University of Mumbai

No. AAMS_UGS/ICC/2024-25/139

CIRCULAR:-

Attention of all the Principals of the Affiliated Colleges, Directors of the Recognized Institutions and the Head, University Departments is invited to this office Circular No. AAMS_UGS/ICC/2023-24/23 dated 08th September, 2023 relating to the NEP UG & PG Syllabus.

They are hereby informed that the recommendations made by the **Board of Studies in Zoology** at its meeting held on 22nd May, 2024 and subsequently passed by the Board of Deans at its meeting held on 3rd September, 2024 **vide** item No. 6.3 (N) have been accepted by the Hon'ble Vice Chancellor as per the power confirmed upon him under section 12 (7) of the Maharashtra Public Universities Act, 2016 and that in accordance therewith syllabus for **M.Sc. (Zoology) Sem – III & IV** with specialisation in

1) Animal Physiology
2) Endocrinology
3) Oceanography & Fishery Technology
4) Entomology
5) Environmental Science is introduced as per appendix (NEP 2020) with effect from the academic year 2024-25.

(The Circular is available on the University's website www.mu.ac.in).

(Dr. Prasad Karande)
REGISTRAR

MUMBAI – 400 032
21st September, 2024

To

All the Principals of the Affiliated Colleges, Directors of the Recognized Institutions and the Head, University Departments.

BOD 6.3(N) 03/09/2024

Copy forwarded with Compliments for information to:-

1) The Chairman, Board of Deans,
2) The Dean, Faculty of Science,
3) The Chairman, **Board of Studies in Zoology**
4) The Director, Board of Examinations and Evaluation,
5) The Director, Department of Students Development,
6) The Director, Department of Information & Communication Technology,
7) The Director, Centre for Distance and Online Education (CDOE) Vidyanagari,
8) The Deputy Registrar, Admission, Enrolment, Eligibility & Migration Department (AEM),

Copy forwarded for information and necessary action to :-	
1	The Deputy Registrar, (Admissions, Enrolment, Eligibility and Migration Dept)(AEM), dr@eligi.mu.ac.in
2	The Deputy Registrar, Result unit, Vidyanagari drresults@exam.mu.ac.in
3	The Deputy Registrar, Marks and Certificate Unit,. Vidyanagari dr.verification@mu.ac.in
4	The Deputy Registrar, Appointment Unit, Vidyanagari dr.appointment@exam.mu.ac.in
5	The Deputy Registrar, CAP Unit, Vidyanagari cap.exam@mu.ac.in
6	The Deputy Registrar, College Affiliations & Development Department (CAD), deputyregistrar.uni@gmail.com
7	The Deputy Registrar, PRO, Fort, (Publication Section), Pro@mu.ac.in
8	The Deputy Registrar, Executive Authorities Section (EA) eau120@fort.mu.ac.in He is requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to the above circular.
9	The Deputy Registrar, Research Administration & Promotion Cell (RAPC), rapc@mu.ac.in
10	The Deputy Registrar, Academic Appointments & Quality Assurance (AAQA) dy.registrar.tau.fort.mu.ac.in ar.tau@fort.mu.ac.in
11	The Deputy Registrar, College Teachers Approval Unit (CTA), concolsection@gmail.com
12	The Deputy Registrars, Finance & Accounts Section, fort draccounts@fort.mu.ac.in
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14	The Assistant Registrar, Administrative Sub-Campus Thane, thanesubcampus@mu.ac.in
15	The Assistant Registrar, School of Engg. & Applied Sciences, Kalyan, ar.seask@mu.ac.in
16	The Assistant Registrar, Ratnagiri Sub-centre, Ratnagiri, ratnagirisubcentar@gmail.com
17	The Director, Centre for Distance and Online Education (CDOE), Vidyanagari, director@idol.mu.ac.in
18	Director, Innovation, Incubation and Linkages, Dr. Sachin Laddha pinkumanno@gmail.com
19	Director, Department of Lifelong Learning and Extension (DLLE), dlleuniversityofmumbai@gmail.com

Copy for information :-	
1	P.A to Hon'ble Vice-Chancellor, vice-chancellor@mu.ac.in
2	P.A to Pro-Vice-Chancellor pvc@fort.mu.ac.in
3	P.A to Registrar, registrar@fort.mu.ac.in
4	P.A to all Deans of all Faculties
5	P.A to Finance & Account Officers, (F & A.O), camu@accounts.mu.ac.in

To,

1	The Chairman, Board of Deans pvc@fort.mu.ac.in
2	**Faculty of Humanities,** **Dean** 1. Prof.Anil Singh Dranilsingh129@gmail.com **Associate Dean** 2. Dr.Suchitra Naik Naiksuchitra27@gmail.com 3.Prof.Manisha Karne mkarne@economics.mu.ac.in
	Faculty of Commerce & Management, **Dean** 1. Dr.Kavita Laghate kavitalaghate@jbims.mu.ac.in **Associate Dean** 2. Dr.Ravikant Balkrishna Sangurde Ravikant.s.@somaiya.edu 3. Prin.Kishori Bhagat kishoribhagat@rediffmail.com

	Faculty of Science & Technology **Dean** 1. Prof. Shivram Garje ssgarje@chem.mu.ac.in **Associate Dean** 2. Dr. Madhav R. Rajwade Madhavr64@gmail.com 3. Prin. Deven Shah sir.deven@gmail.com
	Faculty of Inter-Disciplinary Studies, **Dean** 1.Dr. Anil K. Singh aksingh@trcl.org.in **Associate Dean** 2.Prin.Chadrashekhar Ashok Chakradeo cachakradeo@gmail.com
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6	The Director, Department of Information & Communication Technology, director.dict@mu.ac.in

BOD – 3/9/2024
12 (7) of M.P.U.A. 2016
Item No. – 6.3 (1) (N)

As Per NEP 2020

University of Mumbai

Title of the P.G. Program
M.Sc. (Zoology - Animal Physiology)

Syllabus for

Semester – Sem.- III & 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	M.Sc. (Zoology - Animal Physiology)
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: SP – 80 B (1)	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 Coordinator
Dr. Vaishali Somani
BOS in Zoology

Sign of the Offg. Associate Dean
Dr. Madhav R. Rajwade
Faculty of Science & Technology

Sign of the Offg. Dean
Prof. Shivram S. Garje
Faculty of Science & Technology

Preamble

Introduction:

The faculty members of the Master's program in Zoology (Animal Physiology) have intentionally crafted the syllabus to align with the objectives of the National Education Policy 2020. The syllabus design emphasizes holistic, flexible, and multidisciplinary education, which is tailored to meet the demands of the 21st century. In this syllabus, students would delve into the intricate connections between science and society by exploring life processes and applied physiology, which significantly impact our quality of life.

Aims and Objectives:

The aim of the course is to cater to the aspirations of students aiming for careers in applied medicine, healthcare, nutritional sciences, pharmaceuticals, field biology and those who want to venture into hard core research, eventually benefiting the society as a whole. The course also aims at enhancing student's experiences and preparing them for both academia and employability. The course is structured with the objective to identify and explain basic physiological processes that enable animals to thrive in different habitats. In addition, the course also connects the principles of animal physiology to other scientific disciplines like ecology, behavior, morphology, immunology, oncology to name a few.

Learning outcomes:

The learning outcomes of the course MSc in Zoology (Animal Physiology) are: i) The learners would be acquainted with the structural and functional facets of various life processes. ii)The learner would have an in-depth understanding on animals' adaptive responses to fluctuations in environmental factors. iii) The learner would be able to understand the intricacies involved in the cancer cell physiology and physiology of memory. iv) The learner would comprehend clinical features, diagnostic methods and therapeutic strategies for managing diverse clinical disorders. v) The learners would correlate principles of physiology with real-world scenarios. vi) The learners would gain an introductory understanding of physiological ecology and conservation physiology enabling them to apply this knowledge in analyzing ecological systems and environmental impacts.

Credit Structure of the Program (Sem III & IV)

Post Graduate Programs in University Parishishta – 1

R: SP – 80B (1)

Exit option: PG Diploma (44 Credits) after Three Year UG Degree

Year	Level	Sem	Major		RM	OJT / FP	RP	Cum. Cr.	Degree
			Mandatory	**Electives Any one**					
II	**6.5**	**Sem III**	**PSZOPHY301** Physiology of Nutritive, Respiratory, Circulatory and Endocrine systems **Credits 4** **PSZOPHY302** Environmental physiology **Credits 4** **PSZOPHYP303** Laboratory exercises based on Physiology of Nutritive, Respiratory, Circulatory and Endocrine systems **Credits 2** **PSZOPHYP304** Laboratory exercises based on Environmental physiology **Credits 2** **PSZOPHY305** Cancer Cell Biology & Physiology of Memory **Credits 2**	**PSZOPHY306** Physiology of Metabolic Disorders **Credits 2** **PSZOPHYP307** Laboratory exercises based on Physiology of Metabolic disorders **Credits 2** **OR** **PSZOPHY308** Human Physiological Disorders and Physiology of Blood **Credits 2** **PSZOPHYP309** Laboratory exercises based on Human Physiological Disorders and Physiology of Blood **Credits 2**			Research Project **Credits 4**	22	**PG Degree After 3- Yr UG**
		Sem IV	**PSZOPHY401** Physiology of Movement and Locomotion, Excretion and Osmoregulation, Nervous and Reproductive systems **Credits 4** **PSZOPHY402** Applied Physiology **Credits 4** **PSZOPHYP403**	**PSZOPHY405** Sports and Exercise Physiology **Credits 2** **PSZOPHYP406** Laboratory exercises based on Sports and Exercise Physiology **Credits 2**			Research Project **Credits 6**	22	

			Laboratory exercises based on Physiology of Movement and Locomotion, Excretion and Osmoregulation, Nervous and Reproductive systems **Credits 2** **PSZOPHYP404** Laboratory exercises based on Applied Physiology **Credits 2**	**OR** **PSZOPHY407** Physiological Ecology and Conservational Physiology **Credits 2** **PSZOPHYP408** Laboratory exercises based on Physiological Ecology and Conservational Physiology **Credits 2**					
Cum. Cr. for 1 Yr PG Degree			**26**	**8**			**10**	**44**	
Cum. Cr. for 2 Yr PG Degree			**54**	**16**	**4**	**4**	**10**	**88**	

Note: * The number of courses can vary for totaling 14 Credits for Major Mandatory Courses in a semester as illustrated.

Sem. - III

Syllabus

M.Sc. (Zoology - Animal Physiology) (Sem.- III)

Course 1: PSZOPHY301

Physiology of Nutritive, Respiratory, Circulatory and Endocrine systems

Objectives — To acquaint the learners with a comprehensive understanding of life processes like nutrition, respiration circulation and endocrine regulation in both invertebrate and vertebrate animals.

Desired outcomes — The learners would be able to:

- Recall food capturing structures, respiratory structures, types of circulatory system and circulatory pumps.
- Classify hormones and circulating fluids.
- Correlate the food capturing structures in the animals with their feeding mechanisms, respiratory structures with their habitats.
- Discuss physiology of various life processes like nutrition, respiration, circulation in animals
- Explain endocrine physiology of invertebrate and vertebrate animals
- Compare and contrast the feeding habits of mammals to the physiology of digestion

Unit1: Nutritive Physiology (15Hrs)

1.1 Physiology of food capture and processing in invertebrates

1.1.1 Types of feeding mechanism in invertebrates: Suspension feeding mechanism (Protozoa & Porifera), Manipulative feeding (Insects), Pumping mechanism for fluid feeding (Insects), Mechanism of direct nutrient absorption (Helminths and Annelids).

1.1.2 Physiology of nutrition in cockroach

1.2 Physiology of food capture and processing in vertebrates

1.2.1 Feeding mechanism in vertebrates: Filter feeding mechanism (Pisces, aquatic birds, crab eating seal, baleen whales), Manipulative feeding mechanism (Carnivorous, herbivorous and omnivorous animals), Fluid feeding mechanism (Birds and mammals)

1.2.2 Physiology of nutrition in vertebrates:
Shark**,** Pigeon**,** Non-ruminant herbivores (rabbit)**,** Ruminant herbivores (cattle)**,** Insectivore (shrew), Carnivore (tiger/wolf)

1.3 Biochemistry of digestion in human beings

1.4 Neural and hormonal regulation of digestive secretions in human beings

1.5 Microbiota in human gut and its significance

Unit 2: Physiology of gas exchange and acid base balance (15Hrs)

2.1 Essentials of respiratory structures

2.2 Respiratory structures in invertebrates

2.2.1 Spiracles and book lungs in arthropods, ctenidia in molluscs, cutaneous respiration in annelids, respiratory tree in echinoderms

2.3 Respiration in vertebrates

2.3.1 Gas exchange in water via gills, respiration in lung fishes, swim bladders in fishes, and air breathing fishes

2.3.2 Respiration in frog (branchial, cutaneous, buccal and pulmonary)

2.3.3 Air sacs in birds (pigeon)

2.3.4 Physiology of respiration in human:
Functional anatomy of lung
Lung ventilation (Eupnea, hyperventilation, hypoventilation, hyperpnea, apnea, dyspnea, polypnea)
Mechanism of ventilation of lungs: Oxygen and carbon dioxide transport in blood

2.3.5 Regulation of body pH (Hamburger's effect), hydrogen ion production and excretion, hydrogen ion distribution between compartments, factors influencing intracellular pH and blood pH

Unit 3: Physiology of Circulation (15Hrs)

3.1 Types of circulatory system: open and closed circulatory system
3.2 Circulatory pumps (hearts) in arthropods, annelids and molluscs
3.3 Circulating fluids in invertebrates: cytoplasm, hydrolymph and hemolymph
3.4 Types of hearts in vertebrates: 2 chambered (shark), 3 chambered (frog), partially 4 chambered (calotes) and complete 4 chambered heart (human)
3.5 Blood and lymph as circulating fluid in vertebrates
3.6 Principle of pressure, resistance and flow in vascular systems: laminar and turbulent flow, relationship between pressure and flow (Poiseuille's equation, resistance to flow, viscosity of blood)
3.7 Regulation of blood flow and blood pressure- Control of blood distribution by the arterioles, influence of the metabolic activity of the tissue on blood flow, myogenic autoregulation, regulation of arteriolar diameter by nervous and endocrine systems

Unit 4: Endocrine Physiology (15Hrs)

4.1 Introduction to endocrine systems and classical endocrine glands
4.2 Classification of hormones and mechanism of hormone action (peptide and steroid hormones)
4.3 Hormones in invertebrates
4.3.1 Feed-back substance (polychaetes), Prothoracicotropic hormone, Moulting hormones (Juvenile hormone & ecdysone), Trypsin modulating oostatic factor (TMOF), Allomones, Ecdysteroids and molt-inhibiting hormone (MIH), Methyl farnesoate (MF), Gonadotropic hormone in gastropods and cephalopods, 1-Methyl – adenine (meiosis inducing substance) endocrine disruptors, Gamete shedding substance (GSS) in star fish
4.4 Chordate endocrine glands
4.4.1 Pineal gland, adrenal gland, parathyroid gland, corpuscles of stannous, Maunthner cells
4.5 Endocrine disorders due to alteration in receptor number and functions

PSZOPHY302
Environmental Physiology

Objectives: To widen the knowledge of the learner with respect to the impact of environmental factors such as stress, water, oxygen, pressure and temperature on animal physiology.

Desired outcomes: The learners would be able to:

- Enlist environmental factors that have impact on the physiology of animals and biomolecules involved in perception of solar radiations.
- Recall the concept of homeostasis, endothermy and ectothermy.
- Discuss the concepts of various environmental stress, antifreeze substances, heat shock proteins and strategies of biochemical adaptations.
- Explain the physiology of biological rhythms.
- Interpret the role of salt glands with reference to the habitat of the animals.

Unit1: Stress and water as environmental factors

1.1 Environmental stress, homeostasis and strategies of biochemical adaptations
1.1.1 Basic concept of environmental stress, plastic and elastic strain, stress resistance, stress avoidance and stress tolerance
1.2 Homeostasis and biochemical adaptation
1.2.1 External and internal environment
1.2.2 Strategies of biochemical adaptations
1.3 Water and solute problem
1.3.1 Preservation of intracellular solvent capacity
1.3.2 Strategies and degrees of ionic regulation
1.3.3 ATPase: the model regulatory enzyme
1.3.4 Key role of GDH reaction
1.3.5 Salt glands in animal kingdom

Unit2: Oxygen as environmental factor

2.1 Oxygen and origin of life
2.2 Oxygen dependencies in living organisms
2.3 Oxygen supply and tissue energetics
2.4 Anoxia adaptations in invertebrates: Fermentable fuel storage, ATP production, production of alternative end products to lactic acid, metabolic rate depression.
2.5 Physiological strategies to low oxygen level exhibited by invertebrates in Arctic region: freeze avoidance, freeze tolerance and dehydration
2.6 Adaptations of vertebrates during prolonged diving: Bradycardia, blood flow redistribution, size of the lungs and habitat, myoglobin and oxygen storage, anaerobic metabolism
2.7 Oxygen debt in vertebrate muscle

Unit3: Pressure and temperature as environmental factor (15Hrs)

3.1.1 Fundamental effects of pressure on biological systems
3.1.2 Effect of pressure on weak bonds and the consequences for higher orders of protein structure
3.1.3 Effects of pressure on cellular processes viz., transcription, translation and gene regulation
3.1.4 Strategies of enzyme adaptations to pressure in marine organisms: FDPase and PK
3.2 Temperature regulation and response to thermal fluctuations
3.2.1 Thermal limits of survival
3.2.2 Temperature and structural effects with response to biological molecules and biological membranes
3.2.3 Temperature and rate effects: Temperature dependent E~S affinity, lipoprotein enzymes
3.2.4 Thermal resistance of dormant and active cells
3.2.5 Thermoregulatory mechanisms with respect to ectothermy and endothermy
3.2.6 Biochemical adaptations of ectothermy: antifreeze substances, heat shock proteins

Unit 4: Physiology of environmental radiations & biological rhythms

4.1 Radiation as an environmental parameter

4.1.1 Biomolecules involved in perception and trapping of solar radiations: chlorophyll in hydra and euglena, bacteriorhodopsin, rhodopsin and vitamin A

4.1.2 Adaptations of animals to the absence of solar radiations

4.1.3 Effects of ionizing radiations at cellular and molecular level

4.1.4 Phenomenon of radioprotection

4.2 Physiology of biological rhythms and timings

4.2.1 Temporal organization of cells

4.2.2 Circadian rhythms; synchronization of circadian rhythms

4.2.3 Infradian rhythm, monthly rhythm

4.3 Dormancy in freshwater and terrestrial animals

4.3.1 Preparatory phases, induction of dormancy, arousal from dormancy, entrainment and dormancy

4.3.2 Diapause in insects: induction, factors affecting diapause, termination of diapause, diapause and endocrine functions

4.4 Photoperiodism

PSZOPHYP303

Laboratory exercises based on Nutritive, Respiratory, Circulatory and Endocrine systems (60Hrs)

Objectives: To enhance the observational and analytical skills of the learners.

Desired outcomes: The learners would be able to:

- Understand the effect of various parameters on enzyme activity.
- Identify the slides of endocrine glands in vertebrates.
- Correlate the mouth parts of insects and dentition in mammals with the feeding patterns.
- Interpret and conclude the results obtained in the experiments.

1. Study of effect of pH, activator, inhibitor on the activity of salivary amylase.
2. Study of insect mouth parts (cockroach, housefly, honey bee, butterfly).
3. Study dentition and gut content of fish (Bombay duck and mackerel).
4. Study of dental formulae in mammals. (dog, cat, goat, cattle, human beings) (Dental formula will be provided to the students and students have to comment on the diet of the animal).
5. Effect of decreasing *P*O2 of water on the lactic acid content of fish muscles.
6. Study of the endocrine gland of vertebrates. (pineal gland, adrenal gland, parathyroid gland, corpuscles of stannous, Maunthner cells).
7. Study of the effect of insulin/ adrenaline on heart rate of chick embryo.
8. Study of eyestalk ablation on glucose metabolism of mud crab.
9. Conduct a survey and submit a report based on: dietary patterns and nutrient intake amongst different demographics/ blood glucose levels of the family members and neighbours and correlate with their diet and lifestyle/ Report submission based on 6 minutes' walk test project/ Submit the charts or clay models of endocrine glands that you have studied.

PSZOPHYP304

Laboratory exercises based on Environmental Physiology (60Hrs)

Objectives: To enrich the learner's microscopy skills, analytical skills and observational skills

Desired outcomes: The learners would be able to:

- Demonstrate the principle of osmosis and its physiological relevance in maintaining cell volume and function.
- Identify and describe the specimens/ colored plates with respect to salt glands, diapause in insects and biological rhythms in animals.
- Interpret and conclude the results obtained in the experiments based on osmosis, temperature variation on enzymes, salt concentration variations on the respiratory rate of fish.

1. Determine the effect of different salt concentrations on RBC.
2. Observation of decreasing *P*O2 of water on the respiratory rate of fish.
3. Study of effect of temperature on the activity of enzyme amylase.
4. Study of salt glands in animals (shark, marine iguana, penguin and sea gulls).
5. Study of diapause in insects: Beetle (*Lagria hirta*), mouse bot fly (*Cuterebra fontinella*), wheat midge (*Sitodiplosis mosellana*) flesh fly (*Sarcophage crassipalpis*).
6. Study of the effect of temperature on heart rate/development of chick embryo.
7. Study of the effect of variations in salt concentrations/pH on the respiratory rate of fish.
8. Study of biological rhythms: Ultradian rhythm (sleep stages in human beings), infradian rhythm (menstrual cycle in human beings), circannual rhythm (Golden-mantled ground squirrels).
9. Conduct a survey and submit a report based on: Sleep patterns among night job workers and day job workers/ Sleeping hours and existence of metabolic disorders like BP, diabetes, high cholesterol /Report submission based on biological rhythms exhibited by the animals in your surrounding/ Write a report on the topic "The impact of smartphone usage on circadian cycles of human beings".

PSZOPHY305

Cancer Cell Biology & Physiology of Memory

Objectives

- To provide students with a comprehensive understanding of cancer cell biology, including tumors, components of the cell cycle, mechanisms of cell death and the role of mitochondria in cell death.
- To acquaint learners with the fundamental processes of memory physiology and discoveries in memory research by pioneers.

Desired outcomes

The learners would be able to:

- Recall types of tumors and concepts of autopsy, cell growth and cell death
- Explain molecular mechanisms of cell death pathways, the significance of synaptic plasticity in memory formation.
- Discuss the principles of cancer treatment.
- Describe the physiological processes involved in memory encoding and consolidation
- Analyze the role of mitochondria in cell death.
- Evaluate the significance of cell division, senescence, autophagy and neurotransmitters in memory processes.

Unit 1: Cancer Cell Biology (15Hrs)

1.1 Introduction - benign and malignant tumors, role of autopsy
1.2 Components of cell cycle and control system, mitotic catastrophe
1.3 Extracellular control of cell division
413.1 Cell growth
1.3.2 Apoptosis: morphological and biochemical features of apoptosis
1.3.3 Necroptosis
1.4 Cell death
1.4.1 Role of mitochondria in cell death: Mechanism of mitochondrial outer membrane permeabilization (MOMP), cell death effectors released from mitochondria: caspases (effector molecules)
1.4.2 Extrinsic and intrinsic apoptotic pathway
1.4.3 Poly-ADP-ribose Polymerase (PARP) proteolysis as an indicator of cell death
1.4.4 Immunogenicity of cancer cell death
1.5 Senescence, chemoresistance and cancer
1.6 Cancer cell lines - HeLa Cells, HEK293 Cells, CHO cells, MCF-7 (breast cancer cells), HL 60 (Leukemia).
1.7 Autophagy: Role of autophagy in tumor survival, role of oncogenes in suppression and regulation of cancer
1.8 Cancer treatment: Immunotherapy

Unit 2: Physiology of Memory (15Hrs)

2.1 Overview of memory physiology
2.1.1 Introduction to memory physiology
2.1.2 Overview of memory as a cognitive process involving the encoding, storage, and retrieval of information
2.1.3 Introduction to landmark studies and discoveries in memory research, including contributions from pioneers like Ramón y Cajal, Pavlov, and Hebb.
2.2 Neural basis of memory
2.2.1 Neuronal networks and synaptic plasticity
2.2.1 Molecular mechanisms of synaptic plasticity
2.3 Types of memory and brain structures
2.3.1 Types of memory: Short-term versus long-term memory, declarative versus

procedural memory

2.3.2 Brain structures involved in memory: hippocampus, amygdala, prefrontal Cortex

2.4 Memory encoding and consolidation

2.4.1 Cellular and molecular processes of memory encoding

2.4.2 Memory consolidation: Neural circuits and synaptic plasticity

2.5 Neurotransmitters and memory

2.5.1 Role of neurotransmitters in memory processes

2.5.2 Neurotransmitter systems: glutamate (glutamatergic system), acetylcholine (cholinergic system), dopamine (dopamine system)

Elective-1

PSZOPHY306

Physiology of metabolic disorders

Objectives

- To familiarize learners with metabolic disorders by exploring the affected metabolic pathways.
- To develop a comprehensive understanding of clinical features, diagnostic techniques, and therapeutic approaches for managing various metabolic disorders.

Desired outcomes

The learner would be able to:

- Recall key biochemical pathways.
- Identify and list various metabolic disorders.
- Define and classify metabolic errors.
- Discuss different types of metabolic disorders.
- Apply diverse therapeutic strategies for managing metabolic disorders.

Unit 1: Physiology of metabolic disorders-I (15hrs)

1.1 Introduction to metabolic disorders

1.1.1 Overview of metabolism- Introduction to metabolism and its regulation, key biochemical pathways (glycolysis, TCA cycle, oxidative phosphorylation)

1.1.2 Metabolic errors: Classification based on affected pathway (carbohydrate, lipid, amino acid metabolism)

1.2 Genetics of metabolic disorders

1.2.1 Inheritance patterns (autosomal recessive, autosomal dominant, X-linked), genetic mutations and their impact on enzyme function

1.3 Carbohydrate metabolism disorders

1.3.1 Biochemical basis and clinical features of glycogen storage disorders: Pompe disease and Von Gierke disease.

1.3.2 Biochemical basis and clinical features of disorders in gluconeogenesis and glycolysis: Hereditary fructose intolerance and Pyruvate kinase deficiency

1.3.3 Biochemical basis and clinical features of disorders in sugar transport: Glucose/galactose malabsorption

1.4 Lipid metabolism disorders

1.4.1 Biochemical basis and clinical features of lysosomal storage diseases: Gaucher disease, Niemann-Pick disease

1.4.2 Biochemical basis and clinical features of disorders in fatty acid oxidation: Medium-chain acyl-CoA dehydrogenase deficiency (MCAD), Carnitine palmitoyltransferase deficiency

Unit 2: Physiology of metabolic disorders-II

2.1 Amino acid and Organic acid metabolism disorders

2.1.1 Biochemical basis, clinical manifestations and management of phenylketonuria (PKU) and disorders of aromatic amino acid metabolism

2.1.2 Biochemical basis and clinical manifestations of Maple Syrup Urine Disease (MSUD) and branched-chain amino acid disorders

2.1.3 Biochemical basis and clinical manifestations of organic acidemias: propionic acidemia, methylmalonic acidemia

2.2 Mitochondrial disorders

2.2.1 Biochemical basis and clinical manifestations of mitochondrial DNA disorders: mitochondrial myopathies and Leigh syndrome

2.2.2 Biochemical basis and clinical features of mitochondrial respiratory chain disorders: mitochondrial encephalopathy, lactic acidosis

2.3 Clinical diagnosis and management of metabolic disorders

2.3.1 Diagnostic approaches: Biochemical testing (plasma/urine metabolites and enzyme

assays), molecular genetic testing (sequencing and mutation analysis)

2.3.2 Nutritional and pharmacological management: Dietary interventions (specialized diets and enzyme replacement therapy), pharmacological approaches (substrate reduction therapy and gene therapy)

2.4 Current research and future directions

2.4.1 Emerging therapeutic strategies- Novel therapies and clinical trials for metabolic disorders, gene editing technologies (CRISPR/Cas9) and their potential applications

Elective-1
PSZOPHYP307
Laboratory exercises based on Physiology of metabolic disorders (60Hrs)

Objectives
Desired outcomes

To improve the problem-solving skill and the analytical skills of the learner
The learner would be able to:

- Solve problems based on inheritance pattern, metabolic pathways and diet formulation
- Interpret the case studies based on metabolic disorders
- Estimate G6PD from blood sample and analyze the results

1. Problems based on inheritance pattern.
2. Case studies based on metabolic disorders (PKU, Maple syrup disease, Gaucher disease, Niemann-Pick disease, Mitochondrial myopathies, Leigh syndrome).
3. Problems based on metabolic pathways.
4. Problem based on diet formulation for patients suffering from metabolic disorders.
5. Estimation of G6PD from blood sample.
6. Report submission based on: Review of secondary data on metabolic errors/ Correlation studies like BP and BMI,/Diabetes and BMI/ Blood glucose level and Pulse rate before and after 30 minutes walk or exercise.

Elective-2

PSZOPHY308

Human Physiological disorders and Physiology of Blood

Objectives

- To enhance the knowledge of the learner on human physiological disorders.
- To widen the learner's horizon of knowledge specifically with regards to blood physiology.

Desired outcomes

The learners would be able to:

- Recall blood related disorders
- Classify various physiological disorders
- Discuss homeostasis with respect to blood physiology
- Explain hemorrhage, blood coagulation, iron metabolism in blood and hematopathology.
- Compare and contrast chill coma and heat coma, leukocytes and erythrocytes, hypotension and hypertension, atherosclerosis and arteriosclerosis

Unit 1: Human Physiological Disorders (15Hrs)

1.1 Physiological disorders of digestive system (causes, symptoms, diagnosis and remedy): pellagra, pancreatic-stones, gall-stones, kwashiorkor and marasmus
1.2 Physiological disorders of respiratory system (causes, symptoms, diagnosis and remedy): asthma, emphysema, hypoxia and tuberculosis
1.3 Physiological disorders of excretory system (causes, symptoms, diagnosis and remedy): renal calculi, uremia and gout.
1.4 Physiological disorders of circulatory system (causes, symptoms, diagnosis and remedy): myocardial infarction, arteriosclerosis, hypotension and hypertension.
1.5 Physiological disorders of nervous system (causes, symptoms, diagnosis and remedy): Alzheimer's disease, cervical Spondylosis, epilepsy
1.6 Physiological disorders of reproductive system (causes, symptoms, diagnosis and remedy): oligospermia, PCOD, breast cancer, cervical cancer
1.7 General fever, chill coma, heat coma

Unit 2: Physiology of Blood (15Hrs)

2.1 Composition of blood RBC, WBC, Platelets, Hb (variants), plasma (fibrionlytic activity of the plasma) and functions of blood
2.1.2 Iron metabolism in blood
2.1.3 Destruction of the red blood cell
2.2 Homeostasis and blood coagulation
2.2.1 Homeostasis: Blood pH, blood glucose levels to maintain fluid balance, sodium, potassium and calcium ion concentrations.
2.2.2 Disorders of hemostasis- Hemophilia, thrombosis and embolism
2.2.3 Blood coagulation: Factors affecting blood coagulation, intrinsic and extrinsic pathway
2.3 Hemorrhage and blood transfusion
2.3.1 Hemorrhage: Introduction, etiology, epidemiology, pathophysiology
2.3.2 Anticoagulants, procoagulants
2.3.3 Blood transfusion - complete and partial
2.4 Blood related disorders: Sickle cell anemia, megaloblastic anemia due to vit B12 or folate deficiency, acute lymphoblastic leukemia, acute myeloid leukemia, multiple myeloma, erythrocytosis, leucopenia

Elective-2

Course 2: PSZOPHYP309

Laboratory exercises based on Human Physiological disorders and Physiology of Blood (60Hrs)

Objectives	To create awareness about various human physiological disorders To enhance the microscopy skills, observational skills and analytical skills of the learners
Desired outcomes	The learners would be able to: • Identify abnormal morphology of blood cells • Estimate physiological parameters from the blood sample • Interpret and analyze the results obtained after performing the experiments

1. Measure the pH of blood or gastric juice using pH meter (Chicken/Goat/ suitable sample).
2. Demonstrate the efficacy of natural and commercial acid neutralizers.
3. Estimate uric acid from the serum sample.
4. Demonstrate the presence of urine cast and crystals from the given sample and interpret the results.
5. Determine the catalase activity in blood using hydrogen peroxide disc method.
6. Identify abnormal RBC cell morphology, WBC morphology, Platelets morphology.
7. Study of peak expiratory flow rate to assess the quality of lungs.
8. Conduct a survey and submit a report based on: Blood group study in the neighbourhood /Anaemic and non-anaemic population of the college students or of neighbours/ Submission of charts or clay models explaining composition of blood/ Submission of charts or clay models explaining types of blood disorders.

Sem. - IV

Syllabus
M.Sc. (Animal Physiology)
(Sem.- IV)

PSZOPHY401

Physiology of Movement and locomotion, Excretion and osmoregulation, Nervous and Reproductive system

Objectives

- To make the learner conversant with various types of locomotory, osmoregulatory, excretory structures and unusual reproductive strategies adopted by the animals
- To acquaint the learner with the functional and structural facets of neurophysiology, sensory-effector systems and with different modes of reproduction in both invertebrate and vertebrate animals

Desired outcomes

The learners would be able to:

- Enlist locomotory structures in invertebrates and vertebrates.
- Identify and classify the type of receptors and effectors, unusual reproductive strategies in animals.
- Correlate locomotory structures with the type of locomotion in the animals, brain of animal with the physiological functions.
- Explain the mechanism and energetics of locomotion, physiology of excretion, physiology of reproduction in animals, physiology of pregnancy, parturition and lactation in humans.
- Compare and contrast the various excretory and osmoregulatory structures, unusual modes of reproduction in animals.

Unit1: Physiology of movement and locomotion (15 hours)

1.1 Physiology of movement and locomotion in invertebrates

1.1.1 Structure and functions of locomotory organs: Pseudopodia (Sol-gel theory), cilia, flagella, setae, tentacles, foot, wings, jointed legs and tube feet

1.1.2 Movement and Locomotion: Swimming, crawling, walking, running, rolling, jumping and flying

1.1.3 Comparative physiology of invertebrate muscles: Polyneural innervation in arthropod muscle, insect non-oscillatory postural muscle, resonant flight and tymbal muscle in insects, catch muscle and delayed relaxation in molluscs

1.2 Physiology of movement and locomotion in vertebrates

1.2.1 Structure and functions of locomotory organs: Fins, flippers, wings and legs

1.2.2 Movement and locomotion: Swimming, crawling, wading, walking, running, jumping and flying

1.2.3 Physiology of skeletal muscle fiber: Contractile proteins, actinomyosin complex, molecular mechanism of muscle contraction-Huxley's Sliding filament theory, neuromuscular transmission, excitation-contraction coupling and mechanism of relaxation

1.2.4 Energetics of muscle contraction, phosphagens, electromyography, neuromuscular blocking agents, effect of exercise on skeletal muscle contraction, muscle tone and its maintenance

Unit 2: Physiology of excretory and osmoregulatory system (15Hrs)

2.1 Excretory and osmoregulatory structures in invertebrates: contractile vacuole, coelomoducts, flame cells, green gland, malpighian tubules and invertebrate nephridia.

2.2 Osmoregulation in freshwater and marine animals

2.3 Comparative physiology of excretion in pisces, amphibians, reptiles and birds

2.4 Structure of mammalian kidney, uriniferous tubule

2.5 Physiology and regulation of urine formation in humans
Hormonal regulation of urine formation in humans

Unit3: Physiology of nervous system & sensory physiology (15 hours)

3.1 Nervous and sensory system in invertebrates

3.1.1 Nerve nets, ganglia, nerve cords, giant nerve fibers, neuropeptides - FMRF amide family, Neuropeptide-like proteins (NLPs), Insulin-like peptides (INSs), head activator peptides

3.1.2 Physiological receptors and effectors: Mechanoreceptors (statocyst, trichoid and campaniform sensillum), stretch receptors (tympanum in mosquito), chemoreceptors (olfactory sensillum), photoreceptors (sensory cells in tentacles of Hydra, pigment spots, simple and compound eyes), thermoreceptors (antennae and tarsi of insects) neurosecretory cells (cockroach)

3.2 Nervous and sensory systems in the vertebrates

3.2.1 General organization of CNS and PNS, structure, function and classification of neurons and nerves, neuroglia, resting membrane potential of nerve and muscle, action potential, conduction of nerve impulse, synaptic transmission

3.2.2 Neurotransmitters - Dale's Law, acetylcholine, dopamine, catecholamine, GABA, ATP, adrenaline, noradrenaline

3.2.3 Sensory and effector physiology: Organs of equilibrium, chemoreception (gustation and olfaction), photoreception, thermoreception, auditory perception, echolocation, electroreception, magnetoreception

Unit 4: Reproductive physiology (15Hrs)

4.1 Asexual reproduction in invertebrates

4.1.1 Fission, budding & fragmentation in lower invertebrates.

4.1.2 Gemmule formation in sponges, fissiparity and budding in echinoderms

4.1.3 Palleal and stolonial budding in urochordates

4.2 Sexual reproduction in vertebrates

4.2.1 Reproductive strategies (oviparity, viviparity & ovoviviparity) & their significance

4.2.2 Comparative account on the male reproductive system (gonads, ducts & accessory glands) among pisces, amphibians, reptiles, aves and mammals

4.2.3 Comparative account on the female reproductive system (gonads, ducts/tracts & accessory glands) among pisces, amphibians, reptiles, aves and mammals

4.2.4 Types (internal & external) fertilization & mechanism of fertilization and their significance.

4.2.5 Physiology of pregnancy, parturition & lactation in humans

4.3 Unusual reproduction strategies

4.3.1 Polyembryony, polyandry, polygamy & parthenogenesis

PSZOPHY402
Applied Physiology

Objectives

- To familiarize the learners to the branch of physiology dealing with enzymes, body fluids and antibodies as physiological tools for clinical diagnosis of pathological conditions in humans.
- To abreast learners with the latest clinical diagnostic tools employed in detection of pathological conditions in humans.

Desired outcomes

The learners would be able to:

- Enlist various clinical diagnostic tools.
- Explain the use of enzymes and body fluids in clinical diagnosis of pathological conditions.
- Describe molecular diagnostic techniques.
- Discuss and interpret human clinical diagnostic reports.

Unit 1: Enzymes as clinical diagnostic tools (15Hrs)

1.1 Enzymes as diagnostic tools
1.1.1 Plasma specific and non-plasma specific enzymes
1.1.2 Diagnostic importance of LDH
1.1.3 Enzymes in diagnosis of myocardial infarction
1.1.4 Enzymes in liver diseases and toxicity
1.1.5 Enzymes in cancer

Unit 2: Body fluids as clinical diagnostic tools (15Hrs)

2.1 Physiological fluids as diagnostic tools
2.1.1 Blood as physiological fluid for diagnostic tests
2.1.2 Urine as physiological fluid for diagnostic tests
2.1.3 Semen as physiological fluid for diagnostic tests
2.1.4 Cerebrospinal fluid as physiological fluid for diagnostic tests

Unit 3: Antibodies as tools for clinical diagnostics and molecular diagnostic techniques (15Hrs)

3.1 Antibodies as diagnostic tools
3.1.1 RIA of GnRH, gonadotropins, T3, T4, TSH, HCG and insulin
3.1.2 ELISA for detection of HCG, diagnosis of Amoebiasis, typhoid, HIV
3.1.3 Monoclonal antibodies as diagnostic tools: Detection of HCG, diagnosis of STD, streptococcal throat infections, herpes and cancer
3.1.4 Immunohistochemistry in diagnosis of cancer
3.1.5 Molecular diagnostic techniques: RT-PCR, Next Generation Sequencing, DNA microarray, multicolor Fluorescence in situ hybridization (m-FISH), RNA sequencing, tiling array

Unit 4: Organ function Tests as diagnostic tools (15Hrs)

4.2.1 Liver function tests and toxicity tests
4.2.2 Pancreatic function tests
4.2.3 Gastric function tests
4.2.4 Kidney function tests
4.2.5 Cardiac profile tests

PSZOPHYP403

Laboratory exercises based on Movement and locomotion, Excretion and osmoregulation, Nervous and Reproductive systems (60 Hrs)

Objectives

To enable the learners to do structure function analysis.
To acquaint the learners with various techniques used in the study of physiological systems

Desired outcomes

The learners would be able to:

- Identify the locomotory structures, brains and reproductive structures of different animals.
- Do structure function analysis of locomotory structures.
- Understand various techniques used to study physiological systems.
- Compare and contrast the brains of different animals.
- Interpret and analyze the results of various experiments that are performed.

1. Study of locomotory structures in invertebrates - cilia in *Paramecium*, foot in *Pila*, jointed legs and wings in *Periplaneta*, tubefeet in *Asterias*
2. Study of locomotory structures in vertebrate - Fins in fishes, fore and hind limbs in frog, wings in birds, legs in mammals
3. Preparation of glycerinated muscle fibre and study of its properties
4. Study of effect of stimuli (light, chemical, temperature and gravity) on paramecia
5. Comparative study of brain of vertebrates (shark, frog, lizard, pigeon and rat or goat)
6. Study of techniques: Electroencephalography (EEG), Electromyography (EMG), Electrooculography (EOG), CT scan, MRI imaging
7. Study of Kymograph - principle, preparation and applications.
8. Study of salt loss and salt gain in fish in different media
9. Study of reproduction:
   a) Asexual reproduction: Binary fission in *Paramecium*, gemmule in sponge,budding in hydra
   b) Sexual reproduction: Oviparity (fowl or pigeon), viviparity (rat) and ovoviviparity (shark)
10. Conduct a survey and submit a report based on different gaits exhibited by animals in your vicinity/ Submit a report based on routine urine analysis (color, clarity, pH, protein, glucose, ketone bodies and blood cells)/ Submission of clay models or charts based on reproductive strategies exhibited by the animals/ Submission of clay models or charts based on locomotory structures exhibited by the animals.

PSZOPHYP404

Laboratory exercises based on Applied Physiology (60 Hrs)

Objectives

To familiarize the learners to various tests that are performed in the detection of infectious agents.

To abreast the learners with various organ function tests

Desired outcomes

The learners would be able to:

- Perform various tests to detect the presence of infectious agents, antigen or antibody and to diagnose conditions like liver disorder, renal disorder, prostate cancer
- Analyze and interpret the results that are obtained after performing various organ function tests

1. Perform Widal test to detect typhoid.
2. Estimation of acid phosphatase level and alkaline phosphatase level in the serum sample.
3. Estimation of GPT and GOT levels in serum.
4. Estimation of urea and creatinine in urine sample.
5. Estimation of bilirubin levels in serum sample.
6. Study of immunodiffusion by Ouchterlony technique.
7. Study of single radial immunodiffusion of antibody and antigen.
8. Analysis and interpretation of clinical diagnostic reports (CBC, Semen report, Cerebrospinal fluid report, myocardial infarction report, muscle disease report).
9. Report submission based on: Visit to a blood bank to understand its functioning/ Visit to a pathology laboratory to study various clinical tests that are performed in the pathology laboratory/ Visit to a pathology laboratory to study various instruments that are used/ Prepare a brochure indicating various types of clinical diagnostic tests and facilities that are available in the pathology laboratory

Elective-1

Course 1: PSZOPHY405: Sports and exercise physiology

Objectives

- To comprehend the learner with basic concepts in sports and exercise physiology.
- To familiarize the learners with major muscle groups in various regions of the body.
- To acquaint the learners to the role of exercise physiology in promoting health, performance, and overall well-being.

Learning outcomes

The learner would be able to:

- Understand sports and exercise physiology and articulate its significance in optimizing athletic performance and preventing injuries.
- Discuss ethical implications of drug use and doping regulations in sports.
- Describe the roles of tendons, ligaments, and aponeurosis in supporting and stabilizing the musculoskeletal system.
- Analyze common sports injuries its evaluative and rehabilitation protocols.

Unit 1: Sports and exercise physiology-I (15 Hrs)

1.1 Introduction to sports and exercise physiology: definition, scope and significance

1.2 Basic concepts in sports and exercise physiology: endurance, strength, speed, flexibility, coordination; agility

1.3 Muscles: classification (skeletal, cardiac and smooth muscle), structure and functions of skeletal muscle

1.4 Kinesiology

1.4.1 Definition, aims and objectives of kinesiology, role of kinesiology in sports

1.4.2 Principles of plane and axis: planes of movement (sagittal, frontal and transverse planes) and axis of rotation: (frontal, sagittal and vertical axis)

1.4.3 Origin, insertion and action of major muscle groups of the body:
Head and face muscles: buccinator, temporalis
Neck muscles: digastric, longus capitis
Abdominal muscles: rectus abdominis
Hand muscles: adductor pollicis, bicep brachii and tricep brachii
Leg muscles: bicep femoris, gluteus maximus

1.5 Classification of muscles based on fiber arrangements

1.5.1 Circular (circularly arranged): pupillary sphincter in the eye or anal sphincter

1.5.2 Parallel (parallelly arranged): sartorius muscle and rectus abdominus

1.5.3 Convergent (convergently arranged): pectoralis major (chest muscle)

1.5.4 Pennate (pennately arranged): unipennate (e.g., extensor digitorum longus in the leg), bipennate: (e.g., rectus femoris in the thigh), multipennate: (e.g., deltoid in the shoulder).

1.6 Physiology of muscle contraction

1.7 Types of muscle contraction: Isotonic muscle contraction (concentric contractions & eccentric contractions), isometric contractions

1.8 Tendons, ligaments and aponeurosis

Unit 2: Sports and exercise physiology-II (15 Hrs)

2.1 Body composition and its applications

2.1.1 Concept of body composition: Fat and lean body tissue (Fat Free Mass-FFM), components of FFM, components of body fat (essential fat and storage fat)

2.1.2 Need for body composition assessment before exercise and sports training

2.2 Respiration in exercise

2.2.1 Oxygen consumption and pulmonary ventilation in exercise
oxygen-diffusing capacity of athletes.

2.3 Cardiovascular system in exercise

2.3.1 Muscle blood flow, cardiac output during exercise

2.3.2 Effect of training on heart hypertrophy and on cardiac output

2.3.3 Role of stroke volume and heart rate in increasing the cardiac output

2.4 Exercise and immune system

2.4.1 Exercise and resistance to infections

2.4.2 Risks of infections due to high intensity workout and environmental extremes

2.5 Thermoregulation and exercise

2.5.1 Importance of thermoregulation

2.5.2 Mechanism of thermoregulation: Sweat evaporation, vasodilation and behavioural adaptations

2.5.3 Heat stress and hydration

2.6 Hormonal responses to exercise

2.6.1 Role of cortisol, epinephrine, norepinephrine, insulin, glucagon, growth hormone and testosterone

2.7 Injury prevention and rehabilitation during sports and exercise

2.7.1 Common sports injury

2.7.2 Rehabilitation protocols and return to play

2.8 Drugs and Doping in sports

2.8.1 Performance enhancing drugs

2.8.2 Anti-doping regulations and ethics

Elective-1

PSZOPPHYP406

Laboratory exercises based on Sports and Exercise Physiology (60Hrs)

Objectives

To abreast the learners with the knowledge of sports and exercise physiology
To introduce sports and exercise physiology as a viable entrepreneur skill option

Desired outcomes

The learners would be able to:

- Differentiate between striated and non-striated muscles
- Identify muscles based on fiber arrangement, types of muscle contractions
- Understand origin, insertion and action of major muscle groups of the body
- Determine the body fat with help of fat analyzer and calliper
- Analyze the impact of exercise on parameters like blood glucose level

1 Mounting of striated and nonstriated muscles (chicken / goat muscles).

2 Study of muscles based on fiber arrangements: Circular (pupillary sphincter), parallel (sartorius muscle and rectus abdominus), convergent (pectoralis major, extensor digitorum longus, rectus femoris, deltoid).

3 Study of types of muscle contraction: Isotonic muscle contraction (concentric contractions & eccentric contractions), isometric contractions.

4 Study of origin, insertion and action of major muscle groups of the body (buccinator, temporalis, digastric, longus capitis, rectus abdominis, adductor pollicis, bicep brachii and triceps brachii, bicep femoris, gluteus maximus).

5 Estimation of blood glucose by GOD POD method.

6 Determination of body fat with the help of body fat analyser.

7 Determination of body fat with the help of body fat callipers.

8 Report submission based on: Visit to a Fitness center and record observations based on types of machines available in the center, and their uses/ Study of various sports supplements available in the market, their benefits and side effects/ Conduct a correlation study based on exercise and BMI of different people/ Submission of clay models for the location of different muscles.

Elective-2

PSZOPHY407

Physiological ecology and Conservational physiology

Objectives

- To introduce the learners to the basics of physiological ecology, isotopic ecology,ecotoxicology, conservation physiology.
- The learners will explore real world case studies related to conservation physiology
- The learners will delve into the practical applications and broader scope of conservation physiology.

Desired outcomes

The learner would be able to:

- Define physiological ecology and conservation physiology.
- Explain the relationship between physiological adaptations and ecological systems, the impact of various stressors on physiological processes.
- Describe how organisms adapt to extreme environments.
- Compare and contrast different physiological adaptations in extreme environments.
- Develop hypotheses about potential physiological adaptations in specific extreme environments.
- Analyze case studies showcasing the application of conservation physiology.
- Apply knowledge of physiological ecology to analyze environmental impacts and knowledge of stressors to predict potential ecological outcomes.
- Illustrate how conservation physiology is used in real-world scenarios.

Unit 1: Physiological ecology

1.1 Introduction to physiological ecology
1.1.1 Input and output budget, isometry and allometry, scaling of physiological and ecological traits, use of historical data in comparative studies
1.1.2 Evolutionary match between environmental aridity and water relation
1.2 Food intake and utilization efficiency
1.2.1 Energy maximization or regulation
1.2.2 Intermittent feeders
1.2.3 Gut in diet switchers
1.2.4 Photosynthetic animals
1.3 Isotopic ecology**:**
1.3.1 Basic principle of isotopic ecology, mixing models
1.3.2 Isotopic signatures, stable isotopes and migration studies
1.3.3 Remote sensing and thermal logging
1.4 Ecotoxicology
1.4.1 Absorption and distribution of xenobiotics in the body
1.4.2 Biotransformation and elimination of xenobiotics and their metabolites
1.4.3 Cost of xenobiotic biotransformation and elimination
1.4.4 Toxic effects of xenobiotics in wild animals
1.5 Allocation to reproduction
1.5.1 Trade off with development and effects of body size
1.5.2 Approaches for measuring costs of reproduction, material cost and nutritional control of reproduction
1.6 Physiological adaptations to extreme environments
1.6.1 Cold environment, hot environment, underground environment, high altitude environment, aquatic environment
1.6.2 Extreme terrestrial locomotion: Cursorial locomotion, branchiation and climbing, migration
1.6.3 Difficult digestion- Keratin, bones, wax and chitin
1.6.4 Flying mammals- metabolic cost of flight, thermal balance

Unit 2: Conservation physiology **15Hrs**

2.1 Introduction to conservation physiology
2.1.1 Definition and basic concept of conservation physiology
2.1.2 History of combining animal physiology and conservation science
2.1.3 Types of ecological scales related to conservation physiology: Biological, temporal, spatial, allometric, phylogenetic
2.2 Scope of conservation physiology
2.2.1 Sub-disciplines of conservation science with relevant connections to conservation physiology
2.2.2 Bioindication of contaminants and pollution
2.3 Application of conservation physiology: validation toolbox, sensitive biomarker of organismal condition or health, identifying underlying mechanism of decline, proactive and predictive capacity
2.4 Case study related to conservation physiology
2.4.1 Toxicological study - maternal transfer of contaminants to developing eggs (Osprey / Vulture)
2.4.2 Physiological assessment of environmental stressors (corticosterone levels)- Male owls (*Strix occidentalis caurina*) and Iguana (*Amblyrhynchus cristatus*)
2.4.3 Nutritional stress - Desert tortoise (*Gopherus agassizii*)
2.4.4 Relation of heart rate and body temperature to foraging events - Black Browed Albatross (*Thalassarche melanophris*)
2.4.5 Integrating stress physiology and behaviour to monitor their health and welfare - Tigers (*Panthera tigris*) in zoo

Elective-2

PSZOPHYP408
Laboratory exercises based on Physiological Ecology and Conservational Physiology (60Hrs)

Objectives
To acquaint the learners to various experiments based on physiological ecology and conservational physiology.
To enhance the analytical and observational skills of the learners.

Desired outcomes
The learners would be able to:

- Calculate resting metabolic rate.
- Perform the experiments based on effect of parameters like osmotic condition. temperature, chemical pollutants on invertebrate animals like paramecia or daphnia
- Analyze the behavioral responses of organisms.

1 Calculate RMR (Resting metabolic rate) in humans using Mifflin-St Jeor equation

2 Study of effect of heavy metal on the heartbeat of Daphnia using any

3 Observe and quantify behavioral responses (using BORIS) of organisms in natural environments (resource budgeting).

4 To study the effect of osmotic conditions/temperature on Paramecium

5 To study the effect of chemical pollutants/ environmental toxins on Paramecium.

6 Report submission on behavioral responses with respect to feeding behaviour of rice weevil or rust red flour beetle / Report submission on behavioural responses of rice weevil *Sitophilus oryzae*/ rust red flour beetle *Tribolium* to environmental cues/Submit a review on the impact of a xenobiotic on different animals based on research papers available/ Report submission on various bioindicator species present in your area to access the pollution status.

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10. Cancer Fundamentals by Mrs Jyotsna Govil (https://onlinecourses.swayam2.ac.in/aic20_ge02/preview)
11. Cancer Biology Specialization (https://www.coursera.org/specializations/cancer-biology)
12. Introduction to the Biology of Cancer (https://www.coursera.org/learn/cancer)
13. Introduction to Breast Cancer (https://www.coursera.org/learn/breast-cancer-causes-prevention)
14. The Science of Stem Cells (https://www.coursera.org/learn/stem-cells)
15. Understanding Cancer Metastasis (https://www.coursera.org/learn/cancer-metastasis)
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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 and8 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

2) 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 practical 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 CO_2 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
PSZOPHYP303

Laboratory exercises based on Physiology of Nutritive, Respiratory, Circulatory and Endocrine systems

(Time: 10.00 am - 2.00 pm)

Total Marks: 25 **Duration: 4 hours**

Q.1 **(10M)**

Determine the effect of pH/ activator/inhibitor on the activity of salivary amylase.

OR

Determine the effect of insulin/ adrenaline on the heart rate of chick embryos.

OR

Demonstrate the effect of decreasing $_{P}O_{2}$ of water on the lactic acid content of fish muscles.

OR

Demonstrate the effect of eyestalk ablation on glucose metabolism of mud crab.

Q.2 Identify and describe: **(12M)**
a. Mouth parts of insects
b. Dental formula
c. Gut content of fish
d. Endocrine glands

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

Submission of certified journal is mandatory

Suggested Guidelines for Practical Assessment (Internal)

Internal examination **(Total marks 25)**

Q. 1 Conduct a survey and submit a report based on: dietary patterns and nutrient intake amongst different demographics/ blood glucose levels of the family members and neighbours and correlate with their diet and lifestyle/ Report submission based on 6 minutes' walk test project/ Submit the charts or clay models of endocrine glands that you have studied **(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
PSZOPHYP304
Laboratory exercises based on Environmental physiology
(Time: 10.00 am - 2.00 pm)

Total Marks: 25 **Duration: 4 hours**

Q.1 **(10M)**
Determine the effect of different salt concentrations on RBC

OR

Determine the effect of temperature on the activity of enzyme amylase

Q.2 **(6M)**
Determine the effect of decreasing $_{P}O_2$ of water on the respiratory rate of fish

OR

Determine the effect of temperature on the heart rate of a chick embryo.

OR

Determine the effect of variations in salt concentrations/pH on the respiratory rate of fish

Q.3 Identification **(6M)**

a) Salt glands in animals
b) Diapause in insects
c) Biological rhythms

Q. 4 Viva based on theory **(3M)**

Submission of certified journal is mandatory

Suggested Guidelines for Practical Assessment (Internal)

Internal examination **(Total marks 25)**

Q. 1 Conduct a survey and submit a report based on: Sleep patterns among night job workers and day job workers/ Sleeping hours and existence of metabolic disorders like BP, diabetes, high cholesterol /Report submission based on Biological rhythms exhibited by the animals in your surrounding/ Submit the report on the topic: “The impact of smartphone usage on circadian cycles of human beings” **(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
PSZOPHYP307
Laboratory exercises based on
(Time: 10.00 am - 2.00 pm)

Total Marks: 25 **Duration: 4 hours**

Q.1 **(12M)**

Problem based on inheritance pattern (Any two disorders)

OR

Problem based on metabolic pathway (Any two disorders)

OR

Problem based on diet formulation for patients suffering from metabolic disorders (Any two disorders)

OR

Estimate G6PD from the given serum sample

Q.2 **(10M)**

From the symptoms provided to you, identify the metabolic disorder and describe in detail the cause,diagnostic tools and therapeutic measures for the disorder (Any two disorders)

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

Submission of certified journal is mandatory

Suggested Guidelines for Practical Assessment (Internal)

Internal examination **(Total marks 25)**

Q. 1 Report submission based on: Review of secondary data on metabolic errors/ Correlation studies like BP and BMI,/Diabetes and BMI/ Blood glucose level and Pulse rate before and after 30 mins walk or exercise.

(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
PSZOPHYP309
Laboratory exercises based on
(Time: 10.00 am - 2.00 pm)

Total Marks: 25 **Duration: 4 hours**

Q.1 **(12M)**

Estimate uric acid levels from the serum sample

OR

Determine catalase activity of blood using hydrogen peroxide disc method

OR

Demonstrate the presence of urine cast and crystals from the given sample and interpret the results

Q.2 **(4M)**

Record the pH of any one biological sample (blood/gastric juice) provided to you and interpret the result

OR

Demonstrate the efficacy of natural and commercial acid neutralizers

OR

Determine peak expiratory flow rate to assess the quality of lungs

Q.3 **(6M)**

a) Identify abnormal morphology of blood cells and comment on the pathology (RBCs/WBC / Platelet) (Any two)

Q.4 Viva based on theory **(3M)**

Submission of certified journal is mandatory

Suggested Guidelines for Practical Assessment (Internal)

Internal examination **(Total marks 25)**

Q. 1Conduct a survey and submit a report based on: Blood group study in the neighborhood/ Anemic and non-anemic population of the college students or of neighbors/ Submission of charts or clay models explaining composition of blood/ Submission of charts or claymodels explaining types of blood disorders. **(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
PSZOPHYP403
Laboratory exercises based on
(Time: 10.00 am - 2.00 pm)

Total Marks: 25 **Duration: 4 hours**

Q.1 **(10M)**
Demonstrate the effect of ATP and Mn^{++}/ ATP and Mg^{++}/ ATP and KCl/ ATP and CaCl2 and NaCl on glycerinated fiber. Submit a report.

OR

Estimate salt loss and salt gain in fish when it is transferred to salt free medium and natural medium.

OR

Demonstrate the effect of any three stimuli (Light, Chemical, Temperature, Gravity) on paramecia

Q.2 Identify **(12M)**
a. Identify and describe: locomotory structures invertebrates
b. Identify and describe: locomotory structures in the vertebrate
c. Compare and contrast the brains of two animals
d. Identify and describe slides/pictures based on asexual reproduction
e.Identify and describe of the technique EEG/ MRI scans/ CT scans / EMG/ EOG
f.Identify and describe the technique Kymograph

Q.3 Viva based on theory **(3M)**
Submission of certified journal is mandatory

Suggested Guidelines for Practical Assessment (Internal)

Internal examination **(Total marks 25)**

Q. 1Conduct a survey and submit a report based on different gaits exhibited by animals in your vicinity/ Submit a report based on routine urine analysis (color, clarity, pH, protein, glucose, ketone bodies and blood cells)/ Submission of clay models or charts based on reproductive strategies exhibited by the animals/ Submission of clay models or charts based on locomotory structures exhibited by the animals. **(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
PSZOPHYP404
Laboratory exercises based on
(Time: 10.00 am - 2.00 pm)

Total Marks: 25 **Duration: 4 hours**

Q.1 **(10M)**
Estimation of ACP/ALP/GPT/GOT from the given sample (Any one)

OR

Demonstration of immunodiffusion by Ouchterlony technique

OR

Demonstration of single radial immunodiffusion of antibody and antigen

Q.2 **(07M)**

Estimation of Urea/ Bilirubin/Creatinine (Any one)

OR

Perform Widal test to detect typhoid

Q.3 **(05M))**

Analysis and interpretation of clinical diagnostic reports (CBC/ Semen report/ Cerebrospinal fluid report/ myocardial infarction report/ muscle disease report)

Q.4 Viva-voce based on theory **(3M)**
Submission of certified journal is mandatory

Suggested Guidelines for Practical Assessment (Internal)

Internal examination **(Total marks 25)**

Q. 1Report submission based on: Visit to a blood bank to understand its functioning/ Visit to a pathology laboratory to study various clinical tests that are performed in the pathology laboratory/ Visit to a pathology laboratory to study various instruments that are used/ Prepare a brochure indicating various types of clinical diagnostic tests and facilities that are available in the pathology 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
PSZOPHYP406
Laboratory exercises based on
(Time: 10.00 am - 2.00 pm)

Total Marks: 25 **Duration: 4 hours**

Q.1 **(9M)**
Estimate blood glucose by GOD POD method from serum sample

OR

Mount striated and nonstriated muscles (Chicken / goat muscles)

OR

Prepare a report based on 6 minutes walk test using pulse oxymeter to determine stress levels

Q.2 **(4M)**
Determine the body fat with the help of body fat analyzer

OR

Determine body fat with the help of body fat calipers

Q.3 Identify and describe **(9M)**
a) Muscle based on fiber arrangements
b) Type of muscle contraction
c) Origin, Insertion and action of any one of the major muscle groups of the body

Q.4 Viva-voce based of theory **(3M)**

Submission of certified journal is mandatory

Suggested Guidelines for Practical Assesment (Internal)

Internal examination **(Total marks 25)**

Q. 1 Report submission based on: Visit to a Fitness centre and record observations based on types of machines available in the centre, and their uses/ Study of various sports supplements available in the market, their benefits and side effects/ Conduct a correlation study based on exercise and BMI of different people/ Submission of clay models for the location of different muscles. **(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
PSZOPHYP408
Laboratory exercises based on
(Time: 10.00 am - 2.00 pm)

Total Marks: 25 **Duration: 4 hours**

Q.1 **(12)**
Demonstrate the behavioral responses (using BORIS software) of organisms in natural environments.

OR

Demonstrate the toxicological stress in Daphnia using heavy metals

Q.2 **(10)**
From the data provided calculate RMR (Resting metabolic rate) in humans using Mifflin-St Jeor equation and comment on the results obtained (Data of two individuals to be given)

OR

Demonstrate the effect of **(Any two)** temperature/ osmotic conditions /chemical pollutants/ environmental toxins on paramoecium.

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

Submission of certified journal is mandatory

Suggested Guidelines for Practical Assessment (Internal)

Internal examination **(Total marks 25)**

Q.1 Report submission on behavioral responses with respect to feeding behaviour of rice weevil or rust red flour beetle **/** Report submission on behavioural responses of rice weevil *Sitophilus oryzae*/ rust red flour beetle *Tribolium* to environmental cues/Submit a review on the impact of a xenobiotic on different animals based on research papers available/ Report submission on various bioindicator species present in your area to access the pollution status. **(15 marks)**

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

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.

Letter Grades and Grade Points:

Semester GPA/ Programme CGPA Semester/ Programme	% of Marks	Alpha-Sign/ Letter Grade Result	Grading Point
9.00 - 10.00	90.0 - 100	O (Outstanding)	10
8.00 - < 9.00	80.0 - < 90.0	A+ (Excellent)	9
7.00 - < 8.00	70.0 - < 80.0	A (Very Good)	8
6.00 - < 7.00	60.0 - < 70.0	B+ (Good)	7
5.50 - < 6.00	55.0 - < 60.0	B (Above Average)	6
5.00 - < 5.50	50.0 - < 55.0	C (Average)	5
4.00 - < 5.00	40.0 - < 50.0	P (Pass)	4
Below 4.00	Below 40.0	F (Fail)	0
Ab (Absent)	-	Ab (Absent)	0

Sign of the BOS Coordinator
Dr. Vaishali Somani
BOS in Zoology

Sign of the Offg. Associate Dean
Dr. Madhav R. Rajwade
Faculty of Science & Technology

Sign of the Offg. Dean
Prof. Shivram S. Garje
Faculty of Science & Technology

BOD – 3/9/2024
12 (7) of M.P.U.A. 2016
Item No. – 6.3 (2) (N)

As Per NEP 2020

University of Mumbai

Title of the P.G. Program

M.Sc. (Zoology - Endocrinology)

Syllabus for

Semester – Sem.- III & 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:_____	M.Sc. (Zoology - Endocrinology)
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: SP- 80 B (2)	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 Coordinator Dr. Vaishali Somani BOS in Zoology	Sign of the Offg. Associate Dean Dr. Madhav R. Rajwade Faculty of Science & Technology	Sign of the Offg. Dean Prof. Shivram S. Garje Faculty of Science & Technology

Preamble

Introduction

The Master Course in Zoology with specialization in Endocrinology and Reproductive Physiology offers a comprehensive exploration of the fascinating world of hormones and their profound impacts on living organisms. Throughout this course, students embark on an illuminating journey spanning both invertebrate and vertebrate domains, where they uncover the intricate mechanisms of hormonal regulation from the most basic organisms to the most complex vertebrates. With a focus on understanding the neurohormonal intricacies of invertebrates and conducting comparative analyses of endocrine glands in vertebrates, learners gain deep insights into the fundamental principles governing vital life processes. Moreover, through hands-on practical experiences, students acquire detailed knowledge of human and non-human reproductive physiology, enhancing their employability in various medical fields related to reproduction. The electives offer foundational knowledge and practical skills for working with laboratory animals, covering ethics, animal housing layout, and communication. Students learn about classification, normal behaviors, breeding techniques, and safe handling, preparing them for responsible laboratory practices. Visits to research institutes and animal breeding centers, enhance students' understanding through real-world exposure.

Aims and Objectives

The primary aim of this course is to furnish learners with an extensive comprehension of Zoology with a focus on Endocrinology and Reproductive Physiology, integrating theoretical comprehension with practical competencies. The objectives are designed to provide learners with thorough insights into the endocrine systems of both vertebrates and invertebrates, encompassing their structural, functional, and evolutionary dimensions. The study of Reproductive Physiology acquaints learners with both theoretical principles and practical applications, including emerging reproductive technologies applicable to humans and domestic animals, thereby enhancing their employability in related professional domains. The course also focuses on familiarizing students with ethical considerations and regulations governing the use of laboratory animals, fostering a culture of responsible and humane animal research. Visits to research laboratories, animal breeding centers and fertility centers allow learners to apply theoretical knowledge in real-world laboratory settings.

Learning Outcomes

Upon completion of the course, learners will demonstrate a comprehensive understanding of Zoology with specialization in Endocrinology and Reproductive Physiology, proficiently integrating theoretical knowledge with practical skills. They will exhibit detailed knowledge of the endocrine systems of vertebrates and invertebrates, including their structural, functional, and evolutionary characteristics. Furthermore, learners will be adept in the theoretical principles and practical applications of Reproductive Physiology, including emerging technologies relevant to human and domestic animal reproduction. This acquired expertise will enable learners to pursue diverse career opportunities in fields such as medical research, clinical practice, and reproductive technologies.

Credit Structure of the Program for Semesters III & IV

Post Graduate Programs in University Parishishta – 1

R: SP- 80 B (2)									
Exit option: PG Diploma (44 Credits) after Three Year UG Degree									
Year (2 Yrs PG)	**Level**	**Sem.** (2 Yrs)	**Major**		**RM**	**OJT / FP**	**RP**	**Cum. Cr.**	**Degree**
			Mandatory*	**Electives (Any one)**					
I	**6.0**	**Sem III**	**PSZOENDO301:** Comparative Invertebrate Endocrinology Credits 4 **PSZOENDO302:** Comparative Vertebrate Endocrinology Credits 4 **PSZOENDO303:** Practical –Invertebrate Endocrinology Credits 2 **PSZOENDO304:** Practical –Vertebrate Endocrinology Credits 2 **PSZOENDO305:** Medical & Applied Endocrinology Credits 2	**PSZOENDO306:** Ethics of Animal Handling, Care taking & Breeding Credits 2 **PSZOENDO307:** Practical – Ethical Practices in Animal Handling Credits 2 **OR** **PSZOENDO308:** Endocrinology Related to Metabolism Credits 2 **PSZOENDO309:** Practical – Clinical Surveys in Endocrinology Credits 2	–	–	4	22	**PG Degree (after 3-year UG course)**
		Sem IV	**PSZOENDO401:** Endocrinology & Reproductive Physiology Credits 4 **PSZOENDO402:** Comparative Endocrinology & Reproductive Physiology of vertebrates (except human) Credits 4 **PSZOENDO403:** Practical – Endocrinology of Human Reproduction **PSZOENDO404:** Practical – Comparative Endocrinology of Non-human Mammals	**PSZOENDO405:** Infertility, Contraception and Counselling on Sexual Development Credits 2 **PSZOENDO406:** Practical – Reproduction: Health and Diagnostics Credits 2 **OR** **PSZOENDO407:** Endocrinology and Animal Husbandry Credits 2 **PSZOENDO408:** Practical – Animal Husbandry: Infrastructure and Practices Credits 2	–	–	6	22	
Cum. Cr. for 1 Yr PG Degree			**26**	**8**	**–**	**–**	**10**	**44**	**–**
Cum. Cr. for 2 Yr PG Degree			**54**	**16**	**4**	**4**	**10**	**88**	

Note: * The number of courses can vary for totaling 14 Credits for Major Mandatory Courses in a semester as illustrated.

Sem. - III

Syllabus

M.Sc. (Zoology - Endocrinology)

(Sem.- III)

M. Sc. Part 2: Semester III (Theory)
PSZOENDO301: Comparative Invertebrate Endocrinology

Course Objectives:

- *To define and differentiate between neurohormones, neurotransmitters, and hormones in invertebrates.*
- *To explain the concept of neurosecretion and its significance in invertebrate physiology.*
- *To identify key endocrine organs and their secretions in various invertebrate groups.*
- *To study the histological structure of endocrine glands in invertebrates.*
- *To describe the roles of hormones in regulating essential life processes in invertebrates.*
- *To evaluate the impact of endocrine disruptors on invertebrate populations and its application in its control.*

Outcome of the Course:

- *The learners will be able to demonstrate a comprehensive understanding of the structure and function of endocrine systems in various groups of invertebrates.*
- *The learner will be able to differentiate between different types of signaling molecules and their roles in regulating physiological processes in invertebrates.*
- *The learner will apply their knowledge of invertebrate endocrinology to analyze and interpret hormonal regulation in different invertebrate species.*
- *The learners will analyze and compare endocrine systems across diverse invertebrate taxa, identifying evolutionary trends and adaptations.*
- *The learner will propose evidence-based strategies for mitigating the impacts of endocrine disruptors on invertebrate populations and ecosystems, considering ethical and ecological implications.*
- *The learners will effectively communicate complex concepts and findings related to invertebrate endocrinology through written reports, presentations, and discussions.*

Unit 1: Invertebrate Endocrinology – Part 1 (15 L)

1.1 Concept of Neurohormone, Neurosecretion and neuroendocrine relation in the invertebrates

1.2 Invertebrate organs and hormones – secretion, function and their role in life process

- 1.2.1 Cnidarian – Neuropeptides and GnRH-like substance
- 1.2.2 Helminths – Neurotransmitter secretions
- 1.2.3 Estrogens of Annelids produced by NSC of supraoesophageal ganglia, Annelid – Brain hormone, Feedback substance
- 1.2.4 Neurosecretory centres have been identified in the simple nemertine brain – Ecdysteroids
- 1.2.5 Mollusca – Optic glands of the cephalopods and the dorsal bodies of the gastropods are endocrine organs, gonads and specialized neuroendocrine cells
- 1.2.6 Echinoderm – Asexual and sexual reproduction, sex reversal, sex differentiation, gonadal development, maturation, gametogenesis, and reproductive behaviour. Hormones – Sex steroid hormones, Enteroendocrine cells in the luminal epithelia of the digestive tract.

Unit 2: Invertebrate Endocrinology – Part 2 **(15 L)**

2.1 Insects – Endocrine glands
- 2.1.1 Corpora cardiaca
- 2.1.2 Corpora allata
- 2.1.3 Moulting glands
- 2.1.4 Inka cells
- 2.1.5 Epitracheal gland
- 2.1.6 Neurosecretory cells of the ventral nerve cord and associated ganglia.
- 2.1.7 Neurohormones and hormones controlling moulting, diapause, reproduction, osmoregulation, metabolism, and muscle contraction.

Unit 3: Invertebrate Endocrinology – Part 3 **(15 L)**

3.1 Crustacean Neuroendocrine system
- 3.1.1 Neurosecretory X-organ and its associated neurohemal organ – sinus gland
- 3.1.2 Y-organ
- 3.1.3 Androgenic gland
- 3.1.4 Green gland
- 3.1.5 Mandibular organs
- 3.1.6 Hormones and neurohormones of the crustaceans regulating moulting, reproduction, osmoregulation, metabolism, and heart rate.
- 3.1.7 Regulation of colour changes in crustaceans

Unit 4: Applied Invertebrate Endocrinology **(15 L)**

4.1 Pheromones

4.2 Allomones, Kairomones, Synomones

4.3 Invertebrate Endocrine Disruption
- 4.3.1 Insects – Fipronil, Organophosphates, Carbamates, Pyrethroids
- 4.3.2 Crustaceans – Endosulfan, Methoprene,
- 4.3.3 Molluscs – Bisphenol A, Octylphenol, Nonylphenol, Tributyltin

PSZOENDO302: Comparative Vertebrate Endocrinology

Course Objectives:

- *To define hormones and classify them based on their types of secretion and functions.*
- *To describe the phylogenetic and ontogenetic development of major endocrine glands across vertebrate taxa, from Pisces to Mammalia.*
- *To analyze the origin, anatomy, and histology of various endocrine glands, understanding their structural adaptations for hormone production and secretion.*
- *To compare and contrast the hormonal regulation of different physiological processes, assessing their roles in maintaining homeostasis and responding to environmental stimuli.*

Outcome of the Course:

- *The learner will be able to demonstrate a comprehensive understanding of the fundamental concepts of endocrinology, including hormone classification, secretion types, and their evolutionary development.*
- *The learner will proficiently identify and describe the anatomy and histology of major endocrine glands, understanding their structural adaptations and physiological roles.*
- *The learner will analyze and comprehend the mechanisms of hormonal regulation in key endocrine glands.*

Unit 1: General Endocrinology, Phylogeny and Ontogeny (15 L)

1.1 Hormones – Definition, Classification, Types of secretion
1.2 Phylogeny of Pituitary, Pancreas, Adrenal, Thyroid, Parathyroid in Pisces, Amphibia, Reptilia, Aves and Mammalia
1.3 Ontogeny of Pituitary, Pancreas, Adrenal, Thyroid, Parathyroid in Pisces, Amphibia, Reptilia, Aves and Mammalia

Unit 2: Study of endocrine glands (15 L)

2.1 Endocrine glands – Origin, Anatomy and Histology
- 2.1.1 Pituitary
- 2.1.2 Thyroid
- 2.1.3 Parathyroid & Ultimobranchial Glands
- 2.1.4 Adrenal
- 2.1.5 Pancreas
- 2.1.6 Pineal
- 2.1.7 Testes
- 2.1.8 Ovaries
- 2.1.9 Thymus
- 2.1.10 Gastrointestinal Tract

Unit 3: Hormonal Regulation (15 L)

3.1 Pituitary
3.2 Thyroid
3.3 Parathyroid
3.4 Adrenal
3.5 Pancreas

Unit 4: Neuroendocrine Regulation **(15 L)**

4.1 Neuroendocrine organ: Hypothalamus – Structure and function

- 4.1.1 Hypothalamo-hypophyseal complex
- 4.1.2 Role of neurotransmitters in regulation of anterior pituitary hormonal release
  - a) TSH-RH
  - b) GnRH
  - c) ACTH-RH
  - d) GH-RH
  - e) Somatostatin
  - f) PIF-RH

4.2 The role of pineal in the transduction of environmental cues

4.3 Gastrointestinal hormones and endocrine regulation of digestion

4.4 Thymic hormones

PSZOENDO303: Practical – Invertebrate Endocrinology

Course objectives:

- *To study the representative nervous system of invertebrates.*
- *To analyze and apply knowledge of the neuroendocrine system in arthropods, elucidating its role in coordinating physiological processes.*
- *To comprehend their reproductive physiology of few invertebrates.*
- *To apply knowledge of pheromones to develop strategies for insect management, demonstrating an understanding of their role in pest control.*

Outcome of the Course:

- *The learner will gain a thorough understanding of the nervous and reproductive systems across various invertebrate species such as earthworm, prawn, crab, cockroach, and Sepia.*
- *The learner will develop the ability to analyze and interpret the neuroendocrine systems of invertebrates, applying this knowledge to comprehend their integral role in physiological coordination.*
- *The learner will acquire expertise in preparing slides featuring neurosecretory cells from diverse invertebrate specimens, showcasing competency in microscopy and slide preparation methodologies.*
- *The learner will be able to demonstrate proficiency in comparing and evaluating the reproductive systems of different invertebrate taxa, discerning both commonalities and variations in their anatomical structures and functional mechanisms.*
- *The learner will be able to apply theoretical knowledge of insect pheromones to formulate and implement targeted strategies for insect management.*

Practical

1. Study of nervous system of Earthworm.
2. Study of neuroendocrine system of Prawn / Crab / Cockroach.
3. Preparation of slides – Neurosecretory cells in different invertebrate examples. Sepia / Mytilus / Crab / Cockroach or any other animal not in schedule and easily available (submission of three slides) and report.
4. Study of reproductive system of Cockroach / Sepia / Crab.
5. Use of pheromones in Insect Pest management – Sex pheromones, Aggregation pheromones, Alarm pheromones, Trail pheromones, Host marking Pheromones.

PSZOENDO304: Practical – Vertebrate Endocrinology

Course objectives:

- To comprehend the structure and function of vertebrate endocrine glands through dissection and demonstration using a Rat model.
- To analyze the histology of vertebrate endocrine glands by studying comparative aspects across different vertebrate groups.

Outcome of the Course:

- The learner will develop a comprehensive understanding of vertebrate endocrinology, including the anatomy and histology of major endocrine glands.
- The learner will gain the ability to analyze, interpret, and apply concepts in vertebrate endocrinology research and practical contexts.

Practical

1. Dissect and demonstrate endocrine glands of vertebrate group (Rat).
   a) Pituitary
   b) Thyroid
   c) Adrenal
   d) Pancreas
2. Study of histology of vertebrate endocrine glands with help of photographs / slides (Comparative aspects – Fish, Amphibians, Reptiles, Birds, Mammals).
   a) Pituitary
   b) Thyroid
   c) Adrenal
   d) Pancreas
   e) Parathyroid
3. Preparation of Permanent slides of Pituitary, Thyroid and Adrenal Gland of Rat.

PSZOENDO305: Medical & Applied Endocrinology

Course Objectives:

- *To identify and comprehend various hormonal disorders.*
- *To analyze the etiology, clinical manifestations, and treatment options of hormonal disorders, demonstrating the ability to evaluate diagnostic criteria and therapeutic interventions.*
- *To explore natural sources of hormones and their applications in medical practice, as well as the role of phytosteroids in hormonal regulation.*
- *To explore the mechanisms underlying hormone-dependent cancers and assess the risk factors, prognosis, and treatment modalities associated with these cancers.*

Outcome of the Course:

- *The learner will attain an in-depth understanding of various hormonal disorders encompassing genetic, rare, and other conditions.*
- *The learner will be able to demonstrate the ability to critically analyze the causes, clinical presentations, and therapeutic approaches for hormonal disorders, evaluating diagnostic criteria and treatment options effectively.*
- *The learner will develop proficiency in assessing the impact as well as etiology, prognosis and treatment of hormone-dependent cancers.*
- *The learner will be able to delve into the production of hormones from natural sources and their practical applications in medicine.*

Unit 1: Medical Endocrinology **(15 L)**

1.1 Hormonal Disorders

1.1.1 Pituitary – Genetic disorders

- Multiple Endocrine Neoplasia type 1 – MEN I
- Familial Isolated Pituitary Adenoma – FIPA

Pituitary – Rare disorders

- Craniopharyngiomas
- Prolactinoma
- Rathke's Cleft Cyst
- Hypophysitis

Pituitary – Other disorders

- Empty Sella Syndrome
- Sheehan Syndrome
- Pituitary Apoplexy

1.1.2 Thyroid – Genetic Disorders

- Resistance to Thyroid hormone
- Pendred Syndrome

Thyroid – Rare Disorders

- Thyrotropinoma
- MCT8 Deficiency
- Riedel's Thyroiditis

1.1.3 Parathyroid – Genetic Disorders

- Isolated Parathyroid aplasia
- DiGeorge Syndrome
- Kenny Caffey Syndrome

1.1.4 Adrenal – Genetic Disorders

- X-linked Adrenoleukodystrophy
- Primary Adrenal Insufficiency (PAI)
- Congenital Adrenal Hyperplasia (CAH)
- Virilization

1.1.5 Pancreas – Islet of Langerhans disorders

- Non-functional Islet Cell Tumour
- Insulinoma
- Glucagonoma
- Somatostatinoma

Unit 2: Applied Endocrinology (15 L)

2.1 Phytosteroids – Glycine max (Soybean), Withania somnifera (Ashwagandha), Asparagus racemosus (Shatavari), *Trigonella foenum–gracium* (Fenugreek)

2.2 Production of hormones – GH, Insulin, Progesterone, Estrogen

2.3 Hormone-dependent Cancers

- Breast Cancer
- Prostate Cancer
- Ovarian Cancer
- Endometrial Cancer

Endocrinology Elective:
Semester III
PSZOENDO306: Ethics of Animal Handling, Care taking & Breeding

Course Objectives:

- *To understand ethical considerations in using lab animals and create conducive environments for their welfare.*
- *To gain skills in safely handling animals and establish effective communication for research cooperation.*
- *To learn ethical breeding practices to ensure the animal welfare.*
- *To develop theoretical considerations in experimental techniques, including handling, drug administration, and sample collection.*
- *To enable to design comprehensive health monitoring programs and methodologies for laboratory animals enabling timely therapeutic and preventive measures.*

Outcome of the Course:

- *The learner will be able to demonstrate a thorough understanding of ethical considerations in the use of laboratory animals and will be able to design and maintain environments that ensure the welfare and humane treatment of these animals in compliance with ethical and regulatory standards.*
- *The learner will acquire and apply safe animal handling techniques and develop effective communication strategies for the efficient conduct of animal-based research.*
- *The learner will be able to design ethical breeding programs that promote the welfare of laboratory animals.*
- *The learner will master theoretical knowledge and practical skills in experimental techniques such as animal handling, drug administration, and sample collection, ensuring these procedures are performed ethically and effectively.*
- *The learner will be able to implement the knowledge to design comprehensive health monitoring programs for laboratory animals, utilizing timely therapeutic and preventive measures to enhance animal health and welfare, and ensuring compliance with ethical standards and best practices in laboratory animal care.*

Unit 1: Introduction to Laboratory Animals (15 L)

1.1 Introduction to Laboratory Animals
- 1.1.1 Animal Ethics
- 1.1.2 Layout of Animal House

1.2 Different Types of Laboratory Animals
- 1.2.1 Classification of Laboratory Animals
- 1.2.2 Importance of Communication with Laboratory Animals
- 1.2.3 Normal and abnormal behaviour of the laboratory animals

1.3 Laboratory Animal Breeding
- 1.3.1 Ethical Breeding techniques of Laboratory Animals
- 1.3.2 Methods of safe handling of small animals

Unit 2: Animal Experimental Techniques and Pathology (15 L)

1.1 Animal Experimental Techniques
- 1.1.1 Animal handling and restraining
- 1.1.2 Routes of drug administration
- 1.1.3 Sampling techniques
- 1.1.4 Necropsy procedures and euthanasia

1.2 Pathology
- 1.2.1 Health monitoring program and Methodologies
- 1.2.2 Basic techniques for detection of bacterial and viral diseases in laboratory rodents
- 1.2.3 Therapeutic and preventive measures.
- 1.2.4 Methods of monitoring bacterial load in-floor, feed, water and bedding.

PSZOENDO307: Practical: Ethical Practices in Animal Handling

Course objectives:

- *To observe and evaluate the design, management, and ethical practices of animal houses in diverse research settings, and to prepare detailed reports reflecting on these observations.*
- *To apply theoretical knowledge by designing and constructing a model animal house using sustainable, biodegradable materials, demonstrating an understanding of animal welfare and environmental considerations.*
- *To gain insights into veterinary practices, animal care, and research activities by visiting a veterinary college and preparing a comprehensive report on the visit, highlighting key learnings and observations.*
- *To understand the principles and practices of animal breeding by visiting a breeding center, and to document the visit through a detailed report that examines breeding techniques, ethical considerations, and animal welfare standards.*

Outcome of the Course:

- *The learner will be able to critically assess and report on the design, management, and ethical practices of animal houses in various research institutes.*
- *The learner will be able to design and construct a sustainable animal house model using biodegradable materials, demonstrating understanding of animal welfare and environmental considerations.*
- *The learner will be able to analyze veterinary practices and animal care during a veterinary college visit / animal house and compile a comprehensive report on their findings.*
- *The learner will be able to evaluate animal breeding principles and practices during a breeding center visit and produce a detailed report on breeding techniques and animal welfare standards.*

Practical

1. Visit to veterinary college / animal houses / animal care centre of zoological park or national park in various research institutes (minimum three) and preparation of reports on each.
2. Preparation of Model of Animal house (making use of biodegradable substances only).
3. Visit to animal breeding centre & preparation of report.
4. Filling Form B and Form D as per CCSEA (Committee for Control and Supervision of Experiments on Animals) considering Hypothetical Experimental Protocol.

Endocrinology Elective: Semester III
PSZOENDO308: Endocrinology Related to Metabolism

Course Objectives:

- *To understand different types of diabetes.*
- *To comprehend the roles of the hypothalamus and pituitary gland in regulating thyroid function.*
- *To evaluate the impact of thyroid hormones on various organs.*
- *To interpret and understand the significance of various thyroid function tests.*

Outcome of the Course:

- *The learner will be able to accurately define and differentiate between the various types of diabetes*
- *The learner will be able to explain the regulatory mechanisms of the thyroid gland, detailing the roles of the hypothalamus and pituitary gland.*
- *The learner will be able to evaluate the physiological effects of thyroid hormones on the heart, skeletal muscles, and lungs, understanding their systemic impact.*
- *The learner will be able to interpret various thyroid function tests and explain their clinical significance in diagnosing thyroid disorders.*

Unit 1: Diabetes – Definition, basic types **(15 L)**

1.1 Diabetes insipidus
- 1.1.1 Central Diabetes insipidus
- 1.1.2 Nephrogenic Diabetes insipidus
- 1.1.3 Gestational Diabetes insipidus
- 1.1.4 Dipsogenic Diabetes insipidus

1.2 Diabetes mellitus
- 1.2.1 Type 1
- 1.2.2 Type 2
- 1.2.3 Gestational
- 1.2.4 Impaired Glucose Tolerance (IGT)
- 1.2.5 Impaired Fasting Glycemia (IFG)

Unit 2: Thyroid Regulation and Function **(15 L)**

1.1 Organs responsible for regulation of Thyroid gland
- 1.1.1 Hypothalamus
- 1.1.2 Pituitary Gland

1.2 Effect of thyroid on other organs – Heart, skeletal muscles, lungs

1.3 Thyroid Function Test
- 1.3.1 T_4 Test
- 1.3.2 T_3 Test
- 1.3.3 TSH test
- 1.3.4 Thyroid Antibody Test
- 1.3.5 Reverse T_3 Test
- 1.3.6 Thyroglobulin Test
- 1.3.7 Radioactive-iodine uptake

PSZOENDO309: Practical: Clinical Surveys in Endocrinology

Course objectives:

- *To develop and implement a comprehensive questionnaire to survey patients for diabetes mellitus, aiming to gather data on patient demographics, symptoms, medical history, and lifestyle factors, and to analyze and interpret the collected data to identify patterns and trends in diabetes prevalence and management.*
- *To design and conduct a detailed questionnaire to survey patients for thyroid function, focusing on collecting information regarding thyroid-related symptoms, medical history, treatment regimens, and patient outcomes, and to compile and evaluate the survey results to understand the impact of thyroid disorders on patient health and quality of life.*

Outcome of the Course:

- *The learner will be able to develop and administer a comprehensive diabetes mellitus survey, analyze patient data, and identify key patterns and trends in diabetes prevalence and management.*
- *The learner will be able to design and conduct a detailed thyroid function survey, compile and evaluate patient data, and gain insights into the impact of thyroid disorders on health and quality of life.*

Practical

1. Survey for Diabetes mellitus for 30 patients, including treatment modalities and preparation of comprehensive report.
2. Survey for Thyroid Function for 30 patients including treatment modalities and preparation of comprehensive report.

(Students are expected to prepare a questionnaire and do the survey. They are expected to submit printouts of the patients' survey).

Sem. - IV

Syllabus
M.Sc. (Endocrinology)
(Sem.- IV)

PSZOENDO401: Endocrinology and Reproductive Physiology

Course Objectives:

- *To gain a comprehensive understanding of Reproductive anatomy and physiology and its role in endocrinology.*
- *To evaluate Reproductive disorders and treatments.*
- *To explore management and treatment strategies for the reproductive health.*
- *To examine Ethical Considerations in Reproductive Health.*

Outcome of the Course:

- *The learner will be able to demonstrate a thorough understanding of the anatomical structures, histological features, and physiological processes of the male and female reproductive systems, including the endocrine regulation and feedback mechanisms involved.*
- *The learner will learn to assess and diagnose common reproductive disorders and suggest appropriate management and treatment strategies, including the application of artificial reproductive techniques (ART).*
- *The learner will be able to critically analyze the ethical dilemmas and societal implications associated with reproductive health, particularly regarding the use of ART, and develop an understanding of the importance of regulatory frameworks in ensuring ethical practice and patient welfare.*

Unit 1: Male Reproductive System **(15 L)**

1.1 Testis
- 1.1.1 Anatomy & Histology
- 1.1.2 Spermatogenesis & Spermiogenesis
- 1.1.3 Steroidogenesis endocrine, paracrine and autocrine regulation

1.2 Epididymis
- 1.2.1 Anatomy & Histology
- 1.2.2 Function
- 1.2.3 Regulation

1.3 Accessory sex organs – Anatomy & Histology, function and regulation
- 1.3.1 Prostate
- 1.3.2 Seminal vesicles
- 1.3.3 Bulbourethral gland

1.4 Hypothalamo-hypophysial-gonadal Axis (Male)

1.5 Reproductive disorders and Andropause

Unit 2: Female reproductive system **(15 L)**

2.1 Ovary
- 2.1.1 Anatomy and histology
- 2.1.2 Function
- 2.1.3 Hormonal regulation

2.2 Uterus
- 2.2.1 Anatomy and histology
- 2.2.2 Function
- 2.2.3 Hormonal regulation

2.3 Fallopian tube
- 2.3.1 Anatomy and histology
- 2.3.2 Function

2.4 Mammary glands
- 2.4.1 Anatomy and Histology
- 2.4.2 Function
- 2.4.3 Regulation

2.5 Hypothalamo-hypophysial-gonadal Axis (Female)

2.6 Reproductive disorders and problem of menopause

Unit 3: Fertilization and Parturition **(15 L)**

3.1 Fertilization

3.2 Conception

3.3 Parturition

3.4 Concept of implantation, nidation

3.5 Mechanism of implantation, Endometrial antigen involved in implantation

3.6 Maternal–foetal placental hormones

Unit 4: Artificial Reproductive Techniques **(15 L)**

4.1 Fertility – Problems
- 4.1.1 Endometriosis
- 4.1.2 Polycystic Ovary Syndrome (PCOS)

4.2 Fertility – Treatment
- 4.2.1 In-vitro fertilization (IVF)
- 4.2.2 Intra-cytoplasmic sperm injection (ICSI)
- 4.2.3 Intrauterine insemination (IUI)
- 4.2.4 Gamete intrafallopian transfer (GIFT)
- 4.2.5 Testicular Sperm Extraction (TESE)
- 4.2.6 Frozen Embryo Transfer (FET)
- 4.2.7 Surrogacy

4.3 Ethical considerations of ART

PSZOENDO402: Comparative Endocrinology & Reproductive Physiology of Vertebrates (except human)

Course Objectives:

- *To analyze and compare the anatomical structures, histological features, and physiological processes of reproductive systems across the species.*
- *To investigate and compare the mechanisms and patterns of reproductive cycles and analyze hormonal regulation and feedback mechanisms governing them.*
- *To explore the diversity of placental structures and types across vertebrates*
- *To examine the roles of placental hormones in pregnancy maintenance and fetal development*
- *To investigate placental disorders, ectopic pregnancy, analyzing their causes, consequences, and management strategies.*

Outcome of the Course:

- *The learner will be able to demonstrate a comprehensive understanding of the anatomical structures, histological features, and physiological processes of male and female reproductive systems across diverse vertebrate species, including variations in reproductive strategies and adaptations.*
- *The learner will be able to analyze proficiently the mechanisms and patterns of reproductive cycles, encompassing estrous cycles and menstrual cycles, while critically examining hormonal regulation and feedback mechanisms and exploring their evolutionary significance.*
- *The learner will possess advanced knowledge of placental structures and functions across vertebrates, including histological features and adaptations for maternal-foetal exchange, as well as an understanding of the roles of placental hormones in pregnancy maintenance and foetal development, and the ability to analyze their implications for maternal and foetal health.*

Unit 1: Comparative Male Reproductive System (15 L)

1.1 Testis (fish, amphibian, reptile, birds, mammals)
- 1.1.1 Anatomy and Histology
- 1.1.2 Spermatogenesis & Spermiogenesis
- 1.1.3 Steroidogenesis endocrine, paracrine and autocrine regulation

Unit 2: Female reproductive system (15 L)

2.1 Ovary (fish, amphibian, reptile, birds, mammals)
- 2.1.1 Anatomy and Histology
- 2.1.2 Functions
- 2.1.3 Hormonal regulation

Unit 3: Reproductive cycles – Estrous and Menstrual (15 L)

3.1 Estrous cycles in different animals – Rat, Rabbit, Cat, Cow, Elephant, Horse, Dog.

3.2 Menstrual Cycle – Humans, Chimpanzees and Bats.

Unit 4: Placentae (15 L)

4.1 Types of placentae
4.2 Histology of placentae
4.3 Placental hormones
4.4 Placental disorders
4.5 Ectopic pregnancy

PSZOENDO403: Practical: Endocrinology of Human Reproduction

Course objectives:

- *To understand the principles and methodologies behind reproductive diagnostic techniques, including pregnancy diagnosis via hCG detection in urine.*
- *To explore various methods for detecting ovulation, such as ovulation kits and temperature tracking, to optimize conception timing.*
- *To gain insight into chromatographic separation techniques for analyzing steroidal hormones, enhancing understanding of reproductive health monitoring.*

Outcome of the Course:

- *The learner will be able to demonstrate proficiency in applying various reproductive diagnostic techniques, including pregnancy diagnosis through hCG detection in urine and ovulation prediction using different methods such as ovulation kits and temperature tracking.*
- *The learner will be able to develop practical skills in performing reproductive diagnostic tests and chromatographic separations of steroidal hormones, enhancing their ability to contribute effectively to reproductive health research and clinical practice.*

Practical

1. Diagnosis of pregnancy by the presence of HCG in urine.
2. Detection of ovulation day by different methods – using ovulation kit (by Urine and Saliva), temperature.
3. Chromatographic separation of steroidal hormones.
4. Visit to a Fertility Centre and submission of Report.

PSZOENDO404: Practical: Comparative Endocrinology of Non-human Mammals

Course objectives:

- *To gain a thorough understanding of the estrous cycles through the utilization of study tools such as slides, photographs, TC tools, models, and charts.*
- *To understand the structural and functional characteristics of phytosteroid-mimicking animal steroids derived from plants.*
- *To compare and contrast reproductive strategies among different mammalian species.*

Outcome of the Course:

- *The learner will be able to demonstrate proficiency in analyzing and interpreting estrous cycles in mammals.*
- *The learner will be able to develop skills in chemical analysis and identification methods, enabling them to recognize and describe phytosteroid-mimicking animal steroids.*

Practical

1. Study of estrous cycles in different mammals (Slides / Photographs / TC tools / Models / Charts)
   a) Mammals – rodents as prolific breeders
   b) Cattle seasonal breeder
   c) Marsupial
2. Identify and describe Phytosteroid mimicking animal steroids [*Glycine max* (Soybean), *Withania somnifera* (Ashwagandha), *Asparagus racemosus* (Shatavari)].

Endocrinology Elective: Semester IV:

PSZOENDO405: Infertility, Contraception and Counselling on Sexual Development

Course Objectives:

- *To understand the causes of infertility in both males and females, encompassing hormonal disorders, structural abnormalities, infections, autoimmune conditions, and environmental factors.*
- *To study the impact of sexually transmitted diseases (STDs) on reproductive health.*
- *To develop counselling skills to address pre-marital and post-marital challenges related to intimacy, trust-building, communication, and alignment of values, with a focus on promoting healthy sexual development and resolving conflicts effectively.*
- *To analyze the psychological and emotional aspects of sexual development and relationships.*

Outcome of the Course:

- *The learner will be able to demonstrate proficiency in understanding the multifaceted causes of infertility in both male and female, including hormonal, structural, environmental, and infectious factors.*
- *The learner will be able to select his career in the field so as to provide comprehensive support to individuals and couples in navigating reproductive health concerns.*
- *The learner will be able to promote holistic sexual wellness by analyzing the psychological and emotional aspects of sexual development and relationships.*

Unit 1: Infertility Contraception and Sexually Transmitted Diseases (15 L)

1.1 Male Infertility
- 1.1.1 Hypothalamic or pituitary disorder
- 1.1.2 Gonad Disorder
- 1.1.3 Sperm Disorder
- 1.1.4 Varicocele
- 1.1.5 Ejaculation Issues
- 1.1.6 Problems with sexual intercourse
- 1.1.7 Environmental causes
- 1.1.8 Health, lifestyle and other causes

1.2 Female Infertility
- 1.2.1 Endometriosis
- 1.2.2 Polycystic Ovary Syndrome (PCOS)
- 1.2.3 Primary Ovary Insufficiency (POI)
- 1.2.4 Uterine Fibroids
- 1.2.5 General Causes of Infertility
- 1.2.6 Failure to Ovulate
- 1.2.7 Structural Problems of the Reproductive System
- 1.2.8 Infections
- 1.2.9 Failure of an Egg to Mature Properly
- 1.2.10 Implantation Failure
- 1.2.11 Autoimmune Disorders

1.3 Sexually Transmitted Diseases (STDs) and Infertility
- 1.3.1 Chlamydia
- 1.3.2 Gonorrhea
- 1.3.3 Herpes
- 1.3.4 HIV
- 1.3.5 Syphilis

Unit 2: Counselling on Sex and Sexual Development (15 L)

2.1 Pre-marital counselling
- 2.1.1 Communication
- 2.1.2 Problems with Trust
- 2.1.3 Differences in Values and beliefs
- 2.1.4 Financial Disagreements
- 2.1.5 Intimation and sexual issues
- 2.1.6 Boundaries with Family members

2.2 Post-marital counselling
- 2.2.1 Co-Parenting
- 2.2.2 Emotional Recovery
- 2.2.3 Effective Communication
- 2.2.4 Restoring Trust and Addressing Discord
- 2.2.5 Envisioning the Future

PSZOENDO406: Practical: Reproduction: Health and Diagnostics

Course objectives

- *To accurately identify and differentiate histological and ultrasound images of abnormalities related to the male and female reproductive organs to recognize pathological features.*
- *To create detailed reports summarizing findings from histological and ultrasound examinations, demonstrating the ability to communicate diagnostic observations effectively.*

Outcome of the Course

- *The learners will be able to accurately identify and differentiate between normal and pathological histological and ultrasound images of male and female reproductive organs.*
- *The learners will be able to produce detailed and coherent reports that effectively summarize and communicate diagnostic observations from histological and ultrasound examinations.*

Practical

1. Identification of Endometriosis using histological and ultrasound images.
2. Identification of PCOS using histological and ultrasound images.
3. Identification of Uterine Fibroids using histological and ultrasound images.
4. Identification of normal and abnormal histology of Testis, Epididymis and Sperms).

(Photographs should be used for the above-mentioned practicals)

Endocrinology Elective: Semester IV

PSZOENDO407: Endocrinology and Animal Husbandry

Course Objectives:

- *To analyze the role of endocrine regulators and steroids in regulating growth, development, and reproduction in both invertebrates and vertebrates.*
- *To evaluate the mechanisms of action and applications of endocrine regulators in animal production systems.*
- *To learn practical strategies for hormone manipulation and supplementation to optimize animal production outcomes.*
- *To assess the ethical, regulatory, and environmental implications of using endocrine regulators and xenobiotic agents in animal production, ensuring responsible and sustainable management practices.*

Outcome of the Course:

- *The learner will be able to demonstrate a comprehensive understanding of endocrine regulators' roles in growth, development, and reproduction across invertebrate and vertebrate species utilized in animal production.*
- *The learner will be able to apply knowledge of endocrine principles to design effective strategies for hormone manipulation and supplementation aimed at optimizing animal production outcomes, including growth promotion, reproductive efficiency, and product quality enhancement.*
- *The learner will be able to evaluate the ethical, regulatory, and environmental implications of utilizing endocrine regulators and xenobiotic agents in animal production, and develop skills to implement responsible and sustainable management practices prioritizing animal welfare, human health, and environmental conservation.*

Unit 1: Applied Invertebrate Endocrinology (15 L)

1.1 Apiculture
- 1.1.1 Juvenile hormones (JHs)
- 1.1.2 JH plus sugar augmentation

1.2 Sericulture
- 1.2.1 Insect growth regulators (IGRs)
- 1.2.2 Juvenile hormones (JHs)

Unit 2: Applied Vertebrate Endocrinology (15 L)

2.1 Poultry
- 2.1.1 Growth Hormones
- 2.1.2 Thyroid Hormones
- 2.1.3 Somatomedin
- 2.1.4 Insulin
- 2.1.5 Adrenal Glucocorticoids (Corticosterone and Cortisol)

2.2 Cattle
- 2.2.1 Growth hormones
- 2.2.2 β-adrenergic agonists
- 2.2.3 Estradiol, progesterone, testosterone
- 2.2.4 Xenobiotic anabolic agents

2.3 Aquaculture

2.3.1 Gonadotropins (LH, HCG, PMSG)

2.3.2 Gonadotropin releasing hormones (GnRH), or Luteinizing hormone releasing hormone (LHRH/LRF) and their analogues (GnRH-A/LHRHA/LRF-A)

2.3.3 Steroids

2.3.4 Others drugs – Prostaglandins and Antiestrogens

PSZOENDO408: Practical: Animal Husbandry: Infrastructure and Practices

Course objectives:

- *To gain practical knowledge of apiculture by visiting an apiculture center and preparing a detailed report on beekeeping practices, bee biology, and honey production.*
- *To understand the techniques and processes involved in sericulture through a visit to a sericulture center, and to compile a report on silk production, silkworm rearing, and related practices.*
- *To acquire insights into poultry farming by visiting a poultry center, and to document the visit with a report covering poultry management, breeding practices, and health care.*
- *To explore cattle breeding methods by visiting a Cattle breeding center and preparing a comprehensive report on cattle genetics, breeding programs, and herd management.*
- *To learn about aquaculture practices by visiting an aquaculture center and producing a detailed report on fish farming techniques, water quality management, and species selection.*

Outcome of the Course:

- *The learner will be able to analyze apiculture practices and report on beekeeping, bee biology, and honey production.*
- *The learner will be able to evaluate sericulture techniques and report on silk production and silkworm rearing.*
- *The learner will be able to assess poultry farming methods and report on management, breeding, and health care.*
- *The learner will be able to examine cattle breeding methods and report on genetics, breeding programs, and herd management.*
- *The learner will be able to investigate aquaculture practices and report on fish farming techniques and water quality management.*

Practical

1. Visit / E-visit to Apiculture centre and preparation of report.
2. Visit / E-visit to Sericulture centre and preparation of report.
3. Visit to Poultry centre and preparation of report.
4. Visit to Cattle Breeding centre and preparation of report.
5. Visit to Aquaculture centre and preparation of report.

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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 and8 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

2) 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 CO_2 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 - Endocrinology) Semester – III
PSZOENDO303: Invertebrate Endocrinology

Time: 10:00 am to 2:00 pm **Total Marks: 25**

1. Nervous system of earthworm (Dissection/virtual dissection or any suitable method as directed by examination panel). **10**

OR

1. Neuroendocrine system of prawn/crab/cockroach (Dissection/virtual dissection or any suitable method as directed by examination panel). **10**

OR

1. Reproductive system of Cockroach / Sepia / Crab (Dissection/virtual dissection or any suitable method as directed by examination panel). **10**

2. Mounting of any neuroendocrine cell of anyone. (Sepia / Mytilus / Crab / Cockroach or any other animal not in schedule and easily available). **05**

3. Identify the possible pheromone responsible for the behaviour of the animal (Invertebrates) (Any three). **06**

4. Viva based on practical component. **04**

Note: Submission of the certified journal is mandatory for the examination.

Suggested Guidelines for Practical Examination (Internal) (Total marks 25).

1. Preparation of 3 permanent HE-stained slides of neuroendocrine cells from any three invertebrates which are not in the Scheduled categories I to IV of Wildlife Protection Act and are easily available and submission of its report. **15**
2. Timely completion and submission of journal. **05**
3. Overall participation and attendance. **05**

UNIVERSITY OF MUMBAI
MSc (Zoology - Endocrinology) Semester – III
PSZOENDO304: Vertebrate Endocrinology

Time: 10:00 am to 2:00 pm **Total Marks: 25**

1. Dissection of pituitary/ Thyroid/Adrenal/Pancreas of rat. **07**

2. Identification of following glands of Fish/ Amphibians/ Reptiles/ Birds/ Mammals. **15**
   A. Pituitary
   B. Thyroid
   C. Adrenal
   D. Pancreas
   E. Parathyroid

3. Viva on practical component. **03**

Note: Submission of the certified journal is mandatory for the examination.

Suggested Guidelines for Practical Examination (Internal) (Total marks 25).

1. Preparation of 3 permanent HE-stained slides (Pituitary, Thyroid and Adrenal) of endocrine glands from rat and submission of its report. **15**
2. Timely completion and submission of journal. **05**
3. Overall participation and attendance. **05**

UNIVERSITY OF MUMBAI
MSc (Zoology - Endocrinology) Semester – III
PSZOENDO307: Ethical Practices in Animal Handling

Time: 10:00 am to 2:00 pm **Total Marks: 25**

1. Design the layout of an animal house for any suitable model organism. **09**

OR

1. Give the layout of different laboratories (to be mentioned) in the veterinary college. **09**

2. Submission of report of visit to the animal breeding centre and viva based on it. **08**

3. Submission of reports of visit to the research institutes and viva based on it. **08**

Submission of certified Journal and Reports is mandatory.

Suggested Guidelines for Practical Examination (Internal) (Total marks 25)

1. Preparation of Model of Animal house by using biodegradable substances only. **10**
2. Timely completion and submission of reports. **10**
3. Overall participation and attendance. **05**

UNIVERSITY OF MUMBAI
MSc (Zoology - Endocrinology) Semester – III
Skeleton of Practical Examination Question Paper Practical: PSZOENDO309: Clinical Surveys in Endocrinology

Time: 10:00 am to 2:00 pm **Total Marks: 25**

1. Submission of detailed report of the survey of the patients suffering from diabetes along with the raw data and viva based on it. **10**
2. Submission of detailed report of the survey of the patients suffering from thyroid disorder along with the raw data and viva based on it. **10**
3. Detailed discussion of any case study that student have come across mentioning the history and its implications. **05**

Submission of certified Journal and Reports is mandatory.

Suggested Guidelines for Practical Examination (Internal) (Total marks 25)

1. Presentation on any disorder (apart from diabetes) associated with endocrine disturbance in metabolism. **10**
2. Timely completion and submission of reports. **10**
3. Overall participation and attendance. **05**

UNIVERSITY OF MUMBAI
MSc (Zoology - Endocrinology) Semester – IV
Skeleton of Practical Examination Question Paper Practical: PSZOENDO403: Endocrinology of Human Reproduction

Time: 10:00 am to 2:00 pm **Total Marks: 25**

1. Detect pregnancy in given urine sample by the presence of HCG and prepare report of it. **08**

2. Detect ovulation day using ovulation kit / temperature from saliva/ urine and prepare report. **07**

3. Separate steroidal hormones by chromatographic method. **07**

4. Viva based on practical component. **03**

Note: Submission of the certified journal is mandatory for the examination.

Suggested Guidelines for Practical Examination (Internal) (Total marks 25).

1. Report on visit to fertility centre (minimum 10 pages with photographic evidences). **15**
2. Timely completion and submission of journal. **05**
3. Overall participation and attendance. **05**

UNIVERSITY OF MUMBAI
MSc (Zoology - Endocrinology) Semester – IV
Skeleton of Practical Examination Question Paper Practical: PSZOENDO404: Comparative Endocrinology of Non-Human Mammals

Time: 10:00 am to 2:00 pm **Total Marks: 25**

1. Identify and describe the stages (any two) of estrous cycle of animal given in photographs / slides / schematic diagrams. **10**

2. Identify and describe the following plants (any two) with respect to its phytosteroids which mimics animal steroid. Also give its uses. **10**

3. Viva on practical component. **05**

Note: Submission of the certified journal is mandatory for the examination.

Suggested Guidelines for Practical Examination (Internal) (Total marks 25).
1. Presentation on phytosteroids for Human welfare. **15**
2. Timely completion and submission of journal. **05**
3. Overall participation and attendance. **05**

UNIVERSITY OF MUMBAI
MSc (Zoology - Endocrinology) Semester – IV
Skeleton of Practical Examination Question Paper Practical: PSZOENDO406: Reproduction: Health and Diagnostics

Time: 10:00 am to 2:00 pm **Total Marks: 25**

1. Identify and describe abnormalities using histological or ultrasound images. **20**
   a) Endometriosis
   b) PCOS
   c) Uterine Fibroids
   d) Abnormality in testis
   e) Abnormality in Epididymis

2. Viva based on practical component. **05**

Submission of certified Journal and Reports is mandatory.

Suggested Guidelines for Practical Examination (Internal) (Total marks 25)

1. Three case studies, one each on Endometriosis, PCOS, Uterine Fibroids. **10**
2. Timely completion and submission of reports. **10**
3. Overall participation and attendance. **05**

UNIVERSITY OF MUMBAI
MSc (Zoology - Endocrinology) Semester – IV
Skeleton of Practical Examination Question Paper Practical: PSZOENDO408: Animal Husbandry: Infrastructure and Practices

Time: 10:00 am to 2:00 pm **Total Marks: 25**

1. Submission of detailed report of the visit to Apiculture center and viva based on it. **10**

OR

1. Submission of detailed report of the visit to Sericulture center and viva based on it. **10**

2. Submission of detailed report of the visit to Poultry Centre and viva based on it. **10**

OR

3. Submission of detailed report of the visit to Cattle Breeding Centre and viva based on it. **10**

4. Viva based on Aquaculture Centre. **05**

Submission of certified Journal and Reports is mandatory.

Suggested Guidelines for Practical Examination (Internal) (Total marks 25)

1. Any two activities of the following. **20**
   a) Collection of different types of silk fibres and making a portfolio
   b) Preparation of model of an apiary
   c) Preparation of poultry feed
   d) Making an album of different cattle breeds fund in India – Indigenous and exotic
   e) Information on automation in aquaculture farms

2. Overall participation and attendance. **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.

Letter Grades and Grade Points:

Semester GPA/ Programme CGPA Semester/ Programme	% of Marks	Alpha-Sign/ Letter Grade Result	Grading Point
9.00 - 10.00	90.0 - 100	O (Outstanding)	10
8.00 - < 9.00	80.0 - < 90.0	A+ (Excellent)	9
7.00 - < 8.00	70.0 - < 80.0	A (Very Good)	8
6.00 - < 7.00	60.0 - < 70.0	B+ (Good)	7
5.50 - < 6.00	55.0 - < 60.0	B (Above Average)	6
5.00 - < 5.50	50.0 - < 55.0	C (Average)	5
4.00 - < 5.00	40.0 - < 50.0	P (Pass)	4
Below 4.00	Below 40.0	F (Fail)	0
Ab (Absent)	-	Ab (Absent)	0

Sign of the BOS Coordinator
Dr. Vaishali Somani
BOS in Zoology

Sign of the Offg. Associate Dean
Dr. Madhav R. Rajwade
Faculty of Science & Technology

Sign of the Offg. Dean
Prof. Shivram S. Garje
Faculty of Science & Technology

BOD – 3/9/2024
12 (7) of M.P.U.A. 2016
Item No. – 6.3 (3) (N)

As Per NEP 2020

University of Mumbai

Title of the P.G. Program
M.Sc. (Zoology - Oceanography and Fishery Technology)

Syllabus for

Semester – Sem.- III & 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	M.Sc. (Zoology - 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: SP – 80 B (3)	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 Coordinator Dr. Vaishali Somani BOS in Zoology	Sign of the Offg. Associate Dean Dr. Madhav R. Rajwade Faculty of Science & Technology	Sign of the Offg. Dean Prof. Shivram S. Garje Faculty of Science & Technology

Preamble

1) Introduction

- The existing syllabus is re-constructed following the intent and objectives of the National Education Policy (NEP) 2020 and the National Credit Framework (NCrF).

- We are happy to present this new syllabus of Semester III and Semester IV to the teachers and students of the Post Graduate Course in Zoology of the specialization Oceanography and Fishery Technology. While restructuring the syllabus, the relevant inputs have been considered from mentors, subject experts in the field of oceanography, teachers and stakeholders to make it more effective. An attempt has been made to make post graduate course competitive and on par with global standards as per the directives for the implementation of National Education Policy (NEP) 2020. Hence, the present syllabus is made more interesting with innovative topics as per need of the current situation of the world and stakeholders.

- The syllabus has a total of 44 credits (22 credits in semester-3 and 22 credits in semester-4) covering all classroom teaching and practical.

- In each semester, the courses PSZOOCN301, PSZOOCN302, PSZOOCN303, PSZOOCN304 and PSZOOCN305 for Semester III and PSZOOCN401, PSZOOCN402, PSZOOCN403 and PSZOOCN404 for Semester IV have been designated as Mandatory courses which are subject-specific for the students of Zoology with specializing in Oceanography and Fishery Technology.

- The PSZOOCN306 and PSZOOCN307 or PSZOOCN308 and PSZOOCN309 are elective courses with laboratory exercises for semester III and only one will be chosen by postgraduate students.

- The PSZOOCN405 and PSZOOCN406 or PSZOOCN407 and PSZOOCN408 are elective courses with laboratory exercises for semester IV and only one will be chosen by postgraduate students.

- In addition to core courses field visits, visit to institutions, report submission has been included in the curriculum for experiential learning.

2) Aims and Objectives

The primary aim of the present syllabus is to provide an appropriate blend of classical and applied aspects of the subject. It is designed with following objectives:

- To provide the basic concepts and recent advances in oceanographic investigations.

- To give knowledge about the physical processes of oceans and the ocean- atmospheric interactions, chemical properties of the sea water, the marine ecology, its significance, sustainability and conservation.

- To acquaint learners with the knowledge and skill of hygienic handling of fish and its processing.

- To impart knowledge of site selection, construction and layout of different processing plants and to give insight of recent methods in fish processing and quality control.

- To give in depth knowledge of food and feeding behaviour, reproduction of different species, population dynamics and crafts and gears used in fisheries.

- To impart knowledge about conservation and sustainable harvesting of depletable fishery resources.

3) Learning Outcomes

The learners will be able to-

- recall the history of oceanography.
- apply the skills of various oceanographic sampling techniques.
- explain the significance of the physical processes occurring in the oceans and their effects at local and global scenarios.
- inspect the chemical properties of the sea water and their significance.
- describe life under the sea and their interactions with the marine environment and are aware of the issue of marine pollution.
- demonstrate sorting and hygienic handling of fresh fish.
- apply knowledge for site selection, construction and layout of different fish processing plants.
- evaluate packaging materials, refrigerants, freezers, additives and instruments used in the fish processing industry.
- relate different crafts and gears used for fisheries in India.
- apply the principles of sustainability and conservation of capture fisheries.
- apply critical thinking into their studies in order to conduct objective scientific research.

Credit Structure of the Program (Sem III & IV)

Post Graduate Programs in University Parishishta - 1

R: SP – 80 B (3)									
Exit option: PG Diploma (44 Credits) after Three Year UG Degree									
Year (2 Yr PG)	**Level**	**Sem (2 Yr)**	**Major**		**RM**	**OJT / FP**	**RP**	**Cum. Cr.**	**Degree**
			Mandatory	**Electives (any one)**					
II	**6.5**	**Sem III**	**PSZOOCN301** Oceanography **Credits 4** **PSZOOCN302** Fish Processing Technology **Credits 4** **PSZOOCN303** Laboratory Exercises based on PSZOOCN301 **Credits 2** **PSZOOCN304** Laboratory Exercises based on PSZOOCN302 **Credits 2** **PSZOOCN305** Capture Fisheries **Credits 2**	**PSZOOCN306** Fish Pathology **Credits 2** **PSZOOCN307** Laboratory Exercises based on PSZOOCN306 **Credits 2** OR **PSZOOCN308** Value added products and Marketing **Credits 2** **PSZOOCN309** Laboratory Exercises based on PSZOOCN308 **Credits 2**			4	22	**PG degree after 3-year UG**
		Sem IV	**PSZOOCN401** Aquaculture **Credits 4** **PSZOOCN402** Finfish and Shellfish Biology **Credits 4** **PSZOOCN403** Laboratory Exercises based on PSZOOCN401 **Credits 2** **PSZOOCN404** Laboratory Exercises based on PSZOOCN402 **Credits 2**	**PSZOOCN405** Marine Planktology and Phycology **Credits 2** **PSZOOCN406** Laboratory Exercises based on PSZOOCN405 **Credits 2** OR **PSZOOCN407** Marine products and by-products Credits 2 **PSZOOCN408** Laboratory Exercises based on PSZOOCN407 **Credits 2**			6	22	
Cum. Cr. for 1 Yr PG Degree			**26**	**8**			**10**	**44**	
Cum. Cr. for 2 Yr PG Degree			**54**	**16**	**4**	**4**	**10**	**88**	

Note: * The number of courses can vary for totaling 14 Credits for Major Mandatory Courses in a semester as illustrated.

Sem. - III

Syllabus
M.Sc. (Zoology - Oceanography and Fishery Technology)
(Sem.- III)

PSZOOCN301

Oceanography (4 Credits / 60 Hrs)

Module 1 - General Oceanography (15Hr)

Objective:

- To familiarize learners to the background of Oceanography and the recent developments.
- To understand the basic concepts and instrumentation in Oceanography.

Desired outcome:

- The learner will be to recall the history of oceanography and its current status.
- The learner will be aware of various oceanographic sampling techniques.

1.1 Oceanography – History and expeditions: Challenger, Indian Ocean and Antarctic

1.2 Oceanic climatology: ENSO, Impact of climate change on marine life

1.3 Typical oceanographic research vessel, its equipment and oceanographic laboratories

1.4 Satellite oceanography: Remote sensing satellites and their applications

1.5 Ocean bottom features

- 1.5.1 Continental shelf
- 1.5.2 Continental slope
- 1.5.3 Submarine canyons
- 1.5.4 Submarine mountain ranges
- 1.5.5 Sea mounds and Guyots
- 1.5.6 Oceanic ridges and rises
- 1.5.7 Oceanic trenches
- 1.5.8 Abyssal floor

1.6 Oceanographic Instruments

- 1.6.1 Grabs (Peterson and Van veen) for benthos collection
- 1.6.2 Dredges
- 1.6.3 Trawl – Beam trawl, Otter trawl
- 1.6.4 Plankton nets and Continuous plankton sampling system
- 1.6.5 Niskin Water Sampler
- 1.6.6 CTD instrument
- 1.6.7 Hensen-Stempel Pipette and dilution jar
- 1.6.8 Underwater photography gear
- 1.6.9 SCUBA diving gear
- 1.6.10 Secchi disk

Module 2: Physical Oceanography (15Hr)

Objective:

- To acquaint the learners about the physical processes of Oceans and the Ocean-Atmospheric interactions.

Desired outcome:

- The learner will be able to explain the significance of the physical processes occurring in the oceans.

2.1 Sea water

2.1.1 Physical properties of Sea Water – Distribution of Temperature, Salinity, Density

2.1.2 Acoustical and Optical characteristics of sea water

2.2 Waves and Tides

2.2.1 General aspects of ocean waves, waves characteristics, sea and swell, deep and shallow water waves, storm surges and tsunamis

2.2.2 Tides and tide generating forces, their causes, variation and types, tidal currents

2.3 Ocean Circulation

2.3.1 Coriolis effect and Ekman spiral, geotropic current, westward intensification with dynamic topography

2.3.2 Wind induced circulation, thermohaline circulation and upwelling of water

2.3.3 Types of currents, major currents of the world

Module 3: Chemical Oceanography (15Hr)

Objective:

- To familiarize learners to the chemical properties of the sea water

Desired outcome:

- The learner will be able to explain the chemical properties of the sea water and their significance.

3.1 Major and minor elements in seawater

3.2 Chlorinity and Salinity: definition and significance, practical salinity scale

3.3 Radioactive nuclides in the sea

3.4 Micronutrients and their role in marine environment (Phosphorus, Nitrogen, Silicon)

3.5 Dissolved gases (other than CO_2) in seawater – solubility of gases in seawater

3.6 Oxygen Minimum Zone (OMZ) in Arabian Sea

3.7 Air – sea gas exchange, processes affecting their distribution

3.8 Dissolved gases (CO_2) in seawater

3.8.1 Carbon dioxide equilibria in seawater, ocean acidification

3.8.2 pH, alkalinity and buffering capacity of oceans

3.8.3 Components of CO_2 system in seawater

3.8.4 Percentage composition of inorganic carbon

3.8.5 Calcium carbonate precipitation and dissolution phenomena

3.8.6 Lysocline and carbonate compensation depth

3.9 Mineral resources from the sea:

3.9.1 Deep sea mud oozes and manganese nodules

3.9.2 Oil, gas and sulphur deposits

Module 4: Biological Oceanography (15Hr)

Objective:

- To familiarise learners to the ecology of marine fauna, its interaction with marine environment and effect of marine pollution.

Desired outcome:

- The learner will be able to describe life under the sea and their interactions with the marine environment.
- The learner will be able to explain effects of marine pollution.

4.1 Division of marine environment

4.1.1 Marine biotic diversity:

a) Plankton

b) Nekton

c) Benthos

4.1.2 Intertidal organisms and their zonation:

a) Rocky

b) Muddy

c) Sandy

4.1.3 Diversity indices and models explaining diversity gradient.

4.2 Deep Sea Ecology

4.2.1 Faunal composition, species diversity, food sources, rates of biological processes, whale fall ecosystem

4.2.2 Hydrothermal vents and cold seeps:

a) Chemosynthetic production

b) Vent Fauna

c) Shallow Vents and Cold seeps

d) Unique environmental features of sulphide communities

4.3 Effect of anthropogenic activities on marine environment:

4.3.1 Fishery impacts

4.3.2 Marine pollutants:

a) Petroleum Hydrocarbons

b) Plastics

c) Heavy metals

d) Sewage

e) Radioactive waste

f) Thermal effluents

g) Noise

4.3.3 Marine bio-invasion and its impact

4.3.4 Reclamation of coastal areas

4.3.5 Impact of oil drilling

PSZOOCN302

Fish Processing Technology (4 Credits / 60 Hrs)

Module 1: Hygienic Handling of Fish (15Hr)

Objectives:

- To imbibe skills of hygienic handling, assessing freshness of fish.
- To impart knowledge of site selection, construction and layout of different processing plants.

Desired Outcome:

- The learner will be able demonstrate sorting and hygienic handling of fish.
- To evaluate site selection, construction and layout of different processing plants.

1.1 Methods of handling of fish

1.2 Hygienic conditions required onboard, landing centres and processing industry

1.3 Organoleptic tests

1.4 Methods of transportation of fish to the processing plant

1.5 Temperature modelling and relationships in fish transportation

1.6 Typical layout for freezing unit, ice factory and canning unit

1.7 Site Selection:

- 1.7.1 Location
- 1.7.2 Site Level and Site size
- 1.7.3 Communications

1.8 Processing plant specifications:

- 1.8.1 General introduction
- 1.8.2 Doors and windows
- 1.8.3 Lighting
- 1.8.4 Ventilation
- 1.8.5 Drains
- 1.8.6 Power and water supply
- 1.8.7 Factory yards

Module 2: Traditional Fish Processing (15Hr)

Objectives:

- Acquaint learners to the different traditional and modern methods of fish processing.

Desired Outcome:

- The learner will be able to evaluate the different packaging materials, refrigerants, freezers, additives and instruments used in the fish processing industry.

2.1 Indigenous methods of preservation (salting, smoking, brining, icing)

2.2 Simple vapour compression system (refrigerator):

2.2.1 Ideal refrigerant

2.2.2 Types of refrigerants

2.3 Types of freezers, freezing of fin fishes and shell fishes

2.4 Accessories for canning – equipments and machineries, methods for canning of fin fishes, shell fishes and cephalopods

2.5 Additives in fish processing

2.6 Major equipment used in fish processing industry and its maintenance

Module 3: Modern Fish Processing (15Hr)

Objectives:

- To give in depth knowledge of recent methods in fish processing.

Desired Outcome:

- The learner will be able to explain the recent technologies of fish processing.

3.1 Surimi technology and surimi based analogue products (only technology aspect)

3.2 Thermal processing of fishery products and their applications

3.2.1 Thermal processing

3.2.2 Pulsed light technology

3.2.3 Infra-red (IR) and Radio frequency (RF)

3.2.4 Ohmic or Joule Heating

3.3 Non-thermal processing of fishery products

3.3.1 High pressure processing

3.3.2 Vacuum cooling

3.3.3 Irradiation

Module 4: Quality Assurance Norms and Methods (15Hr)

Objectives:

- To give in depth knowledge of recent methods in quality control and their norms.

Desired Outcome:

- The learner will be able to explain recent methods in quality control and their norms.

4.1 Introduction to quality assurance

4.2 Microbiological testing:

4.2.1 Standard norms

4.2.2 Biogenic amines

4.2.3 Rapid detection kits

4.3 Fish toxins – intrinsic and extrinsic factors for toxicity of fish

4.4 Hazard Analysis Critical Control Point (HACCP)

4.5 Checklist for ensuring sea food safety

4.6 Changes occurring during freezing, frozen storage and protective treatments:

4.6.1 Changes:

a) Microbiological

b) Physical and chemical changes

c) Protein denaturation

d) Fat oxidation

e) Dehydration

f) Drip

4.6.2 Protective treatments:

a) Polyphosphate

b) Glazing

c) Antioxidants

d) Packaging

4.7 ISO-9000 series certification

4.8 National and International food laws, integrated food law (FSSAI, CODEX GMP)

4.9 Harbour management

PSZOOCN303

Laboratory Exercises based on PSZOOCN301 (2 Credits/60Hr)

Objectives:

- To provide knowledge of application of oceanographic instruments and adaptations of organisms in different marine environments.
- To provide skills for evaluating physico-chemical properties of the seawater.

Desired Outcome:

- The learner will be able to explain the application of oceanographic instruments.
- The learner will be able to evaluate and interpret physico-chemical properties of seawater.
- The learner will be able to explain the adaptations of marine intertidal organisms.

1. Oceanographic instruments:
   a) Niskin water sampler
   b) CTD meter
   c) Bathythermometer
   d) Ekman's current meter
   e) Secchi disc
   f) Plankton nets:
   i. Standard net
   ii. Hensen net
   iii. Clarke Bumpus net
   g) Stemple pipette and counting slide
   h) Nekton sampling device:
   i. Beam trawl
   ii. Otter trawl
   i) Benthic sampling devices:
   i. Naturalist dredge
   ii. Scallop dredge
   iii. Petersen grab
   iv. Ekman grab
   v. Corer
2. Determination of physico-chemical parameters of seawater:
   a) Turbidity (nephelometry / colorimetry)
   b) TDS (Total dissolved solids)
   c) TSS (Total suspended solids)
   d) Salinity (Argentometric method / Conductivity method)
   e) Silicates
   f) Nitrate-nitrites
   g) Phosphates-phosphorus

3. Estimation of primary productivity by light and dark bottle method.
4. Identification of intertidal organisms:
    a) Rocky shore: Patella, Chiton, *Perna viridis*, *Cardium*, Balanus, Gorgonids, Littorina and Corals (*Acropora, Meandrina, Astraea* / Star coral)
    b) Sandy shore: *Solen*, *Umbonium*, *Oliva*, Fiddler crab, Star fish, Balanoglossus
    c) Muddy shore: *Lingula*, *Chaetopterus*, *Arenicola*, *Tubiculus* worm, Mudskipper
5. Field visit and submission of report on observations of intertidal organisms.
6. Visit to Institutes involved in marine biology / oceanography research.

PSZOOCN304

Laboratory Exercises based on PSZOOCN302 (2 Credits / 60 Hrs)

Objectives:

- To provide knowledge of layout of processing industry and equipment used.
- To provide skills for assessing quality, dressing, filleting and grading of fishes.

Desired Outcome:

- The learner will be able to explain the layout of the processing industry and equipment used.
- The learner will be able to evaluate the quality of fish.
- The learner will be able to demonstrate dressing, filleting and grading of fishes.

1. Organoleptic tests for freshness of fish and fishery products.
2. Dressing (Beheading, Peeling and Deveining) and grading of shrimps.
3. Fish dressing and filleting.
4. Sketching of layout of ice factory, cold storage, freezing and canning industry.
5. Identification of various equipment (photographs)
    a) Thermal processing
    b) Pulsed light technology
    c) Infra-red (IR) processing
    d) Radio frequency (RF) processing
    e) Ohmic or Joule heating
    f) High pressure processing
    g) Vacuum cooling
    h) Irradiation
6. Visit to the fish processing industry / fish landing centres / cold storages / ice factory.

PSZOOCN305

Capture Fisheries (2 Credits / 30 Hrs)

Module 1: Commercially Important Marine Fisheries in India (15Hr)

Objective:

- To provide knowledge about food and feeding, reproduction and related crafts and gears for important marine fish resources of India.

Desired outcome:

- Learners will be able to describe food and feeding, reproduction and related crafts and gears for important marine fish resources of India.

(taxonomy, distribution, food and feeding, reproduction, crafts and gears used and catch trends of the following fisheries)

1.1 Coastal fisheries

1.1.1 Shark – *Scoliodon laticaudus*

1.1.2 Ray – *Himantura uarnak (Trygon uarnak)*

1.1.3 Sardine – *Sardinella longiceps*

1.1.4 Mackerel – *Rastrelliger kanagurta*

1.1.5 Bombay duck – *Harpodon nehereus*

1.1.6 Pomfret – *Pampus cinereus (Stromateus cinerius), Pampus chinensis (Stromateus sinensis), Parastromateus niger*

1.1.7 Thread fin – *Eleutheronema tetradactylum (Polynemus tetradactylus)*

1.1.8 Pink Perch – *Nemipterus japonicus (Synagris japonicus)*

1.1.9 Ribbon fish – *Lepturacanthus savala (Trichiurus savala)*

1.2 Deep Sea fisheries

1.2.1 Yellowfin Tuna - *Thunnus albacares*

1.2.2 Skipjack Tuna - *Katsuwonus pelamis*

1.3 Commercial Shellfish fisheries

1.3.1 Crustacean

a) Crab – *Scylla serrata*

b) Prawn – *Penaeus monodon*

c) Lobster – *Panulirus polyphagus*

1.3.2 Mollusca

a) Clam – *Katelysia opima*

b) Mussels – *Perna viridis (Mytilus viridis)*

c) Oyster – *Crassostrea madrasensis.*

d) Cephalopod – Sepia, Loligo

Module 2: Population Dynamics and Conservation (15Hr)

Objective:

- To impart knowledge about population dynamics and conservation marine fishery resources.

Desired outcome:

- Learners will be able to apply the concept of population dynamics for conservation of capture fisheries resources.

2.1 Factors affecting fish population

2.2 Problems of overfishing

2.3 Stock assessment : Concept and objectives, importance in fisheries management

2.4 Concept of MSY (Maximum Sustainable Yield), MEY (Maximum Economic Yield) and recruitment, length-weight relationship and condition factor

2.5 Fishery catches and fluctuation, optimum yield, age composition, population growth, population models.

2.6 Conservation of capture fisheries resource

2.7 Blue Economy - concepts and theory, socio-economic benefits.

Elective 1

PSZOOCN306

Fish Pathology (2 Credits / 30 Hrs)

Objective:

- To impart knowledge on various fish diseases, pathology, clinical diagnosis and management.

Desired outcome:

- Learners will be able to evaluate various fish diseases, pathology, clinical diagnosis and apply appropriate management strategies.

1.1 Fish Pathology: Causative agents, symptoms, host-parasite relationships, immune responses and control of some infectious diseases.

1.1.1 Fungal Diseases - Saprolegniasis, Branchiomycosis

1.1.2 Bacterial Diseases - Fin and tail rot, Ulcers, Dropsy, eye diseases, Furunculosis, bacterial gill diseases, ERM (Enteric Redmouth disease), Edwardsiellosis, Vibriosis

1.1.3 Protozoan Diseases - White spot diseases, Costiasis, Trichodiniasis, Whirling disease

1.1.4 Metazoans - Dactylogyrus, Gyrodactylus, Hirudiniasis, Lernaea, Argulus

1.1.5 Viral diseases - IPN, IHN, VHs, CCVD, EUS

1.2 Shellfish Pathology: Causative agents, symptoms, host-parasite relationships, immune responses and control of some infectious diseases.

1.2.1 IHNV, Baculovirus, Black gill disease, brown spot disease

1.3 Nutritional deficiency (amino acid, fat and lipids, vitamins and minerals)

1.4 Health Management

1.4.1 Principles of disease diagnosis

1.4.2 Epidemiological and clinical diagnosis

1.4.3 Microbiological and post mortem examination

1.4.4 Environmental impact of disease management

1.4.5 Prebiotics, probiotics and synbiotics

1.4.6 Fish vaccines

1.4.7 Water management for prevention of diseases

1.4.8 Aquaculture medicines

PSZOOCN307

Laboratory Exercises based on PSZOOCN306 (2 Credits / 60 Hrs)

Objective:

- To impart skills on evaluation of various fish diseases, pathologies, clinical diagnosis and management strategies.

Desired outcome:

- Learners will be able to deduce various fish diseases and recommend appropriate management strategies.

1. Identification of finfish and shellfish diseases:
   a) Fungal Diseases – Saprolegniasis, Branchiomycosis
   b) Bacterial Diseases – Fin and tail rot, Ulcer diseases, Dropsy, eye diseases, Furunculosis, Bacterial gill diseases, ERM , Edwardsiellosis, Vibriosis
   c) Protozoan Diseases – White spot diseases, Costiasis, Trichodiniasis, Whirling disease
   d) Metazoans – Dactylogyrus, Gyrodactylus, Hirudiniasis, Lernaea, Argulus
   e) Viral diseases – IPN, IHN, VHs, CCVD, EUS.
2. Haematological analysis of blood from Clarius sps./ suitable fish – Total count (RBC, WBC), Differential count (WBC), Haemoglobin (Sahli's acid-hematin method)
3. Medication for treating fish diseases:
   Geotox, aquanone, Bio-ox, sodium chloride, formalin, malachite green, methylene blue, potassium permanganate, hydrogen peroxide and glutaraldehyde phostoxin, dipterex, antimicrobials, copper sulphate, sumithion, malathion

Elective 2

PSZOOCN308 Value Added Products and Marketing (2 Credits / 30 Hrs)

Objective:

- To impart knowledge on various fish value added products and marketing.

Desired outcome:

- Learners will be able to survey various fish value added products and evaluate marketing strategies.

Module 1: Value Added Products

1.1 Dry, salted and smoked products

1.2 Fish / Prawn Pickle

1.3 Fish chakli and wafers

1.4 Artificial products / Crab sticks

1.5 RTE (Ready to eat) products

1.6 Fish kabab

1.7 Fish cutlet

1.8 Fish curry

1.9 Fish noodles

1.10 Fish fillets

Module 2: Marketing

2.1 Fish Market

- 2.1.1 Structure, functions and types
- 2.1.2 Marketing channels & supply chains
- 2.1.3 Consumer behaviour
- 2.1.4 Marketing research

2.2 Fish markets & marketing in India:

- 2.2.1 Problems of fish marketing in India
- 2.2.2 Cold storage & other marketing infrastructure in India

2.2.3 Marketing organisation and improvement

2.2.4 E-marketing

2.2.5 Role of Government and Co-operatives in fish marketing

2.2.6 Export and import of fish & fishery products, Role of MPEDA

PSZOOCN309

Laboratory Exercises based on PSZOOCN308 (2 Credits / 60 Hrs)

Objective:

- To impart skills on preparation of various fish value added products.
- To impart skills for market surveys.

Desired outcome:

- Learners will be able to prepare various fish value added products and evaluate marketing strategies.

1. Preparation of value-added products (any 4):
   a) Fish/prawn pickle
   b) Fish chakli and wafers
   c) Fish kabab
   d) Fish cutlet
   e) Fish curry
   f) Fish noodles
   g) Fish fillets
   h) Fish papad
   i) Dry fish/prawn preparations
2. Method of peeling, deveining of prawn and grading of prawns
3. Method of fish dressing and filleting
4. Fish market survey to study and submission of report on:
   a) Commercially important fishes, their availability and pricing structure.
   b) Problems faced by vendors (landing centres, local fish market)
   c) Supply chain management (landing centres, local fish market)
   d) Consumer behaviour (consumption, pricing, availability)
5. Report on fish products and value-added products from offline/online stores.

Sem. - IV

Syllabus
M.Sc. (Oceanography and Fishery Technology)
(Sem.- IV)

PSZOOCN401

Aquaculture (4 Credits / 60 Hrs)

Module 1 - Basics of Aquaculture (15Hr)

Objective:

- To impart knowledge on the various aspects of aquaculture.

Desired outcome:

- Learners will be able explain the various aspects of aquaculture.

1.1 Basics of aquaculture – definition and scope

1.2 Aquaculture systems:

1.2.1 Pond culture

1.2.2 Pen culture

1.2.3 Cage culture

1.2.4 Rope culture

1.2.5 Running water culture

1.2.6 Zero water exchange system

1.2.7 Re-circulatory aquaculture system (RAS)

1.2.8 Biofloc

1.3 Physical, chemical and biological factors affecting productivity of ponds

1.4 Criteria for selection of candidate species for aquaculture

1.4.1 Major finfish candidate species for freshwater aquaculture such as

a) Indian major carps – *Rohu, Catla, Mrigal*

b) Exotic carps – Grass carp, Common carp, Silver carp

c) Catfishes – *Pangasius sps* (Basa), *Clarias* (Magur)

1.5 Monoculture, polyculture, composite culture and integrated culture systems

1.6 Rearing practices

1.6.1 Traditional

1.6.2 Extensive

1.6.3 Semi intensive

1.6.4 Intensive

1.6.5 Sustainable Aquaculture

Module 2: Aquarium Fishes and Management (15Hr)

Objective:

- To impart knowledge on the various aquarium fishes, plants and their management.

Desired outcome:

- Learners will be able to describe various ornamental fishes and plants and demonstrate management of aquariums.

2.1 Identification, breeding and maintenance of important ornamental fishes

2.1.1 Angel

2.1.2 Zebrafish

2.1.3 Discus

2.1.4 Flower horn

2.1.5 Gourami

2.1.6 Betta fish

2.1.7 Swordtail

2.1.8 Goldfish

2.1.9 Koi

2.2 Setting and design of freshwater aquarium, aeration devices and accessories, types of filters

2.3 Aquatic plants

2.3.1 Amazon sword

2.3.2 Corkscrew

2.3.3 Ludwigia

2.3.4 Aqua rose

2.3.5 Cobamba

2.3.6 Pistia

2.4. Fish feed

2.4.1. Live feed

2.4.2 Formulated feed

Module 3: Breeding and Hatchery Management of Major carps (15Hr)

Objective:

- To impart knowledge on various aspects of brood selection, breeding and hatchery management of major carps.

Desired outcome:

- Learners will be able to explain various aspects of brood selection, breeding and hatchery management of major carps.

3.1 Brood selection criteria for carps

3.2 Induced breeding

3.2.1 History of induced breeding of fishes

3.2.2 Methods of pituitary extract preparation

3.2.3 Dosage determination and injection to the brood fishes

3.2.4 Spawning and hatching

3.2.5 Use of different synthetic hormones and analogues for induced spawning

3.2.6 Induced breeding in Indian Carps – Rohu, Catla and Mrigal

3.2.7 Induced breeding in Exotic Carps – Common Carp, Silver Carp and Grass Carp

3.3 Hatchery design and operation

3.3.1 Criteria for site selection of hatchery

3.3.2 Design and function of incubators

3.3.3 Essential components of hatchery

3.3.4 Management of hatchery

3.3.5 Traditional double-walled hapa and floating hapa

3.3.6 Types of hatchery

a) Vertical hatchery – glass jar hatchery, plastic bucket hatchery

b) Chinese hatchery

c) Circular hatchery – CIFE D-81 model

3.3.7 Mahseer and Trout hatchery

3.4 Nursery pond management

3.4.1 Pre-stocking pond management

3.4.2 Stocking pond management

3.4.3 Post stocking pond management

3.5 Packaging and transport.

3.5.1 Containers used in packaging and transportation

3.5.2 Transport of fish seed and fish brooders

3.5.3 Use of anaesthetics and disinfectants in transportation.

Module 4: Giant Freshwater Prawn – *Macrobrachium rosenbergii* (15Hr)

Objective:

- To impart knowledge on breeding and rearing of *Macrobrachium rosenbergii*.

Desired outcome:

- Learners will be able to describe the sex dimorphism, breeding and hatchery management of *Macrobrachium rosenbergii*.

4.1 Taxonomy and sexual dimorphism

4.2 Rearing of *Macrobrachium rosenbergii*

4.3 Selection of brooder, breeding and Life cycle

4.4 Hatchery management

4.4.1 Indoor and outdoor nurseries, grow-out facilities

4.4.2 Management of broodstock

4.4.3 Feed management

4.4.4 Health, predation and diseases

4.4.5 Harvesting and post-harvest handling

PSZOOCN402

Finfish and Shellfish Biology (4 Credits / 60 Hrs)

Module 1: Morphology of Finfish and Shellfish (15Hr)

Objective:

- To impart knowledge on morphological characteristics of finfish and shellfish.

Desired outcome:

- Learners will be able to describe the morphological characteristics of finfish and shellfish.

1.1 Taxonomic importance of morphological characters

1.2 Finfish morphology: skin, colour, eye, mouth structure, jaws and teeth, fins, fin ray and spine, scales, operculum, gills and gill rakers, claspers

1.3 Shellfish morphology: eye, hectocotylus arm, foot, shells, carapace, tentacles, pleopods, uropods, cephalothoracic appendages, antennae, antennules, spines

1.4 Morphometric measurements, meristic measurements, biometric index, truss analysis

1.5 Significance of morphometric and meristic measurements

Module 2: Splanchnology of finfish (15Hr)

Objective:

- To impart knowledge of various organ systems and life processes of finfishes.

Desired outcome:

- Learners will be able to describe various organ systems and life processes of finfishes.

2.1 Digestive system of a teleost and its associated glands

2.2 Respiratory system

2.2.1 Gill - structure and types, mechanism of respiration

2.2.2 Air bladder – structure, types and functions

2.2.3 Accessory respiratory organs

2.2.4 Respiratory pigment

2.3 Nervous system of teleost

2.4 Sense organs and endocrine organs in fishes

2.5 Weberian ossicle – structure and functions

2.6 Heart and aortic arches in teleost

2.7 Excretion and Osmoregulation:

2.7.1 Structure and function of the excretory organs

2.7.2 Major excretory products of fishes, patterns of nitrogen excretion

2.7.3 Osmotic and ionic regulation – acid-base balance

Module 3: Locomotion and Bioluminescence (15Hr)

Objective:

- To acquaint learners about locomotion, migration and phenomenon of bioluminescence in fishes.

Desired outcome:

- Learners will be able to explain locomotion, migration and phenomenon of bioluminescence in fishes.

3.1 Locomotion

3.1.1 Types of locomotion

3.1.2 Special mode of locomotion

3.1.3 Locomotion due to the movement of appendages

3.2 Migration in fishes

3.2.1 General account of migration

3.2.2 Types of migration

3.2.3 Advantages of migration

3.2.4 Factors influencing migration

3.3 Bioluminescence in fish

3.3.1 Location of light producing organs

3.3.2 Nature of light producing organs

3.3.3 Structure of light producing organs

3.3.4 Symbiotic association with luminous bacteria

3.3.5 Significance of bioluminescence in fishes

Module 4: Biology of *Penaeus monodon* and *Scylla serrata* (15Hr)

Objective:

- To acquaint learners about the biology of *Penaeus monodon* and *Scylla serrata.*

Desired outcome:

- Learners will be able to describe the biology of *Penaeus monodon* and *Scylla serrata*.

1.1 *Penaeus Monodon*

1.1.1 Taxonomy, distribution, habit and habitat

1.1.2 External characters

1.1.3 Life cycle

1.1.4 Digestive system

1.1.5 Heart and circulatory system

1.1.6 Respiratory system

1.1.7 Reproductive system

1.1.8 Economic importance

1.2 *Scylla serrata*

1.2.1 Taxonomy, distribution, habit and habitat

1.2.2 External characters

1.2.3 Life cycle

1.2.4 Digestive system

1.2.5 Heart and circulatory system

1.2.6 Respiratory system

1.2.7 Reproductive system

1.2.8 Economic importance

PSZOOCN403

Laboratory Exercises based on Course PSZOOCN401 (2 Credits / 60 Hrs)

Objective:

- To impart skills of water quality analysis, various aspects of aquarium setup and basic aspect of aquaculture management.

Desired outcome:

- Learners will be able to analyse water quality parameters and demonstrate setup of aquarium.
- Learners will be able to explain the various aspects of aquaculture management.

1. Estimation of Turbidity, acidity, alkalinity, Hardness, DO, CO2 and BOD of pond water.
2. Identification with reference to aquaculture -
   Labeo rohita, Catla catla, Cirrhina mrigala, Cyprinus carpio, Ctenopharyngodon idellus, Hypophthalmichthys molitrix, Oreochromis mossambicus, Clarias batrachus, Pangasius sps., Piaractus brachypomus, Macrobrachium rosenbergii, Litopenaeus vannamei, Penaeus monodon.
3. Identification of important ornamental fishes (Angel, Danio, Discus, Flower horn, Gourami, Siamese fighter, Sword tail, Gold fish, Koi).
4. Identification of important aquatic plants used in aquariums. (Amazon sword, Cork screw, Ludwigia, Aqua rose, Cobamba, Pistia).
5. Setting up of aquariums and maintenance of aquarium fishes.
6. Study of developmental stages in fish – eggs, hatchings and fingerlings.
7. Study of various components of fish hatchery.
8. Preparation of formulated fish feed.
9. Study of various stages in the life cycle of *Macrobrachium rosenbergii* (Eggs, larva, Juvenile)
10. Visit a freshwater hatchery/aquaculture farm and submit a report.

PSZOOCN404

Laboratory Exercises based on PSZOOCN402 (2 Credits / 60 Hrs)

Objective:

- To impart skills of taxonomy of finfishes and shellfishes.
- To impart skills for analysis of biometry and food and feeding habits of fishes.

Desired outcome:

- Learners will be able to classify finfishes and shellfishes.
- Learners will be able to analyse biometry and food and feeding habits of fishes.

1. Taxonomic identification of marine fishes using Francis Day and FAO identification sheets using fresh / preserved specimens.

A. Elasmobranchs:

a) Family Carcharidae: *Scoliodon laticaudus, Zygaena malleus*

b) Family Rhinobatidae: *Rhynchobatus djiddensis*

c) Family Trygonidae: Himantura uarnak *(Trygon urnak)*

B. Teleost:

a) Family Percidae: *Lutjanus johnii, Therapon sps., Nemipterus japonicus (Synagris japonicus)*

b) Family Squamipinnes: *Scatophagus argus*

c) Family Polynemidae: *Eleutheronema tetradactylum (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 Mugillidae: *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. Taxonomic identification of marine prawns and shrimps using taxonomic key- *Penaeus monodon, Fenneropenaeus merguiensis, Metapenaeus monoceros, Metapenaeus affinis, Parapenaeopsis stylifera, Solenocera crassicornis, Nematopalaemon tenuipes, Acetes indicus*

(note - include additional available sps.)

3. Taxonomic identification of crustaceans and molluscs - *Scylla serrata, Neptunus sanguinolentus, Neptunus pelagicus, Charybdis feriata., Sepia sp., Loligo sp., Perna viridis*

4. Study of -

a) Food and feeding habit in suitable fish
b) Fecundity of fish (gonadosomatic index, standard length - fecundity relationship, weight – fecundity relationship, ova diameter and frequency polygon)
c) Age determination using otolith / scales

5. Biometric studies of fishes --

a) Study of relationship between total length and standard length/head length/body depth length/body weight.
b) Calculate correlation (standard length and total length, head length and total length, body depth and total length). Calculate the index values for various relationships.

6. Identification with reference to accessory respiratory organs – *Anabas testudineus, Clarius batrachus, Boleophthalmus sps, Heteropneustes fossilis.*
7. Visit to the local fish market to identify commercially important shell fishes and prepare a report.

Elective 1

PSZOOCN405

Marine Planktology and Phycology (2 Credits / 30 Hrs)

Module 1: Marine Planktology (15Hr)

Objective:

- To acquaint learners about classification and biology of marine plankton.

Desired outcome:

- Learners will be able to explain classification and biology of marine plankton.

1.1 Classification of Plankton (size, habitat and development).

1.2 Adaptation to planktonic life.

1.3 Factors influencing the distribution and abundance.

1.4 Plankton bloom, patchiness, vertical distribution and red tide.

1.5 Marine algae and plankton in relation to fisheries - indicator species

1.6 Diurnal migration of zooplankton - inter-relationship between phyto and zooplankton.

1.7 Methods of collection, preservation and analysis of plankton.

Module 2: Phycology (15Hr)

Objective:

- To acquaint learners about classification, biology and commercial importance of marine algae.

Desired outcome:

- Learners will be able to explain classification, biology and commercial importance of marine algae.

2.1 General characters, classification and distribution of marine algae

2.2 Reproduction in algae (vegetative, asexual and sexual)

2.3 Life cycles in algae (Haplontic life cycle, Diplontic life cycle, Haplodiplontic life cycle)

2.4 Bioactive compounds from marine algae

2.5 Algal products and by-products

2.5.1 Agar, Carrageenan, Alginate, Agarose

2.5.2 Biofuel

2.5.3 Nutraceuticals

2.5.4 Nori (Porphyra), Kombu (Laminaria), Arame (Eisenia), Dulse (Palmaria)

2.5.5 Liquid seaweed fertilizer

PSZOOCN406

Laboratory Exercises based on PSZOOCN405 (2 Credits / 60 Hrs)

Objective:

- To impart skills of classification and analysis of marine plankton.
- To impart skills for analysis and preparation of products from marine algae.

Desired outcome:

- Learners will be able to classify and analyse marine plankton.
- Learners will be able to analyse and prepare products from marine algae.

1. Temporary preparations of marine zooplankton (at least five)
2. Quantitative estimation of plankton settling method, wet weight method, weight displacement method, counting method.
3. Identification of zooplankton permanent slides (*Noctiluca*, *Obelia* medusa, Zoea, Copepods, Mysids, Echinoderm larvae, Nauplius, *Sagitta*, *Doliolum, Salpa*, Fish eggs and larvae, Jellyfish, *Physalia*, Porpita)
4. Estimation of protein content from marine algae
5. Estimation of chlorophyll pigments from marine algae
6. Extraction of agar from seaweeds
7. Identification of common seaweeds (*Sargassum, Ulva, Padina, Enteromorpha, Gracilaria, Dictyota, Caulerpa, Gelidium, Hypnea*)
8. Preparation of sodium alginate from seaweeds
9. Report on distribution of seaweeds near coastal areas
10. Preparation of herbarium of seaweeds

Elective 2

PSZOOCN407

Marine Products and By-Products (2 Credits / 30 Hrs)

Objective:

- To acquaint learners about various marine products and by-products.

Desired outcome:

- Learners will be able to describe various marine products and by-products.

2.1 By-products

- 2.1.1 Fish meal
- 2.1.2 Fish oil
- 2.1.3 Fish protein concentrate
- 2.1.4 Functional fish protein concentrates
- 2.1.5 Isinglass
- 2.1.6 Shark leather
- 2.1.7 Fish glue
- 2.1.8 Fish gelatin
- 2.1.9 Pearl essence
- 2.1.10 Shark fin soup

2.2 Fermented fish products

- 2.2.1 Fish-Shrimp sauces and pastes
- 2.2.2 Philippine Bagoong
- 2.2.3 Malaysian Budu
- 2.2.4 Fish silage
- 2.2.5 Fish Protein Hydrolysate

2.3 Products from marine invertebrates' shell waste

- 2.3.1 Chitin
- 2.3.2 Chitosan
- 2.3.3 Glucosamine hydrochloride
- 2.3.4 Astaxanthin
- 2.3.5 Calcium Supplements from shell

2.4 Seaweed products

- 2.4.1 Alginates
- 2.4.2 Agar agar
- 2.4.3 Agarose
- 2.4.4 Carrageenan

PSZOOCN408
Laboratory Exercises based on PSZOOCN407 (2 Credits / 60 Hrs)

Objective:

- To impart skills for preparation of marine products and by-products.

Desired outcome:

- Learners will be able to prepare marine products and by-products.

1. Extraction of chitin from crab / prawn shell
2. Extraction of shark liver oil
3. Extraction of fish body oil
4. Extraction of collagen from shark skin
5. Preparation of fish meal
6. Preparation of fish protein concentrate
7. Extraction of agar from seaweeds
8. Preparation of sodium alginate from seaweeds
9. Market survey of marine products and by-products

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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 and8 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

2) 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 CO_2 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

PSZOOCN303 Laboratory exercises based on PSZOOCN301

Duration: 10 am to 2 pm

25 marks

Q1	Estimate the physico-chemical parameters from the given sample of seawater (any one) 1. Turbidity and TDS 2. Salinity and TSS 3. Silicates 4. Nitrate-nitrites 5. Phosphates-phosphorus	06
Q2	Estimate the primary productivity using light and dark bottle method from the given sample water	05
Q3	Identify and describe 1. Oceanographic instruments (any two) 2. Intertidal organisms (any two)	08
Q4	Submission of report on intertidal organisms and viva	03
Q5	Submission of report on visit to oceanographic institute and viva	03

Submission of certified journal is mandatory

Recommendations for Internal Evaluation for PSZOOCN303

Sr. no.	**Type of Evaluation**	**25 marks**
1	Estimation of physico-chemical parameters from different locations along the coastal areas.	10
2	Overall conduct in practicals and submission of reports.	10
3	Attendance (0-25% = 0 marks, 25-50% = 1 marks, 50-75% = 3 marks, 75-100% = 5 marks)	05

PSZOOCN304 Laboratory exercises based on PSZOOCN302

Duration: 10 am to 2 pm

25 marks

Q1	Determine freshness of fish on the basis of organoleptic tests	06
Q2	Prepare the shrimps for processing after dressing and grading	04
	OR	
	Demonstrate dressing and filleting of fish	
Q3	Sketch the layout of ice factory/cold storage/freezing industry/canning industry	03
Q4	Identification of processing equipments (any four) 1. Thermal processing 2. Pulsed light technology 3. Infra-red (IR) processing 4. Radio frequency (RF) processing 5. Ohmic or Joule heating 6. High pressure processing 7. Vacuum cooling 8. Irradiation	08
Q5	Submission of report on visit to fish processing plant and viva	04

Submission of certified journal is mandatory

Recommendations for Internal Evaluation for PSZOOCN304

Sr. no.	Type of Evaluation	25 marks
1	Assessment of freshness by organoleptic tests from various fish samples (landing centre / fish market)	10
2	Overall conduct in practicals and submission of reports	10
3	Attendance (0-25% = 0 marks, 25-50% = 1 marks, 50-75% = 3 marks, 75-100% = 5 marks)	05

PSZOOCN307 Laboratory exercises based on PSZOOCN306

Duration: 10 am to 2 pm

25 marks

Q1	Estimate total RBC from given fish blood sample	08
	OR	
	Estimate total WBC from given fish blood sample	
	OR	
	Estimate differential WBC count from the given fish blood sample	
Q2	Estimate haemoglobin from the given fish blood sample	03
Q3	Identify and describe the fish diseases (any four)	08
Q4	Describe the use of given medication in aquaculture (any three)	06

Submission of certified journal is mandatory

Recommendations for Internal Evaluation for PSZOOCN307

Sr. no.	Type of Evaluation	25 marks
1	Haematological parameters from different fish blood samples.	10
2	Overall conduct in practicals and submission of reports.	10
3	Attendance (0-25% = 0 marks, 25-50% = 1 marks, 50-75% = 3 marks, 75-100% = 5 marks).	05

PSZOOCN309 Laboratory exercises based on PSZOOCN308

Duration: 10 am to 2 pm

25 marks

Q1	Preparation of value-added product (fish/prawn pickle, fish chakli and wafers, fish kabab, fish cutlet, fish curry, fish noodles, fish fillet, preparations from dry fish or prawn) - any one	10
Q2	Prepare the prawns for processing after dressing and grading	04
	OR	
	Demonstrate dressing and filleting of fish	
Q3	Submission of report on survey of fish marketing and viva	06
Q4	Submission of report on products and value-added products from offline/online store and viva	05

Submission of certified journal is mandatory

Recommendations for Internal Evaluation for PSZOOCN309

Sr. no.	Type of Evaluation	25 marks
1	Preparation of value-added products from consumable and commercially available fish/prawns (not included during practical)	10
2	Overall conduct in practicals and submission of reports	10
3	Attendance (0-25% = 0 marks, 25-50% = 1 marks, 50-75% = 3 marks, 75-100% = 5 marks)	05

PSZOOCN403 Laboratory exercises based on PSZOOCN401

Duration: 10 am to 2 pm

25 marks

Q1	Estimate turbidity/acidity/alkalinity from the given pond water	07
	OR	
	Estimate Hardness/DO/CO_2 from the given pond water	
Q2	Submission of report on setting up and maintenance of aquarium and viva	03
	OR	
	Submission of report on formulated fish feed	
Q3	Identify and describe 1. Candidate species of fish/prawn 2. Ornamental fish 3. Aquatic plant used in aquariums 4. Developmental stage in fish (any one) 5. Developmental stage in *Macrobrachium rosenbergii* (any one) 6. Component of fish hatchery	12
Q4	Submission of field visit report and viva	03

Submission of certified journal is mandatory

Recommendations for Internal Evaluation for PSZOOCN403

Sr. no.	**Type of Evaluation**	**25 marks**
1	Setting up of aquarium and estimation of physico-chemical parameters / Preparation of home-made fish feed	10
2	Overall conduct in practicals and submission of reports	10
3	Attendance (0-25% = 0 marks, 25-50% = 1 marks, 50-75% = 3 marks, 75-100% = 5 marks)	05

PSZOOCN404 Laboratory exercises based on PSZOOCN402

Duration: 10 am to 2 pm
25 marks

Q1	Identify and assign to their respective genera and species 1. Elasmobranch 2. Teleost 3. Teleost 4. Marine prawn / shrimp 5. Mollusc	10
Q2	Analyze the gut contents from the fish and make a report OR i) Measure ova diameter and plot a frequency polygon for the given fish ii) Calculate gonadosomatic index from the data provided OR Give an account of biometric parameters of the given fish data: i) Relationship between total length and standard length/head length/body depth/ body weight ii) Calculate its correlation	08
Q3	Identify and describe accessory respiratory organ (any one)	02
Q4	Submission of report on local fish market and viva	05

Submission of certified journal is mandatory

Recommendations for Internal Evaluation for PSZOOCN404

Sr. no.	**Type of Evaluation**	**25 marks**
1	Identification of by-catch at landing centres / gut content and biometry analysis of commercially important / by-catch fishes	10
2	Overall conduct in practicals and submission of reports	10
3	Attendance (0-25% = 0 marks, 25-50% = 1 marks, 50-75% = 3 marks, 75-100% = 5 marks)	05

PSZOOCN406 Laboratory exercises based on PSZOOCN405

Duration: 10 am to 2 pm
25 marks

Q1	Estimate protein content / chlorophyll pigments from the given marine algae	06
	OR	
	Prepare agar / sodium alginate from the seaweed sample	
Q2	Quantitative estimation of plankton by settling method/wet weight method/weight displacement method/counting method.	05
Q3	Identify and describe 1. Zooplankton 2. Zooplankton 3. Seaweeds 4. Seaweeds	08
Q4	Submission of report on distribution of seaweeds near coastal areas	02
Q5	Submission of herbarium	04

Submission of certified journal is mandatory

Recommendations for Internal Evaluation for PSZOOCN406

Sr. no.	**Type of Evaluation**	**25 marks**
1	Biochemical analysis of different types of marine algae / Identification of zooplanktons from different water samples	10
2	Overall conduct in practicals and submission of reports	10
3	Attendance (0-25% = 0 marks, 25-50% = 1 marks, 50-75% = 3 marks, 75-100% = 5 marks)	05

PSZOOCN408 Laboratory exercises based on PSZOOCN407

Duration: 10 am to 2 pm

25 marks

Q1	Preparation of fish protein concentrate / fish body oil / fish meal / shark liver oil	14
Q2	Extraction of chitin / collagen / agar / sodium alginate from sample provided	06
Q3	Submission of report on fish market survey	05

Submission of certified journal is mandatory

Recommendations for Internal Evaluation for PSZOOCN408

Sr. no.	**Type of Evaluation**	**25 marks**
1	Extraction / Preparation of by-products from different fish samples	10
2	Overall conduct in practicals and submission of reports	10
3	Attendance (0-25% = 0 marks, 25-50% = 1 marks, 50-75% = 3 marks, 75-100% = 5 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.

Letter Grades and Grade Points:

Semester GPA/ Programme CGPA Semester/ Programme	% of Marks	Alpha-Sign/ Letter Grade Result	Grading Point
9.00 - 10.00	90.0 - 100	O (Outstanding)	10
8.00 - < 9.00	80.0 - < 90.0	A+ (Excellent)	9
7.00 - < 8.00	70.0 - < 80.0	A (Very Good)	8
6.00 - < 7.00	60.0 - < 70.0	B+ (Good)	7
5.50 - < 6.00	55.0 - < 60.0	B (Above Average)	6
5.00 - < 5.50	50.0 - < 55.0	C (Average)	5
4.00 - < 5.00	40.0 - < 50.0	P (Pass)	4
Below 4.00	Below 40.0	F (Fail)	0
Ab (Absent)	-	Ab (Absent)	0

Sign of the BOS Coordinator
Dr. Vaishali Somani
BOS in Zoology

Sign of the Offg. Associate Dean
Dr. Madhav R. Rajwade
Faculty of Science & Technology

Sign of the Offg. Dean
Prof. Shivram S. Garje
Faculty of Science & Technology

BOD – 3/9/2024
12 (7) of M.P.U.A. 2016
Item No. – 6.3 (4) (N)

As Per NEP 2020

University of Mumbai

Title of the P.G. Program
M. Sc. (Zoology - Entomology)

Syllabus for
Semester – Sem.- III & 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	M.Sc. (Zoology - Entomology)
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: SP- 80 B (4)	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 Coordinator Dr. Vaishali Somani BOS in Zoology	Sign of the Offg. Associate Dean Dr. Madhav R. Rajwade Faculty of Science & Technology	Sign of the Offg. Dean Prof. Shivram S. Garje Faculty of Science & Technology

Preamble

Introduction

The designers of the Master's Programme in Zoology (Entomology) are conscious of the fact that the learners who choose to pursue this program in Zoology (Entomology) would need to be familiarized with the scope of Zoology (Entomology). The syllabus of the Semester III and IV of the Masters level in Zoology (Entomology) provides avenues to the learner for exploring different facets of Zoology (Entomology).

Aims and Objectives

1. To study specific anatomical and morphological characters of insects with taxonomy. To study physiological adaptations, development, reproduction and behavioural patterns of insects.
2. To study ecological interconnectedness of insects by studying ecological principles with an emphasis on useful and harmful insects in the ecosystems.
3. To have theoretical and hands on trainings of Sericulture and Apiculture.
4. To study demonstrate proficiency in the experimental techniques and methods.

Learning Outcomes

1. After completion of the courses related to taxonomic classification and diversity, the learners will be able to identify the major groups of useful and harmful insects and be equipped to classify them within a phylogenetic framework.

2. The learners will also be able to compare and contrast the characteristics patterns and modifications and differentiate them from each other through the study of life cycles and different systems.

3. They will be able to explain how insects function at the level of the gene, genome, organ and organ system. Drawing upon this knowledge, they will be able to give specific examples of the physiological adaptations, development, reproduction, and behavioural patterns.

4. The learners will be able to explicate the ecological interconnectedness of insects by studying ecological principles with an emphasis on useful and harmful insects in the ecosystems.

5. Students will be able to carry out a thorough study of the medical entomology with an emphasis on the agricultural and veterinary insects.

6. Students will be able to get the theoretical and hands on trainings of sericulture and Apiculture this will be helpful for learner to become entrepreneur.

7. The learners will be able to demonstrate proficiency in the experimental techniques and methods of analysis appropriate for understanding the above aspects of entomology

Credit Structure of the Program (Sem III & IV)

Post Graduate Programs in University Parishishta – 1

R: SP- 80 B (4)

Exit option: PG Diploma (44 Credits) after Three Year UG Degree

Year	Level	Sem	Major		RM	OJT / FP	RP	Cum. Cr.	Degree
			Mandatory	**Electives Any one**					
II	**6.5**	**Sem III**	PSZOENT 301: Taxonomy, Phylogeny and Diversity of insects **Credits 4** PSZOENT302: Insect Anatomy and Physiology **Credits 4** PSZOENT303: Laboratory Exercises- Insect Classification and Diversity **Credits 2** PSZOENT304: Laboratory Exercises- Insect Morphology and Physiology **Credits 2** PSZOENT305: Insect Preservation and Type study **Credits 2**	PSZOENT306: Industrial Entomology **Credits 2** PSZOENT307: Laboratory Exercises– Sericulture and Apiculture **Credits 2** **OR** PSZOENT308: Insect Behaviour and Ecology **Credits 2** PSZOENT309: Laboratory Exercises- Insect migration, communication and social organization **Credits 2**			Research Project **Credits 4**	22	**PG Degree After 3-YrUG**
		Sem IV	PSZOENT401: Agricultural, Veterinary Entomology, Vector Borne diseases with respect to insects **Credits 4** PSZOENT402: Forest Entomology, Forensic Entomology and Insect Toxicology **Credits 4** PSZOENT 403 Laboratory Exercises- Insect pests of Agricultural, veterinary and medical importance **Credits 2** PSZOENT 404 Laboratory Exercises- Chemical and biological control of insect pests **Credits 2**	PSZOENT405: Neo Entomology and Drosophila Studies **Credits 2** PSZOENT406: Laboratory Exercises Drosophila Culture, Experiments and New Avenues in Use of Insects **Credits 2** **OR** PSZOENT407: Insects- Ecological Interactions **Credits 2** PSZOENT408: Laboratory Exercises– Ecological Interrelationships- Insects, Plants and other organisms **Credits 2**			Research Project **Credits 6**	22	
Cum. Cr. for 1 Yr PG Degree			**26**	**8**			**10**	**44**	
Cum. Cr. for 2 Yr PG Degree			**54**	**16**	**4**	**4**	**10**	**88**	

Note: * The number of courses can vary for totaling 14 Credits for Major Mandatory Courses in a semester as illustrated.

Sem. - III

Syllabus

M.Sc. (Zoology - Entomology)

(Sem.- III)

PSZOENT301

TAXONOMY, PHYLOGENY AND DIVERSITY OF INSECTS

Objectives: To introduce learners to the field of Entomology and the basics of Insect Classification

Outcome: After successful completion of this course, the learner will be able to

- understand the basic taxonomic keys and its use for the classification of insects
- classify the insects up to orders and compare the characteristics of different families.

Unit 1: Introduction, History and Classification of insects up to families (15Hr)

1.1 Introduction to Entomology

1.2 History of Insect Classification

1.3 Taxonomic Keys of Identification

1.4 Classification of insects up to families: Dichotomous Key Ametabola (Apterygota)–Thysanura, Diplura, Protura, Collembola

1.5 Insect taxonomy and phylogeny in the molecular age

1.6 Extinct Insects

Unit 2: Hemimetabola (Pterygota) – Classification up to families (15Hr)

2.1 Ephemeroptera, Odonata, Plecoptera, Grylloblattoidea

2.2 Orthoptera, Phasmida, Dermaptera, Heteroptera, Hemiptera

2.3 Embioptera, Blattaria, Mantoidea, Isoptera

2.4 Zoraptera, Pscoptera, Siphunculata

Unit 3: Holometabola I – Classification up to families (15Hr)

3.1 Thysanoptera, Neuroptera, Mecoptera

3.2 Trichoptera, Strepsiptera, Siphunculata

Unit 4: Holometabola II – Classification up to families (15Hr)

4.1 Diptera

4.2 Coleoptera

4.3 Lepidoptera

4.4 Hymenoptera

PSZOENT302:

INSECT ANATOMY AND PHYSIOLOGY

Objectives: To familiarize the learners with anatomical features of the insects and physiology related to the life processes

Outcome: After successful completion of this course, the learner will be able to

- illustrate the structure of integument, muscles, digestive system, respiratory system, circulatory system, nervous system, endocrine system and reproductive system in insects
- understand the physiological processes in digestion, muscle movement, respiration, circulation and reproduction
- explain the structure and functioning of sense organs in insects
- identify and compare different types of larvae, pupae and the metamorphosis

Unit 1: The Integument, Digestive System and Muscles (15Hr)

1.1 Integument

1.1.1 Structure of Integument

1.1.2 Physiology of Integument –Moulting and Sclerotization

1.1.3 Function of Integument

1.2 Digestive system

1.2.1 The alimentary canal and associated glands

1.2.2 Digestion and absorption

1.2.3 Filter chamber

1.3 Insect muscles

1.3.1 Structure of muscles

1.3.2 Muscle physiology – contraction and relaxation

Unit 2: Respiration, Circulation and Excretion (15Hr)

2.1 Respiratory system

2.1.1 Structure of tracheal system

2.1.2 Types of tracheal system

2.1.3 Mechanism of Respiration: Gaseous Exchange in the tracheal system

2.1.4 Respiration in Parasitic insects and aquatic respiration

2.2 Circulation

2.2.1 Structure of Circulatory system, Haemocoel, the dorsal vessel, Accessory Pulsatile organs

2.2.2 Haemolymph – composition and function

2.2.3 Haemocytes – structure and function

2.2.4 Mechanism of circulation

2.3 Excretion

2.3.1 Structure of Malpighian tubules

2.3.2 Physiology of excretion and osmoregulation

Unit 3: Nervous system, Sense organs and Endocrine system

(15Hr)

3.1 Nervous system

3.1.1 Central Nervous system (CNS)

3.1.2 Peripheral Nervous system (PNS)

3.1.3 Autonomic Nervous system (ANS), Physiology and Neuro bio-chemistry

3.2 Sense organs

3.2.1 Photoreceptor

3.2.2 Mechanoreceptor

3.2.3 Audio receptor

3.2.4 Effector organ- sound-producing organ and light-producing organ

3.3 Structure of endocrine system

3.3.1 Endocrine system: structure, histology and function, mechanism of secretion

3.3.2 Chemical structure of Hormones, their synthesis and mode of action

3.3.3 Hormonal Regulation -Metamorphosis and diapauses

Unit 4: Reproduction and development **(15Hr)**

4.1 Male and female reproductive system, structure of testis and ovary,

4.2 Mechanisms of spermatogenesis and vitellogenesis.

4.3 Specialized reproductive mechanism: viviparity, polyembryony, paedogenesis and parthenogenesis.

4.4 Early embryonic development up to germ band formation.

4.5 Types of metamorphosis

4.6 Types of larvae and pupae

PSZOENT303

LABORATORY EXERCISES- Insect Classification and Diversity

Objectives To develop skill in the learners to classify the insects using taxonomic keys

To acquaint learners to the basic structural aspects of insect head, thorax and abdomen

Outcomes **After successful completion of this course, the learner will be able to**

- demonstrate the suitable collection and preservation techniques as per the type of insect
- apply the principles of taxonomy to classify the insects
- understand the structure of the head, thorax, abdomen and the related appendages in insects
- draw, label and describe the components of different types of mouth parts and antenna in insects

1. Preparation of dichotomous key for insects- at least 5 insects.
2. General classification of Insects up to families of the orders mentioned in theory: At least 2 examples of representative families from each order to be studied.
3. Study of insect head and its appendages.
4. Study of types of mouth parts and antennae: Cockroach, Bedbug, Butterfly.
5. Temporary preparation of antennae and mouth parts of the mosquito and House fly
6. Mounting of Tentorium (Cockroach).
7. Study of Thorax and its appendages: Mosquitoes, Honeybees.
8. Mounting of halters- House fly
9. Study of the abdomen and its appendages: cockroaches, Honeybees, Mosquitoes (Any two).
10. Study of types of genitalia, Cerci, Tympanum, Pseudo legs and Sting apparatus.
11. Submission of insect collection (suitably preserved) representing at least 5 orders
12. Demonstration of pit fall trap and swipe net in field

PSZOENT304

LABORATORY EXERCISES- Insect morphology and Physiology

Objectives: To develop understanding of different internal systems of insects
To generate interest in the learners to study mechanism of digestion and development

Outcomes: **After successful completion of this course, the learner will be able to**

- Illustrate and compare the organ system in different types of insects
- Demonstrate skills to estimate proteins, enzymes, amino acids and haemocyte count in insects
- Maintain scientific record of observations related to life cycle and identify the types of the metamorphosis in insects

1. Study of following organ system of Insects: Housefly, Cockroach, Grasshopper, Bugs, Beetles (any two)
2. a) Digestive system b) Nervous System c) Male and Female Reproductive system
3. Study of Histology (Permanent slides) of the digestive system (Midgut), Neuroendocrine system (secretary cells) and reproductive system (Testes and ovary).
4. Estimation of total proteins in Haemolymph /tissues.
5. Estimation of carbohydrates in Haemolymph/tissues.
6. Estimation of the digestive enzyme by DNSA method from mid-gut (Amylase/Invertase/Trehalase).
7. Study of Haemocytes and Total Haemocyte count.
8. Demonstration of the presence of chitin by using chitosan test.
9. Chromatographic analysis of amino acids in insect Haemolymph
10. Observation of metamorphosis in any two suitable insects and submission of report

PSZOENT305
INSECTS RESERVATION AND TYPE STUDY

Objectives: *Introduce the learners about field techniques and method of insect preservation and culture.*

Outcome: **After successful completion of this course, the learner will be able to**

- apply and demonstrate the methods of insect collection and preservation
- understand the classification, morphology and life cycle of butterflies
- design the set up for the rearing and breeding of insects
- explain the morphology, life cycle and economic importance of Mango stem borer as pest insect

Unit 1: Insects Collection, Preservation and Culture **(15Hr)**

1.1 Insect Collection

1.1.1 Equipment for collection of insects

1.1.2 Insect collection kit

Killing bottles

Aspirator (Suction Bottle)

Suction tube (Pooter)

Insect or butterfly Net

Beating Tray

Light Trap, Sticky trap, Water trap, Pitfall trap, Pond trap

Insect setting board

Cards (Triangular, Rectangular)

Hand lens

Pen knife or scalpel, scissors, forceps

Small brushes, stoppered tubes, and insect pins (Entomological pins)

1.2 Methods of Insect collection

1.2.1 Handpicking

1.2.2 Use of Insect or Butterfly Net

1.2.3 Sweeping

1.2.4 Beating

1.2.5 Insects collection from debris

1.2.6 Transferring to containers-getting the insects out of the net

1.2.7 Killing of Insects: Killing bottles, Pinching, Injecting, Hot water

1.3 Insect preservation

1.3.1 Temporary storage

1.3.2 Permanent preservation

Direct pining

Carding, Triangle carding, or pointing

Micro pinning or staging

Setting or spreading

Labeling

1.3.3 Liquid Preservation technique for soft-bodied Insects

1.3.4 Mounting-preparation of permanent slides

1.3.5 Keeping Adult Insects Alive

1.3.6 Insect Rearing

1.3.7 Insect Breeding

Unit 2: Type Study–Common Crow and Mango Stem Borer **(15Hr)**

2.1 Butterfly study

2.1.1 Classification and Diversity (Any five species locally recorded)

2.1.2 Classification, distribution and Morphology of Common Crow butterfly - *Euploea core*

2.1.3 Life Cycle, Metamorphosis, Larval food plants of - Common Crow and Blue Mormon

2.1.4 Ecological aspects of butterflies

2.2 Mango stem borer

2.2.1 Distribution of Mango stem Borer

2.2.2 Classification and Nomenclature

2.2.3 Morphology and Life Cycle

2.2.4 Nature of damage and control measures

Elective-1

PSZOENT306

Industrial Entomology

Objectives: *To introduce learners to the basic skills for Industrial Entomology with special reference to sericulture and apiculture*

Outcome: After successful completion of this course, the learner will be able to

- understand the host plants and life cycle of silk moth
- identify varieties of honey bees useful for apiculture
- gain knowledge about economic aspects of sericulture and apiculture

Unit 1: Sericulture **(15Hr)**

1.1 History of Sericulture
1.2 Host plants of Mulberry and non- mulberry Silkworm especially present in Western Ghats of Konkan Region
1.3 Moriculture
1.4 Life cycle of Mulberry and non-Mulberry Silkworm
1.5 Rearing of Mulberry silkworm and Tasar Silkworm
1.6 Diseases and Pests of Mulberry silkworm and Tasar silkworm

Unit 2: Apiculutre **(15Hr)**

2.1 Types of Honey Bees.
2.2 Social Behavior of honey bees
2.3 Life cycle of Honey bees
2.4 Nectar-containing Plants and Rearing of honey bees- Natural and Artificial Hive
2.5 Extraction and Purification of Honey
2.6 Marketing of Apiculture products and Economics of Apiculture
2.7 Therapeutic use of honey bees

PSZOENT307

LABORATORY EXERCISES – Sericulture and Apiculture (Based on PSZOENT306)

Objective **To prepare the learner to identify the opportunities in sericulture and apiculture**
Outcome After successful completion of this course, the learner will be able to

- Identify suitable food plants for sericulture and demonstrate rearing techniques related to silk moth
- Acquire basic skills for apiculture
- Design and set up small scale unit for sericulture/apiculture based on locally available resources

1 Study of types of silk moths.
2 Study of various host plants of silk worms especially found in Konkan region.
3 Study of Rearing Appliances of Mulberry silkworm and demonstration.
4 Study of mouthparts and legs of honey bees
5 Study of equipment used in Apiculture
6 Chemical Analysis of different honey samples
7 Industrial/Field visit and submission of report (Sericulture /Apiculture)
8 Preparation of model bee box using suitable material

Elective -2

PSZOENT308
Insect Behaviour and Ecology

Objectives:
- *To develop the approach of enquiry in the learners to understand the migration and communication in insects*
- *To generate the interest in the learners about the courtship behaviour and social life in insects*

Outcome: After successful completion of this course, the learner will be able to
- Understand the routes and ecological factors affecting insect migration
- Describe diverse ways of courtship and mating in insects
- Explain the different types of communication in insects
- Understand the complexity of social life in insects

Unit 1: Insect Migration And Social Insects **(15Hr)**

1.1 Insect Migration
1.2 Swarming in insects- with reference to locust
1.3 Migration in butterflies
1.4 Courtship behavior and mating in insects
1.5 Social life in honey bees, Termites, Ants and Wasps

Unit 2: Insect Communication **(15Hr)**

2.1 Communication instincts, learning and memory
2.2 Visual communication, Communication using light
2.3 Communication using chemicals (pheromones)
2.4 Communication using sound- specialized structures for the production and reception of sound

PSZOENT309
LABORATORY EXERCISES- Insect behaviour and Ecology (Based on PSZOENT308)

Objectives
- **To develop skills to identify the communication pathways in insects**
- **To understand management of colonies in social insects**

Outcomes After successful completion of this course, the learner will be able to
- Record and analyze the communication pattern in insects
- Identify different types of migratory insects
- Understand the characteristics of insect nests, social insects and success of colony
- Develop participatory skills to use online platforms with scientific and educational approach

1 Study of migratory insects- Desert Locust, Monarch butterfly, Cockchafers, Globe Skimmer Dragonfly
2 Study of communication in insects (Fire fly, Crickets, Cicadas, ants, honey bees- Round dance and waggle dance) using specimens/photographs/ videos/audio
3 Study of Termite colony, Weaver ants, harvester ants, Wasp - Paper wasp, Hornet Wasp using model/photographs of nests
4 Study of castes in termites, ants and bees
5 Field visit report based on social insects, colonies/nests and insect communication
6 Visit to Online platforms of insect records /sites of Citizen Science related to Insect Migration and submission of report
7 Effect of pheromones on insects (field study using commercially available pheromones)

Sem. - IV

Syllabus
M.Sc. (Entomology)
(Sem.- IV)

PSZOENT401
AGRICULTURAL, VETERINARY ENTOMOLOGY AND VECTOR BORNE DISEASES WITH RESPECT TO INSECTS

Objectives:
- To introduce the learners to the important insect pests of cereals and other important crops
- To introduce learners to the insect pests of veterinary importance.
- To prepare the learners to understand the concept and principle of epidemiology concerning insects.

Outcome: After successful completion of this course, the learner will be able to

- Explain the classification, life history, damage caused, and control of a few insect pests of cereals, oilseeds, cotton, sugarcane, stored grain., vegetables, fruits, spices, and some flowering plants
- Identify the stages in the life cycle of veterinary pest and relate them with the symptoms
- Understand the role of insect vectors in epidemics of related diseases.

Unit 1: Insect pests of cereals, oilseeds, cotton, sugarcane and stored grain (15Hr)

Study of Insect pests with special reference to their classification up to families, appearance, habit, life history, distribution, host plant damage and control measures. (At least two major insect pests of each host to be studied)

1.1 Insect Pests of cereals-Rice, Jowar, Bajra, Wheat, Maize

1.2 Insect pests of oilseeds-Groundnut, Soyabean, Sunflower

1.3 Insect pests of Cotton and Sugarcane

1.4 Stored Grain Pests -*Tenebrio, Trogoderma, Bruchus.*

Unit 2: Insect pests of vegetables, fruits, spices and flowering plants (15Hr)

Study of Insect pests with special reference to their classification upto families, appearance, habit, life history, distribution, host plant damage and control measures (at least two major insect pests of each host to be studied.

2.1 Insect Pests of vegetables-Cabbage, Brinjal, Okra, Tomato, Red Pumpkin

2.2 Insect Pests of fruits- Mango, Citrus, Coconut, Cashew, Sapota

2.3 Insect pests of spices-Black pepper, Tumeric, Ginger

2.4 Pests of Flowering Plants- Mealy Bugs, Aphids, Whiteflies, Scale insect.

Unit 3: Veterinary Entomology (15Hr)

Study of following insects as pests of domestic animals with general reference of their classification up to family, habit, brief life history, damage, diseases caused and control measures.

3.1 Horsefly

3.2 Cattle blood sucking fly

3.3 Flesh fly

3.4 *Hypoderma*

Unit 4: Vector borne diseases with respect to insects

(15Hr)

4.1 Scope of Insect Epidemiology- Definition-scope and application-endemic-epidemic, and pandemic.

4.2 Malaria: basic reproduction rate-vector capacity-vector competence-inoculation rate- stability index-human blood index (HBI) –parasite indices.

4.3 Arboviral Disease: Vector indices (Dusk index, house index, container index pupal index) Minimum infection Rate (MIR)

PSZOENT402

FOREST, FORENSIC ENTOMOLOGY, INSECT CONTROL AND TOXICOLOGY

Objectives:
- To develop an understanding of the learners about the insects in forest ecosystem and forensic studies
- To orient the learners to the variety of methods of insect control.

Outcome: **After successful completion of this course, the learner will be able to**
- Understand the role of insects in the forest ecosystem and in forensic investigation
- Categorizing different insecticides and implementing the use of biological control agents

Unit 1: Forest Entomology (15Hr)

1.1 Introduction to forest Entomology about forests and forest produce

1.2 Insect pests of nurseries, natural and plantation forests, standing and felled trees

1.3 Insects pests of timber in storage (broad-leaved and conifers)

1.4 Biology and ecology of the key pests of tree species of economic value and forest nurseries and their management-Gall insects. Borers, Leaf miners, Defoliators

1.5 Insects of mangrove forest

1.6 Role of insects in forest food web

1.7 Termites, *Eutectona macharalis*, *Hybleapurea*

Unit 2: Forensic Entomology (15Hr)

2.1 History, corpse-associated arthropod classes, role of arthropods in forensic entomology, examples

2.2 Brief mention of Common insects of Forensic importance

2.2.1. Order Diptera–Calliphoridae, Sarcophagidae & Muscidae

2.2.2. Order Coleoptera– Staphylinidae, Histeridae, Silphidae, Dermestidae &Cleridae

2.3 Collection of entomological evidence during a death investigation

2.3.1. Temperature and climatic records, collection

2.3.2. Preservation and handling of insects /maggots from the crime scene

2.4 Analysis of entomological evidence and estimating PMI (Post Mortem Index) using Maggot age and Insect succession

Unit 3: Methods of Insect control, Types of insecticides and their effects (15 hrs)

3.1 Natural control of insect pest-Abiotic and biotic factors
Cultural, mechanical, and physical methods of insect control

3.2 Chemical Control

Classification of insecticides- Inorganic insecticides, Insecticides of plant origin, Synthetic organic insecticides, Types and examples

Chemistry,Mode of action

3.3 Insecticide formulations and applications, Insecticide synergists

3.4 Autocidal Control Method-Sterile Male Technique

3.5 Use of Hormones, Pheromones, Attractants and Repellents in insect control

3.6 Microbial and Environmental degradation of pesticides. Metabolism of pesticides

3.7 Dynamics of Environmental Pollution by Insecticides and impact on human health and ecosystem

Unit 4: Biological Control and IPM **(15Hr)**

4.1 Biological Control- Definition, types of biological agents used for insect control

4.2 Use of parasites

4.3 Use of predators

4.4 Use of pathogen, Microbial pesticides

4.5 Microbial insecticides - Use of bacteria, virus, fungus, protozoans in insect control

4.6 Bio-control programs in Maharashtra and India

4.5 Integrated Pests Management- definition, Principle and steps

4.6 Advantages and Limitations of biological control

4.6 Integrated Pest Management-Definition, Principle and steps

PSZOENT403
LABORATORY EXERCISES
Insect pests of Agriculture, Veterinary and medical importance (Based on PSZOENT401)

Objectives: **To introduce the common insect pests related to agriculture and veterinary science.**
Outcome: After successful completion of this course, the learner will be able to

- Identify the pests of common crops, the damage caused by them and correlate it with field observations
- Identify the pests of medical and veterinary importance

1 Identification of economic importance of the following insect pests;

Household Pest- Termite, Carpet moth, Cockroach

Pests of medical importance- Sandfly, Tsetse fly, rat flea

Veterinary pest- Horsefly, Stable fly, screwworm, Cattle warble fly,

Forest pest- Teak defoliator, Polyphagous drywood borer- *Sinoxylon sp*.

Pest of cereals- Paddy grasshopper, Sorghum shoot fly

Pest of pulses- Greasy cut worm (*Agrotis sp*.), Plume moth (*Exelastis sp*.)

Pest of fiber crops- Red cotton bug, Pink Bollworm

Pest of fruits and fruit trees- Lemon butterfly (*Papilio demoleus*), Oriental fruit fly (*Dacus dorsalis*)

Pest of oil seed crop– Castor semilooper (*Achaea janata*), Ground nut stem borer– (*Sphenoptera sp)*.

Pest of vegetable crops– Hadda beetle (*Epilachna p*.), Cabbage caterpillar (*Pieris brassicae)*

Pest of spices–turmeric shoot borer–*Conogethes punctiferalis*, Pest of black pepper–Pollu beetle (*Longitarsus nigripennis*)

Pest of narcotic crops-Leaf eating caterpillar- *Spodoptera litura* Fab., Tobacco aphid– *Myzus nicotianae* Black.

2 Field visit to the agricultural area /fruit plantation /forest to study the pests and submission of report based on it.

3 Visit to cattle farm /Veterinary center to study the pests of cattle /other pet animals and submission of report based on it.

PSZOENT404
LABORATORY EXERCISES
Chemical and Biological Control of insect pests
(Based on PSZOENT402)

Objectives:
- To acquaint the learners to the application and the action of chemical insecticides
- To provide the knowledge of biocontrol agents and common predators of insects

Outcome: After successful completion of this course, the learner will be able to
- Understand the working of commonly used appliances for insect control
- Evaluate the insecticidal treatment and interpret the results
- Identify the important biocontrol agents and insect predators

1 Study of insecticide appliances

Simple sprayer

Hydraulic sprayer

Rocker sprayer

Duster

2 Identification and economic importance of parasitoids (Biocontrol agents).

Trichograma spp.

Aphytis melinus

Cryptolaemus montrouizeri

Crysoperla carnea

Isotima javensis

Xanthopimpla punctata

Apanteles spp.

3 Identification and economic importance of insect predators:

Birds

Reptiles

Amphibians

Mammals

Pisces

Coelenterates

Arachnids(spider)

Insect

4 Study of weed controlling insects.

Beetles (*Octotoma scabripennis, Uroplata girardi*)

Scale insect (*Dactylopius tomentosus)*

Flea beetle (*Agasicles hygrophyla*)

5 Whole mount preparations of parasitic insects and microscopic pest.

Thrips

Aphids

Jassids

Cowbug

Termites

Pentatomid bug

6 Symptomology of following different types of insecticide treatment in Cockroach.

Contact poison

Stomach poison

Fumigant.

7 Bioassay of insecticides in a suitable insect; (LC_{50})

Contact to poison.

Stomach poison.

Fumigant

8 Estimation of synergistic ratio using suitable insect model.

Elective-1

PSZOENT405
Neo entomology and Drosophila study

Objectives: *To introduce the learners to the new avenues and prospects in Insect studies (Entomology).*
To orient the learner to different aspects of Drosophila studies

Outcome: After successful completion of this course, the learner will be able to

- *acquire knowledge of insects used as medicine, food and for ornamental purposes*
- *learn morphology, taxonomy, life cycle and genetic variation in Drosophila species*

Unit 1: Neo Avenues in entomology **(15Hr)**

1.1 Insect as a medicine (Entomo therapeutics)

1.2 Insect as weapons (Entomo logical warfare)

1.3 Insects as food

1.4 Ornamental Entomology: Ornamental products from insects

1.5 Use of Insect in textile Industry: Fashion designing

1.6 Insect as ecological Indicators

Unit 2: Drosophila study **(15Hr)**

2.1 Taxonomy

2.2 Morphology

2.3 Life cycle

2.4 Drosophila as model organism

2.5 Genetics

2.6 Genomics

PSZOENT406
LABORATORY EXERCISES –Drosophila Culture, experiments and new avenues in use of insects (Based on PSZOENT405)

Objectives:

- To introduce the learners to the uses of insects as a source of food and medicine
- To equip the learners to use Drosophila as a model organism

Outcome: After successful completion of this course, the learner will be able to

- Identify the use of insects as resource and indicators of ecosystem
- *develop skills to maintain the culture and handle drosophila to perform experiments*
- *understand the morphology, sexual dimorphism and development of Drosophila*

1 Study of insects used as food

2 Study of ornamental insects, ornamental products from insects

3 Study of insects used as ecological indicators

4 Study of the morphology and sexual dimorphism of adult Drosophila

5 Temporary mounting of wing of Drosophila

6 Temporary mounting of salivary glands in Drosophila-Study of polytene chromosomes

7 Observation of Drosophila courtship behaviour

8 Identification of larval stages and handling III instar larvae during collection and transfer

9 Collection and identification of natural populations of Drosophila flies from different locations, in different months and submission of the report

10 To study the feeding preference in Drosophila

11 Development and maintenance of Drosophila culture using suitable media

12 Effect of UV radiation on Drosophila culture

13 Problems based on Drosophila Genetics

Elective-2

PSZOENT407
Insects- Ecological

Objectives:

- *To facilitate the learning of insect population ecology, its dynamics and regulatory factors important for its sustenance.*
- *To orient the learners to the ecological association of insects with plants and other organisms*

Outcome: After successful completion of this course, the learner will be able to

- Assess the feeding relationships of insects with plants
- discuss the factors affecting insect population
- Understand the types of mimicry in insects

Unit 1: Insect ecology **(15Hr)**

1.1 Population ecology

Concept of population

Population dynamics and Characteristics

Factors affecting insect population

Abiotic factors– Photoperiod, Temperature and Humidity.

Biotic factors – Food as a limiting factor for distribution and abundance,

1.2 Nutritional ecology

Food chain, Food Web and Ecological Succession

Interspecific interactions –Basic factors governing the interspecific Interactions

1.3 Polymorphism in Aphids

1.4 Mimicry in Insects

1.5 Venomous Insects

Unit 2: Insect relations to other organisms **(15Hr)**

2.1 Insect plant interaction

Types of positive and negative interaction

Leaf eater

Frugivory

Bark feeders

Galls

Pollination

2.2 Insect– Animal interaction. Types of positive and negative interaction

2.3 Insect– insect interaction. Types of positive and negative interaction

PSZOENT408

LABORATORY EXERCISES- Ecological Interrelationships- Insects, plants, other organisms

Objectives

- The learners will be introduced to the ecological aspects of insects including predation and mimicry
- The learners will be prepared to perform the experiments related to aspects of feeding in insects

Outcomes After successful completion of this course, the learner will be able to

- design experiments to understand feeding behaviour in insects
- assess the role of plants in ecology of insects
- recognize the examples and types of mimicry in the world of insects
- understand the common predators of insects

1 Report of nectar plants and food plants of butterflies. (At least 5 species each available locally).

2 Study of insectivorous birds, spiders, and other animals (Any two from each).

3 Study of myrmecophytes (Any two).

4 Study of insectivorous plants (Any two).

5 Report on feeding experiment – ants / other suitable insects including comparison of types of baits / Time for recruitment of foragers / Time for removal of food material / Competition between two species

6 Study of Pathogens from suitable insects.

7 Temporary mounting of Different types of gall insects.

8 Mimicry and camouflage in insects:

Batesian (any two examples).

Mullerian (Any two examples).

Camouflage–leaf insect, Orchid-mantis

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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 and8 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

2) 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 CO_2 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
PSZOENTP303
Insect Classification and Diversity

(Time: 10.00 am - 2.00 pm)

Total Marks: 25 **Duration: 4 hours**

Q1. Observe two given insect specimens using a hand lens or dissecting microscope and write their morphological features. (5 marks)

Q2. Utilize the provided dichotomous key to identify the order to which each insect specimen belongs to (any two insects). (5 marks)

Q3. Temporary preparation of antennae/halters /tentorium/ mouth parts of……. (Cockroach/Housefly/Mosquitoes). (4 marks)

Q4. Identify and describe (8 marks)

a) Types of mouthparts
b) Type of antenna
c) Type of thoracic appendages
d) Type of abdominal appendages

Q5. Viva (3 marks)

Submission of the certified journal is mandatory for the examination
Suggested Guidelines for Practical Examination (Internal)

Internal examination (Total marks 25)

Q. 1 Demonstration of pitfall trap and Swipe net in the field (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
PSZOENTP304
Laboratory Exercises- Insect Morphology and Physiology
(Time: 10.00 am - 2.00 pm)

Total Marks: 25 **Duration: 4 hours**

Q1. Present the ……. System of Housefly / Grasshopper/ Bug/ Beetle. Describe the function of all the parts. (Digestive system / Nervous System/ male / Female Reproductive system) (6 marks)

Q. 2 Identify and describe (Study of histology) (04 marks)
a) and b)

Q2. Estimation of total proteins in Haemolymph /tissues from given insect. (6 marks)

OR

Q2. Estimation of carbohydrates in Haemolymph/tissues from given insect. (6 marks)

OR

Q. 2 Study of Total hemocyte count from given insect (6 marks)

OR

Q. 2 Detection of uric acid as an excretory product of terrestrial insects. (6 marks)

Q3. Estimation of the digestive enzyme by DNSA method from midget (Amylase/Invertase/Trehalase). (08 marks)

OR

Q3. Perform chromatographic analysis of amino acids in insect Haemolymph (08 marks)

OR

Q3. Demonstrate of the presence of chitin by using chitosan test. (08 marks)

Q4. Viva (03 marks)

Submission of the certified journal is mandatory for the examination

Suggested Guidelines for Practical Examination (Internal)
Internal examination (Total marks 25)

1. Documentation with geotagged photos and description of metamorphosis in at two insects (20 marks)
2. Timely completion and submission of journal (05 marks)
3. Overall participation and attendance (05 marks)

UNIVERSITY OF MUMBAI
MSc Zoology Semester-III
PSZOENTP307
Laboratory Exercises- Sericulture and Apiculture
(Time: 10.00 am - 2.00 pm)

Total Marks: 25 **Duration: 4 hours**

Q1. Chemical Analysis of different samples of honey. (08 marks)

OR

Q.1 Study of mouth parts and legs of honey bee (08 marks)

Q2. Identify and describe. (8 marks)

a) Rearing appliances in sericulture
b) Equipment used in apiculture
c) Product from apiculture
d) Product from sericulture

Q3. Submission of field report and viva based on it. (6 marks)

Q4. Viva (3 marks)

Submission of certified journal is mandatory for the examination

Suggested Guidelines for Practical Examination (Internal)
Internal Examination (Total marks- 25)
1. Submission of the model of bee box (15 marks)
2 Timely completion and submission of journal (05 marks)
3 Overall participation and attendance (05 marks)

UNIVERSITY OF MUMBAI
MSc Zoology Semester-III
PSZOENTP309
Laboratory Exercises- Insect Migration, Communication and Social organization
(Time: 10.00 am - 2.00 pm)

Total Marks: 25 **Duration: 4 hours**

Q1. Identify the video/audio clip/photographs and comment on insect communication.

a) And b) (4 marks)

Q2. Identify and describe. (8 marks)

a) Migratory insect
b) Insect nest/colony
c) Castes in social insects
d) Castes in social insects

Q. 3. Submission of field report and viva based on it. (05 marks)

Q. 4 Study of the Effect of pheromones on insects and Submission of report (05 marks)

Q4. Viva Voce. (03 marks)

Submission of certified journal is mandatory for the examination

Suggested Guidelines for Practical Examination (Internal)
Internal Examination (Total marks- 25)

1. Submission of the observations about insects on any suitable portal/ Citizen Science Portal (15 marks)
2. Timely completion and submission of journal (05 marks)
3. Overall participation and attendance (05 marks)

UNIVERSITY OF MUMBAI

MSc Zoology (Entomology)

Semester – IV

PSZOENTP403

Laboratory Exercises- Insect Pests of Agriculture, Veterniary and Medical Importance

(Time: 10.00 am to 2.00 pm)

Total Marks: 25 Duration: 4 hours

Q1. Identify and describe the economic importance of given specimen/photograph. **(06)**
Three spots from Household pests/ Medical pests/ Veterinary pest/ Forest pest. (Not more than one from each group)

a)
b)
c)

Q2. Identify and describe the economic importance of given specimen/photograph. **(10)**
Three spots from pests of cereals/ pulses/ fiber crop/ fruit and fruit trees/ oil seeds/ vegetables/ spices/ narcotic crops. (Not more than one from each group)

a)
b)
c)
d)
e)

Q3. Field visit to agricultural area/ fruit plantation/ forest to study the pests and submission of report based on it. (06)

Q4. Viva. (03)

Submission of the certified journal is mandatory for the examination

Suggested Guidelines for Practical Examination (Internal)
Internal Examination (Total marks- 25)

1. Visit to cattle farm/ Veterinary center to study the pests of cattle/other pet animals and submission of report based on it**.** (07 marks)
2. Submission of suitable preserved insects (at least 4 species) – Forest pest/Household pest/ Agricultural/ Stored Grain pest/Pest of fruit plantation/ Veterinary pest (08 marks)
3. Timely completion and submission of journal (05 marks)
4. Overall participation and attendance (05 marks**)**

UNIVERSITY OF MUMBAI

MSc (Zoology - Entomology) Semester – IV

PSZOENTP404

Laboratory Exercises-Insect Control and Toxicology

(Time: 10.00 am to 2.00 pm)

Total Marks: 25 Duration: 4 hours

Q1. Assay/Experiment

Assess LC50 for given insecticide (Mosquito larvae/Chironomous larvae). **(08)**

OR

Q1. Estimation of synergistic ratio using suitable insect model. **(08)**

Q2. Identification (**08)**

i. Identify and describe the insecticide appliances.
ii. Identify and give economic importance of insect predators.
iii. Identify and give economic importance of parasitoids.
iv. Identify and describe weed control insects/bio control agents

Q3. Preparation of whole mount of parasitic insect and /microscopic insect pest. (any two) **(06)**

OR

Q3 Identify the symptomology of given insecticide treatment on cockroach (Contact poison/ Stomach poison/ Fumigant) **(06)**

Q4. Viva- Voce based on theory. **(03)**

Submission of certified journal is mandatory for the examination

Suggested Guidelines for Practical Examination (Internal)
Internal Examination (Total marks-25)

1. Study/Interaction with Experts/Entrepreneurs/ Farmers in Agricultural/household/Commercial pest control services and submission of report about use of insecticides and commonly used appliances. Submission of the report and Viva based on it (15 marks)
2. Timely completion and submission of journal (05 marks)
3. Overall participation and attendance (05 marks)

UNIVERSITY OF MUMBAI

MSc (Zoology - Entomology) Semester – IV

PSZOP406

Laboratory Exercises-Drosophila Culture, Experiments and New Avenues in Use of Insects

(Time: 10.00 am to 2.00 pm)

Total Marks: 25 Duration: 4 hours

Q1. Identification **(08)**

i. Identify and describe the given insect specimen/photograph and comment for its use as food/ Ornamental purpose
ii. Identify and describe the given insect specimen/photograph and comment for its use as ecological indicator/ornamental product
iii. Identify and describe the morphology of the adult / larval stage in Drosophila
iv. Comment on the sexual dimorphism of a given specimen/photograph in Drosophila.

Q2. Temporary mounting of the wing of Drosophila. **(04)**

OR

Q2. Temporary mounting of salivary gland to study polytene chromosome

Q3. Problems Based on Drosophila Genetics (Any two) **(05)**

Q4. Submission of certified report on effect of UV radiation on Drosophila culture and viva based on it. **(05)**

Q5. Viva **(03)**

Submission of certified journal is mandatory for the examination

Suggested Guidelines for Practical Examination (Internal)
Internal Examination- (Total marks 25)

1. Submission of report on the experiment - feeding preference in Drosophila using suitable media and viva based on it. (08 Marks)
2. Maintainance of Drosophila Culture and Submission of the report including observations on courtship behaviour in Drosophila (07 Marks)
3. Timely completion and submission of journal (05 Marks)
4. Overall participation and attendance (05 Marks)

UNIVERSITY OF MUMBAI

MSc (Zoology - Entomology) Semester – IV

PSZOENTP408

Laboratory Exercises-Ecological Interrelationships- Insects, Plants and other organisms

(Time: 10.00 am to 2.00 pm)

Total Marks: 25 Duration: 4 hours

Q1. Make a temporary preparation (stain if necessary) of pathogens from the given insect.
(07)

OR

Q1. Make a temporary preparation of gall insects and make a report.
(07)

Q2. Identification
(10)

i. Identify and describe the insectivorous animal from give photograph.
ii. Identify and describe the myrmecophytes from given photograph.
iii. Identify and describe the insectivorous plants from given photograph.
iv. Identify and describe the mimicry in insect from given photograph.
v. Identify and describe the camouflage behavior in insect from given photograph.

Q3. Submission of certified report on feeding experiment – ants / other suitable insects with respect to points mentioned in syllabus and viva based on it.
(05)

Q4. Viva
(03)

Submission of the certified journal is mandatory for the examination

Suggested Guidelines for Practical Examination (Internal)
Internal Examination- (Total marks 25)

1. Submission of certified report on report of nectar plants and food plants of butterflies (At least 5 species each available locally) and viva based on it (15 Marks)
2. Timely completion and submission of journal (05 Marks)
3. Overall participation and attendance (05 Marks)

Letter Grades and Grade Points:

Semester GPA/ Programme CGPA Semester/ Programme	% of Marks	Alpha-Sign/ Letter Grade Result	Grading Point
9.00 - 10.00	90.0 - 100	O (Outstanding)	10
8.00 - < 9.00	80.0 - < 90.0	A+ (Excellent)	9
7.00 - < 8.00	70.0 - < 80.0	A (Very Good)	8
6.00 - < 7.00	60.0 - < 70.0	B+ (Good)	7
5.50 - < 6.00	55.0 - < 60.0	B (Above Average)	6
5.00 - < 5.50	50.0 - < 55.0	C (Average)	5
4.00 - < 5.00	40.0 - < 50.0	P (Pass)	4
Below 4.00	Below 40.0	F (Fail)	0
Ab (Absent)	-	Ab (Absent)	0

Sign of the BOS Coordinator
Dr. Vaishali Somani
BOS in Zoology

Sign of the Offg. Associate Dean
Dr. Madhav R. Rajwade
Faculty of Science & Technology

Sign of the Offg. Dean
Prof. Shivram S. Garje
Faculty of Science & Technology

BOD – 3/9/2024
12 (7) of M.P.U.A. 2016
Item No. – 6.3 (5) (N)

As Per NEP 2020

University of Mumbai

Title of the P.G. Program

M.Sc. (Zoology - Environmental Science)

Syllabus for

Semester – Sem.- III & 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**	**M.Sc. (Zoology - Environmental Science)**
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: SP- 80 B (5)**	**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 Coordinator
Dr. Vaishali Somani
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Sign of the Offg. Associate Dean
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Faculty of Science & Technology

Sign of the Offg. Dean
Prof. Shivram S. Garje
Faculty of Science & Technology

Preamble

1) Introduction:

The current curriculum has been redesigned in alignment with the goals of the National Education Policy (NEP) 2020 and the National Credit Framework (NCrF). It consists of 44 credits in total, evenly distributed between semester III and IV, encompassing theoretical and practical aspects. Semester III comprises three 4-credit courses and one 2-credit course in the mandatory section, while semester IV includes three 4-credit mandatory courses. Both semesters offer two elective options, each worth 2 credits. A research project is also integrated into the curriculum, with 4 credits allocated in semester III and 6 credits in semester IV.

2) Aims and Objectives

The aim of the Zoology degree within the specialisation in environmental science syllabus or curriculum typically revolves around providing learners with a comprehensive understanding of the nexus between zoological concepts and environmental dynamics. This mainly includes: (1) Exploring the diversity of animal life forms and their roles within ecosystems, emphasising conservation and preservation strategies, (2) Examining the ecological interactions between animals and their environments, including energy dynamics, ecological relationships, and the impact of human activities on ecosystems, (3) Focusing on the conservation of endangered species, habitat restoration, and the implementation of sustainable practices to mitigate environmental degradation, (4) Investigating the effects of environmental pollutants, climate change, and habitat destruction on animal populations and ecosystems, and exploring strategies for mitigation and adaptation, (5) Developing practical skills in fieldwork, data collection, and analysis to conduct research projects aimed at addressing environmental challenges and informing conservation efforts and (6) Integrating knowledge from various disciplines such as ecology, genetics, physiology, and environmental science to understand complex environmental issues from a zoological perspective. Ultimately, the objective is to furnish learners with the knowledge, expertise, and ethical consciousness essential for contributing to the preservation and responsible management of biodiversity and ecosystems amidst global environmental challenges.

3) Learning Outcomes

The specific learning outcomes of the present syllabus are as follows: (1) To equip the learners with a deep understanding of the fundamental concepts, principles, and theories in environmental sciences, including ecology, environmental chemistry, and environmental policy. (2) To enhance the critical thinking and analytical skills of learners to evaluate environmental issues, assess the impact of human activities on ecosystems, and propose evidence-based solutions. (3) To educate the learner to acquire advanced research skills, including understanding environmental problems, collecting and analysing data, and interpreting findings to contribute to the advancement of knowledge in environmental sciences. (4) To provide learners with information across multiple disciplines, such as

biology, chemistry, geology, and journalism, and understand how these fields intersect in addressing complex environmental challenges. (5) To develop expertise in learner on environmental management techniques, including pollution control, waste management, and sustainable resource utilisation, to contribute to the development and implementation of effective environmental policies and practices and (6) To prepare the learner for careers in academia, government agencies, non-profit organisations, consulting firms, and industry by gaining practical experience through internships, fieldwork, and collaboration with professionals in the field. Overall, the learning outcome of the program is to equip learners with the knowledge and skills necessary to address complex environmental challenges and contribute to the sustainable management of natural resources and ecosystems.

4) Any other point (if any)

In the second year of the master's program, apart from theory and practical components, the primary focus is on research projects (10 credits), which can be divided into two phases: the preparatory/synthesis phase during semester III and the execution phase during semester IV. In the synthesis phase, tasks include identifying the research problem, conducting a literature review, developing the research proposal, selecting survey sites or model systems, obtaining necessary permissions, seeking funding, calibrating equipment, conducting pilot experiments, optimising protocols, finalising data collection and analysis methods, and reporting preliminary results. The second phase involves executing the research project, including fieldwork, sample collection and processing, conducting experiments, data acquisition, statistical analysis, uploading findings to databases, presenting results at conferences, writing research manuscripts, checking for plagiarism, and submitting the final project work.

Credit Structure of the Program (Sem III & IV)

Post Graduate Programs in University Parishishta – 1

R: SP- 80 B (5)									
Exit option: PG Diploma (44 Credits) after Three Year UG Degree									
Year	**Level**	**Sem**	**Major**		**RM**	**OJT / FP**	**RP**	**Cum. Cr.**	**Degree**
			Mandatory	**Electives Any one**					
II	**6.5**	**Sem III**	**PSZO301 (4 Credits):** Fundamentals of Environment Sciences **PSZO302 (4 Credits):** Occupational safety and Disaster management-I **PSZO303 (2 Credits):** Lab exercise based on PSZO301 **PSZO304 (2 Credits):** Lab exercise based on PSZO302 **PSZO305 (2 Credits):** Climate change and Sustainability	**PSZO306 (2 Credits):** Environmental Technology **AND** **PSZO307 (2 Credits):** Lab exercise based on PSZO306 **OR** **PSZO308 (2 C Credits):** Environmental Journalism **AND** **PSZO309 (2 Credits):** Lab exercise based on PSZO308			Research Project **Credits 4**	22	**PG Degree After 3-Yr UG**
		Sem IV	**PSZO401 (4 Credits):** Environmental pollution: Assessment and control methods **PSZO402 (4 Credits):** Occupational safety and Disaster management-II **PSZO403 (2 Credits):** Lab exercise based on PSZO401 **PSZO404 (2 Credits):** Lab exercise based on PSZO402	**PSZO405 (2 Credits):** The Biodiversity Blueprint: Monitoring and assessment **AND** **PSZO406 (2 Credits):** Lab exercise based on PSZO405 **OR** **PSZO407 (2 Credits):** Environmental Entrepreneurship **AND** **PSZO408 (2 Credits):** Lab exercise based on PSZO407			Research Project **Credits 6**	22	
Cum. Cr. for 1 Yr PG Degree			**26**	**8**			**10**	**44**	
Cum. Cr. for 2 Yr PG Degree			**54**	**16**	**4**	**4**	**10**	**88**	

Note: * The number of courses can vary for totaling 14 Credits for Major Mandatory Courses in a semester as illustrated.

Sem. - III

PSZO301 (4 Credits): Fundamentals of Environmental Sciences
(60 Hrs.)

Objectives:
- To introduce learner to the basic concepts and principles of environmental science
- Introduce learners to methods of biodiversity conservation and acquaint them with wildlife legislation in India.

Desired Outcomes:
- Learner should demonstrate a solid understanding of key environmental concepts, theories, and principles.
- Learner should demonstrate a thorough understanding of stoichiometry, thermodynamics, energy flow models, and energy consumption patterns.
- Learner should acquire practical skills in biodiversity assessment, conservation planning, and implementation of conservation measures and relevant legislation, both nationally and globally.

Unit 1: Basics of Environmental Science (15 Hrs.)

1.1. Definition and scope of Environmental Science

1.2. Structure and composition of atmosphere, Hydrosphere, Lithosphere, Biosphere

1.3. Introduction and Types of natural resources–
- 1.3.1. Forest resources: Introduction to forest resources, Types of forest
- 1.3.2. Water resources: Surface and ground water resources, River network of India
- 1.3.3. Mineral resources: Mineral resources, Mineral Belts in India
- 1.3.4. Food resources: Food sources, Food crops, Live Stock
- 1.3.5. Land resources: Land resources, land use and land cover in India

1.4. Non-conventional energy resources- solar, wind, tidal resources, their pros and cons

1.5. Role of an individual in the conservation of natural resources

Unit 2: Ecology, Ecological interactions, and Ecosystem services (15 Hrs.)

2.1. Ecosystem Structure: Concept, biotic and Abiotic components
2.2. Ecosystem stability and various factors affecting the ecosystem stability
2.3. Basis of Ecosystem classification: Types of Ecosystem: Desert, forest, wetlands, lotic, lentic, estuarine (mangrove), Oceanic
2.4. Biological interactions: Positive and Negative interactions: Mutualism, Proto-cooperation, Commensalism, Competition, Amensalism, Parasitism, Predation, herbivory, altruism
2.5. Biomes– Concept and their characteristics: Tundra, Taiga, Grassland, Deciduous forest biome, Highland Icy Alpine Biome, Savanna, Tropical Rain forest.
2.6. Population ecology– Characteristics, Population structure, Concept of ‘r’ and ‘k’ species, Concept of carrying capacity, Population dispersal (migration, Immigration and emigration)

Unit 3: Energy and Environment (15 Hrs.)

3.1. Concept of Stoichiometry, Thermodynamics: entropy, enthalpy, Gibb’s energy
3.2. Energy flow and Energy flow models- Single Channel, Y-Shaped Model
3.3. Biogeochemical cycles- Gaseous cycles (Carbon, Oxygen, Nitrogen cycle) and Sedimentary cycles – Includes Iron, Sulphur, Phosphorus
3.4. Fossil fuels– Classification, Concept of Gross-calorific value and net-calorific value

3.5. Nuclear energy –Nuclear fuels (U-235, Pu-239), Nuclear reactor – principles and types
3.6. Bioenergy– Concept of biomass, Biomass-based energy production methods, Biofuels
3.7. Energy consumption – Energy use pattern and Emissions of CO_2 in India, Radiative forcing

Unit 4: Biodiversity: Assessment and Conservation (15 Hrs.)

4.1. Levels of Biodiversity– Community diversity (alpha, beta and gamma biodiversity), Concept of Flagship species, key stone species, umbrella species and EDGE species in India

4.2. Biodiversity status– Biodiversity Hotspots-Global versus Indian, Protected Area Network (PAN) in India, Common flora and fauna in India: The Western Ghats of India and Eastern Himalaya

4.3. Methods of biodiversity conservation – *In situ* (National Parks, Sanctuaries, Sacred groves, herbarium) and *Ex situ* (Botanical gardens, Zoological parks, Gene banks, seed banks)

4.4. Biodiversity databases – iNaturalist, AntWeb, Butterflies of India, AviBase, Eschmeyer's Catalog of Fishes, AmphibiaWeb, The Reptile Database, ASM's Mammal Diversity Database

4.5.Wildlife legislations–Indian Wildlife (Protection) Act, 1972, Biological Diversity (Amendment) Act, 2023, Role of CITES, TRAFFIC, NAGOA protocol, CBD, AICHI

PSZO302 (4 Credits): Occupational safety and disaster management-I
(60 Hrs.)

Objectives:
- To provide a basic conceptual understanding of safety and disasters, various approaches to safety management and disaster Management.
- To understand the importance of PPE safety, prepare off-site and on-site plans for occupational safety, and study the usage of AI, GIS, and remote sensing in disaster management.

Desired Outcomes:
- Learners will be able to understand the concepts and approaches of safety management and disaster Management.
- Learners will be able to explain the importance of PPE in safety and will be able to prepare SOPs for safety and Disaster Management Plans.
- Trained learners with the help of AI, GIS and Remote sensing will be able to assist disaster management in reducing disaster risk.

Unit 1: Introduction to Occupational Safety (15 Hrs.)

1.1. Understanding Safety and Its Significance–

1.1.1 Definition and concept of occupational safety, Importance of occupational safety

1.1.2. Historical context and evolution of occupational safety regulations

1.1.3. Safety psychology: Understanding human behaviour and its impact on safety practices

1.2. Accident Causation and Prevention–

1.2.1. Causes and problems of accident

1.2.2. Reasons for accident prevention: Ethical, legal, and economic considerations

1.2.3. Accident prevention strategies

1.3. Regulatory Agencies and Enforcing Safety Standards–

1.3.1. International regulatory agencies: ACGIH, OSHA

1.3.2. National regulatory agencies

1.3.3.Roles and responsibilities in ensuring occupational safety

1.3.4. Guide to health and safety signs in the workplace. GHS pictogram for safety

Unit 2: Safety Management (15 Hrs.)

2.1. Fundamentals of Safety Management–

2.1.1. Concept and its significance, element of effective safety management

2.1.2. Functions and principles, Role and responsibilities in safety management

2.1.3. Organisational structure for safety management

2.2. Hazardous Materials Management–

2.2.1. Safety precautions for transportation of hazardous chemicals

2.2.2. Safety audit in the chemical industry and other high-risk sectors

2.2.3. Handling and storage of hazardous chemicals: Best practices

2.2.4. Safety in pipelines and colour coding for hazard identification

2.3. Personal Protective Equipment (PPE) –

2.3.1. Respiratory personal protective equipment (RPPE) and non-respiratory personal protection equipment (NRPPE): head protection, ear protection, face and eye protection, hand protection, foot protection and body protection.

2.4. Quality Control and Sustainability–

2.4.1. Quality control measures for protective equipment

2.4.2. Maintenance of PPE

2.4.3. Environmental considerations in PPE design and disposal

2.4.4. Recycling and reuse of PPE components

Unit 3: Introduction to Disaster and Environmental Implications (15 Hrs.)

3.1. Introduction and classification to Disasters –

3.1.1. Definition and concept, Nature, causes, and impacts of disasters

3.1.2. Occurrences and patterns of disasters globally and locally

3.1.3. Hazards and disasters: Understanding the relationship

3.1.4. Environmental implications of different types of disasters

3.2. Natural Disasters and Environmental Consequences – Earthquakes, floods, drought, forest fire, landside and land subsidence, cyclones and hurricanes, volcanoes, tsunami, avalanches, global climate extremes and their mitigation

3.3. Human-induced disasters and Environmental degradation–War, gas and radiation leaks, toxic waste disposal, oil spills, forest fires.

3.4. Industrial and Technological Hazards –

3.4.1. Types and causes of industrial accidents: fire and explosion hazards

3.4.2. Toxic release and dispersion: Effects on air, water, and soil

Unit 4: Disaster Management (15 Hrs.)

4.1. Introduction to Disaster Management **–**

4.1.1. Meaning, nature and importance of disaster management

4.1.2. Dimensions and Scope of Disaster Management

4.2. Disaster Management Planning:

4.2.1. Components of disaster management plan

4.2.2. On-site and off-site emergency plans

4.2.3. Integration of environmental considerations in disaster management planning

4.3. Hazard Control and Assessment Techniques **–**

4.3.1. Technical hazards control system

4.3.2. Incident reduction strategies, incident management techniques

4.3.3. Hazard assessment methodologies: PHA, HAZOP, HAZAN, MCAA

4.4. Advanced Technologies in Disaster Management **–** Usages of AI, GIS and Remote sensing techniques in disaster management.

PSZO303 (2 Credits): Lab exercise based on PSZO301
(30 Hrs.)

Practical 1: Comparative study of a suitable animal/plant community by using line, belt and profile transects.
Practical 2: Prepare a map of India showing various bio-geographical zones.
Practical 3: Prepare a map of Maharashtra showing PAN for Tiger, Giant squirrel, and Indian pangolin.
Practical 4: Measurement of species diversity and calculation of diversity indices from data collected on insects/birds/plant species in your college campus or nearby gardens.
Practical 5: Study phytoplankton (identification) and zooplankton (performing) from the water sample
Practical 6: To measure primary productivity using the Light and Dark bottle method.
Practical 7: To search the taxonomic history of fish species using the biodiversity Catalog of fishes.
Practical 8: Study the geographic distribution of Bauxite, Gold, Iron, and Diamond deposits in India.
Practical 9: To visit the nearby butterfly garden and document the host plants.
Practical 10: Visit the Seed bank/national park/botanical garden/zoo and make a report on it with special emphasis on species diversity inhabiting there.

PSZO304 (2 Credits): Lab exercise based on PSZO302
(30 Hrs.)

Practical 1: Preparation of Material Safety Data Sheet for some common chemicals.
Practical 2: To neutralise the given samples/chemicals using NaOH / HCl/ $CaCO_3$
Practical 3: Determination of CO_2 from the atmosphere by volumetric method in a workplace.
Practical 4: Estimation of Sulphur in coal and calculation of release of SO_2 on combustion per ton of coal.
Practical 5: Enlisting the characteristics, advantages and disadvantages of PPE and NRPPE of any industry.
Practical 6: Identify and describe various safety symbols.
Practical 7: Environment SOP for fire safety, Electrical shock.
Practical 8: Visit the safety department/fire station.

PSZO305 (2 Credits): Climate change and Sustainability
(30 Hrs.)

Objectives:
- To equip the learner with concepts and principles of climate change, mitigation strategies and policies to overcome this global issue.
- To make learner aware of the social, economic, and environmental dimensions of sustainable development

Desired Outcomes:
- Learner should comprehend climate change as a significant global problem and think of possible solutions to it.
- Learner should communicate effectively about the climate change crisis and its sustainable solutions locally and globally.

Unit 1: Introduction to Climate Change (15 Hrs.)

1.1. Basics of climate science **–** Definition, History and reasons behind climate change

1.2. Understanding global warming **–**
- 1.2.1. Human interference and climate change
- 1.2.2. Green House effect, Ozone layer depletion, Warmer oceans and Melting ice (Sea level rise)
- 1.2.3. Impact on polar regions, extreme weather conditions (Droughts, floods and cyclones)

1.3. Impact of climate change **–** On Ecosystem and Biodiversity, On public health, Agriculture, and Food Security

1.4. Climate Change and mitigation strategies for sustainable use of resources **–**
- 1.4.1. Renewable energy resources: Solar power, Wind power, hydroelectric and tidal energy
- 1.4.2. Mitigation strategies for droughts, floods and Cyclones in coastal areas
- 1.4.3. Carbon Sequestration, Carbon Credits and carbon finance

Unit 2: Global Climate Policy Network and Sustainability (15 Hrs.)

2.1. Policies, agreements and Treaties **–** United Nations Framework Convention on Climate Change (UNFCCC), The Paris Agreement, Conference of Parties (COP), Climate Policies in India- National Action Plan on Climate Change (NAPCC)

2.2. Climate Change Adaptation Strategies **–** Green buildings, Smart agriculture, Green industries

2.3. Awareness about climate change: Role of youths, educational institutes and NGOs

2.4. Sustainable Development: Definition, Principles and UN- Sustainable Development Goals (SDGs)

2.5. Sustainable Development in Practice **–** Sustainable agriculture, Sustainable cities, Sustainable transportation and infrastructure, Circular Economy

ELECTIVE COURSES

PSZO306 (2 Credits): Environmental Technology
(30 Hrs.)

Objectives:
- Learner should comprehend the principles and processes involved in making water resources safe in terms of human use and environment.
- Learner should explore various methods for removing pollutants and the process and importance of biodegradation and bioremediation.

Desired Outcomes:
- Learners should demonstrate the effective use, efficacy, and limitations of various technologies in different water treatment contexts used in environmental management.
- Learner should demonstrate a thorough understanding of nanoparticles and their applications in handling environmental problems.

Unit 1: Wastewater Treatment Technology (15 Hrs.)

1.1. Design and operation of Drinking Water Treatment Plant (DWP), Effluent Treatment Plant (ETP), Sewage Treatment Plant (STP)

1.2. Methods of water treatment **–**
- 1.2.1. Use of activated sludge, biofilters
- 1.2.2. Membrane Processes **–** Ultrafiltration, Electrocoagulation, Electrodialysis

1.3. Techniques for removal of pollutants:
- 1.3.1. Arsenic **–** Oxidation/ Reduction, Coagulation and Precipitation
- 1.3.2. Fluoride **–** Adsorption/Ion exchange, Reverse Osmosis (RO), Nano-filtration (NF)
- 1.3.3. Nitrate **–** Biological denitrification, Catalytic reduction, Electrodialysis, Blending
- 1.3.4. Health impacts of arsenic, fluorides and nitrates

1.4. Techniques for removal of salinity from water **–** Membrane processes, Reverse osmosis, Multi Stage Flash (MSF) desalination, Solar Humidification

Unit 2: Soil, Air Technology and Environmental Nanotechnology (15 Hrs.)

2.1. Soil Contaminants: Inorganic and Organic, Health Hazards of Contaminants

2.2. Bioremediation of Contaminated Sites **–** bioaugmentation, bio-stimulation, Phytoremediation

2.3. Biodegradation and Bioremediation **–** Principles, microbial degradation pathways, Applications of bioremediation in soil, water, and air pollution control

2.4. Air Pollution Control Technologies **–**
- 2.4.1. Indoor air quality assessment and carbon capture utilisation and storage
- 2.4.2. Green House gases separation and Different types of cycles for CO_2 Adsorption

2.5. Nanotechnology in Environmental Biotechnology**–**
- 2.5.1. Overview of nanotechnology and nanomaterials
- 2.5.2. Nanotechnology applications of nanomaterials for pollutant removal
- 2.5.3. Nanomaterials for pollutant capture and removal- Nanofibers and Nanowires, Metal-Organic Frameworks (MOFs), nanocomposites of metal oxides (e.g., TiO_2, Fe_2O_3)
- 2.5.4. Environmental implications and safety considerations of nanobiotechnology

PSZO307 (2 Credits): Lab exercise based on PSZO306
(30 Hrs.)

Practical 1: Construction of Solar Oxidation and Removal of Arsenic (SORAS) analysis of Arsenic
Practical 2: Construct Eawag fluoride removal by Bone Char.
Practical 3: Illustrate and describe the ETP, STP, and DWT plants.
Practical 4: Quantitative estimation of Heavy metals (Zinc, Arsenic, Lead, Mercury) from suitable fish tissue/ water /soil/plant parts using a suitable method.
Practical 5: Synthesis of activated Nano-carbon for absorption of organic/ inorganic contaminants
Practical 6: Identification and culture of Plants used in bioremediation.
Practical 7: Isolation and characterisation of microorganisms from contaminated sites for bioremediation studies.
Practical 8: Determination of Nitrates from water
Practical 9: Determination of Phosphates from water
Practical 10: Case studies of successful bioremediation projects.
Practical 11: Field Visit to DTP, STP, ETP and report submission

PSZO308 (2 Credits): Environmental Journalism
(30 Hrs.)

Objectives:

- Learner should understand the concept of journalism in general and environmental journalism in particular.
- Learner should understand the methodology of environmental journalism and should address complex environmental issues and challenges through journalism.
- Learner should be able to promote awareness about environmental issues amongst the public.

Desired Outcomes:

- Learner will be familiar with the development coverage of environmental news in media.
- Learner will be able to analyse the current environmental issues and scientific reporting of those issues through appropriate media.
- Learner will understand the importance of print media, social media and digital media communication in environmental management.

Unit 1: Introduction to Environmental Journalism (15 Hrs.)

1.1. Basics of Journalism**–**

1.1.1. Definition, concept, process, and elements of communication through journalism.

1.1.2. Role, scope and need of communication in society

1.2. Understanding Environmental Journalism**–**

1.2.1. Definition, Nature and Functions of Environmental Communication

1.2.2. Natural resources and associated problems, Major Environmental Issues and strategies

1.3. Public understanding of major environmental issues**–** Biodiversity conservation, Pollution, Climate Change, Solid waste management etc.

1.4. Need for Public Awareness about Environmental Issues such as air pollution, Climate change, Deforestation, Plastic pollution, Water crisis, public health, Agriculture and Food Security in India

1.5. Role of Governmental and Non-Governmental Bodies in environmental protection **–** MoEF, Biodiversity Boards, Pollution Control Boards, National Green Tribunals, NGOs, WWF, CEE

Unit 2: Techniques and Methods in Environmental Journalism (15 Hrs.)

1.1. Planning Environmental Communication Campaign **–** Selection of environmental issue, Audience analysis and message Development for Environmental Communication.

1.2. Characteristics of Effective Messages for print media **–** Developing Posters, Brochures, Pamphlets, Press Releases, articles, cover stories, interviews.

1.3. Types of Electronic Media Planning and Selection **–** Characteristics of Mass Media

1.4. Reporting Environmental Issues:

1.4.1. Through Social media: YouTube, WhatsApp, Instagram, Facebook, Blogs etc.

1.4.2. Through Radio and Television, Other online platforms

1.4.3. Basics of photography and video making for journalism

1.4.4. Role of documentary movies in environmental journalism

1.5. Responsibilities, Ethics and code of conduct for environmental journalists

PSZO309 (2 Credits): Lab exercise based on PSZO308
(30 Hrs.)

Practical 1. Develop a questionnaire in Google form format based on local environmental issues and survey at least 100 stakeholders.

Practical 2. Write a newspaper article on solid waste management/ water pollution or crisis/ climate change/ industrial pollution.

Practical 3. Write news on local environmental issues or initiatives taken by local NGOs

Practical 4. Take at least 20 photos (Geo-tagged) related to environmental issues and give them appropriate captions.

Practical 5. Generate awareness amongst your college students through Posters, Brochures, Pamphlets, Press Releases (Either two of these)

Practical 6. Create a YouTube channel and develop a minimum of five documentaries/small videos on local or global environmental issues using free mobile applications.

Practical 7. Create a PowerPoint presentation on issues like climate change, waste management, international environment policies, etc.

PSZO310 (4 Credits): Research Project
(60 Hrs.)

Guidelines for the research project:

1. The Project 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 project must be typed using a computer and printed for binding.
3. No minimum or maximum limit on 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 mentor may be reflected on the first page of the project, along with the student's names.
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 an individual PowerPoint presentation (PPT) on the project and present it to examiners at the time of examination.
7. The project will be prepared individually by students.

Sem. - IV

Syllabus
M.Sc. (Environmental Science)
(Sem.- IV)
PSZO401 (4 Credits): Environmental Pollution: Assessment and Control methods
(60 Hrs.)

Objectives:

- To familiarise learner with the key pollutants associated with each type of pollution and the potential impacts on human health and the environment.
- To introduce learner to various analytical methods used in pollution assessment, including gravimetric, volumetric, electrochemical, spectroscopic, and chromatographic techniques.
- Learner should be able to analyse and interpret environmental data to make informed decisions and recommendations for pollution control and management.

Desired Outcomes:

- Learner will develop a comprehensive understanding of various types of pollution and their possible impacts on humans.
- Learner will gain proficiency in various analytical methods used in pollution assessment, including gravimetric, volumetric, electrochemical, spectroscopic, and chromatographic techniques.
- Learner will Acquire practical skills in sample collection, preparation, analysis, and interpretation of environmental data using statistical methods and visualisation tools.

Unit 1: Fundamentals of Environmental Pollution (15 Hrs.)

1.1. Overview of pollution, types of pollutants **–** Primary and secondary pollutants

1.2. Air Pollution **–** Sources, air pollutants, (particulate matter, SOx, NOx, PAN, carbon monoxide) and mitigation methods (scrubbers, filters, catalytic converters)

1.3. Water Pollution **–** Sources (point, non-point), water pollutants (organic, inorganic, heavy metals, pathogens), Best practices for reducing water pollution (riparian buffers, stormwater management)

1.4. Soil pollution **–** Sources (industrial waste, agricultural runoff, landfill leachate), soil pollutants (pesticides, heavy metals, hydrocarbons) and their mitigation using bioremediation

1.5. Noise and Radioactive pollution: Sources, impacts, and mitigation methods

1.6. Emerging pollutants **–**

1.6.1. Microplastics- Definition, sources, potential impacts on human and animal health

1.6.2. Pharmaceuticals and Personal Care Products (PPCPs)- Introduction to PPCPs, Commonly used PPCPs (Phthalates, Triclosan, Metoprolol, 17β-Estradiol) and their impact on humans

Unit 2: Regulatory bodies and basics of pollution assessment (15 Hrs.)

2.1. Pollution control boards and key environmental laws **–**

2.1.1. Environmental Protection Agency (EPA), Central Pollution Control Board (CPCB), State Pollution Control Board (SPCB), Air (Prevention and Control of Pollution) Act, 1981, Water (Prevention and Control of Pollution) Act, 1974, Plastic Waste Management (Amendment) Rules, 2022

2.2. Overview of pollution assessment and its importance **–**

2.2.1. Basic concepts in analytical chemistry (precision, accuracy, calibration)

2.2.2. Sampling and sample preparation for air, water, and soil (fixation, extraction, digestion)
2.2.4. Best practices for sample handling and storage

2.3. Importance of quality control in analytical methods

2.4. Best practices for ensuring data quality and accuracy in sample analysis

Unit 3: Analytical Methods in Pollution Assessment-I (15 Hrs.)

3.1. Gravimetric and Volumetric Techniques **–**
3.1.1. Measuring particulate matter in air and water
3.1.2. Volumetric analysis (titration) for determining concentrations of pollutants

3.2. Electrochemical techniques **–** Introduction and applications of potentiometry, voltammetry, and flame photometry in pollution assessment (pH measurement, metal detection)

3.3. Spectroscopic techniques **–** Analysing heavy metals, microplastics, and organic compounds
using UV-visible spectroscopy, FTIR spectroscopy, Atomic Absorption Spectroscopy, Inductive coupled plasma atomic emission spectroscopy (ICP-AES)

3.4. Chromatography techniques **–** Analysing organic pollutants and pesticides using GC and HPLC

Unit 4: Analytical Methods in Pollution Assessment-II (15 Hrs.)

4.1. Advanced Techniques for Pollution Assessment **–** Principles and applications of GC-MS, X-ray fluorescence, Raman spectroscopy, SEM- EDX in the assessment of heavy metals, polymers and complex organic compounds

4.2. Basic of analysing environmental data **–**
4.2.1. Criteria for deciding the appropriate test for data analysis- normality testing
4.2.2. Calculating descriptive statistics parameters using Microsoft EXCEL or PAST
4.2.3. Visualising data using appropriate softwares

4.3. Analysis of environmental data **–**
4.3.1. Data reqirements for two sample tests **–** t-test, Chi-square test, Mann-Whitney Test
4.3.2. Data reqirements for multiple sample tests **–** One-way ANOVA, Kruskal-Wallis Test
4.3.3. Understanding inter-relationships between environmental datasets using Correlation analysis, Classical Hierarchical clustering

PSZO402 (4 Credits): Occupational Safety and Disaster Management-II
(60 Hrs.)

Objectives:

- Learner should gain knowledge of Laws and Acts in safety and disaster management.
- To train learners in risk assessment, vulnerability analysis, responding to disasters, and preparedness measures for disasters.
- To orient learners about disaster response techniques and educate learners about disaster response organisations and post-disaster issues in recovery and rehabilitation.

Desired Outcomes:

- Learners will be able to identify vulnerable regions and calculate the risk associated with the disaster.
- Learners will be able to prepare a structured preparedness plan that will help reduce the risk associated with disasters.
- Trained learners can act as first respondents, handle on-site situations, and carry out pre-and post-disaster damage assessments.

Unit 1: Laws and Acts for Safety and Disaster Management (15 Hrs.)

1.1. Need for safety, Safety legislation: Acts and rules
1.2. The Factory Act, 1948
1.3. Safety standards and codes
1.4. Safety policy: safety organisation and responsibilities and authorities of different levels
1.5. Disaster Management Act 2005
1.6. The Dock Workers (Safety, Health & Welfare) Act, (16th February 1990).

Unit 2: Disaster Risk and Vulnerability Analysis (15 Hrs.)

2.1. Understanding Disaster Risk and Risk Reduction Strategies **–**
- 2.1.1. Concept of risk and its multidimensional nature
- 2.1.2. Analysis of disaster risks: Methodologies and approaches
- 2.1.3. Role of science and technology in Disaster Risk Reduction
- 2.1.4. Strategies for risk reduction

2.2. Risk Assessment Techniques and Decision Support Systems **–**
- 2.2.1. Process of risk assessment
- 2.2.2. Natural hazards and risk assessment, Understanding climate risk
- 2.2.3. Mapping of risk assessment
- 2.2.4. Decision-making for risk reduction
- 2.2.5. Challenges and limitations in risk assessment

2.3. Vulnerability Analysis **–**
- 2.3.1. Observation and perception of vulnerability
- 2.3.2. Vulnerability Identification, Types and dimensions of vulnerability: Social, economic, environmental
- 2.3.3. Risks in urban areas: Challenges and opportunities for urban planning
- 2.3.4. Initiatives for risk reduction and vulnerability reduction in India

2.4. Strategic Development for Vulnerability Reduction –
- 2.4.1. Physical and Social Infrastructure for Vulnerability reduction, Interactive areas for Vulnerability reduction and Policymaking
- 2.4.2. Hazard-resistant designs and construction, System management and strategic planning for vulnerability reduction

Unit 3: Disaster Preparedness and Response Preparedness (15 Hrs.)

3.1. Disaster Preparedness and Proactive Measures **–**

- 3.1.1. Disaster Preparedness Plan, Prediction and early warning systems
- 3.1.2. Safety measures and community preparedness
- 3.1.3. Role of Information, Education, Communication, and Training
- 3.1.4. Involvement of government agencies, international bodies, and NGOs

3.2. Disaster Response **–**

- 3.2.1. Introduction, Disaster Response Plan
- 3.2.2. Communication strategies and stakeholder participation, Activation of Emergency Preparedness Plan, Search, Rescue and Evacuation operations
- 3.2.3. Psychological Response and Management (Trauma, Stress, Rumor and Panic).
- 3.2.4. Relief and Recovery efforts. Medical Health Response to different types of disasters

3.3. Multi-stakeholder Collaboration in Disaster Response **–**

- 3.3.1. NDRF, SDRF, ITBP, CRPF, SRPF, EMS
- 3.3.2. Coordinating efforts and resource sharing among stakeholders

Unit 4: Rehabilitation, Reconstruction and Recovery (15 Hrs.)

4.1. Rehabilitation and Disaster Mitigation **–**

- 4.1.1. Concept and Meaning, Types of Rehabilitation and Reconstruction Efforts
- 4.1.2. Importance of disaster mitigation strategies

4.2. Role of Different organisation in Rehabilitation **–**

- 4.2.1. Role of government agencies, Non-governmental organisations and their contributions
- 4.2.2. Role of Local Institutions and Community Involvement
- 4.2.3. Roles of insurance companies, law enforcement, and media

4.3. Speedy Reconstructions **–**

- 4.3.1. Restoring essential services and social infrastructure, immediate shelters/camps establishment, Contingency plans for reconstruction efforts
- 4.3.2. Developing physical and economic infrastructure, Environmental infrastructure development and ecosystem restoration

4.4 Funding and Resource Mobilisation **–**

- 4.4.1. Funding arrangements at the state level and central level, Fiscal discipline
- 4.4.2. Role of international agencies and organisations, Mobilisation of community for resource generation, Public-private partnerships for resource generation

PSZO403 (2 Credits): Lab exercise based on PSZO401
(30 Hrs.)

Practical 1. Comparative assessment of various water quality parameters (pH, Temperature, TDS, salinity) between polluted versus non-polluted water bodies using multi-parameter probe.
Practical 2. To measure the redox potential of the lake or pond water using ORP meter.
Practical 3. Determination of Total Suspended Solids (TSS) and Total Dissolved Solids (TDS) of wastewater sample using gravimetric method.
Practical 4: Determination of sodium and potassium in a water sample by flame photometer.
Practical 5. Determining the chloride content in a given water sample using Mohr's method.
Practical 6. Determination of turbidity of a water sample using a Nephelometer.
Practical 7. Traffic noise monitoring using a sound level meter.
Practical 8. To check the regional air quality using free Apps and submit a report.
Practical 9. Identify the polymers using OpenSpecy free databases for FTIR.
Practical 10. Calculating descriptive statistics parameters using EXCEL or PAST.
Practical 11. Perform two-sample (T-test) and multiple-sample tests (ANOVA) using PAST software.

PSZO404 (2 Credits): Lab exercise based on PSZO402
(30 Hrs.)

Practical 1: Preparation of safety management plan for laboratory/institute.
Practical 2: Preparation of risk assessment chart for microbiology laboratory.
Practical 3: Identifying types and hands-on training of fire extinguishers.
Practical 4: Preparation of DMP for nuclear power plant, petrochemical industry, fertiliser plant, hydropower station, chemical industry, thermal power plant, textile mill, metallurgical industry.
Practical 5: Case studies: Chernobyl Nuclear Disaster, Bhopal Gas Tragedy, COVID-19, Uttarakhand Flash Floods, 2013, The Indian Ocean Tsunami 2004, Gujarat Earthquake, 2001
Practical 6: Study of Seismic Zones in India
Practical 7: Study and Interpretation of Weather Forecasting.
Practical 8: Basic First Aid Training

ELECTIVE COURSES

PSZO405 (2 Credits): The Biodiversity Blueprint: Monitoring and Assessment (30 Hrs.)

Objectives:
- Learner should be able to apply knowledge of biodiversity monitoring and assessment to support conservation efforts.
- To train the learner in critical analysis and interpretation of biodiversity data to develop effective conservation strategies and identify priority areas and species for conservation.
- Learner should be able to communicate effectively with diverse stakeholders to promote biodiversity conservation and sustainable practices.

Desired Outcomes:
- Learner will apply the gained knowledge for biodiversity monitoring and assessment to support conservation efforts.
- The learner will be able to interpret the biodiversity data to develop effective conservation strategies accurately.
- Learner will be able to promote the importance of biodiversity conservation sustainable practices to policymakers, local communities, and conservation organisations,

Unit 1: Biodiversity Blueprint and Monitoring Strategies (15 Hrs.)

1.1. Introduction to the Biodiversity Blueprint **–** Definition, Rationale and Goals of the Biodiversity Blueprint

1.2. Introduction to Biodiversity Monitoring **–**

1.2.1. Definition, importance, objectives, goals and scaling (local, regional, global)

1.2.2. Overview of Monitoring Techniques:

- ✓ Species inventories and surveys (Terrestrial, e.g., quadrats, transects, point counts; Aquatic, e.g., electrofishing, benthic sampling)
- ✓ Habitat assessments: Vegetation mapping, Remote sensing and geospatial technologies
- ✓ Ecosystem function monitoring: Productivity measurements, Nutrient cycling
- ✓ Citizen science and community-based monitoring

1.3. New technologies in monitoring: drones, artificial intelligence, and environmental DNA

1.4. Monitoring Program Design: Selecting appropriate indicators and metrics, Sampling strategies and protocols, Data collection, management, and quality control

Unit 2: Biodiversity Assessment and Implementation Challenges (15 Hrs.)

2.1. Introduction to Biodiversity Assessment**–**

2.1.1. Definition, importance of biodiversity assessment

2.1.2. Objectives and goals of assessment programs

2.2. Biodiversity Assessment Techniques**–**

2.2.1. Species richness and diversity indices

2.2.2. Habitat quality assessment, Ecosystem integrity assessment, Threat and vulnerability Assessments

2.3. Data Analysis and Interpretation**–**

2.3.1. Statistical methods for biodiversity data analysis

2.3.2. Spatial analysis and modelling using GIS

2.3.3. Indicators and indices for biodiversity assessment

2.4. Challenges and Opportunities in Implementing the Biodiversity Blueprint

2.4.1. Funding and resource constraints, Capacity building and training

2.4.2. Data management and sharing, Stakeholder engagement and communication, Policy implications and decision-making

PSZO406 (2 Credits): Lab exercise based on PSZO405
(30 Hrs.)

Practical 1: Conduct species inventories and surveys in local ecosystems (forests, wetlands, streams)
Practical 2: Collect and record data using appropriate field data sheets and protocols.
Practical 3: Develop a biodiversity monitoring plan for a specific ecosystem or study area.
Practical 4: Enter and organise field data using spreadsheets or databases.
Practical 5: Using real-world data, calculate and interpret various biodiversity indices (e.g., Shannon-Wiener, Simpson's).
Practical 6: Conduct habitat quality assessments using standardised protocols.
Practical 7: Group project: Designing a biodiversity monitoring plan for a specific ecosystem or study area, including selecting appropriate indicators, sampling strategies, and data management protocols.

PSZO407 (2 Credits): Environmental Entrepreneurship (30 Hrs.)

Objectives:
- Learners should be able to understand the principles of environmental entrepreneurship and its role in addressing environmental sustainability challenges.
- Learner should identify opportunities for sustainable innovation and business development in various environmental sectors.
- Learner should develop skills in business planning, market research, financial analysis, and project management for environmental ventures.

Desired Outcomes:
- Learner will understand various steps in environmental startups.
- Learner will develop a comprehensive business plan for an environmental venture, incorporating elements such as market analysis, financial projections, sustainability goals, and social impact assessment.
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Unit 1: Understanding Environmental Entrepreneurship (10 Hrs.)

Types of businesses
1.1. Solid waste management:
1.1.1 Production of Bio fertilizers: From green waste, kitchen waste at source, municipal waste, apartment level segregation and treatment.
1.1.2 Solar Panel: Installation and power generation at individual house, apartment, commercials, street, industries, municipal level
1.1.3 Rainwater harvesting: Installation at individual house, apartment, educational institute, commercials
1.1.4 Bioremediation, industrial waste briquette (white coal), textile waste, e-waste, cycling stations, Electric vehicle (EV) charging stations, Kitchen gardening,
1.1.5 Eco-friendly products, organic products harvesting and store, Reused articles store, such as toys, utensils, decorative items etc., refurbish furniture, refurbish electronics, green catering, community fridge,
1.1.6. Recycling units: Collection and recycling of paper, plastic, metal, rubber and their products, green apps and software

Unit 2: Consultancy services, Funding and Schemes (05 Hrs.)

2.1. Consultancy services:
2.1.1. Environment Impact assessment (EIA), Green audit, water audit, environmental audit, carbon footprint, Green business consultant, green infopreneur, Green laws – legal firm,
2.2. Funding and schemes:
2.2.1. Government (state and central) schemes
2.2.2 Funding agencies, CSR funds
2.2.3 Startups, social entrepreneurship

PSZO408 (2 Credits): Lab exercise based on PSZO407
(30 Hrs.)

Practical 1: Set up bio fertilizer unit at institute level.
Practical 2: Survey at Municipal Corporation for segregation and disposal methods.
Practical 3: Survey of different bio composting methods at house, apartment and offices.
Practical 4: Visit to nearby solar panel installed unit and submit a report.
Practical 5: Prepare a model/project of rainwater harvesting.
Practical 6: Display eco-friendly articles and different types of waste and comment on its method of segregation, reuse, disposal and recycling.
Practical 7: Visit agencies working on green concepts and make a report.
Practical 8: Prepare a report on Government and non-government agencies schemes, subsidies, funding and documentation to apply for the sanction of the project.

PSZO409 (6 Credits): Research Projects
(90 Hrs.)

Guidelines for the research project:

1. The Project 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 project must be typed using a computer and printed for binding.
3. No minimum or maximum limit on 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 mentor may be reflected on the first page of the project, along with the student's names.
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 an individual PowerPoint presentation (PPT) on the project and present it to examiners at the time of examination.
7. The project will be prepared individually by students.

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- Entrepreneurship in Renewable Energy Technologies, Manoj Kumar Ghosal, CRC Press, 24 Nov 2022 - Science - 684 pages, ISBN 1000799700, 9781000799705
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PSZO406 and PSZO408:

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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 and8 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

2) 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 CO_2 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 (Environmental Science) Semester-III
PSZO303
Laboratory exercises based on Fundamentals of Environmental Sciences

(Time: 10.00 am - 2.00 pm)

Total Marks: 25 **Duration: 4 hours**

Q. 1)	Estimate the primary productivity using the Light and Dark bottle method. **OR** Prepare the temporary slide and identify the phytoplankton and zooplankton from the water sample (at least three). **OR** Measurement of species diversity and calculation of diversity indices (any three) from given data.	**(12 M)**
Q. 2)	Prepare a map of India showing various bio-geographical zones. **OR** Prepare a map of Maharashtra showing PAN for Tiger and Giant squirrel or Indian pangolin.	**(08 M)**
Q. 3)	Viva-voce based on theory and practical	**03**
Q. 4)	Certified Journal (mandatory for practical examination)	**02**

Internal examination ---------- (Total marks 25)

Q. 1) Visit a nearby butterfly or suitable garden to document the diversity of butterflies or insects. While gathering data, students should employ various biodiversity assessment methods, such as line, belt, and profile transects. Alternatively, visit a seed bank, national park, botanical garden, or zoo and create a report focusing on the species diversity present. Students may be evaluated through comprehensive report submissions, PowerPoint presentations, or poster presentations of the collected data having description of methods, calculations and results **(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 (Environmental Science) Semester-III
PSZO304
Laboratory exercises based on Occupational safety and Disaster management-I

(Time: 10.00 am - 2.00 pm)

Total Marks: 25 **Duration: 4 hours**

Q. 1)	Neutralize the given samples/chemicals using NaOH/HCl/ $CaCO_3$ **OR** Determine CO_2 from the atmosphere by volumetric method in a workplace. **OR** Estimate the Sulphur in coal and calculate the release of SO_2 on combustion per ton of coal.	**(10 M)**
Q. 2)	Identify and describe a) Safety symbol b) Safety symbol c) Safety symbol c) PPE/NRPPE	**(08 M)**
Q. 3)	Visit report on the safety department/fire station & viva-voce based on it.	**(05 M)**
Q. 4)	Certified Journal (mandatory for practical examination)	**(02 M)**

Internal examination ---------- (Total marks 25)

Q. 1) Students are encouraged to actively engage in visits to local safety departments or fire stations, as well as participate in various safety and disaster management programs organized by colleges and nearby institutes. They may undergo training in first aid and civil defense, lasting from a few days to several weeks. Additionally, students can conduct a brief survey of the college campus to identify areas that may require safety management and report their findings to the department or college through the proper format and channels. **(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 (Environmental Science) Semester-III
PSZO307
Laboratory exercises based on Occupational safety and Disaster management-I

(Time: 10.00 am - 2.00 pm)

Total Marks: 25 **Duration: 4 hours**

Q. 1)	Perform the quantitative estimation of Heavy metal (Zinc/Arsenic /Lead/Mercury) from given sample (fish tissue/ water/ soil/ plant parts) using a suitable method.	**(10 M)**
Q. 2)	Determine the Nitrates from given water sample using suitable method **OR** Determine the phosphate from given water sample using suitable method	**(08 M)**
Q. 3)	Visit report on the DTP/ STP/ ETP and viva-voce based on it.	**(05 M)**
Q. 4)	Certified Journal (mandatory for practical examination)	**(02 M)**

Internal examination ---------- (Total marks 25)

Q. 1) Students can be organized into groups to engage in activities such as building a SORAS system for arsenic removal from water, constructing a fluoride removal system using bone char, synthesizing activated nano-carbon in the lab, cultivating plants for bioremediation and monitoring their growth in contaminated environments, collecting samples from contaminated sites, and isolating and characterizing microorganisms to assess their bioremediation potential. Additionally, students can research and present case studies of successful bioremediation projects. They can be evaluated based on detailed reports of their construction processes, experimental procedures, and results, as well as through presentations (PowerPoint or posters) summarizing their research findings and case studies. Practical demonstrations of the systems and materials they constructed or synthesized can also be part of the assessment. **(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 (Environmental Science) Semester-III
PSZO309
Laboratory exercises based on Occupational safety and Disaster management-I

(Time: 10.00 am - 2.00 pm)

Total Marks: 25 **Duration: 4 hours**

Q. 1)	Develop a questionnaire in Google form format based on environmental issue provided by the examiner. **OR** Write a newspaper article/News on the topic provided by examiner.	**(09 M)**
Q. 2)	Prepare the poster/brochure/pamphlet on the topic provided by the examiners. **OR** Create your YouTube channel and upload any one video on your channel. (Do not make it publicly available)	**(09 M)**
Q. 3)	Survey report of on local environmental issues based on the questionnaire and viva-voce based on it.	**(05 M)**
Q. 4)	Certified Journal (mandatory for practical examination)	**(02 M)**

Internal examination ---------- (Total marks 25)

Q. 1) Students should to take at least 20 geo-tagged photos related to environmental issues. They can be assessed using criterions such as number of photos submitted (Ensure at least 20 geo-tagged photos are submitted), relevance (each photo should clearly depict an environmental issue), and captions (Evaluate the appropriateness and informativeness of the captions). **(10 Marks)**

Q. 2) Ask the students to create their own YouTube Channel. Develop and upload a minimum of five documentaries or small videos on local or global environmental issues using free mobile applications. Evaluate the videos considering relevance, accuracy, and depth of the environmental issues discussed and technical quality such as clarity, editing, and overall production quality of the videos. OR Students can create a comprehensive PowerPoint presentation on topics such as climate change, waste management, international environmental policies, etc. Students should present their findings, photos, videos, and PowerPoint presentations through oral presentations, allowing for interaction and feedback. Evaluate the students based on content, Depth and accuracy of information on the chosen environmental issue, organization of PPT, visuals and delivery of the presentation. **(10 marks)**

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

SKELETON QUESTION PAPER FOR PRACTICAL EXAMINATION
UNIVERSITY OF MUMBAI

M.Sc. Zoology (Environmental Science) Semester - IV
PSZO403
Lab exercise based on Environmental Pollution: Assessment and Control Methods
(Time: 10.00 am - 2.00 pm)

Total Marks: 25 **Duration: 4 hours**

Q.1	Perform the comparative assessment of water quality parameters (pH, temperature, salinity) using multi-parameter probe (Three samples). **OR** Determine Total Suspended Solids (TSS) and Total Dissolved Solids (TDS) of wastewater sample using gravimetric method. **OR** Determine sodium and potassium in a water sample by flame photometer. **OR** Perform two-sample (T-test)/ multiple-sample tests (ANOVA) using PAST software.	**(8 M)**
Q.2	Measure the redox potential of the lake or pond water using ORP meter. **OR** Determine the chloride content in a given water sample using Mohr's method. **OR** Determine turbidity of water sample using a Nephelometer.	**(7 M)**
Q.3	Calculate descriptive statistical parameters using EXCEL. **OR** Identify the polymer from given spectra (one) using OpenSpecy free databases for FTIR. **OR** Determine noise monitoring using a sound level meter.	**(5 M)**
Q.4	Viva-voce based on theory and practical	**(3 M)**
Q.5	Certified Journal (mandatory for practical examination)	**(2 M)**

Internal examination----------(Total marks 25)

Q.1) Practical related activities conducted by department/college for continuous evaluation. (field visit/ comprehensive report submissions, PowerPoint presentations, or poster presentations/report submissions/case studies/model making) **(15 marks)**
Q. 2) Timely completion and submission of journal. **(05 marks)**
Q. 3) Overall participation and attendance. **(05 marks)**

SKELETON QUESTION PAPER FOR PRACTICAL EXAMINATION
UNIVERSITY OF MUMBAI

M.Sc. Zoology (Environmental Science) Semester - IV
PSZO404
Lab exercise based on Occupational Safety and Disaster Management-II
(Time: 10.00 am - 2.00 pm)

Total Marks: 25 **Duration: 4 hours**

Q.1	Identification: a. Identify different types of fire extinguishers. b. Case studies: Chernobyl Nuclear Disaster, Bhopal Gas Tragedy, COVID-19, Uttarakhand Flash Floods, 2013, The Indian Ocean Tsunami 2004, Gujarat Earthquake, 2001.	**(8 M)**
Q.2	Preparation of safety management plan for laboratory/institute. **OR** Preparation of risk assessment chart for microbiology laboratory. **OR** Preparation of DMP for nuclear power plant/petrochemical industry/ fertilizer plant/hydropower station/chemical industry/thermal power plant/textile mill/metallurgical industry.	**(8 M)**
Q.3	Study of Seismic Zones in India. **OR** Study and Interpretation of Weather Forecasting.	**(5 M)**
Q.4	Viva-voce based on theory and practical.	**(2 M)**
Q.5	Certified Journal (mandatory for practical examination).	**(2 M)**

Internal examination----------(Total marks 25)

Q.1) Practical related activities conducted by department/college for continuous evaluation. (field visit/ comprehensive report submissions, PowerPoint presentations, or poster presentations/report submissions/case studies/model making) **(15 marks)**
Q. 2) Timely completion and submission of journal. **(05 marks)**
Q. 3) Overall participation and attendance. **(05 marks)**

SKELETON QUESTION PAPER FOR PRACTICAL EXAMINATION
UNIVERSITY OF MUMBAI

M.Sc. Zoology (Environmental Science) Semester - IV
PSZO406
Lab exercise based on The Biodiversity Blueprint: Monitoring and Assessment
(Time: 10.00 am - 2.00 pm)

Total Marks: 25 **Duration: 4 hours**

Q.1)	Calculate and interpret various biodiversity indices from the given data. (Shannon-Wiener/Simpson's) **OR** Develop a biodiversity monitoring plan for a specific ecosystem.	**(12 M)**
Q.2)	Create and organize species inventories using databases.	**(4 M)**
Q.3)	**Submission of project report:** Group project: Design a biodiversity monitoring plan for a specific ecosystem or study area including selecting appropriate indicators, sampling strategies, and data management protocols.	**(5 M)**
Q.4)	Viva-voce based on theory and practical.	**(2 M)**
Q.5)	Certified Journal (mandatory for practical examination).	**(2 M)**

Internal examination----------(Total marks 25)

Q.1) Practical related activities conducted by department/college for continuous evaluation. (field visit/ comprehensive report submissions, PowerPoint presentations, or poster presentations/report submissions/case studies/model making) **(15 marks)**
Q. 2) Timely completion and submission of journal. **(05 marks)**
Q. 3) Overall participation and attendance. **(05 marks)**

SKELETON QUESTION PAPER FOR PRACTICAL EXAMINATION
UNIVERSITY OF MUMBAI

M.Sc. Zoology (Environmental Science) Semester - IV
PSZO408
Lab exercise based on Environmental Entrepreneurship
(Time: 10.00 am - 2.00 pm)

Total Marks: 25 **Duration: 4 hours**

Q.1)	Prepare a model/project of rainwater harvesting. **OR** Display eco-friendly articles and different types of waste and comment on its method of segregation, reuse, disposal and recycling.	**(10 M)**
Q.2)	**Submission of survey report and viva based on it:** Survey at Municipal Corporation for segregation and disposal methods. **OR** Survey of different bio composting methods at house, apartment and offices. **OR** Preparation/submission of report on Government and non-government agencies schemes, subsidies, funding and documentation to apply for the sanction of the project.	**(6 M)**
Q.3)	**Submission of field visit report:** Visit to nearby solar panel installed unit/Visit to agency working on green concepts.	**(5 M)**
Q.4)	Viva-voce based on theory and practical.	**(2 M)**
Q.5)	Certified Journal (mandatory for practical examination).	**(2 M)**

Internal examination----------(Total marks 25)

Q.1) Practical related activities conducted by department/college for continuous evaluation. (field visit/ comprehensive report submissions, PowerPoint presentations, or poster presentations/report submissions/case studies/model making/) **(15 marks)**
Q. 2) Timely completion and submission of journal. **(05 marks)**
Q. 3) Overall participation and attendance. **(05 marks)**

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.

Letter Grades and Grade Points:

Semester GPA/ Programme CGPA Semester/ Programme	% of Marks	Alpha-Sign/ Letter Grade Result	Grading Point
9.00 - 10.00	90.0 - 100	O (Outstanding)	10
8.00 - < 9.00	80.0 - < 90.0	A+ (Excellent)	9
7.00 - < 8.00	70.0 - < 80.0	A (Very Good)	8
6.00 - < 7.00	60.0 - < 70.0	B+ (Good)	7
5.50 - < 6.00	55.0 - < 60.0	B (Above Average)	6
5.00 - < 5.50	50.0 - < 55.0	C (Average)	5
4.00 - < 5.00	40.0 - < 50.0	P (Pass)	4
Below 4.00	Below 40.0	F (Fail)	0
Ab (Absent)	-	Ab (Absent)	0

Sign of the BOS Coordinator
Dr. Vaishali Somani
BOS in Zoology

Sign of the Offg. Associate Dean
Dr. Madhav R. Rajwade
Faculty of Science & Technology

Sign of the Offg. Dean
Prof. Shivram S. Garje
Faculty of Science & Technology