

As Per NEP 2020

University of
Mumbai



Program: MSc Part II

NEP

**Course: Zoology SSS
(Oceanography and Fishery Technology)**

Syllabus for MSc Semester III to IV

Ref: GR dated 16th May 2023 for Credit Structure of PG

(With effect from the academic year 2024-25)

University of Mumbai



(As per NEP 2020)

Sr. No.	Heading	Particulars
1	Title of program O: _____ B	PG Degree (MSc Zoology SSS) (Two Years) (Oceanography and Fishery Technology)
2	Scheme of Examination R: _____	NEP 50% Internal 50% External, Semester End Examination Individual Passing in Internal and External Examination
3	Standards of Passing R: _____	40%
4	Credit Structure R: _____	Attached herewith
5	Semesters	Sem. III & IV
6	Program Academic Level	6.5
7	Pattern	Semester
8	Status	New
9	To be implemented from Academic Year	2024-25

Sign of the BOS
Chairman
Name of the Chairman
BOS in Zoology

Sign of the
Offg. Associate Dean
Name of the Associate
Dean
Faculty of Science

Sign of the
Offg. Associate Dean
Name of the
Associate Dean
Faculty of Science

Sign of the
Offg. Dean
Name of the Dean
Faculty of Science

Preamble

VISION OF SSS

‘Developing **centre of excellence** to bring about **blue revolution** in Maharashtra, contributing to the National wealth’

MISSION OF SSS

To facilitate **training, education** and **research** of global standards; **developing skills** and **knowledge** of youth in general and socio-economically weak strata in particular, addressing the issue of food security and employability by **providing cadre** for sustainable exploitation of living and non-living resources of inland water bodies as well as along EEZ of Maharashtra and beyond the Continental shelf.

OVERVIEW & HISTORY OF SSS

SSS was inaugurated by then minister of Industry and Ports, Shri Narayan Rane on **5th Sept 2014** at the Kalina campus, University of Mumbai. Seven students were enrolled in the first batch. They faced **challenges** in terms of infrastructural facilities restricted to one classroom in the Life Science building at Kalina, no permanent staff (administrative, teaching and non-teaching). At the behest of the then Chairman BOS Zoology Vinayak Dalvie and support of Vice Chancellor Prof Suhas Pednekar, some of the **teachers volunteered** by conducting classes, practicals, short and long excursions.

During 2015, SSS led by Hon’ble Minister Shri Vinodji Tawade had a synergistic meet with the **Australian delegation led by Premier** (Chief Minister) and Minister of State Development, Government of Western Australia Hon. Colin Barnett

Students of SSS were initially enrolled in Mithibai, Khalsa, Vaze college and Ratnagiri sub-center for M.Sc. Zoology offering oceanography. Students enrolled for M.Sc. Life sciences offering Marine Biotechnology at Kalina. SSS under the able leadership of the first Academic Coordinator of SSS V.V. Dalvie, achieved a few worthy milestones. A few of them are as follows:

International Interdisciplinary Symposium organized by Department of Biological Sciences, KIHE Society’s, Maharashtra College of Arts, Science and Commerce in

collaboration with Sindhu Swadyay Sanstha (SSS), University of Mumbai, Mumbai, on occasion of the Founder's Day on 7th January 2019. Guest speaker for the symposium - **Prof. V.N Attri, Chair in Indian Ocean Studies (IOS) at the IORA Secretariat, University of Mauritius**

Organised Seminar "Aquifer Management in Sindhudurg" followed by a discussion. Vijayalaxmi Vishwanath Dalvie College" at Talere on Saturday, 18th August, 2018 at 11.00

Invited talk By **Shri Rajendra Singhji (Waterman of India, Magsaysay Award and Stockholm Water Award winner)**, Tarun Bharat Sangh

UGC, Human Resource Development Centre, University of Mumbai "SHORT TERM COURSE IN MARINE SCIENCES" Funded by RUSA was Coordinated by Sindhu Swaddhyay Sanstha (SSS) , Venue - Naval War College, INS Mandovi, Verem, Goa – 403 109 **(21st February 2018 –28th February2018)**

An excursion for SSS PG students to Goa to visit NIO, NCAOR (Current name NCPOR) from 22nd Feb 2016 to 25th Feb 2016

Biodiversity at Burundi, Jaitapur, Malvan were also carried out by the PG teachers, Visits to landing centers, processing and value addition industries. Hands on training in aquaculture and Chinese hatchery, Onboard experiences, and lectures by naval officers and International and national resource persons were all invited to deliver guest lectures at SSS during conferences like ' Know Your Oceans' organized by Director CEMAS Dr. Anuradha Majumdar.

SSS has conceived plans for expansion and spreading its wings through-out the jurisdiction of the coastal regions of Konkan under UoM. The plans included PG & Doctoral Centre at Kalina in 'Health Centre' Building; Processing & Value addition Centre at Ratnagiri University Subcenter ; Centre for Aquaculture at Palghar and Marine Fishery Capture Station at Vengurle. It was envisioned that the students of SSS would be offered a cafeteria approach to complete courses in all these centers during their PG courses

INTRODUCTION

The interdisciplinary field of oceanography includes the study of the oceans' physical, chemical, geological, and biological components. A specialisation in oceanography provides zoology students with a deeper understanding of the various life forms that inhabit marine ecosystems and the intricate interactions that occur within these environments. This postgraduate curriculum is specifically designed to enhance students' understanding of marine zoology by giving them a thorough foundation in oceanographic principles. The curriculum makes sure that students are prepared to pursue careers in marine sciences or advanced research by fusing theoretical knowledge with practical skills.

AIMS&OBJECTIVES

- ***To offer a thorough comprehension of oceanographic processes:*** Give students an understanding of the ocean's physical, chemical, geological, and biological dynamics.
- ***To draw attention to the value of marine ecosystems:*** Promote an understanding of the intricacy and significance of marine ecosystem services and biodiversity.
- ***To hone research abilities:*** Instruct students in the use of modern oceanographic research methodologies and analytical techniques.
- ***To encourage interdisciplinary learning:*** Promote the application of ideas from different scientific fields to tackle challenging marine-related issues.
- ***To get ready for careers in the workforce:*** Students should be prepared for careers in environmental consulting, conservation, marine biology, and related fields.

LEARNINGOUTCOMES:

After finishing this course, students will be able to:

1. ***Understand Oceanographic Processes:*** Show that they have a solid grasp of the basic geological, biological, chemical, and physical processes that control ocean systems.
2. ***Examine Marine Ecosystems:*** Considerably examine the dynamics, structure, and functions of marine ecosystems as well as the biological communities that inhabit them.
3. ***Conduct Research:*** Using the proper oceanographic techniques and instruments, plan and carry-out autonomous research projects.
4. ***Use Interdisciplinary Approaches:*** Utilize interdisciplinary approaches to integrate information from environmental science, oceanography, and zoology to address complex

issues in the marine sciences.

5. ***Communicate Scientific Information:*** Use publications, talks, and written reports to effectively convey scientific findings.

6. ***Assess Human Impact:*** Determine how human activity affects marine environments and make recommendations for long-term conservation and management strategies.

7. ***Seek Professional Development:*** Demonstrate preparedness for positions in government, business, academia, and non-governmental organizations pertaining to marine sciences.

This curriculum seeks to motivate students to support the conservation and sustainable management of marine resources by fostering a profound understanding and appreciation of the ocean's role in the Earth's system.

Credit Structure of the Program (Sem I, II, III & IV) (Table as per Parishish (1 withsign of HOD and Dean)

Year	Level	Semester III			Hours
2nd Year	6.5	Semester I (Mandatory)			
		Course Code	Title	Credit	
		PSZO301	Capture fisheries (4T)	4	30+60
		PSZO302	Industrial Fishery (4T)	4	30+60
		PSZO303	Planktonology & Biotechnology in fishery (2C)	2	30
		PSZO304	Lab Exercises based on Capture & Industrial fishery PSZO301 & PSZO302 (4P)	4	120
		Elective			
		PSZOE1,305	Biochemistry and metabolic pathways (2T+2P)	4	30+60
		PSZOE2,305	Developmental biology (2T+2P)		
		PSZO106RP	Research Project (4C)	4	60
		Total Credit		22	450
		Semester IV			
		PSZO401	Brackish and Marine Water Aquaculture(4T)	4	30+60
		PSZO402	Blue Economy and Fishery Science (4T)	4	30+60
		PSZO403	Lab Exercises based on Aquaculture and fishery science PSZO401 & PSZO402 (4P)	4	30+60
		Elective			
		PSZOE1:404	Basic and applied biotechnology (2T+2P)	4	30+60
		PSZOE2:04	Oceanic pollution I & II (2T+2P)		
		PSZO205FP	Research Project (6C)	6	90
		Total Credit		22	450
Total Credits (both semesters)			4 4	900	

OJT/FP has been kept open and will be decided by the institutions/colleges in their capacity and infrastructures/resources available.

SEM III

Syllabus
M.Sc. Zoology (Oceanography and Fishery Technology)
(Sem.- III)
Course I PSZO 301 Capture fisheries (credits 4)

Unit 1: Inland Fishery resources of India

15 Hrs

Objective:

- *To create awareness about the rich diversity of commercially important aquatic resource organisms of inland fisheries and their economic potential.*

Desired outcome:

- *Learners will get a bird eye view on the dimension and magnitude of inland fisheries potential of India.*

1.1 Riverine fisheries

1.1.1 West coast riverine system

- a. Narmada
- b. Tapti.

1.1.2 East coast riverine system

- a. Mahanadi,
- b. Godavari ,
- c. Krishna,
- d. Kaveri

1.1.3 North Eastern riverine system

- a. Bramhaputra,
- b. Barak

1.2 Lacustrine fisheries:

1.2.1 Origin

1.2.1 Ecology

1.2.2 Productivity of lakes

1.3 Tropical fisheries:

1.3.1 Carps

1.3.2 Cat fishes

1.4 Temperate fisheries:

1.4.1 Trout

1.4.2 Mahaseer

1.5 Fishery Resources of Maharashtra

1.5.1 East coast river system

1.5.2 North Eastern river system

Unit 2: Estuarine fishery resources of India

15 Hrs

Objective:

- To create awareness about the rich diversity of commercially important aquatic resource of estuaries and other economic potential.

Desired outcome:

- Learners will get knowledge about the specific estuarine resource of India.
- 2.1 Ecology of Estuaries
 - 2.2 Principle Fisheries of Brackish water, Fisheries of Chilka, Pulicat & Kolleru lake
 - 2.3 Hooghly Matlah Estuary
 - 2.4 Hilsa fishery, Mullet fishery, Khajuri fishery

Unit 3: Commercially important fisheries in India

15 Hrs

(Taxonomy, Distribution, Food and feeding, Reproduction, Crafts and gears used and catch trends of the following fisheries)

Objective:

- To create awareness about food and feeding, reproduction and crafts and gears used in fisheries.

Desired outcome:

- Learners will get knowledge about the crafts and gears, food and feeding used in fisheries of India with fresh or preserved specimens.

3.1 Coastal fisheries

- 3.1.1. Shark – *Scoliodon laticaudus*
- 3.1.2 Ray – *Himantura uarnak* (*Trygon uarnakx*)
- 3.1.3 Sardine – *Sardinella longiceps*
- 3.1.4 Mackerel – *Rastrelliger kanagurta*
- 3.1.5 Bombay duck – *Harpodon nehereus*
- 3.1.6 Pomfret – *Pampus cinereus* (*Stromateus cinerius*), *Pampus chinensis* (*Stromateus sinensis*), *Parastrumateus niger*
- 3.1.7 Thread fin – *Eleutheronemate tradactylum* (*Polynemus tetradactylus*), *Galeoides decadactylus* (*Polynemus polydactylus*)
- 3.1.8 Pink Perch – *Nemipterus japonicus* (*Synagrisjaponicus*)
- 3.1.9 Ribbon fish – *Lepturacanthus savala* (*Trichiurus savala*)

3.2 Deep Sea fisheries

- 1.2.1. Yellow fin Tuna – *Thunnus albacares*
- 1.2.2 Skipjack Tuna – *Katsuwonus pelamis*

3.3 Commercial Shell fish fisheries

- 3.3.1 Crustacean
 - a) Shrimp – *Litopenaeus vannamei*
 - b) Crab – *Scylla serrata*
 - c) Prawn – *Penaeus monodon*
 - d) Lobster – *Panulirus sp.*
- 3.3.2 Mollusca
 - a) Clam – *Katelysia opima*

- b) Mussels – *Perna viridis* (*Mytilus viridis*)
- c) Oyster – *Crassostrea ingens*
- d) Cephalopod – *Sepia pharaonis*

Unit 4 : Population Dynamics and Conservation

15 Hrs

Objective:

- *To impart knowledge about conservation and sustainable consumption / harvesting of these depletable natural resources.*

Desired outcome:

- *Learners will appreciate and adapt the principles of sustainability for conservation and long-term sustenance of the capture fisheries.*

- 4.1 Structure and estimation of population
- 4.2 Factors affecting fish population
- 4.3 Problems of overfishing
- 4.4 Concept of MSY (Maximum Sustainable Yield), MEY (Maximum Economic Yield) and recruitment
- 4.5 Conservation of capture fisheries resource
- 4.6 Abundance in population and fishery
- 4.7 Fishery catches and fluctuation, Optimum Yield, Age Composition, Population Growth.

Course II PSZO 302 Industrial fisheries (credits 4)

Objectives: The course aims at

- imparting a comprehensive overview of the scientific and technical aspects of food packaging.
- familiarizing the students with the basic concepts of entrepreneurship and marketing related to fishery industries

Desired outcomes :On completing the course, the student will be able to:

- get equipped with the knowledge of packaging machinery, systems, testing and regulations of packaging, helping in job placement in fish processing / export units
- understand and apply the entrepreneurship and marketing skills and become a successful entrepreneur.

Unit 1 Dry, salted and smoked products

15 Hrs

- 1.1 Fish / Prawn Pickle
- 1.2 Fish Chakli and Wafers
- 1.3 Artificial products / Crabs streaks
- 1.4 RTE products
- 1.5 Fish Kabab ,
- 1.6 Fish cutlet
- 1.7 Fish Ambotik

Unit 2 Fish, Shellfish and Seaweed Products and By-products

15Hrs

- 2.1 By-products
- 2.2 Fermented fish products
- 2.3 Products from marine invertebrate's shell waste
- 2.4 Seaweed products

Unit 3 Packaging Methods for Fish Products and By-products

15Hrs

- 3.1 Food packaging
- 3.2 Packaging materials
- 3.3 Modified atmosphere packaging
- 3.4 Labeling and printing of packaging materials
- 3.5 Biodegradable plastics, Edible packaging and Bio-composites
- 3.6 Environmental Concerns: Recycling and Disposal of Plastic waste

Unit 4 Entrepreneurship and Marketing

15hrs

- 4.1 Role of Government and other organizations in promoting entrepreneurship.
- 4.2 Science and Technology in Entrepreneurship Development

4.3 Fish Market

4.4 Fish markets & marketing in India

Course III PSZO 303 Planktonology & Biotechnology in fishery (Credits 2)

Objective :

- Students can learn about plankton.
- Students will learn about the scope of biotechnology in the field of fishery.

Outcome

- Students will have overall knowledge about plankton.
- Students will have knowledge about the importance of biotechnology in the field of fishery.

Unit 1 Planktonology

15Hrs

1.1 Classification of Plankton.

1.2 Adaptation to planktonic life.

- a. Factors influencing the distribution and abundance,
- b. plankton bloom,
- c. patchiness,
- d. vertical distribution
- e. red tide.
- f. Diurnal migration of zooplankton.

1.3 Inter-relationship between phyto and zooplankton.

Unit 2 Biotechnology in fishery.

15Hrs

3.1. Fish stock improvement through selective hybridization.

3.2. Gene transfer technology in fish:

- a. General steps for developing transgenic fishes.
- b. Gene transfer by microinjection,
- c. electroporation,
- d. transfer of transgenes by injection with pantropic retroviral viruses,
- e. fish antifreeze protein gene,
- f. promoter in the production of growth hormone.

3.3 Characterization of transgenic fish. (Identification of transgenic fish and expression of transgenes).

3.4 Gene transfer in common carp and channel fish.

Course IV Lab exercises based on PSZO 301 & PSZO 302 (Credits 4)

Lab exercises based on Capture fishery PSZO 301

1. Identification, Classification of Marine fishes w.r.t. Fishery Aspects on the following: List of Marine fishes:
 - A. Elasmobranchs:
 - a) Family Carchariidae: *Carcharias* sps., *Zygaena malleus*
 - b) Family Rhinobatidae: *Rhynchobatus djiddensis*
 - c) Family Trygonidae: *Himantura uarnak*(*Trygon urnakx*)
 - B. Teleost:
 - a) Family Percidae: *Lutjanus johnii*, *Therapon* sps.,
Nemipterus japonicus (*Synagris japonicus*)
 - b) Family Squamipinnes: *Scatophagus argus*
 - c) Family Polynemidae: *Eleutheronemate tradactylum* (*Polynemus tetradactylus*),
 - d) Family Sciaenidae: *Sciaena* sps.
 - e) Family Trichuridae: *Lepturacanthus savala* (*Trichiurus savala*)/(*haumela*)
 - f) Family Carangidae: *Caranx rottleri*
 - g) Family Stromatidae: *Pampus argenteus*, *Pampus chinensis* (*Stromateus sinensis*),
 - h) Family Scombridae: *Rastrelliger kanagurta*, *Cybium guttatum*
 - i) Family Gobidae: *Boleophthalmus* sps.
 - j) Family Mugilidae: *Mugil* sps.
 - k) Family Pleuronectidae: *Psettodes erumei*, *Cynoglossus elongatus*
 - l) Family Scopelidae: *Saurida tumbil*, *Harpodon nehereus*
 - m) Family Sombresocidae: *Strongylura strongylura* (*Belone stongylurus*), *Hemiramphus* sps.
 - n) Family Clupeidae: *Sardinella longiceps* (*Clupea longiceps*)
 - o) Family Chirocentridae: *Chirocentrus dorab*
 - p) Family Muraenesox: *Muraenesox* sps.
2. Plotting the frequency polygon by ova diameter measurement.
3. A. Biometric studies of fish / prawn relationship between Total length & standard length.
3. B. Calculate correlation between Total length and standard length & calculate the index values for various relationships.
4. A. Biometric studies of fish / prawn relationship between Total length and head length.
4. B. Calculate correlation between Total length and Head length & calculate the index values for various relationships.
5. A. Biometric studies of fish / prawn relationship between Total length and body depth.
5. B. Calculate correlation between Total length and body depth & calculate the index values for various relationships.
6. A. Biometric studies of fish / prawn relationship between Total length and body weight.

- B. Calculate correlation between Total length and Body weight & calculate the index values for various relationships.
7. Identification & Classification of fresh water, estuarine and marine non fish organisms
 - a) Tilapia, Cat fishes- *Clarias batrachus*
 - b) Fresh water prawn (*Macrobrachium rosenbergii*)
 - c) Hilsa fishery, Mullet fishery
 - d) Trout and Mahaseer
 8. Visit to fish landing centre / local fish market.

Lab exercises based on Industrial fishery based on PSZO 302

1. Collection of seaweeds and preparation of herberia.
2. Collection of sea shells and preparation of artifacts.
3. Preparation of fish by-products:
 - a) Fish Protein Concentrate
 - b) Fish body oil
 - c) Fish meal
 - d) Chitosan
 - e) Isinglass
4. Identification of packaging materials:
 - a) Simple & Lacquered Cans
 - b) Polyolefin Films
 - c) Waxed Duplex cartons
 - d) Retort Pouches
 - e) Corrugated Fiberboard box
5. Fish market survey to study (any one):
 - a) Fluctuations in the availability and price of fish
 - b) Various preserved & processed fish / prawns
 - c) The availability of various by products, value added products and its price
 - d) Various packaging materials used in fish processing industries
6. Mounting of the different types of scales of fishes.
7. Comparative study of gill rakers of fishes w.r.t. different feeding habit
8. Qualitative tests of protein and lipid from algae.

PSZOE1,305 Elective: Biochemistry and Metabolic pathways. (2C)

Unit 1: Fundamentals of Biochemistry

15Hrs

Objectives:

- To understand the fundamentals of chemistry of biomolecules, their interactions and their role in biological system.

Outcomes:

- Learners shall have in-depth understanding of the fundamentals of chemical basis of life.
- Learners shall apply the fundamental knowledge about the biomolecules to identify and analyse these biomolecules in real life practices.

1.1 Interactions of Macromolecules

1.1.1 Stability of Proteins and Nucleic Acids; Stabilizing Interactions such as Vander Waals, Electrostatic, Hydrogen Bonding, Hydrophobic Interactions

1.1.2 Conformation of proteins: Ramachandran plot, secondary structure, domains, motif and folds, hydropathy index of amino acids, isoelectric point (pi) of proteins

1.2 Complex biomolecules

1.2.1 Glycoproteins: blood group determinants

1.2.2 Complex Lipids: Phospholipids, Sphingolipids, Gangliosides, Sterols and Waxes

1.2.3 Lipoproteins: classification and functions of chylomicrons, VLDL, LDL, HDL, and free fatty acid-albumin complex

Unit 2: Metabolism and Metabolic Pathways

15Hrs

Objectives:

- To understand the metabolic pathways of various biomolecules, their significance and interrelationships in the biological systems.

Outcomes:

- Learners shall illustrate the bioenergetics and metabolic pathways of various biomolecules.
- Learners shall apply the understanding of the regulatory mechanisms underlying various metabolic pathways and interpret it in real life practices.

2.1 Carbohydrate and Lipid Metabolism

2.1.1 Glycolysis and its energetics.

2.1.2 Gluconeogenesis: reaction sequence from pyruvate, gluconeogenesis from amino acids, glycerol, propionate and lactate

2.1.3 Glycogen metabolism: Glycogenesis, Glycogenolysis.

2.1.4 Significance of the pathways: Hexose Monophosphate (HMP) Shunt as a multifunctional pathway; Uronic acid pathway; glyoxalate cycle

2.1.5 Fatty acid metabolism: Oxidation of saturated even and odd carbon atom, and unsaturated fatty acids, metabolism of cholesterol

2.2: Amino acid and Nucleic acid Metabolism

2.2.1: Metabolism of Amino acids: Transamination, Deamination, Urea cycle.

2.2.2: Formation of amino acids from Pyruvate, TCA cycle intermediates, Acetyl CoA.

2.2.3: Nucleic Acid metabolism: Denovo synthesis: synthesis of purine and pyrimidine nucleotides; Salvage Pathway; Catabolism of purine and pyrimidine nucleotides.

Lab exercises based on Biochemistry PSZOE1 304 (2C)

1. Titration curve of weak acid.
2. Titration curve of strong acid.
3. Estimation of proteins by Bradford's method.
4. Estimation of glucose by Benedict's quantitative reagent (Titrimetric method).
5. Isolation and determination of glycogen in the given tissue (liver/ skeletal muscle/kidney) by Anthrone method.
6. Determination of saponification value of fats/oils.
7. Preparation of beads by immobilization of yeast cells in calcium alginate.
8. Monitoring of Invertase activity in bioreactor column of immobilized yeast cells by DNSA method.
9. Restriction digestion of the given DNA sample and separation of the fragments by agarose gel electrophoresis.
10. SDS-polyacrylamide slab gel electrophoresis of proteins

OR

PSZOE2, 305 Elective: Developmental biology (2C)

Unit I: Developmental Biology-I

15 Hrs

- 1.1. Basic concepts in developmental Biology
 - 1.1.1. Cell fate and commitment
 - 1.1.2. Mechanism of developmental commitment
 - 1.1.3. Mosaic and regulative development
 - 1.1.4. Pattern formation and compartments
 - 1.1.5. Morphogenesis and cell adhesion:
 - a) Differential cell affinity
 - b) Cadherins and catenins
 - c) Sorting out of embryonic tissues and cell recognition
- 1.2. Cell differentiation and Totipotency
 - 1.2.1. Nucleocytoplasmic interaction
 - 1.2.2. Mechanism of gene action during cell differentiation
 - 1.2.3. Factors affecting cellular differentiation
 - 1.2.4. Maintenance of differentiation

Unit II: Developmental Biology- II

15 Hrs

- 2.1. Cell specialization: RBC, secretory cell, retinal rod cell
- 2.2. Organizer and its role in embryonic development
- 2.3. Primary embryonic induction
- 2.4. Metamorphosis, Regeneration and Aging
 - 2.4.1. Metamorphosis:
 - (a) Amphibian metamorphosis;
 - b) metamorphosis in insects-
 - (i) Types of insect metamorphosis
 - (ii) Eversion and differentiation of imaginal discs;
 - (iii). Hormonal control of insect metamorphosis;
- c) programmed cell death

2.4.2. Regeneration:

- (a) Regeneration in Hydra
- (b) Regeneration of Salamander limbs.

2.4.3. Aging: Senescence, life span and causes of aging.

Lab exercises based on developmental biology PSZOE2 (2C)

1. To study morphogenetic movement in chick embryo.
2. To study development of Chick embryo at 18hrs.
3. To study development of Chick embryo at 24hrs.
4. To study development of Chick embryo at 48hrs.
5. To study development of Chick embryo at 72hrs.
6. To study regeneration in Hydra
7. To study different types of metamorphosis.

SEM IV

Course I PSZO401 Shell fish& fin fish culture (Credit 4)

Objective:

- To understanding the measures for reducing operating costs and maximizing the farmer's income.
- To develop a more economic ration for fish from wastes to useful fish protein production

Outcomes:

- The student will have the knowledge about breeding, raising and harvesting of fin fish.
- The student will able to learn about the employment and economic advantages, as well as the possibility of sustaining species that might be over fished.

Unit 1 Shellfish culture

15Hrs

- 1.1 Crab culture
- 1.2 Brackish water Prawn – *Penaeus monodon* Culture
- 1.3 Pearl oyster culture
- 1.4 Live feed culture

Unit 2 Finfish culture

15Hrs

- 2.1 Lates calcarifer
- 2.2 Mullet
- 2.3 Milk fish

Unit 3 Farm Engineering

15Hrs

- 3.1 Design, layout and construction of different aqua farms and aqua house.
- 3.2 Construction and design of pond dyke and sluice gate
- 3.3 Water supply and drainage system
- 3.4 Design and fabrication of automatic feeder, aerator and bio filter
- 3.5 Instruments (Kits) for measuring water quality

Unit 4 Fin Fish and Shell fish Pathology and Health Management

15Hrs

- 4.1 Fish Pathology: Causative agents, symptoms and control of some infectious diseases of fish.
- 4.2 Shell Fish Pathology: Some common diseases of prawns.
- 4.3 Health Management.

Course II PSZO402 Blue Economy and Fishery Science (4C)

UNIT 1 Blue Economy

15Hrs

Objectives:

- To explain the significance of the ocean in economic development.
- To apply economic valuation techniques to assess the worth of marine ecosystems.

Desired outcomes:

- The learner evaluates the economic, social and environmental impacts of different Blue Economy practices.
- Learner can assess the potential of emerging technologies in advancing the goals of Blue Economy

- 1.1 Introduction to Blue Economy.
- 2.1 Importance of Ocean resources
- 1.3 Sustainable Development Goals and Blue Economy
- 1.4 Economic Valuation of Marine Ecosystem
- 1.5 Challenges and Opportunities in Blue Economy
- 1.6 Case Studies in Blue Economy initiatives
- 1.7 Policy and Governance in Blue Economy

Unit: 2 Fish Behavior

15Hrs

Objectives:

- To describe the sensory perception and communication methods used by fish.
- To analyze the factors influencing foraging behavior in different marine habitats.

Desired Outcomes:

- The learner develops the ability to summarize the sensory systems in fish and explain how they facilitate communication and interaction within fish populations.
- Learner applies knowledge of environmental cues and prey availability to predict and interpret foraging behavior in various fish species

- 2.1 Introduction to Fish Behavior.
- 2.2 Sensory systems in fish (vision, hearing, smell, taste, touch, and lateral line).
- 2.3 Reproductive strategies in fish (spawning behaviors, parental care, mating systems).
- 2.4 Types of fish migrations (diel, seasonal, reproductive).
- 2.5 Recent advancements in the study of fish behavior (genetics, neurobiology, bioacoustics).
- 2.6 Effects of pollution, habitat degradation, and climate change on fish behavior.

UNIT 3: Biometric studies

15Hrs

3.1. Statistical methods:

- a. Collection of data,
- b. Sampling methods,

- c. Presentation data,
- d. Measurement of central tendency and dispersion,
- e. Frequency distribution,
- f. Analysis of variance and co-variance,
- g. Correlation regression,
- h. Theory of probability,
- i. Tests of significance,
- j. Chi-square test.

3.2. Measurement of fish:

- a) Measurement of length and weight
- b) Morphometric measurements
- c) Meristic counts
- d) Biometric index

Unit 4 Crafts and gears

15Hrs

- 4.1 Basic boat building (Parts, Design, Material used)
- 4.2 Methods of protection from fouler & borers.
- 4.3 Crafts used on the east coast & west coast.
- 4.4 Operations – Gill, Trawl, Purse seine nets, Hooks & lines
- 4.5 Turtle exclusion device (TED)
- 4.6 Non-conventional fishing methods.
- 4.7 Navigational & sea safety equipment.

Course III Practicals based on PSZO 401 & PSZO 402 (Credits 4)

Lab exercises based on Aquaculture PSZO 401

1. Identification of various farm equipment such as feeding cups, trays, paddle wheels, aerators, fountains, Sluice gate models, elbow pipe outlets.
2. Identification of Aquaculture feed:
 - Green algae, blue-green algae, spirulina, diatoms, infusoria, rotifers, cladocerons, tubifex, brine shrimp, chironomids.
 - Culture of earthworms, bait fish and forage fish.
3. Identification of finfish and shellfish diseases
 - a) Fungal Diseases – Saprolegniasis, Branchiomycosis.
 - b) Bacterial Diseases – Fin and Tail rot, Dropsy, Vibriosis.
 - c) Protozoan Diseases – White spot diseases, Costiasis.
 - d) Metazoans – Hirudiniasis, Argulosis.
 - e) Viral diseases – IHN, CCV.
4. Aquaculture medicines and its importance in fisheries:

Geotax, aqua one, formalin, malachite green, methylene blue, potassium permanganate, hydrogen peroxide and glutaraldehyde phostoxin, dipterex, antimicrobials, copper sulphate, sumithion, melathion
5. Estimation of salinity of given sample of water.
6. Estimation of conductivity of given water sample.
7. Estimation of Nitrate of the given sample of water .
8. Estimation of phosphate of the given sample of water.
9. Visit to fish farming and submit its report.

Lab exercises based on fishery Science PSZO 402

1. Aquaculture Efficiency Analysis - Analyze the efficiency of aquaculture systems.
2. Ocean Pollution Remediation Techniques- Evaluate the effectiveness of different pollution remediation methods.
3. Marine Biodiversity Assessment- Assess the biodiversity of a specific marine habitat.
 - A) Index of diversity
 - B) Index of rarity
 - C) Index of frequency
 - D) Index of dominance.
 - E) Shanon Index
4. Sustainable Fishing Practices Evaluation-Assess the sustainability of fishing practices in a local fishery.
5. Exploration Behavior in Fish- To observe and analyze the exploration behavior of fish in a novel environment.
6. Social Hierarchies in Fish - To study the establishment and maintenance of social hierarchies among fish in a controlled environment.
7. Feeding Behavior in Fish - To investigate the feeding behavior of fish in response to different food types and feeding regimes.
8. Shoaling Behavior in Fish - To explore the shoaling behavior of fish and its underlying mechanisms in a controlled setting.
9. Aggression and Territoriality in Fish - To investigate aggression and territorial behavior in fish and its role in resource defense and social structure.
10. Learning and Memory in Fish - To investigate learning and memory capabilities in fish using a conditioning paradigm.

PSZOE1- 404 Elective: Basic and Applied Biotechnology. (2C)

Objectives-

- To know basics of biotechnology, techniques of sterilization of equipment and lab
- How to handle different chemicals and instruments in sterilized environment
- To know the types of pollution and how it'll be cleaned by using different strains of bacteria
- How to know biotechnological techniques can be beneficial for human health, livestock, and agriculture

Learning Outcomes-

- To know benefits of eradicating pollution by using natural resources instead of artificial ones
- Use of biotechnology in improvement of healthy human life, productive livestock, and profitable agriculture

Unit 1 Basic Biotechnology

15Hrs

1.1 Waste management-

1.1.1 Bio degradation of heavy metals

1.1.2 Water cleaning

1.1.3 Removing oil spills

1.1.4 Air, water and soil pollution

1.1.5 Bio-mining

Unit 2 Applied Biotechnology

15Hrs

2.1 Applications in Human Health and livestock:

2.1.1 Antibiotic production

2.1.2 Molecular diagnostics

2.1.3 Animal vaccine production

2.1.4 Poultry and fisheries

2.2 Applications in Agriculture:

2.2.1 Major types of beneficial and harmful microorganisms in soil.

2.2.2 Bio-remediation

Lab exercises based on Biotechnology PSZOE1:404 Elective (2C)

- 1) Structure, Principle, and Process of sterilization using an autoclave.
- 2) Preparation of glassware for autoclaving.
- 3) Preparation of media.
- 4) Study of basic laboratory symbols and precautionary measures while handling the instruments.
- 5) Preparation of agar plate, slant, and butt and techniques of inoculation of *E.coli* sample to observe the growth after incubation.
- 6) Methods of decontamination and disposal.
- 7) Maintaining and labeling for chemicals, samples, kits etc. by putting barcodes.
- 8) Maintaining SOPs and log books for instruments along with periodic checking.
- 9) Visit to agricultural research Institute/IVF center/vaccine production industry/animal tissue culture laboratory along with report submission.

OR

PSZOE2:404 Elective: Oceanic Pollution I &II (2C)

Unit 1- Oceanic Pollution I

15hrs

- 1.1 Etiology of marine & oceanic pollution
- 1.2 Possible natural disturbances causing pollution in oceans with detailed account in each ocean in particular
- 1.3 Anthropogenic activities resulting in oceanic pollution
- 1.4 Oceanic pollutants and their characteristics for human benefits
- 1.5 Known remedial measures for pollution at sea & oceanic level

Unit 2 - Oceanic Pollution II

15Hrs

- 2.1 Effects of marine & oceanic pollution in view of modern advances in Chemistry
- 2.2 Natural disturbances causing pollution in oceans with detailed account in each ocean in particular using actual & virtual models
- 2.3 Carbon sequestration

2.4 Converting the ill-effects of pollutants for development of seas & oceans

2.5 Remedial measures for pollution at sea & oceanic level using various recent advances in Biochemistry and Nanobiotechnology

Lab exercises based on Marine pollution. PSZOE2:404 (2C)

1. Estimation of COD
2. Estimation of BOD
3. Estimation of Nitrates.
4. Estimation of Phosphates.
5. Estimation of heavy metal Lead.
6. Estimation of heavy metal Copper.
7. Estimation of heavy metal Zinc.
8. Estimation of heavy metal cadmium.
9. Estimation of biodiversity of planktons and seaweeds .

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1. Book: "The Blue Economy: 10 Years, 100 Innovations, 100 Million Jobs" by Gunter Pauli
Article: "What is the Blue Economy?" by World Bank

Video: "Introduction to Blue Economy" by Blue Economy

2. Book: "Blue Economy and Sustainable Development" edited by Wickramaratne and Berkes
Article: "The Role of Blue Economy in Achieving Sustainable Development Goals" by

UNDP

- Video: "Sustainable Development Goals: Ocean Economy" by SDG Academy
3. Book: "Valuing Ecosystem Services: Methodological Issues and Case Studies" edited by Pushpam Kumar
Article: "Economic Valuation of Marine and Coastal Ecosystems: Is it Useful for Policy?" by PNAS
Video: "Valuing Marine Ecosystem Services" by World Bank - Link
 4. Book: "Blue Economy Case Studies" edited by UNESCO
Article: "Success Stories in Blue Economy" by World Ocean Initiative
Video: "Blue Economy Success Stories" by Blue Frontier
 5. Book: "Governance of the Blue Economy: Policy Implications in the Context of SIDS" edited by Veitayaki and Singh
Article: "Policy and Governance for Blue Economy" by OECD - Link
Video: "Policy and Governance in Blue Economy" by IISD - Link
 6. Book: "Fish Behavior" by John E. Bardach, John J. Magnuson, and Robert C. May. (ISBN: 978-0878930103)
Article: "Fish Behavior in Relation to Fisheries Management and Conservation" by David L.G. Noakes et al. (Journal of Fish Biology, 2012)
Video: "Introduction to Fish Behavior" by Dr. Karen Cheney (YouTube)
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Article: "Communication in Fishes" by Jacques Bshary and Redouan Bshary (Behaviour, 2013)
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 11. Book: "Fisheries Management: Progress Towards Sustainability" edited by Graeme F. Smith et al. (ISBN: 978-1119962663)
Article: "Anthropogenic Effects on Fish Behavior" by Steven J. Cooke et al. (Conservation Physiology, 2014)
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Modality of Assessment

The examination pattern for all courses (Theory and Practical) offered in this syllabus will be 50% internal and 50% external (semester end).

A) Internal Assessment (Theory)- 50%

Sr. No.	Evaluation type	Total Marks (50)	Total Marks (25)
1	One Assignment/ Case study	20	15
2	Active participation in routine class instructional deliveries (Seminar)	20	05
3	Group discussion/ quiz/ test	10	05

B) External examination (Semester End Theory Examination)- 50%

Semester end theory examination (for both semester III and IV) shall be conducted as per the following pattern:

a) Mandatory courses (Theory):

i) Course I and II of 50 Marks each.

ii) Duration – These examinations shall be of two hours duration for each paper.

iii) Theory Question Paper Pattern:

- There shall be five questions each of 10 marks.
- For each unit there will be one question and the first one will be based on the entire paper.
- All questions shall be compulsory with internal choice within the question. Each question will be of 15 to 20 marks with options.
- Questions may be subdivided into sub-questions a, b, c... and the allocation of marks depend on the weightage of the topic.

b) Mandatory paper (Theory) and Elective courses (Theory)

i) Course 5- **PSZOPHY305** in semester III and Elective courses in both the semesters will be of 25 Marks.

ii)Duration – These examinations shall be of one hour duration for each paper.

iii)Theory Question Paper Pattern:

- There shall be three questions of 9, 8 and 8 marks.
- First question (with 09 marks) will be based on the entire paper.
- On each unit there will be one question of 08 marks
- All questions shall be compulsory with internal choice within the questions. Each question will be of 12 to 18 marks with options.
- Question may be subdivided into sub-questions a, b, c... and the allocation of marks depend on the weightage of the topic.

c) Laboratory exercises (For both Mandatory and Elective courses) 25 Marks

1) Internal Assessment (Practical)- 50%

Sr. No.	Evaluation type	Total Marks (25)
1	Survey/Review submission/Charts and clay model submission/Report submission based on Field visit/ Report submission of behavioral studies * Suggestive topics are given below	15
2	Timely completion and submission of journal	05
3	Overall participation and attendance	05

External Assessment (Practical)- 50%

25 Marks

Semester End Practical Examination shall be based on the practical conducted (course wise) and shall be decided by the Chairperson concerned covering all the practical mentioned in the syllabus and without affecting integrity of the practical course.

***Note** - The practicals may be conducted by using specimens authorized by the wild life and such other regulating authorities though it is strongly recommended that the same should be taught by using photographs / audio-visual aids / simulations / models etc. as recommended by the UGC and as envisaged in the regulation of the relevant monitoring bodies. No new specimens, however, shall be procured for the purpose of conducting practicals mentioned here-in above.

N.B: I) It is pertinent to note that we have to adhere strictly to the directions as given in the UGC Circular F14-4/2006 (CPP-II). II) Apart from the Institutional Animal Ethics Committee (IAEC) and any other Committee appointed by a Competent Authority / Body from time to time, every college should constitute the following Committees: 1) A Committee for the Purpose of Care and Supervision of Experimental Animals (CPCSEA) and 2) A Dissection Monitoring Committee (DMC) to ensure that no dissections are done.

Composition of DMC shall be as follows:

- i) Head of the Concerned Department (Convener / Chairperson)
- ii) Two Senior Faculty Members of the concerned Department
- iii) One Faculty of related department from the same College
- iv) One or two members of related department from neighboring colleges. Use of animals for any experiment / dissection /mounting is banned. Simulations, authorized permanent specimens / slides, charts, models and other innovative methods are encouraged.

Following points will be noted while conducting animal experiments:

- a) No animals will be sacrificed by the students.
- b) Euthanasia by CO₂ gas will be practiced in a separate room away from the students.
- c) Students will be sensitized to the minimal use of animals for experiments and alternatives to use of animals.

Skeleton Question Paper pattern for theory examinations

University of Mumbai
M.Sc. ZOOLOGY Paper Pattern of
Semester III / Semester IV examination
(For 50 Marks Papers)

Maximum Marks: 50

Duration: 2.0 Hours

Marks Option: 80

- Question 1. Based on Modules I to IV (Mixed Questions)
Question 2. Based on module I
Question 3. Based on module II
Question 4. Based on module III
Question 5. Based on module IV

Instructions:

- a. All questions are compulsory.
- b. All questions carry equal marks.
- c. Draw neat and labelled diagrams wherever necessary.

1. Answer any **four questions** from the following: (Based on all 4 modules) **(10)**
 - a)
 - b)
 - c)
 - d)
 - e)
 - f)
 - g)
 - h)
2. Answer any **two questions** from the following: (Based on module I) **(10)**
 - a)
 - b)
 - c)
3. Answer any **two questions** from the following: (Based on module II) **(10)**
 - a)
 - b)
 - c)
4. Answer any **two questions** from the following: (Based on module III) **(10)**
 - a)
 - b)
 - c)
5. Answer any **two questions** from the following: (Based on module IV) **(10)**
 - a)
 - b)
 - c)

University of Mumbai
M.Sc. ZOOLOGY Paper Pattern of
Semester III / Semester IV examination
(For 25 Marks Papers)

Maximum Marks: 25

Duration: 1.0 Hour

Marks Option: 42

Question 1: Based on modules I to II (Mixed Questions)

Question 2: Based on module I

Question 3: Based on module II

Instructions:

- a.** All questions are compulsory.
- b.** All carry equal marks.
- c.** Draw neat and labeled diagrams wherever necessary.

1. Answer any **four questions** from the following: (Based on all 2 module) **(09)**
 - a)
 - b)
 - c)
 - d)
 - e)
 - f)
2. Answer any **two questions** from the following: (Based on module I) **(08)**
 - a)
 - b)
 - c)
3. Answer any **two questions** from the following: (Based on module II) **(08)**
 - a)
 - b)
 - c)

Skeleton question papers for Practical examination

**UNIVERSITY OF MUMBAI
MSc Zoology Semester-III
PSZOP301**

Laboratory exercises based on Capture fishery

(Time: 10.00 am - 2.00 pm)

Total Marks: 25

Duration: 4 hours

Semester End Examination

(Total Marks 25)

- Q.1 Calculate the correlation between (Total length and standard length/ Total length and head length/ Total length and body depth/ Total length and body weight) and calculate the Index values for various relationships. (08marks)
- Q.2 Identify and classify. (A to C) (06 marks)
- Q.3 Fish landing Centre/ Local fish market visit report.
a. Submission (05 marks)
b. Viva (03 marks)
- Q.4 Viva voce based on the theory. (03 marks)

Submission of certified journal is mandatory

.....

Suggested Guidelines for Practical Assessment (Internal)

Internal examination

(Total marks 25)

- Q.1 Plotting the frequency polygon by Ova diameter measurement. (15 marks)
- Q.2 Timely completion and submission of Journal. (05 marks)
- Q.3 Overall participation and attendance. (05 marks)

Skeleton question papers for Practical examination

**UNIVERSITY OF MUMBAI
MSc Zoology Semester-III
PSZOP302**

Laboratory exercises based on Industrial Fishery (4T)

(Time: 10.00 am - 2.00 pm)

Total Marks: 25

Duration: 4 hours

Semester End Examination

(Total Marks 25)

- | | | |
|-----|--|--------------------------|
| Q.1 | Identification of packaging materials.
A. B C D | (08marks) |
| Q.2 | Mounting of the different types of scales of fishes.
OR | (06 marks) |
| Q.2 | Comparative study of gill rakers of fishes.
OR | (06 marks) |
| Q.2 | Qualitative tests for protein and lipid from algae. | (06 marks) |
| Q.3 | Fish market survey report.
a. Submission
b. Viva | (05 marks)
(03 marks) |
| Q.4 | Viva voce based on the theory. | (03 marks) |

Submission of certified journal is mandatory

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Suggested Guidelines for Practical Assessment (Internal)

Internal examination

(Total marks 25)

- | | | |
|-----|---|------------|
| Q.1 | Collection of sea weeds and preparation of herbaria.
OR | (15 marks) |
| Q.1 | Collection of seashells and preparation of Artifacts.
OR | |
| Q.1 | Preparation fish byproducts (Fish Protein Concentrate/ Fish body oil/ Fish meal/ Chitosan/ Isinglass) | |
| Q.2 | Timely completion and submission of Journal. | (05 marks) |
| Q.3 | Overall participation and attendance. | (05 marks) |

UNIVERSITY OF MUMBAI
MSc Zoology Semester-III
PSZOE1,304
Laboratory exercises based on Biochemistry
(Time: 10.00 am - 2.00 pm)

Semester End Examination

(Total Marks 25)

Total Marks: 25

Duration: 4 hours

Q.1. Determine a titration curve of weak acid. (08marks)

OR

Determine a titration curve of strong acid.

Q.2. Estimate an amount of protein by Bradford's method. (06 marks)

OR

Estimate an amount of glucose by Titrimetric method.

OR

Estimate a saponification value of fats/oil.

OR

Prepare beads by immobilization of yeast cells in calcium alginate.

Q.3. Monitor an invertase activity of immobilized yeast cells by DNSA method. (08marks)

OR

Restriction digestion of DNA sample and separate the fragments by agarose gel electrophoresis.

OR

Carry out electrophoresis of given proteins by SDS-PAGE and interpret the result.

Q.3. Viva voce based on the theory. (03 marks)

Submission of certified journal is mandatory

.....

Suggested Guidelines for Practical Assessment (Internal)

Internal Examination	(Total Marks 25)
Q.1. Isolate and compare amount of glycogen from different fishes captured from three different habitat.	(15 marks)
Q.2. Timely completion and submission of Journal.	(05 marks)
Q.3. Overall participation and attendance.	(05 marks)

UNIVERSITY OF MUMBAI
MSc Zoology Semester-III
PSZOE2,305
Laboratory exercises based on Developmental Biology.

(Time: 10.00 am - 2.00 pm)

Total Marks: 25

Duration: 4 hours

Semester End Examination

(Total Marks 25)

Q.1. Mount chick embryo at 18hrs/24hrs/48hrs/72hrs and describe. (10 marks)

Q.2. Identify and describe: (12 marks)

w.r.t. Metamorphosis- (Any 3)

- a) Cockroach
- b) Termite
- c) Butterfly

w.r.t. Morphogenetic movements in chick embryo- (Any 3)

- a) Gastrulation
- b) Epiboly
- c) Invagination

Q.3. Viva voce based on the theory (03 marks)

Submission of certified journal is mandatory

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Suggested Guidelines for Practical Assessment (Internal)

Internal Examination

(Total Marks 25)

Q.1. Set up a hydra culture to study its regeneration and observe the effect of pollutants like heavy metal (lead)/tobacco extract/ copper sulphate. (15 marks)

Q.2. Timely completion and submission of Journal. (05 marks)

Q.3. Overall participation and attendance. (05 marks)

UNIVERSITY OF MUMBAI
MSc Zoology Semester-IV
PSZOP401
Laboratory exercises based on Aquaculture
(Time: 10.00 am - 2.00 pm)

Total Marks: 25

Duration: 4 hours

Semester End Examination

(Total Marks 25)

- Q.1 Identification. (A to D) (08marks)
A. Farm equipment
B. Farm equipment
C. Aquaculture feed
D. Finfish and shellfish disease
- Q.2 Estimation of Salinity/ Conductivity/ Nitrate/ Phosphate of given sample water. (06 marks)
- Q.3 Fish farming visit report. (05 marks)
a. Submission (03 marks)
b. Viva
- Q.5 Viva voce based on the theory. (03 marks)

Submission of certified journal is mandatory

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Suggested Guidelines for Practical Assessment (Internal)

Internal Examination

(Total Marks 25)

- Q.1 Aquaculture medicines and its importance in fisheries. (15 marks)
- Q.2 Timely completion and submission of Journal. (05 marks)
- Q.3 Overall participation and attendance. (05 marks)

UNIVERSITY OF MUMBAI
MSc Zoology Semester-IV
PSZOP402
Laboratory exercises based on fishery science
(Time: 10.00 am - 2.00 pm)

Total Marks: 25

Duration: 4 hours

Semester End Examination

(Total Marks 25)

- | | | |
|-----|--|------------|
| Q.1 | Assess the biodiversity of a specific marine habitat. (Any 2)
A. Index of diversity
B. Index of rarity
C. Index of frequency
D. Index of dominance
E. Shannon index | (08marks) |
| Q.2 | Assess the sustainability of fishing practices in local fishery.
OR | (08 marks) |
| Q.2 | To observe and analyze the exploration behavior of fish in a novel environment.

OR | (08 marks) |
| Q.2 | To observe and analyze the establishment and maintenance of social hierarchies among fish in controlled environment.
OR | (08 marks) |
| Q.2 | To investigate the feeding behavior in of fish in response to different food types and food regimes.
OR | (08 marks) |
| Q.2 | To study the shoaling behavior of fish and its underlying mechanisms in a controlled setting. | (08 marks) |
| Q.3 | To investigate aggression and territorial behavior in fish.
OR | (06marks) |
| Q.3 | To investigate learning and memory capabilities of fish using a conditioning paradigm | (06marks) |
| Q.4 | Viva voce based on the theory. | (03 marks) |

Submission of certified journal is mandatory

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Suggested Guidelines for Practical Assessment (Internal)

Internal Examination

(Total Marks 25)

- | | | |
|-----|--|------------|
| Q.1 | Analyse the efficiency of aquaculture systems
OR | (15 marks) |
| Q.1 | Evaluate the effectiveness of different pollution remediation methods. | |

Q.2 Timely completion and submission of Journal. (05 marks)

Q.3 Overall participation and attendance. (05 marks)

UNIVERSITY OF MUMBAI
MSc Zoology Semester-IV
PSZOPE1 404
Lab exercises based on Biotechnology
(Time: 10.00 am - 2.00 pm)

Total Marks: 25

Duration: 4 hours

Q.1 Prepare the agar plate/ slant/ butt and inoculate it with *E. coli* to observe the growth after incubation.
(12)

Q.2 Prepare culture medium for given sample. **(10)**
OR

Prepare glassware (pipettes/conical flasks/petri plates) for autoclaving.

Q.3 Viva-voce based on theory. **(03)**

Submission of certified journal is mandatory
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Suggested Guidelines for Practical Assessment (Internal)

Internal examination

(Total marks 25)

Q.1 Submit a report on SOP for the major lab equipment in your college/department laboratory/ Submit a report on maintaining an inventory for chemicals/ samples/ kits your college/department laboratory/ Submit a report on visit to agricultural research Institute/IVF center/vaccine production industry/animal tissue culture laboratory. **(15 marks)**

Q. 2 Timely completion and submission of journal. **(05 marks)**
Q. 3 Overall participation and attendance. **(05 marks)**

UNIVERSITY OF MUMBAI
MSc Zoology Semester-IV
PSZOPE2 405
Lab exercises based on Marine pollution
(Time: 10.00 am - 2.00 pm)

Total Marks: 25

Duration: 4 hours

Q.1 Estimate the COD/Nitrates of the given marine water sample. **(12)**

OR

Estimate the BOD/Phosphates of the given marine water sample.

Q.2 Estimate the heavy metal-Lead/Copper from the given water sample. **(10)**

OR

Estimate the heavy metal-Zinc/Cadmium from the given water sample.

Q.3 Viva-voce based on theory. **(03)**

Submission of certified journal is mandatory

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Suggested Guidelines for Practical Assessment (Internal)

Internal examination

(Total marks 25)

Q.1 Submit the report on diversity, abundance and composition of plankton-
(Phytoplankton or Zooplankton)/ seaweeds from any of the nearby marine habitat.
(15 marks)

Q. 2 Timely completion and submission of journal.

(05 marks)

Q. 3 Overall participation and attendance.
marks)

(05

Suggested modalities for

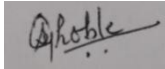
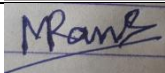
Vertical 05: Research Project (RP)

Semester III: Selection and Continuation of Project – 4 credits

Semester IV: Submission of Project Dissertation, Presentation and Viva-Voce – 6 credits

Guide lines to the Project:

1. The Projects shall include:
 - Title of the Project
 - Aims, Objectives and Rationale
 - Materials and Methods
 - Observation and / Results
 - Interpretation of Observation / Results and Discussion
 - Conclusion and / Recommendation
 - Relevance of Work / Justification of Work with Project title
 - Relevant References
2. The completed project must be submitted as a computer-typed printed and bound copy.
3. No minimum or maximum limit of the number of pages is defined since the volume of the proposal is dependent on the scope of the selected topic.
4. Name of the Guiding Teacher (along with the affiliation, department and College / Institute / Industry name) may be reflected on the first page of the Project along with the student's name.
5. The hard copy of proposal must be retained and submitted along with the dissertation in the examination for the reference of the external examiner/s.
6. Student should prepare individual power point presentation (PPT) on the project and must present it in front of examiners at the time of examination.
7. Student will be allowed to carry out the project work under the guidance of recognized Teacher / Researcher / Industry expert at other suitable Laboratories / Research organizations / Industry / Institutes with due permission from their college.
8. The project will be prepared individually by students.

Name	College Name	Sign	
Dr. Surekha Gupta	G.N.Khalsa College ,Matunga ,Mumbai		
Capt.Dr.Nilima Prabhu	Patkar College,Goregaon,Mumbai		
Dr.Durga Patkar	Ruia College,Matunga,Mumbai		
Dr.Sachin Ghoble	ACS College Lanja,Ratnagiri		
Ms. Mrunmayi Rane	SSS Kalina, University of Mumbai.		
Dr.Suyash Dikwalkar	Students representative		

Letter Grades and Grade Points:

Semester GPA/ Programme CGPA Semester/ Programme	% of Marks	Alpha-Sign/ Letter Grade Result
9.00 - 10.00	90.0 - 100	O (Outstanding)
8.00 - < 9.00	80.0 - < 90.0	A+ (Excellent)
7.00 - < 8.00	70.0 - < 80.0	A (Very Good)
6.00 - < 7.00	60.0 - < 70.0	B+ (Good)
5.50 - < 6.00	55.0 - < 60.0	B (Above Average)
5.00 - < 5.50	50.0 - < 55.0	C (Average)
4.00 - < 5.00	40.0 - < 50.0	P (Pass)
Below 4.00	Below 40.0	F (Fail)
Ab (Absent)	-	Absent

**Sign of the BOS
Chairman
Name of the Chairman
BOS in Zoology**

**Sign of the
Offg. Associate Dean
Name of the Associate
Dean
Faculty of Science**

**Sign of the
Offg. Associate Dean
Name of the Associate
Dean
Faculty of Science**

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Offg. Dean
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Faculty of Science**