

University of Mumbai



No. UG/20 of 2020-21

CIRCULAR:-

Attention of the Principals of the Affiliated Colleges, the Head University Departments and Directors of the recognized Institutions in Science & Technology Faculty is invited to the syllabus uploaded Academic Authority Unit which was accepted by the Academic Council at its meeting held on 27th February, 2013 vide item No. 4.39 relating to the revised syllabus as per the (CBSGS) of M.Sc. in Course Zoology- Biotechnology – Oceanography and Fishery Science (Sem. III & IV).

They are hereby informed that the recommendations made by the Board of Studies in Zoology at its meeting held on 23rd March, 2020 and subsequently made by the Board of Deans at its meeting held on 20th July, 2020 vide item No. 50 have been accepted by the Academic Council at its meeting held on 23rd July, 2020 vide item No. 4.102 and that in accordance therewith, the revised syllabus as per the (CBCS) of M.Sc. Part-II (Sem. III & IV) in Zoology with specializations viz Animal Physiology, Entomology, Endocrinology and Reproductive Physiology, Environmental Science, Oceanography and Fishery has been brought into force with effect from the academic year 2020-21 accordingly. (The same is available on the University's website www.mu.ac.in).

MUMBAI – 400 032

(1st November, 2020

To

(Dr. Vinod Patil)

I/c REGISTRAR

The Principals of the affiliated Colleges, the Head University Departments and Directors of the recognized Institutions in Science & Technology Faculty. (Circular No. UG/334 of 2017-18 dated 9th January, 2018.)

A.C/4.102/23/07/2020

No. UG/ 20 -A of 2020-21

MUMBAI-400 032

1st November, 2020

Copy forwarded with Compliments for information to:-

- 1) The Dean, Faculty of Science & Technology,
- 2) The Chairman, Board of Studies in Zoology,
- 3) The Director, Board of Examinations and Evaluation,
- 4) The Director, Board of Students Development,
- 5) The Co-ordinator, University Computerization Centre,

(Dr. Vinod Patil)

I/c REGISTRAR

Copy to :-

1. The Director of Board of Student Development.,
2. The Deputy Registrar (Eligibility and Migration Section)
3. The Director of Students Welfare,
4. The Executive Secretary to the to the Vice-Chancellor,
5. The Pro-Vice-Chancellor
6. The Registrar and
- 7 The Assistant Registrar, Administrative sub-centers, Ratnagiri, Thane & Kalyan, for information.

1. The Director of Board of Examinations and Evaluation
2. The Finance and Accounts Officers
3. Record Section
4. Publications Section
5. The Deputy Registrar, Enrolment, Eligibility and Migration Section
6. The Deputy Registrar (Accounts Section), Vidyanagari
7. The Deputy Registrar, Affiliation Section
8. The Professor-cum- Director, Institute of Distance and Open Learning Education,
9. The Director University Computer Center (IDE Building), Vidyanagari,
10. The Deputy Registrar (Special Cell),
11. The Deputy Registrar, (PRO)
12. The Deputy Registrar, Academic Authorities Unit (1 copies) and
13. The Assistant Registrar, Executive Authorities Unit

They are requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to in the above circular and that on separate Action Taken Report will be sent in this connection.

1. The Assistant Registrar Constituent Colleges Unit
2. BUCTU
3. The Deputy Accountant, Unit V
4. The In-charge Director, Centralize Computing Facility
5. The Receptionist
6. The Telephone Operator
7. The Secretary MUASA
8. The Superintendent, Post-Graduate Section
9. The Superintendent, Thesis Section

for information.

UNIVERSITY OF MUMBAI**Syllabus for Approval**

Sr. No.	Heading	Particulars
1	Title of the Course	Zoology (Animal Physiology)
2	Eligibility for Admission	The students who have granted both the Semesters and might have or have not cleared their Semester I and Semester II are eligible.
3	Passing Marks	40% in each Paper
4	Ordinances / Regulations (if any)	-----
5	No. of Years / Semesters	Two Semesters
6	Level	P.G. / U.G. / Diploma / Certificate (Strike out which is not applicable)
7	Pattern	Yearly / Semester (Strike out which is not applicable)
8	Status	New / Revised (Strike out which is not applicable)
9	To be implemented from Academic Year	From Academic Year 2020-2021

Date:

Signature :

Name of BOS Chairman / Dean: Dr. Bharmal Deelip L.

Dr. Anuradha Mayumdas
Dean, Science & Technology

UNIVERSITY OF MUMBAI



Program: M.Sc.

Course: Zoology **(Animal Physiology)**

Syllabus for Semester III & IV

(Choice Based Credit System
with effect from the academic year 2020-21)

M.Sc. Part II (Semester III and Semester IV): Zoology (Animal Physiology)
Syllabus Committee Members

Dr. Nisar Shaikh Chairman, G. M. Momin Women's College, Bhiwandi Dist. Thane, Maharashtra	Dr. Vasanti Katchi Mentor, Former Board of Chairperson in Zoology, University of Mumbai, Mumbai
Dr. Smita Durve Mentor, Former Board of Chairperson in Zoology, University of Mumbai, Mumbai	Dr. Kalpana Pai Mentor, Centre of Advanced Study, Department of Zoology, Savitribai Phule Pune University, Ganeshkhind, Pune – 411007
Dr. G. Gyananath Mentor, Former Director, School of Life Sciences, SRTM University, Nanded.	Dr. Arthur Frank Mentor, Professor and Chair Emeritus, Department of Environmental and Occupational health Dornsife School of Public Health, Drexel University, Philadelphia, PA, USA.
Dr. P. G. Kale Former Head and Professor, Department of Zoology R. J. College, Ghatkopar (w), Mumbai	Dr. Bhavita Chavan Convener, Government of Maharashtra's Ismail Yusuf College, Hardevi Society, Natwar Nagar, Jogeshwari (E), Mumbai – 400 060
Dr. Asha Rao Head and Associate Professor, Department of Zoology, Bhavan's College, Andheri (W), Mumbai – 400058	Dr. Vaishali T. Phusate Head and Associate Professor, Department of Zoology, Ruia College, Matunga, Mumbai - 400 019
Dr. Rupali Vaity Assistant Professor, Department of Zoology, S. I. E. S. College, Sion, Mumbai – 400 022	Dr. Shailesh Anaji Tawade Assistant Professor, Department of Zoology, Patkar College, Goregaon (W), Mumbai - 400 062

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PREFACE

The main objective of reconstructing the Post Graduate syllabus of Zoology for Semester III and Semester IV is to provide global level advanced and skill oriented deep knowledge to the stakeholders which is currently needed for their survival. The current research and teaching in Zoology includes diverse aspects with a balance of organismic and reductionist biology. It offers teaching and research programs in the diverse areas, such as, Animal Physiology, Entomology, Fish Biology, Immunology, Developmental Biology, Cell Signaling, Cell Biology, Radiation Biology, Reproductive Biology, Endocrinology, Genomics, Metagenomic, Cancer Biology, etc. Our vision is to provide Global Knowledge in education, training & research in the field of Zoology where teaching and research encrust detailed understanding from microbes to human. The broad skills and deeper knowledge in the field would make them highly successful and excellent researcher in advanced areas of research in the Biological sciences.

Therefore, the Board of Studies in Zoology aims to impart holistic understanding of Zoology by “redefining Zoology” to students of every age so that they develop interest in Science. It also aims to develop teaching and research programs that have relevance to society and employability. The M.Sc. program is being revised under CBCS scheme of UGC to meet the expectations of students.

To keep all of the above factors in mind, this syllabus was developed by the curriculum committee of Mentors, subject experts from other Universities and dedicated teachers. Their major role was to abridge, grow, augment and give a forward bearing to Zoology taught in undergraduate curriculum, with projections to future requirements. They have successfully completed this colossal task. I congratulate them.

Dr. Deelip L. Bharmal
Chairman Board of Studies in Zoology University of Mumbai

PREAMBLE

I am extremely happy to present this new syllabus of Semester III and Semester IV to the teachers and students of Post Graduate Course in Zoology of the specializations, Oceanography and Fishery Technology, Entomology, Endocrinology, Animal Physiology and Environmental Science. While constructing the syllabus, the relevant inputs have been considered from Mentors, subject experts from various fields of other Universities, teachers and stakeholders to make it more effective.

An attempt has been made to make post graduate courses competitive and on par with global standards, as per the directives of University Grant Commission for the implementation of choice based credit system. Hence as per the guideline of UGC the present syllabus is made more interesting with new, innovative topics as per need of the current situation of the world and stakeholders.

The M.Sc. Zoology program provides an appropriate blend of classical and applied aspects of the subject. This newly designed curriculum will allow students to acquire skills in handling scientific instruments planning and performing in the laboratory and exercising critical judgment, independent thinking and problem solving skills.

The utmost care has been taken to declare the final syllabus well in advance to enable the teachers to make preparations before commencement of the academic year and facilitating students to execute their right to know the details before admissions.

The draft of Syllabus was approved in meeting of the Board of Studies in Zoology held on 10th March 2020, and it was unanimously resolved to implement the revised syllabus of Zoology at M.Sc. Semester-III and IV and make it effective from the Academic Year 2020-2021 after approval from concerned authorities of the University.

The success of this revamped syllabus will depend totally on the enthusiasm and interest shown by the stakeholders.

Dr. Nisar Shaikh
Chairman, M.Sc. Part II
Syllabus Committee

PEDAGOGY

PSZOPHY301 deals with '**Systems' Physiology (Invertebrates) I**'. Any life process could be better understood, if the concept of cell physiology is clear, hence the course starts with the topic on cell physiology followed by physiological processes like Nutrition, Respiration, Circulation and Excretion with respect to invertebrates. Use of animated videos (ICT) will be a good help for the learner in understanding the concepts of membrane physiology. The students will get a clear insight and understand these topics with the help of lectures, demonstrations as well as observation of permanent slides or specimens and comparing the structures with that of the function.

PSZOPHY302 covers topics with respect to '**Systems' Physiology (Vertebrates) II**'. Life processes like Nutrition, Respiration, Circulation and Excretion in the vertebrates will be covered in this course. All the physiological processes that are to be studied in this unit will focus on structure and function analysis. The analytical skills of the students will be developed if the topics are taught by correlating the habitat and behaviour of the organism with that of the structure involved in maintenance of physiological processes. Life processes studied in the syllabus also include various disorders associated with it. These topics can be made more effective by indulging class room discussion, paper presentations and seminars wherein the recent studies and treatments involved with respect to a particular disorder can be understood by the students.

PSZOPHY303, 'Biochemical adaptations and Instrumentation' covers topics Biochemical adaptations, Oxygen and Environmental radiations, Water, Temperature and Pressure, Instrumentation I and II. The concepts of environmental stress with respect to oxygen, temperature, pressure, and water can be elucidated with the help of simple laboratory experiments along with classroom teaching. The knowledge of instruments being essential in research, hence the learners should be encouraged to visit research institutes in order to understand the working and principles of various instruments that are used in research. Learners should be motivated to participate in workshops for hands on training in research institutes so that they can handle the instruments confidently and at the same time their interaction with the scientists and research scholars would enhance their analytical and reasoning skills

PSZOPHY304, 'Applied Physiology' deals with Cellular physiology, Human Immune response and Medical applications, Cancer cell biology, Exercise physiology. Learners have already comprehended the basics of Cell biology and immunology at the undergraduate level. Hence at post graduate level the syllabus involves various aspects of cell signaling, cell communication, immune response and related medical applications in healthcare. This topic will be well perceived by the students as the theoretical part of this topic is supported enough with the practical component. Cell signaling and communication can be explained with the aid of ICT, visit to pathology laboratory wherein medical tests involving immune responses are conducted will further help the learners in understanding the diagnostic tests. The learners being familiar with the concepts of cell cycle, the topic of Cancer cell biology will help them to relate the role of variations in cell cycle with that of the development of cancer. Recent advances in cancer treatment can be effectively understood by the learners with emphasis on reference of recent research papers. Exercise physiology a newly introduced topic in the syllabus highlights the basic physiology related to exercise. The learner will understand the importance of exercise though much needed in our present lifestyle. Learners can comprehend this concept easily as most of them enjoy strength training and they will be more conscious about the physiological changes that take place during and due to work outs. Avenues are available as fitness trainers and the knowledge of exercise physiology may benefit and allow the learner an added career option.

PSZOPHY401, 'Systems' Physiology III' deals with Locomotor system, Physiology of motility, Neurophysiology, and Sensory and Effector Physiology in animals. Locomotion is one of the characteristic features of the animal kingdom. The locomotory structures vary in different animals depending upon their habitat. Hence, study of locomotory structures and the mechanism of their

working may to be explained by conducting field visits. Neurophysiology and Sensory & effector physiology can be best elucidated with the help of ICT enabled teaching learning methodology along with regular class room teaching.

PSZOPHY402, 'Systems' Physiology IV includes Endocrine Physiology I & II in invertebrates and the vertebrates respectively, Biological rhythms and Physiology of migration. Endocrine Physiology both in invertebrates and vertebrates may be made interesting to the learner not only by chalk and board or ICT method but also with the help of simple laboratory experiments. In 2017, Nobel Prize in Physiology was awarded to Hall, Rosbash and Young for their discoveries in molecular mechanisms controlling circadian rhythm. Such great discoveries and research work should be discussed in the class to motivate and encourage the learners to understand biological rhythms in animals. Having already studied the concept of migration at undergraduate level the learner can comprehend physiology of migration and adaptation in animals not only by lectures but more effectively by screening of various documentaries based on migratory routes of animals with geographical distribution.

PSZOPHY403, 'Recent Trends in Physiology' introduces the learners to the topics of Drug Designing & Modelling, Clinical trials, Clinical trial management & Guidelines and Stem Cell physiology. Drug designing, an integrated developing discipline in an era of tailored drug, involves the study of effects of biologically active compounds in animals whereas the topic on Clinical trials will make the learners understand various types and phases of clinical trials. The syllabus also focuses upon the guidelines to be followed during clinical trials and the management of clinical trials. The topics of this course being newly introduced would require the learner to understand the basic concepts aided with ICT tools, animation, video clips and visits to industry and pharmaceutical company. The concepts of stem cell physiology may be better comprehended by the learners with the help of class room discussions, review of recent research papers and invited talks from expertise of the subject.

PSZOPHY404 consists of '**Instrumentation and Presentation of Scientific data**' which help the students to choose suitable measuring instruments for their applications and understanding of limitations, principles and measurement errors. The students will aware the efficiency of the instruments. Similarly the course also has the unit of presentation of scientific data. Text, tables, and graphs for data and information presentation are very powerful communication tools. They can make scientific report easy to understand, attract and sustain the interest of beneficiary.

Convener and Committee Members

M. Sc. II Zoology Syllabus
Choice Based Credit System
To be implemented from the Academic Year 2020-2021

Animal Physiology: Semester III						
Course Name and Code	Unit	Topic Headings	Credit	Lecture/ Week	College Assessment Internal	University Assessment External
Paper I: Systems' Physiology (Invertebrates) I						
PSZOPHY301	1	Nutritive System	4	1	40	60
	2	Respiratory System		1		
	3	Circulatory System		1		
	4	Osmoregulation and Excretory System		1		
Paper II: Systems' Physiology (Vertebrates) II						
PSZOPHY302	1	Nutritive System	4	1	40	60
	2	Respiratory System		1		
	3	Circulatory System		1		
	4	Osmoregulation and Excretory System		1		
Paper III: Biochemical adaptation and Instrumentation						
PSZOPHY303	1	Biochemical adaptation, Oxygen and Environmental Radiation	4	1	40	60
	2	Water, Temperature and Pressure		1		
	3	Instrumentation I		1		
	4	Instrumentation II		1		
Paper IV: Applied Physiology						
PSZOPHY304	1	Cellular Physiology	4	1	40	60
	2	Human Immune Response and Applications		1		
	3	Cancer Cell Biology		1		
	4	Exercise Physiology		1		
		Total	16	16	160	240
Practicals						
PSZOPHY3P1	Practicals based on PSZOPHY301		2	4	–	50
PSZOPHY3P2	Practicals based on PSZOPHY302		2	4	–	50
PSZOPHY3P3	Practicals based on PSZOPHY303		2	4	–	50
PSZOPHY3P4	Practicals based on PSZOPHY304		2	4	–	50
		Total	8	16	–	200
		Grant Total	24	32	160	440

Animal Physiology: Semester IV						
Course Name and Code	Unit	Topic Headings	Credit	Lecture/ Week	College Assessment Internal	University Assessment External
Paper I: Systems' Physiology III						
PSZOPHY401	1	Locomotor System	4	1	40	60
	2	Physiology of Motility		1		
	3	Neurophysiology		1		
	4	Sensory and Effectors Physiology		1		
Paper II: Systems' Physiology IV						
PSZOPHY402	1	Endocrine Physiology - I	4	1	40	60
	2	Endocrine Physiology - II		1		
	3	Biological Rhythms		1		
	4	Physiology of Migration		1		
Paper III: Recent Trends in Physiology						
PSZOPHY403	1	Drug Designing & modelling	4	1	40	60
	2	Clinical trials		1		
	3	Clinical Trial Management and Guidelines		1		
	4	Stem Cell Physiology		1		
Paper IV: Instrumentation and Presentation of Scientific data						
PSZOPHY404	1	Instrumentation	2	1	40	60
	2	Presentation of Scientific data		1		
	3	Project		2		
		Total	16	16	160	240
Practicals						
PSZOPHY4P1	Practicals based on PSZOPHY401		2	4	–	50
PSZOPHY4P2	Practicals based on PSZOPHY402		2	4	–	50
PSZOPHY4P3	Practicals based on PSZOPHY403		2	4	–	50
PSZOPHY4P4	Practicals based on PSZOPHY404		2	4	–	50
	Total		8	16	–	200
	Grant Total		24	32	160	440

M. SC. PART 2: SEMESTER III (THEORY)
PAPER 1: PSZOPHY301
SYSTEMS' PHYSIOLOGY (INVERTEBRATES) I

Unit 1: Nutritive System

(15 L)

Objectives:

- *To familiarize the learner with nutritional physiology at various structural levels from membranes to systems.*

Desired Outcome:

- *The learner shall comprehend the molecular processes at membrane level and their significance in nutrition, food capture and processing, nutritive types and their correlation to variety of structures of nutritional apparatus in invertebrates.*

1.1 Nutritional Physiology at Cellular level

1.1.1 Membrane physiology

Functional consequences of molecular composition and arrangement of cell membrane

1.1.2 Transport across cell membrane

Diffusion, active transport, pump; uniports, symports and antiport, co-transport by symporters and antiporters

1.2 Physiology of Food Capture and Processing in Invertebrate

1.2.1 Nutritive Patterns – Origin of Nutritive types

1.2.2 Feeding patterns

a) Large particle feeding

b) Surface nutrient absorption

1.2.3 Modifications in the digestive system of invertebrates

a) Arthropoda

b) Mollusca

1.3 Dietary toxins and chemical defense strategies nematocyst, milk weed in monarch butterfly

Unit 2: Respiratory System

(15 L)

Objectives:

- *To familiarize the learner to different structural elements in respiratory process and their operational mechanism.*

Desired outcome:

- *The learner shall discern relationship of respiratory pigments, organization of membranes into structures like gills and trachea, mechanism of operation, patterns of respiration and their relationship to the habitat of invertebrates.*

2.1 Invertebrate transition from water to land

2.2 Respiratory mechanisms in aquatic invertebrates

2.2.1 Respiration across the cell membrane

2.2.2 Ostia

2.2.3 Gills – Crustacean and Echinoderms

2.2.4 Plastron

2.2.5 Aquatic insects

2.3 Tracheal system

2.3.1 Millipedes, Centipedes and insects

2.3.2 Tracheal ventilation

2.3.3 Gas exchange across tracheolar walls

- 2.3.4 Spiracle and its movement
- 2.4 Discontinuous or cyclic respiration
- 2.5 Regulation of respiration
- 2.6 Respiratory pigments
 - a) Chlorocruorin
 - b) Haemerythrin
 - c) Haemocyanin

Unit 3: Circulatory System

(15 L)

Objectives:

- *To familiarize the learner to circulation of body fluids and types of circulation in various phyla of invertebrates*

Desired outcome:

- *The learner shall study variety of circulatory fluids, patterns of circulation and physiological types of hearts in invertebrates.*

- 3.1 Evolution of Invertebrate circulatory system
- 3.2 Circulating Fluids
 - 3.2.1 Cytoplasm
 - 3.2.2 Hydrolymph
 - 3.2.3 Haemolymph
 - 3.2.4 Lymph
 - 3.2.5 Blood
- 3.3 Circulation of external fluid through an open body cavity – Sponge
- 3.4 Circulation of internal fluid through an open circulatory system – Cockroach
- 3.5 Open circulatory system in Mollusca
- 3.6 Circulatory mechanism and fluid compartments, movements of body fluids by somatic muscle
- 3.7 Physiological types of hearts with special reference to Arthropods, Annelids, Mollusca
- 3.8 Circulation in Cnidarians, Nemertean worms, Nematods, Annelids, Echinoderms, Molluscs, Arachnids

Unit 4: Osmoregulation and Excretory System

(15 L)

Objectives:

- *To familiarize the learner to organizational levels of osmo-regulatory and excretory structures in invertebrates and types of molecules generated as excretory product.*

Desired outcome:

- *The learner shall appreciate the relationship between increasing complexity of structure of excretory systems, the metabolic pathways generating the excretory waste products and the habitat of the invertebrates.*

- 4.1 Invertebrate excretory organs and physiology
 - 4.1.1 Epithelial exchange
 - 4.1.2 Coelom
 - 4.1.3 Coelomoducts
 - 4.1.4 Malpighian tubules
 - 4.1.5 Protonephridia and metanephridia
 - 4.1.6 Molluscan kidney
 - 4.1.7 Antennal gland in crustacean
- 4.2 Multifunctional aspects of nitrogen excretory pathways in the Molluscs
- 4.3 Channelling of the flow of nitrogen towards uric acids or urea in the Molluscs
- 4.4 Significance of ammonia production in crustaceans,
- 4.5 Ammonotelic-Uricotelic transition in insects, formation of urine in insects

PAPER 2: PSZOPHY302

SYSTEMS' PHYSIOLOGY (VERTEBRATES) I

Unit 1: Nutritive System

(15 L)

Objectives:

- *To familiarize the learner to different feeding patterns, variety of nutritional apparatus, process of digestion in the vertebrates and digestive system in human beings.*

Desired outcome:

- *The learner shall comprehend the comparative and specialized aspects of nutritional type, digestive systems, digestion as a metabolic process and neuro-hormonal regulation of nutrition.*
- *Role of microbes in digestion, balanced diet and disorders of digestive function are applied aspects of nutrition, the study of which is an important take away for learners, which will help them in healthcare.*

1.1. Feeding mechanism in vertebrates

1.1.1 Filter feeding

- a) Pisces
- b) Flamingoes
- c) Tadpoles of frog

1.1.2 Reptiles (Jacobson's organ)

1.2. Specialized compartmentalization of digestive system in vertebrates

1.2.1 Intestinal modification in herbivore and carnivore

1.2.2 Intestine in fish, bird and mammal

1.3. Comparative study of mechanical or physiological digestion – gill rakers, Dentition in Pisces, Amphibians, Reptiles, Birds and Mammals

1.4. Comparative study of Chemical digestion

1.5. Absorptive adaptation of the Gut

1.6. Micro-biome of human gut and its significance

1.7. Metabolic transition between meals

1.7.1 Hormonal control postprandial regulation of nutrient stores

1.7.2 Effect of prolonged food deprivation

1.8. Balanced diet- a human perspectives

1.9. Disorders of digestive system:

1.9.1 Acid reflux

1.9.2 Gall stones

1.9.3 Haemorrhoids

1.9.4 Dental Acidity

1.9.5 Acidity and its impact

1.9.6 Stress and hunger drive

Unit 2: Respiratory System

(15 L)

Objectives:

- *To introduce the learner to physico-chemical parameters of respiration in the vertebrates.*

Desired outcome:

- *The learner shall comprehend change in physiology as an adaptive process in transition of vertebrates between aquatic and terrestrial mode of life.*
- *The learners shall realize the clinical significance of simple diagnostic tests for estimation of blood parameters.*

2.1 Transition of vertebrates from water to land

- 2.2 Comparative study of Respiratory system in vertebrates:
 - 2.2.1 Aquatic, terrestrial, gas exchange in terrestrial eggs
 - 2.2.2 Respiration in lungfish
- 2.3 Chemistry of respiration
 - 2.3.1 Composition of atmospheric and expired air
 - 2.3.2 Aerodynamic Sub-division of air in the lungs
 - 2.3.3 Regulation of lung breathing
 - 2.3.4 Transport of gases in the blood
 - 2.3.5 Diffusion of gases in the lungs
 - 2.3.6 Transport of CO₂ in the blood
 - 2.3.7 Haldane effect- Partial pressure of gases
- 2.4 Dissociation of Oxyhaemoglobin and factors affecting it (temperature, electrolytes, CO₂ and Carboxyhaemoglobin)
- 2.5 Acid-base balance:
 - 2.5.1 Measurements
 - 2.5.2 Causes of disturbances
 - 2.5.3 Metabolic Acidosis
 - 2.5.4 Respiratory Acidosis
 - 2.5.5 Metabolic, Alkalosis
 - 2.5.6 Respiratory Alkalosis
- 2.6 Role of medulla oblongata in respiration
 - 2.6.1 Chemoreceptor
 - 2.6.2 Mechanoreceptor and Ventilation reflexes
 - 2.6.3 Chemical factors regulating respiration
 - 2.6.4 Oxygen equilibrium curve and its significance
- 2.7 Manifestation of variation in haemoglobin saturation
 - 2.7.1 Oxygen toxicity
 - 2.7.2 Carbon monoxide poisoning
 - 2.7.3 Clinical significance

Unit 3: Circulatory System

(15 L)

Objectives:

- *To introduce the learner to functional dynamics of circulatory systems in the vertebrates.*

Desired outcome:

- *The learner shall gauge the evolutionary adaptations of the circulatory system and understand the control and coordination of circulation in the vertebrates.*
- *The learner shall comprehend the applied aspects of circulatory system in the context of human health.*

- 3.1 Rheology:
 - 3.1.1 Viscosity, Poiseuille
 - 3.1.2 Hagen flow formula
 - 3.1.3 Laminar and turbulent flow Resistance
 - 3.1.4 Pressure, velocity and gravity
- 3.2 Chordate circulatory system:
 - 3.2.1 Arterial system
 - 3.2.2 Venous System
 - 3.2.3 Lymphatic System
- 3.3 Circulatory patterns in Vertebrates
 - 3.3.1 Lung fish
 - 3.3.2 Amphibians
 - 3.3.3 Reptiles
 - 3.3.4 Birds

- 3.3.5 Mammals
- 3.4 Regulation of cardiovascular system
 - 3.4.1 Heart
 - 3.4.2 Cardiac output
 - 3.4.3 Blood pressure
- 3.5 The buffer system of the blood
 - 3.5.1 Haemoglobin buffer
 - 3.5.2 The Chloride shift
- 3.6 Selective distribution of blood flow
- 3.7 Circulatory disorders in humans – Varicose veins

Unit 4: Osmoregulation and Excretory System

(15 L)

Objectives:

- *To enable the learner to become well versed with patterns of nitrogen metabolism, excretion of wastes, osmoregulation and applied aspects renal function in human beings.*

Desired outcome:

- *The learner shall discern the variations in metabolic waste products and their relationship to habitat, metabolic pathways of nitrogen metabolism in the vertebrates, role of renal functions in electrolyte balance, blood pressure and acid-base balance.*
- *The learner shall be introduced health effects of compromised kidney functions.*

- 4.1 Variation in vertebrate kidneys
- 4.2 Nitrogen Metabolism: Formation of nitrogenous excretory products
 - 4.2.1 Amino-N Metabolism
 - 4.2.2 Nucleic Acid Metabolism
 - 4.2.3 Other nitrogenous waste products
- 4.3 Regulation of Urine formation
 - 4.3.1 Urine concentration,
 - 4.3.2 Micturition,
 - 4.3.3 Relationship of regulation of water balance with reference to blood volume, blood pressure, electrolyte balance, acid-base balance.
- 4.4 Kidney failure and diseases in human:
 - 4.4.1 Acute kidney injury,
 - 4.4.2 Causes of kidney failure,
 - 4.4.3 Chronic kidney disease
 - a) Causes,
 - b) Kidney stone
 - c) Dialysis (renal and peritoneal dialysis)

PAPER 3: PSZOPHY303

BIOCHEMICAL ADAPTATION AND INSTRUMENTATION

Unit 1: Biochemical Adaptation, Oxygen and Environmental Radiation

(15 L)

Objectives:

- *Learner shall reinforce concepts of homeostasis and understand environmental stress and physiological adaptations to withstand the stress.*

Desired outcome:

- *The learner shall comprehend metabolic strategies and physiological adaptations to withstand environmental stress in the form of ambient oxygen availability and environmental radiation.*

1.1 Environmental Stress, Homeostasis and strategies of biochemical adaptations:

1.1.1 Basic concept of environmental stress

- a) Plastic and elastic strain
- b) Stress resistance, stress avoidance and stress tolerance

1.1.2 Homeostasis and biochemical adaptation:

- a) External and internal environment
- b) Multiple control system
- c) Strategies of biochemical adaptations

1.2 Oxygen as an environmental factor:

1.2.1 Oxygen and Origin of life

1.2.2 Oxygen dependencies in living organism

1.2.3 Anoxia adaptations in invertebrates

1.2.4 Adaptations of vertebrates during prolonged diving

1.2.5 Oxygen debt in vertebrate muscle

1.3 Radiation as an environmental factor:

1.3.1 Biomolecules involved in perception and trapping of solar radiations:

- a) Chlorophyll
- b) Bacterio-rhodopsin
- c) Rhodopsin
- d) Vitamin A

1.3.2 Adaptations of animals to absence of solar radiations

Unit 2: Water, Temperature and Pressure

(15 L)

Objectives:

- *Learner shall reinforce concepts of homeostasis and understand environmental stress and physiological adaptations to withstand the stress.*

Desired outcome:

- *The learner shall comprehend metabolic strategies and physiological adaptations to withstand stress in the form of water, temperature and pressure as environmental factors.*

2.1 Water and Solute problem:

2.1.1 Preservation of intracellular solvent capacity

2.1.2 ATPase the model regulatory enzyme

2.1.3 Key role of GDH reaction

2.2 Temperature as environmental factor

2.2.1 Thermal limits of survival

2.2.2 Temperature and Structural effects with response to Biological molecules and biological membranes

- 2.2.3 Temperature and rate effects:
 - a) Temperature dependent E~S affinity
 - b) Lipoprotein enzymes
- 2.3 Thermal resistance of dormant and active cells
 - 2.3.1 Ectothermy and endothermy
 - 2.3.2 Endothermy in invertebrates
 - 2.3.3 Biochemical adaptations of Ectothermy:
 - a) Antifreeze substances
 - b) Heat shock proteins
- 2.4 Pressure as an environmental factor:
 - 2.4.1 Fundamental effects of pressure on biological system
 - 2.4.2 Effect of pressure on weak bonds and the consequences for higher orders of molecular structures and process (transcription, translation and gene regulation)
 - 2.4.3 Strategies of enzyme adaptations to pressure in marine organisms:
 - a) FDPase
 - b) PK

Unit 3: Instrumentation – I

(15 L)

Objectives:

- To familiarize the learner with various tools and techniques required to study animal physiology.

Desired outcome:

- The learner will be acquainted with principles and procedures necessary to prepare samples for physiological studies and learn experientially through observing demonstration or hands on experience of instruments.

- 1.1 Histochemical and Immunotechniques
 - 1.1.1 Detection of molecules using
 - a) ELISA
 - b) RIA
 - c) Western blot
 - d) Immunoprecipitation
 - e) Fluocytometry
 - f) Immunofluorescence microscopy
 - 1.1.2 Detection of molecules in living cells, in situ localization by techniques such as FISH and GISH
- 3.2 Chromatographic techniques: Principles and applications
 - 3.2.1 Column Chromatography
 - 3.2.2 Ion exchange chromatography
 - 3.2.3 HPTLC
 - 3.2.4 HPLC
 - 3.2.5 Gas chromatography

Unit 4: Instrumentation – II

(15 L)

Objectives:

- To familiarize the learner with various tools and techniques required to study animal physiology.

Desired outcome:

- The learner will be acquainted with principles and protocols necessary to operate instruments for estimations and analyses of samples for physiological studies and learn experientially through observing demonstration or hands on experience of analytical instruments.

- 4.1 Biophysical Method: Molecular analysis
 - 4.1.1 UV/visible
 - 4.1.2 Fluorescence,
 - 4.1.3 Circular dichroism
 - 4.1.4 NMR
- 4.2 ESR spectroscopy Molecular structure determination using X-ray diffraction and NMR
- 4.3 Molecular analysis using light scattering
- 4.4 Different types of mass spectrometry and surface plasma resonance methods
- 4.5 Radiolabeling techniques:
 - 4.5.1 Detection and measurement of different types of radioisotopes normally used in biology
 - 4.5.2 Incorporation of radioisotopes in biological tissues and cells
 - 4.5.3 Molecular imaging of radioactive material, safety guidelines

PAPER 4: PSZOPHY304 APPLIED PHYSIOLOGY

Unit 1: Cellular Physiology

(15 L)

Objectives:

- *To initiate the learner in the process of cellular signaling and communication as well as protein sorting.*

Desired outcome:

- *The learner shall envisage molecular processes involved in cellular signaling and communication.*
- *The learner shall be able to trace the transport of proteins from their site of synthesis to the site of their action.*

1.1 Cell signaling:

- 1.1.1 Hormones and their receptors
- 1.1.2 Cell surface receptor,
- 1.1.3 Signaling through G-protein coupled receptors
- 1.1.4 Signal transduction pathways
- 1.1.5 Second messengers
- 1.1.6 Regulation of signalling pathways

1.2 General principles of cell communication

- 1.2.1 Cell adhesion and roles of different adhesion molecules
- 1.2.2 Gap junctions
- 1.2.3 Extracellular matrix
- 1.2.4 Integrins
- 1.2.5 Neurotransmission and its regulation

1.3 Protein sorting and transportation

Unit 2: Human Immune Response and Medical Application

(15 L)

Objectives:

- *To familiarize the learner to immune response and defence mechanisms in human systems.*

Desired outcome:

- *The learner shall comprehend various molecular defence mechanisms and immune response and their applications in healthcare in terms of therapeutics and organ transplantation.*

2.1 Major Histocompatibility complex, antigen processing and presenting cells

2.2 Tolerance and Autoimmunity

2.3 Immunity to pathogens and vaccines

2.4 The Complement System

- 2.4.1 Functions
- 2.4.2 Components
- 2.4.3 Activation and regulation of the complement
- 2.4.4 Biological consequences of the complement activation

2.5 Lymphocyte Ontogeny and Membrane Markers

2.6 Transplantation Immunology

- 2.6.1 basis of graft rejection
- 2.6.2 Clinical manifestation of graft rejection
- 2.6.3 General and specific immunosuppressive therapy

- 2.6.4 Immune tolerance to allograft
- 2.6.5 Clinical transplantation
- 2.7 Organ-Specific Autoimmune Diseases
 - 2.7.1 Systemic Lupus Erythematosus
 - 2.7.2 Rheumatoid Arthritis
 - 2.7.3 General account of Immunodeficiency diseases

Unit 3: Cancer Cell Biology

(15 L)

Objectives:

- *To introduce the learner to development of cancer in terms of cell cycle and apoptosis.*

Desired outcome:

- *The learner shall comprehend factors responsible for apoptosis, variations in cell cycle and their role in development of cancer.*

- 3.1 Components of cell cycle and control system, Mitotic catastrophe
- 3.2 Extracellular control of cell division
 - 3.2.1 Cell growth and apoptosis
 - 3.2.2 Morphological and biochemical features of apoptosis
 - 3.2.3 Necroptosis
- 3.3 Caspases (effector molecules)
 - 3.3.1 Executioners of the apoptosis process
 - 3.3.2 Extrinsic and intrinsic apoptotic pathway
- 3.4 Role of mitochondria in cell death
 - 3.4.1 Mechanism of mitochondrial outer membrane permeabilization (MOMP)
 - 3.4.2 Cell death effectors released from mitochondria
- 3.5 Poly – ADP –ribose Polymerase (PARP) proteolysis as an indicator of cell death
- 3.6 Senescence and cancer
- 3.7 Chemoresistance and cancer
- 3.8 Immunogenicity of cancer cell death
- 3.9 Autophagy and Role of autophagy in tumour survival, oncogenic genes that regulate Autophagy
- 3.10 Cancer treatment: Immunotherapy

Unit 4: Exercise Physiology

(15 L)

Objectives:

- *To initiate the learner to fundamentals of exercise physiology.*

Desired outcome:

- *The learner shall comprehend effect of exercise on various physiological parameters for molecular to systems level.*

- 4.1 Exercise and Immune system:
 - 4.1.1 Exercise and resistance to infections
 - 4.1.2 Risks of infections due to high intensity workout and environmental extremes
- 4.2 Cell signaling and Hormonal response to exercise:
 - 4.2.1 Blood hormone concentration
 - 4.2.2 Hormone receptor interaction
 - 4.2.3 Muscle glycogen utilization
 - 4.2.4 Blood glucose homeostasis during exercise
 - 4.2.5 Hormone substrate interaction
- 4.3 Circulatory responses to exercise:
 - 4.3.1 Organization of circulatory system

- 4.3.2 Cardiac cycle
- 4.3.3 Changes in oxygen delivery to muscles during exercise
- 4.4 Role of nervous system exercise:
 - 4.4.1 Control and coordination of movements during exercise
 - 4.4.2 Joint and muscle proprioceptors
 - 4.4.3 Muscle chemoreceptors
 - 4.4.4 Motor functions of the spinal cord

M. Sc. Part 2: Semester III Practical

Practical 1: PSZOPHY3P1

1. Study of Mouth parts in different insects, observe the modifications and write the adaptations – Biting, chewing, piercing and sucking.
2. Study of digestive system of earthworm.
3. Study of nephridia of earthworm and Malpighian tubules of cockroach.
4. Study of Digestive system of cockroach, earthworm / crab.
5. Study of Nervous system of cockroach.
6. Study of heartbeat in *Daphnia*, effect of heavy metals / nicotine on heartbeat of *Daphnia*.
7. Study of Respiratory quotient (R.Q.) of cockroach.
8. Study of transport of glucose across a semi-permeable membrane (egg membrane).

Practical 2: PSZOPHY3P2

1. Determination of activities of digestive enzymes viz. amylase, trypsin etc. in different animals (human saliva for amylase, Intestine of goat or chicken for trypsin).
2. Study of effect on activity of salivary/ pancreatic amylase enzyme on various factors substrate concentration, pH, temperature, activator, inhibitor (enzyme) and determination of K_m of a given enzyme.
3. Study of pathological report and interpretation of report with respect to human physiology
 - a. Renal function test
 - b. Liver function test
 - c. Stress test
 - d. Polycythemia
 - e. Various scans – X rays / CT Scan or any other scan images interpretation
4. Effect of different concentrations of sodium chloride on the diameter of RBCs and determination of concentration isotonic to blood.
5. Determination of urea, uric acid and creatinine in blood – human / goat.
6. Determination of blood cholesterol content – human / goat.
7. Routine urine tests. Prepare a report as provided by pathological laboratory.
8. Influence of sub lethal concentration (50-60ppm) ammonia (as liquor ammonia / ammonium hydroxide / ammonium chloride) on a suitable fish exposed to ammonia stress for 3 / 7 / 15 days with reference to the following parameters:
 - a. Level of excretory ammonia
 - b. Level of activity of hepatic and brain glutamate dehydrogenase
 - c. Level of amino acid content of muscle, gill, brain and liver

Practical 3: PSZOPHY3P3

1. Observation of decreasing PO_2 of water on the respiratory rate of a fish.
2. Effect of decreasing PO_2 of water on lactic acid in the fish muscle.
3. Estimation of salt loss and gain in an aquatic animal when transferred to a salt free medium and to natural medium.
4. Effect of temperature on opercula movement of suitable fish.
5. Study of effect of temperature on development of chick embryo.
6. Study of effect of electrolyte stress on angiogenesis using chick embryo.
7. Separation of plasma proteins by PAGE electrophoresis.
8. Separation of serum globulins by PAGE electrophoresis.
9. Immobilize Yeast cells in calcium alginate and prepare a bioreactor column to demonstrate invertase activity in the bioreactor column.

Practical 4: PSZOPHY3P4

1. Performance of Ouchterlony technique to demonstrate immune-diffusion.
2. Demonstration of single radial immune-diffusion of antibody and antigen.
3. Study of counter-current immune-electrophoresis.
4. Study of Agglutination Reaction:
 - a) Tube Agglutination Reaction
 - b) Slide Agglutination Reaction
 - c) Indirect Agglutination Inhibition Reaction
5. Separation of Lymphocytes.
6. Study of Phagocytosis.
7. Identification of histological slides of lymphoid tissue:
 - a) Spleen
 - b) Thymus
 - c) Lymph node
 - d) Bone marrow

M. SC. PART 2: SEMESTER IV (THEORY)
PAPER 1: PSZOPHYN401
SYSTEMS' PHYSIOLOGY III

Unit 1: Locomotor System

(15 L)

Objectives:

- *To familiarize the learner with various types of locomotory structures in invertebrates.*

Desired outcome:

- *The learner shall understand the functional and operating mechanisms of various locomotory structures and organs in invertebrates.*

1.1 Functions of locomotory organs

1.1.1 Pseudopodia

- Lobopodia
- Reticulopodia
- Filopodia
- Axopodia

1.1.2 Cilia

1.1.3 Flagella

1.1.4 Tentacles

1.1.5 Foot

1.1.6 Tube feet

1.1.7 Setae

1.2 Locomotion in Arthropods

1.2.1 Legs

1.2.2 Wings

1.3 Pyloric rhythm of the crustacean

1.4 Comparative physiology of invertebrate muscles

1.4.1 Polyneuronal innervation in arthropod muscle

1.4.2 Insect non-oscillatory postural muscle

1.4.3 Resonant flight and tymbal muscle in insects

1.4.4 Catch muscle and delayed relaxation

Unit 2: Physiology of Motility

(15 L)

Objectives:

- *To familiarize the learner to intracellular and extracellular processes involved in movement and locomotion in the vertebrates.*

Desired outcome:

- *The learner shall discern molecular and supra-molecular structures and processes responsible for movement and locomotion in the vertebrates.*

2.1 Physiology of movement and locomotion:

2.1.1 Biochemistry of contractile proteins

2.1.2 Physiology of non-muscular contractile elements:

- a) Axoplasmic movement
- b) Chromosome involvement

2.1.3 Physiology of skeletal muscle fibre:

- a) Actomyosin complex
- b) Source of energy for muscle contraction
- c) Sliding filament theory

- d) Excitation of contraction and mechanism of regulation of contraction by calcium ions
- e) Mechanism of relaxation

Unit 3: Neuro Physiology

(15 L)

Objectives:

- *To familiarize the learner to structural and functional aspects of neurophysiology.*

Desired outcome:

- *The learner shall comprehend molecular, structural and functional dimensions of neurophysiology in the animal kingdom.*

- 3.1 Excitable membranes
 - 3.1.1 Membrane potential
 - 3.1.2 Ions as current carriers
 - a) Protons
 - b) Calcium
 - c) Potassium
 - 3.1.3 structure of Cation
 - a) Permeable channels
 - b) Chloride channels
- 3.2 Primitive nervous system
 - 3.2.1 Nerve nets
 - 3.2.2 Central pattern generators in invertebrates
 - 3.2.3 Motor control in Arthropods
- 3.3 Nervous tissue
 - 3.3.1 Neurons
 - 3.3.2 Glial cells
- 3.4 Integrative neurophysiology:
 - 3.4.1 Interneurons
 - 3.4.2 Neural circuits
- 3.5 Neurotransmitters
 - 3.5.1 Acetylcholine
 - 3.5.2 Dopamine
 - 3.5.3 Catecholamine
 - 3.5.4 GABA
 - 3.5.5 ATP
 - 3.5.6 Adrenaline
 - 3.5.7 Noradrenaline
 - 3.5.8 FMRF amide family
 - 3.5.9 Neuropeptide
- 3.6 Central Nervous system processing
- 3.7 Memory and learning
- 3.8 Neurophysiological disorders
 - 3.8.1 Alzheimer
 - 3.8.2 Parkinson
 - 3.8.3 Dementia

Unit 4: Sensory and Effector Physiology

(15 L)

Objectives:

- *To familiarize the learner to sensory and effector systems in the animal kingdom.*

Desired outcome:

- *The learner shall understand the organizational aspects of sensory structures at the molecular, membrane and organ level and their functioning as transducers in reception of sensory stimuli.*
- *The learner shall understand physiology of effectors.*

4.1 Sensory and effector system in invertebrates

4.1.1 Specificity, membrane bound receptor system, cytosolic receptor system

4.1.2 Mechanisms of insect olfactory reception

4.1.3 Organs of Equilibrium – statocyst, insect ear

4.1.4 Habituation and sensitization in *Aplysia*

4.1.5 Physiological effectors – Cnidoblast, Chromatophores, Bioluminescent system

4.2 Sensory and effector system in the vertebrates:

4.2.1 Organs of Equilibrium – statocyst, internal ear of vertebrate

4.2.2 Sensory modalities of animals: Sensory coding and transduction of sensory stimuli:

a) Chemoreception (Gustation and olfaction)

b) Hygroreception

c) Thermoreception

d) Mechanoreception

e) Echolocation

f) Electroreception

g) Magnetoreception

h) Photoreception

PAPER 2: PSZOPHY402

SYSTEMS' PHYSIOLOGY IV

Unit 1: Endocrine Physiology – I

(15 L)

Objectives: *To introduce to the learner various Endocrine systems in Invertebrates.*

Desired outcome: *The learner shall understand various molecular and structural aspects of invertebrate endocrine systems, the effect of endocrine secretions on various life-processes and development as well as the mechanism of action of hormones in invertebrates.*

- 1.1 Invertebrate endocrine system
 - 1.1.1 Lower invertebrates in general
 - 1.1.2 Annelids
 - 1.1.3 Arthropods
 - 1.1.4 Molluscs
 - 1.1.5 Echinoderms
- 1.2 Hormonal action in invertebrates
 - 1.2.1 Feed-back substance (polychetes)
 - 1.2.2 Prothoracicotropic hormone
 - 1.2.3 Juvenile hormone
 - 1.2.4 Ecdysone
 - 1.2.5 Trypsin modulating oostatic factor (TMOF)
 - 1.2.6 Allomones
 - 1.2.7 X and Y Organs
 - 1.2.8 Epitracheal glands (Inka cells)
 - 1.2.9 Methyl farnesoate (MF)
 - 1.2.10 Gonadotropic hormone in gastropods and cephalopods
 - 1.2.11 1- Methyl – adenine (meiosis inducing substance) endocrine disruptors
 - 1.2.12 Gamete shedding substance (GSS) in Star fish
- 1.3 Mechanism of hormone action in invertebrates

Unit 2: Endocrine Physiology II

(15 L)

Objectives:

- *To familiarize the learner to vertebrate endocrine cellular structures, organs and glands and types of their secretions.*

Desired outcome:

- *The learner shall comprehend various types of endocrine organs, glands, types of their secretions, neurohormones; and effects of these hormones on life processes including reproduction and development.*

- 2.1 Introduction to Endocrine systems (Neurosecretion and classical endocrine glands) – an overview
- 2.2 Synthesis and Release of Hormone, Transport and Metabolism of Hormones, Mechanism of endocrine diseases
- 2.3 Mechanism of Hormone action in the vertebrates
- 2.4 Chordate endocrine systems
 - 2.4.1 Hypothalamo-hypophyseal axis
 - 2.4.2 Pineal gland
 - 2.4.3 Thyroid gland
 - 2.4.4 Parathyroid gland
 - 2.4.5 Ultimobranchial gland
 - 2.4.6 Corpuscles of stannous

- 2.4.7 Gastroenteropancreatic cells
- 2.4.8 Maunthner cells
- 2.4.9 Chromaffin tissues
- 2.4.10 Steroid hormones
- 2.5 Endocrine disorders due to alteration in receptor number and functions
- 2.6 Endocrine regulation during sex differentiation

Unit 3: Biological rhythms

(15 L)

Objectives:

- *To introduce the learner to temporal aspects of biological systems.*

Desired outcome:

- *The learner shall understand the various types of rhythms encountered in biological systems and their manifestations through various activities.*

- 3.1 Physiology of Biological Rhythms and timings:
 - 3.1.1 Temporal organization of the cells
 - 3.1.2 Circadian Rhythms. Synchronization of circadian rhythms
 - 3.1.3 Dormancy in fresh water and terrestrial animals
 - a) Preparatory phases
 - b) Induction of dormancy
 - c) Arousal from dormancy Entrainment and dormancy
 - 3.1.4 Diapause in insects
 - a) Induction
 - b) Factors affecting and termination of diapause,
 - c) Diapause and endocrine functions
 - 3.1.5 Photoperiodism
 - 3.1.6 Biological clocks (circadian rhythms, lunar rhythms and circannual rhythms)

Unit 4: Physiology of Migration

(15 L)

Objectives:

- *To familiarize the learner to various aspects of animal migration.*

Desired outcome:

- *The learner shall be able to discern causative, temporal, spatial, energetic and metabolic aspects of animal migration and its adaptive value to the migrating animal species.*

- 4.1 Physiological stimulus of Migration
- 4.2 Orientation and Navigation
- 4.3 Energetic
- 4.4 Timing
- 4.5 Synthesis
- 4.6 Migration for food, reproduction, territory
- 4.7 Migration as factor in life cycle
- 4.8 Adaptations for Migration
- 4.9 Communication during Migration

PAPER 3: PSZOPHY403

RECENT TRENDS IN PHYSIOLOGY

Unit 1: Drug Designing & Modelling

(15 L)

Objectives:

- *To introduce the learner to the fundamental concept of drug discovery and designing.*

Desired outcome:

- *The learner will comprehend steps involved in discovery and identification of new potential therapeutic molecules using combination of computational and experimental processing drug development.*

- 1.1 Introduction to Drug Design and Development
 - 1.1.1 Drug Discovery as a Process
 - 1.1.2 Target Identification and Validation
 - 1.1.3 Target Validation and Drug Validation Practical
- 1.2 Drug targets
- 1.3 Targets: Membrane Proteins, DNA, RNA, Enzymes
- 1.4 Lead Identification and Modification:
 - 1.4.1 Lead Identification and High Throughput Screening
 - 1.4.2 Sources of active compounds, Biologics
- 1.5 Computer-Aided Drug Design:
 - 1.5.1 Molecular Modelling
 - 1.5.2 Ligand-based Drug Design
 - 1.5.3 Structure Determination
 - 1.5.4 Structure-based Drug Design
- 1.6 Drug Delivery: Bioavailability, Pro-drugs and Drug Delivery

Unit 2: Clinical trials

(15 L)

Objectives:

- *To introduce the learner to different steps involved in clinical trials.*

Desired outcome:

- *The learner will comprehend types of clinical trials, designing of clinical trials, ethics in clinical trials and its application in health care.*

- 2.1 Pre-clinical Toxicology: In vivo
- 2.2 Pre-clinical Toxicology: In vitro
- 2.3 Clinical Trials: Clinical Trial Design
- 2.4 Ethics of Human and Animal Experimentation
- 2.5 Commercial Considerations in Drug Development
- 2.6 Introduction to artificial intelligence and its application
 - 2.6.1 Clinical trials
 - 2.6.2 Toxicology
 - 2.6.3 Healthcare

Unit 3: Clinical Trial Management and Guidelines

(15 L)

Objectives:

- *To introduce the learner to operation and management in clinical trials.*

Desired outcomes:

- *The learner will comprehend the monitoring and regulatory affairs with defined guidelines used in clinical trials.*

- 3.1 Project Management; protocol in clinical research; quality assurance & clinical data management
- 3.2 Informed consent; Case report form; investigator's brochure (Ib)
- 3.3 Ethical and regulatory submission; roles and responsibilities of clinical research professionals
- 3.4 Retention of Clinical trial subjects; monitoring visits; Documentation of clinical trials
- 3.5 Introduction to OECD
 - 3.5.1 Guidelines for the testing of chemicals
 - 3.5.2 Description of the method
 - 3.5.3 Selection of animal species
 - 3.5.4 Housing and feeding conditions, preparation of animals for experiment, preparation of doses
 - 3.5.5 Administration of doses
 - 3.5.6 Limit test and main test
 - 3.5.7 Observations:
 - a) Body weight
 - b) Pathology
 - c) Data and Reporting
 - d) Calculation of LD50 for the main test
 - e) Test report

Unit 4: Stem Cell Physiology**(15 L)****Objectives:**

- *To introduce the learner to the fundamentals of stem cell physiology.*

Desired outcome:

- *The learners shall comprehend the physiological aspects of stem cells and their functions in homeostasis of tissues, embryonic and somatic stem cells, cancer stem cells and stem cell therapy.*

- 4.1 Introduction to stem cell
- 4.2 Differentiation, dedifferentiation and redifferentiation
- 4.3 Wnt Signaling pathway
- 4.4 Orchestrating Wnt / B-catenin signaling
- 4.5 Somatic and cancer stem cells
- 4.6 Role of stem cells in physiology, pathophysiology and therapy
- 4.7 Future of stem therapy as an alternative to organ transplant

PAPER 4: PSZOPHY404

INSTRUMENTATION AND PRESENTATION OF SCIENTIFIC DATA

Unit 1: Instrumentation

(15 L)

Objective

- *To learn how to design and build instruments for laboratory measurement.*
- *To understand fundamental principles of operation.*

Desired Outcome

- *The learner will understand methods for operation of instruments and data analysis.*
- *The learner will understand how instrumentation can advance scientific research.*

1.1 Centrifugation:

- Principle and applications of Centrifugation
- Differential and density gradient Centrifugation

1.2 Electrophoresis:

- Principle
- Structural components
- Applications

1.3 Chromatography:

- Principle and applications
- Adsorption
- Ion exchange
- Gel permeation
- Affinity

1.4 Spectrophotometer:

- Principle
- Applications

1.5 pH meter

- Principle
- Applications

1.6 Microscopy

- Binocular
- Trinocular

Unit 2: Presentation of Scientific data

(15 L)

Objective

- *To aware the students for good practice in data presentation.*
- *To aware the students to use different data presentation formats.*

Desired Outcome

- *The students will familiarize to explain their research data by using different techniques for presenting their scientific data.*

2.1 Types of presentation:

- Oral
- Poster
- Written
- Audio-visual

Aids for presentation

2.2 Preparing the manuscript

- Guidelines for authors
- The IMRAD format

2.3 Title, Byline, Abstract and Summary, Keywords

2.4 Introduction:

- Defining the problem
- Literature survey
- Justification of study

2.5 Materials and Methods:

- Contents
- Sources
- Procedures
- Techniques
- Reproducibility
- Significance

2.6 Results:

- Text
- How to present data
- Tables and illustrations
- Writing captions
- Labels and legends

2.7 Discussion:

- Components and Sequence
- Analysis, Comparison and Integration of Data
- Likely Sources of Errors in Results

2.8 Conclusions and significance

Unit 3: Project

(30 L)

Objective

- *To familiarize learner for analyzing a scientific occurrence with an investigation or to solve a problem with an invention.*

Desired Outcome

- *Research expands the current state of knowledge (at a certain cost) of the learners.*
- *Experimental findings that may yield new insights or lead to other research among the learners.*

- 1. Dissertation 60 Marks**
- 2. Examination 50 Marks**

Guidelines to the 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 type-written using computer and printed for binding.

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 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 individual power point presentation (PPT) on the project and must present it in front of examiners at the time of examination.

7. The project will be prepared individually by students.

M. Sc. Part 2: Semester IV Practical

Practical 1: PSZOPHY4P1

1. Water and ionic regulation of freshwater animal in different osmotic media.
2. Estimation of sugar from blood plasma.
3. Extraction of glycogen from muscle and liver.
4. Estimation of liver glycogen content.
5. Preparation of glycerinated muscle fibre and study of its properties.
6. Study of nerve cells and neurosecretory cells of cockroach.
7. Study of various types of invertebrate physiological effectors.
8. Study of irritability in *Paramoecium*.
9. Study of different sense organs in the vertebrates.

Practical 2: PSZOPHY4P2

1. Study of hormones in invertebrates.
2. Study of endocrine gland of vertebrates.
3. Effect of insulin /adrenalin on fish scales.
4. Effect of insulin/ adrenaline on rate of heart beat in *Daphnia* and chick embryo.
5. Effect of light and dark phase on *Drosophila*.
6. Study of X and Y organs in crab.
7. Study of estrous cycle of rat using histological slides or photographs.
8. Study of menstrual cycle.
9. Study of migration in animals in relation to food, reproduction and environment.
10. Study of migratory routes in birds and fishes.

Practical 3: PSZOPHY4P3

1. Estimation of LC_{50} or LD_{50} of an organo-phosphorous pesticide on *Artemia* cysts.
2. Designing protocols for toxicity experiments such as acute, sub-acute toxicity, reproduction toxicity, dermal toxicity.
3. Determination of pesticide residues in soil or water.
4. Effect of administration of carbon tetra chloride in rat/mice with reference to the following parameters:
 - a) Total lipid and free fatty acid content of liver
 - b) Free fatty acid content of plasma
 - c) Level of activity of the following enzymes:
 - i. AspAT
 - ii. AlaAT
 - iii. AICP
 - iv. ACP
 - v. LDH
 - vi. SDH
5. Study of stem cells in animals.
6. Visit to an animal house/clinical trial laboratory. Prepare a report on its role and significance.

Practical 4: PSZOPHY4P4

The practical of Semester 4 paper 4 comprises the Research Project for which students will have to take up a particular topic based on which they will be doing research applying the ethics of research, methods and methodology, etc. They are expected to abide rules of Scientific Research and if possible derive at a conclusion for the same. This will help the learners to build a strong foundation for pursuing research. Learners will acquaint about preparation of lay out, structure and language of typical reports, illustrations and tables. Learners will gain knowledge about how to write bibliography, referencing and footnotes in reports and thesis or in research articles.

Further, learners will be oriented to presentation of data through effective communication with the help of advanced visual technology. In addition to that they will be aware about the application of results, environmental impacts, conservation of biodiversity, ethical issues and ethical committees. The practical should be organized in such a manner that learners can be trained to manage large data sets generated via multiple observations, arrange them in a proper format and present them in relevant graphs/charts by adopting a hands-on in silico approach.

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University of Mumbai
M.Sc. ZOOLOGY (Animal Physiology) Semester III and
Semester IV EXAMINATIONS
Modality of Assessment

A. Internal Assessment 40%

Sr. No.	Evaluation type	Total Marks
1	One Assignments / Case study	25
2	Active participation in routine class instructional deliveries	05
3	Attendance – (0-25% = 0 marks, 25-50% = 1mark, 50-75% = 3 marks and 75-100%= 5 marks)	05
4	Overall conduct as a responsible student, manners, skill in articulation, leadership qualities demonstrated through organizing co-curricular, etc.	05

B. External Assessment 60%

a. Semester End Examination 60 Marks

- Duration – These examinations shall be of two and half hours duration for each paper.
- Theory Question Paper Pattern:
 - ❖ There shall be five questions each of 12 marks. On each unit there will be one question and the first one will be based on entire syllabus.
 - ❖ All questions shall be compulsory with internal choice within the questions. Each question will be of 18 to 30 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.

b. Practicals: 50 Marks

c. Project in Semester IV: Internal Examination 40 Marks
Dissertation: 60 Marks
External Evaluation: 50 Marks

***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 neighbouring colleges.

Use of animals for any experiment / dissection /mounting is banned. Simulations, authorized permanent specimens / slides, charts, models and other innovative methods are encouraged.

University of Mumbai
M.Sc. ZOOLOGY (Animal Physiology) Paper Pattern of
Semester III (Papers 1, 2, 3, 4) / IV (Papers 1, 2, 3) Examination

Maximum Marks: 60

Duration: 2.5 Hours

Marks Option: 90

Question 1. Based on Unit I to IV (Mixed Questions)

Question 2. Based on Unit I

Question 3. Based on Unit II

Question 4. Based on Unit III

Question 5. Based on Unit 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 Units) **(12)**
 - a)
 - b)
 - c)
 - d)
 - e)
 - f)
2. Answer any **two questions** from the following: (Based on Unit I) **(12)**
 - a)
 - b)
 - c)
3. Answer any **two questions** from the following: (Based on Unit II) **(12)**
 - a)
 - b)
 - c)
4. Answer any **two questions** from the following: (Based on Unit III) **(12)**
 - a)
 - b)
 - c)
5. Answer any **two questions** from the following: (Based on Unit IV) **(12)**
 - a)
 - b)
 - c)

Semester IV Examination
Paper IV: Instrumentation and Presentation of Scientific data
Internal (Theory) Paper Pattern of PSZOPHY404

Maximum Marks: 40

Duration: 1.15 Hours

Marks Option: 60

Instructions:

- a. All questions are compulsory.
 - b. Draw neat and labeled diagrams wherever necessary.
-
1. Fill in the blank by choosing the correct option given in the brackets (Based on both Units) Four sub-questions from each unit. **(08)**

 2. Answer any **two questions** from the following: (Based on Unit I) **(16)**
 - a)
 - b)
 - c)

 3. Answer any **two questions** from the following: (Based on Unit II) **(16)**
 - a)
 - b)
 - c)

Skeleton of Practical Examination Question Paper

Practical Paper 1: PSZOPHY3P1

Time: 10:00 am to 3:00 pm

Total Marks: 50

- 1. Major Question** **18**
Dissect Earthworm / Crab / Cockroach so as to expose its digestive system.
OR
Dissect Cockroach so as to expose its Nervous system.
- 2. Minor question**
Demonstrate the transport of glucose across semi-permeable membrane (egg membrane). **09**
OR
Demonstrate the effect of suitable toxicant (heavy metal / nicotine) on the heartbeat of *Daphnia*. **09**
OR
Calculate the respiratory quotient of cockroach with the help of respirometer. **09**
- 3. Identify and mention the parts of invertebrate excretory organs. (Any two)** **07**
- 4. Identification**
Identify the insect mouth parts with respect to their modifications and adaptations. (Two spots). **06**
- 5. Viva- voce.** **05**
- 6. Journal.** **05**

Practical 2: PSZOPHY3P2

Time: 10:00 am to 3:00 pm

Total Marks: 50

- 1. Major question** **18**
- Determination of activities of Amylase / Trypsin from suitable source (human saliva for amylase, Intestine of goat or chicken for trypsin) and Determination of Km of a given enzyme.
- OR**
- Determination of effect of pH / Temperature / Activator / Inhibitor on the activity of salivary / pancreatic amylase enzyme.
- OR**
- Determination of isotonic concentration to blood by studying the effect of different concentrations of sodium chloride on the diameter of RBCs.
- OR**
- Show the influence of sublethal concentration of ammonia (50-60 ppm) on suitable fish exposed to ammonia stress for 3/7 days with reference the following parameters:
- i. Level of excretory ammonia **08**
 - ii. Level of activity of hepatic and brain glutamate dehydrogenase. **10**
- OR**
- ii. Level of amino acid content of muscle / gill / brain / liver. **10**
- 2. Determine the cholesterol / urea / uric acid / creatinine content in the given blood sample.** **08**
- 3. Prepare a report from the given**
- Parameters of routine test: renal function/liver function/ Stress test/Polycythemia/ urine. **12**
- OR**
- X-ray / CT scan images. Interpret the result and submit the report. **12**
- 4. Viva- voce.** **05**
- 5 Journal.** **05**

Practical 3: PSZOPHY3P3

Time: 10:00 am to 3:00 pm

Total Marks: 50

1. Major question

18

Set up an experiment to demonstrate the effect of decreasing PO_2 of water on the respiratory rate of a fish / lactic acid content of fish muscle. Compare it with control fish and submit the report.

OR

Estimate the salt loss and salt gain in an aquatic animal when it is transferred to a salt free and natural medium.

2. Minor question

a) Separate from the given sample serum globulin / plasma proteins by PAGE electrophoresis.

12

b) Demonstrate the effect of temperature on development of chick embryo / opercula movement of fish.

10

3. Viva-voce.

05

4. Journal.

05

Practical 4: PSZOPHY3P4

Time: 10:00 am to 3:00 pm

Total Marks: 50

- | | |
|--|-----------|
| 1. Major question | 18 |
| Demonstration of immune-diffusion by Ouchterlony technique. | |
| OR | |
| Demonstration of single radial immune-diffusion of antigen and antibody. | |
| OR | |
| Demonstration of counter current immune electrophoresis. | |
| 2. Minor question | |
| a) Study of phagocytosis / Separation of lymphocytes. | 09 |
| b) Perform Agglutination Reaction: Tube Agglutination Reaction / Slide Agglutination Reaction / Indirect Agglutination Inhibition Reaction. Submit a report. | 07 |
| 3. Identify lymphoid tissue and lymph node/bone marrow. (Any two slides) | 06 |
| 4. Viva- voce. | 05 |
| 5. Journal. | 05 |

Practical 4: PSZOPHY4P1

Time: 10:00 am to 3:00 pm

Total Marks: 50

1. Major question 18
 - a) Demonstrate water and ionic regulation in the given freshwater fish in different osmotic media. (Any 3 media).

OR

 - b) Estimate the blood sugar level / liver glycogen in the given sample. Interpret the result and submit the report.
2. Prepare a setup to show the properties of glycerinated muscle fibre. 10
3. Identification: 12
 - a) Sense organs (vertebrates)
 - b) Physiological effectors (invertebrates)
4. Viva- voce. 05
5. Journal. 05

Practical 4: PSZOPHY4P2

Time: 10:00 am to 3:00 pm

Total Marks: 50

- 1. Major Question** **18**
Set up an experiment to demonstrate the effect of insulin / adrenaline on rate of heartbeat In *Daphnia*. Compare with control *Daphnia* and submit the report.
OR
Set up an experiment to show the effect of light and dark phase on *Drosophila*. Submit the report.
- 2. Identification:** **12**
a) The endocrine glands (vertebrates) and
b) The hormones (invertebrates)
OR
From the given data identify the migratory routes birds / fishes. Interpret the reason for migration.
- 3. Identify stage of:** **10**
a) estrous cycle
b) menstrual cycle
- 4. Viva voce.** **05**
- 5. Journal.** **05**

Practical 4: PSZOPHY4P3

Time: 10:00 am to 3:00 pm

Total Marks: 50

1. Major Question

Show the toxicity effect of carbon tetra chloride in rat / mice with reference to the following parameters:

18

Level of enzyme activity:

- i. AspAT and AlAT
- ii. ACP / ALP, SDH, LDH

OR

a) Total lipid and free fatty acid content of liver.

09

b) Free fatty acid content of plasma.

09

2. Design protocol for toxicity experiment from the data provided.

12

- a) Acute and sub-acute toxicity
- b) Reproduction toxicity
- c) Dermal toxicity

3. Submit a report of visit to animal house/clinical trial laboratory and viva based on it.

10

4. Viva voce.

05

5. Journal.

05

Practical 4: PSZOPHY4P4

Evaluation of Project: 60 Marks

- | | | |
|----|--|------|
| 1. | Title of the Project | (01) |
| 2. | Aim, Objectives and Rationale | (04) |
| 3. | Materials and Methods | (05) |
| 4. | Observations and / Results | (10) |
| 5. | Interpretation of Observations / Results and Discussion | (10) |
| 6. | Conclusion and / Recommendation | (10) |
| 7. | Relevant work / Justification of work with Project title | (10) |
| 8. | Relevant References | (05) |
| 9. | Certified Dissertation | (05) |

External Evaluation: 50 Marks

- | | | |
|----|--|------|
| 1. | Content of Presentation | (10) |
| 2. | Quality of Presentation | (10) |
| 3. | Presentation Skill | (10) |
| 4. | Quality of Work | (10) |
| 5. | Viva based on Proposal / Question Answer Session | (10) |

UNIVERSITY OF MUMBAISyllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course	Zoology (Entomology)
2	Eligibility for Admission	The students who have granted both the Semesters and might have or have not cleared their Semester I and Semester II are eligible.
3	Passing Marks	40% in each Paper
4	Ordinances Regulations (if any)	-----
5	No. of Years Semesters	Two Semesters
6	Level	P.G. U.G. Diploma Certificate (Strike out which is not applicable)
7	Pattern	Yearly Semester (Strike out which is not applicable)
8	Status	New Revised (Strike out which is not applicable)
9	To be implemented from Academic Year	From Academic Year 2020-2021

Date:

Signature :

Name of BOS Chairman / Dean: Dr. Bharmal Deelip L.

Dr. Anuradha Majumdar

 Dean, Science & Technology

UNIVERSITY OF MUMBAI



Program: M.Sc.

Course: Zoology **(Entomology)**

Syllabus for Semester III & IV

(Choice Based Credit System
with effect from the academic year 2020-21)

**M.Sc. Part II (Semester III and Semester IV): Zoology (Entomology) Syllabus
Committee Members**

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- 6. Practical Syllabus for Semester III
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- 7. References
(Course codes: PSZOENT301- PSZOENT304)**
- 8. Theory Syllabus for Semester IV
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PREFACE

The main objective of reconstructing the Post Graduate syllabus of Zoology for Semester III and Semester IV is to provide global level advanced and skill oriented deep knowledge to the stakeholders which is currently needed for their survival. The current research and teaching in Zoology includes diverse aspects with a balance of organismic and reductionist biology. It offers teaching and research programs in the diverse areas, such as, Animal Physiology, Entomology, Fish Biology, Immunology, Developmental Biology, Cell Signaling, Cell Biology, Radiation Biology, Reproductive Biology, Endocrinology, Genomics, Metagenomic, Cancer Biology, etc. Our vision is to provide Global Knowledge in education, training & research in the field of Zoology where teaching and research encrust detailed understanding from microbes to human. The broad skills and deeper knowledge in the field would make them highly successful and excellent researcher in advanced areas of research in the Biological sciences.

Therefore, the Board of Study in Zoology aims to impart holistic understanding of Zoology by “redefining Zoology” to students of every age so that they develop interest in Science. It also aims to develop teaching and research programs that have relevance to society and employability. The M.Sc. program is being revised under CBCS scheme of UGC to meet the expectations of students.

To keep all of the above factors in mind, this syllabus was developed by the curriculum committee of Mentors, subject experts from other Universities and dedicated teachers. Their major role was to abridge, grow, augment and give a forward bearing to Zoology taught in undergraduate curriculum, with projections to future requirements. They have successfully completed this colossal task. I congratulate them.

Dr. Deelip L. Bharmal
Chairman Board of Studies in Zoology University of Mumbai

PREAMBLE

I am extremely happy to present this new syllabus of Semester III and Semester IV to the teachers and students of Post Graduate Course in Zoology of the specializations, Oceanography and Fishery Technology, Entomology, Endocrinology, Animal Physiology and Environmental Science. While constructing the syllabus, the relevant inputs have been considered from Mentors, subject experts from various fields of other Universities, teachers and stakeholders to make it more effective.

An attempt has been made to make post graduate courses competitive and on par with global standards, as per the directives of University Grant Commission for the implementation of choice based credit system. Hence as per the guideline of UGC the present syllabus is made more interesting with new, innovative topics as per need of the current situation of the world and stakeholders.

The M.Sc. Zoology program provides an appropriate blend of classical and applied aspects of the subject. This newly designed curriculum will allow students to acquire skills in handling scientific instruments planning and performing in the laboratory and exercising critical judgment, independent thinking and problem solving skills.

The utmost care has taken to declare the final syllabus well in advance to enable the teachers to make preparations before commencement of the academic year and facilitating students to execute their right to know the details before admissions.

The draft of Syllabus was approved in meeting of the Board of Studies in Zoology held on 10th March 2020, and it was unanimously resolved to implement the revised syllabus of Zoology at M.Sc. Semester-III and IV and make it effective from the Academic Year 2020-2021 after approval from concerned authorities of the University.

The success of this revamped syllabus will depend totally on the enthusiasm and interest shown by the stakeholders.

Dr. Nisar Shaikh
Chairman, M.Sc. Part II
Syllabus Committee

PEDAGOGY

The course **PSZOENT301 'Taxonomy, Phylogeny and Diversity of Insects'** introduces the learner to the fascinating world of insect classification. The learner will get oriented to topics such as extinct insects, basics of insect taxonomy and useful keys. Photographic documentation during field visits and observations of museum collections will be helpful to generate interest in taxonomy. The practical course will equip the learner to designate the observed insect to its respective order and family and also understand the basic morphology of head, thorax, abdomen and the related appendages in some commonly occurring insects. It will also give an opportunity to prepare dichotomous keys for understanding classification of insects. Field visits to forests, agricultural systems, gardens, aquatic ecosystems and household areas will enable the learner to understand insect diversity and classify them using the characteristics of respective orders and families. The learners can also visit place that have taxonomic databases available for classification studies. Activities like butterfly walks can be conducted to generate interest in taxonomy. Web-based field guide can be developed to classify the insects recorded during field visits. The information about simple mobile based apps can be shared to increase motivation. This course will also allow the learner to understand basic morphology of head, thorax, abdomen and the related appendages in some commonly occurring insects.

The course **PSZOENT302 'Insect Anatomy and Physiology'** will help develop a strong foundation in Entomology, including understanding of the importance of insects' anatomy and physiology. This course will assist in understanding of the anatomical and physiological similarities and differences in various systems of insects like digestive, respiratory, reproductive, nervous, etc. Learners will get familiar with external and internal features of insects. The course will help in understanding moulting and sclerotization process, and integument formation in insects. Practical aspects of this course could be undertaken through observation of various system found in locally available insects in laboratory level, observation of life cycle of various insects that can be cultured in the laboratory as per the ethical permission granted or teachers are expected to show the video clips, photographs for the understanding of the topics.

The course **PSZOENT303** It is crucial time to explore scientifically the useful insects like lac insects, silk moths and honey bees in our country. Student community shall be given enough academic support to get indulged in bio-industries viz, lac-culture, sericulture and apiculture. Although, we are recognized as one of the leading nation in lac export, we have not generalized its natural products up to the high level. It may be due to lack of practical approach towards exploitation of these short lived insects. Credit / Choice based grading system offers wide scope to study use of renewable natural resources like lac moths and silk moths which adds to the national income. Worldwide insects as versatile living being form food in China, primary consumer or secondary consumer in ecosystems, major pollinators in agriculture, sericulture and horticulture. As an interdisciplinary trend, flesh flies life cycles enable us to investigate the time of death of an individual. So, forensic science also depends on such insects.

The course **PSZOENT304** Biological vectors like, *Glossina*, *Phlebotomus*, *Anopheles*, *Culex*, *Aedes*, *Xenopsylla*, *Periplaneta*, *Musca* species are well elaborated with reference to avoid transmission of dreadful diseases, the learners are expected to familiarize with this. The nature of damaged caused by stored grain and agricultural insect pests shall be main concerned of teaching which would probably be useful to take serious preventive and curative action against pests. Usually, insect-pests and bio-vectors population should be checked by employing Integrated Pest Management (IPM). Pest control agencies should be strictly warned not to use chlorinated carbon compounds to stop bio-magnifications and avoid subsequent ill effects on member of other trophic levels in the food chain. Lastly it is advisable to search for government and non-government funding agencies viz, DIC, NABARD, Nationalized Banks which offers subsidized loans for agriculture supporting projects. To understand, commercialization of bio-industrial projects, feasibility report shall be well understood. Students could be trained practically

to establish 'butterfly garden' in metropolitan cities.

The **course PSZOENT401** introduces the learners to classification, habit, life history, damage and control of insect pests of agriculture, and related to medical and veterinary importance. Interaction with local farmers and visit to agricultural areas will give better understanding of the life cycle of such agricultural pests and the control measures. Visit to cattle farm, horse stables and veterinary clinics and hospitals will be helpful to understand the damage caused and the treatment followed. The practical course will include the study of damage causing stages of these pests using suitable specimen or photographs. The practical course includes equip the learner to identify the economically important pests from household, agriculture, forest, medical and veterinary field. The damage causing stages of these pests can be studied from suitable specimen or photographs.

The **course PSZOENT402** has developed a strong foundation in entomology, including understanding of the importance of insects to human society. The learners expected to familiarize with identification of insect pests, vectors and their control methods. This course also provides sufficient background for those students who wish to study more advanced entomological aspects. In unit 1 learner will be able to understand the various forest pests with respect to life cycle, nature of damage and control measures. Unit 2, Forensic Entomology, learner will be able to understand the role of insects in crime investigation. In unit 3 and Unit 4 included basic principle of insect pest control such as chemical, biological and its application and limitations. The knowledge of these topics will set up ideal base for learners to move in to field of applied entomology for their interest. Teacher should arrange a visit to nearby Forest area, Forensic lab, Insect Museum, BNHS or ZSI etc. so that learners expected to understand the theoretical approach in much better way.

The course **PSZOENT403** deals with new avenues of subject Entomology of modern time in present scenario. Objective this course is to make the students in the entrepreneur approach. Today's time the insects are used as Medicine, Ornamental Entomology creates interest to visualize insects in attractive ways. In the light of insect weapon, learners will be familiarized with this new avenue. Biotechnology aspects, insect genomic and insect proteomic are advanced fields where the insects are studied in molecular level. Learners are expected to know this field, too. Computer based tool are also new avenue thereby learners are exposed on the light of Bioinformatics with reference to insect world.

The **course PSZOENT404** consists of Instrumentations and Presentation of Scientific data which help the students to choose suitable measuring instruments for their applications and understanding of limitations, principles and measurement errors. The students will aware the efficiency of the instruments. Similarly the course also has the unit of presentation of scientific data. Text, tables, and graphs for data and information presentation are very powerful communication tools. They can make scientific report easy to understand, attract and sustain the interest of beneficiary.

Convener and Committee Members

M. Sc. II Zoology Syllabus
Choice Based Credit System
To be implemented from the Academic Year 2020-2021

Entomology: Semester III						
Course Name and Code	Unit	Topic Headings	Credit	Lecture/ Week	College Assessment Internal	University Assessment External
Paper I:Taxonomy, Phylogeny and Diversity of Insects						
PSZOENT301	1	Introduction, History and Classification of Insects up to Families	4	1	40	60
	2	Hemimetabola (Pterygota)		1		
	3	Holometabola - I		1		
	4	Holometabola - II		1		
Paper II: Insects Anatomy and Physiology						
PSZOENT302	1	The Integument, Digestive System and Muscles	4	1	40	60
	2	Respiration, Circulation and Excretion		1		
	3	Nervous system, Sense organs and Endocrine system		1		
	4	Reproduction		1		
Paper III: Insects Preservation, Genetics, Type study and Sericulture						
PSZOENT303	1	Insects Collection, Preservation and Culture	4	1	40	60
	2	Insect Genetics – Drosophila		1		
	3	Type animal – Butterfly		1		
	4	Industrial Entomology: Sericulture		1		
Paper IV: Insects Ecology and Economic Insects						
PSZOENT304	1	Useful Insects of Economic Importance	4	1	40	60
	2	Insects in Relation to other Organisms		1		
	3	Insect Ecology – I		1		
	4	Insect Ecology – II		1		
		Total	16	16	160	240
Practicals						
PSZOENT3P1	Practicals based on PSZOENT301		2	4	–	50
PSZOENT3P2	Practicals based on PSZOENT302		2	4	–	50
PSZOENT3P3	Practicals based on PSZOENT303		2	4	–	50
PSZOENT3P4	Practicals based on PSZOENT304		2	4	–	50
	Total		8	16	–	200
	Grant Total		24	32	160	440

Entomology: SEMESTER IV

Course Name and Code	Unit	Topic Headings	Credit	Lecture/ Week	College Assessment Internal	University Assessment External
Paper I: Agriculture, Medical and Veterinary Entomology						
PSZOENT401	1	Agricultural Entomology – I	4	1	40	60
	2	Agricultural Entomology – II		1		
	3	Medical Entomology		1		
	4	Veterinary Entomology		1		
Paper II: Forest, Forensic Entomology and Insect Toxicology						
PSZOENT402	1	Forest Entomology	4	1	40	60
	2	Forensic Entomology		1		
	3	Insect Control and Toxicology – I		1		
	4	Insect Control and Toxicology – II		1		
Paper III: Neo-Entomology, Computational Entomology and Insects Biotechnology						
PSZOENT403	1	Neo-avenues in Entomology	4	1	40	60
	2	Insect Biotechnology and Molecular Biology – I		1		
	3	Insect Biotechnology and Molecular Biology – II		1		
	4	Insect Bioinformatics		1		
Paper IV: Instrumentation and Presentation of Scientific data						
PSZOENT404	1	Instrumentation	2	1	40	60
	2	Presentation of Scientific data		1		
	3	Project		2		
		Total	16	16	160	240
Practicals						
PSZOENT4P1	Practicals based on PSZOENT401		2	4	–	50
PSZOENT4P2	Practicals based on PSZOENT402		2	4	–	50
PSZOENT4P3	Practicals based on PSZOENT403		2	4	–	50
PSZOENT4P4	Practicals based on PSZOENT404		2	4	–	50
	Total		8	16	–	200
	Grant Total		24	32	160	440

M. Sc. Part 2: Semester III (Theory)
PAPER 1: PSZOENT301
TAXONOMY, PHYLOGENY AND DIVERSITY OF INSECTS

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

Objective:

- *To introduce learners to the field of Entomology and the basics of Insect Classification.*

Desired outcome:

- *The learner will be able to understand the basic Taxonomic keys and its use for Classification of insects.*

- 1.1 Introduction to Entomology
- 1.2 History of Insect Classification
- 1.3 Extinct Insects
- 1.4 Taxonomic Keys of Identification
- 1.5 Classification of insects up to families: Ametabola (Apterygota) – Thysanura, Diplura, Protura, Collembola

Unit 2: Hemimetabola (Pterygota) (15 L)
(Classification of insects up to families)

Objective:

- *To familiarize learners to the classification of Hemimetabola.*

Desired outcome:

- *The learner will be able to classify the important orders of insects from Hemimetabola and understand the characteristics of important families with examples.*

- 2.1 Ephemeroptera, Odonata, Plecoptera, Grylloblattoidea
- 2.2 Orthoptera, Phasmida, Dermaptera, Heteroptera, Hemiptera
- 2.3 Embioptera, Blattaria, Mantodea, Isoptera
- 2.4 Zoraptera, Psocoptera, Siphunculata

Unit 3: Holometabola – I (15 L)
(Classification of insects up to families)

Objective:

- *To familiarize learners to classification of insects from Holometabola.*

Desired outcome:

- *The learner will be made aware of the characteristics of some important orders of Holometabola and their important families with suitable examples.*

- 3.1 Thysanoptera, Neuroptera, Mecoptera
- 3.2 Trichoptera, Strepsiptera, Siphunculata

Unit 4: Holometabola – II

(15 L)

(Classification of insects up to families)

Objective:

- *To familiarize learners to classification of insects from Holometabola.*

Desired outcome:

- *The learner will be aware of the characteristics of four important orders of Holometabola and their important families with suitable examples.*

- 4.1 Diptera
- 4.2 Coleoptera
- 4.3 Lepidoptera
- 4.4 Hymenoptera

PAPER 2: PSZOENT302

INSECT ANATOMY AND PHYSIOLOGY

Unit 1: The Integument, Digestive System and Muscles

(15 L)

Objective:

- *To familiarize the learners with external and internal features such as digestive system of insects.*

Desired outcome:

- *The unit would allow learners to study about structure and physiology of integument, digestive system and muscle structure in insects.*

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

(15 L)

Objective:

- *To familiarize the learners with various systems such as respiration, circulation and excretion in insects.*

Desired Outcome:

- *Learners will be able to grasp the concepts of respiratory system and its mechanism, parasitic and aquatic respiration, physiology of circulation, haemocytes, excretory system in insects, Malpighian body and osmoregulation.*

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 Tracheal system

2.1.4 Respiration in Parasitic 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 Excretory system structure of Malpighian Tubules

2.3.2 Physiology of Excretion and Osmoregulation

Unit 3: Nervous system, Sense organs and Endocrine system

(15 L)

Objective:

- *To familiarize learners with nervous system, sense organs and endocrine system of insects.*

Desired outcome:

- *Learners would acquire knowledge of physiology of nervous system and endocrine glands and their function.*
- *Learners will gain information about insect sense organs their structure and function.*

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 Neurobio-chemistry

3.2 Sense organs

3.2.1 Photoreceptor

3.2.2 Mechanoreceptor

3.2.3 Audioreceptor

3.2.4 Effectors 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

(15 L)

Objective:

- *To familiarize students with insect reproduction.*

Desired outcome:

- *Learners will acquire the knowledge of reproduction, development of insect, structure of larvae, pupae and adults.*

4.1 Structure of Male Reproductive system

4.2 Structure of Female Reproductive system

4.3 Physiology of reproduction

4.4 Embryonic development

4.4.1 Egg

4.4.2 Cleavage

4.4.3 Blastoderm formation

4.4.4 Gastrulation and Growth of Germ layer

4.5 Types of Larvae and Pupae

PAPER 3: PSZOENT303

INSECTS PRESERVATION, GENETICS, TYPE STUDY AND SERICULTURE

Unit 1: Insects Collection, Preservation and Culture

(15 L)

Objective:

- *To introduce branches of applied entomology and industrial entomology sericulture.*

Desired outcome:

- *It will help in learning Insects preservation techniques and also insect culture techniques.*
- *It will help in learning about versatile role of insects in Indian economy.*

1.1 Insect Collection

1.1.1 Equipment for collection of Insect

1.1.2 Insect collection kit:

- a) Killing bottles
- b) Aspirator (Suction Bottle)
- c) Suction tube (Pooter)
- d) Insect or butterfly Net
- e) Beating Tray
- f) Light Trap, Sticky trap, Water trap, Pit fall trap, Pond trap
- g) Insect setting board
- h) Cards (Triangular, Rectangular)
- i) Hand lens
- j) Pen knife or scalpel, scissors, forceps
- k) Notebook and pencil
- l) 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 Trapping – Light traps, Sticky traps, Water traps, Pitfall traps, Bait sand bait traps

1.2.6 Pond Net

1.2.7 Insects collection from debris

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

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

1.3 Insect Preservation

1.3.1 Temporary storage

1.3.2 Permanent preservation

- a) Direct pinning
- b) Carding, Triangle carding or pointing
- c) micro pinning or staging
- d) Setting or spreading
- e) Labeling

1.3.3 Liquid Preservation technique for soft bodies Insects

1.3.4 Mounting - preparation of permanent slides

- a) Maceration
- b) Dehydration
- c) Clearing
- d) Mounting
- e) Mounting

f) Finishing

1.4 Culture of Insects

1.4.1 Keeping adult insects alive

1.4.2 Insect Rearing

1.4.3 Insect Breeding

Unit 2: Insect Genetics – *Drosophila*

(15 L)

Objective:

- *To introduce insect genetics with *Drosophila* as example to learn genetics.*

Desired outcome:

- *Learners will be able to understand insect genetics, its role in formation of new species along with closed phylogenetics relationship among insects.*

2.1 *Drosophila* Genetics

2.1.1 Introduction to *Drosophila* Genetics

2.1.2 Advantages

2.1.3 Methodologies

2.1.4 Balanced lethal systems

2.2 Polytene chromosome

2.2.1 Polytenisation process

2.2.2 Significance

2.2.3 Features

2.2.4 Puffs, regulation of puffing

2.2.5 Evidences of transcriptional activity

2.2.6 Induction by stress

2.3 Sex Determination

2.3.1 Sex Determination and dosage compensation

2.3.2 Chromosomal genetic and molecular aspects

2.3.3 Behavioural and Neuro-Genetics

2.3.4 Behavioural traits, mutants, tools & Methodologies for genetic analysis

2.3.5 Genetic and molecular basis of behavioral traits in *Drosophila*

2.3.6 *Drosophila* Transposons & Phenocopies

Unit 3: Type animal – Butterfly

(15 L)

Objective:

- *To study Butterfly as a model insect.*

Desired outcome:

- *Learners will understand classification and diversity of butterflies.*
- *Learners will also understand general morphological structure, anatomy, physiology, and systems of butterfly.*

3.1 Classification and diversity

3.2 Morphology

3.3 Digestive system

3.4 Circulatory system

3.5 Nervous system

3.6 Reproductive system

Objective:

- *To introduce Industrial Entomology with a special reference to sericulture industry.*

Desired outcome:

- *Learners will gain knowledge about sericulture practices like silkworm rearing, cocoon production and marketing of cocoon.*

4.1 History of Sericulture

4.2 Host plants of Mulberry and non-Mulberry Silkworm especially present in Western Ghats of Konkan Region

4.3 Life cycle of Mulberry and non-Mulberry Silkworm

4.4 Rearing of Mulberry silkworm and Tasar Silkworm

4.5 Diseases and Pests of Mulberry silkworm and Tasar silkworm

4.6 Moriculture and Marketing of sericulture products

PAPER 4: PSZOENT304

INSECT ECOLOGY AND INSECTS OF ECONOMIC IMPORTANCE

Unit 1: Useful Insects of Economic Importance

(15 L)

Objective:

- *To introduce learners to the field of Economic Entomology and its importance.*

Desired outcome:

- *Learners also gain information of lac culture, Apiculture and its importance.*
- *Learners will become oriented to nutritional role of insects.*
- *Learners will acquire the knowledge of apiculture in which they gain techniques of bee keeping extraction and marketing of honey.*

- 1.1 Types and Life history of Honey bees used in Apiculture
- 1.2 Bee Keeping Management & Prospects
- 1.3 Life History and Cropping of Lac insect
- 1.4 Lac – Utility and scope of Lac industry
- 1.5 Nutritional Entomology
 - 1.5.1 Insects as a food
 - 1.5.2 Example of Insects generally consumed
 - 1.5.3 Advantages of Eating Insects (Entomophagy) – Nutritional Value
 - 1.5.4 Entomophagy as a source of income

Unit 2: Insects in relation to other organisms

(15 L)

Objective:

- *To introduce the insect and plants association.*

Desired outcome:

- *They will also gain knowledge about insect feeding habits and role of insects in pollination.*
- *Learners will obtain the knowledge of positive and negative interaction among insects and plants as well as other animals.*

- 2.1 Insect – Plant interaction
 - 2.1.1 Types of positive and negative interaction
 - 2.1.2 Leaf eater
 - 2.1.3 Frugivory
 - 2.1.4 Bark feeders
 - 2.1.5 Galls
 - 2.1.6 Pollination
- 2.2 Insect – Animal interaction. Types of positive and negative interaction
- 2.3 Insect – Insect interaction. Types of positive and negative interaction

Unit 3: Insect Ecology – I

(15 L)

Objective:

- *To facilitate the learning of insect population ecology, its dynamics and regulatory factors important for its sustenance.*

Desired outcome:

- *This unit would allow learners to study about nature of insect population, specific factors affecting its growth and its impact on the population of other life forms.*

- 3.1 Population Ecology
 - 3.1.1 Concept of population
 - 3.1.2 Buildup of insect population,
 - 3.1.3 Population dynamics and Characteristics
 - 3.1.4 Factors affecting insect population
 - a) Abiotic factors – Photoperiod, Temperature and Humidity.
 - b) Biotic factors – Food as a limiting factor for distribution and abundance,
- 3.2 Nutritional Ecology
 - 3.2.1 Food chain, Food Web and Ecological Succession
 - 3.2.2 Interspecific interactions – Basic factors governing the interspecific Interactions
- 3.3 High altitude Ecology
- 3.4 Polymorphism in Aphids
- 3.5 Mimicry in Insects
- 3.6 Venomous Insects

Unit 4: Insect Ecology – II

(15 L)

Objective:

- *To facilitate the learning of insect behavior and factors important for its sustenance.*

Desired outcome:

- *This unit would allow learners to study about nature of insect behaviour including social, communication, migratory and reproductive.*
- *Learners will also gain the knowledge about role of insects as environmental indicator.*

- 4.1 Social life in Termites, Ants and Wasps
- 4.2 Insect Migrations
- 4.3 Communication, Instinct, Learning and Memory
- 4.4 Courtship Behaviour and Mating in Insects
- 4.5 Swarming in insects with reference to Locust
- 4.6 Insect as Indicators of Environment

M. Sc. Part 2: Semester III Practical

PRACTICAL 1: PSZOENT3P1

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, other than the pests to be studied, of each order.
3. Study of insect head and its appendages.
4. Study of types of mouth parts and antennae: Cockroach, Mosquito, House Fly, Bedbug, Butterfly (any two whichever is available).
5. Temporary Preparation of slide: Mouth parts, Legs, antennae of Cockroach/Mosquito.
6. Mounting of Tentorium (Cockroach/Mosquitoes).
7. Study of Thorax and its appendages: Cockroach, Mosquitoes, Honey bees (Any two).
8. Mounting of halteres, wings and legs: Cockroach, Mosquitoes, Honey bees and Housefly.
9. Study of abdomen and its appendages: Cockroach, Honey bees, Mosquitoes (Any two).
10. Study of types of Genitalia, Cerci, Typhanum, Pseudolegs and Sting apparatus.
11. Field visit for collection of insect.

PRACTICAL 2: PSZOENT3P2

1. Dissection of following organ system of Insects: Cockroach, Housefly, Grasshopper, Bugs, Beetles (any two)
 - a) Digestive system
 - b) Nervous system
 - c) Reproductive system
2. Study of Histology (Permanent slides) of digestive system (Midgut), Neuroendocrine system (secretory cells) and reproductive system (Testes and ovary).
3. Estimation of total proteins in Haemolymph / tissues.
4. Estimation of carbohydrates in Haemolymph / tissues.
5. Estimation of digestive enzyme by DNSA method from mid-gut (amylase / invertase / Trehalase).
6. Study of Haemocytes and their total haemocyte count.
7. Demonstration of presence of chitin by using of chitosan test.
8. Uptake of dyes by Malpighian Tubes.
9. Chromatographic analysis of amino acids in insect Haemolymph.
10. Detection of uric acid as an excretory product of terrestrial insect.

Practical 3: PSZOENT3P3

1. Collection and preservation of insect (Dry and wet preservation).
2. Preparation of permanent slide of small insects.eg. Aphids, Jassids, cow bug etc.(At least two)
3. Study of collection equipment- pit fall traps, collection net, Berlelies funnel, light trap, chemical trap, etc.
4. Study of types of silk moths.
5. Study of various host plants of silkworm especially found in Konkan region.
6. Study of Rearing appliances of Mulberry silk worm and demonstration.
7. Industrial visit and submission of report (Sericulture / Apiculture / Lac culture).
8. Problem based on Drosophila Genetics.
9. Effect of UV radiation on Drosophila cultures.
10. Submission of insect collection (minimum 5 orders).

PRACTICAL 4: PSZOENT3P4

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 insect including comparison of types of baits / Time for recruitment of foragers / Time for removal of food material / Competition between two species
6. Chemical analysis of Honey samples.
7. Pathogens from suitable insects.
8. Different types of gall insects.
9. Mimicry and camouflage in insects:
 - a) Batesian (Any one example).
 - b) Mullerian (Any one example).
 - c) Camouflage – leaf insect, orchid, mantis, etc.

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M. Sc. Part 2: Semester IV (Theory)
PAPER 1: PSZOENT401
AGRICULTURE, MEDICAL AND VETERINARY ENTOMOLOGY

Unit 1: Agricultural Entomology I

(15 L)

(At least two major insect pests of each host to be studied)

Objective:

- *To introduce learners to the important insect pests of cereals, oil seeds, cotton, Sugarcane and stored grains.*

Desired outcome:

- *The learner will be aware of the classification, life history, damage caused and control of few insect pests of cereals, oil seeds, cotton, sugarcane and stored grain.*
- *Study of Insect pests with special reference to their classification up to families, appearance, habit, life history, distribution, host plant damage and control measures.*

- 1.1 Insect Pests of cereals- Rice, Jowar, Bajra, Wheat, Maize
- 1.2 Insect pests of oil seeds- Ground nut, Soyabean, Sunflower
- 1.3 Insect pests of Cotton and Sugarcane
- 1.4 Stored Grain Pests - *Tenebrio, Trogoderma, Bruchus*.

Unit 2: Agricultural Entomology II

(15 L)

(At least two major insect pests of each host to be studied)

Objective:

- *To introduce learners to the important insect pests of some vegetables, fruits, spices and flowering plants*

Desired outcome:

- *The Learner will be aware of the classification, life history, damage caused and control of few insect pests of vegetables, fruits, spices and some flowering plants.*
- ❖ *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.*

- 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 White flies, Scale insect.

Unit 3: Medical Entomology

(15 L)

Objective:

- *To introduce learners to the important insect vectors with reference to diseases in human.*

Desired outcome:

- *The learner will be aware of the classification, life history, disease transmitted and control of important insect vectors.*
- *Study of following insects as vectors of human diseases regarding their classification up to*

family, appearance, habit, brief life history, distribution, diseases caused and control measures.

- 3.1 Mosquito
- 3.2 Flea
- 3.3 Housefly
- 3.4 Tsetse fly
- 3.5 Sand fly
- 3.6 Blow fly
- 3.7 Stable fly
- 3.8 Warble fly

Unit 4: Veterinary Entomology

(15 L)

Objective:

- *To introduce learners to the insect pests of veterinary importance*

Desired outcome:

- *The Learner will be aware of the classification, life history, damage caused and control of insect pests of domestic animals.*
- 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.

- 4.1 Horse fly
- 4.2 Cattle blood sucking fly
- 4.3 Flesh fly
- 4.4 *Hypoderma*
- 4.5 Poultry louse
- 4.6 Screw worm fly

PAPER 2: PSZOENT402

FOREST, FORENSIC ENTOMOLOGY AND INSECT TOXICOLOGY

Unit 1: Forest Entomology

(15 L)

Objective:

- *To develop a strong foundation in entomology, including understanding of the importance of insects to human society.*
- *To familiarize the students with identification of insect pests, vectors and their control methods.*

Desired outcome:

- *Learners will grasp the concepts of Forest plants and its pest, Host-Pest relationship.*

- 1.1 Introduction to forest Entomology in relation to 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*, *Hyblea pura*

Unit 2: Forensic Entomology

(15 L)

Objective:

- *To develop a strong foundation in entomology, including understanding of the importance of insects to human society.*

Desired outcome:

- *Learners expected to gain the knowledge of role of insects in criminology.*

- 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: Insect Control and Toxicology – I

(15 L)

Objective:

- *To develop a strong foundation in entomology, including understanding of the importance of insects to human society.*
- *To familiarize the students with identification of insect pests, vectors and their control methods.*

Desired outcome:

- *Learners expected to acquire the knowledge about insect pest control techniques.*
- *Learner also obtained the knowledge of chemical, bio-control and used natural control agents and toxicology.*

- 3.1 Basic Principles of Insects Control
 - 3.1.1 Chemical Control
 - a) Classification and evolution of insecticides.
 - b) Different types of insecticides.
 - c) Mode of action.
 - 3.1.2 Biological Control
 - a) Principles, application, success and limitations.
 - b) Use of enemies such as predators, parasites and pathogens.
- 3.2 Natural control of insect pest- Abiotic and biotic factors
- 3.3 Cultural, mechanical, physical methods of pest control
- 3.4 The use of Antifeedent in pest management.
- 3.5 Autocidal Methods
 - 3.5.1 Chemosterillants and radiations for sterilization,
 - 3.5.2 Male sterile Theory,
 - 3.5.3 Hormones and Pheromones, Attractants and Repellants.
- 3.6 Insecticide formulations and applications, Insecticide synergists

Unit 4: Insect Control and Toxicology II

(15 L)

Objective:

- *To develop a strong foundation in entomology, including understanding of the importance of insects to human society.*
- *To familiarize the students with identification of insect pests, vectors and their control methods.*

Desired outcome:

- *Learners expected to acquire the knowledge about insect pest control development of resistance to Insecticides.*
- *Learners also gain the knowledge of impact of insecticides on human health and environment and IPM.*

- 4.1 Microbial and Environmental degradation of pesticides. Metabolism of pesticides
- 4.2 Integrated Pests Managements
- 4.3 Dynamics of Environmental Pollution by Insecticides and impact on human health and ecosystem
- 4.4 Plants origin, synthetic (organic and inorganic) insecticides, chemistry, mode of action and application
- 4.5 Fungicides – Definition, classification and application
- 4.6 Organizational Biological pest control
 - 4.6.1 Definition and History
 - 4.6.2 Methods
 - 4.6.3 Bio-control agent
 - 4.6.4 Aspects of biological organization
 - 4.6.5 Bio-control programme in Maharashtra and in India
- 4.7 Microbial control
 - 4.7.1 Introduction
 - 4.7.2 Pathogens used in microbial control (fungi, bacteria, viruses, protozoan, nematodes) toxins produced
 - 4.7.3 Mode of action and application
- 4.8 Recent trends in pest management
 - 4.8.1 Global scenario
 - 4.8.2 India
 - 4.8.3 Maharashtra
 - 4.8.4 Traditional pest management techniques

PAPER 3: PSZOENT403 NEO-ENTOMOLOGY, COMPUTATIONAL ENTOMOLOGY AND INSECTS BIOTECHNOLOGY

Unit 1: Neo-avenues in Entomology

(15 L)

Objective:

- *To learn neo-avenues and prospective in Insects study (Entomology).*

Desired outcome:

- *Learner should acquire the knowledge of insects use as a medicine, weapons.*
- *They will also learn role of insect in textile industry, ornamental use.*

- 1.1 Insect as a medicine (Entomotherapeutics)
- 1.2 Insect as weapons (Entomological warfare's)
- 1.3 Ornamental Entomology: Ornamental products from insects
- 1.4 Use of Insect in textile Industry : Fashion designing

Unit 2: Insect Biotechnology and Molecular Biology – I

(15 L)

Objective:

- *To introduce the insect Biotechnology and Molecular Biology.*

Desired outcome:

- *Learners get the knowledge of central dogma process in insects.*
- *They will also learn about insect cell lines, role of baculoviruses, marker genes use to detect sex.*
- *They will also get the knowledge of Bt toxins, neurohormones secreted in insect.*

- 2.1 DNA and RNA analysis in insects
 - 2.1.1 Transcription and translocation mechanisms.
 - 2.1.2 DNA recombinant technology,
 - 2.1.3 Identification of genes / nucleotide sequences for characters of interest.
- 2.2 Genetic improvement of natural enemies. Cell lines, genetic engineering in baculoviruses, Bt and entomopathogenic fungi
- 2.3 Genes of interest in entomological research
 - 2.1.1 Marker genes for sex identification
 - 2.1.2 Neuropeptides, JH esterase, St toxins and venoms, chitinase
 - 2.1.3 CPTI; lectins and proteases. Peptides and Neuropeptides, J Hesterase,
 - 2.1.4 Toxins and venoms, chitinase, Bt toxin, CPTI; trypsin inhibitors, lectins and proteases, Neuropeptides

Unit 3: Insect Biotechnology and Molecular Biology – II

(15 L)

Objective:

- *To introduce insect biotechnology and molecular biology.*

Desired outcome:

- *Learners have learn the application and principles of DNA finger printing and its role in development of transgenic insect, improvement in silk quality and honey with the help of biotechnology.*

- 3.1 Insect gene transformation; biotechnology in relation to silkworms and honey bees
- 3.2 DNA finger printing for taxonomy and phylogeny.
- 3.3 Genetic improvement -tolerance of natural enemies.
- 3.4 DNA-based diagnostics;
- 3.5 Insect immune systems in comparison to vertebrates
- 3.6 Molecular basis of metamorphosis
- 3.7 Sf transgenic technology and implications

Unit 4: Insect Bioinformatics

(15 L)

Objective:

- *To introduce the principles and application of insect bioinformatics.*

Desired outcome:

- *Learner should gain the knowledge the insect genomics, silkworm gene sequencing, insect proteomics, develop gene sequencing by using application of bioinformatics.*

4.1 Insect Genomics

- 4.1.1 *Drosophila melanogaster* (Fruit fly)
- 4.1.2 *Anopheles gambiae* (Mosquito – the vector for malaria),
- 4.1.3 *Bombyx mori* (Domestic silk worm) and *Apis mellifera* (Honeybee)
- 4.1.4 Dipteran and Hymenopteran insects.
- 4.1.5 Lepidoptera, Butterflies, Diamondback moth
- 4.1.6 Coleoptera (Beetles) Hemiptera (Pea Aphid)
- 4.1.7 Phthiraptera (Head louse)

4.2 Insect Proteomics

- 4.2.1 A proteomic approach for studying insect phylogeny
- 4.2.2 Proteomic Analysis of Interaction between a Plant Virus and Its Vector Insect
- 4.2.3 Proteomic and Bioinformatics Analysis on Endocrine Organs of Domesticated Silkworm, *Bombyx mori*.

PAPER 4: PSZOOCN404

INSTRUMENTATION AND PRESENTATION OF SCIENTIFIC DATA

Unit 1: Instrumentation

(15 L)

Objective

- *To learn how to design and build instruments for laboratory measurement.*
- *To understand fundamental principles of operation.*

Desired Outcome

- *The learner will understand methods for operation of instruments and data analysis.*
- *The learner will understand how instrumentation can advance scientific research.*

1.1 Centrifugation:

- Principle and applications of Centrifugation
- Differential and density gradient Centrifugation

1.2 Electrophoresis:

- Principle
- Structural components
- Applications

1.3 Chromatography:

- Principle and applications
- Adsorption
- Ion exchange
- Gel permeation
- Affinity

1.4 Spectrophotometer:

- Principle
- Applications

1.5 pH meter

- Principle
- Applications

1.6 Microscopy

- Binocular
- Trinocular

Unit 2: Presentation of Scientific data

(15 L)

Objective

- *To aware the students for good practice in data presentation.*
- *To aware the students to use different data presentation formats.*

Desired Outcome

- *The students will familiarize to explain their research data by using different techniques for presenting their scientific data.*

2.1 Types of presentation:

- Oral
- Poster
- Written
- Audio-visual

Aids for presentation

2.2 Preparing the manuscript

- Guidelines for authors
- The IMRAD format

2.3 Title, Byline, Abstract and Summary, Keywords

2.4 Introduction:

- Defining the problem
- Literature survey
- Justification of study

2.5 Materials and Methods:

- Contents
- Sources
- Procedures
- Techniques
- Reproducibility
- Significance

2.6 Results:

- Text
- How to present data
- Tables and illustrations
- Writing captions
- Labels and legends

2.7 Discussion:

- Components and Sequence
- Analysis, Comparison and Integration of Data
- Likely Sources of Errors in Results

2.8 Conclusions and significance

Unit 3: Project

(30 L)

Objective

- *To familiarize learner for analyzing a scientific occurrence with an investigation or to solve a problem with an invention.*

Desired Outcome

- *Research expands the current state of knowledge (at a certain cost) of the learners.*
- *Experimental findings that may yield new insights or lead to other research among the learners.*

- 1. Dissertation 60 Marks**
- 2. Examinations 50 Marks**

Guidelines to the 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 type-written using computer and printed for binding.**
- 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 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 individual power point presentation (PPT) on the project and must present it in front of examiners at the time of examination.**
- 7. The project will be prepared individually by students.**

M. Sc. Part 2: Semester IV

Practical 1: PSZOENT4P1

1. Identification of economic importance of following insect pests;
 - a) Household Pest- Termite, Carpet moth, Cockroach
 - b) Pests of medical importance- Sand fly, Tsetse fly, rat flea
 - c) Veterinary pest- Horse fly, Stable fly, screw worm, Cattle warble fly,
 - d) Forest pest-Teak defoliater, Polyphagous dry wood borer- *Sinoxylon sp.*
 - e) Pest of cereals- Paddy grasshopper, Sorghum shoot fly
 - f) Pest of pulses-Greasy cutworm (*Agrotis sp.*), Plume moth (*Exelastis sp.*)
 - g) Pest of fiber crops- Red cotton bug, Pink Bollworm
 - h) Pest of fruits and fruit trees- Lemon butterfly (*Papilio demoleus*), Oriental fruit fly (*Dacus dorsalis*)
 - i) Pest of oil seed crop – Castor semilooper (*Achaea janata*), Groundnut stem borer – (*Sphenoptera sp.*)
 - j) Pest of vegetable crops – Hadda beetle (*Epilachna sp.*), cabbage caterpillar (*Pieris brassicae*)
 - k) Pest of spices – turmeric shoot borer – *Conogethes punctiferalis*, Pest of black pepper – Pollu beetle (*Longitarsus nigripennis*)
 - l) Pest of narcotic crops- Leaf eating caterpillar- *Spodoptera litura* Fab., Tobacco aphid – *Myzus nicotianae* Black.
2. Field visit to 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.

Practical 2: PSZOENT4P2

1. Study of insecticide appliances
 - a) Simple sprayer
 - b) Hydraulic sprayer
 - c) Rocker sprayer
 - d) Duster
2. Identification and economic importance of parasitoids (Biocontrol agents).
 - a) *Trichogramma spp.*
 - b) *Aphytis melinus*
 - c) *Cryptolaemus montrouzeri*
 - d) *Crysoperia carnea*
 - e) *Isotima javensis*
 - f) *Xanthopimpla punctata*
 - g) *Apanteles spp.*
3. Identification and economic importance of insect predators:
 - a) Birds
 - b) Reptiles
 - c) Amphibians
 - d) Mammals
 - e) Pisces
 - f) Coelenterates
 - g) Arachnids (spider)
 - h) Insect
4. Identification and economic importance of vertebrate pest bio-control agents. *Bufo marinus*, Giant toad, Indian mynah (*Acridotheres tristis*), Indian crow.
5. Study of weed controlling insects.
 - a) Beetles (*Octotoma scabripennis*, *Uroplata giraldi*)
 - b) Scale insect (*Dactylopius tomentosus*)
 - c) Flea beetle (*Agasicles hygrophyla*)
6. Whole mount preparations of parasitic insects and microscopic pest.
 - a) Thrips
 - b) Aphids
 - c) Jassids
 - d) Cow bug
 - e) Termites
 - f) Pentatomid bug
7. Symptomology of following different types of insecticide treatment in Cockroach.
 - a) Contactpoison
 - b) Stomachpoison
 - c) Fumigant.
8. Bioassay of insecticides in a suitable insect for; (LC50)
 - a) Contact poison.
 - b) Stomach poison.
 - c) Fumigant.
9. Estimation of synergistic ratio using suitable insect model.

Practical 3: PSZOENT4P3

1. Isolation and estimation of DNA from *Chironomous* larvae or suitable insects.
2. Isolation and estimation of RNA from *Chironomous* larvae or suitable insects
3. Visit to suitable nearby institute for demonstration of PCR, RFLP and RAPD techniques and submission of report on it.
4. Problems based on molecular biology with reference to insects.

Practical 4: PSZOENT4P4

The practical of Semester 4 paper 4 comprises the Research Project for which students will have to take up a particular topic based on which they will be doing research applying the ethics of research, methods and methodology, etc. They are expected to abide rules of Scientific Research and if possible derive at a conclusion for the same. This will help the learners to build a strong foundation for pursuing research. Learners will acquaint about preparation of lay out, structure and language of typical reports, illustrations and tables. Learners will gain knowledge about how to write bibliography, referencing and footnotes in reports and thesis or in research articles.

Further, learners will be oriented to presentation of data through effective communication with the help of advanced visual technology. In addition to that they will be aware about the application of results, environmental impacts, conservation of biodiversity, ethical issues and ethical committees. The practical should be organized in such a manner that learners can be trained to manage large data sets generated via multiple observations, arrange them in a proper format and present them in relevant graphs/charts by adopting a hands-on in silico approach.

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2. Elements of Entomology-Rajendrasingh.
3. A text book of Forest Entomology – T.V. Sathe,2009.
4. Agricultural Pests of India and South East Asia – A.S. Atwal, 1993.
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11. Entomology and Pest Management, Larry P. Pedigo, Prentice Hall
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14. Destruction and Useful Insect, Their Hanits and Control, C. L. Metcalf, W. P. Flint and R. I. Metcalf, Mc Grow I Ill Co. New York.
15. Integrated Pest Management, J.L. Apple and R. E. Smith, Plenum Publication Co., New Delhi.
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University of Mumbai
M.Sc. ZOOLOGY (Entomology)
Semester III / Semester IV EXAMINATIONS

Modality of Assessment

A. Internal Assessment 40%

Sr. No.	Evaluation type	Total Marks
1	One Assignments / Case study	25
2	Active participation in routine class instructional deliveries	05
3	Attendance – (0-25% = 0 marks, 25-50% = 1mark, 50-75% = 3 marks and 75-100%= 5 marks)	05
4	Overall conduct as a responsible student, manners, skill in articulation, leadership qualities demonstrated through organizing co-curricular, etc.	05

B. External Assessment 60%

a. Semester End Examination 60Marks

- Duration – These examinations shall be of two and half hours duration for each paper.
- Theory Question Paper Pattern:
 - ❖ There shall be five questions each of 12 marks. On each unit there will be one question and the first one will be based on entire syllabus.
 - ❖ All questions shall be compulsory with internal choice within the questions. Each question will be of 18 to 30 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.

b. Practicals: 50Marks

c. Project in Semester IV: Internal Examination 40Marks
Dissertation: 60 Marks
External Evaluation: 50 Marks

University of Mumbai
M.Sc. ZOOLOGY (Entomology) Paper Pattern of
Semester III (Papers 1, 2, 3, 4) / IV (Papers 1, 2, 3) Examination
Maximum Marks: 60 Duration: 2.5 Hours Marks Option: 90

Question 1. Based on Unit I to IV (Mixed Questions)

Question 2. Based on Unit I

Question 3. Based on Unit II

Question 4. Based on Unit III

Question 5. Based on Unit 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 Units) **(12)**
 - a)
 - b)
 - c)
 - d)
 - e)
 - f)
2. Answer any **two questions** from the following: (Based on Unit I) **(12)**
 - a)
 - b)
 - c)
3. Answer any **two questions** from the following: (Based on Unit II) **(12)**
 - a)
 - b)
 - c)
4. Answer any **two questions** from the following: (Based on Unit III) **(12)**
 - a)
 - b)
 - c)
5. Answer any **two questions** from the following: (Based on Unit IV) **(12)**
 - a)
 - b)
 - c)

Semester IV Examination
Paper IV: Instrumentations and Presentation of Scientific data
Internal (Theory) Paper Pattern of PSZOENT404

Maximum Marks: 40

Duration: 1.15 Hours

Marks Option: 60

Instructions:

- a) All questions are compulsory.
- b) Draw neat and labeled diagrams wherever necessary.

1. Fill in the blank by choosing the correct option given in the brackets (Based on both Units)
Four sub-questions from each unit. **08**

2. Answer any **two questions** from the following: (Based on Unit I) **16**
 - a)
 - b)
 - c)

3. Answer any **two questions** from the following: (Based on Unit II) **16**
 - a)
 - b)
 - c)

Skeleton of Practical Examination Question Paper

Practical 1: PSZOENT3P1

Time: 10:00 am to 3:00pm

Total Marks: 50

1. Identification and Classification of given specimen/photo up to family level (with reasons).
15 Spot A, B, C, D, E **15**
 - a) One spot from Ametabola
 - b) One spot from Hemimetabola.
 - c) One spots from Holometabola
 - d) One spots from Holometabola
 - e) One spots from Holometabola
2. Identification. **09**
 - a) Mouth parts / antenna
 - b) Thoracic appendages
 - c) Abdominal appendages
3. Temporary Mounting: Any two of the following: **10**
Mouth parts, legs, antenna, Tentorium, halteres, wings, legs, abdominal appendages.
4. Report of Field visit. **06**
5. Viva-Voce based on theory. **05**
6. Journal. **05**

Practical 2: PSZOENT3P2

Time: 10:00 am to 3:00pm

Total Marks: 50

1. Dissect Cockroach/Housefly/Grasshopper/bugs/beetles so as to expose its digestive system. **10**
OR
1. Dissect Cockroach/Housefly/Grasshopper/bugs/beetles so as to expose its Reproductive system. **10**
OR
1. Dissect Cockroach/Housefly/Grasshopper/bugs/beetles so as to expose its Nervous system. **10**
OR
1. Dissect Cockroach so as to expose its Endocrine glands/ Retro cerebral nervous system. **10**
2. Demonstrate the presence of chitin by using of chitosen test. **06**
OR
2. Uptake of dyes by Malpighian Tubes. **06**
OR
2. Detect uric acid as a excretory product of terrestrial insect. **06**
3. Identifications. **09**
 - a) Identify and describe (T.S. of midgut/ foregut).
 - b) Identify and describe (T.S. of Testis/Ovary).
 - c) Identify and describe (Brain/Endocrine gland/neurosecretory cells.)
4. Assay/Experiment. **15**

Perform Differential and Total Haemocyte count.

OR

Chromatographic analysis of amino acids from insect Haemolymph. **15**

OR

Estimate digestive enzyme by DNSA method from midgut. (amylase / invertase/ Trehalase) **15**

OR

Estimate total proteins/carbohydrates from the given Haemolymph/tissues. **15**
5. Viva voce based on theory. **05**
6. Journal. **05**

Practical 3: PSZOENT3P3

Time: 10:00 am to 3:00pm

Total Marks: 50

- | | |
|--|-----------|
| 1. Identification. | 08 |
| a) Insect collection equipment/preservation techniques | |
| b) Types of silk moths | |
| c) Host plants of silk moth | |
| d) Rearing techniques in sericulture. | |
| 2. Problem based on Drosophila genetics. | 04 |
| 3. Effect of UV radiation on drosophila culture- submission of report. | 08 |
| 4. Submission of permanent slides. (Aphids / Jassids / Cow bug / others) Any two. | 05 |
| 5. Industrial visit and submission of report (Sericulture / Apiculture / Lac culture). | 05 |
| 6. Submission of insect collection. (At least five orders). | 10 |
| 7. Viva voce based on theory. | 05 |
| 8. Journal. | 05 |

Practical 4: PSZOENT3P4

Time: 10:00 am to 3:00pm

Total Marks: 50

1. Identification. **18**
 - a) Identify and describe insectivorous animals.
 - b) Identify and describe insectivorous animals.
 - c) Identify and describe myrmecophytes.
 - d) Identify and describe insectivorous plants.
 - e) Identify and describe mimicry in insect.
 - f) Identify and describe mimicry in insect.
2. Evaluate the physico-chemical characteristics of given honey sample and make a report. **08**
3. Make a temporary preparation stained if necessary of pathogens from the given insect. (minimum four) **10**
OR
3. Make a temporary preparation stained if necessary of gall insects. Make a report. **10**
4. Submission of the report on feeding experiments on ants/suitable insects. **04**
5. Viva voce based on theory. **05**
6. Journal. **05**

Practical 1: PSZOENT4P1

Time: 10:00 am to 3:00pm

Total Marks: 50

1. Identification and description of economic importance of given specimen/photo. **12**
Four spots from Household/Medical/Veterinary/Forest pest (Not more than one from each group).
2. Identification and description of economic importance of given specimen/photo. **10**
Five 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).
3. Visit to agricultural area/fruit plantation/forest to study insect pests and submission of report based on it. **10**
4. Visit to cattle farm/Veterinary center to study pests of cattle/ other pet animals and submission of report based on it. **08**
5. Viva-voce based on theory. **05**
6. Journal. **05**

Practical 2: PSZOENT4P2

Time: 10:00 am to 3:00pm

Total Marks: 50

1. Assay/Experiment. 15
Assess LC₅₀ for given insecticide (Mosquito larvae / *Chironomous* larvae).
OR
a) Identify and give economic importance of vertebrate pest bio-control agents. 10
b) Preparation of whole mount of microscopic pest. 05
2. Identification. 10
 - i. Identify and describe the insecticide appliances.
 - ii. Identify and describe economic importance of parasitoids.
 - iii. Identify and describe insect predators.
 - iv. Identify and describe weed control insects.
 - v. Identify the Symptomology of given insecticides treatment on cockroach (Contact poison/Stomach poison /Fumigant).
3. Submission. 05
 - a) Insect pest collection and observation report. 10
 - b) Report of Field visit or visit to Agricultural University or visit to veterinary Institute. 05
4. Viva voce based on theory. 05
5. Journal. 05

Practical 3: PSZOENT4P3

Time: 10:00 am to 3:00pm

Total Marks: 50

1. Isolate and estimate DNA from *Chironomous* larva or suitable insect sample. **15**
OR
1. Isolate and estimate RNA from *Chironomous* larva or suitable insect sample. **15**
2. Problems based on molecular biology with reference to insects. **08**
3. Demonstrate the use of bioinformatics tools with reference to insects BLAST for nucleotide sequence comparison. **07**
OR
3. Databases of NCBI with querying a nucleotide/protein sequence from insects. **07**
4. Submit visit report of academic/research institute for demonstration of PCR / RFLP / RFLD and submission of report. **10**
5. Viva voce based on theory. **05**
6. Journal. **05**

Skeleton of Practical Examination Question Paper: Practical 4 PSZOENT4P4

Evaluation of Project of Paper IV Project: 60 Marks

1.	Title of the Project	01
2.	Aim, Objectives and Rationale	04
3.	Materials and Methods	05
4.	Observations and / Results	10
5.	Interpretation of Observations / Results and Discussion	10
6.	Conclusion and / Recommendation	10
7.	Relevant work / Justification of work with Project title	10
8.	Relevant References	05
9.	Certified Dissertation	05

External Evaluation: 50 Marks

1.	Content of Presentation	10
2.	Quality of Presentation	10
3.	Presentation Skill	10
4.	Quality of Work	10
5.	Viva based on Proposal / Question Answer Session	10

Cover Page

AC 23-7-2020
Item No. 4.102

UNIVERSITY OF MUMBAI



Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course	Zoology (Endocrinology and Reproductive Physiology)
2	Eligibility for Admission	The students who have granted both the Semesters and might have or have not cleared their Semester I and Semester II are eligible.
3	Passing Marks	40% in each Paper
4	Ordinances / Regulations (if any)	-----
5	No. of Years / Semesters	Two Semesters .
6	Level	P.G. / U.G. / Diploma / Certificate (Strike out which is not applicable)
7	Pattern	Yearly / Semester (Strike out which is not applicable)
8	Status	New / Revised (Strike out which is not applicable)
9	To be implemented from Academic Year	From Academic Year 2020-2021

Date:

Name of BOS Chairman / Dean: Dr. Bharmal Deelip L.

Signature :

Amrutha

Dr. Amrutha Majumdar
Dean, Science & Technology

UNIVERSITY OF MUMBAI



Program: M.Sc.

Course: Zoology

(Endocrinology and Reproductive Physiology)

Syllabus for Semester III & IV

(Choice Based Credit System
with effect from the academic year 2020-21)

**M.Sc. Part II (Semester III and Semester IV):
Zoology (Endocrinology and Reproductive Physiology)**

Syllabus Committee Members

Dr. Nisar Shaikh

Chairman,

G. M. Momin Women's College, Bhiwandi

Dist. Thane, Maharashtra

Dr. Ashok Manekar Mentor, Institute of Science, Mumbai	Dr. Prakash Raut Mentor, Professor and Head, I/C Dean, Shivaji University, Kolhapur
Prof. Rahul Jadhav Convener, Vidyavardhini's Annasaheb Vartak College of Arts, Kedarnath Malhotra College of Commerce & E. S. Andrades College of Science, Vasai Road (W), Dist. Palghar – 401 202	Dr. Vinda Manjramkar B. N. Bandodkar College of Science, Chendani Bunder Road, Thane – 400 601
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(Course codes: PSZOEND3P1- PSZOEND3P4)**
- 7. References (Course codes: PSZOEND3P1- PSZOEND3P4)**
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PREFACE

The main objective of reconstructing the Post Graduate syllabus of Zoology for Semester III and Semester IV is to provide global level advanced and skill oriented deep knowledge to the stakeholders which is currently needed for their survival. The current research and teaching in Zoology includes diverse aspects with a balance of organismic and reductionist biology. It offers teaching and research programs in the diverse areas, such as, Animal Physiology, Entomology, Fish Biology, Immunology, Developmental Biology, Cell Signaling, Cell Biology, Radiation Biology, Reproductive Biology, Endocrinology, Genomics, Metagenomic, Cancer Biology, etc. Our vision is to provide Global Knowledge in education, training & research in the field of Zoology where teaching and research encrust detailed understanding from microbes to human. The broad skills and deeper knowledge in the field would make them highly successful and excellent researcher in advanced areas of research in the Biological sciences.

Therefore, the Board of Study in Zoology aims to impart holistic understanding of Zoology by “redefining Zoology” to students of every age so that they develop interest in Science. It also aims to develop teaching and research programs that have relevance to society and employability. The M.Sc. program is being revised under CBCS scheme of UGC to meet the expectations of students.

To keep all of the above factors in mind, this syllabus was developed by the curriculum committee of Mentors, subject experts from other Universities and dedicated teachers. Their major role was to abridge, grow, augment and give a forward bearing to Zoology taught in undergraduate curriculum, with projections to future requirements. They have successfully completed this colossal task. I congratulate them.

Dr. Deelip L. Bharmal
Chairman Board of Studies in Zoology University of Mumbai

PREAMBLE

I am extremely happy to present this new syllabus of Semester III and Semester IV to the teachers and students of Post Graduate Course in Zoology of the specializations, Oceanography and Fishery Technology, Entomology, Endocrinology, Animal Physiology and Environmental Science. While constructing the syllabus, the relevant inputs have been considered from Mentors, subject experts from various fields of other Universities, teachers and stakeholders to make it more effective.

An attempt has been made to make post graduate courses competitive and on par with global standards, as per the directives of University Grant Commission for the implementation of choice based credit system. Hence as per the guideline of UGC the present syllabus is made more interesting with new, innovative topics as per need of the current situation of the world and stakeholders.

The M.Sc. Zoology program provides an appropriate blend of classical and applied aspects of the subject. This newly designed curriculum will allow students to acquire skills in handling scientific instruments planning and performing in the laboratory and exercising critical judgment, independent thinking and problem solving skills.

The utmost care has taken to declare the final syllabus well in advance to enable the teachers to make preparations before commencement of the academic year and facilitating students to execute their right to know the details before admissions.

The draft of Syllabus was approved in meeting of the Board of Studies in Zoology held on 10th March 2020, and it was unanimously resolved to implement the revised syllabus of Zoology at M.Sc. Semester-III and IV and make it effective from the Academic Year 2020-2021 after approval from concerned authorities of the University.

The success of this revamped syllabus will depend totally on the enthusiasm and interest shown by the stakeholders.

Dr. Nisar Shaikh
Chairman, M.Sc. Part II
Syllabus Committee

PEDAGOGY

PSZOEND301 is '**Invertebrate Endocrinology – I**', a study of Comparative invertebrate neuroendocrine structure, anatomy, mechanisms and their physiological role or function of the glands in different phyla.

PSZOEND302 consists of '**Comparative Vertebrate Endocrinology – I**' which explains General endocrinology, phylogeny and ontogeny of endocrine glands in comparative study in different vertebrates, Comparative study of endocrinology of all vertebrate from Pisces to Mammals. The basic concepts to study comparative study of endocrine glands in relation to their location, anatomy, structure and physiological action on target tissues.

PSZOEND303 is '**Reproductive biology / Physiology – I**' could be dealt with by taking various examples of economic importance. Practical aspects of reproductive and developmental biology could be undertaken through observation of life cycles of various organisms that can be cultured in the laboratory as per the ethical permission granted so that learners can understand the theoretical approach in a much better way.

The course **PSZOEND304 'Medical Endocrinology'** will help the learner for conceptual understanding of the basic medical endocrinology and medical practices in modern medical field or hospitals. In this course students understand the classification of hormones and their discoveries, their types and their role in vertebrates understanding with their details. Beside the routine medical practices some new drugs namely phyto-medicines also used in patient to cure some diseases.

PSZOEND401 'Comparative Invertebrate Endocrinology – II', a study of Comparative invertebrate neuroendocrine structure, anatomy, mechanism at molecular level and their physiological role or function of the glands in different phyla. Further, study of pheromones, and its use in applied fields such as insecticides, aquaculture, endocrine biotechnology etc.

PSZOEND402 'Comparative Vertebrate Endocrinology – II' content deals with Hormones and homeostasis, Neuroendocrine integration etc., for understanding endocrine control in vertebrates. Hormones, their metabolism, actions of steroid hormones and receptors and endocrine disorders will be studied. Recent advances, implications and applications of hormones useful to gain knowledge to learners.

In course **PSZOEND403 'Reproductive biology / Physiology – II'** an attempt has been made to inform the students the basic information sex determination, reproductive system of male and female their accessory sex organs and their functions in more details.

PSZOEND404 consists of '**Instrumentation and Presentation of Scientific data**' which help the students to choose suitable measuring instruments for their applications and understanding of limitations, principles and measurement errors. The students will aware the efficiency of the instruments. Similarly the course also has the unit of presentation of scientific data. Text, tables, and graphs for data and information presentation are very powerful communication tools. They can make scientific report easy to understand, attract and sustain the interest of beneficiary.

Convener and Committee Members

M. Sc. II Zoology Syllabus
Choice Based Credit System
To be implemented from the Academic Year 2020-2021

Endocrinology and Reproductive Physiology : Semester III						
Course Name and Code	Unit	Topic Headings	Credit	Lecture/ Week	College Assessment Internal	University Assessment External
Paper I: Comparative Invertebrate Endocrinology – I						
PSZOEND301	1	Introduction to Invertebrate Endocrinology	4	1	40	60
	2	Histology of Endocrine glands		1		
	3	Neuroendocrine Integration		1		
	4	Invertebrate Hormones and its applications		1		
Paper II: Comparative Vertebrate Endocrinology – I						
PSZOEND302	1	General Endocrinology	4	1	40	60
	2	Phylogeny and Ontogeny of Endocrine glands		1		
	3	Study of Endocrine glands		1		
	4	Hormonal Control and Regulation		1		
Paper III: Reproductive Biology / Physiology – I						
PSZOEND303	1	Embryology of the Gonads and Genital ducts	4	1	40	60
	2	Female Reproductive System-I		1		
	3	Conception		1		
	4	Implantation		1		
Paper IV: Medical Endocrinology						
PSZOEND304	1	Hormones: Function and Classification	4	1	40	60
	2	Biochemical Aspects of Metabolism		1		
	3	Mechanism of Action of Hormones		1		
	4	Applied Endocrinology I		1		
		Total	16	16	160	240
Practicals						
PSZOEND3P1	Practicals based on PSZOEND301		2	4	–	50
PSZOEND3P2	Practicals based on PSZOEND302		2	4	–	50
PSZOEND3P3	Practicals based on PSZOEND303		2	4	–	50
PSZOEND3P4	Practicals based on PSZOEND304		2	4	–	50
		Total	8	16	–	200
		Grant Total	24	32	160	440

Endocrinology and Reproductive Physiology : Semester IV

Course Name and Code	Unit	Topic Headings	Credit	Lecture/ Week	College Assessment Internal	University Assessment External
Paper I: Comparative Invertebrate Endocrinology – II						
PSZOEND401	1	Endocrine Mechanisms	4	1	40	60
	2	Chemistry of Hormones		1		
	3	Pheromones		1		
	4	Applied Endocrinology I		1		
Paper II: Comparative Vertebrate Endocrinology – II						
PSZOEND402	1	Hormones and Physiology	4	1	40	60
	2	Hormones and Metabolism I		1		
	3	Hormones and metabolism-II		1		
	4	Applied Endocrinology II		1		
Paper III: Reproductive Biology / Physiology – II						
PSZOEND403	1	Embryology of the gonads and the genital ducts -II	4	1	40	60
	2	Female reproductive system II		1		
	3	Male Reproductive System		1		
	4	Contraception and hormones		1		
Paper IV: Instrumentation and Presentation of Scientific data						
PSZOEND404	1	Instrumentation	2	1	40	60
	2	Presentation of Scientific data		1		
	3	Project		2		
		Total	16	16	160	240
Practicals						
PSZOEND4P1	Practicals based on PSZOEND401		2	4	–	50
PSZOEND4P2	Practicals based on PSZOEND402		2	4	–	50
PSZOEND4P3	Practicals based on PSZOEND403		2	4	–	50
PSZOEND4P4	Practicals based on PSZOEND404		2	4	–	50
		Total	8	16	–	200
		Grant Total	24	32	160	440

M. Sc. Part 2: Semester III (Theory)
Paper 1: PSZOEND301
Comparative Invertebrate Endocrinology – I

Unit 1: Introduction to invertebrate endocrinology

(15 L)

Objective:

- *Historically invertebrates are excellent models to study as they evolved much before human existence the structures are microscopic, the chemical released are in micro level but very effective. They have withstood lot of climatic changes since their origin.*

Desired outcome:

- *Learner can study the structure and compare with other classes of organisms, chemical released by glands or other such similar organs and their role in life process.*

- 1.1 Scope of invertebrate endocrinology
- 1.2 Anatomical organization
- 1.3 Structure of endocrine glands in invertebrates
- 1.4 Invertebrate hormones - secretion, function and their role in life process
 - 1.4.1 Annelid – Feedback substance
 - 1.4.2 Mollusca – GnRH, Schistosomin
 - 1.4.3 Cephalopoda - Gonadotrophic, Optic glands,
 - 1.4.4 Insects – Juvenile Hormone, Ecdysone, ETH (Ecdysis Hormone, TMOF (Trypsin Modulating Oostatic Factor))
 - 1.4.5 Crustaceans – MF (Methyl Farnesoate)
 - 1.4.6 Echinoderm – GSS (Gamete shredding substance) of starfish

Unit 2: Histology of endocrine glands

(15 L)

Objective:

- *To study histological and ultrastructure of endocrine glands in invertebrates.*

Desired outcome:

- *Learner can identify difference between different gland in detail at microscopic level.*

- 2.1 Endocrine glands of invertebrates
 - 2.1.1 Corpora cardiaca
 - 2.1.2 Corpora allata
 - 2.1.3 Moulting glands
- 2.2 X-organ and Y-organ of Crustaceans
- 2.3 Green gland, Epitracheal gland and Inka cells
- 2.4 Mandibular organs in crustaceans
- 2.5 Submature oocyte of Polychaeta

Unit 3: Neuroendocrine integration

(15 L)

Objective:

- *To understand role of neurohormones and neurosecretion.*

Desired outcome:

- *To make know the role of neuro secretion and neuro endocrine secretion in process of growth.*

- 2.1 Concept of Neurohormone
- 2.2 Neurosecretion and neuroendocrine relation in the invertebrates
- 2.3 Reproduction, development, somatic retinal and pigmentation and metamorphosis (including diapause and molting) in insects
- 2.1 Hormonal control of metabolism, retinal and somatic pigmentation, reproduction and moulting in Crustaceans

Unit 4: Invertebrate Hormones and its applications

(15 L)

Objective:

- *To study the invertebrate hormones and role in endocrine disruption.*

Desired outcome:

- *To make learner acquaint with application of hormones in control of some pest.*

- 4.1 Structure, function and molecular action of Insect and Crustacean hormones with special reference to reproduction
- 4.2 Insect Allomones
- 4.3 Invertebrate Endocrine disruption

Paper 2: PSZOEND302: Comparative Vertebrate Endocrinology – I

Unit 1: General Endocrinology

(15 L)

Objective:

- *To study the neuroendocrine reflexes and integration centers.*

Desired outcome:

- *The learner will understand the orders of reflexes playing role in neuroendocrine integration.*

- 1.1 General introduction to hormone
- 1.2 Neuroendocrine integration
 - 1.2.1 Afferent pathways
 - 1.2.2 Integration centers
 - 1.2.3 Efferent pathways
- 1.3 Neuroendocrine reflex
 - 1.3.1 First order
 - 1.3.2 Second order
 - 1.3.3 Third order

Unit 2: Phylogeny and Ontogeny of endocrine glands

(15 L)

Objective:

- *To acquaint students with the phylogeny and ontogeny of vertebrate endocrine glands.*

Desired outcome:

- *The learner would get an understanding of the phylogenetic and ontogenic relationship of endocrine glands from Pisces to Mammals.*

- 2.1 Phylogeny of Pituitary, Pancreas, Adrenal, Thyroid, parathyroid in Pisces, Amphibia, Reptiles and Mammals
- 2.2 Ontogeny of Pituitary, Pancreas, Adrenal, Thyroid, parathyroid in Pisces, Amphibia, Reptiles and Mammals

Unit 3: Study of endocrine glands

(15 L)

Objective:

- *To familiarize the learners about the anatomy and role of endocrine glands in the human reproduction.*

Desired outcome:

- *The learners will get the knowledge of endocrine glands.*

- 3.1 Endocrine glands - Anatomy and Microstructure
 - 1.1.1 Pituitary
 - 1.1.2 Thyroid
 - 1.1.3 Parathyroid
 - 1.1.4 Ultimobranchial glands
 - 1.1.5 Adrenal, pancreas
 - 1.1.6 Pineal
- 3.2 Role of hypothalamus and the higher brain centers in reproductive behaviour

Objective:

- *To aware the learners about functioning of neurotransmitter substances.*

Desired outcome:

- *To impart knowledge to learner about endocrine and physiological regulation*

4.1 Neuroendocrine integration in vertebrates

4.1.1 Hypothalamo-hypophyseal complex

4.1.2 Role of transmitters in regulation of anterior pituitary hormonal release

- a) TSH-RH
- b) Gn-RH
- c) ACTH- RH
- d) GH-RH
- e) Somatostatin
- f) PIF-RH

4.1.3 The role of pineal in the transduction of environmental cues

4.2 Gastro-intestinal hormones and endocrine regulation of digestion

4.3 Carbohydrate and Lipid metabolism

4.4 Endocrine disorders

Paper 3: PSZOEND303: Reproductive Biology / Physiology – I

Unit 1: Embryology of the gonads and genital ducts

(15 L)

Objective:

- *To understand the sexual dimorphism in early stages of development.*

Desired outcome:

- *The learner will study in detail the difference between genetic and somatic sex along with the embryological sexual dimorphism.*

- 1.1 Sexual differentiation
 - 1.1.1 Genetic sex
 - 1.1.2 Somatic sex
- 1.2 Origin of the primordial germ cells
 - 1.2.1 Migration to the genital ridge
 - 1.2.2 Embryological origin of cell types
- 1.3 Differentiation of testis and Ovary
 - 1.3.1 Morphological
 - 1.3.2 Biochemical
 - 1.3.3 Hormonal aspects
- 1.4 Formation and differentiation of the genital ducts
- 1.5 Hypothamo-hypophysial-gonadal axis

Unit 2: Female reproductive system – I

(15 L)

Objective:

- *To acquaint the learner with different aspects female gonads and hormones with respect to aves and mammals.*

Desired outcome:

- *The learner will understand process of ovarian functions from two different class of vertebrates.*

- 2.1 Study of ovary in birds and mammals
 - 2.1.1 Folliculogenesis
 - 2.1.2 Ovulation.
- 2.2 Sources of ovarian hormones
 - 2.2.1 Ovarian androgen
 - 2.2.2 Ovarian Inhibin
 - 2.2.3 Endocrine regulation of ovarian functions
 - 2.2.4 Super ovulation

Unit 3: Implantation

(15 L)

Objective:

- *To familiarize the learner with concept and mechanism of implantation and placentation.*

Desired outcome:

- *The learner would understand the process of implantation, placentation and hormones*

- 3.1 Concept of implantation, nidation

- 3.2 Mechanism of implantation, Endometrial antigen involved in implantation
- 3.3 Deciduation
- 3.4 Placentation –Types of placentation

Unit 4: Conception

(15 L)

Objective:

- *To enable the learner understand the process of fertilization, conception, parturition.*

Desired outcome:

- *Learner would gain insight into the process from fertilization to parturition with add on information on placental hormones.*

- 4.1 Fertilization
- 4.2 Conception
- 4.3 Parturition.
- 4.4 Maternal–foetal placental hormones

Paper 4: PSZOEND304: Medical Endocrinology

Unit 1: Hormones – Function and Classification

(15 L)

Objective:

- *To aware the leaners about the classification of hormones.*

Desired outcome:

- *The learners will get the knowledge of about the advance knowledge of the hormones.*

- 1.1 Hormones as messengers.
- 1.2 Hormones and eukaryotic metabolic regulation
- 1.3 Classification and Discovery of hormones

Unit 2: Biochemical Aspects of Metabolism

(15 L)

Objective:

- *To familiarize the learners about biochemical aspects of metabolism.*

Desired outcome:

- *The learner will aware the role of peptide, thyroid and steroid hormones on metabolism.*

- 2.1 Peptide hormones
- 2.2 Thyroid hormones
- 2.3 Steroid hormones

Unit 3: Mechanism of action of hormones

(15 L)

Objective:

- *To familiarize the learners about the mechanism of action of hormones.*

Desired outcome:

- *The learners will get knowledge of the mechanism of action of hormones.*

- 3.1 Cell surface receptors
- 3.2 Cascade of reaction linked to signal transduction
- 3.3 Prostaglandins
- 3.4 Pineal gland structure
 - 3.4.1 Biosynthesis of melatonin
 - 3.4.2 Diurnal variations of pineal gland functions
- 3.5 Gastro-Intestinal hormones: Source, composition and functions

Unit 4: Applied Endocrinology

(15 L)

Objective:

- *To familiarize the learners about applied aspects of Endocrinology.*

Desired outcome:

- *The leaner will aware about the relationships of hormones with human being and their*

applied aspects.

- 4.1 Hormones, growth and development
- 4.2 Hormones and human health
- 4.3 Production of hormones as Pharmaceuticals
- 4.4 Molecular Endocrinology and Physiology of the Aging Central Nervous System

M. Sc. Part 2: Semester III Practical

Practical 1: PSZOEND3P1

1. Study of neuroendocrine system of Prawn / cockroach.
2. Preparation of slides – Neurosecretory cells in different invertebrates examples. Cockroach or any other animal not in schedule and easily available (submission of three slides) and report.
3. Study of reproductive system of Cockroach and Sepia.

Practical 2: PSZOEND3P2

1. Study of histology of vertebrate endocrine glands (comparative aspects).
 - a) Pituitary
 - b) Thyroid
 - c) Adrenal,
 - d) Pancreas
 - e) Pineal,
 - f) Parathyroid.
2. Demonstration of endocrine glands of vertebrate group (rat / mice).
(Simulation / Photographs / ICT)
3. Hypophysectomy in fish (catfish / Tilapia)
4. Study of reproductive system of any suitable edible species bony fish.
5. Types of placenta (Identification).

Practical 3: PSZOEND3P3

1. Preparation and submission of slides of adrenal, ovary and testis in vertebrate (Goat / Chicken)
2. Diagnosis of pregnancy by the presence of HCG in urine.
3. Study of estrous cycle in different mammals (Slides / Photographs / TC tools / models / charts / photographs)
 - a) Mammals rodents prolific breeders
 - b) Cattle seasonal breeder
 - c) Post birth estrous Kangaroo
4. Phytosteroid-mimicking animal steroid (Soybean, Ashwagandha, Shatavari).

Practical 4: PSZOEND3P4

1. Estimation of calcium level in given blood sample.
2. Estimation of glucose level in given blood sample.
3. Effect of acetylcholine / Adrenalin on fish chromatophores.
4. Study of Endocrine disorders in human (Slides / Photographs / TC tools / models / charts / photographs)

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1. Mandal A. (1994). Handbook of Neuroendocrinology, EMKAY Publications.
2. Comparative Endocrinology of the Invertebrates, Kenneth C. Highnam, Second Edition, ELBS Low price Edition.
3. Tambhare D. B. (2012). Invertebrate Endocrinology, Himalaya Publication House.
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M. Sc. Part 2: Semester IV (Theory)
PAPER 1: PSZOEND401
COMPARATIVE INVERTEBRATE ENDOCRINOLOGY – II

Unit 1: Endocrine Mechanisms

(15 L)

Objective:

- *Invertebrates are dominant group of organisms they have economic importance although small in size they entire communication with chemical signals*

Desired outcome:

- *The learner will understand the role of endocrine gland and hormones.*

- 1.1 Molluscan Endocrinology
- 1.2 Crustacean Endocrinology
- 1.3 Insect Endocrinology
 - 1.3.1 Anatomical structure and location
 - 1.3.2 Hormones
 - 1.3.3 Moulting,
 - 1.3.4 Reproduction and Metamorphosis, reproduction
- 1.4 Echinoderm Endocrinology

Unit 2: Chemistry of hormones

(15 L)

Objective:

- *Invertebrates are excellent models. They have variety of hormones like steroids, peptides and terpenes.*

Desired outcome:

- *The learner will understand the chemistry of all the hormones and there use.*

- 2.1 Spawning hormones in starfish
- 2.2 Neuroendocrine system
 - 2.2.1 Insect
 - 2.2.2 Crustaceans
- 2.3 Steroid hormones in Arthropod
- 2.4 Insect Juvenile hormones
 - 2.4.1 Biochemical structure
 - 2.4.2 Synthesis of juvenile hormones
 - 2.4.3 Ecdysone
- 2.5 Hormonomimetic insecticides

Unit 3: Pheromones

(15 L)

Objective:

- *They are chemicals functioning under the influence of endocrine glands, which control life activities.*

Desired outcome:

- *The learners will understand the chemical nature, structure, and functions of pheromones and there role in life of invertebrates.*

- 3.1 Classification, Chemical nature, Structure, Functions relevance in applied fields, Clinical applications.
- 3.2 Sex Pheromones in insects
- 3.3 Maturation Pheromones
- 3.4 Pheromones and insect control
- 3.5 Hormones and the Environment

Unit 4: Applied Endocrinology I

(15 L)

Objective:

- *To study the role of hormones, pheromones in growth and control of invertebrates has the wide use and application since ancient times.*

Desired outcome:

- *Learner will understand the applicative of various chemical substances synthesized and secreted by the invertebrates.*

- 4.1 Insect hormones, pheromones and Insecticides for eradication pest
- 4.2 Hormonal manipulation in Echinoderm Aquaculture
- 4.3 Tick control by their hormones and Pheromones
- 4.4 Structure function and molecular action of crustacean hormones with special reference to reproduction, crustacean Aquaculture, Endocrine Biotechnology

PAPER 2: PSZOEND402

COMPARATIVE VERTEBRATE ENDOCRINOLOGY – II

Unit 1: Hormones and Physiology

(15 L)

Objective:

- *To study integration of hormones and physiological process.*

Desired outcome:

- *To make learner understand that physiological process require hormonal stimulus*

- 1.1 Osmoregulation and Excretion
- 1.2 Thermo regulation
- 1.3 Neuroendocrine control of water balance and milk ejection reflex
- 1.4 Calcium metabolism

Unit 2: Hormones and metabolism – I

(15 L)

Objective:

- *To study various disorder due to hormonal imbalance.*

Desired outcome:

- *To make learner acquaint with role of hormones in disorders and behavioral changes.*

- 2.1 Stress
- 2.2 Metabolic and reproductive disorders
 - 2.2.1 Pituitary
 - 2.2.2 Adrenal
 - 2.2.3 Pancreas
 - 2.2.4 Thyroid
 - 2.2.5 Testis
 - 2.2.6 Ovary
- 2.3 Thymic hormones and cell immunity
- 2.4 Behavioral Endocrinology

Unit 3: Hormones and Metabolism – II

(15 L)

Objective:

- *To expose the learners with the role of hormones in homeostasis and physiological processes.*

Desired outcome:

- *The learner would understand the process of homeostasis and physiology and their correlation with hormones.*

- 3.1 Glucose, Calcium and Sodium homeostasis,
- 3.2 Gastro-intestinal hormones and endocrine regulation of digestion.
- 3.3 Endocrine regulation of cardio-vascular function
- 3.4 Endocrine control of colour change with emphasis on pars intermedia in amphibians
- 3.6 Endocrine regulation of stress
- 3.7 Endocrine control of growth
- 3.8 Endocrine disorders in childhood and adults
- 3.9 Bone and mineral metabolism

Objective:

- *To understand the applicative values of hormones phytosteroids, industrial production and genetic analysis of hormonal disorders.*

Desired outcome:

- *The learner will understand the process of hormone preparation, phytosteroids and its applicative values.*

- 4.1 Preparation of somatotropin, insulin and its Application
- 4.2 Genetic analysis of hormonal disorders
- 4.3 Zebra fish in endocrine systems: recent advances and implications for human disease
- 4.4 Production of hormones
- 4.5 Phytosteroid for human benefits

PAPER 3: PSZOEND403

REPRODUCTIVE BIOLOGY / PHYSIOLOGY – II

Unit 1: Endocrinology of Reproduction

(15 L)

Objective:

- *To aware the learners about the role of endocrine glands in reproduction.*

Desired outcome:

- *The learners will aware about the endocrine role of gonads in reproduction.*

- 1.1 Endocrine disruption of reproduction
- 1.2 Endocrinology of photo sexual activity:
 - 1.2.1 Extra-retinal photoreceptors,
 - 1.2.2 Photo refractoriness,
- 1.3 Role of melatonin in reproduction
- 1.4 Development abnormalities of male and female sex organs: genetic and Endocrine aspects

Unit 2: Male Reproductive System

(15 L)

Objective:

- *To aware the learners about male gonadal structure and their functions in the reproduction.*

Desired outcome:

- *The learners will aware the process of gametogenesis and the hormonal role in it.*

- 2.1 Testis
 - 2.1.1 Structure,
 - 2.1.2 Spermatogenesis
 - 2.1.3 Spermiogenesis
 - 2.1.4 Steroidogenesis endocrine, paracrine and autocrine regulation
- 2.2 Epididymis
 - 2.2.1 Structure
 - 2.2.2 Function
 - 2.2.3 Regulation
- 2.3 Accessory sex organs
 - 2.3.1 Prostate
 - 2.3.2 Seminal vesicles
 - 2.3.3 Bulbo urethral gland- structure, function and regulation

Unit 3: Female reproductive tract

(15 L)

Objective:

- *To aware the learners about female gonadal structure and their functions in the reproduction.*

Desired outcome:

- *The learners will aware the process of gametogenesis and the hormonal role in it.*

- 3.1 Study of Uterus
 - 3.1.1 Uterus and fallopian tube
 - 3.1.2 Structure,
 - 3.1.3 Function

- 3.1.4 Hormonal regulation
- 3.2 Reproductive cycles in vertebrates.
- 3.3 Mammary gland
 - 3.3.1 Structure
 - 3.3.2 Function
 - 3.3.3 Regulation.
- 3.4 Reproductive disorders and problem of menopause

Unit 4: Contraception and hormones

(15 L)

Objective:

- *To aware learners about the methods of family planning.*

Desired outcome:

- *The learners will learnt various contraceptive methods to control birth.*

- 4.1 Sterility: Male and Female
- 4.2 Regulation of male and female fertility.
- 4.3 Contraception: methods of contraception.
- 4.4 Surgical, hormonal and non-hormonal methods
- 4.5 Frontiers in contraceptive Research

PAPER 4: PSZOEND404 INSTRUMENTATION AND PRESENTATION OF SCIENTIFIC DATA

Unit 1: Instrumentation

(15 L)

Objective

- *To learn how to design and build instruments for laboratory measurement.*
- *To understand fundamental principles of operation.*

Desired Outcome

- *The learner will understand methods for operation of instruments and data analysis.*
- *The learner will understand how instrumentation can advance scientific research.*

1.1 Centrifugation:

- Principle and applications of Centrifugation
- Differential and density gradient Centrifugation

1.2 Electrophoresis:

- Principle
- Structural components
- Applications

1.3 Chromatography:

- Principle and applications
- Adsorption
- Ion exchange
- Gel permeation
- Affinity

1.4 Spectrophotometer:

- Principle
- Applications

1.5 PH meter

- Principle
- Applications

1.6 Microscopy

- Binocular
- Trinocular

Unit 2: Presentation of Scientific data

(15 L)

Objective

- *To aware the students for good practice in data presentation.*
- *To aware the students to use different data presentation formats.*

Desired Outcome

- *The students will familiarize to explain their research data by using different techniques for presenting their scientific data.*

2.1 Types of presentation:

- Oral
- Poster
- Written
- Audio-visual

Aids for presentation

2.2 Preparing the manuscript

- Guidelines for authors
- The IMRAD format

2.3 Title, Byline, Abstract and Summary, Keywords

2.4 Introduction:

- Defining the problem
- Literature survey
- Justification of study

2.5 Materials and Methods:

- Contents
- Sources
- Procedures
- Techniques
- Reproducibility
- Significance

2.6 Results:

- Text
- How to present data
- Tables and illustrations
- Writing captions
- Labels and legends

2.7 Discussion:

- Components and Sequence
- Analysis, Comparison and Integration of Data
- Likely Sources of Errors in Results

2.8 Conclusions and significance

Unit 3: Project

(30 L)

Objective

- *To familiarize learner for analyzing a scientific occurrence with an investigation or to solve a problem with an invention.*

Desired Outcome

- *Research expands the current state of knowledge (at a certain cost) of the learners.*
- *Experimental findings that may yield new insights or lead to other research among the learners.*

1. Dissertation 60 Marks

2. Examinations 50 Marks

Guidelines to the 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 type-written using computer and printed for binding.

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 mentor may be reflected on the first page of the project proposal 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 individual power point presentation (PPT) on the project and must present it in front of examiners at the time of examination.

7. The project will be prepared individually by students.

M. Sc. Part 2: Semester IV

Practical 1: PSZOEND4P1

1. Study of neuroendocrine system of *Sepia / Mytilus*
2. Estimation of Glucose level after Eye stalk ablation in edible crab (*Scylla serrata*).
3. Mounting of chromatophore of *Sepia*.
4. Identification: X-organ, Y-organ, corpora cardiaca, corpora allata, optic gland, moulting gland, by photographs / permanent slides / ICT tools / models

Practical 2: PSZOEND4P2

1. Effect of epinephrine on blood sugar level in cat fish.
2. Study of glycogen level (liver / muscle) in bony fish
3. Paper chromatographic separation of steroid hormones
4. Study of polycystic ovary (Slides / photographs)
5. Estimation of adrenal cholesterol from goat / chicken.
6. Estimation of ascorbic acid from adrenal / testis of goat / chicken.

Practical 3: PSZOEND4P3

1. Study of gonado-somatic index.
2. Induced breeding technique in fish with injection of pituitary extract)
3. Extraction of total gonadotropins from human pregnant urine.
4. Study of endocrine disorders of pituitary, Thyroid, Adrenal- Symptoms, effects and causes (by photographs)(Identification)

Practical 4: PSZOEND4P4

Instrumentation and Presentation of Scientific data

The practical of Semester 4 paper 4 comprises the Research Project for which students will have to take up a particular topic based on which they will be doing research applying the ethics of research, methods and methodology, etc. They are expected to abide rules of Scientific Research and if possible derive at a conclusion for the same. This will help the learners to build a strong foundation for pursuing research. Learners will acquaint about preparation of lay out, structure and language of typical reports, illustrations and tables. Learners will gain knowledge about how to write bibliography, referencing and footnotes in reports and thesis or in research articles.

Further, learners will be oriented to presentation of data through effective communication with the help of advanced visual technology. In addition to that they will be aware about the application of results, environmental impacts, conservation of biodiversity, ethical issues and ethical committees. The practical should be organized in such a manner that learners can be trained to manage large data sets generated via multiple observations, arrange them in a proper format and present them in relevant graphs/charts by adopting a hands-on in silico approach.

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1. Mandal A. (1994). Handbook of Neuroendocrinology, EMKAY Publications.
2. Comparative Endocrinology of the Invertebrates, Kenneth C. Highnam, Second Edition, ELBS Low price Edition.
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4. Invertebrate Endocrinology-Tombes, Academic Press.
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1. Barington (1979) Hormones and Evolution Vol. I&II Academic Press, New York.
2. Bentley P.J. (1994) Comparative Vertebrate Endocrinology-II Cambridge University Press, New York.
3. Johnf-Laycock and Peter H. Wise, Essential of Endocrinology.
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5. Turner C.D. and Bugnara J.T. (2013).General Endocrinology, sixth Edition, W.B. Saunders. EPW East West Press Pvt. Ltd. New Delhi.
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8. Benjamin Levin-Gene VII, Oxford University Press.
9. Lodish et.al. Molecular Cell Biology
10. Mammalian Endocrinology, Ashok Kumar Boral, New Central Book Agency (P) Ltd. London
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2. Bentley P.J. (1994) Comparative Vertebrate Endocrinology-II Cambridge University Press, New York.
3. Johnf-Laycock and Peter H. Wise, Essential of Endocrinology.
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1. Sharma V.K. (1991) - Techniques in microscopy and cell biology, Tata-McGrawHill.
2. Bisen & Mathew - Tools and Techniques in Life Sciences – CBS Publishers & distributors.
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4. Wilson and Walker – Principles and Techniques of Practical Biochemistry. Cambridge Univ.Press.
5. C. R. Kothari – Research Methodology, Methods and Techniques. Wiley Eastern Ltd. Mumbai.

University of Mumbai
M.Sc. ZOOLOGY (Endocrinology and Reproductive Physiology)
Semester III / Semester IV EXAMINATIONS

Modality of Assessment

A. Internal Assessment 40%

Sr. No.	Evaluation type	Total Marks
1	One Assignments / Case study	25
2	Active participation in routine class instructional deliveries	05
3	Attendance – (0-25% = 0 marks, 25-50% = 1mark, 50-75% = 3 marks and 75-100%= 5 marks)	05
4	Overall conduct as a responsible student, manners, skill in articulation, leadership qualities demonstrated through organizing co-curricular, etc.	05

B. External Assessment 60%

a. Semester End Examination 60 Marks

- Duration – These examinations shall be of two and half hours duration for each paper.
- Theory Question Paper Pattern:
 - ❖ There shall be five questions each of 12 marks. On each unit there will be one question and the first one will be based on entire syllabus.
 - ❖ All questions shall be compulsory with internal choice within the questions. Each question will be of 18 to 30 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.

b. Practicals: 50 Marks

c. Project in Semester IV: Internal Examination 40 Marks
Dissertation: 60 Marks
External Evaluation: 50 Marks

***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 neighbouring colleges.

Use of animals for any experiment / dissection /mounting is banned. Simulations, authorized permanent specimens / slides, charts, models and other innovative methods are encouraged.

University of Mumbai
M.Sc. ZOOLOGY (Endocrinology and Reproductive Physiology)
Paper Pattern of
Semester III (Papers 1, 2, 3, 4) / IV (Papers 1, 2, 3) Examination

Maximum Marks: 60

Duration: 2.5 Hours

Marks Option: 90

Question 1. Based on Unit I to IV (Mixed Questions)

Question 2. Based on Unit I

Question 3. Based on Unit II

Question 4. Based on Unit III

Question 5. Based on Unit 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 Units) **(12)**
 - a)
 - b)
 - c)
 - d)
 - e)
 - f)
2. Answer any **two questions** from the following: (Based on Unit I) **(12)**
 - a)
 - b)
 - c)
3. Answer any **two questions** from the following: (Based on Unit II) **(12)**
 - a)
 - b)
 - c)
4. Answer any **two questions** from the following: (Based on Unit III) **(12)**
 - a)
 - b)
 - c)
5. Answer any **two questions** from the following: (Based on Unit IV) **(12)**
 - a)
 - b)
 - c)

Semester IV Examination
Paper IV: Instrumentation and Presentation of Scientific data
Internal (Theory) Paper Pattern of PSZOEND404

Maximum Marks: 40

Duration: 1.15 Hours

Marks Option: 60

Instructions:

- a. All questions are compulsory.
 - b. Draw neat and labeled diagrams wherever necessary.
-
1. Fill in the blank by choosing the correct option given in the brackets (Based on both Units) Four sub-questions from each unit. **(08)**
 2. Answer any **two questions** from the following: (Based on Unit I) **(16)**
 - a)
 - b)
 - c)
 3. Answer any **two questions** from the following: (Based on Unit II) **(16)**
 - a)
 - b)
 - c)

Skeleton of Practical Examination Question Paper Practical Practical 1: PSZOEND3P1

Time: 10:00 am to 3:00 pm

Total Marks: 50

1. Dissect prawn / cockroach so as to expose its neuroendocrine system. **20**
OR
1. Make a temporary preparation of neurosecretory cells in cockroach and make report. **20**
OR
1. Dissect Sepia so as to expose its reproductive system. **20**
2. Submit any one permanent slide of invertebrates' neurosecretory cells and make report. **10**
3. Identify and comment on neurosecretory cells in invertebrates **10**
4. Viva voce. **05**
5. Journal. **05**

Practical 2: PSZOEND3P2

Time: 10:00 am to 3:00 pm

Total Marks: 50

1. Demonstrate effect of epinephrine on blood sugar level in cat fish. 20
OR
1. Perform experiment for separation of mixture of amino acids by paper chromatography. 20
2. Dissect given teleost fish so as to expose its reproductive system. 10
OR
2. Demonstrate the endocrine glands of vertebrate group (rat/mice). 10
(Simulation / photographs/ ICT, etc.)
OR
2. Perform experiment to show hypophysectomy in fish (catfish / Tilapia) 10
3. Identify and comment on histological structure of endocrine glands (any two). 10
OR
3. Identify and describe (Types of placentae) 10
4. Viva voce based on theory. 05
5. Journal. 05

Practical 3: PSZOEND3P3

Time: 10:00 am to 3:00 pm

Total Marks: 50

1. Diagnose the pregnancy by presence/ absence of HCG in urine. **20**
- OR**
1. Submit histological slides of adrenal, ovary and testis in vertebrate (goat/chicken) (any one). **20**
2. Demonstrate phytosteroid-mimicking as animal steroid. **10**
- OR**
2. Demonstrate the technique of ectomies in vertebrates and comment. **10**
3. Identify and describe estrous cycle in different mammals
(Slides/Photographs/TC tools/models/charts/photographs) (Identification) **10**
4. Viva voce. **05**
5. Journal. **05**

Practical 4: PSZOEND3P4

Time: 10:00 am to 3:00 pm

Total Marks: 50

- | | |
|--|----|
| 1. Estimate calcium level from the given blood sample.
OR | 20 |
| 1. Estimate glucose level from the given blood sample. | 20 |
| 2. Demonstrate the effect of acetylcholine/adrenalin on Fish chromatophores. | 10 |
| 3. Identification (Endocrine disorders in human) (Any Two) | 10 |
| 4. Viva voce. | 05 |
| 5. Journal. | 05 |

Practical 1: PSZOEND4P1

Time: 10:00 am to 3:00 pm

Total Marks: 50

1. Dissect nervous system of *Mytilus* / *Sepia*. 20
2. Estimate glucose level after eyestalk ablation in edible crab (*Scylla serrata*). 10
- OR
2. Mounting of chromatophore of sepia. 10
3. Identify and describe the given photographs/pictures of neurosecretory cells of different invertebrate classes (Any Two) 10
4. Viva voce based on theory. 05
5. Journal. 05

Practical 2: PSZOEND4P2

Time: 10:00 am to 3:00 pm

Total Marks: 50

- | | |
|--|-----------|
| 1. Estimate adrenal cholesterol from the given vertebrate tissues (goat / chicken). | 20 |
| OR | |
| 1. Estimate ascorbic acid from the given vertebrate adrenal / testis (goat / chicken). | 20 |
| 2. Identification. (Polycystic ovary by Slides / photographs). | 10 |
| 3. Demonstrate glycogen level (liver / muscle) from the given bony fish. | 10 |
| 4. Viva voce based on theory. | 05 |
| 5. Journal. | 05 |

Practical 3: PSZOEND4P3

Time: 10:00 am to 3:00 pm

Total Marks: 50

1. Extract total gonadotropins from the given human pregnant urine. **20**
- OR**
1. Perform the experiment on Induced breeding technique in given fish with injection of pituitary extract. **20**
2. Calculate gonado-somatic index of the given fish. **10**
- OR**
2. Estimate the fecundity of the given fish using the data provided. **10**
3. Identify and describe. (endocrine disorders, symptoms, effects and causes) **10**
4. Viva voce based on theory. **05**
5. Journal **05**

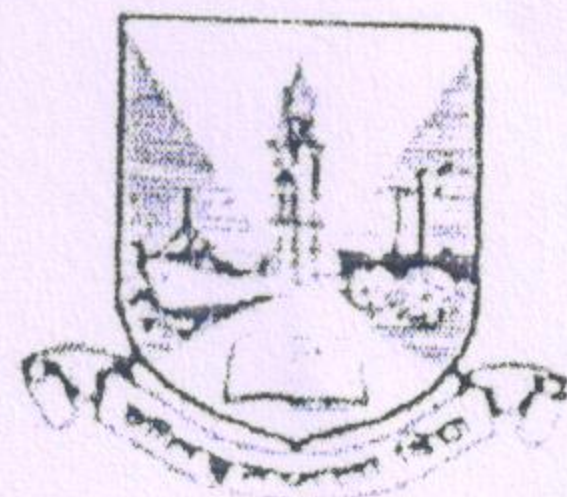
Skeleton of Practical Examination Question Paper: Practical 4 PSZOEND4P4

Evaluation of Project of Paper IV Project: 60 Marks

1.	Title of the Project	01
2.	Aim, Objectives and Rationale	04
3.	Materials and Methods	05
4.	Observations and / Results	10
5.	Interpretation of Observations / Results and Discussion	10
6.	Conclusion and / Recommendation	10
7.	Relevant work / Justification of work with Project title	10
8.	Relevant References	05
9.	Certified Dissertation	05

External Evaluation: 50 Marks

1.	Content of Presentation	10
2.	Quality of Presentation	10
3.	Presentation Skill	10
4.	Quality of Work	10
5.	Viva based on Proposal / Question Answer Session	10

UNIVERSITY OF MUMBAI**Syllabus for Approval**

Sr. No.	Heading	Particulars
1	Title of the Course	Zoology (Environmental Science)
2	Eligibility for Admission	The students who have granted both the Semesters and might have or have not cleared their Semester I and Semester II are eligible.
3	Passing Marks	40% in each Paper
4	Ordinances / Regulations (if any)	-----
5	No. of Years / Semesters	Two Semesters
6	Level	P.G. / U.G. / Diploma / Certificate (Strike out which is not applicable)
7	Pattern	Yearly / Semester (Strike out which is not applicable)
8	Status	New / Revised (Strike out which is not applicable)
9	To be implemented from Academic Year	From Academic Year 2020-2021

Date:

Name of BOS Chairman /Dean: Dr. Bharmal Deelip L.

Signature :

Dr. Anuradha Mayumdar
Dean, Science & Technology

UNIVERSITY OF MUMBAI



Program: M.Sc.

Course: Zoology **(Environmental Science)**

Syllabus for Semester III & IV

(Choice Based Credit System
with effect from the academic year 2020-21)

**M.Sc. Part II (Semester III and Semester IV):
Zoology (Environmental Science)**

Syllabus Committee Members

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PREFACE

The main objective of reconstructing the Post Graduate syllabus of Zoology for Semester III and Semester IV is to provide global level advanced and skill oriented deep knowledge to the stakeholders which is currently needed for their survival. The current research and teaching in Zoology includes diverse aspects with a balance of organismic and reductionist biology. It offers teaching and research programs in the diverse areas, such as, Animal Physiology, Entomology, Fish Biology, Immunology, Developmental Biology, Cell Signaling, Cell Biology, Radiation Biology, Reproductive Biology, Endocrinology, Genomics, Metagenomic, Cancer Biology, etc. Our vision is to provide Global Knowledge in education, training & research in the field of Zoology where teaching and research encrust detailed understanding from microbes to human. The broad skills and deeper knowledge in the field would make them highly successful and excellent researcher in advanced areas of research in the Biological sciences.

Therefore, the Board of Study in Zoology aims to impart holistic understanding of Zoology by “redefining Zoology” to students of every age so that they develop interest in Science. It also aims to develop teaching and research programs that have relevance to society and employability. The M.Sc. program is being revised under CBCS scheme of UGC to meet the expectations of students.

To keep all of the above factors in mind, this syllabus was developed by the curriculum committee of Mentors, subject experts from other Universities and dedicated teachers. Their major role was to abridge, grow, augment and give a forward bearing to Zoology taught in undergraduate curriculum, with projections to future requirements. They have successfully completed this colossal task. I congratulate them.

Dr. Deelip L. Bharmal
Chairman Board of Studies in Zoology
University of Mumbai

PREAMBLE

I am extremely happy to present this new syllabus of Semester III and Semester IV to the teachers and students of Post Graduate Course in Zoology of the specializations, Oceanography and Fishery Technology, Entomology, Endocrinology, Animal Physiology and Environmental Science. While constructing the syllabus, the relevant inputs have been considered from Mentors, subject experts from various fields of other Universities, teachers and stakeholders to make it more effective.

An attempt has been made to make post graduate courses competitive and on par with global standards, as per the directives of University Grant Commission for the implementation of choice based credit system. Hence as per the guideline of UGC the present syllabus is made more interesting with new, innovative topics as per need of the current situation of the world and stakeholders.

The M.Sc. Zoology program provides an appropriate blend of classical and applied aspects of the subject. This newly designed curriculum will allow students to acquire skills in handling scientific instruments planning and performing in the laboratory and exercising critical judgment, independent thinking and problem solving skills.

The utmost care has been taken to declare the final syllabus well in advance to enable the teachers to make preparations before commencement of the academic year and facilitating students to execute their right to know the details before admissions.

The draft of Syllabus was approved in meeting of the Board of Studies in Zoology held on 10th March 2020, and it was unanimously resolved to implement the revised syllabus of Zoology at M.Sc. Semester-III and IV and make it effective from the Academic Year 2020-2021 after approval from concerned authorities of the University.

The success of this revamped syllabus will depend totally on the enthusiasm and interest shown by the stakeholders.

Dr. Nisar Shaikh Chairman,
M.Sc. Part II
Syllabus Committee

PEDAGOGY

PSZOOEVS301 is '**Introduction to Environmental Science**'. It is the study involving basic knowledge of different environmental components and their relevant aspects. It also involves learning regarding serious global and environmental issues like global warming, carbon credits and biodiversity loss. It will also assist to encourage research in different areas of environmental science and technologies. It also focuses the learner's attention to generate awareness about interrelationships between different divisions of ecosphere and impacts of various human activities on different environmental parameters. The new areas included in the syllabus here are learning about agricultural and industrial societies, public health & energy crisis. The other new areas of environmental science included here are Tragedy of commons, national and international standards of water quality, study on biography of some internationally reputed personalities known for their social work towards different environmental aspects and conservation of natural resources. So, it is expected that the learners may get well acquainted with the basic concepts of environmental science.

PSZOOEVS302 is related with '**Environmental Chemistry**'. It includes a study of concepts and scope of environmental chemistry, chemistry of Air, Chemistry of organic and inorganic chemicals in environment. This paper also includes advanced chapters that will help the learners to get the knowledge of Environmental Monitoring through various sampling techniques. These studies are incorporated with concerned detail studies of different advanced instruments and their procedures.

PSZOOEVS303 consists of topics concerned with the '**Natural Resources and Their Conservation**'. It will help the learners to get an insight regarding optimum use of Natural Resources and their conservation. It mainly focuses on all basic types of conventional resources like water, land and forest resources. The emphasis is mainly given on certain sensitive issues like mining, sustainable development, Wetland aquaculture, cloud seeding and Ground Water Conservation etc.

PSZOOEVS304 consists of '**Environmental Physics and Biology**'. It is a study which includes Heat and heat flow in biological system. Energy budget, its types and its various resources are the main points of discussion here. Biomes of the world and environmental microbiology are also included in this unit to make the learners access to relevant knowledge in the field of heat budget. Obviously, it aims at basic understanding about laws of thermodynamics, Hyperthermia treatment for cancer and tumors, role of IREDA and MEDA, energy from sun and biomass, bio-geographical realms, flora and fauna of India, Microbiology of water, air and soil. It also includes environmental microbiology involving various aspects of air, water and soil microbiology and few relevant diseases.

PSZOOEVS401 is related with '**Environmental Science and Media**'. It consists of use of Information technology in Environmental science. It is mainly involving parameters like the study of Environmental science and media, methods of scientific writing and its ethics etc. Main purpose of this paper is to make the learners well acquainted with the use of social media and Information technology in Environmental conservation, sustainable development, awareness etc. It also supports in the studies of IPR and Patenting as well as Principles of remote sensing, GIS and geographical information. This paper also highlights traditional and environmental journalism, scientific writing, futurology and future science, trade secret, patents, application of remote sensing.

PSZOOEVS402 is related with '**Socio-economic Aspects of Environment**'. It is a study involving environmental economics, environmental education, concept of eco-development vs. growth and national and international legislation. It also gives insight about environmental policies, environmental and integrated health in India, right to healthy environment as fundamental right, integrated approach to environment and development.

PSZOOEVS403 consists of '**Environmental Pollution**'. It is a study of air pollution, water pollution, solid waste pollution, radioactive and thermal pollution. It also gives insight of sources, types, treatment and preventive measures of air, water, solid waste, radioactive and thermal pollutions. The student will also be able to learn about specific case studies, acid rains, eutrophication, radiation etc.

PSZOOCN404 consists of '**Instrumentation and Presentation of Scientific data**'. It will help the learners to choose suitable measuring instruments for their applications and understanding of limitations, principles and measurement errors. The students will aware the efficiency of the instruments. Similarly the course also has the unit of presentation of scientific data. Text, tables, and graphs for data and information presentation are very powerful communication tools. They can make scientific report easy to understand, attract and sustain the interest of beneficiary.

Convener and Committee Members

M. Sc. II Zoology Syllabus
Choice Based Credit System
To be implemented from the Academic Year 2020-2021

Environmental Science: Semester III						
Course Name and Code	Unit	Topic Headings	Credit	Lecture/ Week	College Assessment Internal	University Assessment External
Paper I: Introduction to Environmental Science						
PSZOEVS301	1	Meaning, Scope, Interdisciplinary Nature of science	4	1	40	60
	2	Global & National environmental Issues		1		
	3	Human Impact on environment and its consequences		1		
	4	Concept of carrying capacity		1		
Paper II: Environmental Chemistry						
PSZOEVS302	1	Concept and scope of environmental chemistry	4	1	40	60
	2	Chemistry of Air		1		
	3	Chemistry of organic and inorganic chemicals in environment		1		
	4	Environmental Monitoring and Sample Analysis		1		
Paper III: Natural Resources and Their Conservation						
PSZOEVS303	1	Introduction to Natural Resources	4	1	40	60
	2	Biodiversity Conservation		1		
	3	Wetland and Ground Water Conservation		1		
	4	Forest Resources		1		
Paper IV: Environmental Physics And Biology						
PSZOEVS304	1	Heat and heat flow in biological system	4	1	40	60
	2	Energy types and resources		1		
	3	Biomes of the World		1		
	4	Environmental Microbiology		1		
		Total	16	16	160	240
Practicals						
PSZOEVS3P1	Practicals based on PSZOEVS301		2	4	–	50
PSZOEVS3P2	Practicals based on PSZOEVS302		2	4	–	50
PSZOEVS3P3	Practicals based on PSZOEVS303		2	4	–	50
PSZOEVS3P4	Practicals based on PSZOEVS304		2	4	–	50
	Total		8	16	–	200
	Grant Total		24	32	160	440

Environmental Science: SEMESTER IV

Course Name and Code	Unit	Topic Headings	Credit	Lecture/ Week	College Assessment Internal	University Assessment External
Paper I: Information Technology and in Environmental sciences						
PSZOEVS401	1	Environmental Science and Media	4	1	40	60
	2	Use of Information Technology in Environmental study.		1		
	3	IPR and Patenting		1		
	4	Principle of remote sensing and its application		1		
Paper II: Socio-Economic aspects of environment						
PSZOEVS402	1	Environmental Economics	4	1	40	60
	2	Environmental Toxicology		1		
	3	Concepts of Eco-development versus Growth		1		
	4	Environmental Education & Legislation		1		
Paper III: Environmental Pollution						
PSZOEVS403	1	Air Pollution	4	1	40	60
	2	Water Pollution		1		
	3	Soil Pollution		1		
	4	Radioactive Pollution		1		
Paper IV: Instrumentation and Presentation of Scientific data						
PSZOEVS404	1	Instrumentation	2	1	40	60
	2	Presentation of Scientific data		1		
	3	Project		2		
		Total	16	16	160	240
Practicals						
PSZOEVS4P1	Practicals based on PSZOEVS401		2	4	–	50
PSZOEVS4P2	Practicals based on PSZOEVS402		2	4	–	50
PSZOEVS4P3	Practicals based on PSZOEVS403		2	4	–	50
PSZOEVS4P4	Practicals based on PSZOEVS404		2	4	–	50
	Total		8	16	–	200
	Grant Total		24	32	160	440

M. SC. PART 2: SEMESTER III (THEORY)

PAPER 1: PSZOEVS301

INTRODUCTION TO ENVIRONMENTAL SCIENCE

Unit 1: Meaning, Scope, Interdisciplinary Nature of science

(15 L)

Objective:

- To encourage the learners for research on environmental, scientific and technological issues relevant to different Environmental issues.
- To aware the learners about heat budget and water masses of the environment.

Desired outcome

- The learners may predict changes in key environmental parameters, scope Nature of science.
- The Learners may also be aware about types of water masses.

1.1 Ecosphere & Biosphere

1.2 Lithosphere

1.2.1 Physico-chemical characteristics

1.2.2 weathering & Soil Formation

1.2.3 Geomorphologic processes

1.2.4 Stratification of lithosphere

1.3 Atmosphere

1.3.1 Physico-chemical characteristics

1.3.2 Divisions, composition & significance of components

1.4 Hydrosphere

1.4.1 Physico-chemical characteristics

1.4.2 Range of aquatic habitats

1.4.3 Comparison aquatic and terrestrial habitats

1.5 Interrelationship between the divisions of Ecosphere

Unit 2: Global & National environmental Issues

(15 L)

Objective:

- To aware the learners about the Global and National Environmental issues
- To offer the platform for discussion and solve the problem related to environmental issues.

Desired outcome:

- The Learner may explain, distinguish and apply advanced knowledge of the key concepts and principles of recent environmental issues.

2.1 Greenhouse effect

2.2 Acid Rain

2.3 Carbon credit and Carbon Sequestration

2.4 Clean Development Mechanism.

2.5 Carbon credits

2.6 Deforestation and Desertification

2.7 Biodiversity Loss

2.8 Forest fires (Case studies: Brazil and Australian Forest fires)

Unit 3: Human Impact on environment and its consequences

(15 L)

Objective:

- To encourage the learners to get an insight of different human activities those are interfering with the existence of natural resources and biodiversity.
- To focus on the studies of impact of cultural changes as well as agricultural societies and industrial societies with reference to conservation of natural resources. To aware the learners about heat budget and water masses of the environment.

Desired outcome:

- The learners may be able to get an insight of effects of population explosion, concept of agricultural and industrial societies, impact of cultural changes on environment as well as scope Nature of science
- The Learners may be aware of impact of human being on various environmental parameters.

- 3.1 Hunting and gathering
- 3.2 Agriculture and Industrial societies
- 3.3 Impact of cultural change on environment
- 3.4 Population explosion
- 3.5 Urbanization, industrialization food security, public health and energy crisis
- 3.6 Efforts for conservation: Case studies of the work done by-
 - 3.6.1 Rahibai Popare – Natural Seed Bank
 - 3.6.2 Greta Thunberg – Environmental Protection
 - 3.6.3 Steve Irwin – Marine Biodiversity studies and Conservation
 - 3.6.4 Tulasi Gowda – Encyclopaedia of forests
 - 3.6.5 Sunita Narain – Green concept of sustainable development
 - 3.6.6 Wangari Maathai – Green Belt Movement
 - 3.6.7 Jane Gudal – Primatologist
 - 3.6.8 Saalmumarada Thimmakka – Environmental activist [Tree Plantation]

Unit 4: Concept of ecosystems and community

(15 L)

Objective:

- To aware the learners about the important concepts in ecosystem and community ecology.
- To inform the learners about the concepts of carrying capacity, sustainability and concerned population parameters and standards.
- To make the learners to think of future scenarios of environmental status.

Desired outcome:

- The Learner may understand the basic concepts of ecosystem and community
- To get the idea about environmental sustainability and standard parameters of different environmental standards.

- 4.1 Biotic and abiotic components of environment
- 4.2 Types of ecosystems and their characters
 - 4.2.1 Terrestrial:
 - a) Forests and their types
 - b) Deserts (Hot and Cold)
 - c) Grasslands
 - d) Tundra
 - 4.2.2 Fresh water: Lentic and lotic with examples
 - 4.2.3 Estuarine and brackish water ecosystems with special reference to mangrove ecosystems
 - 4.2.4 Marine ecosystems: Oceans, sea and Bay

- 4.2.5 Glaciers and life of Polar regions
- 4.2.6 Wetlands: Types, characters and significance, Concept of Ramsar convention
- 4.3 Concept of sustainability and carrying capacity
- 4.4 Tragedy of commons
- 4.5 Water quality parameters and standards (Indian standards, BIS standards and WHO standards)
- 4.6 Human population and food
- 4.7 Water and energy security
- 4.8 Present status of environment and future scenarios

PAPER 2: PSZOEVS302 ENVIRONMENTAL CHEMISTRY

Unit 1: Concept and Scope of Environmental Chemistry

(15 L)

Objective:

- *To encourage the learners about the basic concepts of different chemical components of environment and different issues related to that.*

Desired outcome:

- *The learners may get acquainted with basics of key environmental parameters and the scope of relevant studies*
- *The learners will be equipped with the different components of the environment*

1.1 Concept and scope of environmental chemistry

1.2 Chemistry of environmental segments

1.2.1 Lithosphere

1.2.2 Hydrosphere

1.2.3 Atmosphere

Unit 2: Chemistry of Air

(15 L)

Objective:

- *To encourage the learners about various chemical factors of atmosphere and their impact on life on earth.*
- *To aware the learners about photochemical reactions occurring in the atmosphere like photochemical smog*

Desired outcome:

- *The learners may get an adequate knowledge regarding air composition and different chemical reactions of atmosphere that can influence on different forms of life.*

2.1 Classification of elements in air, composition of air and chemical speciation

2.2 Particle ions and radicals in the atmosphere, Chemical processes for formation of non-organic and organic particulate matter

2.3 Thermo chemical and photochemical reactions in the atmosphere

2.4 Chemistry of oxygen and ozone, chemistry of selective air pollutants – photochemical smog

Unit 3: Chemistry of Water and Soil

(15 L)

Objective:

- *To encourage the learners about basic concepts of water and soil chemistry*
- *Also to focus on impacts of different parameters of these environmental components and their role in the concerned ecosystems*

Desired outcome:

- *The learners may be able to analyze different components of water and soil ecosystems*
- *The Learners may become aware of flora and fauna of the concerned ecosystems*

3.1 Chemistry of Water:

- 3.1.1 Physical parameters of water – pH, temperature, turbidity, Total dissolved solids, conductance
- 3.1.2 Chemical parameters of water – Dissolved oxygen, Free CO₂, Hardness, Salinity
- 3.1.3 Biological parameters of water
 - a) Microflora and microfauna [Neuston and Plankton study]
 - b) Macroflora and macrofauna

3.2 Chemistry of Soil:

- 3.2.1 Physico-chemical factors of soil – Color, Nutrient composition, Water holding capacity, pH,
- 3.2.2 Types of soil and soil profile
- 3.2.3 Factors influencing soil fertility
- 3.2.4 Soil flora and fauna [Brief account]
- 3.2.5 Information of soils from different parts of India

Unit 4: Environmental Monitoring and Sample Analysis**(15 L)****Objective:**

- *To encourage the learners for research on environmental, scientific and technological issues relevant to the Environment.*

Desired outcome:

- *The learners may predict changes in key environmental parameters and their impact on ecosystems*

4.1 Sampling of air and water pollutants:

- 4.1.1 Monitoring techniques and methodology
- 4.1.2 Chemical oxygen demand (COD), Biological Oxygen demand (BOD)

4.2 Monitoring and analysis of particulate matter, Carbon monoxide, Carbon dioxide, Nitrogen oxides, Sulphur oxides, Pesticide residues, Phenols and Petrochemicals

PAPER 3: PSZOEVS303

NATURAL RESOURCES AND THEIR CONSERVATION

Unit 1: Introduction to Natural Resources

(15 L)

Objective:

- *To make the learners aware of natural resources and their present status as well as nature of exploitation*
- *To convey the basic knowledge of sustainable development and conservation of natural resources.*

Desired outcome:

- *The learners may be able to get an idea about different types of natural resources and their present scenario in different parts of the world.*
- *The Learners may become aware of policies regarding sustainable development. .*

- 1.1 Classification of Natural Resources
- 1.2 Types: Conventional & Non-conventional, Biodegradable and non-biodegradable, renewable and non-renewable
- 1.3 Exploration of natural resources and its relation with economic growth
- 1.4 Demand of resources
- 1.5 Concept of Sustainable Development, different types of Government policies in Sustainable development
- 1.6 Strategies for conservation and management of natural resources.

Unit 2: Water Resource

(15 L)

Objective:

- *To encourage the learners about management of aquatic resources and related matters*
- *To aware the learners about new concepts in water management*

Desired outcome:

- *The learners may get acquainted with different types of consumable water resources and their management.*

- 2.1 Manmade water resources:
 - 2.1.1 Storing water by dams
 - 2.1.2 Cloud seeding
 - 2.1.3 Water from icebergs
 - 2.1.4 Desalination
 - 2.1.5 Ground water and its channeling, recharging and its significance
 - 2.1.6 Farm ponds in agricultural lands and their significance
 - 2.1.7 Domestic rain water harvesting
- 2.2 Degradation of Water aquifers and its reasons : Case study: Reduction in ground water table and its impacts all over the world
- 2.3 Management strategies for water conservation: Personal and public [National Lake Conservation Plan - NLCP] and National Wetlands Conservation Program [NWCP]

Unit 3: Land Resources

(15 L)

Objective:

- *To encourage the learners about basics of land resources and their management.*
- *To aware the learners about different concepts in soil resource management.*

Desired outcome:

- *The learners may get acquainted with different strategies and policies regarding soil management.*

- 3.1 Land resources – types of lands: Agricultural & nonagricultural lands, arid lands,
- 3.2 Concept of Green Revolution
- 3.3 Degradation of land resources due to soil erosion, overuse of chemical fertilizers, weedicides and pesticides
- 3.4 Need of Soil conservation
- 3.5 Strategies of land conservation by organic farming, use of manures, Bio-fertilizers and Biological pest control
- 3.6 Nonagricultural uses of land- aquaculture practices, mineral development, Mining
- 3.7 Case Study- Impact of sugarcane farming and sugar industry

Unit 4: Forest Resources

(15 L)

Objective:

- *To introduce the learners with the causes of deforestation and need of silviculture.*
- *Present status of ratio of trees to human populations worldwide and in India*
- *To encourage awareness program among common people and environmental education.*

Desired outcome:

- *The learners may get adequate knowledge about various forest resources and their management.*

- 4.1 Forest as main resources in the past, present and future
- 4.2 Causes of deforestation and their impacts
- 4.3 Silviculture: Concept, objectives and advantages
- 4.4 Social Forestry, Joint Forest Management Program and Agro-forestry system
- 4.5 Concept of Sacred groves
 - 4.5.1 Types of sacred groves (personally owned,
 - 4.5.2 Owned by local deity trust and owned by local Government agencies),
 - 4.5.3 Role of sacred groves in conservation of forest resources
- 4.6 Generation of botanical gardens, medicinal plant gardens and seed banks as a part of forest conservation
- 4.7 Concept of energy plantation and its significance
- 4.8 Forest ecotourism

PAPER 4: PSZOEVS304 ENVIRONMENTAL PHYSICS AND BIOLOGY

Unit 1: Heat and heat flow in biological system

(15 L)

Objective:

- *To make the learners acquainted with different resources, patterns of heat flow and exchange methods in environment.*

Desired outcome:

- *The learners may predict changes in key environmental parameters, scope Nature of science.*
- *The Learners may aware about water type and masses.*

1.1 Environmental Physics:

- 1.1.1 Concept of heat and heat flow in biological systems
- 1.1.2 Heat capacity, heat exchange, waste heat and its environmental implications
- 1.1.3 Sound – Its nature, energy, intensity of sound waves, ear and hearing, noise measurements and its effects
- 1.1.4 Radiation
 - a) Introduction and types
 - b) Absorption of radiation and units of dose
 - c) Radiation as a tool in biological investigations

1.2 Environmental Biology:

- 1.2.1 Applications of principles of thermodynamics to life
- 1.2.2 Hypothermia treatment for cancers and tumors

Unit 2: Energy types and resources

(15 L)

Objective

- *To encourage research on environmental, scientific and technological issues relevant to the environment.*
- *To aware the learners about heat budget and water masses of the environment.*

Desired outcome

- *The learners may predict changes in key environmental parameters, scope Nature of science.*
- *The Learners may aware about water type and masses.*

2.1 Introduction to energy resources:

- 2.1.1 Human energy requirements for basal metabolism, metabolic response to food, Physical activity, growth, pregnancy and lactation
- 2.1.2 Patterns of energy use in different parts of the world with special emphasis on India and its impact on environment
- 2.1.3 Sources of energy and their classification
- 2.1.4 Energy forms and transformation energy use pattern in rural and urban area
- 2.1.5 Role of IREDA (Indian Renewable Energy Development Agency) and MEDA

- (Maharashtra Energy Development Agency) in energy generation
- 2.2 Fossil Fuels:
- 2.2.1 Classification, composition, physicochemical characteristics
 - 2.2.2 Concept of energy content and energy content of coal, petroleum and natural gas
 - 2.2.3 Environmental problems associated with exploration/mining, processing, transportation and uses
- 2.3 Energy from the Sun and Biomass
- 2.3.1 Sun as a source of energy
 - 2.3.2 Harnessing of solar energy
 - 2.3.3 Solar collectors and concentrators
 - 2.3.4 Solar thermal energy
 - 2.3.5 Solar electricity generation
 - 2.3.6 Solar heaters, dryers, cookers, and photovoltaic
 - 2.3.7 Biomass composition and types
 - 2.3.8 Conversion process
 - a) Pyrolysis
 - b) Charcoal production
 - c) Compression
 - d) Gasification
 - e) Liquefaction
 - 2.3.9 Biogas production and uses and energy from solid wastes
- 2.4 Energy from water, wind and Geothermal, Nuclear energy
- 2.4.1 Hydroelectric power and its impact on environment
 - 2.4.2 Energy from tides and waves
 - 2.4.3 Wind power and its potential in India
 - 2.4.4 Temperature aquifers and geothermal energy prospect in India
 - 2.4.5 Nuclear fission and fusion, nuclear reactors and radioactive waste

Unit 3: Biomes and biodiversity hotspots of the World

(15 L)

Objective

- *To encourage the students to know more about biomes and biodiversity hotspots of the world.*

Desired outcome

- *Learners will be acquitted with the animal distribution pattern on the basis topographical and climatological conditions and their interregional relationship.*

- 3.1 Concept of biome and biodiversity hot spots
- 3.2 Study of Topography, climatic factors and flora-fauna of Bio-geographical realms
 - 3.2.1 Palearctic
 - 3.2.2 Nearctic
 - 3.2.3 Afrotropic
 - 3.2.4 Indomalaya
 - 3.2.5 Australasia
 - 3.2.6 Neotropic
 - 3.2.7 Oceanea and Antarctic
- 3.3 Study of biodiversity hotspots in India

Unit 4: Environmental Microbiology

(15 L)

Objective

- *To offer the learners the basic knowledge regarding different types of micro-organisms and their role in environment*
- *To aware the learners about microbiology of different environmental components*

Desired outcome

- *The learners may be able to get a substantial knowledge about different aspects of microbes and their role in different components of the environment.*

4.1 Environmental Microbiology

4.1.1 Prokaryotes

4.1.2 Classification of microbes

4.1.3 Microbial communities in nature and their interaction with human beings, animals and plants

4.1.4 Dispersal of micro-organisms in different environment

4.1.5 Pure culture concept, techniques, preservation and maintenance of microbial culture

4.2 Water Microbiology

4.2.1 Water borne diseases

4.2.2 Bioremediation used for effluents

4.3 Air Microbiology

4.3.1 Aerobiology, allergy, role of microorganisms in air borne diseases

4.3.2 Classification enumeration of microbes in air, dust, droplets and droplet nuclei

4.4 Soil Microbiology

4.4.1 Importance microbes for soil fertility

4.4.2 Biodegradation

4.4.3 Soil borne diseases

4.4.4 Role of microbes in soil reclamation

M. Sc. Part 2: Semester III Practical

Practical 1: PSZOEVS3P1

1. Estimation of various diversity indices from at least four different local ecosystems by using quadrat and line transect methods.
2. Collection, laboratory culture and identification of planktons from two different local aquatic ecosystems. Preparation of at least 05 permanent slides with proper identifications.
3. Determination of primary productivity by light and dark bottle method.
4. Determination of status of water quality of a given ecosystem by –
 - a) Estimation of dissolved oxygen (DO)
 - b) Estimation of Salinity
 - c) Estimation of Hardness
 - d) Estimation of Phosphate-phosphorous
 - e) Estimation of Nitrates [NO₃-N] and Nitrites [NO₂-N]
 - f) Estimation of heavy metals – Cu, Zn & Pb
 - g) Estimation of Free CO₂
 - h) Comparison of the results of all above estimations with national and international standards to determine the standard of water quality in the ecosystem under study
5. Visit to an NGO in your area working in the field of environmental conservation. Make a report of the work being done by the NGO.
6. Visit and make an interview/discussion with a renowned naturalist, Conservationist or ecologist in your area with the help of a well-prepared questionnaire. Make a case study report on the work done by that person, importance of the work and its impact on local population. Attach the sample questionnaire with your report.
7. Visit and Make a report on geological stratification and geographical features of any habitat region of your choice.
8. Prepare a proper questionnaire and interview any ten people of your choice to understand their views and attitudes towards utilization of natural resources, sustainable development and conservation of nature. Make a consolidated report on that. Attach the sample questionnaire with your report.

Practical 2: PSZOEVS3P2

1. Determination of types of particulate matter, its concentration and overall impact on environment from selected area to determine its air quality.
2. Determination of status of water quality of a given ecosystem by –
 - a) Estimation of pH
 - b) Estimation of Turbidity
 - c) Estimation of Conductance
 - d) Estimation of Total dissolved solids
 - e) Estimation of Suspended solids
 - f) Estimation of Chemical Oxygen Demand (COD)
 - g) Estimation of Biological Oxygen Demand (BOD)
3. Qualitative as well as quantitative estimation of Planktons from two selected aquatic ecosystems.
4. Survey of macroflora and macrofauna of the same selected aquatic ecosystems.
5. Determination of food chain and food web in those selected aquatic ecosystems.
6. Estimation of physicochemical factors of soil – colour, pH and water holding capacity.
7. Make a report on different types of pesticides and fertilizers used in agricultural practices in your area. Comment on their impact on agricultural yield, local ecosystems, animal communities and human beings.
8. Make a consolidated report on soil profile involving information regarding soil flora and fauna of any five different spots of your choice in your area. Write your comments on fertility of the soil, need of its improvement, if any and strategies to improve the same.

Practical 3: PSZOEVS3P3

1. Determination of total organic matter in soil.
2. Determination of Sodium Absorption Ratio (SAR) value of soil.
3. Determination of total nitrogen value of the soil by Kjeldahl's method.
4. Determination of mechanical composition of soil by Pipette method.
5. Determination of Cation-exchange capacity, moisture content, alkalinity/acidity of soil sample.
6. Determination of Residual Chlorine from drinking water using colorimetric method.
7. Make a brief study on types of natural resources available in your area, the way and extent of their use by local population, their present status and methods of their conservation.
8. Make a report on present status of ground water table and other fresh water aquifers in your area. Comment on the strategies like rain water harvesting, followed in your area, for water conservation.
9. Make a biodiversity survey and/or habitat type survey of your choice from your own area. Produce a consolidated scientific report of that.

Practical 4: PSZOEVS3P4

1. Study of Topography, climatic factors and flora-fauna of Bio- geographical realms with the help of maps –
 - a) Palearctic
 - b) Nearctic
 - c) Afrotropic
 - d) Indomalaya
 - e) Australasia
 - f) Neotropic
 - g) Oceanea and Antarctic
2. Prepare a map of India, showing bio-geographical zones and expanse of territorial waters.
3. Prepare a map of Maharashtra showing Protected Area Network (PAN) in it.
4. Prepare a document of endemic and exotic species of plants and animals for a selected PAN.
5. Indicate distribution range of endangered plant and animal species on Indian map.
6. To study qualitative and quantitative characters of a plant community by quadrat method.
7. To study a plant community by using line transect method using line, belt and profile transects.

Two compulsory short field excursions of one day and one long excursion for the study different aspects from all theory papers. Properly written excursion report should be presented by each student along with the journal of IVth Paper Practical Examination. A separate viva must be taken by the examiners on that report. Students not producing the excursion report at the time of examination shall be asked additional relevant questions apart from regular viva of the examination. But such students will get maximum up to 50% marks only from those allotted for the excursion report in such cases.

M. SC. PART 2: SEMESTER IV (THEORY)
PAPER 1: PSZOEVS401
INFORMATION TECHNOLOGY IN
ENVIRONMENTAL SCIENCES

Unit 1: Environmental Science and Media

(15 L)

Objective:

- *To make the learners aware of use of information technology in different areas of environmental science*
- *To generate an awareness towards common environmental education using different information technologies and social media*

Desired outcome:

- *The learners may get well acquainted with the advances in social media towards environmental education as well as research.*

- 1.1 Trend of environmental journalism, role of print and electronic media
- 1.2 Environmental awareness through mass media, application in environmental protection
- 1.3 Scientific writing on environmental issues, Principles of research experimentation in environmental science, ethics in scientific writing on environmental crisis and issues
Role and involvement of NGOS Women and youth in environmental protection
- 1.4 Use of social media in generation of environmental awareness and education
- 1.5 Need of environmental education in academic fields as well as social fields

Unit 2: Use of Information Technology in Environmental studies

(15 L)

Objective:

- *To make the learners aware of use of information technology in different areas of environmental science.*
- *To generate an awareness towards common environmental education using different information technologies and social media*

Desired outcome:

- *The learners may get well acquainted with the advances in information technology towards environmental education as well as research.*

- 2.1 Definition and scope of information technology
- 2.2 Futurology and future science, impact of changing life styles and innovative technologies
- 2.3 Future needs and humanity, new ethics in research in environmental sciences, space travel, robotics etc.
- 2.4 Use of information technology in environmental education with suitable examples

Unit III: IPR and Patenting

(15 L)

Objective:

- *To make the learners aware of intellectual property rights and patenting in the field of environmental science.*

Desired outcome:

- *The learners may get a knowledge of intellectual property rights in the field of environmental science with respect to discovery of new species and similar concerns.*

- 3.1 Intellectual property right (IPR)
- 3.2 Trade secret, patent- rules and regulations
- 3.3 International harmonization of patent laws, Protection of inventions
- 3.4 Benefits from IPR and problems from IPR
- 3.5 Patenting methods for discovery of new species with proper evidence and proof, discoveries of new drugs, tools and techniques or methodology in concern with the environmental science

Unit IV: Principles of remote sensing, Geographical Information System and its application

(15 L)

Objective:

- *To make the learners well acquainted with different techniques like remote sensing and GIS.*

Desired outcome:

- *The learners may get a knowledge of remote sensing and GIS mapping techniques*

- 4.1 Principles of remote sensing, EMR and its interaction with matter, Types of sensors and platforms, IRS satellites and sensors
- 4.2 Aerial photography, satellite imagery, elements of satellite/aerial image interpretation
- 4.3 Advancement in satellite research and role in environmental protection
- 4.4 Geographical Information System - Concept of GIS, Use of softwares in GIS to evaluate and monitor environmental protection acts including groundwater and natural resource exploration, rainwater harvesting etc.
- 4.5 Applications of remote sensing and GIS in natural disasters: Early warning of Tsunami, Earthquake, snowfall, forest fires and other natural disasters

PAPER 2: PSZOEVS402

SOCIO-ECONOMIC ASPECTS OF ENVIRONMENT

Unit 1: Environmental Economics

(15 L)

Objective:

- *To make the learners well acquainted with different techniques like remote sensing and GIS.*

Desired outcome:

- *The learners may get a knowledge of remote sensing and GIS mapping techniques*

- 1.1 Concept of Environmental Impact Assessment [EIA]
- 1.2 Methods of impact assessment of different Environmental problems
- 1.3 Concept of green audit
- 1.4 Economics of Environmental pollution and its control in India
- 1.5 Environmental consideration in public project planning
- 1.6 Tools for Environmental Policy
- 1.7 Basic pollution control, Industrial pollution, control and effluent standards at national and international levels
- 1.8 Environmental and integrated health in India

Unit 2: Environmental Education and Planning

(15 L)

Objective:

- *To inform the learners about planning and legislations regarding environmental education.*

Desired outcome:

- *The learners may get the knowledge of planning and legislations regarding environmental education.*

- 2.1 Concept of Environmental Education, History of nature education in India, Principle goal, need and objectives, awareness and action through environmental education
- 2.2 Right to Healthy Environment as a fundamental right, Environmental protection under common law, Implementation of Environmental laws in India
- 2.3 Role of stake holders and governing authorities in Environmental education
- 2.4 Case study of reports: Madhav Gadgil report on Konkan Zone, and Madhav Chitale report on global water partnership and Mithi river; in concern with Environmental protection and conservation

Unit 3: Concepts of Eco-development versus Growth

(15 L)

Objective:

- *To inform the learners about the nature of dispute and its aspects in eco-development and growth.*

Desired outcome:

- *The learners may get aware of the need of conservation by avoiding the dispute between eco-development and growth*

- 3.1 Concepts of eco-developments, integrating economic and ecological principles, Concept of CRZ & SEZ
- 3.2 Definition of physical and economic growth, cost benefit ratio, development process and growth, Cost benefit ratio
- 3.3 Integrated approach to environment and development
- 3.4 Western Ghat Eco-development Plan, development models for hilly area, river basin land and growth centre

Unit 4: National and international legislations**(15 L)****Objective:**

- *To inform the learners about the national and international legislations regarding environmental issues.*

Desired outcome:

- *The learners may get aware of national and international legislations regarding various national and international environmental issues.*

- 4.1 History and Development of Environmental Protection under National and International Law, Concept of Environmental law
- 4.2 Major international agencies for environmental protection and their actual role
- 4.3 Fundamental Principles of National and International Environmental Law
- 4.4 United Nations Conference on Human Environment, 1972 (Stockholm Conference) – Aims and Objectives of the Conference, Stockholm Declaration, 1972, Impact of 3 Stockholm, UNEP- Vienna Convention & Montreal Protocol, World Charter for Nature, 1982
- 4.5 WCED – The Brundtland Commission, Brundtland Report 1987
- 4.6 United Nations Conference on Environment and Development (UNCED/Earth Summit) – Aims and Objectives of Conference, Rio Declaration 1992, Agenda 21, Convention on Biological Diversity, 1992, Statement of Forest Principles, UNFCCC
- 4.7 Earth Summit Plus Five - Kyoto Protocol, 1997; Millennium Development Goals g. Johannesburg Conference 2002 (WSSD) - Johannesburg Declaration & Major Outcomes
- 4.8 The water (Prevention and control of pollution) Act 1974
- 4.9 The air (Prevention and control of pollution) Act 1981
- 4.10 The Environment (Protection) Act 1986
- 4.11 The wildlife Protection Act 1972
- 4.12 The Forest conservation Act 1980
- 4.13 The Biodiversity Protection Act 2002

PAPER 3: PSZOEVS403 ENVIRONMENTAL POLLUTION

Unit 1: Air Pollution

(15L)

Objective:

- *The learners will get informed about different aspects of atmosphere and its pollutants along with their impacts on environment.*

Desired outcome:

- *The learners may get an idea regarding air pollution and its various aspects.*

- 1.1 Air Pollution- Meteorology and climatology of air pollution
- 1.2 Sources of air pollution- mobile and non-mobile combustion sources, aerosols and refrigerants
- 1.3 Indoor air pollution- ventilation, heating, air conditioning
- 1.4 Acid rain, greenhouse gases, photochemical smog, nuclear winter, ozone depletion
- 1.5 Sampling and analysis of air pollutants and monitoring
- 1.6 Case studies- London smog, Delhi air pollution, Bhopal gas tragedy, Chernobyl incidence

Unit 2: Water Pollution

(15 L)

Objective:

- *The learners will get informed about different aspects of water qualities and its pollutants along with their impacts on aquatic ecosystems.*

Desired outcome:

- *The learners may get an idea regarding Water pollution and its various aspects.*

- 2.1 Point and Non-point resources of water pollution, Pollution and treatment of ground water table, streams, estuaries, lakes and oceans
- 2.2 Process of Eutrophication
- 2.3 Bio-amplification of the pollutants and their impact on food chain
- 2.4 Case Studies. – Torry Canyon, Minamata
- 2.5 Preventive measures and treatment - effluents from Domestic and Industrial establishments, Primary, Secondary and Tertiary water quality management in India

Unit 3: Solid waste Pollution

(15 L)

Objective:

- *The learners will get informed about different types of solid wastes and their impacts on environment*

Desired outcome:

- *The learners may get an idea regarding management of solid waste.*

- 3.1 Solid waste and its types, sources
- 3.2 Concept of e-waste and its impact on environment
- 3.3 Modern trends in solid waste management.
- 3.4 Energy from refuse
- 3.5 “Best out of waste” concept and its examples – Road construction by using plastic waste, Maharashtra nature park in Dharavi, Mumbai

Unit 4: Radioactive, Thermal and Sound Pollution

(15 L)

Objective:

- *The learners will get informed about different types of radioactive pollutants as well as thermal pollutants and their impacts on environment.*

Desired outcome:

- *The learners may get an idea regarding impacts of radiation and thermal pollutants and their management.*

- 4.1 Types and sources of radioactive pollutants – Natural and manmade, Fuel Processing and Radiation intensity
- 4.2 Effects of radioactive pollution, Radioactive fallout
- 4.3 Control radiation, Nuclear reactor safety
- 4.4 Thermal pollution
 - 4.4.1 Definition
 - 4.4.2 Sources and effects
 - 4.4.3 Examples and Control of thermal pollution
- 4.5 Sound pollution control technologies:
 - 4.5.1 Noise monitoring
 - 4.5.2 Noise monitoring devices
 - 4.5.3 Ear muffs
 - 4.5.4 Silencers
 - 4.5.5 Noise absorbers, anti-noise devices
 - 4.5.6 Noise control methods

PAPER 4: PSZOEVS404 INSTRUMENTATION AND PRESENTATION OF SCIENTIFIC DATA

Unit 1: Instrumentation

(15L)

Objective

- *To learn how to design and build instruments for laboratory measurement.*
- *To understand fundamental principles of operation.*

Desired Outcome

- *The learner will understand methods for operation of instruments and data analysis.*
- *The learner will understand how instrumentation can advance Scientific research.*

1.1 Centrifugation:

- Principle and applications of Centrifugation
- Differential and density gradient Centrifugation

1.2 Electrophoresis:

- Principle
- Structural components
- Applications

1.3 Chromatography:

- Principle and applications
- Adsorption
- Ion exchange
- Gel permeation
- Affinity

1.4 Spectrophotometer:

- Principle
- Applications

1.5 PH meter

- Principle
- Applications

1.6 Microscopy

- Binocular
- Trinocular

Unit 2: Presentation of Scientific data

(15L)

Objective

- *To aware the students for good practice in data presentation.*
- *To aware the students to use different data presentation formats.*

Desired Outcome

- *The students will familiarize to explain their research data by using different techniques for presenting their scientific data.*

2.1 Types of presentation:

- Oral
- Poster
- Written
- Audio-visual

Aids for presentation

2.2 Preparing the manuscript

- Guidelines for authors
- The IMRAD format

2.3 Title, Byline, Abstract and Summary, Keywords

2.4 Introduction:

- Defining the problem
- Literature survey
- Justification of study

2.5 Materials and Methods:

- Contents
- Sources
- Procedures
- Techniques
- Reproducibility
- Significance

2.6 Results:

- Text
- How to present data
- Tables and illustrations
- Writing captions
- Labels and legends

2.7 Discussion:

- Components and Sequence
- Analysis, Comparison and Integration of Data
- Likely Sources of Errors in Results

2.8 Conclusions and significance

Unit 3: Project

(30L)

Objective

- *To familiarize learner for analyzing a scientific occurrence with an investigation or to solve a problem with an invention.*

Desired Outcome

- *Research expands the current state of knowledge (at a certain cost) of the learners.*
- *Experimental findings that may yield new insights or lead to other research among the learners.*

- 1. Dissertation 60 Marks**
- 2. Examinations 50 Marks**

Guidelines to the 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 type-written using computer and printed for binding.**
- 3. No minimum or maximum limit of the number of pages is defined since the volume of the project 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 project 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. The project will be prepared individually by students.**

M. Sc. Part 2: Semester IV Practical

Practical 1: PSZOEVS4P1

1. Interpretation of Aerial photographs and preparing weather report based on it.
2. Study of different satellite imaging techniques and their interpretation methods.
3. Study of any three softwares used in GPS and GIS techniques.
4. Study of different remote sensing techniques and their significance.
5. Actual field work involving geological or geographical mapping of any three selected habitats. (One of them must be a fresh water body).
6. Case studies on applications of remote sensing and GIS in natural disasters like Tsunami, Earthquake and forest fires etc.
7. Scientific writing on local, state level, national and international environmental issues. Students are supposed to write at least one brief report on each of these types.
8. Studies on different patenting techniques for discovery of new species.
9. Preparation of a role model for environmental journalism and environmental education in academic field and social field.
10. Actual ICT presentations through appropriate models by every student in any school, college or any public place for generating environmental awareness. Each student must deliver at least two presentations in two different places for the purpose throughout the term. Proper written report of this activity, duly signed by the concerned Teacher-in-charge and Head of the department, should be produced by the student at the time of practical examination with adequate documentary and photographic evidences. Examiners should go through the same properly, ask few relevant questions and offer the marks accordingly for that allotted separately during practical examination of this paper.

Practical 2: PSZOEVS4P2

1. To prepare a detail report on scope of eco-tourism and its present status in case of any tourist place in your area. Each student should produce a separate report. No group reports.
2. Environmental Impact Assessment [EIA] of an ecologically sensitive site or any industry or similar place. It may be a group project involving not more than three students in a group
3. Preparation of Green Audit Report of any educational institute/public places like gardens/industry/Government offices or any preferable premises. It may be a group project involving not more than three students in a group.
4. Studies on legal cases filed by forest department in that year towards conservation and protection of environment. [Legal Case citation – compulsory one per student]
5. Report on any public movement or incidence of individual/public awareness towards environmental protection or conservation or sustainable development. The report may include implementation of eco-friendly practices like wind mill, use of solar energy, eco-friendly festivals etc. at individual/family levels or at society levels in the study area. It may be an individual report or group report involving maximum two students.
6. One day short excursion to any ecosensitive spot or ecotourism place. All students should produce a common report on that involving the assessment of the spot including status and scope of ecotourism of that place and impact of different local and outside factors on the ecological status of the place. The report should also suggest probable methods for improvement in the situation.

Practical 3: PSZOEVS4P3

1. To isolate and study a pure culture of microorganisms from air, water and sewage.
2. To study the effect of pH on microbial growth.
3. Study the effect of heavy metals on the growth of bacteria.
4. Determination of MPN value of the drinking water and mineral water.
5. Determination of SO₂ by spectrophotometry using high volume sampler.
6. Determination of NO₂ from the atmosphere by Colorimetric method using high volume sampler.
7. Report on sources, types and impacts of different solid wastes in your area in different seasons. Also add a note on local methods implemented for eradication of that waste and feasibility of those methods.
8. Report on survey done for the production of e-waste generated from various sources like educational institutes, technical and technological institutes, government and semi-government agencies and departments, public level institutions as well as at individual levels. It may be group report involving not more than three students for a prescribed study area.

Practical 4: PSZOEVS4P4

The practical of Semester 4 paper 4 comprises the Research Project for which students will have to take up a particular topic based on which they will be doing research applying the ethics of research, methods and methodology, etc. They are expected to abide rules of Scientific Research and if possible derive at a conclusion for the same. This will help the learners to build a strong foundation for pursuing research. Learners will acquaint about preparation of lay out, structure and language of typical reports, illustrations and tables. Learners will gain knowledge about how to write bibliography, referencing and footnotes in reports and thesis or in research articles.

Further, learners will be oriented to presentation of data through effective communication with the help of advanced visual technology. In addition to that they will be aware about the application of results, environmental impacts, conservation of biodiversity, ethical issues and ethical committees. The practical should be organized in such a manner that learners can be trained to manage large data sets generated via multiple observations, arrange them in a proper format and present them in relevant graphs/charts by adopting a hands-on in silico approach.

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University of Mumbai
M.Sc. ZOOLOGY (Environmental Science)
Semester III / Semester IV EXAMINATIONS

Modality of Assessment

A. Internal Assessment 40%

Sr. No.	Evaluation type	Total Marks
1	One Assignments / Case study	25
2	Active participation in routine class instructional deliveries	05
3	Attendance – (0-25% = 0 marks, 25-50% = 1mark, 50-75% = 3 marks and 75-100%= 5 marks)	05
4	Overall conduct as a responsible student, manners, skill in articulation, leadership qualities demonstrated through organizing co-curricular, etc.	05

B. External Assessment 60%

a. Semester End Examination 60 Marks

- Duration – These examinations shall be of two and half hours duration for each paper.
- Theory Question Paper Pattern:
 - ❖ There shall be five questions each of 12 marks. On each unit there will be one question and the first one will be based on entire syllabus.
 - ❖ All questions shall be compulsory with internal choice within the questions. Each question will be of 18 to 30 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.

b. Practicals: 50 Marks

c. Project in Semester IV: Internal Examination 40 Marks

Dissertation: 60 Marks

External Evaluation: 50 Marks

***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 neighbouring colleges.

Use of animals for any experiment / dissection / mounting is banned. Simulations, authorized permanent specimens / slides, charts, models and other innovative methods are encouraged.

University of Mumbai
M.Sc. ZOOLOGY (Environmental Science)
Paper Pattern of Semester III (Papers 1, 2, 3, 4) &
Semester IV (Papers 1, 2, 3) Examination

Maximum Marks: 60

Duration: 2.5 Hours

Marks Option: 90

Question 1. Based on Unit I to IV (Mixed Questions)

Question 2. Based on Unit I

Question 3. Based on Unit II

Question 4. Based on Unit III

Question 5. Based on Unit 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 Units) **(12)**
 - a)
 - b)
 - c)
 - d)
 - e)
 - f)
- 2. Answer any **two questions** from the following: (Based on Unit I) **(12)**
 - a)
 - b)
 - c)
- 3. Answer any **two questions** from the following: (Based on Unit II) **(12)**
 - a)
 - b)
 - c)
- 4. Answer any **two questions** from the following: (Based on Unit III) **(12)**
 - a)
 - b)
 - c)
- 5. Answer any **two questions** from the following: (Based on Unit IV) **(12)**
 - a)
 - b)
 - c)

Semester IV Examination
Paper IV: Skill in Scientific communication and Writing
Internal (Theory) Paper Pattern of PSZOEVS404

Maximum Marks: 40

Duration: 1.15 Hours

Marks Option: 60

Instructions:

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

- 1.** Fill in the blank by choosing the correct option given in the brackets (Based on both Units) (Four sub-questions from each unit) **(08)**
- 2.** Answer any **two questions** from the following: (Based on Unit I) **(16)**
 - a)
 - b)
 - c)
- 3.** Answer any **two questions** from the following: (Based on Unit II) **(16)**
 - a)
 - b)
 - c)

Skeleton of Practical Examination Question

Practical 1: PSZOEVS3P1

Time: 10:00 am to 3:00 pm

Total Marks: 50

1. **Major experiment** **12**
Estimation of Nitrates [NO₃-N] and Nitrites [NO₂-N] from the given water sample.
OR
Estimation of Phosphate-Phosphorous from the given water sample.
OR
Estimation of heavy metals – Cu/Zn/Pb from the given water sample.
OR
Estimation of species diversity indices from the given ecosystem using quadrat and/or line transect method.

2. **Minor experiment** **07**
Estimation of Salinity from the given water sample.
OR
Estimation of Hardness from the given water sample.
OR
Estimation of Free CO₂ from the given water sample.
OR
Estimation of acidity from the given water sample.
OR
Estimation of alkalinity from the given water sample.

3. Evaluation of Permanent slides of Plankton made by the student **05**

4. Evaluation of two reports by examiners through viva. **06**
 - a) Report on visit to an NGO
 - b) Report on geological stratification and geographical features of any habitat

5. Evaluation of two reports. **10**
 - a) Report on interview/discussion with a renowned naturalist/Conservationist/an ecologist.
 - b) Report on interview with any ten people of choice for environmental awareness.

6. Viva voce based on theory. **05**

7. Journal. **05**

Practical 2: PSZOEVS3P2

Time: 10:00 am to 3:00 pm

Total Marks: 50

1. **Major experiment** **14**
Estimation of Chemical Oxygen Demand (COD) from the given water sample.
OR
Estimation of Biological Oxygen Demand (BOD) from the given water sample.
2. **Minor experiment** **06**
Estimation of pH and Turbidity.
OR
Estimation of Turbidity and Conductance.
OR
Estimation of Conductance and pH.
OR
Estimation of Total dissolved solids.
OR
Estimation of Suspended solids.
OR
Estimation of physicochemical factors of soil - colour, pH and water holding capacity.
3. Quantitative estimation of Plankton by settling/displacement/counting/wet weight method from the given water sample. **06**
4. Evaluation of two reports.
 - a) Report on different types of pesticides and fertilizers **08**
 - b) Report on soil profile. **08**
5. Evaluation of two reports.
 - a) Report on determination of structure of food chain and food web. **06**
 - b) Report on survey of macroflora and macrofauna. **06**
6. Viva voce based on theory. **05**
7. Journal. **05**

Practical 3: PSZOEVS3P3

Time: 10:00 am to 3:00 pm

Total Marks: 50

1. **Major experiment** **14**
Determination of total organic matter in soil.
OR
Determination of Sodium Absorption Ratio (SAR) value of soil.
OR
Determination of total nitrogen value of the soil by Kjeldahl's method.
OR
Determination of mechanical composition of soil by Pipette method.
2. **Minor experiment** **10**
Estimation of Determination of Cation-exchange capacity of soil sample.
OR
Estimation of moisture content of soil sample.
OR
Estimation of alkalinity of soil sample.
OR
Estimation of acidity of soil sample.
OR
Estimation of Residual Chlorine from drinking water using colorimetric method.
3. Evaluation of two reports. **06**
 - a) Report on types of natural resources available in the area
 - b) Report on present status of ground water table and other fresh water aquifers and strategies on water conservation
4. Evaluation of Scientific report on Biodiversity survey/habitat type survey. **10**
5. Viva voce based on theory. **05**
6. Journal. **05**

Practical 4: PSZOEVS3P4

Time: 10:00 am to 3:00 pm

Total Marks: 50

1. **Major experiment:** **16**
Estimate of plant diversity indices (species abundance and richness) from the given area using quadrat and/or line transect method.
2. **Minor experiment: (Any three will be asked)** **09**
Mapping of flora and fauna of Bio-geographical realms with the help of maps
 1. Palearctic
 2. Nearctic
 3. Afrotropic
 4. Indomalaya
 5. Australasia
 6. Neotropic
 7. Oceania and Antarctic
3. **Minor experiment:** **05**
Plotting different biogeographical zones in the map of India and expanse of territorial waters.
OR
Evaluation of a map of Maharashtra showing Protected Area Network (PAN) in it.
OR
Prepare a document of endemic and exotic species of plants and animals for a selected PAN.
OR
Mapping of distribution range of endangered plant and animal species on Indian map.
4. Excursion reports. **10**
5. Viva voce based on theory. **05**
6. Journal. **05**

Practical 1: PSZOEVS4P1

Time: 10:00 am to 3:00 pm

Total Marks: 50

1. Evaluation of actual ICT presentations on environmental awareness. **10**
2. Evaluation of actual field work involving geological or geographical mapping of any three selected habitats. **08**
3. Evaluation of role model prepared by the student for environmental journalism and environmental education in academic field and social field. **10**
4. Evaluation of any one Scientific report on either local, state level, national/ international environmental issues written by the student **06**
5. Identification. **06**
 - a) Any one aerial / satellite photograph for interpretation of weather status.
 - b) Identification of habitat / area by GIS / GPS photograph or map
6. Viva voce based on theory. **05**
7. Journal. **05**

Practical 2: PSZOEVS4P2

Time: 10:00 am to 3:00 pm

Total Marks: 50

- | | |
|---|-----------|
| 1. Evaluation of the individual report on status and scope of eco-tourism. | 12 |
| 2. Evaluation of group project on Environmental Impact Assessment [EIA]. | 07 |
| 3. Evaluation of group project on Preparation of Green Audit Report. | 10 |
| 4. Evaluation of two reports. | 06 |
| a) Report on Studies on legal cases filed by forest department | |
| b) Report on public movement or individual awareness towards environmental protection | |
| 5. Excursion report and viva based on it | 05 |
| 6. Viva voce based on theory. | 05 |
| 7. Journal. | 05 |

Practical 3: PSZOEVS4P3

Time: 10:00 am to 3:00 pm

Total Marks: 50

- | | |
|--|-----------|
| 1. Major Experiment | 14 |
| To study the effect of pH on microbial growth. | |
| OR | |
| Determine of SO ₂ by spectrophotometry using high volume sampler. | |
| OR | |
| Determine of NO ₂ from the atmosphere by Colorimetric method using high volume sampler. | |
| 2. Minor Experiment | 10 |
| Study the effect of heavy metals on the growth of bacteria. | |
| OR | |
| Determination of MPN value of the drinking water and mineral water. | |
| 3. Evaluation of the Report on solid wastes. | 08 |
| 4. Evaluation of Report on survey of e-waste. | 08 |
| 5. Viva voce based on theory. | 05 |
| 6. Journal. | 05 |

Skeleton of Practical Examination Question Paper: Practical 4: PSZOEVS4P4

Evaluation of Project of Paper IV: 60 Marks

- | | |
|---|------|
| 1. Title of the Project | (01) |
| 2. Aim, Objectives and Rationale | (04) |
| 3. Materials and Methods | (05) |
| 4. Observations and / Results | (10) |
| 5. Interpretation of Observations / Results and Discussion | (10) |
| 6. Conclusion and / Recommendation | (10) |
| 7. Relevant work / Justification of work with Project title | (10) |
| 8. Relevant References | (05) |
| 9. Certified Dissertation | (05) |

External Evaluation: 50 Marks

- | | |
|---|------|
| 1. Content of Presentation | (10) |
| 2. Quality of Presentation | (10) |
| 3. Presentation Skill | (10) |
| 4. Quality of Work | (10) |
| 5. Viva based on Proposal / Question Answer Session | (10) |

UNIVERSITY OF MUMBAISyllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course	Zoology (Oceanography and Fishery Technology)
2	Eligibility for Admission	The students who have granted both the Semesters and might have or have not cleared their Semester I and Semester II are eligible.
3	Passing Marks	40% in each Paper
4	Ordinances / Regulations (if any)	-----
5	No. of Years / Semesters	Two Semesters
6	Level	P.G. / U.G. / Diploma / Certificate (Strike out which is not applicable)
7	Pattern	Yearly / Semester (Strike out which is not applicable)
8	Status	New / Revised (Strike out which is not applicable)
9	To be implemented from Academic Year	From Academic Year 2020-2021

Date:

Signature :

Name of BOS Chairman / Dean: Dr. Bharmal Deelip L.

Dr. Anuradha Majumdar
Dean, Science & Technology

UNIVERSITY OF MUMBAI



Program: M.Sc.

Course: Zoology
(Oceanography and Fishery Technology)

Syllabus for Semester III & IV

(Choice Based Credit System
with effect from the academic year 2020-21)

M.Sc. Part II (Semester III and Semester IV)

Zoology (Oceanography and Fishery Technology) Syllabus Committee Members

Dr. Nisar Shaikh
Chairman,
G. M. Momin Women's College, Bhiwandi
Dist. Thane, Maharashtra

Semester III

Paper I: Oceanography

Comde Ashok Rai Mentor, Commanding Officer, INS Agrani, Red fields, Kamraj Road, Pulliakulam, Coimbatore – 641 018	Dr. Chhaya Panse Convener, M. D. College, 25, Dr. S.S.Rao Road, Shri Mangaldas Verma Chowk, Parel - East, Opp. Gandhi Hospital, Mumbai- 400 012
Dr. Mrunmayi Prakash Rane SSS, Kalyan Center, University of Mumbai	Dr. Vitthal Dandawate Sathaye College, Dixit Rd, Satsang CHSL, Navpada, Vile Parle East, Mumbai- 400 057
Ms. Nisha C. Tripathi Ex-student, Room No. 9, Opp Mittal Commercial, Marol Naka, Hasan Pada, Andheri East	

Paper II: Freshwater Aquaculture

Shri. Vinayak Dalvie Mentor, Mithibai College, Bhaktivedanta Swami Marg, V.L. Mehta Road, Vile Parle (W), Mumbai -400 056	Dr. Rajendra Lendhe Convener, B.N.N. College, BNN College Rd, Padma Nagar, Dhamankar Naka, Kamatghar, Bhiwandi, Maharashtra - 421302
Dr. Rajakumar Naik (Dy Director) MPEDA, Yogakshema, Flat No 605, Regent Chamber, 6th Floor, Jamnalal Bajaj Rd, Nariman Point, Mumbai- 400 021	Dr. Anis Choudhari G. M. Momin Women's College, Samad Nagar, Kaneri, Bhiwandi, Dist. Thane – 421 302
Ms. Simeen Rumani Student, SSS, Kalina, Mumbai- 400 098	

Paper III: Fish Processing Technology

Dr. B. G. Kulkarni Mentor, 301, B Himalayan Height, Bhakti Park, Wadala, Mumbai – 400 037	Dr. Pramod Shinde Convener, B.N.N. College, BNN College Rd, Padma Nagar, Dhamankar Naka, Kamatghar, Bhiwandi, Maharashtra - 421302
Dr. Girish N. Kulkarni Professor & Head, Department of Fish Processing Technology, College of Fisheries, (DBSKKV, Dapoli), Shirgaon, Ratnagiri. Pin 415629, Maharashtra, India	Dr. Utkarsha Chavan Bhavan's Hazarimal Somani College, Chowpatty, Mumbai – 400 007
Ms. Rakshita Poojari Student, SSS, Kalina.	Ms. Kajol Madhukar Shiralkar Ex-student, 31-A, Bhagwate Wadi, Dayaldas Road, Vile Parle (E), Mumbai – 400 057

Paper IV: Fin Fish and Shell Fish Biology

Dr. Suman Sharad Pawar Mentor, K312, Tarapore Towers CHSL, New Link Road, Andheri (w), Mumbai – 400 053	Dr. Nisar Shaikh Convenor, G. M. Momin Women's College, Bhiwandi Dist. Thane, Maharashtra
Dr. Popat Ajinath Bhosale S. M. College, NH-66, At & Post Poladpur, Raigad Dist, Cholai, Maharashtra 402 303	Dr. Ganesh Sambhu Margaj S. Z. S. P. Mandal's, Shri. Pancham Khemraj Mahavidyalaya, Sawantwadi, Dist. Sindhudurg – 416 510
Dr. Leena Namdeo Meshram M. P. A. S. C. College, Taluka, Panvel, Navi Mumbai- 410 206	Dr. Vasantrao Maruti Patole Balasaheb Khardekar College, Kudal-Vengurla Road, Vengurla, Maharashtra -416 516
Mr. Vind Kumar Krishna Tiwari Ex-student, Room No. 6109, Sangathan Chowk, Buwapada, K. B. Road, Ambernath (W) – 421 505	

Semester IV

Paper I: Capture Fisheries

Dr. Charitha Pattiaratchi Mentor, Professor of Coastal Oceanography, Leader, Australian National Facility for Ocean Gliders (ANFOG)	Dr. Shanta Janyani Convenor, Ramchand Kimatram Talreja College of Arts, Science and Commerce, Chatrapati Shivaji Maharaj Chowk, Ulhasnagar – 421 003
Dr. Anirudh Ram S. Jaiswar CSIR-National Institute of Oceanography Regional Centre, Lokhandawala Road, 4 Bungalows, Andheri (W)	Dr. Subhash Donde Kashinath Dhuru Road, Off. Veer Savarkar Marg, Dadar West, Dadar (W), Mumbai, Maharashtra 400 028
Mr. Tanveerussalam Md. Salim Khan Ex-student, Plot No. 30/A/4, Road No. 4, Shivaji Nagar, Govandi, Mumbai – 400 043	

Paper II: Marine/Brackish water Aquaculture

Dr. Ajitsinha Bajirao Patil Mentor, Managing Director, Pancham Aquaculture Farms Ltd., 103-B Mittal Tower Nariman Point, Nariman Point, Nariman Point, Mumbai- 400021	Mrs. Parimita Sharma Convener, Ramchand Kimatram Talreja College of Arts, Science and Commerce, Chatrapati Shivaji Maharaj Chowk, Ulhasnagar – 421 003
Dr. A. K. Reddy Principal Scientist, Division of Aquaculture, Central Institute Fishery Education, Mumbai – 400 061	Dr. Ajai Singh Ramchand Kimatram Talreja College of Arts, Science and Commerce, Chatrapati Shivaji Maharaj Chowk, Ulhasnagar – 421 003
Mr. Udit Anil Desai Ex-student, 201, Gaurav Vatan Building No. 1, Phase - 4, 15 No Last Stop, Mira Road East,	

Paper III: Industrial Fisheries

Dr. Madhavi Manohar Indap Mentor, 606, Ellora, Sant Muktabai Road, Vile Parle (E), Mumbai – 400 057	Dr. Rupinder Kaur Convener, Guru Nanak Khalsa College, Nathalal Parekh M Matunga, Mumbai - 400 019.
Dr. Nandita Singh G. M. Momin Women's College, Samad Nagar, Kaneri, Bhiwandi, Maharashtra 421 302	Dr. L. Narasimhamurthy Mumbai Research Centre of CIFT, CIDCO Administrative Building Ground Floor, Sector 1, Vashi, Navi Mumbai- 400 703.
Dr. Zeenat Surve Maharashtra College, 246-A, Jahangir Boman Behram Marg, Opp. Alexandra Cinema, Nagpada, Mumbai – 400 008	Mr. Vrushabh Khulatkhar Student, SSS, Kalina

Paper IV: Instrumentation and Presentation of Scientific data

Dr. Nisar Shaikh Convener, G. M. Momin Women's College, Bhiwandi, Dist. Thane, Maharashtra	Dr. Utkarsha Chavan Bhavan's Hazarimal Somani College, Chowpatty, Mumbai – 400 007
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PREFACE

The main objective of reconstructing the Post Graduate syllabus of Zoology for Semester III and Semester IV is to provide global level advanced and skill oriented deep knowledge to the stakeholders which is currently needed for their survival. The current research and teaching in Zoology includes diverse aspects with a balance of organismic and reductionist biology. It offers teaching and research programs in the diverse areas, such as, Animal Physiology, Entomology, Fish Biology, Immunology, Developmental Biology, Cell Signaling, Cell Biology, Radiation Biology, Reproductive Biology, Endocrinology, Genomics, Metagenomic, Cancer Biology, etc. Our vision is to provide Global Knowledge in education, training & research in the field of Zoology where teaching and research encrust detailed understanding from microbes to human. The broad skills and deeper knowledge in the field would make them highly successful and excellent researcher in advanced areas of research in the Biological sciences.

Therefore, the Board of Studies in Zoology aims to impart holistic understanding of Zoology by “redefining Zoology” to students of every age so that they develop interest in Science. It also aims to develop teaching and research programs that have relevance to society and employability. The M.Sc. program is being revised under CBCS scheme of UGC to meet the expectations of students.

To keep all of the above factors in mind, this syllabus was developed by the curriculum committee of Mentors, subject experts from other Universities and dedicated teachers. Their major role was to abridge, grow, augment and give a forward bearing to Zoology taught in undergraduate curriculum, with projections to future requirements. They have successfully completed this colossal task. I congratulate them.

Dr. Deelip L. Bharmal
Chairman Board of Studies in Zoology
University of Mumbai

PREAMBLE

I am extremely happy to present this new syllabus of Semester III and Semester IV to the teachers and students of Post Graduate Course in Zoology of the specializations, Oceanography and Fishery Technology, Entomology, Endocrinology, Animal Physiology and Environmental Science. While constructing the syllabus, the relevant inputs have been considered from Mentors, subject experts from various fields of other Universities, teachers and stakeholders to make it more effective.

An attempt has been made to make post graduate courses competitive and on par with global standards, as per the directives of University Grant Commission for the implementation of choice based credit system. Hence as per the guideline of UGC the present syllabus is made more interesting with new, innovative topics as per need of the current situation of the world and stakeholders.

The M.Sc. Zoology program provides an appropriate blend of classical and applied aspects of the subject. This newly designed curriculum will allow students to acquire skills in handling scientific instruments planning and performing in the laboratory and exercising critical judgment, independent thinking and problem solving skills.

The utmost care has been taken to declare the final syllabus well in advance to enable the teachers to make preparations before commencement of the academic year and facilitating students to execute their right to know the details before admissions.

The draft of Syllabus was approved in meeting of the Board of Studies in Zoology held on 10th March 2020, and it was unanimously resolved to implement the revised syllabus of Zoology at M.Sc. Semester-III and IV and make it effective from the Academic Year 2020-2021 after approval from concerned authorities of the University.

The success of this revamped syllabus will depend totally on the enthusiasm and interest shown by the stakeholders.

Dr. Nisar Shaikh
Chairman, M.Sc. Part II
Syllabus Committee

PEDAGOGY

The course **PSZOOCN301, 'Oceanography'** intends developing in learners a comprehensive understanding of the various aspects of general, physical, chemical and biological oceanography. The practical syllabus complements the prescribed theory syllabus emphasizing on experience or field based teaching and learning. Facilitators may avail the use of ICT including video clips, photographs, and other online resources for enhancing the delivery of the topics. Apart from the regular classroom teaching, the multi-dimensional aspects of oceanography could be effectively taught by frequent visits to intertidal zones to study the marine fauna and flora. Similarly, learners can be instructed to collect sea water samples for physicochemical analyses in-situ or in the laboratory. Additionally, visit to institutes involved in marine biology or oceanography research will augment the knowledge of the learners.

PSZOOCN302: The course '**Freshwater Aquaculture**' will help the learner for conceptual understanding of various methods for Freshwater Aquaculture, Aquarium fish maintenance, sustainable Aquaculture and various funding and insurance agencies. For understanding maintenance and management, visit to freshwater aquaculture farm and aquarium should be organized. For practical knowledge, project for aquarium maintenance in laboratory should be assigned to the learners. Guest lectures should be arranged to provide information about various funding and insurance agencies.

PSZOOCN303 is '**Fish Processing Technology**' which deals with preservation, processing, marketing, logistics, infrastructure required for processing of fish and shell fish. It will impart basic knowledge about the recent techniques used worldwide. It is a need of the time to supply best quality of available sea food by maintaining high levels of quality standard. Students will also learn the layouts of various processing industries and skills to start their own business in this area thereby boosting self-employability.

The Course '**The Fin Fish and Shell Fish Biology (PSZOOCN304)**' deals with the study of morphological characters which will enhance the learners' skill in taxonomy. The fish anatomy provides knowledge of mechanisms and structure of the various life processes of fishes. Similarly the locomotion and light producing organs of fishes focus on their behaviour. Mud crab is a sea food preferred by various people. Its study in biology is essential. Care has been taken to make the learners aware of the Biological aspects in this course.

PSZOOCN401 deals with the '**Capture Fisheries of India**'. This paper includes inland, estuarine and marine capture fishery resources of India. These various fisheries include taxonomy, distribution, food and feeding, breeding season, reproduction, crafts and gears used and catch trends of important fishes available on both the coasts of India. It also involves the population dynamics & conservation, problems of overfishing, maximum sustainable yield and maximum economic yield.

PSZOOCN402, 'Brackish and Marine water aquaculture' Paper deals with several aspects of brackish water and marine water aquaculture systems. It describes the cultivation methods and management of marine and brackish water aquaculture systems. Learners will also procure the knowledge of recent developments, disease diagnosis and integrated marine and brackish water aquaculture systems. Field visits, video clips, models can be used for effective learning. The key focus of this unit is to equip the learners with the skills and encourage them towards entrepreneurship and job creation in the field.

In course **PSZOOCN403, 'Industrial Fishery'** the main focus is given on the applied aspects of fishery. This may develop a platform to produce successful fishery entrepreneurs. Keeping this in the mind, the practicals have been designed, so that the learners develop skills and gain relevant knowledge to prepare various fishery products. Visit to fish processing industry, export unit and marketing surveys can be conducted to get first-hand information on packaging and marketing

aspects of fish products and by-products. Assignment based on case studies of fish entrepreneurs, various agribusiness models and feasibility report can be given to develop entrepreneurial skills of the learners.

PSZOOCN404 consists of '**Instrumentation and Presentation of Scientific Data**' which help the students to choose suitable measuring instruments for their applications and understanding of limitations, principles and measurement errors. The students will aware the efficiency of the instruments. Similarly the course also has the unit of presentation of scientific data. Text, tables, and graphs for data and information presentation are very powerful communication tools. They can make scientific report easy to understand, attract and sustain the interest of beneficiary.

Conveners and Committee Members

M. Sc. II Zoology Syllabus
Choice Based Credit System
To be implemented from the Academic Year 2020-2021

Oceanography and Fishery Technology: Semester III						
Course Name and Code	Unit	Topic Headings	Credit	Lecture/ Week	College Assessment Internal	University Assessment External
Paper I: Oceanography						
PSZOOCN301	1	General Oceanography	4	1	40	60
	2	Physical Oceanography		1		
	3	Chemical Oceanography		1		
	4	Biological Oceanography		1		
Paper II: Freshwater Aquaculture						
PSZOOCN302	1	Principles of Aquaculture	4	1	40	60
	2	Aquarium Fishes and Management		1		
	3	Brooder and Sexual dimorphism in Major carps		1		
	4	Giant freshwater prawn - <i>Macrobrachium rosenbergii</i>		1		
Paper III: Fish Processing Technology						
PSZOOCN303	1	Hygienic logistics and Infrastructure	4	1	40	60
	2	Traditional fish processing		1		
	3	Modern fish processing		1		
	4	Quality assurance norms and methods		1		
Paper IV: Fin Fish and Shell Fish Biology						
PSZOOCN304	1	Morphology of fin fish and shell fish	4	1	40	60
	2	Basic fish anatomy		1		
	3	Locomotion and Light producing organs in fishes		1		
	4	Mud Crab		1		
		Total	16	16	160	240
Practicals						
PSZOOCN3P1	Practicals based on PSZOOCN301		2	4	—	50
PSZOOCN3P2	Practicals based on PSZOOCN302		2	4	—	50
PSZOOCN3P3	Practicals based on PSZOOCN303		2	4	—	50
PSZOOCN3P4	Practicals based on PSZOOCN304		2	4	—	50
		Total	8	16	—	200
		Grant Total	24	32	160	440

Oceanography and Fishery Technology: SEMESTER IV

Course Name and Code	Unit	Topic Headings	Credit	Lecture/ Week	College Assessment Internal	University Assessment External
Paper I: Capture Fisheries						
PSZOOCN401	1	Inland Fisheries resources of India	4	1	40	60
	2	Estuarine fisheries resources of India		1		
	3	Marine capture fisheries resources of India		1		
	4	Population Dynamics and Conservation		1		
Paper II: Brackish and Marine Water Aquaculture						
PSZOOCN402	1	Shell fish culture	4	1	40	60
	2	Fin Fish culture		1		
	3	Farm Engineering		1		
	4	Fin Fish and Shell fish Pathology and Health Management		1		
Paper III: Industrial Fishery						
PSZOOCN403	1	Value added Products	4	1	40	60
	2	Fish, Shell fish and Seaweed Products and By-products		1		
	3	Packaging Methods for Fish Products and By-products		1		
	4	Entrepreneurship and Marketing		1		
Paper IV: Instrumentation and Presentation of Scientific data						
PSZOOCN404	1	Instrumentation	2	1	40	60
	2	Presentation of Scientific data		1		
	3	Project		2		
		Total	16	16	160	240
Practicals						
PSZOOCN4P1	Practicals based on PSZOOCN401		2	4	—	50
PSZOOCN4P2	Practicals based on PSZOOCN402		2	4	—	50
PSZOOCN4P3	Practicals based on PSZOOCN403		2	4	—	50
PSZOOCN4P4	Practicals based on PSZOOCN404		2	4	—	50
	Total		8	16	—	200
	Grant Total		24	32	160	440

M. Sc. Part 2: Semester III (Theory)
PAPER 1: PSZOOCN301
OCEANOGRAPHY

Unit 1: General Oceanography

(15 L)

Objective:

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

Desired outcome:

- *The learner will be able to understand the history of Oceanography and its current status.*
- *The learner will be aware of various oceanographic sampling techniques.*

- 1.1 Oceanographic History, Oceanographic 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 Naturalist's dredge
 - 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 / meter
 - 1.6.7 Stempel's pipette and dilution jar
 - 1.6.8 Underwater photography
 - 1.6.9 SCUBA apparatus
 - 1.6.10 Secchi disk

Unit 2: Physical Oceanography

(15 L)

Objective:

- *To familiarize learners to the physical processes of Oceans and the Ocean- Atmospheric interactions.*

Desired outcome:

- *The learner will be able to understand the significant physical processes occurring in the oceans and their effects at Local and Global scenario.*

- 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 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, Coriolis effect

Unit 3: Chemical Oceanography

(15 L)

Objective:

- *To familiarize learners to the chemical properties of the sea water and basics of Chemical Oceanography.*

Desired outcome:

- *The learner will be aware of 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 CO₂) in seawater – Basic concepts: solubility of gases in seawater and Oxygen Minimum Zone (OMZ) in Arabian Sea
- 3.6 Air – sea gas exchange, processes affecting their distribution
- 3.7 Dissolved gases (CO₂) in seawater
 - 3.7.1 Carbon dioxide equilibria in seawater
 - 3.7.2 pH, alkalinity and buffering capacity of oceans
 - 3.7.3 Components of CO₂ system in seawater
 - 3.7.4 Percentage composition of inorganic carbon
 - 3.7.5 Calcium carbonate precipitation and dissolution phenomena
 - 3.7.6 Lysocline and carbonate compensation depth
- 3.8 Mineral resources from the sea:
 - 3.8.1 Deep sea mud oozes and manganese nodules
 - 3.8.2 Oil, gas and sulphur deposits

Unit 4: Biological Oceanography

(15 L)

Objective:

- *To familiarize learners to the ecology of marine fauna, its significance and sustainable conservation.*

Desired outcome:

- *The learner will be able to understand the life under the sea and their interactions with marine environment.*
- *The learner will be aware of the issue of Marine Pollution.*

- 4.1 Division of marine environment
 - 4.1.1 Intertidal organisms and their zonation
 - 4.1.2 Marine biotic diversity:
 - a) Plankton
 - b) Nekton
 - c) Benthos
 - 4.1.3 Indices of species richness, measuring diversity, models explaining diversity gradient
 - 4.1.4 Benthic communities:
 - a) Kelp forests

- b) Estuaries
 - c) Formation and Growth of Coral Reefs
 - d) Ecological Features of Mangrove Swamps
- 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 Human impact on marine Biota
 - 4.3.1 Fisheries impact
 - 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 Impact on marine environments:
 - a) Estuaries
 - b) Mangrove Swamps
 - c) Coral Reefs

Learners' Space:

- 1 Law of Seas
- 2 Maritime Security

PAPER 2: PSZOOCN302 FRESHWATER AQUACULTURE

Unit 1: Principles of Aquaculture

(15 L)

Objectives

- *To impart essential knowledge and skills regarding advanced technologies of different aquaculture production systems.*
- *To focus on provision of basic concepts of farming of aquatic organisms.*
- *To educate students to learn different methods of culture.*

Desired Outcome

- *The learner will acquire knowledge regarding advanced technologies in aquaculture.*

- 1.1 Basics of aquaculture – definition and scope
- 1.2 Systems of aquaculture:
 - 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 fin fish candidate species for fresh water aquaculture such as
 - a) Indian major carps – Rohu, Catla, Mrigal
 - b) Exotic carps – Grass carp, Common carp, Silver carp
 - c) Catfishes – Basa, Magur
- 1.5 Monoculture, polyculture, composite culture and integrated culture systems
- 1.6 Rearing Practices and its feasibility/economics
 - 1.6.1 Traditional
 - 1.6.2 Extensive
 - 1.6.3 Semi intensive
 - 1.6.4 Intensive methods
 - 1.6.5 Sustainable Aquaculture

Unit 2: Aquarium Fishes and Management

(15 L)

Objectives

- *To gain knowledge regarding setting of fresh water aquarium, behavioural pattern, feeding habits, live food organisms and supplementary diet for ornamental fishes.*

Desired Outcome

- *The learner will gain knowledge about the setting of commercial aquarium.*

- 2.1 Identification, breeding and maintenance of important ornamental fishes
 - 2.1.1 Angel
 - 2.1.2 Danio
 - 2.1.3 Discus
 - 2.1.4 Flower horn
 - 2.1.5 Gourami
 - 2.1.6 Siamese fighter

- 2.1.7 Sword tail
- 2.1.8 Gold fish
- 2.1.9 Koi
- 2.2 Setting and design of freshwater aquarium, aeration devices, aeration accessories, various types of filters
- 2.3 Aquatic plants and other structures for beautification and utility
 - 2.3.1 Amazon sword
 - 2.3.2 Cork screw
 - 2.3.3 Ludwigia
 - 2.3.4 Aqua rose
 - 2.3.5 Cobamba
 - 2.3.6 Pistia
 - 2.3.7 Formulated feed, its composition and its production

Unit 3: Brooder and Sexual dimorphism in Major carps

(15 L)

Objective

- *To aware the learners for identification of sexual dimorphism in Major carps and their maturity and spawning.*

Desired Outcome

- *The learner will acquire knowledge regarding sexual dimorphism in Major carps and their maturity and spawning.*

- 3.1 Induced breeding
 - 3.1.1 History of induced breeding of fishes
 - 3.1.2 Methods of pituitary extract preparation
 - 3.1.3 Dosage determination and injection to the brood fishes
 - 3.1.4 Spawning and hatching
 - 3.1.5 Use of different synthetic hormones and analogues for induced spawning.
 - 3.1.6 Induced breeding in Indian Carps – Catla, Labeo, Mrigal
 - 3.1.7 Induced breeding in Exotic Carps – Common Carp, Silver Carp, Grass Carps
- 3.2 Hatchery design and operation
 - 3.2.1 Criteria for site selection of hatchery
 - 3.2.2 Design and function of incubators
 - 3.2.3 Essential components of hatchery, Role of hatchery
 - 3.2.4 Management of hatchery
 - 3.2.5 Traditional double-walled hapa, Floating hapa
 - 3.2.6 Types of hatchery
 - a) Vertical hatchery – Glass jar hatchery, Plastic Bucket hatchery
 - b) Chinese hatchery
 - c) Circular hatchery – CIEF D 80 Model and CIEF 81 Model
 - 3.2.7 Mahaseer and Trout hatchery
- 3.3 Nursery Pond Management
 - 3.3.1 Pre-stocking pond management
 - 3.3.2 Stocking pond management
 - 3.3.3 Post stocking management
- 3.4 Packaging and Transport.
 - 3.4.1 Quality of container used in packaging and transporting the fish seed
 - 3.4.2 Transport containers for fish and fingerlings
 - 3.4.3 Packing and transportation of fish seed
 - 3.4.4 Use of anaesthetics and disinfectants in fish breeding and transport.

Unit 4: Giant freshwater prawn – *Microbranchium rosenbergii*

(15 L)

Objective:

- To aware the learners about the life history and hatchery of Giant Fresh Water Prawn.

Desired outcome:

- The learners will familiarize the breeding, hatchery and rearing of the prawn.

- 4.1 Identification, sexual dimorphism, selection of brooder
- 4.2 Breeding and hatchery management
- 4.3 Life cycle
- 4.4 Rearing of Fresh water Giant Prawn

Learners' Space:

1. Present scenario of Aquaculture.
2. Role of Aquatic resources in food and nutrition.
3. Role of NABARD and NFDB (National Fisheries Development Board) in fisheries development.

PAPER 3: PSZOOCN303

FISH PROCESSING TECHNOLOGY

Unit 1: Hygienic Handling of fish

(15 L)

Objectives:

- *To impart knowledge and skill of handling of fish in hygienic conditions at various levels as well as personnel hygiene.*
- *To assess freshness of fish.*
- *To gain knowledge of site selection, building construction and layout of different processing units.*

Desired Outcome:

- *The learner will be able to handle the fish hygienically after sorting the fresh fish.*
- *To gain knowledge of site selection, building construction and layout of different processing units.*

- 1.1 Methods of handling of fish
- 1.2 Hygienic conditions required on board, landing centres and processing industry
- 1.3 Methods of transportation (conventional and recent) of fish to processing industry
- 1.4 Organoleptic tests
- 1.5 Temperature modeling and relationships in fish transportation
- 1.6 Typical layout for freezing industry, ice factory and canning industry
- 1.7 Site Selection:
 - 1.7.1 Location
 - 1.7.2 Site Level
 - 1.7.3 Communications
 - 1.7.4 Site size
- 1.8 Building 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 supply
 - 1.8.7 Water supply
 - 1.8.8 Factory yards

Unit 2: Traditional fish processing

(15 L)

Objectives:

- *To get acquainted with different methods and materials required in traditional fish processing.*

Desired Outcome:

- *The learner will understand packaging materials, compression system, refrigerants, freezers, freezing, canning of fish with additional knowledge of additives and instrumentation used in fish processing industry.*

- 2.1 Indigenous methods of preservation
- 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 Accessory industry for canning, 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

Unit 3: Modern fish processing

(15 L)

Objectives:

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

Desired Outcome:

- The learner will gain insight of recent methods in fish processing industry.

- 1.1 Surimi technology and surimi based analogue products (only technology aspect)
- 1.2 Thermal processing of fishery products
 - 1.2.1 Thermal processing
 - 1.2.2 Pulsed light technology
 - 1.2.3 Infra-red (IR) and Radio frequency (RF) processing technology and its applications
 - 1.2.4 Ohmic or Joule heating
- 1.3 Non-thermal processing of fishery products
 - 1.3.1 High pressure processing
 - 1.3.2 Vacuum cooling
 - 1.3.3 Irradiation

Unit 4: Quality assurance norms and methods

(15 L)

Objectives:

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

Desired Outcome:

- The learner will gain insight of 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 Hazard Analysis Critical Control Point (HACCP)
- 4.4 Check list for ensuing sea food safety
- 4.5 Changes that occur during freezing and frozen storage, and Protective treatments:
 - 4.5.1 Changes:
 - a) Microbiological
 - b) Physical and chemical changes
 - c) Protein denaturation
 - d) Fat oxidation
 - e) Dehydration
 - f) Drip
 - 4.5.2 Protective treatments:
 - a) Polyphosphate
 - b) Glazing
 - c) Antioxidants
 - d) Packaging
- 4.6 ISO-9000 series certification of the International Standard Organization
- 4.7 National and International food laws, integrated food law (FSSAI, CODEX GMP)
- 4.8 Harbour management
- 4.9 Fish Toxins – Intrinsic and extrinsic factors for toxicity of fish

Learners' Space:

- 1. Accessary used in fish processing industry for maintaining hygiene.
- 2. Work experience in fish processing industry.

PAPER 4: PSZOOCN304

FIN FISH AND SHELL FISH BIOLOGY

Unit 1: Morphology of fin fish and shell fish

(15 L)

Objective:

- *To familiarize the learners about importance of morphological characters of fin fish and shell fish for taxonomy.*

Desired outcome:

- *The learners will gain the knowledge of morphological characters and will enable to use in the taxonomy of fin fish and shell fish.*

- 1.1 Fin fish morphology: skin, colour, eyes, mouth structure, jaws and teeth, fins, fin rays, spine, scales, operculum, gills and gill rakers, claspers,
- 1.2 Shell fish morphology: eyes, hectocotylus arm, foot, shells, tentacles, pleopods, uropods, cephalo-thoracic appendages, antennae, antennules, spines
- 1.3 Morphometric measurement, Significance of morphometric measurement
- 1.4 Taxonomic importance of morphological characters

Unit 2: Basic fish anatomy

(15 L)

Objective:

- *The learners will familiarize the basic of fish anatomy.*

Desired outcome:

- *The learners will aware about basic of fish anatomy.*

- 3.1 Digestive system of a teleost and its associated glands
- 3.2 Respiratory system
 - 3.2.1 Gill - Structure and Types, Mechanism of respiration
 - 3.2.2 Air bladder – Structure and Types, functions
 - 3.2.3 Accessory Respiratory Organs
 - 3.2.4 Respiratory pigment
- 3.3 Nervous system of Teleost
- 3.4 Sense organs and Endocrine organs in fishes
- 3.5 Weberian ossicle – Structure and functions
- 3.6 Heart and aortic arches of a teleost
- 3.7 Excretion and Osmoregulation:
 - 3.7.1 Structure and function of the excretory organs
 - 3.7.2 Major excretory products of fishes, Patterns of nitrogen excretion
 - 3.7.3 Osmotic and ionic regulation – Acid-base balance

Unit 3: Locomotion and Light producing organs in fishes

(15 L)

Objective:

- *The learners will familiarize about locomotion and light producing organs.*

Desired outcome:

- *The learners will gain the knowledge of types of locomotion, significance of luminescent and advantages of migration of 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
 - 3.2.5 Symbiosis
- 3.3 Light producing organs
 - 3.3.1 Location
 - 3.3.2 Nature of light producing organs
 - 3.3.3 Structure of light producing organs
 - 3.3.4 Significance of luminescence in fishes

Unit IV: Mud Crab

(15 L)

Objective:

- *To aware the learners about importance of mud crab.*

Desired outcome:

- *The learners will get the knowledge about biology and importance of the mud crab.*

- 1.1 Distribution, Habit and Habitat
- 1.2 External characters
- 1.3 Life history
- 1.4 Migration and movement
- 1.5 Heart and circulatory system
- 1.6 Respiratory system
- 1.7 Economic importance

Learners' space:

- 1. Collect the photographs of various locomotion of fishes
- 2. Collect the photographs of light producing fishes.

M. Sc. Part 2: Semester III Practical

Practical 1: PSZOOCN3P1: Oceanography

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. Van veen grab
 - v. Ekman grab and corers
2. Physical and chemical oceanography: Determination of physico-chemical parameters:
 - a) Salinity (Argentometric method)
 - b) Silicates
3. Estimation of primary productivity by light and dark bottle.
4. Identification of Zooplankton permanent slides: *Noctiluca*, *Obelia* medusa, Jelly fish, *Physalia*, *Porpita*, Zoea, Copepods, Mysids, Megalopa, Bipinnaria, Nauplius, Pteropods, *Sagitta*, *Doliolum*, *Oikopleura*, Fish eggs and larvae
5. Laboratory procedure for quantitative estimation of plankton settling method, wet weight method, weight displacement method, counting method.
6. Identification of intertidal organisms:
 - a) Rocky shore: *Patella*, *Chiton*, *Pernaviridis*, *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, Mud skipper
7. Food and feeding habit in fish.
8. Students Activity: Observation of Molluscan shells and Marine algae during field visit and submit report.
9. Visit to Institutes involved in Marine Biology or Oceanography Research.

Practical 2: PSZOOCN3P2: Freshwater Aquaculture

1. Estimation of Turbidity, DO, pH, Hardness CO₂ and BOD of pond water.
2. Identification
 - a) Major candidate species of fishes - *Labeo rohita*, *Catla catla*, *Cirrhina mrigala*, *Cyprinus carpio*, *Ctenopharyngodon idellus*, *Hypophthalmichthys molitrix*)
 - b) Crustaceans - *Macrobrachium rosenbergii*.
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 aquarium. (Amazon sword, Cork screw, *Ludwigia*, Aqua rose, *Cobamba*, *Pistia*).
5. Setting up of aquarium 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. Study of sexual dimorphism in *Macrobrachium rosenbergii*
9. Study of various stages in the life cycle of *Macrobrachium rosenbergii* (Eggs larva, Juvenile)
10. Visit to fresh water hatchery/aquaculture farm and submit a report.

Practical 3: PSZOOCN3P3: Fish Processing Technology

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

Practical 4: PSZOOCN3P4: Fin fish and Shell Fish Biology

1. Identification - *Matuta sp.*, *Scylla serrata*, *Neptunus sanguinolentus*, *Neptunus pelagicus*, *Charybdis sp.*, *Sepia sp.*, *Loligo sp.*
2. Dissections
 - a) Nervous system of a suitable bony fish
 - b) Aortic arches of a suitable bony fish
 - c) Digestive system of a suitable bony fish
 - d) Weberian ossicles from a suitable bony fish
 - e) Heart and circulatory system of mud crab
3. Mountings
 - Fins, Gills and rakers, clasper, hectocotylus arm, rostrum, chelate leg, pleopod, uropod, antenna, antennule, walking leg, air bladder,
4. Types of fins and scales
5. Permanent slides
 - Larval stages of crab,
6. To identify and locate the shoals of fishes from the data/photographs captured by remote sensing devices/techniques/GPS (Demonstration only)
7. Determination of ammonia from the tank water
8. Identification of Air Breathing Fishes – *Anabas testudineus*, *Clarius batrachus*, *Boleophthalmus spp*
9. Visit to local fish market to identify commercially important shell fishes and and prepare a report.

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M. Sc. Part 2: Semester IV (Theory)
PAPER 1: PSZOOCN401
CAPTURE FISHERIES

Unit 1: Inland Fishery resources of India

(15 L)

Objective:

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

Desired outcome:

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

- 1.1 Riverine fisheries
 - 1.1.1 West coast riverine system
 - 1.1.2 East coast riverine system
 - 1.1.3 North Eastern riverine system
- 1.2 Lacustrine fisheries:
 - 1.2.1 Origin
 - 1.2.2 Ecology
 - 1.2.3 Productivity of lakes
- 1.3 Tropical fisheries:
 - 1.3.1 Carps
 - 1.3.2 Cat fishes
- 1.4 Temperate fisheries:
 - 1.4.1 Trout
 - 1.4.2 Mahaseer
- 1.5 Fishery Resources of Maharashtra
 - 1.5.1 East coast river system
 - 1.5.2 North Eastern river system

Unit 2: Estuarine fishery resources of India

(15 L)

Objective:

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

Desired outcome:

- *Learners will get knowledge about the specific estuarine resource of India.*

- 2.1 Ecology of Estuaries
- 2.2 Principle Fisheries of Brackish water, Fisheries of Chilka, Pulicat and Kolleru lake
- 2.3 Hooghly Matlah Estuary
- 2.4 Hilsa fishery, Mullet fishery, Khajuri fishery

Unit 3: Commercially important fisheries in India

(15 L)

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

Objective:

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

Desired outcome:

- *Learners will get knowledge about the crafts and gears, food and feeding used in fisheries of India.*

- 3.1 Coastal fisheries
 - 3.1.1 Shark – *Scoliodon sorrakowah*
 - 3.1.2 Ray – *Himantura uarnak* (*Trygon uarnak*)
 - 3.1.3 Sardine – *Sardinella longiceps*
 - 3.1.4 Mackerel – *Rastrelliger kanagurta*
 - 3.1.5 Bombay duck – *Harpodon nehereus*
 - 3.1.6 Pomfret – *Pampus cinereus* (*Stromateus cinerius*), *Pampus chinensis* (*Stromateus sinensis*), *Parastromateus niger*
 - 3.1.7 Thread fin – *Eleutheronema tetradactylum* (*Polynemus tetradactylus*), *Galeoides decadactylus* (*Polynemus polydactylus*)
 - 3.1.8 Pink Perch – *Nemipterus japonicus* (*Synagris japonicus*)
 - 3.1.9 Ribbon fish – *Lepturacanthus savala* (*Trichiurus savala*)
- 3.2 Deep Sea fisheries
 - 3.2.1 Yellow fin Tuna - *Thunnus albacares*
 - 3.2.2 Skipjack Tuna - *Katsuwonus pelamis*
- 3.3 Commercial Shell fish fisheries
 - 3.3.1 Crustacean
 - a) Shrimp – *Litopenaeus vannamei*
 - b) Crab – *Scylla serrata*
 - c) Prawn – *Penaeus monodon*
 - d) Lobster – *Panulirus sp.*
 - 3.3.2 Mollusca
 - a) Clam – *Kataysia opima*
 - b) Mussels – *Perna viridis* (*Mytilus viridis*)
 - c) Oyster – *Crassostrea ingens*
 - d) Cephalopod – *Sepia pharaonis*

Unit 4: Population Dynamics and Conservation

(15 L)

Objective:

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

Desired outcome:

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

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

Learners' Space:

1. Commercially marine captured fisheries of
 - a) Pakistan
 - b) Australia
 - c) Philippine
2. Blue water economy

PAPER 2: PSZOOCN402

BRACKISH AND MARINE WATER AQUACULTURE

Unit 1: Shell fish culture

(15 L)

Objective

- To familiarize the learners about breeding, raising and harvesting of shellfish and aquatic plants.

Desired outcome

- The objective is an environmentally responsible source of food and commercial products, helps to create healthier habitats, and is used to rebuild stocks of threatened or endangered species.

1.1 Crab culture

- 1.1.1 Introduction, History and Present status of crab culture
- 1.1.2 Cultivable species of crabs in India
- 1.1.3 Pond design
- 1.1.4 Principles of crab hatchery, brood stock, larval and post-larval management
- 1.1.5 Techniques of Crabs culture, cage culture and pen culture
- 1.1.6 Crabs fattening
- 1.1.7 Prospect, problems and development of crab culture in India

1.2 Brackish water Prawn – *Penaeus monodon* Culture

- 1.2.1 Breeding techniques
- 1.2.2 Hatchery & Nursery Management
- 1.2.3 Rearing practices – Extensive, Semi-intensive, Intensive & Sustainable

1.3 Pearl oyster culture

- 1.3.1 Techniques of pearl oyster culture (Fresh water and Marine water) for artificial production of pearls
- 1.3.2 Pearl culture techniques
 - a) Rafts
 - b) Long lines
 - c) Pearls oyster baskets
 - d) Under water platforms
 - e) Mother oyster culture / Collection of oysters
 - f) Rearing of oysters
 - g) Environmental parameters
 - h) Pearl Oyster surgery
 - i. Selection of Oyster
 - ii. Graft tissue preparation
 - iii. Nucleus insertion
 - iv. Conditioning for surgery
 - i) Post-operative culture, harvesting of pearl, clearing of pearl
 - j) Present status, Economic importance of pearls
 - k) Prospects and problems of pearl industry in India

1.4 Live feed culture

- 1.4.1 Candidate species of phytoplankton and zooplankton as food organisms
- 1.4.2 Tropic potentials- proximate composition of live feed
- 1.4.3 Culture requirements of important live food organisms
- 1.4.4 Culture of Green algae, blue-green algae, spirulina, diatoms, infusoria, rotifers, cladocerans, tubifex, brine shrimp, chironomids. Culture of earthworms, bait fish and forage fish

Unit 2: Fin Fish culture

(15 L)

Objective

- To familiarize the learners about breeding, raising and harvesting of fin fish.

Desired outcome

- The objective is an environmentally responsible source of food and commercial products, helps to create healthier habitats, and is used to rebuild stocks of threatened or endangered species.

2.1 Lates calcarifer

2.2 Mullet

2.3 Milk fish

Unit 3: Farm Engineering

(15 L)

Objective

- To reduce operating costs and maximize the farmer's income.
- To develop a more economic ration for fish from wastes to useful fish protein production.
- To solve the waste management problem.
- To control the pollution problem associated with livestock.

Desired outcome

- The employment and economic advantages, as well as the possibility of sustaining species that might be over-fished if not for the controlled environments of fish farms.

3.1 Design, layout and construction of different aqua farms and aqua house

3.2 Construction and design of pond dyke and sluice gate

3.3 Water supply and drainage system

3.4 Design and fabrication of automatic feeder, aerator and bio filter

3.5 Instruments (Kits) for measuring water quality

Unit 4: Fin Fish and Shell fish Pathology and Health Management

(15 L)

Objective

- To undertake surveillance of existing and emerging fish and shellfish diseases.
- To develop improved diagnostic techniques for the detection of existing and emerging fish and shellfish diseases.

Desired outcome

- The study of fish and shellfish diseases gives a wide knowledge, not only of the potential pathogens, but also of the environmental constraints and specialist adaptations, which govern the ectothermic, aqueous, existence of organisms.

4.1 Fish Pathology: Causative agents, symptoms and control of some infectious diseases of fish

4.1.1 Diseases

a) Fungal Diseases - Saprolegniasis, Branchiomycosis

b) Bacterial Diseases - Fin and Tail rot, Ulcer diseases, Dropsy, Eye diseases, Ferunculosis, Bacterial Gill diseases, ERM, Edwardsiellosis, Vibriosis

c) Protozoan Diseases - White spot diseases, Costiasis, Trichodinosis, Whirling disease

- d) Metazoans - Dactylogyrus, Gyrodactylus, Hirudinosis, Lernaea, Argulus
 - e) Viral diseases - IPN, IHN, VHS, CCVD, EUS
- 4.2 Shell Fish Pathology: Some common diseases of prawns – pathogens, symptoms and control-
 - 4.2.1 IHN, Baculovirus, Black gill disease, brown spot disease
- 4.3 Health Management
 - 4.3.1 Principles of disease diagnosis
 - 4.3.2 Epidemiological and clinical diagnosis
 - 4.3.3 Microbiological and post mortem examination of fin fishes in fresh water, brackish water and marine water environment
 - 4.3.4 Environmental impact of disease management
 - 4.3.5 Aquaculture medicines and its importance in fisheries
 - 4.3.6 Rules and regulation for use of aquaculture medicine

Learners' Space:

1. Recent advances in brackish and marine water aquaculture.
2. Concept of cold water marine aquaculture.

PAPER 3: PSZOOCN403

INDUSTRIAL FISHERY

Unit 1: Value added Products

(15 L)

Objective

- *To familiarize the learners about the entrepreneur of value added products from the fin fish and shell fish.*

Desired Outcome

- *The learners will get knowledge of value added preparation and will start its own business.*

- 1.1 Dry, salted and smoked products
- 1.2 Fish / Prawn Pickle
- 1.3 Fish Chakli and Wafers
- 1.4 Artificial products / Crabs streaks
- 1.5 RTE products
- 1.6 Fish Kabab
- 1.7 Fish cuttlet
- 1.8 Fish Amoti
- 1.9 Fish Rumani
- 1.10 Fish fillets

Unit 2: Fish, Shell fish and Seaweed Products and By-products

(15 L)

Objective

- *To provide information on various fish products and by-products, utilization of fishery wastes and their nutritional value.*

Desired Outcome

- *The learner will develop the competence for making fish by products leading to self-employment.*

- 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 Astaxanthine
- 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 Carageenan

Unit 3: Packaging Methods for Fish Products and By-products

(15 L)

Objective

- *To impart comprehensive overview of the scientific and technical aspects of food packaging.*

Desired Outcome

- *The learner will be equipped with the knowledge on packaging machinery, systems, testing and regulations of packaging, thus helping in job placement in fish processing / export unit.*

- 3.1 Food packaging
 - 3.1.1 Purposes of food packaging
 - 3.1.2 Technological aspects of packaging of fishery products
 - 3.1.3 Packing of fresh and frozen fish for consumers
 - 3.1.4 Packaging for transport, shipping and institutional supplies
 - 3.1.5 Packaging standards for domestic and international trade
- 3.2 Packaging materials
 - 3.2.1 Basic films and laminates, their manufacture and identification
 - 3.2.2 Resistance of packaging materials
 - 3.2.3 Development of protective packaging for fishery products
- 3.3 Modified atmosphere packaging
 - 3.3.1 Controlled packaging and aseptic packaging
 - 3.3.2 Flexible packing, retort pouch processing of fish and fishery products principles and techniques
- 3.4 Labelling and printing of packaging materials.
 - 3.4.1 Labeling requirements – national and international, legislation on labeling
 - 3.4.2 Labeling for product traceability
 - 3.4.3 Type of labeling for organic foods, specific foods like organic foods, GM foods, irradiated foods, vegetarian and non-vegetarian foods. Label design specification – size, colour
- 3.5 Biodegradable plastics, Edible packaging and Bio-composites
- 3.6 Environmental Concerns: Recycling and Disposal of Plastic waste
- 3.7 Paper and Paper-based materials, Corrugated Fiber Board box (CFB)

Unit 4: Entrepreneurship and Marketing

(15 L)

Objective

- *To familiarize the students with the basic concepts of Entrepreneurship and marketing as applied to fishery industries.*

Desired Outcome

- *The learner will understand and apply the entrepreneurship and marketing skills and become a successful entrepreneur.*

- 4.1 Role of Government and other organizations in promoting entrepreneurship

- 4.1.1 Government schemes and incentives for Small and Medium enterprises (SMEs)
- 4.1.2 Small Scale Industries (SSIs), START Ups, Women entrepreneurs
- 4.2 Science and Technology in Entrepreneurship Development (STED project of NSTEDB), Agribusiness Incubation Centre (ICAR), National Fisheries Development Board (NFDB), National Bank for Agriculture and Rural Development (NABARD), Entrepreneurship Development Institute of India (EDII), National Co-operative Development Corporation (NCDC), Small Industry Development Organization (SIDO), National Institute for Entrepreneurship and Small Business Development (NIESBUD), National Alliance Young Entrepreneur (NAYE), Self Employed Women Association (SEWA), Self Help Groups (SHGs)
- 4.3 Fish Market
 - 4.3.1 Structure, Functions and Types
 - 4.3.2 Marketing channels & supply chains
 - 4.3.3 Consumer behaviour
 - 4.3.4 Marketing research
- 4.4 Fish markets & marketing in India:
 - 4.4.1 Problems of fish marketing in India
 - 4.4.2 Cold storage & other marketing infrastructure in India
 - 4.4.3 Marketing organization and improvement
 - 4.4.4 E-marketing
 - 4.4.5 Role of Government and Co-operatives in fish marketing, Export and import of fish & fishery products, Role of MPEDA

Learners' Space:

1. Food Packaging Laws and Regulations
2. Packaging Machinery

PAPER 4: PSZOOCN404

INSTRUMENTATION AND PRESENTATION OF SCIENTIFIC DATA

Unit 1: Instrumentation

(15 L)

Objective

- *To learn how to design and build instruments for laboratory measurement.*
- *To understand fundamental principles of operation.*

Desired Outcome

- *The learner will understand methods for operation of instruments and data analysis.*
- *The learner will understand how instrumentation can advance scientific research.*

1.1 Centrifugation:

- Principle and applications of Centrifugation
- Differential and density gradient Centrifugation

1.2 Electrophoresis:

- Principle
- Structural components
- Applications

1.3 Chromatography:

- Principle and applications
- Adsorption
- Ion exchange
- Gel permeation
- Affinity

1.4 Spectrophotometer:

- Principle
- Applications

1.5 pH meter

- Principle
- Applications

1.6 Microscopy

- Binocular
- Trinocular

Unit 2: Presentation of Scientific data

(15 L)

Objective

- *To aware the students for good practice in data presentation.*
- *To aware the students to use different data presentation formats.*

Desired Outcome

- *The students will familiarize to explain their research data by using different techniques for presenting their scientific data.*

2.1 Types of presentation:

- Oral
- Poster
- Written
- Audio-visual

Aids for presentation

2.2 Preparing the manuscript

- Guidelines for authors
- The IMRAD format

2.3 Title, Byline, Abstract and Summary, Keywords

2.4 Introduction:

- Defining the problem
- Literature survey
- Justification of study

2.5 Materials and Methods:

- Contents
- Sources
- Procedures
- Techniques
- Reproducibility
- Significance

2.6 Results:

- Text
- How to present data
- Tables and illustrations
- Writing captions
- Labels and legends

2.7 Discussion:

- Components and Sequence
- Analysis, Comparison and Integration of Data
- Likely Sources of Errors in Results

2.8 Conclusions and significance

Unit 3: Project

(30 L)

Objective

- *To familiarize learner for analyzing a scientific occurrence with an investigation or to solve a problem with an invention.*

Desired Outcome

- *Research expands the current state of knowledge (at a certain cost) of the learners.*
- *Experimental findings that may yield new insights or lead to other research among the learners.*

- 1. Dissertation 60 Marks**
- 2. Examinations 50 Marks**

Guidelines to the 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 type-written using computer and printed for binding.

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 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 individual power point presentation (PPT) on the project and must present it in front of examiners at the time of examination.

7. The project will be prepared individually by students.

M. Sc. Part 2: Semester IV Practical
Practical 1: PSZOOCN4P1
Capture Fisheries

1. Identification, Classification of Marine fishes w.r.t. Fishery Aspects on the following: List of Marine fishes:
 - A. Elasmobranchs:
 - a) Family Carcharidae: *Carcharias* sps., *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 roottleri*
 - g) Family Stromatidae: *Pampus argenteus*, *Pampus chinensis* (*Stromateus sinensis*),
 - h) Family Scombridae: *Rastrelliger kanagurta*, *Cybium guttatum*
 - i) Family Gobidae: *Boleophthalmus* sps.
 - j) Family Mugilidae: *Mugil* sps.
 - k) Family Pleuronectidae: *Psettodes erumei*, *Cynoglossus elongatus*
 - l) Family Scopelidae: *Saurida tumbil*, *Harpodon nehereus*
 - m) Family Sombresocidae: *Strongylura strongylura* (*Belone stongylurus*), *Hemiramphus* sps.
 - n) Family Clupeidae: *Sardinella longiceps* (*Clupea longiceps*)
 - o) Family Chirocentridae: *Chirocentrus dorab*
 - p) Family Muraenesox: *Muraenesox* sps.
2. Plotting the frequency polygon by ova diameter measurement.
3. Biometric studies of fish / prawn
 - a) Study of relationship between total length and standard length / head length / body depth length / body weight.
 - b) Calculate correlation (standard length and total length, head length and total length, body depth and total length). Calculate the index values for various relationships.
4. Identification & Classification of fresh water, estuarine and marine non fish marine organisms
 - a) Tilapia, Cat fishes
 - b) Fresh water prawn (*Macrobrachium rosenbergii*)
 - c) Hilsa fishery, Mullet fishery
 - d) Trout and Mahaseer
5. Study of crafts and gears used on the East and West coast of India.
6. Visit to fish landing centre / local fish market.

Practical 2: PSZOOCN4P2

Brackish and Marine Water Aquaculture

1. Identification *Peneaus monodon*, *Scylla serrata*, *Lates calcarifer*, Mullet, Milk fish, Pearl Oyster.
2. Identification of various farm equipment such as feeding cups, trays, paddle wheels, aerators, fountains, Sluice gate models, elbow pipe outlets.
3. Identification of Aquaculture feed:
 - Green algae, blue-green algae, spirulina, diatoms, infusoria, rotifers, cladocerons, tubifex, brine shrimp, chironomids.
 - Culture of earthworms, bait fish and forage fish.
4. Identification of fin fish and shell fish diseases
 - a) Fungal Diseases – Saprolegniasis, Branchiomycosis
 - b) Bacterial Diseases – Fin and Tail rot, Ulcer diseases, Dropsy, Eye diseases, Ferunculosis, Bacterial Gill diseases, ERM, Edwardsiellosis, Vibriosis
 - c) Protozoan Diseases – White spot diseases, Costiasis, Trichodinosis, Whirling disease
 - d) Metazoans – Dactylogyrus, Gyrodactylus, Hirodinosis, Lernaea, Argulus
 - e) Viral diseases – IPN, IHN, VHs, CCVD, EUS.
5. Aquaculture medicines and its importance in fisheries:
Geotox, aquanone, Bio-ox, sodium chloride, formalin, malachite green, methylene blue, potassium permanganate, hydrogen per oxide and glutaraldehyde phostoxin, dipterex, antimicrobials, copper sulphate, sumithion, melathion
6. Visit to fish farming and submit its report.

PRACTICAL 3: PSZOOCN4P3 INDUSTRIAL FISHERY

1. Preparation of value added products:
 - a) Fish/Prawn Pickle
 - b) Fish Chakli and wafers
 - c) Artificial products/crabs streaks
 - d) Fish Kabab
 - e) Fish cuttlet
 - f) Fish Amoti
 - g) Fish Rumani
 - h) Fish fillets
2. Preparation of fish by-products:
 - a) Fish Protein Concentrate
 - b) Fish body oil
 - c) Fish meal
 - d) Chitosan
 - e) Isinglass
3. Identification of packaging materials:
 - a) Simple & Lacquered Cans
 - b) Polyolefin Films
 - c) Waxed Duplex cartons
 - d) Retort Pouches
 - e) Corrugated Fibre Board box
4. Fish market survey to study (any one):
 - a) Fluctuations in the availability and price of fish
 - b) Various preserved & processed fish / prawns
 - c) The availability of various by products, value added products and its price
 - d) Various packaging materials used in fish processing industries

Practical 4: PSZOOCN4P4

Instrumentation and Presentation of Scientific data

The practical of Semester 4 paper 4 comprises the Research Project for which students will have to take up a particular topic based on which they will be doing research applying the ethics of research, methods and methodology, etc. They are expected to abide rules of Scientific Research and if possible derive at a conclusion for the same. This will help the learners to build a strong foundation for pursuing research. Learners will acquaint about preparation of lay out, structure and language of typical reports, illustrations and tables. Learners will gain knowledge about how to write bibliography, referencing and footnotes in reports and thesis or in research articles.

Further, learners will be oriented to presentation of data through effective communication with the help of advanced visual technology. In addition to that they will be aware about the application of results, environmental impacts, conservation of biodiversity, ethical issues and ethical committees. The practical should be organized in such a manner that learners can be trained to manage large data sets generated via multiple observations, arrange them in a proper format and present them in relevant graphs/charts by adopting a hands-on in silico approach.

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University of Mumbai
M.Sc. ZOOLOGY (Oceanography and Fishery Technology)
Semester III / Semester IV EXAMINATIONS

Modality of Assessment

A. Internal Assessment 40%

Sr. No.	Evaluation type	Total Marks
1	One Assignments / Case study	25
2	Active participation in routine class instructional deliveries	05
3	Attendance – (0-25% = 0 marks, 25-50% = 1mark, 50-75% = 3 marks and 75-100%= 5 marks)	05
4	Overall conduct as a responsible student, manners, skill in articulation, leadership qualities demonstrated through organizing co-curricular, etc.	05

B. External Assessment 60%

a. Semester End Examination 60 Marks

- Duration – These examinations shall be of two and half hours duration for each paper.
- Theory Question Paper Pattern:
 - ❖ There shall be five questions each of 12 marks. On each unit there will be one question and the first one will be based on entire syllabus.
 - ❖ All questions shall be compulsory with internal choice within the questions. Each question will be of 18 to 30 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.

b. Practicals: 50 Marks

c. Project in Semester IV: Internal Examination 40 Marks

Dissertation: 60 Marks

External Evaluation: 50 Marks

***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 neighbouring colleges.

Use of animals for any experiment / dissection / mounting is banned. Simulations, authorized permanent specimens / slides, charts, models and other innovative methods are encouraged.

University of Mumbai
M.Sc. ZOOLOGY (Oceanography and Fishery Technology) Paper
Pattern of
Semester III (Papers 1, 2, 3, 4) / IV (Papers 1, 2, 3) Examination

Maximum Marks: 60

Duration: 2.5 Hours

Marks Option: 90

Question 1. Based on Unit I to IV (Mixed Questions)

Question 2. Based on Unit I

Question 3. Based on Unit II

Question 4. Based on Unit III

Question 5. Based on Unit 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 Units) **(12)**
 - a)
 - b)
 - c)
 - d)
 - e)
 - f)
2. Answer any **two questions** from the following: (Based on Unit I) **(12)**
 - a)
 - b)
 - c)
3. Answer any **two questions** from the following: (Based on Unit II) **(12)**
 - a)
 - b)
 - c)
4. Answer any **two questions** from the following: (Based on Unit III) **(12)**
 - a)
 - b)
 - c)
5. Answer any **two questions** from the following: (Based on Unit IV) **(12)**
 - a)
 - b)
 - c)

Semester IV Examination
Paper IV: Instrumentation and Presentation of Scientific data
Internal (Theory) Paper Pattern of PSZOOCN404

Maximum Marks: 40

Duration: 1.15 Hours

Marks Option: 60

Instructions:

- a. All questions are compulsory.
 - b. Draw neat and labeled diagrams wherever necessary.
-
1. Fill in the blank by choosing the correct option given in the brackets (Based on both Units) Four sub-questions from each unit. **(08)**
 2. Answer any **two questions** from the following: (Based on Unit I) **(16)**
 - a)
 - b)
 - c)
 3. Answer any **two questions** from the following: (Based on Unit II) **(16)**
 - a)
 - b)
 - c)

Skeleton of Practical Examination Question Paper Practical Paper 1: PSZOOCN3P1

Time: 10:00 am to 3:00 pm

Total Marks: 50

- | | | |
|----|---|-----------|
| 1. | Estimate the Salinity and Silicates of the given water sample. | 14 |
| | OR | |
| 1 | Estimate the primary productivity using light and dark bottle method of the given water sample. | 14 |
| 2 | Quantitative estimation of plankton using settling method / wet weight method / weight displacement method / counting method. | 08 |
| | OR | |
| 2. | Analyze and make a report of gut contents of the fishes provided. | 08 |
| 3. | Identification | 18 |
| | a) Oceanographic instrument | |
| | b) Oceanographic instrument | |
| | c) Intertidal organism – Rocky shore | |
| | d) Intertidal organism – Sandy shore | |
| | e) Intertidal organism – Muddy shore | |
| | f) Zooplankton | |
| 4. | Viva voce based on Theory. | 05 |
| 5. | Journal. | 05 |

Skeleton of Practical Examination Question Paper

Practical 2: PSZOOCN3P2

Time: 10:00 am to 3:00 pm

Total Marks: 50

- | | | |
|----|---|-----------|
| 1. | Estimation of Turbidity and pH / Hardness and CO ₂ of the given pond water sample. | 10 |
| | OR | |
| 1. | Estimation of BOD of given pond water sample. | 10 |
| 2. | Submit a report on setting and maintenance of aquarium and viva voce based on it. | 07 |
| | OR | |
| 2. | Identification of characteristics of male and female <i>Macrobrachium rosenbergii</i> . | 07 |
| 3. | Identify and describe. | 18 |
| | a) Candidate species of fish / crustacean | |
| | b) Ornamental fish | |
| | c) Aquatic plant used in aquarium | |
| | d) Developmental stage in fish | |
| | e) Developmental stage in <i>Macrobrachium rosenbergii</i> | |
| | f) Component of fish hatchery | |
| 4. | Viva voce based on Theory. | 05 |
| 5. | Journal and Field Report. | 10 |

Skeleton of Practical Examination Question Paper: Practical 3: PSZOOCN3P3

Time: 10:00 am to 3:00 pm

Total Marks: 50

- | | | |
|----|---|-----------|
| 1. | Estimate moisture content from the given fish sample. | 12 |
| | OR | |
| 1. | Sketch the layout of ice factory / cold storage / freezing industry / canning industry. | 12 |
| 2. | Differentiate between fresh fish or prawn on the basis of organoleptic tests. | 11 |
| | OR | |
| 2. | Prepare the shrimps for processing after dressing and grading. | 11 |
| | OR | |
| 2. | Demonstrate fish dressing and filleting of fish. | 11 |
| 3. | Identification (a to d) based on practical 4 and 7. | 12 |
| 4. | Viva based on Theory. | 05 |
| 5. | Journal and Field Report. | 10 |

Skeleton of Practical Examination Question Paper

Practical 4: PSZOOCN3P4

Time: 10:00 am to 3:00 pm

Total Marks: 50

1. Dissect any given Teleost fish so as to expose its Digestive system / Nervous system / Aortic arches. **14**
OR
1. Dissect any given Teleost fish so as to expose its weberian ossicles. **14**
OR
1. Dissect Crab so as to expose its circulatory system. **14**
2. Determine ammonia from the given tank water. **05**
3. Make a temporary preparation of (stain if necessary) **12**
 - a) Fins / Gills and rakers / Clasper / Walking leg
 - b) Hectocotylus arm / Rostrum / Chelate leg
 - c) Pleopod / Uropod / Antenna / Antennule
 - d) Scales / Air bladder
4. Identify and describe. **09**
 - a) Schooling /One Mollusc
 - b) Shoaling /One Crab Larva
 - c) One crab / One air breathing fish
5. Viva voce based on Theory. **05**
6. Journal. **05**

Skeleton of Practical Examination Question Paper

Practical 1: PSZOOCN4P1

Time: 10:00 am to 3:00 pm

Total Marks: 50

1. Major:

A. Identify and assign the given fishes to their respective genera and species. **12**

- i. Elasmobranch
- ii. Teleost
- iii. Teleost
- iv. Teleost

B. One Fish with Francis Day Volume. **05**

2. Minor:

Measure ova diameter and plot a frequency polygon for the given fish. **09**

OR

From the data provided present an account of biometric parameters of the given fish.

- i) Study of relationship between total length and standard length / head length / body depth / body weight. **05**
- ii) Calculate its correlation. **04**

3. Identify and comment on Inland fisheries, Estuarine and marine Shell fish resource organisms. **09**

- a) Specimen
- b) Craft
- c) Gear

4. Viva–voce based on Theory. **05**

5. Report based on Visit to fish Landing Centre / Local fish market and Journal. **10**

Skeleton of Practical Examination Question Paper:

Practical 2: PSZOOCN4P2

Time: 10:00 am to 3:00 pm

Total Marks: 50

1. Identify and describe their importance in fisheries **12**
(Any four photographs of Aquaculture medicines)
2. Identify and describe. **10**
(Any four photographs of equipment of fish farming)
3. Identify and describe their treatment. **09**
(Any three Fin fish and Shell diseases)
4. Identify and describe. **04**
Any two from *Peneaus monodon*, *Scylla serrata*, *Lates calcarifer*, Mullet, Milk fish, Pearl Oyster
5. Vive voce based on theory. **05**
6. Journal. **05**

Skeleton of Practical Examination Question Paper:

Practical 3: PSZOOCN4P3

Time: 10:00 am to 3:00 pm

Total Marks: 50

1. Preparation of any one value added product / by-product: **20**
Fish / Prawn Pickle / Fish Kabab / Fish cutlet / Fish Protein Concentrate / Fish body oil / Fish meal
2. Identify and describe packaging material (three spots). **15**
3. Viva voce based on theory. **05**
4. Journal and fish marketing survey report. **10**

Skeleton of Practical Examination Question Paper: Practical 4 PSZOO CN4P4

Evaluation of Project of Paper IV Project: 60 Marks

1.	Title of the Project	01
2.	Aim, Objectives and Rationale	04
3.	Materials and Methods	05
4.	Observations and / Results	10
5.	Interpretation of Observations / Results and Discussion	10
6.	Conclusion and / Recommendation	10
7.	Relevant work / Justification of work with Project title	10
8.	Relevant References	05
9.	Certified Dissertation	05

External Evaluation: 50 Marks

1.	Content of Presentation	10
2.	Quality of Presentation	10
3.	Presentation Skill	10
4.	Quality of Work	10
5.	Viva based on Proposal / Question Answer Session	10
