AC/4.8.18/RS 2

SIES College of Arts, Science & Commerce

RISE WITH EDUCATION

**Sion (West), Mumbai – 400022**
**(Autonomous)**

**Faculty: Science**

**Program: M.Sc.-II**

# Subject: ZOOLOGY

**Specialization: BIOTECHNOLOGY-OCEANOGRAPHY AND FISHERY SCIENCE**

**Academic Year: 2018 – 2019**

**Credit Based Semester and Grading System approved by Board of Studies in Zoology to be brought into effect from June 2018**

**M.Sc. Zoology (Biotechnology-Oceanography and Fishery Science) Syllabus (Autonomous)**
**Semester III and Semester IV**
**(Credit Based Semester and Grading System, with effect from academic year 2018-19)**

***Preamble***

*"You cannot inquire into reality if you are not courageous. Hence, courage comes first andeverything else follows."*

*Academic Autonomy signifies a paradigm shift to academic freedom which is instrumental in promoting academic excellence. One of the ways to achieve this is through fine-tuning the curriculum. As students at the postgraduate level would have a foundation of the basics of the subject, this syllabus focuses on the need to furnish them with skills and understanding essential to make them self-sufficient and build a future.*

*This syllabus acknowledges the significance of the world under water and the resources it provides, which can be directed for human benefit if used with precision. It also considers the technological advancements in Biology through Biotechnology that have raised the standard of living.*

*This syllabus is a product of the valuable inputs and ideas from the professors of Zoology at SIES College, Sion (West) and other board members from outside the institution. It was approved by the Board of Studies (Ad hoc) in the subject of Zoology, in the meeting held on 16th June 2018 at the institution's department of Zoology.*

*By implementing this course we expect to fulfil the aspirations of students who want to pursue careers in fields relating to marine science, aquaculture, pharmaceuticals, etc. and those who want to venture into hard core research, eventually benefitting the society in whole.*

*Dr. Satish SarfareChairman,*
*Board of Studies in the subject of Zoology*

**M.Sc. II Zoology (Biotechnology-Oceanography and Fishery Science) Syllabus (Autonomous)**
**Credit Based Semester and Grading System (With effect from academic year 2018-19)**
**Semester III**

| THEORY | | | | |
|---|---|---|---|---|
| **Course name and code** | **Unit** | **Topic Headings** | **Credits** | **Lectures/ week** |
| **SEMESTER III** | | | | |
| **Paper I: Basics of Industrial and Environmental Biotechnology - I** | | | | |
| **SIPSZOBT31** | 1 | The implications of recombinant DNA technology of commercial products and microbial synthesis | **4** | **1** |
| | 2 | Large scale culture and production from recombinant microorganisms and genetically engineered animal cells | | **1** |
| | 3 | Medical Biotechnology | | **1** |
| | 4 | Environmental Biotechnology- I | | **1** |
| **Paper II: Genetic Engineering Techniques and its applications** | | | | |
| **SIPSZOBT32** | 1 | Genome Management and Analysis | **4** | **1** |
| | 2 | Manipulation of Gene expression in Prokaryotes | | **1** |
| | 3 | Bioinformatics | | **1** |
| | 4 | Animal Biotechnology and Human therapies | | **1** |
| **Paper III: General, Physical, Chemical, Biological Oceanography** | | | | |
| **SIPSZOOCN33** | 1 | General Oceanography- I | **4** | **1** |
| | 2 | Physical Oceanography- I | | **1** |
| | 3 | Chemical Oceanography- I | | **1** |
| | 4 | Biological Oceanography- I | | **1** |
| **Paper IV: Planktology, Fish and Fishery Science and Aquaculture** | | | | |
| **SIPSZOOCN34** | 1 | Planktology- I | **4** | **1** |
| | 2 | Fish and Fishery Science- I | | **1** |
| | 3 | Biotechnology in Fishery Science and Biometric studies- I | | **1** |
| | 4 | Aquaculture- I | | **1** |
| **PRACTICAL** | | | | |
| **SIPSZOBTP31** | 1 | Based on **SIPSZOBT31** | **2** | **4** |
| **SIPSZOBTP32** | 2 | Based on **SIPSZOBT32** | **2** | **4** |
| **SIPSZOOCNP33** | 3 | Based on **SIPSZOOCN33** | **2** | **4** |
| **SIPSZOOCNP34** | 4 | Based on **SIPSZOOCN34** | **2** | **4** |
| | | **Total** | **24** | **32** |

**M.Sc. II Zoology (Biotechnology-Oceanography and Fishery Science) Syllabus (Autonomous)**
**Credit Based Semester and Grading System (With effect from academic year 2018-19)**
**Semester IV**

| THEORY | | | | |
|---|---|---|---|---|
| **Course name and code** | **Unit** | **Topic Headings** | **Credits** | **Lectures/ week** |
| **SEMESTER IV** | | | | |
| **Paper I: Basics of Industrial and Environmental Biotechnology - II** | | | | |
| **SIPSZOBT41** | 1 | Microbial synthesis of commercial products | **4** | **1** |
| | 2 | Large scale culture and production for Industrial Biotechnology | | **1** |
| | 3 | Agricultural Biotechnology | | **1** |
| | 4 | Environmental Biotechnology- II | | **1** |
| **Paper II: Genome Management, Manipulation, Regulations and Patents in Biotechnology** | | | | |
| **SIPSZOBT42** | 1 | Genome Management | **4** | **1** |
| | 2 | Manipulation of Gene expression in Eukaryotes | | **1** |
| | 3 | The Human Genome Project | | **1** |
| | 4 | Regulations and Patents in Biotechnology | | **1** |
| **Paper III: General, Physical, Chemical, Biological Oceanography** | | | | |
| **SIPSZOPHY43** | 1 | General Oceanography- II | **4** | **1** |
| | 2 | Physical Oceanography- II | | **1** |
| | 3 | Chemical Oceanography- II | | **1** |
| | 4 | Biological Oceanography- II | | **1** |
| **Paper IV: Planktology, Fish and Fishery Science and Aquaculture** | | | | |
| **SIPSZOPHY44** | 1 | Planktology- II | **4** | **1** |
| | 2 | Fish and Fishery Science- II | | **1** |
| | 3 | Biotechnology in Fishery Science and Biometric studies- II | | **1** |
| | 4 | Aquaculture- II | | **1** |
| **PRACTICAL** | | | | |
| **SIPSZOBTP41** | 1 | Based on **SIPSZOBT41** | **2** | **4** |
| **SIPSZOBTP42** | 2 | Based on **SIPSZOBT42** | **2** | **4** |
| **SIPSZOOCNP43** | 3 | Based on **SIPSZOOCN43** | **2** | **4** |
| **SIPSZOOCNP44** | 4 | Based on **SIPSZOOCN44** | **2** | **4** |
| | | **Total** | **24** | **32** |

**SIES College of Arts, Science and Commerce (Autonomous)Sion (West), Mumbai – 400 022**

**Programme: Master of Science, M.Sc. Part 2 – Zoology**

*"That is the essence of science: ask an impertinent question, and you are on the way to a pertinent answer."*
*- Jacob Bronowski*

The characteristic Post-graduate attributes comprising of Programme Outcomes, Programme Specific Outcomes and Course Outcomes for a science post graduate in the subject of Zoology are as follows:

**Note the list of abbreviations:**

*PO: Programme Outcome, PSO: Programme Specific Outcome, CO: Course Outcome*
*Cognitive Levels: R: Remember, U: Understand, Ap: Apply, An: Analyze, E: Evaluate, C: Create*

| Serial Number | Details of Programme Outcomes (POs) |
|---|---|
| PO1 *(Skill Level)* | **Problem Solving Ability *(U, Ap)*** <br>• Apply the knowledge of various courses learned under a program to break down complex problems into simple components. <br>• Adopt and assimilate problem-based learning models and apply one's learning to solve real life problem situations. |
| PO2 *(Skill Level)* | **Critical Thinking *(U, An, E)*** <br>• Develop critical thinking based on a rationale to identify assumptions, verifying the accuracy and validity of assumptions, and making informed decisions. <br>• Inculcate the ability of logical reasoning to question the rationale behind concepts, ideas, and perspectives. |
| PO3 *(Skill Level)* | **Effective Communication Skills *(Ap, C)*** <br>• Improve written and oral communication skills so as to express thoughts and ideas effectively. <br>• Demonstrate the ability to listen carefully and imbibe soft skills to convey and receive instructions clearly. <br>• Develop presentation skills to present complex information in a clear, lucid and concise manner. |
| PO4 *(Skill Level)* | **Proficiency with Information and Communication Technology *(U, An, E)*** <br>• Demonstrate ability to access, evaluate and use a variety of relevant information resources inclusive of internet and electronic media for the purpose of collating and analyzing data. <br>• Understand the scope and limitations of tools or software used in Information and Communication Technology. |
| PO5 *(Skill Level)* | **Leadership Skills and Team Work *(U, Ap, An, C)*** <br>• Demonstrate leadership skills formulating an inspiring vision, thereby building a team, motivating and inspiring team members to engage and achieve that vision. <br>• Develop management skills to guide people in takings tasks to their logical conclusion. <br>• Inculcate the ability to facilitate coordinated effort as a group or team in the interests of common cause and recognize the contribution of team members. |
| PO6 *(AttitudeLevel)* | **Self-directed and Lifelong Learning *(U, Ap, An)*** <br>• Demonstrate the ability to work independently and take responsibility for one sactions. <br>• Acquire the ability to explore and evolve by becoming self-sufficient and self-reliant. <br>• Adapt lifelong learning approaches to broaden one's horizons for personal growth |

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| PO7<br>*(AttitudeLevel)* | **Ethical Values and Environmental Concerns *(U, Ap, E)***<br>• Embrace moral or ethical values in conducting one's life and implement ethical practices in all aspects of life.<br>• Create awareness and concern for environmental and sustainability issues.<br>• Understand and realize the significance and relevance of co-habitation and co-evolution in attaining the needs of sustainable development. |
| PO8<br>*(AttitudeLevel)* | **Gender Sensitization and Community Service *(U, Ap, An)***<br>• Respect gender sensitivity, gender equity and gender justice.<br>• Encourage mutual understanding and express empathetic social concern towards different value systems and different strata of society.<br>• Engage in community service through Institutional Social Responsibility. |

| **Serial Number** | **Details of Programme Specific Outcomes (PSOs)<br>( Biotechnology-Oceanography and Fishery Science)** |
|---|---|
| PSO1 | **Conceptual Understanding and Emerging Applications *(R, U, Ap, An)***<br>• Inculcate conceptual and coherent understanding of Oceanography and Fishery Science, and demonstrate a broad understanding of different aspects of Oceanography and to learn about the general features of the earth's surface under water.<br>• Understand the in-depth concepts of different areas of Biotechnology such as Recombinant DNA technology, Medical biotechnology, Environmental biotechnology, Agricultural biotechnology, Genome management, Animal biotechnology, Bioinformatics etc. and Oceanography and Fishery science such as Oceanography, Fishery science, Aquaculture, Marine Biotechnology, Planktology, Marine ecology so as to recognize the current scenario and apply appropriate methodologies with cutting edge tools/techniques to seek solutions to emerging problems faced by mankind.<br>• Demonstrate the relevance of the procedural subject knowledge that creates different types of professionals related to the disciplinary/subject area of zoology, including professionals engaged in research and development, teaching and government/public service. |
| PSO2 | **Analytical reasoning and Scientific Inquiry *(U, An, E)***<br>• Inculcate a sense of inquiry and capability for asking relevant or appropriate questions, articulating problems or concepts or questions.<br>• Encourage the ability to analyze, interpret and draw conclusions from qualitative/quantitative data and critically evaluate ideas, experiences, theories and concepts by following scientific approach to knowledge development from an open minded and reasoned perspective.<br>• Develop analytical skills involving paying attention to detail and imbibe the ability to construct logical arguments using correct technical language related to the relevant subject.<br>• Analyze and interpret data/information collected or related to experiments or investigations, using appropriate methods involving Biostatistics, Bioinformatics among others and report accurately the findings of the experiment/investigations while relating the conclusions/ findings to relevant theories of zoology. |
| PSO3 | **Laboratory Skills and Fieldwork *(R, U, E, C)***<br>• Understand and apply standard operating procedures as per Good Laboratory Practices so as to develop laboratory skills and qualities required for successful career in teaching, research, industry, etc.<br>• Demonstrate awareness regarding animal ethics, human ethics, conservation of flora and fauna, so as to promote safe environment and ecosystem, in the pursuit of disciplinary knowledge. |

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| PSO4 | **Research Aptitude and Interdisciplinary Approach *(Ap, An, E, C)*** <br>• Inculcate and adapt to research aptitude and culture, integrate research-based knowledge in an interdisciplinary framework, and realize the relevance of choosing research as an alternative career option. <br>• Demonstrate the awareness regarding compliance with research ethics, awareness about conflicts of interests and Intellectual Property Rights, and avoiding unethical behavior such as fabricating, falsifying, or misrepresenting data or to committing plagiarism. <br>• Inculcate the ability to recognize cause and effect relationships, formulate hypothesis, reporting the results of an experiment or investigation, and application of research tools for analysis and interpretation of data. <br>• Inculcate an interdisciplinary approach, to understand and consolidate fundamental concepts through inquiry-based curriculum, develop critical thinking and problem-solving ability required to solve different types of biology related problems with well-defined solutions, and tackle open-ended problems that may cross disciplinary-area boundaries. |

## Course Outcomes for M.Sc. Part 2

**At the root of all (science) education (Core Learning Outcome):**
"The imaginative and original mind need not be overawed by the imposing body of present knowledge or by the complex and costly paraphernalia which today surround much of scientific activity. The great shortage in science now is not opportunity, manpower, money, or laboratory space. What is really needed is more of that healthy skepticism which generates the key idea – the liberating concept."– *P.H. Abelson*

Purity of mind leads to clarity in thought and action for creation of an original archaic work. As well, to consciously attempt the basic pursuit of understanding human existence.

## Biotechnology-Oceanography and Fishery Science

## Semester III – Theory

**Course Code: SIPSZOBT31**
**Course Name: Basics of Industrial and Environmental Biotechnology – I**
The study of this course will accomplish the following outcomes:

| Unit | Course Outcome (CO) | Cognitive Level | Affinity with PO/ PSO |
|---|---|---|---|
| Unit 1: The implications of recombinant DNA technology of commercial products and microbial synthesis | **CO1:** <br>• Keep abreast with the current trends in this fast-moving field of Biotechnology, which is an intersection of technology and Biology. <br>• Gain an in-depth knowledge of the application of recombinant DNA technology in food, microbial technology and for the production of genetically engineered animal cells to obtain commercial products for human use. <br>• Understand the Commercialization of biotechnology and biotech companies. <br>• Get acquainted to the prospects of novel food technology and the involvement of biotechnology in food science. <br>• Understand the implications of recombinant DNA technology, its applications, production of | *R, U, Ap, An* | *PO1, PO2* <br> *PSO1, PSO2* |

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|---|---|---|---|
| | genetically modified organisms (GMOs) and areas of significant public concerns regarding GMOs. | | |
| Unit 2:<br>Large scale culture and production from recombinant microorganisms and genetically engineered animal cells | **CO1:**<br>• Gain an in-depth knowledge of the application of recombinant DNA technology in food, microbial technology and for the production of genetically engineered animal cells to obtain commercial products for human use.<br>• Learn about different types of fermenters employed to obtain different commercial products and to understand basics of recombinant cell physiology, for process development and industrial production of recombinant proteins<br>• Comprehend the knowledge of animal cell cultures and their role as adequate test systems for studying biochemical pathways, virus production, pathological mechanisms, and intra/intercellular responses. | *R, U, Ap, An* | *PO1, PO2, PO7*<br>*PSO1, PSO2* |
| Unit 3:<br>Medical Biotechnology | **CO2:**<br>• To emphasize the significance of Biotechnology in the field of medicine for production of therapeutic agents viz., vaccines and monoclonal antibodies that have revolutionized medical science.<br>• Get acquainted to the modern tools practiced in medical biotechnology.<br>• Learn about the biological reagents such as engineered monoclonal antibodies and their role in improved laboratory diagnostics.<br>• Gain knowledge about improvements in vaccine technology and improved therapeutics such as humanized monoclonal antibodies, genetically engineered cytokines like interferons, hormones, and growth factors. | *R, U, Ap, An,* | *PO1, PO2*<br>*PSO1, PSO2* |
| Unit 4:<br>Environmental Biotechnology-I | **CO4:**<br>• The aim of environmental biotechnology is to prevent, arrest and reverse. environmental degradation through the appropriate use of biotechnology in combination with other technologies.<br>• The course is an introduction to environmental biotechnology and focuses on the utilization of microbial processes in bioremediation. And elementary relevant microbiological processes, microbial ecology and basic principles in bioremediation and biological waste water treatment.<br>• Evaluate the potential for biodegradation of organic pollutants, taking microbial and | *R, U, Ap, An* | *PO1, PO2*<br>*PSO1, PSO2* |

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| | physical/chemical environments, as well as the chemical structure of the compound itself, with respect to bioleaching. | | |

**Course Code: SIPSZOBT32**
**Course Name: Genetic Engineering Techniques and its applications**
The study of this course will accomplish the following outcomes:

| Unit | Course Outcome (CO) | Cognitive Level | Affinity with PO/ PSO |
|---|---|---|---|
| Unit 1: Genome Management and Analysis | **CO3:**<br>• Explore the basic tools of genetic engineering practiced in genome management and analysis.<br>• To get acquainted to various gene transfer techniques employed in genome management- a skill-based approach in biotechnology.<br>• Understand various methods used in genome analysis. Also, elucidate the mechanism, instrumentation, and commercial applications of the same. | *R, U, Ap, An* | *PO1, PO2*<br>*PSO1, PSO2* |
| Unit 2: Manipulation of gene expression in prokaryotes | **CO2:**<br>• Gain an in-depth knowledge of the application of recombinant DNA technology for the production of genetically engineered animal cells to obtain commercial products for human use.<br>• Understand the significance of manipulation of gene expression (this case in prokaryotes) and comprehend the role of promoters of prokaryotes in genetic engineering. | *R, U, Ap, An* | *PO1, PO2*<br>*PSO1, PSO2* |
| Unit 3: Bioinformatics | **CO3:**<br>• Use and understand bioinformatics tools to analyses proteomics data, involving identification and quantification approaches.<br>• Discuss standards in proteomics bioinformatics and recognize its importance.<br>• Evaluate the strengths and weaknesses of several experimental and bioinformatics analysis approaches.<br>• Use tools to perform functional annotation of lists of protein.<br>• Students will understand how to utilize bioinformatics tools and databases for retrieving, analyzing, understanding, and managing biological data.<br>• The program aims to understand how genes and proteins determine their functions and establish evolutionary relationships. | *R, U, Ap, An* | *PO1, PO2, PO4*<br>*PSO1, PSO2, PSO4* |
| Unit 4: Animal Biotechnology and Human therapies | **CO4:**<br>• To recognize the importance of recombinant DNA technology in making animals with manipulated genes – transgenic animals, that can be potential | *R, U, Ap, An* | *PO1, PO2*<br>*PSO1, PSO2* |

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| | biofactories for production of biopharmaceuticals<br>• Understand the significant role of rDNA technology in preventing various human diseases.<br>• Get acquainted to the regulations and patenting of the genetically engineered animals.<br>• Comprehend the use of animal biotechnology in human therapies using the techniques of tissue engineering, xenotransplantation, antibody engineering, site directed mutagenesis, targeted gene replacement and cell adhesion-based techniques. | | |

**Course Code: SIPSZOOCN33**
**Course Name: General, Physical, Chemical and Biological Oceanography**
The study of this course will accomplish the following outcomes:

| **Unit** | **Course Outcome (CO)** | **Cognitive Level** | **Affinity with PO/ PSO** |
|---|---|---|---|
| Unit 1: General Oceanography | **CO1:**<br>• To give a brief introduction to acquaint students with the different aspects of Oceanography.<br>• To get acquainted to ship-building, oceanographic research vessels, tools and equipment used for oceanographic research, oceanographic laboratories and stations of the world and India in order to inculcate research and application-based attitude.<br>• To learn about the general features of the earth's surface under water with reference to the ocean waters of the Indian subcontinent. | *R, U* | *PO2, PO4, PO6, PO7*<br><br>*PSO1* |
| Unit 2: Physical Oceanography | **CO2:**<br>• To analyze the physical attributes of sea water and comprehend their influence on aquatic life<br>• To throw light on ocean circulation – a key regulator of climatic changes.<br>• To study various physical aspects of oceanography as tides, waves, and currents, which not only influence aquatic life but also life on the terrestrial realm.<br>• To get acquainted to phenomena regulating the global climate. | *R, U, An* | *PO2, PO4, PO6, PO7*<br><br>*PSO1, PSO2* |
| Unit 3: Chemical Oceanography | **CO3:**<br>• To study inorganic constituents – the chemicals that make up the ocean and their role in nurturing oceanic life.<br>• To study the role of dissolved gases and nutrients in marine environment, their availability, distribution in order to appreciate the influence of these factors on aquatic as well as terrestrial life<br>• To value the mineral resources those are obtained from the oceans and their large-scale applications. | *R, U, An* | *PO2, PO4, PO6, PO7*<br><br>*PSO1, PSO2* |

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| Unit 4: Biological Oceanography | **CO4:**<br>• To understand the extent and division of marine environment owing to prevalent physical factors and to analyze their influence on marine biotic diversity<br>• To appreciate the vast array of marine biotic diversity from plankton to large nekton.<br>• To get enlightened by the plethora of adaptations and associations exhibited by varied marine organisms with changing climatic conditions so as to draw appropriate conservation measures. | *R, U* | *PO2, PO4, PO6, PO7*<br><br>*PSO1, PSO2* |

**Course Code: SIPSZOOCN34**
**Course Name: Planktology, Fish and Fishery Science and Aquaculture**
The study of this course will accomplish the following outcomes:

| **Unit** | **Course Outcome (CO)** | **Cognitive Level** | **Affinity with PO/ PSO** |
|---|---|---|---|
| Unit 1: Planktology- I | **CO1:**<br>• To appreciate the enormous world of microscopic splendors called plankton.<br>• To elucidate the role of plankton community in aquatic ecosystems and the factors influencing their distribution and abundance.<br>• To comprehend the vast diversity of plankton by studying their classification based on various criteria. Also, to understand the inter-relationship between them. | *R, U* | *PO2, PO4, PO6, PO7, PO8*<br><br>*PSO1, PSO2* |
| Unit 2: Fish and Fishery Science- I | **CO2:**<br>• To gain knowledge of Fishery Science that opens an avenue for bioeconomics.<br>• To gain in depth knowledge of marine finfish resources in pelagic and demersal systems.<br>• To study commercially important fish species, their distribution, crafts, and gears operated, utilization and recent data on their landing.<br>• To gain in depth knowledge of marine shellfish resources in pelagic and demersal systems.<br>• To get an insight into crustacean fisheries, commercially important species, distribution, methods of capture, recent data on their catch. | *R, U* | *PO2, PO4, PO6, PO7, PO8*<br><br>*PSO1, PSO2* |
| Unit 3: Biotechnology in Fishery and Biometric Studies - I | **CO3:**<br>• To understand the history of biotechnology and to gain knowledge of applications of biotechnology in various fields of marine biology to improve human values.<br>• To learn advanced techniques used in cryopreservation of fish gametes and understand the steps involved in developing the transgenic fish.<br>• To study the gene transfer in common carp and channel fish. | *R, U* | *PO2, PO4, PO6, PO7, PO8*<br><br>*PSO1, PSO2* |

| | | | |
|---|---|---|---|
| Unit 4: Aquaculture- I | **CO4:**<br>• To introduce aquaculture to know its immense potential for generating employment<br>• To acquire knowledge for wise management of aquatic resources to minimize production costs and gain profit.<br>• To consider aquaculture as a subsidiary in the income of someone having a taste for it.<br>• To attain a clear perception of the present status of sea farming in India and to compare it with worldwide production and trends<br>• To impart essential knowledge and skills regarding advanced technologies of different aquaculture production systems. | *R, U* | *PO2, PO4, PO6, PO7, PO8*<br><br>*PSO1, PSO2* |

**PRACTICAL**

"*Study nature not books.*" – An old dictum.

The practical course in Zoology is designed for first hand study of animal life through observation of preserved specimens, *in situ* organ systems, microscopic examination of permanent slides, etc. as well as to perform experiments to strengthen the concept base.

It is an effort to invigorate a thought process that can analyze and reason for the sake of awareness, hence to reach a valid answer.

**Biotechnology-Oceanography and Fishery Science**

**Semester III – Practical**

**Course Code: SIPSZOBTP31 and SIPSZOBTP32**
**Course Name: Practical I & II** based on **SIPSZOBT31 and SIPSZOBT32**

| Course | Course outcomes (CO) | Cognitive Level | Affinity with PO/ PSO |
|---|---|---|---|
| SIPSZOBTP31 and SIPSZOBTP32 | • Comprehend the significance of aseptic techniques in biotechnological experiments and demonstrating those techniques-an important step to skill development in biotechnology.<br>• Understand the significance of culture media in microbiology, develop necessary skills for preparing culture media, demonstrate the techniques to culture bacteria using some commonly practiced techniques in laboratory.<br>• Isolation of genomic DNA from the given strain of bacteria/ tissue and show the purity of the isolate by performing agarose gel electrophoresis, thereby developing skills in electrophoretic techniques.<br>• Estimate the number of bacteria in the given culture by the technique of Nephelometry.<br>• *Students Activity: Visit to the industries/institutes involved in Biotechnology research:* To gain | *R, U, An, Ap, E* | *PO2, PO5, PO6*<br><br>*PSO1, PSO2, PSO3* |

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| | knowledge about potential areas in research, research trends, methodology, instrumentation, facilities in order to inculcate a research-based attitude. | | |

**Course Code: SIPSZOOCNP33**
**Course Name: Practical III** based on **SIPSZOOCN33**

| Course | Course outcomes (CO) | Cognitive Level | Affinity with PO/ PSO |
|---|---|---|---|
| SIPSZOOCNP31 | • To determine various physico-chemical parameters of sea water such as salinity, Dissolved $O_2$, $CO_2$, Nitrites-Nitrates, Silicates, Phosphates etc., in order to analyze their relationship with prevalence of marine organisms.<br>• To estimate the primary productivity of given sample water in order to understand the energy conversions in organisms.<br>• To identify and describe various intertidal organisms based on types of substrata they inhabit (rocky, sandy, muddy) in order to understand the differences in their morphological, anatomical, and behavioral adaptations.<br>• To gain an insight into the world of Micropaleontology which studies microfossils, its morphology, its characteristic details, and commercial importance.<br>• *Student's activity:* Shore walks to observe and appreciate the parallel universe which emerges when the tide recedes. Also, to combine experiential learning in laboratory with actual observations on field.<br>• *Visit to institutes involved in Marine Biology or Oceanography Research:* To gain knowledge about potential areas in oceanographic research, research trends, methodology, instrumentation, facilities in order to inculcate a research-based attitude. | *R, U, An, Ap, E* | *PO1, PO2, PO6, PO7*<br><br>*PSO2, PSO3* |

**Course Code: SIPSZOOCNP34**
**Course Name: Practical IV** based on **SIPSZOOCN34**

| Course | Course Outcomes (CO) | Cognitive Level | Affinity with PO/ PSO |
|---|---|---|---|

| | | | |
|---|---|---|---|
| SIPSZOOCNP34 | • To appreciate the enormous world of microscopic splendors called plankton, various methods of quantitative estimation of zooplankton and develop a skill of preparing permanent mountings of zooplankton.<br>• To measure the reproductive capacity of a female fish, which in turn elucidates the population dynamics, racial characteristics, production, and stock recruitment problems.<br>• To measure the diameter and plotting the frequency polygon to interpret the growth and maturation in fish.<br>• To identify and describe commercially important fishes with respect to capture fishery, their distribution, commercial value, crafts, and gears operated.<br>• *Student's activity:* Visit to fresh water hatchery/aquaculture farm to combine experiential learning in laboratory with actual observations on field.<br>• *Visit to institutes involved in aquaculture research:* To gain knowledge about potential areas in research, research trends, methodology, instrumentation, facilities in order to inculcate a research-based attitude. | *R, U, An, Ap, E* | *PO1, PO2, PO6, PO7*<br><br>*PSO2, PSO3* |

**Biotechnology-Oceanography and Fishery Science**
**Semester IV – Theory**

**Course Code: SIPSZOBT41**
**Course Name: Basics of Industrial and Environmental Biotechnology – II**
The study of this course will accomplish the following outcomes:

| Unit | Course Outcome (CO) | Cognitive Level | Affinity with PO/ PSO |
|---|---|---|---|
| Unit 1: Microbial synthesis of commercial products | **CO1:**<br>• Understand the basic aspects of microbiological science pertaining to industrial applications.<br>• Get acquainted to the techniques involved in synthesis of varied commercial products such as organic acids, antibiotics, polysaccharides, polyesters using the knowledge of microbial biotechnology. | *R, U, Ap, An* | *PO1, PO2*<br><br>*PSO1, PSO2* |

| | | | |
|---|---|---|---|
| Unit 2:<br>Large scale culture and production for Industrial Biotechnology | **CO2:**<br>• To know about enzyme immobilization techniques for obtaining products of commercial use.<br>• Understand the role of biocatalysts in biotransformation and learn about the screening and selection of novel biocatalysts and their genetic modification.<br>• Know about various techniques used in the immobilization of biocatalysts used for commercial purpose. | *R, U, Ap, An* | *PO1, PO2*<br>*PSO1, PSO2* |
| Unit 3:<br>Agricultural Biotechnology | **CO3:**<br>• To realize the role of Biotechnology in agriculture management in benefitting mankind.<br>• Get acquainted to the genetic engineering of nitrogenase cluster, hydrogenase, nodulation genes by taking into the consideration the significant role played by these for plants.<br>• Understand the role of microbial insecticide in controlling pests in agriculture.<br>• Understand the current trend of developing insect resistant, virus resistant and herbicide resistant plant. | *R, U, Ap, An* | *PO1, PO2*<br>*PSO1, PSO2* |
| Unit 4:<br>Environmental Biotechnology-II | **CO4:**<br>• The aim of environmental biotechnology is to prevent, arrest and reverse. environmental degradation through the appropriate use of biotechnology in combination with other technologies.<br>• The course is an introduction to environmental biotechnology and focuses basic principles in bioabsorption of metals to be recovered from effluents using various organisms, role of different bioreactors in bioabsorption and implication of phytoremediation in biotechnology.<br>• Evaluate the potential for biodegradation of organic pollutants, taking microbial and physical/chemical environments, as well as the chemical structure of the compound itself, with respect to bioleaching. | *R, U, Ap, An* | *PO1, PO2*<br>*PSO1, PSO2* |

**Course Code: SIPSZOBT42**
**Course Name: Genome Management, Manipulation, Regulations and Patents in Biotechnology**
The study of this course will accomplish the following outcomes:

| **Unit** | **Course Outcome (CO)** | **Cognitive Level** | **Affinity with PO/ PSO** |
|---|---|---|---|

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|---|---|---|---|
| Unit 1:<br>Genome Management | **CO1:**<br>• Explore the basic tools of genetic engineering practiced in genome management and analysis.<br>• To get acquainted to various gene transfer techniques employed in genome management- a skill-based approach in biotechnology.<br>• Understand various methods used in genome analysis. Also, elucidate the mechanism, instrumentation, and commercial applications of the same.<br>• Comprehend the role of cloning vectors and their applications in genome management. | *R, U, Ap, An* | *PO1, PO2*<br>*PSO1, PSO2* |
| Unit 2:<br>Manipulation of gene expression in eukaryotes | **CO2:**<br>• Gain an in-depth knowledge of the application of recombinant DNA technology for the production of genetically engineered animal cells to obtain commercial products for human use.<br>• Understand the significance of manipulation of gene expression (this case in eukaryotes) and comprehend the role of promoters of prokaryotes in genetic engineering. | *R, U, Ap, An* | *PO1, PO2*<br>*PSO1, PSO2* |
| Unit 3:<br>The Human Genome Project | **CO3:**<br>• Students will be introduced to topics such as scope and goals of human genome , genetic linkage maps, polymorphic dna markers, RFLP and its uses<br>• Mapping human diseases and positional cloning and its limitations | *R, U, Ap, An* | *PO1, PO2*<br>*PSO1, PSO2* |
| Unit 4:<br>Regulations and Patents in Biotechnology | **CO4:**<br>• Students will learn about regulatory agencies, regulatory requirements and process behind regulating environmental release of GEO and also learn about patenting and fundamental research | *R, U, Ap, An* | *PO1, PO2*<br>*PSO1, PSO2* |

**Course Code: SIPSZOOCN43**
**Course Name: General, Physical, Chemical and Biological Oceanography**
The study of this course will accomplish the following outcomes:

| **Unit** | **Course Outcome (CO)** | **Cognitive Level** | **Affinity with PO/ PSO** |
|---|---|---|---|
| Unit 1:<br>General Oceanography-II | **CO1:**<br>• To give a brief introduction to acquaint students with the different aspects of Oceanography.<br>• To appreciate the monumental events in the history of oceanography that have influenced the current understanding of the subject.<br>• To learn about the general features of the earth's surface under water with reference to the ocean waters of the Indian subcontinent.<br>• To identify and describe various oceanographic instruments used in analyzing different | *R, U* | *PO2, PO4, PO6, PO7*<br>*PSO1* |

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| | properties of sea water. Also, to identify and describe various devices practiced in the observation and sampling of marine organisms.<br>• To get acquainted to various laws of the sea so as to get an insight into various legislative measures taken by the government for the utilization and conservation of marine resources. | | |
| Unit 2: Physical Oceanography-II | **CO2:**<br>• To analyze the physical attributes of sea water and comprehend their influence on aquatic life<br>• To throw light on ocean circulation – a key regulator of climatic changes.<br>• To study various physical aspects of oceanography as tides, waves, and currents, which not only influence aquatic life but also life on the terrestrial realm.<br>• To get acquainted to phenomena regulating the global climate. | *R, U, An* | *PO2, PO4, PO6, PO7*<br><br>*PSO1, PSO2* |
| Unit 3: Chemical Oceanography-II | **CO3:**<br>• To study inorganic constituents – the chemicals that make up the ocean and their role in nurturing oceanic life.<br>• To understand the impact of anthropogenic activities such as pollution, ocean dumping, radioactive and thermal waste disposal, reclamation on marine environment considering the examples of various case studies. | *R, U, An* | *PO2, PO4, PO6, PO7*<br><br>*PSO1, PSO2* |
| Unit 4: Biological Oceanography-II | **CO4:**<br>• To understand the extent and division of marine environment owing to prevalent physical factors and to analyze their influence on marine biotic diversity<br>• To appreciate the vast array of marine biotic diversity from plankton to large nekton.<br>• To get enlightened by the plethora of adaptations and associations exhibited by varied marine organisms with changing climatic conditions so as to draw appropriate conservation measures.<br>• To value the mineral resources those are obtained from the oceans and their large-scale applications. | *R, U* | *PO2, PO4, PO6, PO7*<br><br>*PSO1, PSO2* |

**Course Code: SIPSZOOCN44**
**Course Name: Planktology, Fish and Fishery Science and Aquaculture**
The study of this course will accomplish the following outcomes:

| **Unit** | **Course Outcome (CO)** | **Cognitive Level** | **Affinity with PO/ PSO** |
|---|---|---|---|

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| Unit 1:<br>Planktology- II | **CO1:**<br>• To appreciate the enormous world of microscopic splendors called plankton.<br>• To elucidate the role of plankton community in aquatic ecosystems and the factors influencing their distribution and abundance.<br>• Understand the role of plankton and marine algae in relation to fisheries.<br>• Learn various methods of collection, preservation and analysis of plankton- a sought after skill in planktology, limnology and oceanography. | *R, U, An* | *PO2, PO4, PO6, PO7*<br><br>*PSO1, PSO2* |
| Unit 2:<br>Fish and Fishery Science- II | **CO2:**<br>• To gain knowledge of Fishery Science that opens an avenue for bioeconomics.<br>• Learn about population dynamics in fishes by studying their abundance, fluctuation in fishery catches, population growth and population models.<br>• Comprehend the role of Maximum Sustainable Yield and Optimum Yield in fisheries.<br>• Understand the socio-economics of fishermen in India-an attempt to bring into light the life of the fishermen community, to find out the problems that the community faced, the depth of penetration of the public policies and the interesting features about the traditional fishing villages and their heritage, and their expectations from the customers as well as from the government. | *R, U, An* | *PO2, PO4, PO6, PO7*<br><br>*PSO1, PSO2* |
| Unit 3:<br>Biotechnology in Fishery and Biometric Studies - II | **CO3:**<br>• To familiarize students with different biostatistical methods used in oceanographic and fisheries studies.<br>• Understand the role of measurement of fishes in biometric, morphometric, and meristic studies- a widely used skill in fishery science. | *R, U, Ap, An* | *PO1, PO2*<br><br>*PSO1, PSO2* |
| Unit 4:<br>Aquaculture- II | **CO4:**<br>• To introduce aquaculture to know its immense potential for generating employment<br>• To acquire knowledge for wise management of aquatic resources to minimize production costs and gain profit.<br>• To consider aquaculture as a subsidiary in the income of someone having a taste for it.<br>• To attain a clear perception of the present status of sea farming in India and to compare it with worldwide production and trends<br>• To impart essential knowledge and skills regarding advanced technologies of different aquaculture production systems.<br>• Learn about hatchery and grow out practices for cultivable species of freshwater and brackish water prawns, fishes, molluscs, echinoderms, | *R, U* | *PO2, PO4, PO6, PO7, PO8*<br><br>*PSO1, PSO2* |

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| | seaweeds in order to inculcate an entrepreneurial approach. | | |

**Biotechnology-Oceanography and Fishery Science**

**Semester IV – Practical**

**Course Code: SIPSZOBTP41 and SIPSZOBTP42**
**Course Name: Practical I & II** based on **SIPSZOBT41 and SIPSZOBT42**

| Course | Course outcomes (CO) | Cognitive Level | Affinity with PO/ PSO |
|---|---|---|---|
| SIPSZOBTP41 and SIPSZOBTP42 | • Immobilize yeast cells in calcium alginate and prepare a bioreactor column to demonstrate invertase activity in the bioreactor column in order to understand the catalytic role of invertase and its commercial significance.<br>• Plot a growth curve for the microorganisms provided to determine patterns of growth over time and to understand differential effects of media, genetics, and stress on microbial population growth.<br>• Restriction-digest the given DNA sample and demonstrate the separation of fragments by performing agarose gel electrophoresis- a very well sought after technique in molecular cloning.<br>• Considering the commercial and clinical applications, demonstrate the Western blotting for the given sample of protein- a technique used to detect, characterize and quantitate proteins.<br>• *Students Activity: Visit to the industries/institutes involved in Biotechnology research:* To gain knowledge about potential areas in research, research trends, methodology, instrumentation, facilities in order to inculcate a research-based attitude. | *R, U, An, Ap, E* | *PO2, PO5, PO6*<br><br>*PSO1, PSO2, PSO3* |

**Course Code: SIPSZOOCNP43**
**Course Name: Practical III** based on **SIPSZOOCN43**

| Course | Course outcomes (CO) | Cognitive Level | Affinity with PO/ PSO |
|---|---|---|---|
| SIPSZOOCNP43 | • To identify and describe various oceanographic instruments used in analyzing different properties of sea water. Also, to identify and describe various devices practiced in the sampling of marine organisms.<br>• To detect the presence of heavy metals in given | *U, An, Ap, E* | *PO2, PO6, PO7*<br><br>*PSO1, PSO2, PSO3* |

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| | sea water sample, understand and analyze their effects on marine life.<br>• To elucidate the factors which influence distribution, migration, and growth of fish by studying their feeding habits. It provides a key to understand many aspects of fish biology, physiology, and behavior and their conservation.<br>• To identify and describe various crafts and gears operated along the coast of India.<br>• *Student's activity:* Shore walks to observe and appreciate the parallel universe which emerges when the tide recedes. Also, to combine experiential learning in laboratory with actual observations on field.<br>• *Visit to institutes involved in Marine Biology or Oceanography Research:* To gain knowledge about potential areas in oceanographic research, research trends, methodology, instrumentation, facilities in order to inculcate a research-based attitude. | | |

**Course Code: SIPSZOOCNP44**
**Course Name: Practical IV** based on **SIPSZOOCN44**

| **Course** | **Course Outcomes (CO)** | **Cognitive Level** | **Affinity with PO/ PSO** |
|---|---|---|---|

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|---|---|---|---|
| SIPSZOOCNP44 | • To appreciate the enormous world of these microscopic splendors called plankton and develop a skill of preparing permanent mountings of the same.<br>• To provide crucial information on fish population growth and aquatic habitat well-being by studying biometrics.<br>• To identify and describe commercially important crustaceans with respect to capture fishery, their distribution, commercial value, crafts, and gears operated.<br>• To identify and describe commercially important molluscans with respect to capture fishery, their distribution, commercial value, crafts, and gears operated.<br>• To identify and describe commercially important fresh water fishes with respect to capture fishery, their distribution, commercial value, crafts, and gears operated.<br>• *Student's activity: Shell collection, Algae collection, and preparation of Herbaria:*<br>• To carry out an elaborate study involving identification, characterization, and preservation of molluscs and algae.<br>• *(Note: Only abandoned molluscan shells and washed ashore algae specimen are collected and collection is as minimal as possible)* | *U, An, Ap, C* | *PO2, PO6, PO7*<br><br>*PSO1, PSO2, PSO3* |

**Semester III – Theory**

**Paper Code: SIPSZOBT31**
**Basics of Industrial and Environmental Biotechnology – I**

***Learning Objectives:***

- *To keep abreast with the current trends in this fast-moving field of Biotechnology, that is an intersection of technology and Biology.*
- *To gain an in-depth knowledge of the application of recombinant DNA technology in food, microbial technology and for the production of genetically engineered animal cells to obtain commercial products for human use.*
- *To emphasize the significance of Biotechnology in the field of medicine for production of therapeutic agents viz., vaccines and monoclonal antibodies that have revolutionized medical science.*
- *To procure knowledge of the biotechnological aspects dealing with degradation of xenobiotics thatare foreign to our environment, and the effective utilization of biomass.*

**Unit 1: The implications of recombinant DNA technology of commercial products and microbial synthesis** **15 Lectures**

**1.1 :** The implications of recombinant DNA technology:

*****1.1.1: General account on applications of biotechnology

*****1.1.2: Commercialization of biotechnology and biotech companies

1.1.3: Prospects of novel food technology

1.1.4: Economics of microbial biotechnology

1.1.5: Areas of significant public concern: Antibiotic resistance marker gene, transfer of allergies, pollen transfer from GM plants, social, moral and ethical issues associated with GMOs

**1.2 :** Amino acids and their commercial use: Production strain, process of L-glutamate, L-aspartate, L-phenylalanine, L-tryptophan

**Unit 2: Large scale culture and production from recombinant microorganisms and genetically engineered animal cells** **15 Lectures**

**2.1**: Large scale culture and production from recombinant microorganisms:

2.1.1: Batch fermentation

2.1.2: Fed batch fermentation

2.1.3: Continuous fermentation

*****2.1.4: Maximizing the efficiency of fermentation process

2.1.5: Harvesting, disrupting and downstream processing

**2.2**: Large scale culture and production from genetically engineered animal cell cultures:

2.2.1: Design of bioreactors for large scale animal cell culture: Batch, Fed batch

2.2.2: Mammalian cell lines and their characteristics

2.2.3: Media for the cultivation of mammalian cells

*****2.2.4: Commercial products produced with mammalian cell culture

**Unit 3: Medical Biotechnology** **15 Lectures**

**3.1:** Subunit vaccines:

*****3.1.1: Subunit vaccine production against viruses: Herpes simplex, Bovine foot and mouth disease virus

3.1.2: Peptide vaccines: Synthetic drugs (engineered proteins)

3.1.3: Genetic immunization: DNA vaccines, Antisense DNA, Therapeutic ribozymes

3.1.4: Live recombinant vaccines

3.1.5: Attenuated vaccines against Cholera, *Salmonella sp*.

3.1.6: Vector vaccines: Vaccine directed against viruses–Rabies virus G-protein, Hepatitis B surface antigen

3.1.7: Anti-idiotypic vaccine for cancer treatment

**3.2:** Monoclonal antibodies (mAbs) and therapeutic applications:

3.2.1: mAbs for prevention of rejection of transplanted organs

3.2.2: Treatment of bacterial blood infection

3.2.3: Human monoclonal antibodies

3.2.4: Hybrid human-mouse monoclonal antibodies

3.2.5: HIV therapeutic agents

3.2.6: Anti-tumour antibodies

**Unit 4: Environmental Biotechnology – I** **15 Lectures**

**4.1:** Biomass utilization:

4.1.1: Microorganisms in lignocellulose degradation

4.1.2: Isolation of prokaryotic and eukaryotic cellulase gene

4.1.3: Manipulation of cellulase gene

4.1.4: Production of single cell proteins by using biomass as raw material

4.1.5: Commercial production of fructose and alcohol from biomass

4.1.6: Improvements of fructose and alcohol production

4.1.7: Fuel ethanol from biomass

**4.2 :** Bioremediation of xenobiotic compounds:

4.2.1: Characteristics of xenobiotics in the environment

4.2.2: Characteristics of aerobic microorganisms for degradation of organic pollutants

4.2.3: Genetic engineering of biodegradative pathways: Manipulation by transfer of plasmid, manipulation by gene alteration

*****4.2.4: Degradation of xenobiotic compounds: Petroleum products, n-alkanes, alkenes, cycloaliphatic compounds, aromatic hydrocarbons, polyaromatic hydrocarbons, chlorinated organic compounds (aliphatic and aromatic)

*** Topics for Seminars**

*Students Activity:*

*Visit to the industries/institutes involved in Biotechnology research:*

To gain knowledge about potential areas in research, research trends, methodology, instrumentation, facilities in order to inculcate a research-based and Entrepreneurial approach.

**Semester III – Theory**
**Paper Code: SIPSZOBT32**
**Genetic Engineering Techniques and its applications**

***Learning Objectives:***

- *To familiarize with the basic tools of genetic engineering involved in tailoring genetic information to delve into the genomes of organisms; designing cloning vectors and using DNA fragments as researchtools.*
- *To gain insight of the potential of Bioinformatics – a field applying computer knowledge to study genomes.*
- *To recognize the relevance of recombinant DNA technology in making animals with manipulated genes –transgenic animals that can be potential biofactories for production of biopharmaceuticals.*

**Unit 1: Genome Management and Analysis** **15 Lectures**

**1.1:** The basic tools of genetic engineering:

1.1.1: Chemical synthesis of DNA: Oligonucleotide synthesis by Phosphoramidite method, synthesis of genes

*1.1.2: DNA Sequencing: Maxam-Gilbert method, Sanger's dideoxynucleotide method; by using bacteriophage M13; by Primer walking

1.1.3: Polymerase chain reaction and its advantages

**1.2:** Cloning vectors:

*****1.2.1: General purpose plasmid vectors: pUC19, pBR322 (Bacterial vectors)

1.2.2: Bacteriophage and cosmid vectors

1.2.3: Yeast artificial chromosomes (YACs)

**1.3:** Analysis of Genome/ Proteome:

1.3.1: DNA fingerprinting/ physical mapping/ pulsed field gel electrophoresis

1.3.2: Analysis of the proteome

1.3.3: Analysis of mRNA transcripts

**Unit 2: Manipulation of gene expression in prokaryotes** **15 Lectures**

**2.1:** Promoters of gene expression in prokaryotes:

2.1.1: Prokaryotic gene expression

2.1.2: Isolation of functional promoters

2.1.3: Promoter selection with *E.coli* plasmid pBR316

*****2.1.4: Promoter selection with plasmid pKO1

2.1.5: Gene expression from strong and regulatable promoters

**2.2:** Expression of cloned genes in prokaryotes:

2.2.1: Increasing protein production and secretion

*****2.2.2: Inclusion bodies and fusion proteins

2.2.3: Unidirectional tandem gene arrays

2.2.4: Translation expression vectors

2.2.5: Increasing protein stability

**Unit 3: Bioinformatics** **15 Lectures**

**3.1:** Uses and applications of computers in biological sciences

***3.2:** DNA profiling: cDNA and ESTs (Expressed sequence tags)

**3.3 :** Basic research with DNA microarrays and its application in healthcare

**3.4 :** Biomedical genome research and pharmacogenomics

**3.5 :** Random amplified polymorphic DNA (RAPD)

**3.6 :** Human genomic variation: SNPs (Single nucleotide polymorphisms), SNPs and disease; QTL (Quantitative trait loci) and its relation to SNPs

**3.7 :** Satellite DNA and its types

**Unit 4: Animal Biotechnology and Human therapies** **15 Lectures**

**4.1:** Animal Biotechnology:

***4.1.1:** Transgenic animals and their applications: Mice as model system for human diseases and as test case model; cows, pigs, sheep, goats as biopharmaceuticals; transgenic insects and birds

4.1.2: Recombinant DNA technology to prevent animal diseases

4.1.3: Conservation biology: Embryo transfer

4.1.4: Regulation of transgenic animals and patenting genetically engineered animals

**4.2 :** Human therapies:

4.2.1: Tissue engineering: Skin, liver, pancreas

***4.2.2:**Xenotransplantation

4.2.3: Antibody engineering

4.2.4: Cell adhesion-based therapies: Integrins, inflammation, cancer and metastasis

4.2.5: Targeted gene replacement for correcting a mutated gene

4.2.6: Site directed mutagenesis

***Topics for Seminars**

**Semester III – Theory**

**Paper Code: SIPSZOOCN33**
**General, Physical, Chemical and Biological Oceanography**

***Learning Objectives:***

- *To give a brief introduction to acclimate students with the different aspects of Oceanography.*
- *To learn about the general features of the earth's surface under water with reference to theocean waters of the Indian subcontinent.*
- *To gain knowledge of the tools used for oceanographic studies and research.*
- *To analyze the physical attributes of sea water and comprehend their influence on aquatic life;to throw light on ocean circulation – a key regulator of climatic changes.*
- *To study inorganic constituents – the chemicals that make up the ocean and their role in nurturing oceanic life.*
- *To appreciate the vast array of life forms found in the ocean from bacteria to large nektons and their adaptations to best suit the niche in which they thrive, and to study the influence of the fluctuations they encounter in their habitats.*

**Unit 1: General Oceanography - I** **15 Lectures**

**1.1:** Terminology of submarine topography: Continental shelf, continental slope, submarine canyons, submarine mountain ranges, Guyots and trenches with special reference to the Indian Ocean and adjacent seas

***1.2:** A general knowledge of typical oceanographic research vessel and its equipment, oceanographic labs and stations of the world and India

**Unit 2: Physical Oceanography - I** **15 Lectures**

**2.1**: Physical properties of sea water: Salinity, chlorinity, temperature, light, density, pressure; Salinity-Temperature-Density relationship (STD)

**2.2**: Oceanographic circulation: Ekman spiral, geotropic current, westward intensification with dynamic topography

**Unit 3: Chemical Oceanography - I** **15 Lectures**

***3.1:** Composition of sea water: Constancy of its composition and factors affecting the composition, major and minor constituents, trace elements and their biological role

**3.2:** Dissolved gases in sea water and their role in the environment; carbon dioxide system; dissolved oxygen and oxygen profile, hydrogen sulphide

**3.3**: Nutrients in the ocean, their cycles and factors influencing their distribution: Nitrogen, Phosphorus, Silicon

**Unit 4: Biological Oceanography - I** **15 Lectures**

***4.1:** Sea as a biological environment

***4.2:** Division of marine environment

**4.3:**

4.3.1: Marine biotic diversity: An account of plankton, nekton and benthos; implications ofspecies richness, measuring diversity, quadrants of species diversity, models explaining diversity gradient

*4.3.2: Intertidal organisms and their zonation

**4.4:** Effect of physical factors on marine life:

4.4.1: Light: Photosynthesis, coloration, structural adaptations and bioluminescence

4.4.2: Temperature: Tolerance, geographical distribution, size, calcium precipitation,metabolism, bipolarity, tropical submergence, and periodicity

4.4.3: Salinity: Tolerance and distribution, size, buoyancy, and osmoregulation

4.4.4: Currents: Role in Nutrition, Transportation and Propagation

4.4.5: Marine bacteria and their role

*** Topics for Seminars**

*Student's activity:* Shore walks to observe and appreciate the parallel universe which emerges when the tide recedes. Also, to combine experiential learning in laboratory with actual observations on field.

*Visit to institutes involved in Marine Biology or Oceanography Research:* To gain knowledge about potential areas in oceanographic research, research trends, methodology, instrumentation, facilities in order to inculcate a research-based attitude.

**Semester III – Theory**

**Paper Code: SIPSZOOCN34**
**Planktology, Fish and Fishery Science, and Aquaculture**

***Learning Objectives:***

- *To study planktons, the drifting life forms inhabiting water bodies, that nourish the higher trophic levels in the ocean ecosystem.*
- *To gain knowledge of Fishery Science that opens an avenue for bioeconomics.*
- *To consider the application of techniques of Biotechnology in improving fish stock for better yields.*
- *To introduce aquaculture to know its immense potential for generating employment; to acquire knowledge for wise management of aquatic resources to minimize production costs and gain profit. Also to consider aquaculture as a subsidiary in the income of someone having a taste for it.*

**Unit 1: Planktology - I** **15 Lectures**

**1.1:**

1.1.1: Classification of plankton

1.1.2: Adaptation to planktonic life

1.1.3: Factors influencing the distribution and abundance; plankton bloom; patchiness; vertical distribution and red tide

**1.2:**

1.2.1: Diurnal migration of zooplankton

1.2.2: Inter-relationship between phytoplankton and zooplankton

**Unit 2: Fish and Fishery Science - I** **15 Lectures**

**2.1:** An overview of fish classification as per Francis Day and FAO

**2.2:**

2.2.1: Major commercial fisheries:

a) Elasmobranchs (shark and ray)
b) Teleosts: Sciaenids, Indian salmon, Seer fish, Mackerel, Sardine, Carangids, Tuna, Solefish, *Harpodon*, Ribbon fish fisheries

*****2.2.2: Crustacean fisheries: Prawns (penaeid and non-penaeid), Shrimps, Lobster and Crab

*****2.2.3: Molluscan fisheries

**Unit 3: Biotechnology in Fishery and Biometric Studies - I** **15 Lectures**

**3.1:** Fish stock improvement through selective hybridization

**3.2:** Gene transfer technology in fish: General steps for developing transgenic fish – Gene transfer by microinjection, electroporation, transfer of transgenes by injection with pantropic retroviral viruses, fish antifreeze protein gene, promoter in the production of growthhormone; *****characterization of transgenic fish (Identification of transgenic fish and expressionof transgenes); gene transfer in common carp and channel fish

**Unit 4: Aquaculture - I** **15 Lectures**

***4.1:**

4.1.1: History, scope and importance of aquaculture

4.1.2: Aquaculture practices in India

4.1.3: Cultivable organisms for aquaculture and criterion for their selection

**4.2:** Different systems of aquaculture such as Pond Culture, Cage Culture, Pen Culture, Running Water Aquaculture, Raft Culture, Aqua ranching

**4.3:** Impact of aquaculture on environment

*** Topics for Seminars**

*Student's activity:* Visit to fresh water hatchery/aquaculture farm to combine experiential learning in laboratory with actual observations on field.

*Visit to institutes involved in aquaculture research:* To gain knowledge about potential areas in research, research trends, methodology, instrumentation, facilities in order to inculcate a research-based attitude.

**Semester III – Practical**
**SIPSZOBTP31 and SIPSZOBTP32**

**Based on SIPSZOBT31 and SIPSZOBT32**

1. Demonstration of aseptic technique: Work place for aseptic handling; packing glassware (flasks, test tubes, pipettes, petri dishes) for sterilization; aseptic transfer of liquids (pipettingfrom flask to test tube).
2. Preparation of LB agar plate, slant, butt, and demonstration of streaking technique using bacterial culture to obtain isolated colonies.
3. Determination of viable cell count in the given culture of bacteria by dilution and spreading technique.
4. Using mini-prep method isolate plasmid DNA from the given strain of bacteria and show the purity of the isolate by performing agarose gel electrophoresis.
5. To estimate the number of bacteria in the given culture by nephelometry.

**Semester III – Practical**
**SIPSZOOCNP33**

**Based on SIPSZOOCN33**

1. Determination of physico-chemical parameters:
   a) Salinity (Argentometric and conductivity method)
   b) Dissolved oxygen
   c) Carbon dioxide
   d) Nitrates-nitrites
   e) Silicates
   f) Phosphate-phosphorus
2. Textural features: Sediment analysis – size fraction (sand, silt, clay)
3. Identification of foraminiferans and radiolarians from sand.
4. Estimation of primary productivity by light and dark bottle.
5. Identification of intertidal organisms:
   a) Rocky shore: Patella, Chiton, *Fissurella*, *Mytilus* species, *Perna viridis, Cardium*, *Balanus*, Gorgonids, *Littorina* and corals
   *b)* Sandy shore: Solen, Umbonium, *Oliva*, Pea crab, Fiddler crab, Molluscan shells, Starfish and *Balanoglossus*

c) Muddy shore: *Lingula*, *Chaetopterus*, *Arenicola*, Tubiculus worm and Mud skipper

**Semester III – Practical**
**SIPSZOOCNP34**

**Based on SIPSZOOCN34**

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

2. Identification of zooplankton permanent slides:
   *Noctiluca*, *Obelia medusa*, Zoea, *Zoea porcelina*, Copepods, Mysids, Echinoderm larvae,Nauplius, *Sagitta*, *Doliolum*, *Salpa*, Fish eggs and larvae, Jelly fish, *Physalia*, *Porpita*

3. Study of fecundity-maturation studies.

4. Plotting frequency polygon by ova diameter measurement.

5. Identification and classification of Marine fish:

   a) Elasmobranchs
   **Family: Carcharidae**
   *Carcharias sps.*, *Zygaena malleus*
   **Family: Rhinobatidae**
   *Rhynchobatus djeddensis*
   **Family: Trygonidae**
   *Trygon uarnak*

   b) Teleosts
   **Family: Percidae**
   *Lutianus johnii*, *Therapon sps.*, *Pristipoma maculatum*, *Synagris japonicus*, *Gerres filamentosus*
   **Family: Squamipinnes**
   *Scatophagus argus*
   **Family: Mullidae**
   *Upenoides vittatus*
   **Family: Polynemidae**
   *Polynemus tetradactylus*
   **Family: Sciaenidae**
   *Pseudosciaena diacanthus*, *Sciaena* sps.
   **Family: Trichiuridae**
   *Trichiurus savala/ haumela*
   **Family: Carangidae**
   *Caranx rottleri*, *Chorinemus toloo*
   **Family: Stromatidae**
   *Pampus chinensis*, *Pampus argenteus*

**Family: Scombridae**
*Rastrelliger kanagurta, Cybium guttatum*
**Family: Trachinidae**
*Sillago sihama*
**Family: Cottidae**
*Platycephalus punctatus*
**Family: Gobidae**
*Periophthalmus sps., Boleophthalmus sps.*
**Family: Sphyraenidae**
*Sphyraena acutippinis*
**Family: Mugillidae**
*Mugil sps.*
**Family: Gadidae**
*Bregmaceros sps.*
**Family: Pleuronectidae**
*Psettodes erumei, Cynoglossus elongatus*
**Family: Siluridae**
*Arius dussumieri*
**Family: Scopelidae**
*Saurida tumbil, Harpodon nehereus*
**Family: Sombresocidae**
*Belone stongylurus, Hemiramphus sps.*
**Family: Clupeidae**
*Pellona feligera, Clupea longiceps*
**Family: Chirocentridae**
*Chirocentrus dorab*
**Family: Muraenesox**
*Muraenesox sps.*

**Note: Minimum number of animals to be used for experiments**

**Semester IV – Theory**

**Paper Code: SIPSZOBT41**
**Basics of Industrial and Environmental Biotechnology – II**

***Learning Objectives:***

- *To keep abreast with the current trends in this fast-moving field of Biotechnology, that is anintersection of technology and Biology.*
- *To know about enzyme immobilization techniques for obtaining products of commercial use.*
- *To realize the role of Biotechnology in agriculture and environment management in benefittingmankind.*

**Unit 1: Microbial synthesis of commercial products** **15 Lectures**

**1.1:** Organic acids and their commercial applications: Citric acid, gluconic acid, lactic acid

**1.2:** Antibiotics: Cloning antibiotic biosynthetic gene by complementation and other methods; synthesis of novel antibiotics and improving antibiotic production; *****Aminoglycosides and their uses

**1.3:** Polysaccharides:

a) Bacterial polysaccharides: General properties and their commercial applications – Dextran, xanthan, alginate; genetic engineering for large scale production of xanthan gum and its modification

b) Marine polysaccharides: General properties and their commercial application – Agar andagarose, Chitosan

**1.4:** Polyesters: Polyhydroxyalkanoates (PHA) – Biosynthesis of PHA; Biopol, a commercial biodegradable plastic

**Unit 2: Large scale culture and production for Industrial Biotechnology** **15 Lectures**

**2.1: Biotransformations**

2.1.1: Selection of biocatalyst: Screening and use of novel existing biocatalyst

2.1.2: Genetic modification of existing biocatalyst (Indigo biosynthesis)

2.1.3: Biocatalyst immobilization: Methods of immobilization – Cross linking, supported immobilization, adsorption and ionicbinding, covalent coupling, lattice entrapment

2.1.4: Immobilized soluble enzymes and suspended cells

2.1.5: Immobilization of multi-enzyme systems and cells

*2.1.6: Immobilized enzyme reactors: Batch reactors, continuous reactors

2.1.7: Analytical enzymes: Enzymes in diagnostic assays – Test strip systems and Biosensors(Electrochemical and optical type)

**Unit 3: Agricultural Biotechnology** **15 Lectures**

***3.1:** Nitrogen fixation

**3.2:** Nitogenase: Components of nitrogenase; Genetic engineering of nitrogenase cluster

**3.3:** Hydrogenase: Hydrogen metabolism; genetic engineering of hydrogenase gene

**3.4:** Nodulation: Competition among nodulation organisms; genetic engineering of nodulation gene

**3.5:** Microbial insecticides: Toxins of *Bacillus thuringiensis*, mode of action and use ofthuringiensis

toxins, thuringiensis toxin gene isolation, genetic engineering of *Bacillus thuringiensis* strains and cloning of thuringiotoxin gene

**3.6:** Developing insect resistant, virus resistant and herbicide resistant plant

**3.7:** Algal products: Fuels from algae, marine natural products and their medical potential (anticancer, antiviral compounds; antibacterial agents)

**Unit 4: Environmental Biotechnology - II** **15 Lectures**

**4.1:** Bioabsorption of metals (Recovery from effluents)

*****4.1.1: Bioabsorption by fungi, algae, moss and bacteria

4.1.2: Mechanism of bacterial metal resistance and genetic engineering for specific proteins

4.1.3: Bioreactors for bioabsorption: Packed bed, fluidized bed, rotating disc, single blanket, sequential reactors

4.1.4: Phytoremediation and its use in biotechnology

**4.2:** Bioleaching of metals

4.2.1: Biochemical mechanism of bioleaching

4.2.2: Extraction from mixtures

4.2.3: Types of bioleaching

4.2.4: Methods for bioleaching: Tank and heap bioleaching

*****4.2.5: Microorganisms used for bioleaching

***Topics for Seminars**

*Students Activity:*

*Visit to the industries/institutes involved in Biotechnology research:*

To gain knowledge about potential areas in research, research trends, methodology, instrumentation, facilities in order to inculcate a research-based and Entrepreneurial approach.

**Semester IV – Theory**
**Paper Code: SIPSZOBT42**
**Genome Management, Manipulation, Regulations and Patents in Biotechnology**

***Learning Objectives:***

- *To familiarize with the basic tools of genetic engineering involved in tailoring genetic information to delve into the genomes of organisms; designing cloning vectors and using DNA fragments as research tools.*
- *To know about the basics of Human Genome Project, and Regulations and Patents in Biotechnology.*

**Unit 1: Genome management** **15 Lectures**

**1.1:** Basic tools of genetic engineering:

1.1.1: Gene transfer techniques: Protoplast fusion, calcium phosphate, precipitation, electroporation, liposome, ligand mediated, gene gun or biolistic approach, viral mediated

1.1.2: Selection and screening of recombinants

*****1.1.3: Nucleic acid probes and hybridization, Southern blotting, and Northern blotting

1.1.4: Immunological assays for identification of gene product; Western blot

**1.2:** Cloning vectors:

1.2.1: Retrovirus and SV40 vectors

1.2.2: Special purpose vectors: Expression vectors, secretion vectors, shuttle or bi-functional vectors, single stranded phage and phagemids

**Unit 2: Manipulation of gene expression in eukaryotes** **15 Lectures**

**2.1:** Eukaryotic gene expression

***2.2:** Introduction of DNA into fungi: Yeast and filamentous fungi (fungal transformation)

**2.3:** Heterologous protein production in yeasts

**2.4:** Heterologous protein production in filamentous fungi

**2.5:** Cultured insect cell expression systems: Baculovirus transfer vector

***2.6**Mammalian cell expression systems: Human Papova BK virus shuttle vector

**Unit 3: The Human Genome Project** **15 Lectures**

***3.1:** The human genome; scope and goals of the human genome project

**3.2:** Genetic linkage maps, chromosome walking, restriction mapping

**3.3:** Polymorphic DNA markers

**3.4:** Restriction fragment length polymorphism (RFLP) and its uses

**3.5:** Physical maps, Sequence tagged sites

**3.6:** Integrating genetic linkage and physical maps

***3.7:** Mapping human diseases

**3.8:** Positional cloning: Getting closer to a disease-causing gene

**3.9:** Testing for exons

**3.10:** Limitations of positional cloning

**Unit 4: Regulations and Patents in Biotechnology** **15 Lectures**

**4.1:** Regulating recombinant DNA technology

***4.2:** Regulatory requirements: Safety of genetically engineered foods, chymosin, tryptophan, bovine somatotropin

**4.3:** Regulating environmental release of genetically engineered organisms (GEO); Ice minus *Pseudomonas syringae*

**4.4:** Regulatory agencies and laws for product regulation

**4.5:** Risk assessment: How much risk?

***4.6:** Open field tests of GEO

**4.7:** Development of policy for human gene therapy

**4.8:** Patenting biotechnology inventions:

4.8.1: What constitutes the patent?

4.8.2: Patent process

4.8.3: Conditions to be satisfied for an invention to be patentable: Novelty, inventiveness, usefulness

4.8.4: Patenting in different countries; types of inventions that are not patentable in India

4.8.5: What is Paris convention? Principal features of Paris convention

4.8.6: Patenting multicellular organisms

4.8.7: Patenting and fundamental research

***Topics for Seminars**

**Semester IV – Theory**

**Paper Code: SIPSZOOCN43**
**General, Physical, Chemical and Biological Oceanography**

***Learning Objectives:***

- *To gain knowledge of the tools used for oceanographic studies and research.*
- *To analyze the physical attributes of sea water and comprehend their influence on aquatic life.To study such physical aspects of Oceanography as tides, waves and currents that not only influence aquatic life but also life on the terrestrial realm.*
- *To make students mindful of the anthropogenic activities in the ocean that pose a threat not only to the aquatic life, but the environment as a whole.*
- *To value the resources of the ocean (oil and natural gas) formed from large deposits of theremains of marine algae and plants.*

**Unit 1: General Oceanography - II** **15 Lectures**

**1.1:** Oceanographic instruments:
Grab (Peterson and Van Veen) for benthos collection, naturalist's dredge (Ekman Sanders deep sea anchor dredge), trawl, plankton nets and continuous plankton sampling system, reversing Nansen bottles, reversing thermometer, salinometer, Secchi disc, Stempel pipette and dilution jar; underwater photography, remote sensing and satellite imaging, SCUBA apparatus

**1.2:** Oceanographic expeditions: Challenger, Indian Ocean and Antarctic

**1.3:** Law of sea

**Unit 2: Physical Oceanography - II** **15 Lectures**

**2.1:** Vertical circulation: Wind induced circulation, thermohaline circulation and upwelling ofwater

**2.2:** Waves: Characteristics of waves, deep water and shallow water waves, transitional waves,wind generated waves, internal waves and Tsunami

*__2.3:__ Tides: Tides generating forces, equilibrium theory of tides, dynamic theory of tides, tidesas a source of power

*__2.4:__ Currents: Types of currents, major currents of the world, Coriolis effect and El Nino effect

**Unit 3: Chemical Oceanography - II** **15 Lectures**

**3.1:** Impact of anthropogenic activities:

3.1.1:

a) Pollution: Domestic sewage, industrial/ heavy metals; agricultural: fertilizers and pesticides
b) Oil pollution Ocean dumping
c) Radioactive and thermal waste

3.1.2: Reclamation

**Unit 4: Biological Oceanography - II** **15 Lectures**

**4.1:** Resources from the sea:

4.1.1: Mineral resources:

a) Continental margin
b) Deep sea mud oozes and manganese nodules

c) Oil, gas and sulphur deposits, and the role of ONGC

4.1.2: Bioactive compounds from the sea

4.1.3: Scientific and economical aspects of seabed exploration and mining

*** Topics for Seminars**

*Visit to institutes involved in Marine Biology or Oceanography Research:* To gain knowledge about potential areas in oceanographic research, research trends, methodology, instrumentation, facilities in order to inculcate a research-based attitude.

**Semester IV – Theory**

**Paper Code: SIPSZOOCN44**
**Planktology, Fish, Fishery Science and Aquaculture**

***Learning Objectives:***

- *To study planktons, the drifting life forms inhabiting water bodies that nourish the higher trophiclevels in the ocean ecosystem and also act as indicator species.*
- *To gain knowledge of Fishery Science with regards to Population Dynamics.*
- *To consider the application of statistical tools to study fishery science.*
- *To learn about aquaculture of fin fish as well as crustaceans and molluscs.*
- *To attain a clearperception of the present status of sea farming in India.*

**Unit 1: Planktology - II** **15 Lectures**

**1.1 :** Marine algae and plankton in relation to fisheries; indicator species

**1.2 :** Methods of collection, preservation, and analysis of plankton

**1.3 :** Marine biodeterioration: Fouling and Boring organisms

**Unit 2: Fish and Fishery Science - II** **15 Lectures**

**2.1:** Population Dynamics:

2.1.1: Abundance in population and fishery; fishery catches and fluctuation

2.1.2: M.S.Y., optimum yield, age composition, population growth, population models

**2.2:** Socio-economics of fishermen

**Unit 3: Biotechnology in Fishery and Biometric Studies - II** **15 Lectures**

**3.1:** Statistical methods:

Collection of data, sampling methods, presentation of data, measurement of central tendency and dispersion, frequency distribution, analysis of variance and co-variance, correlation regression, theory of probability, tests of significance, Chi-square test

**3.2:** Measurement of fish:

Measurement of length and weight, morphometric measurements, meristic counts, Biometric index

**Unit 4: Aquaculture - II** **15 Lectures**

**4.1:** Hatchery and grow out practices for cultivable species of fresh water fish (Indian major carps

and exotic carps) and prawns (*Macrobrachium rosenbergii*); culture of air breathing fishes

**4.2:** Integrated aquaculture and sewage-fed fishery; hatchery and grow out practices for the culture of brackish water fishes (*Chanos chanos* and *Lates calcarifer*) and prawns (*Penaeus monodon* and *Penaeus indicus*)

**4.3:** Culture of molluscs (clams, oyster: edible and pearl, and mussels), echinoderms (seacucumber), sea weeds

***4.4:** Present status of sea farming in India

***Topics for Seminars**

**Semester IV – Practical SIPSZOBTP41 and SIPSZOBTP42**

**Based on SIPSZOBT41 and SIPSZOBT42**

1. Immobilize yeast cells in calcium alginate and prepare a bioreactor column to demonstrate invertase activity in the bioreactor column.

2. Restriction-digest the given DNA sample and demonstrate the separation of fragments by performing agarose gel electrophoresis. Interpret the results by comparing with the standarddigests provided.

3. Demonstrate the Western blotting technique for the given sample of protein.

4. To plot a growth curve for the microorganisms provided.

5. Demonstrate the effect of media on growth curves of given microorganism, using two different media (minimal and enriched)

**Semester IV – Practical**
**SIPSZOOCNP43**

**Based on SIPSZOOCN43**

1. Oceanographic instruments:
   a) Nansen reversing bottle
   b) Deep sea reversing thermometer
   c) Bathythermometer
   d) Drift bottle
   e) Ekman's current meter
   f) Secchi disc
   g) Plankton nets: Standard net, Hensen net and Clarke Bumpus net
   h) Stempel pipette and counting slide
   i) Nekton sampling device: Trawls
   j) Benthic sampling devices: Dredges, grabs and corers
2. Detection of heavy metals:
   a) Zinc
   b) Lead

c) Copper

3. Study of food and feeding habits in fish.
4. Identification of crafts and gears.

**Semester IV – Practical**
**SIPSZOOCNP44**

**Based on SIPSZOOCN44**

1. Preparation of zooplankton mountings.
2. Collection of marine algae and preparation of herbaria (at least five different forms).
3. Biometric studies of fish/ prawn:
   a) Study of relationship between total length and standard length/ head length/ body depthlength/ body weight.
   b) Calculate correlation (standard length and total length, head length and total length, bodydepth and total length). Calculate the index values for various relationships.
4. Identification of fouling and boring organisms:
   *Limnoria sps., Lepas, Balanus, Caprella, Teredo, Littorina, Crassostrea, Pellaria/ Sertularia*
5.
   a) Identification and classification of fresh water fish: Rohu, *Catla*, Mrigal, *Tilapia*, *Gourami*
   b) Identification and classification of fresh water prawn: Giant fresh water prawn, *Macrobrachium rosenbergii*
6. Crustacean fishery:
   *Penaeus monodon, P. indicus, M. monoceros, P. stylifera, Solenocera indica, Nematopaleomon,Acetes indicus*
7. Molluscan fishery:
   *Meretrix, Perna viridis, Katelysia sps., Crassostrea sps., Xancus pyrum, Solen kempi*, Cuttle fish and gastropods

8. Visit to aquaculture centres, boat building yards, processing plants and marine biological institutions (Excursions or study tours); Student Activity:
   a) Collection of molluscan shells
   b) Preparing herbaria from marine algae (at least 5)
   c) Preparation of shrimp pickle

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

**M.Sc. Zoology Syllabus (Autonomous)**
**Biotechnology-Oceanography and Fishery Science**
**Credit Based Semester and Grading System**
**(With effect from academic year 2018-19)**
**Semester III and Semester IV**

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**M.Sc. Zoology Syllabus (Autonomous)**
**Biotechnology-Oceanography and Fishery Science**
**Credit Based Semester and Grading System**
**(With effect from academic year 2018-19)**
**Semester III and Semester IV**

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**Practical Examination Question Paper Pattern**
**Semester III – Practical (SIPSZOBTP31)**

**Based on SIPSZOBT31**

**Time: 5 hours** **Marks: 50**

**Q.1** Determination of viable cell count in the given culture of bacteria by dilution and spreading technique. **(Day 1)** **25**

**OR**

**Q.1** Using mini-prep method isolate plasmid DNA from the given strain of bacteria and show the purity of the isolate by performing Agarose gel electrophoresis. **(Day 1)** **25**

**Q.2** To demonstrate aseptic techniques: **15**
a) Work place for aseptic handling
b) Packing glassware (flask, test tube, pipette, petri dish) for sterilization
**c)** Aseptic transfer of liquids (pipetting from flask to test tube) **(Day 2)**

**Q.3** Viva **05**

**Q.4** Journal **05**

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**Marking scheme**
**Semester III – Practical (SIPSZOBTP31)**

**Q.1** Determination of viable cell count in the given culture of bacteria by dilution and spreading technique. **(Day 1)** **25**

| Category | Marks |
|---|---|
| Aim and requirement | 01 |
| Principle | 05 |
| Performance | 10 |
| Diagram | 04 |
| Results and Interpretation | 05 |

**OR**

**Q.5** Using mini-prep method isolate plasmid DNA from the given strain of bacteria and show the purity of the isolate by performing Agarose gel electrophoresis. **(Day 1)** **25**

| Category | Marks |
|---|---|
| Aim and requirement | 01 |
| Principle | 05 |
| Performance | 15 |
| Results and Interpretation | 04 |

**Q.6** To demonstrate aseptic techniques: **15**
a) Work place for aseptic handling
b) Packing glassware (flask, test tube, pipette, petri dish) for sterilization
c) Aseptic transfer of liquids (pipetting from flask to test tube) **(Day 2)**

| Category | Marks |
|---|---|
| Aim and requirement | 01 |

| | |
|---|---|
| Principle | 03 |
| Performance | 08 |
| Results and Interpretation | 03 |

**Q.7** Viva **05**

**Q.8** Journal **05**

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**Semester III – Practical (SIPSZOBTP32)**
**Based on SIPSZOBT32**

**Time: 5 hours** **Marks: 50**

**Q.1** Preparation of LB agar plate, slant, butt and demonstration of streaking technique using bacterial culture to obtain isolated colonies. **(Day 1)** **25**

**Q.2** Estimate number of bacteria in the given culture by Nephelometry. **(Day 2)** **15**

**Q.3** Viva **05**

**Q.4** Journal **05**

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**Marking scheme**
**Semester III – Practical (SIPSZOBTP31)**

**Q.1** Preparation of LB agar plate, slant, butt and demonstration of streaking technique using bacterial culture to obtain isolated colonies. **(Day 1)** **25**

| Category | Marks |
|---|---|
| Aim and requirement | 01 |
| Principle | 04 |
| Performance | 15 |
| Results and Interpretation | 05 |

**Q.2** Estimate number of bacteria in the given culture by Nephelometry. **(Day 2)** **15**

| Category | Marks |
|---|---|
| Aim and requirement | 01 |
| Principle | 03 |
| Performance | 05 |
| Observation and Graph | 04 |
| Results and Interpretation | 02 |

**Q.3** Viva **05**
**Q.4** Journal **05**

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**Practical Examination**
**Question Paper Pattern**
**Semester III – Practical (SIPSZOOCNP33)**

**Based on SIPSZOOCN33**

**Time: 5 hours** **Marks: 50**

**Major Question:**

**Q.1 (A)** Determination of physicochemical parameters: **10**
Salinity/ Dissolved oxygen/ $CO_2$/ Nitrates-Nitrites/ Silicates/ Phosphate-Phosphorus

**OR**

**Q.1 (A)** Estimation of primary productivity by light and dark bottle

**Q.1 (B)** Identification of foraminiferan and radiolarian shells (ANY FOUR) **05**

**Minor Question:**

**Q.2** Sediment analysis from the given sample. **07**

**Q.3** Identify and describe (Any 6 intertidal organisms) **18**

**Q.4** Viva **05**

**Q.5** Journal **05**

**********

**Marking scheme**
**Semester III – Practical (SIPSZOOCNP33)**

**Major Question:**

**Q.1 (A)** Determination of physicochemical parameters: **10**
Salinity/ Dissolved oxygen/ $CO_2$/ Nitrates-Nitrites/ Silicates/ Phosphate-Phosphorus

**OR**

**Q.1 (A)** Estimation of primary productivity by light and dark bottle

| **Category** | **Marks** |
|---|---|
| Aim | 01 |
| Reagents | 01 |
| Theory and Principle | 03 |
| Procedure | 03 |
| Result and Interpretation | 02 |

**Q.1 (B)** Identification of foraminiferan and radiolarian shells (ANY FOUR) **05**

| **Category** | **Marks** |
|---|---|
| Correct Identification | 01 |
| Diagram | 01 |
| Description and viva | 03 |

**Minor Question:**

**Q.2** Sediment analysis from the given sample. **07**

| Category | Marks |
|---|---|
| Aim and Principle | 01 |
| Performance | 03 |
| Result and Interpretation | 03 |

**Q.3** Identify and describe (Any 6 intertidal organisms) **18**

For each specimen:

| Category | Marks |
|---|---|
| Correct identification | 01 |
| Description | 02 |

**Q.4** Viva **05**

**Q.5** Journal **05**

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**Semester III – Practical (SIPSZOOCNP34)**
**Based on SIPSZOOCN34**

**Time: 5 hours** **Marks: 50**

**Major Question:**

**Q.1 (A)** Fish identification (1 Elasmobranch, 4 Teleosts) **15**

**(B)** Fish identification as per Francis day volume **05**

**Minor Question:**

**Q.2** Study of maturity, plankton settling method/ weight method/ weight displacement method/ counting method and study of fecundity and maturation studies. **08**

**OR**

**Q.2** Plot a frequency polygon by ova diameter measurement. **08**

**Q.3** Identification (4 spots) **12**

**Q.4** Viva **05**

**Q.5** Journal **05**

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**Marking scheme**
**Semester III – Practical (SIPSZOOCNP33)**

**Major Question:**

**Q.1 (A)** Fish identification (1 Elasmobranch, 4 Teleosts) **15**

For each specimen:

| Category | Marks |
|---|---|
| Correct identification | 01 |
| Description | 02 |

**(B)** Fish identification as per Francis day volume **05**

| Category | Marks |
|---|---|
| Correct identification & fin formula | 01 |
| Description | 04 |

**Minor Question:**

**Q.2** Study of maturity, plankton settling method/ weight method/ weight displacement method/ counting method and study of fecundity and maturation studies. **08**

**OR**

**Q.2** Plot a frequency polygon by ova diameter measurement. **08**

| Category | Marks |
|---|---|
| Aim and Principle | 01 |
| Performance | 04 |
| Calculation, Result & Interpretation | 03 |

**Q.3** Identification (4 spots) For each spot: **12**

| Category | Marks |
|---|---|
| Correct identification | 01 |
| Description | 02 |

**Q.4** Viva **05**

**Q.5** Journal **05**

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**Practical Examination**
**Question Paper Pattern**
**Semester IV – Practical (SIPSZOBTP41)**
**Based on SIPSZOBT41**

**Time: 5 hours** **Marks: 50**

**Q.1** Demonstrate the effect of medium on growth curves of given microorganism using enriched media. **(Day 1)** **25**

**OR**

**Q.1** Demonstrate the effect of medium on growth curves of given microorganism using minimal media. **(Day 1)** **25**

**Q.2** Immobilize yeast cells in calcium alginate, prepare beads and keep them overnight in activation medium. (**Day 1)** **15**

**Q.3** Viva **05**

**Q.4** Journal **05**

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**Marking scheme**
**Semester IV – Practical (SIPSZOBTP41)**

**Q.1** Demonstrate the effect of medium on growth curves of given microorganism using enriched media. **(Day 1)** **25**

**OR**

**Q.1** Demonstrate the effect of medium on growth curves of given microorganism using minimalmedia. **(Day 1)** **25**

| Category | Marks |
|---|---|
| Aim and requirement | 01 |
| Principle | 03 |
| Performance | 15 |
| Observation and Graph | 04 |
| Results and Interpretation | 02 |

**Q.2** Immobilize yeast cells in calcium alginate, prepare beads and keep them overnight in activation medium. (**Day 1)** **15**

| Category | Marks |
|---|---|
| Aim and requirement | 01 |
| Principle | 03 |
| Performance | 08 |
| Results and Interpretation | 03 |

**Q.3** Viva **05**

**Q.4** Journal **05**

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**Semester IV – Practical (SIPSZOBTP42)**
**Based on SIPSZOBT42**

**Time: 5 hours** **Marks: 50**

**Q.1** Prepare a bioreactor column to demonstrate invertase activity in the bioreactor column. **(Day 2)** **25**

**Q.2** Restriction-digest the given DNA sample and demonstrate the separation of fragments by performing Agarose gel electrophoresis. Interpret the results by comparing with the standard digests provided. **(Day 2)** **15**

**OR**

**Q.2** Demonstrate Western blotting technique for the given sample of protein. **(Day 2)** **15**

**Q.3** Viva **05**

**Q.4** Journal **05**

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**Marking scheme**
**Semester IV – Practical (SIPSZOBTP42)**

**Q.1** Prepare a bioreactor column to demonstrate invertase activity in the bioreactor column. **(Day 2)** **25**

| Category | Marks |
|---|---|
| Aim and requirement | 01 |
| Principle | 03 |
| Performance | 15 |
| Observation and Graph | 04 |
| Results and Interpretation | 02 |

**Q.2** Restriction-digest the given DNA sample and demonstrate the separation of fragments by performing Agarose gel electrophoresis. Interpret the results by comparing with the standard digests provided. **(Day 2)** **15**

**OR**

**Q.2** Demonstrate Western blotting technique for the given sample of protein. **(Day 2)**

| Category | Marks |
|---|---|
| Aim and requirement | 01 |
| Principle | 03 |
| Performance | 08 |
| Results and Interpretation | 03 |

**Q.3** Viva

**Q.4** Journal

**Practical Examination Question Paper Pattern**
**Semester IV – Practical (SIPSZOOCNP43)**

**Based on SIPSZOOCN43**

**Time: 5 hours** **Marks: 50**

**Major Question:** **12**

**Q.1** Identification of oceanographic instruments (3 spots)

**Minor Question:**

**Q.2 (A)** Detection of heavy metals: Zinc/ Lead/ Copper **10**

**(B)** Food and feeding habits in fish **06**

**Q.3** Identification (2 crafts and 2 gears) **12**

**Q.4** Viva **05**

**Q.5** Journal **05**

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**Marking Scheme**
**Semester IV – Practical (SIPSZOOCNP43)**

**Major Question:**

**Q.1** Identification of oceanographic instruments (3 spots) **12**

For each spot:

| **Category** | **Marks** |
|---|---|
| Correct identification | 1 |
| Description | 3 |

**Minor Question:**

**Q.2 (A)** Detection of heavy metals: Zinc/ Lead/ Copper **10**

| Category | Marks |
|---|---|
| Aim and requirement | 01 |
| Principle/Background theory | 02 |
| Performance | 05 |
| Results and Interpretation | 02 |

**(B)** Food and feeding habits in fish **06**

| Category | Marks |
|---|---|
| Aim and requirement | 01 |
| Principle/Background theory | 01 |
| Performance | 03 |
| Results and Interpretation | 01 |

**Q.3** Identification (2 crafts and 2 gears) **12**

For each spot:

| **Category** | **Marks** |
|---|---|
| Correct identification | 1 |
| Description | 2 |

**Q.4** Viva **05**

**Q.5** Journal **05**

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**Semester IV – Practical (SIPSZOOCNP44)**
**Based on SIPSZOOCN44**

**Time: 5 hours** **Marks: 50**

**Major Question:**

**Q.1** Biometric study of fish:

a) Study of relationship between total length and standard length/ head length/ body depth length/ body weight. **04**

b) Calculate correlation (standard length and total length/ head length and total length) **03**

**Minor Question:**

**Q.2** Preparation of zooplankton mountings (5 mountings of zooplankton) **10**

**Q.3** Identification: **08**

a) Fouling and boring organism
b) Fresh water fish/ fresh water prawn
c) Crustacean fishery
d) Molluscan fishery

**Q.4**

a) Herbarium **05**
b) Field report (visit to aquaculture center, boat building yards, processing plants, marine biological institutions – Excursion or Study tours) **04**
c) Collection of molluscan shells (5 shells) **04**
d) Report on shrimp/ prawn pickle **02**

**Q.5** Viva **05**

**Q.6** Journal **05**

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## Marking Scheme
## Semester IV – Practical (SIPSZOOCNP44)

**Major Question:**

**Q.1** Biometric study of fish:

a) Study of relationship between total length and standard length/ head length/ body depth length/ body weight. **04**
b) Calculate correlation (standard length and total length/ head length and total length) **03**

| Category | Marks |
|---|---|
| Aim and requirement | 01 |
| Principle | 01 |
| Performance | 03 |
| Calculation, Result and Interpretation | 02 |

**Minor Question:**

**Q.2** Preparation of zooplankton mountings (5 mountings of zooplankton) **10**

| Category | Marks |
|---|---|
| Aim and requirement | 02 |
| Isolation, Identification and mounting | 08 |

**Q.3** Identification: **08**

a) Fouling and boring organism
b) Fresh water fish/ fresh water prawn
c) Crustacean fishery
d) Molluscan fishery

| **Category** | **Marks** |
|---|---|
| Correct identification | 1/2 |
| Description | 1 1/2 |

**Q.4**

a) Herbarium **05**

b) Field report (visit to aquaculture centre, boat building yards, processing plants, marine biological institutions – Excursion or Study tours) **04**

c) Collection of molluscan shells (5 shells) **04**

d) Report on shrimp/ prawn pickle **02**

**Q.5** Viva **05**

**Q.6** Journal **05**

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**M.Sc. Zoology Syllabus (Autonomous)**
**Revised Syllabus under Choice Based Credit System (CBCS)Approved by the Board of Studies in Zoology**
**Effective from Academic year: 2023-24**
**Semester III and Semester IV**

**Scheme of Examination**

The performance of learners will be evaluated in two parts for the Theory component of theCourse:
1. Internal Assessment with 40% marks
2. Semester End Examination (written) with 60% marks
The Practical component of the Course will be evaluated by conducting Semester End Practical Examination of 50 marks.

**Internal Assessment Theory (40%)**
It is the assessment of learners on the basis of continuous evaluation as envisaged in the Credit Based System by way of participation of learners in various academic and correlated activities in the given semester of the program.
**Seminar Marks: 20**
Evaluation will be conducted on the basis of Seminar/ Presentation given by the student on a topic chosen from the syllabus for each paper. The marking scheme shall be:

- Content of Presentation: **05 marks**
- Quality of Presentation: **05 marks**
- Presentation skills: **05 marks**
- Question-Answer discussion: **05 marks**

**Assignment Marks: 20**
Evaluation will be conducted on the basis of Research paper review / Book review / Poster presentation / Abstract writing / Preparation of Standard Operating Procedure or Calibration of Instruments / Role play or Skit on topic relevant to the paper / Report on Industry or Field Visit or Writing an article relevant to the paper etc.

**Semester End Assessment Theory (60%)**
**Marks: 60**
**Duration: 2 hours**
**Theory question paper pattern:**

- There shall be five questions of 12 marks each. On each unit there will be one questionand the 5th question will be based on the entire syllabus.

  **OR**

  There shall be four questions of 15 marks each, each question based on one unit.
- All questions are compulsory with internal choice within the questions.
- Questions may be subdivided and the allocation of marks depends on the weightage ofthe topic.

**Semester End Assessment Practical**
**Marks: 50**
**Duration: 5 hours**

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