrine Physiology by C.R.Martin, Oxford Univ.Press, New York.
5. Text Book of Endocrinology by Turner and Bagnara (W.B.Saunders).
6. Vertebrate Endocrinology by Mc.Hadley.
7. Text Book of Comparative Endocrinology by Gorbman A, and Bern H.A., John Harley and Sous, New York.
8. Essential Endocrinology by JoenLaycock and Peter Louise Oxford Univ. Press.
9. A Text Book of Medical Physiology by A. C. Guyton.
10. Text Book of Endocrinology by R.H.Williams (W.B.Saunders).

<b>Course Code:</b> <b>MSZOLB401P</b>	<b>Course Title: Part C - Endocrinology</b> <b>(Practical based on MSZODE403 &amp; MSZODE404)</b>
<b>Course Credit:2</b>	<b>Total contact hours: 60 Hrs</b>
<b>Sr. No.</b>	<b>Course Contents (Topics &amp; subtopics)</b>
	<ol style="list-style-type: none"> <li>1. Study of Histology slides/Photographs of Endocrine glands - Pituitary, Thyroid, Parathyroid, Thymus, Adrenal, Pancreas, Ovary &amp; Testis, and Uterus.</li> <li>2. In situ demonstration of endocrine glands of rat.</li> <li>3. Pancreatic function tests; estimation of serum amylase activity.</li> <li>4. Estimation of serum acid phosphatase.</li> </ol>

	<p>5. Renal function tests; urea and creatinine clearance test with clinical interpretation.</p> <p>6. Estimation of phosphorus from serum</p>
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<b>Course Code:</b> MSZOSE401T	<b>Course Title: Aquaculture</b>	
<b>Course Credit: 4</b>	<b>Total contact hours: 60 Hrs.</b>	
<b>Learning Objectives:</b>		
<ul style="list-style-type: none"> <li>➤ Production of low-cost protein rich, nutritive, palatable and easily digestible human food.</li> <li>➤ Providing new species and strengthening stocks of existing fish in natural and man-made water-bodies through artificial recruitment</li> <li>➤ Production of ornamental fish for aesthetic appeal.</li> <li>➤ Effective utilization of aquatic and land resource</li> </ul>		
<b>Outcome:</b>		
<ul style="list-style-type: none"> <li>➤ Gain knowledge of sewage fed fish culture</li> <li>➤ Know about the characteristic of sewage</li> <li>➤ Be conscious of problems associated with sewage fed fish culture.</li> <li>➤ Know how to treat sewage to make it suitable for fish culture.</li> </ul>		
<b>Sr. No.</b>	<b>Course Contents (Topics &amp;Subtopics)</b>	

1	<p><b>UNIT I : History, Scope and Different Systems of Aquaculture:</b></p> <ol style="list-style-type: none"> <li>1. History, scope and importance of aquaculture.</li> <li>2. Aquaculture practices in India.</li> <li>3. Cultivable organisms for aquaculture and criterion for their selection.</li> <li>4. Different systems of aquaculture such as Pond Culture, Cage Culture, Pen Culture, Running Water Aquaculture, Raft Culture, Aquaranching.</li> <li>5. Impact of aquaculture on environment.</li> </ol>	<b>Hrs. 15</b>
2	<p><b>Unit II: Aquaculture management</b></p> <ol style="list-style-type: none"> <li>1. Pond management and fertilization; pre and post stocking management, induced breeding with special reference to Indian major carps.</li> <li>2. <b>Fertilization and Artificial Feeding in Aquaculture:</b> Need for fertilizing fish pond, Fertilizers (organic, inorganic and bio-fertilizers), Artificial fish feeds and their formulation, Balanced fish feeds and their preparation.</li> <li>3. <b>Aquatic Weeds and Their Control:</b> Introduction, position of aquatic weeds in fishery ponds, classification of aquatic weeds, aquatic weeds control measure, importance of aquatic weeds.</li> </ol>	<b>15 Hrs.</b>

3	<p><b>UNIT III: Hatchery and grow out practices for cultivable species -I:</b></p> <ol style="list-style-type: none"> <li>1. Hatchery and grow out practices for cultivable species of freshwater Fishes (Indian major carps and exotic carps) Air breathing fishes.</li> <li>2. Integrated aquaculture and sewage fed fishery Hatchery and grow out practices for the culture of brackish water fishes (<i>Chanoschanos</i> and <i>Lates calcarifer</i>),</li> <li>3. Present status of sea farming in India.</li> </ol>	15 Hrs.
4	<p><b>UNIT IV: Hatchery and grow out practices for cultivable species - II:</b></p> <ol style="list-style-type: none"> <li>1. <b>Prawn Culture:</b> Species of prawns, habit and habitat, food and feeding, types of prawn fishery, culture of freshwater prawn, culture of marine prawn, preservation and processing of prawns, pollutional impact on prawn fishery, environmental issues of prawn culture, fate of prawn culture.</li> <li>2. <b>Marine Molluscs culture:</b> Production of marine molluscs through aquaculture, Species of edible molluscs, Culture of oyster and mussels, Techniques of natural seed collection and breeding under controlled conditions.</li> <li>3. <b>Pearl Oyster culture:</b> Species involved, methods of seed collection, techniques of pearl culture, Prospectus in India.</li> </ol>	15 Hrs.

### **Suggested Readings :**

1. Svedrup et al., The Oceans.
2. Nair N.B. and Thampi D.H., A textbook of marine ecology, T-M-H.
3. Harold Thurman, Introductory oceanography, Prentice Hall. London.
4. Qasim S.Z., Glimpses of Indian Ocean, Sangum Bodes Ltd. London.  
NavyaPrinters, Hyderabad.
5. Michael King, Fisheries Biology assessment and management, Fishing News Publishers, 1995.
6. R. GordobPirje, Oceanography.
7. Newell and Newell, Marine Plankton.
8. Jhingran, Fish and fisheries
9. P. Michal, Ecological methods for field and laboratory investigations.
10. R.V. Tait, Marine zoology, Oxford press.
11. David Ross, Introduction to Oceanography.
12. Carl Schlipper, Research method in marine biology.
13. B.F. Chapgar, Sea Shore life of India, SIDGWICK and JACKSON, London
14. D.V. Bal and K.V. Rao, Marine fisheries of India, TM-H.
15. Russel and Young, The Seas
16. Kurian and Sebastian, Prawn and prawn fisheries of India.
17. M. Krishna Pillai. Introduction to Planktology, Himalaya Publishing
18. A.A. Fincham. Basic marine biology, British Museum Natural History.
19. LathaShenoy. Course manual in fishing technology, CIFE, Versova, Mumbai.
20. Jefferey F. Raymond, Plankton and productivity, Vol. I and II.
21. J.S. Levington, Marine Biology, Function, biodiversity, ecology. Oxford University Press.
22. Wealth of India, Vol. IV, CSIR Publications.
23. S.P. Biswas, Manual of methods in fish biology, South Asian publishers private Ltd., New Delhi.
24. J.P. Rilcy and R, Chester, Introduction to marine chemistry, Academic Press, London and New Delhi.

25. American Public Health Association-2000.
26. J.V.R. Pillai, Aquaculture principles and plasia, Blackwell Scientific pub.
27. Das P. and Jhingran A.C.G., Fish genetics in India.
28. Colin E. Purdon, Genetics and Fish breeding, Chapman and Hall.
29. Schroder J.J., Genetics and Mutagenesis of fish, Chapman and Hall.
30. P. Bensam. Development of marine fishery sciences in India, Daya publishing House.



**Dr.Homi Bhabha State University**  
**The Institute of Science**  
**Madam Cama Road, Mumbai, 400032**  
**M.Sc. Zoology Semester I/II/III/IV (Year) Theory Examination**  
**Subject Code: (CC/ID/SEC/DSE)**  
**Title of Paper: .....**

**Day/Date**

**Time Slot: 2 Hrs.**  
**Total Marks 60**

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**Instructions:** *i) Attempt all questions*

*ii) Each Questions carry equal marks (12 marks)*

*iii) Draw neat and labeled diagrams wherever necessary.*

Q. 1. (Based on Unit I)		12
	Or	
Q. 1. A. (Based on Unit I)		06
B. (Based on Unit I)		06
Q. 2. (Based on Unit II)		12
	Or	
Q. 2. A. (Based on Unit II)		06
B. (Based on Unit II)		06
Q. 3. (Based on Unit III)		12
	Or	
Q. 3. A. (Based on Unit III)		06
B. (Based on Unit III)		06
Q. 4. (Based on Unit IV)		12
	Or	
Q. 4. A. (Based on Unit IV)		06
B. (Based on Unit IV)		06
Q. 5. Attempt any 04 out of 08 questions based on entire syllabus.		
A.		03
B.		03
C.		03
D.		03
E.		03
F.		03
G.		03
H.		03

**Dr.Homi Bhabha State University**  
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**Madam Cama Road, Mumbai, 400032**  
**M.Sc. Zoology Semester I/II/III/IV (Year) Theory Examination**  
**Subject Code: (AEC/GE)**  
**Title of Paper: .....**

**Day/Date**

**Time Slot: 1 Hrs.**  
**Total Marks 30**

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**Instructions:** *i) Attempt all questions*  
*ii) Each Questions carry equal marks (12 marks)*  
*iii) Draw neat and labeled diagrams wherever necessary.*

Q. 1. (Based on Unit I)		12
	Or	
Q. 1. A. (Based on Unit I)		06
B. (Based on Unit I)		06
Q. 2. (Based on Unit II)		12
	Or	
Q. 2. A. (Based on Unit II)		06
B. (Based on Unit II)		06
Q. 3. Attempt any 02 out of 04 questions based on entire syllabus.		
A.		03
B.		03
C.		03
D.		03

**Dr.Homi Bhabha State University**  
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**Madam Cama Road, Mumbai, 400032**  
**M.Sc. Zoology Semester I (Year) Practical Examination**  
**Subject Code: MSZOLB401P**  
**Title of Paper: Part A – Animal Physiology and Ecology**

<b>Day /Date</b>	<b>Time Slot: 3 Hrs.</b> <b>Total Marks 50</b>
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Q .1 Measurement of ascorbic acid in blood / urine.	12
Q.2 Determination of Primary productivity by light and dark bottle	12
Or	
Q .2 Determination of sediment analysis by size fractionation.	12
Q .3 . A. Determination of glucose from given urine sample.	
08	
B. Determination of organic matter from given sediment sample.	08
Q. 5. Viva voce	05
Q. 6. Journal.	05

\*Candidates are required to present certified journal on the day of practical examination.

**Dr.Homi Bhabha State University**  
**The Institute of Science**  
**Madam Cama Road, Mumbai, 400032**  
**M.Sc. Zoology Semester I (Year) Practical Examination**  
**Subject Code: MSZOLB401P**  
**Title of Paper: Part B – Oceanography and Fishery Science**

**Day** **Time Slot: 3 Hrs.**  
**/Date** **Total Marks 50**

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Q. 1. Estimate heavy metal (Zn/Cu/Pb) from given water sample. 15

Q. 2. Determination of salinity / D.O./ CO<sub>2</sub> from given water sample. 10

Or

Q. 2. Determination of Nitrates- Nitrites /Silicates / Phosphate- Phosphorus. 10

Q. 3. Identify and Describe Oceanographic instruments (5 spot) 10

Q. 4. Marine algae herbaria submission (at least five different forms) 05

Q. 5. Viva voce 05

Q. 6. Journal 05

\*Candidates are required to present certified journal on the day of practical examination.

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**M.Sc. Zoology Semester I (Year) Practical Examination**  
**Subject Code: MSZOLB401P**  
**Title of Paper: Part C – Endocrinology**

<b>Day /Date</b>	<b>Time Slot: 3 Hrs. Total Marks 50</b>
Q. 1.Estimate the phosphorus from serum.	10
Or	
Q. 1. Identify any two endocrine glands.	10
Q. 2. Estimate the serum acid phosphatase.	10
Or	
Q. 2. Demonstrate any two endocrine glands of rat in Situ	10
Q. 3. Estimate serum amylase activity.	15
Or	
Q. 3. Estimate urea and creatinine.	15
Q. 4. Viva Voce .	05
Q. 5. Journal .	10

\*Candidates are required to present certified journal on the day of practical examination.

**Dr.Homi Bhabha State University**  
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**Madam Cama Road, Mumbai, 400032**  
**M.Sc. Zoology Semester I (Year) Practical Examination**  
**Subject Code: MSZOPR401P**  
**Title of Paper: Project**

<b>Day /Date</b>	<b>Time Slot: 3 Hrs. Total Marks 50</b>
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Q. 1. Project Report	40
Q. 2. Project Presentation	40
Q. 3. Viva-Voce	20