MODERN COLLEGE OF ARTS, SCIENCE AND COMMERCE GANESHKHIND, PUNE-16
(AUTONOMOUS)

SYLLABUS OF SECOND YEAR M.Sc. ZOOLOGY

M.Sc – II (SEMESTER III AND IV)

(SECOND REVIEW)

To be implemented from Academic Year

2025-2026

FRAMED BY

BOARD OF STUDIES IN ZOOLOGY

Progressive Education Society's
MODERN COLLEGE OF ARTS, SCIENCE AND COMMERCE, GANESHKHIND, PUNE- 16
(AUTONOMOUS)

PREAMBLE:

Zoology is a major subject of Basic Sciences which deals with all aspects of animal biology. It includes an interesting range of highly diverse topics. The advancements in biological Sciences demands, a zoology student to be a master of many areas in the subject. This Postgraduate degree program has been designed by the Board of Studies in Zoology of Modern College of Arts, Science and Commerce, Ganeshkhind with a tangible understanding of what is needed from zoologists and what zoologists need to pursue as a skilled career with special emphasis on the National Education Policy, 2020. It emulates closely the Benchmark Statement for Biosciences and the guidelines laid down by the University Grants Commission, New Delhi. This Newly designed Curriculum is an appropriate blend of the classical aspects in Zoology which has been the "backbone" knowledge required for all zoologists and the recent and specialized areas. The flexibility in the Curriculum allows the students to choose their areas of interest leading to enhanced employability. Students will be provided sufficient number of hours for their skill development through the Lab Courses and the Project component. The lab courses have differing flavours and priorities to make a good zoologist. This degree offers specialization in areas like Entomology and Fisheries along with a range of core courses like Biochemistry, Molecular Biology, Comparative Animal Physiology, Developmental Biology, Environmental Biology etc. Various cross cutting issues relating to Environmental biology have been aptly included to develop the students' sense towards human wellbeing. The field trip/surveys and study tours are included to gives the student an enticing taste of what life is specially outside the walls of the classroom. On successful completion of the programme, the students are expected to understand the key life processes of human and other animal groups, the functioning of molecules, cells, tissues, organs and systems. Also the students will gain increased confidence to use initiative and judgement to make decisions in complex and changeable situations and reflect critically and analytically on personal experience and make informed decisions about further study, training and employment opportunities.

The Master of Science (M.Sc.) in Zoology is a Postgraduate program under the Faculty of Science and Technology of Savitribai Phule Pune University Pune. The curriculum designed

encompasses subjects like Physiology, Entomology, Genetics, Cell Biology, Developmental Biology, Endocrinology, Biochemistry, Molecular Biology, Freshwater Zoology, Environmental Biology etc. Both classical and applied subjects of Zoology have been rightly blended to offer holistic understanding of the subject.

The Choice Based Credit System (CBCS) will be implemented through this curriculum. This curriculum would certainly felicitate students to develop a strong base of the fundamentals and

specialize in the desired area of their fondness and abilities. The students pursuing this program would get a privilege to select optional subjects of their choice. This newly designed curriculum will allow students to acquire the skill in handling scientific instruments planning and performing in the laboratory and exercising critical judgement, independent thinking and problem solving skills.

Instructions for the Students:

The students seeking admission to M.Sc. Zoology course is hereby informed that they are supposed to adhere to the following rules:

1. A minimum of 75 % attendance for lectures / practical is the pre-requisite for grant of term.
2. There shall be tutorial / practical / surprise test / home assignment / referencing of research papers / seminar / industrial visits/Field Visit / training course/viva-voce as a part of internal assessment in each semester. The students are supposed to attend all the tests. The students should note that re-test will not be permitted to the student absent for the test/s unless the case is considered by competent authority.
3. The students opting for dissertation course shall follow the rules framed for the same.
4. The students are supposed to attend all the Industrial Workshops / Laboratory Workshops / Training Programme/ symposia/ seminar/ field visit / study tour organized by the department/ college. The students shall attend these programmes at their own cost.

Eligibility:

The candidate should have a B.Sc. degree with Zoology as principal subject or B.Sc. (General) degree with Zoology as one of the subsidiary subjects. Graduates in any life science related subjects such as Biotechnology, Bioinformatics, Life science, Biochemistry, Microbiology, Agriculture, Veterinary sciences, Biology, Botany etc. Admission: Admissions will be given as per the selection procedure / policies adopted by the respective college, in accordance with conditions laid down by the University of Pune. Reservation and relaxation will be as per the government rules.

Examination

[A] Pattern of Examination Evaluation of Students:

1) The In-semester and End-Semester examinations will be of 20 marks each for 2 credits and 40 marks for 4 credits and for End-semester 30 marks for 2 credits and 60 marks for 4 credits.
2) Student has to obtain minimum of 40 % separately in both the In-Semester and End-Semester.
3) Internal marks remain unchanged and internal assessment cannot be repeated. If student

remain absent during internal assessment examination, he/she will have second chance with the permission of the competent authority. But it will not be right of the student. It will be under the discretion of the competent authority and internal departmental assessment committee. In case he/she wants to repeat Internal, he/she can do so only by registering for the said courses.

5) There shall be revaluation of answer script of end semester examination, but not of internal assessment papers.

i. In-semester Examination:

Internal assessment for each course would be continuous and dates for each tutorials/practical tests etc. will be pre-notified in the time table for teaching or placed separately as a part of time table. Department / College Internal Assessment Committee will coordinate this activity.

a) Theory Courses: Students should be encouraged to participate in various academic activities. A teacher must select a variety of the procedures for conducting internal assessment suggested as follows.

a) Multiple choice questions

b) Combination of objective and subjective questions.

c) Open book test (concerned teacher will decide the allowed books)

d) Tutorial

e) Surprise test specified topics in a given notified period

f) Oral

g) Assignments

h) Review of research paper

i) Seminar presentation

j) Journal/Lecture/Library notes Student has to preserve the documentation of the internal assessment except midterm test answer script. It is the responsibility of the student to preserve the documents.

b) Practical Courses:

It is a continuous evaluation process. Practical courses will be evaluated on the basis of the following:

1. Performance assessment of each experiment on the basis of attendance, punctuality, journal completion, practical skills, results, oral and analysis.
2. Assessment on practical course be conducted before the end-semester examination.
3. Assessment of each experiment shall be done for each practical weekly.
4. Assessment of the Activity will be based on any one of the following (per practical course).

i. Special training programs in recognized research institutes such as NCL, NIO, NIV, ZSI, BNHS, etc.

ii. Project on Research Methodology

iii. Industrial/Institution Visit report

iv. Field visit report/ study tour repor.

The student strength of practical batch should be 12

Project Course: Project will be evaluated by the examiner/s in consent with the project guide if required.

ii. End-Semester Examination:

The End-semester examination programme will be scheduled as per the notifications and guidelines issued by the Examination section of University of Pune.

[B] Standard of Passing

Student has to obtain 40% marks separately in In-Semester and End-Semester assessment.

Program outcomes (POs):

After successfully completing the M.Sc. Zoology program students will be able to:

PO1. **Zoology knowledge**: Apply the knowledge of Zoology, Life Sciences and allied subjects to the understanding of complex life processes and phenomena.

PO2. **Problem analysis**: Identify, review research literature, and analyse complex situations of living forms.

PO3. **Design/development of solutions**: Design processes/strategies that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions in real situations.

PO5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and ICT tools for understanding of the subject.

Programme Specific outcomes

PSO1: Understand the impact of the natural and anthropogenic activities in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development. Identify a range of invertebrates and vertebrates and justify their conservation.

PSO2: Apply ethical principles and commit to professional ethics and responsibilities and norms of the work/research practice.

PSO3: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

Course Structure with Credit Distribution of the Postgraduate Science Program in Zoology- M.Sc inZoology under NEP to be implemented from 2025-2026

M.Sc Second year Zoology

Course type	Course code	SEMESTER III	Course Code	SEMESTER IV	Credits
Mandatory major	**ZOO63101**	Entomology (4C) (T)	**ZOO64101**	Advanced Entomology(4C) (T)	4+4
Mandatory major	**ZOO63102**	Systematics and Evolutionary Biology (4C) (T)	**ZOO64102**	Mammalian Reproductive Physiology (4C) (T)	4+4
Mandatory major	**ZOO63103**	Aquaculture (4C) (T)	**ZOO64103**	Biostatistics (2C) (T)	4+2
Mandatory major	**ZOO63104**	Practicals in Entomology, Systematics and Evolutionary Biology (2C) (P)	**ZOO64104**	Practicals in Advanced Entomology and Biostatistics (2C) (P)	2+2
Major Elective	**ZOO63105**	Immunology (2C) (T)	**ZOO64105**	Histology and Histochemistry (2C) (T)	2+2
Major Elective	**ZOO63106**	Practicals in Aquaculture and Immunology (2C) (P)	**ZOO64106**	Practicals in Mammalian Reproductive Physiology, Histology and Histochemistry (2C) (P)	2+2
RP	**ZOO63407**	Research project (4C)	**ZOO64407**	Research project(6C)	4+6
				Total credits	**44**

Abbreviations: RP- Research project

Course Code: ZOO63101						
Course Title: Entomology (Theory)						
M.Sc. SEMESTER-III						
Teaching Pattern				**Evaluation Pattern**		
Course Type Mandatory Major	**Credits**	**Number of Teaching hours**	**Lectures per week**	**Internal Assessment**	**End Semester Exam**	**Total**
Subject 1 (under vertical 1)	**04**	**60**	**04**	**40**	**60**	**100**

Course Outcomes:

After successfully completing this course, students will be able to:

CO1: Define entomology and Insects and understand origin and evolution of insects and their relation to other arthropods.

CO2: Give outline of Classification of insects up to family with distinguishing characters and examples of each order and family.

CO3: Explain the structure, chemical composition and functions of Integument and Derivatives of Integument.

CO4: Explain the structure, modifications of insect body regions and their appendages.

CO5: Explain the Comparative anatomical and histological structure of various body systems.

Sr. No.	Name of the topic	No. of Lectures allotted
1	**Unit 1: Introduction to Entomology:** 1.1 Definition. 1.2 Origin, Evolution and Inter- relationship of insects with other arthropods.	(04L)
2	**Unit 2: General outline of Classification and Phylogeny of insects up to family** 2.1 Apterygote insects (4 orders). 2.2 Exopterygote insects (16 orders). 2.3 Endopterygote insects (9 orders).	(19L)

3	**Unit 3: Integument** 3.1 Structure, chemical composition and functions. 3.2 Derivatives of Integument: Cuticular appendages & Processes.	(02L)
4	**Unit 4: Comparative study of-** 4.1 Head and its appendages. 4.1 Thorax and its appendages. 4.2 Abdomen and its appendages.	(09L))
5	**Unit 5: Comparative anatomical and histological study of the following:** 5.1 Digestive system. 5.2 Respiratory system. 5.3 Circulatory system. 5.4 Excretory system. 5.5 Reproductive system. 5.6 Nervous system and Sense organs.	(18L)
6	**Unit 6: Endocrine and Exocrine glands** 6.1 Hormonal action.	(04L)
7	**Unit 7: Light and Sound producing organs** 7.1 Thermoregulation in insects. 7.2 Insect communication- types of communication in insects	(04L)

REFERENCES:

1. A Text book of Entomology-By H. H. Ross (John Wiley and Sons, Ins. New York,).
2. An Introduction to Entomology- By J. H. Comstock (Ithaca, New York).
3. General & Applied Entomology- By K. K. Nayar, T.N. Anathakrishnan & B.V. David, (Tata McGraw-Hill, New Delhi).
4. General Entomology, 2nd edition- By M.S. Mani Oxford & IBH Publishing Company, New Delhi.
5. Imm's text book of entomology by O. W. Richards and R. G. Davies (Methuen and com, London) vol. I and II
6. Introduction to comparative Entomology- By R. M .Fox and J. W. Fox (Reinhold, New York)

7. Modern Entomology, 2nd edition- By D. B. Tembhare (Himalaya Publication House, Bombay).
8. Principles of insect morphology- By R. E. Snodgrass (Tata Mc-Graw Hill Bombay).
9. The Insect: Structure & Function- By R. F. Chapman (E.L.B.S., & E.U.P. London).

Course Code: ZOO63102						
Course Title: Systematics and Evolutionary Biology (Theory)						
M.Sc. SEMESTER-III						
Teaching Pattern				**Evaluation Pattern**		
Course Type Mandatory Major	**Credits**	**Number of Teaching hours**	**Lectures per week**	**Internal Assessment**	**End Semester Exam**	**Total**
Subject 2 (under vertical 1)	**04**	**60**	**04**	**40**	**60**	**100**

Course Outcomes:

After successfully completing this course, students will be able to:

CO1: Explain principles, methods of biological classification and diversity in kingdom Animalia.

CO2: Explain the importance of taxonomic keys and taxonomic characters.

CO3: Explain the principles of zoological classification and nomenclature

CO4: Discuss the various taxonomic procedures and molecular phylogenetics & phylogeography.

CO5: Illustrate the methodologies used in systematics.

Sr. No	Name of the Topic	No. of Lectures allotted
1	**Unit 1: Science of Biosystematics** 1.1 Concept of Biosystematics. 1.2 Terms used in systematic biology. 1.3 Historical review of taxonomic philosophies. 1.4 Future of taxonomic studies. 1.5 Stages in taxonomy. 1.6 Tasks of taxonomist. 1.7 Systematics as a profession.	(07L)

2	**Unit 2: Kingdoms of Life** 2.1 Systematics and taxonomy. 2.2 Importance and basis of classification. 2.3 Hierarchy of classification and classification systems. 2.4 Types of classification-artificial, natural and phylogenetic. 2.5 General outline of kingdoms including Monera & Protista. 2.6 Broad outline & Diversity in kingdom Animalia (Major and Minor Phyla.	(08L)
3	**Unit 3: Taxonomic Procedures** 3.1 Collection-Purpose, value, scope of collection. 3.2 Content of collection. 3.3 Significance of museum collections. 3.4 Legal aspects of collecting animals. 3.5 Post collection processes. 3.6 Preparation and packaging of specimens of specimen for posting. 3.7 Importance of collections/ museum specimens of the world and India. 3.8 Documentation of biodiversity. 3.9 Preservation-Methods, taxidermy, factors responsible for the deterioration of museum specimens. 3.10 Curating of collections-museum collection policy, preparation of material for study, housing and cataloging. 3.11 Identification-Systematic process of sorting and labelling, procedure of identification; identification services.	(10L)
4	**Unit 4: Taxonomic Keys** 4.1 Types of taxonomic keys, their merits and demerits.	(04L)
5	**Unit 5: International code of Nomenclature** 5.1 Identification, Description, Naming of taxa. 5.2 Principles and rules of International Code of Zoological Nomenclature (ICZN). 5.3 Binominal system, type material, author citation. 5.4 Criteria for publication, types of names. 5.5 Principle of priority and its limitations. 5.6 Curation of taxonomic collections.	(07L)

	5.7 Taxonomic revision. 5.8 Taxonomic literature. 5.9 The relevance of systematics in conservation programmes.	
6	**Unit 6: Methodologies in systematics** 6.1 Morphology based taxonomy, Numerical taxonomy, Cytotaxonomy and chemotaxonomy. 6.2 Molecular systematic, DNA fingerprinting & Molecular markers for detection/evaluation of polymorphism, RFLP, RAPD, etc. 6.3 Evolutionary taxonomy, Molecular phylogenetics & phylogeography.	(06L)
7	**History of Origin of life** 7.1 Speciation: Biological Species concept, Subspecies, Monotypic and Polytypic species, Sibling species. 7.2 Isolation: Reproductive and geographical isolation and their role in speciation process (pre mating and post mating). 7.3 Speciation modes–Sympatric, Allopatric and Parapatric. Type concept – name bearing types (primary and secondary) and their applications. 7.4 DNA bar coding for identification of species.	09L
8	**Animal distribution** 8.1Bathymetric and discontinuous distribution. 8.2 Barriers and dispersals -types and their impact on animal distribution. 8.3 Zoogeographical realms –names and distribution of animal according to Wallace scheme. 8.4 Distinct events in evolution: Adaptative radiations with special reference to Darwin's finches. 8.5 Origin of birds. Evolution in horse. Xeric (camel and lizard); Arboreal (sloth bear) adaptation.	09L

REFERENCES:

1. Kato., The biology of biodiversity, Springer.
2. Avise J.C., Molecular markers, Natural history and evolution, Chapman and Hill, NY.
   Wilson A.O., biodiversity, Academic Press, Washington.
3. Principals of systematic Zoology by Ernst Mayr.
4. Futuyama, D. J. (1986). Evolution, Systematics and Animal Behaviour. EvolutionaryBiology. Sinauer Associates Inc.
5. Strickberger, M. W. (2007). Evolution. CBS Pub.
6. Colbert, E. H.; Morales, M. & Minkoff, E. I. (2001). Evolution of the Vertebrates, Science.
7. Moody, P. A. (2002). Introduction to Evolution, Kalyani Pub.

8. Dobzhansky, T.; Ayala, F. J.; Stebbins G. L. and Valentine, J. W. (1979). Evolution,Surjeet Pub.

9. Mayr, E. & Ashlock, P. D. (1991) Principles of Systematic

Course Code: ZOO63103						
Course Title: Aquaculture (Theory)						
M.Sc. SEMESTER-III						
Teaching Pattern				**Evaluation Pattern**		
Course Type Mandatory Major	**Credits**	**Number of Teaching hours**	**Lectures per week**	**Internal Assessment**	**End Semester Exam**	**Total**
Subject 3 (under vertical 1)	**04**	**60**	**04**	**40**	**60**	**100**

Course outcomes:

After successfully completing this course, students will be able to:

CO1: Mention the various composite fish culture with significance of each type.

CO2: Explain the methods of freshwater prawn and pearl culture.

CO3: Illustrate the preparation and management of fish culture ponds.

CO4: Demonstrate the methods of packaging and transport of fish and brood fish.

CO5: Illustrate techniques of fish harvesting, preservation & processing.

Sr. No.	Name of the Topic	No. of lectures allotted
1.	**Unit 1: Basics of Aquaculture- Scope and importance of Aquaculture- Indian Fisheries – World Fisheries.** 1.1 Introduction and scope of fisheries in India. 1.2 Types of fisheries: Inland and Marine. Riverine fisheries: Major River systems in India, ichthyofauna, and recent catch statistics. Problems encountered in fisheries. 1.3 Cold water fisheries: Cold water fishery resources of India. Representative species of fishes of cold water bodies of India. 1.4 Reservoir and Lacustrine fisheries: Definition and ecological features of reservoirs and lakes. Major reservoirs and lakes in India with emphasis on capture fisheries.	(06L)

	1.5 Estuarine fisheries: Definition and classification of estuaries, capture fisheries resident and migrant species, Fisheries of brackish water lake and backwaters. Problem of brackish water fishery. 1.6 Marine fishery resources in India: Marine capture fishery resources at inshore, offshore and deep sea. EEZ, PFZ and continental shelf, maritime states in India.	
2.	**Unit 2: Physicochemical parameter of water for fish culture** 2.1 pH, Calcium, Total Alkalinity, Nitrate, Ammonia, Total hardness of fresh Water.	(03L)
3.	**Unit 3: Construction and management of fish culture pond** 3.1 Construction of ponds, management of ponds. 3.2 Predatory and weed fishes and their control, Aquatic weeds and their control. 3.3 Aquatic insects and their control, fish feeding: natural and artificial fish feed.	(03L)
4.	**Unit 4: Fish breeding: natural and induced.** 4.1 Natural breeding in pond water. 4.2 Induced breeding- Pituitary extract, selectionof breeders, injection of pituitary extract, spawning, Advantages of induced breeding. 4.3 History of hypophysation. Methods of pituitary extract preparation, dosage determination, injection to the brood fishes, spawning and hatching. 4.4 Use of different synthetic hormones and analogues for induced spawning - Stripping and fertilization. 4.5 Bundh breeding, types of bundh breeding techniques and problems of bundh breeding.	(02L)
5	**Unit 5: Hatchery Technology of fishes** 5.1 Indian Major Carps, Tilapia and Trout hatchery. 5.2 Design and function of incubators, glass jar hatchery, Chinese hatchery and other hatchery systems. 5.3 Hatchery technology for different species: Indian major and minor carps, Exotic carps, Catfishes, Tilapia, Mahseer and Trout. 5.4 Marine fish seed production: Seabass, milkfish, mullets, cobia and silver pompano.	(05L)
6.	**Unit 6: Fish culture** **6.1** Selection of cultivable fish, monoculture, composite culture. **6.2** Culture of Indian major carps, Culture of common carps, culture of cat	(07L)

	fishes, paddy cum fish culture, mari culture, cage culture, integrated fish farming.	
7.	**Unit 7: Post Harvest Technology and Marketing strategies:** 7.1 Principles and importance of fish preservation. 7.2 Fish spoilage- post mortem changes and rigor mortis, post rigor spoilage. 7.3 Methods of fish preservation- Icing, Freezing, Cold storage, Drying, Salting, Smoking, Canning and Fish Pickling. 7.4 Fish transportation: Recent advances in the process of transportation 7.5 Fish product and Byproduct: Fish Oil, Fish liver oil, Fish meal, Fish manure, Fish flour, fish glue, isinglass.	(05L)
8.	**Unit 8: Fish pathology:** bacterial, fungal, protozoan and worm diseases of fish.	(02L)
9.	**Unit 9: Fresh water prawn culture (*Macrobracium rosenbegii)*** 9.1 Seed procurement from natural resources. 9.2 Breeding and larval rearing of fresh water prawn,management of cultural ponds, harvesting and marketing.	(02L)
10.	**Unit 10:Pearl Culture:** 10.1 Composition & quality of pearl. 10.2 Collection of oysters, rearing of oysters, insertion of nucleus, pearl formation, harvesting of pearls.	(02L)
11	**Unit 11: Ornamental Fish production and management:** 11.1 Different varieties of exotic and indigenous ornamental fishes. 11.2 Principles of a balanced aquarium. 11.3 Fabrication, setting up and maintenance of freshwater aquarium. 11.4 Water quality management. Water filtration system – biological, mechanical and chemical.	(04L)
12	**Unit 12: Introduction To Aquaponics** 12.1 Principles of aquaponics; biological components and water quality of aquaponics. 12.2 Different types & techniques of aquaponics- media bed technique, nutrient film technique, deep water culture technique; installation of indoor aquaponics unit.	(04L)

	12.3Fish and Plant health management, monthly activities. 12.4 Design & management of hydroponic system, integrated hydro-aquaponics.	
13.	**Unit 13: Technologies in Fisheries development** 13.1 Geographic Information System(GIS) technology. 13.2 Use of Information Communication Technology (lCT) in fishes: production aspects, marketing aspects.	(2L)

REFERENCES:

1. Agustí, S. 1991. Light environment within dense algal populations: cell size influences on self-shading. Journal of Plankton Research, 13(4): 863–871.
2. Ahamad Ali, S. 1982. Relative efficiencies of pelletized feeds compounded with different animal proteins and the effect of protein level on the growth of the prawn Penaeus indicus. Proceedings of the Symposium on Coastal Aquaculture, MarineBiological Association of India, 1: 321–328.
3. Biswas, K. P. (2002), A Text Book of Fish, Fisheries & Techonology, Narendra Publishing House, Delhi.
4. Jain, K.K. 2003, Indused breeding of carps by hypophysation. In: Carp and Cat fish breeding & culture CIFE. PUBlication, Versova. Mumbai.
5. Jyoti, M. K. & Sharma, A. 2006. Fishes, Aid to collection, preservation and identification daya Publishing House, New Delhi.
6. Langur, R.K., 2002. Management of carp rearing ponds. 62-65. In: Carp and catfish breeding & culture. C.I.F.E.,Versova, Mumbai.
7. Mark, D.L. (1983) Fish Diseases. T.F.H. Publication Inc. New Jersey.
8. Sharma, B.D. and Sanjappa, M. 1993., Flora of India. Botanical Survey of India,Calcutta.1-639.

Course Code: ZOO63205						
Course Title: Immunology(Theory)						
M.Sc. SEMESTER-III						
Teaching Pattern				**Evaluation Pattern**		
Course Type Major elective	**Credits**	**Number of Teaching hours**	**Lectures per week**	**Internal Assessment**	**End Semester Exam**	**Total**
Subject 5 (under vertical 2)	**02**	**30**	**02**	**20**	**30**	**50**

Course Outcomes:

After successfully completing this course, students will be able to:

CO1: Enlist the primary and secondary immune organs.

CO2: Understand the concepts of immunity, self-nonself immune response, autoimmune disease.

CO3: Explain the theories of antibody synthesis and generation of antibody diversity.

CO4: Knowledge of the principle and application of the common techniques used in Immunology

Sr. No.	Name of the topic	No. of Lectures allotted
1.	**Unit 1: Introduction to Immune system.** 1.1. Overview of Immunology. 1.2. Innate and Adaptive immunity; Humoral immunity and cell mediated immunity. 1.3. Primary and secondary lymphoid organ. Tissue, cells and molecules of the human immune system. 1.4. Immediate response to infection: inflammation, cell migration, acute phase response interferons and NK cell. Concept of immunity (self- non self, antigen) and active and passive immunization (natural and artificial)	(07L)

2.	**Unit 2: Antibody structure** 2.1 Antibody classes, subclasses. 2.2 Structure-function relationship. 2.3 Iso, Idio and Allo types., T cell receptors.	(04L)
3.	**Unit 3: Theories of antibody synthesis** 3.1 Generation of antibody diversity (molecular basis). 3.2 Antibody class switching.	(03L)
4.	**Unit 4: Major Histocompatibility complex (MHC)** 4.1 HLA and disease association. 4.2 Immune deficiencies and disorders. 4.3 Antigen processing & Immunogenetics.	(05L)
5.	**Unit 5: Immunological Tolerance –concept and types** 5.1 Autoimmunity- concept and its types with examples.	(02L)
6.	**Unit 6: Hypersensitivity** and its types.	(01L)
7.	**Unit 7: Immunological memory** 7.1 Types of vaccines and vaccination.	(02L)
8.	**Unit 8: Immunotechniques** 8.1 Antigen-antibody reaction. 8.2 Complement system and complement fixation test.	(02L)
9.	**Unit 9: Hybridoma principle and application** 9.1 ELISA, immunofluorescence, immunoelectrophoresis, RIA. 9.2 Monoclonal-polyclonal antibody and its application.	04L

REFERENCES:

1. Immunology: Kindt T. J., Goldsby R.A., Osborme B. A., Kuby J.: freeman WH publications.
2. Essential immunology, IvonRoitt, Blackwell Scientific publication, London.
3. Immunology, Roitt I. V., Butterworth Publishers, USA.

Course Code: ZOO63104						
Course Title: Practicals in Entomology, Systematics and Evolutionary Biology						
M.Sc. SEMESTER-III						
Teaching Pattern				**Evaluation Pattern**		
Course Type Mandatory Major	**Credits**	**Number of Teaching hours**	**Practicals per week**	**Internal Assessment**	**End Semester Exam**	**Total**
Subject 4 (under vertical 1)	**02**	**30**	**02**	**20**	**30**	**50**

	Practicals in Entomology	
Sr. No.	**Name of the Practical**	**Practicals allotted**
1	Method of collection, and preservation of insects and submission of 10 insects belonging to different orders.	2P
2	Study of Taxonomy and diagnostic features up to family of Apterygote, Exopterygote and Endopterygote insects (at least one insect from each order).	2P
3	Study of generalized insect: Grasshopper Systematic position, Habit, Habitat and study of Digestive, Nervous and Reproductive system.	2P
4	Temporary mounting of mouth parts, antenna, legs, wings, spiracles and tympanum of a generalized insect and study of modifications.	1P
5	Study of head capsule: Structure of head capsule, head orientations and modifications. Study of types of mouthparts and antennae modifications. Study of abdominal appendages.	2P

	Practicals in Systematics and Evolutionary Biology	
Sr. No.	**Name of the Practical**	**Practicals allotted**
1	To Study specimens of Minor phyla.	1P
2	Study of museum specimens and slides of invertebrates, protochordates and chordates (2 examples from each phyla)	2P
3	Identification of animals with the help of taxonomic keys-House fly, Honey bee, Cockroach, Earthworm. etc.	1P
4	Study of Preservation techniques- dry, wet preservation and taxidermy.	1P
5	Visits to Scientific Institute like Zoological Survey of India/ Animal Museum and submission of Report.	2P

REFERENCES:

1. A Text book of Entomology-By H. H. Ross (John Wiley and Sons, Ins. New York,).
2. An Introduction to Entomology- By J. H. Comstock (Ithaca, New York).
3. General & Applied Entomology- By K. K. Nayar, T.N. Anathakrishnan & B.V. David, (Tata McGraw-Hill, New Delhi).
4. General Entomology, 2nd edition- By M.S. Mani Oxford & IBH Publishing Company, New Delhi.
5. Kato., The biology of biodiversity, Springer.
6. Avise J.C., Molecular markers, Natural history and evolution, Chapman and Hill, NY. Wilson A.O., biodiversity, Academic Press, Washington.
7. Principals of systematic Zoology by Ernst Mayr.

Course Code: ZOO63106						
Course Title: Practicals in Aquaculture and Immunology						
M.Sc. SEMESTER-I						
Teaching Pattern				**Evaluation Pattern**		
Course Type Major elective	**Credits**	**Number of Teaching hours**	**Practicals per week**	**Internal Assessment**	**End Semester Exam**	**Total**
Subject 6 (under vertical 1)	**02**	**30**	**02**	**20**	**30**	**50**

	Practicals in Aquaculture	
Sr. No.	**Name of the Practical**	**Practicals allotted**
1	Study of Indian major carps, prawns, and oysters.	1P
2	To Study Physico-chemical parameters of fresh water –pH, Turbidity, Calcium, Nitrate, Ammonia.	1P
3	Determination of total alkalinity and total hardness of fresh water.	1P
4	Study of induced breeding techniques by using commercially available pituitary extract.	1P
5	Study of fish disease (bacterial, fungal, protozoan), head and lateral line erosion and eye disease.	1P
6	Use of Geographic Information Technique (GIS) and Information and communication technology (ICT).	1P
7	Visit to fish farm/ fish industry.	1P

	Practicals in Immunology	
Sr. No.	**Name of the Practical**	**Practicals allotted**
1	Histology of lymphoid organs: skin, spleen, thymus, ileum lymph node and bone	2P
2	Demonstration of Immunoelectrophoresis and rocket electrophoresis (using kit).	2P
3	Double diffusion or Ouchterlony technique (using kit).	1P
4	To estimate the antigen concentration by (kit using). (Compulsory).	1P
5	To study the differential count of WBC's.	1P
6	To study the immunology of blood transfusion (universal donor, universal recipient, Bombay blood group and erythroblastosis foetalis). (Compulsory)	2P

REFERENCES:

1. Agustí, S. 1991. Light environment within dense algal populations: cell size influences on self-shading. Journal of Plankton Research, 13(4): 863–871.
2. Ahamad Ali, S. 1982. Relative efficiencies of pelletized feeds compounded with different animal proteins and the effect of protein level on the growth of the prawn Penaeus indicus. Proceedings of the Symposium on Coastal Aquaculture, MarineBiological Association of India, 1: 321–328.
3. Biswas, K. P. (2002), A Text Book of Fish, Fisheries & Techonology, Narendra Publishing House, Delhi.
4. Jain, K.K. 2003, Indused breeding of carps by hypophysation. In: Carp and Cat fish breeding & culture CIFE. PUBlication, Versova. Mumbai.
5. Immunology: Kindt T. J., Goldsby R.A. , Osborme B. A., Kuby J. : freeman WH publications.
6. Essential immunology, IvonRoitt, Blackwell Scientific publication, London.
7. Immunology, Roitt I. V., Butterworth Publishers, USA.

Note: It is mandatory for the students to complete a minimum of two courses from the given links and earn the certificate relevant to the Practical courses:

ZOO63104: Practicals in Entomology, Systematics and Evolutionary Biology (2C) (P)

ZOO63106: Practicals in Aquaculture and Immunology (2C) (P)

https://swayam.gov.in/

https://nptel.ac.in/

https:// coursera.org/

Course Code: ZOO63407						
Course Title: Research project (RP) (4C)						
M.Sc. SEMESTER-I						
Teaching Pattern				**Evaluation Pattern**		
Course Type RP	**Credits**	**Number of Teaching hours**	**Practicals per week**	**Internal Assessment**	**End Semester Exam**	**Total**
Subject 7 (under vertical 4)	**04**	**60**	**02**	**40**	**60**	**100**

M. Sc. Zoology (Semester - IV)

Course Code: ZOO64101						
Course Title: Advanced Entomology (Theory)						
M.Sc. SEMESTER-IV						
Teaching Pattern				**Evaluation Pattern**		
Course Type Mandatory Major	**Credits**	**Number of Teaching hours**	**Lectures per week**	**Internal Assessment**	**End Semester Exam**	**Total**
Subject 1 (under vertical 1)	**04**	**60**	**04**	**40**	**60**	**100**

Course Outcomes:

After successfully completing this course, students will be able to:

CO1: Explain Gametogenesis, Fertilization and oviposition.

CO2: Explain embryonic developmental stages such as Cleavage, Blastoderm and Germ band formation; Gastrulation, Blastokinesis, differentiation of germ layers, Segmentation and Appendages formation and organogenesis.

CO3: Explain post-embryonic developmental stages such as Nymph, Naiad, larva, Pupa and Metamorphosis.

CO4: Explain specialized reproductive mechanisms.

CO5: Explain Hadorn's experiments with imaginal disc, Regeneration and Aging. CO6: Explain Occurrence initiation, Preparations for diapauses and its Controls.

Sr. No.	**Name of the topic**	**No. of Lectures allotted**
1	**Unit 1: General outline of classification and phylogeny of insects upto family of insects.**	(02L)
2	**Unit 2: Reproductive system** 2.1 Male and Female reproductive system of insects. 2.2Spermatogenesis, Seminal transfer and spermatophore formation. 2.2 Oogenesis, Structure and Types of insect eggs. Fertilization and oviposition.	(08L)

3	**Unit 3: Insect embryonic development:** 3.1 Cleavage and Blastoderm formation. 3.2 Germ band formation. 3.3 Gastrulation, Embryonic membranes, Blastokinesis. 3.4 Dorsal closure and dorsal organ. 3.5 Fate/ differentiation of germ layers. 3.6 Segmentation, Appendages formation and organogenesis in brief.	(14L)
4	**Unit 4: The post embryonic development** 4.1 Eclosion from the egg. 4.2 The developmental stages: Nymph, Naiad, larva, Pupa, Emergence from the pupa/ cocoon. 4.3 Metamorphosis and Growth, hormonal control of metamorphosis in insects. 4.4 Different types of insect pheromones and its function.	(10L)
5	**Unit 5: Types of reproduction and Specialized reproductive mechanism:** 5.1 Oviparity, viviparity, polyembryony, paedogenesis and parthenogenesis.	(05L)
6	**Unit 6: Hadorn's experiments with imaginal disc** 5.1 Regeneration and Aging. 5.2 Determination and pattern formation in the imaginal discs of *Drosophila.*	(07L)
6	**Unit 6: Diapause** 6.1 Occurrence, Initiation and Preparations for diapauses. 6.2 Diapause development and Controls. 6.3 Difference between quiescence and diapause. 6.4 Hormonal regulation of diapause and development in insects.	(08L)
7	**Unit 7: Insect Ecology** 7.1 Abiotic and biotic factors of environment concerning distribution and abundance of insects. 7.2 Current theories to explain insect number. 7.3 Ecology of pest control. 7.4 Insect mimicry.	(06L)

	7.5 Entomophagous insects. 7.6 Beneficial and harmful insects.	

REFERENCES:

1. 'The Insect- structure and Function'- by R.F. Chapman , ELBS, London
2. 'A Text book of Entomology'- by H. H. Ross (John Wiley and Sons, Ins. New York,
3. 'Imms' Text Book of Entomology- by O. W. Richards and R. G. Davies, (Methuen &Cc., London,), Vols. I & II.
4. 'Embryology of Insects and Myriapods'- by O. A. Johanson and F.H. Butt, (McGraw Hill, New York,).
5. 'The ecology of insect populations in theory and practice'- by L.R. Clarks P. W. Geier, R.D. Hughes, R.F. Morris (Methuen, London).
6. 'Developmental system: Insects' Vol. I and II- by S. J. Counce and C.H. Waddington (Academic Press, London,).

Course Code: ZOO64102						
Course Title: Mammalian Reproductive Physiology (Theory)						
M.Sc. SEMESTER-IV						
Teaching Pattern				**Evaluation Pattern**		
Course Type Mandatory Major	**Credits**	**Number of Teaching hours**	**Lectures per week**	**Internal Assessment**	**End Semester Exam**	**Total**
Subject 2 (under vertical 1)	**04**	**60**	**04**	**40**	**60**	**100**

Course Outcomes:

After successfully completing this course, students will be able to:

CO1: Explain the male and female reproductive systems and sexual dimorphic characteristics

CO2: Explain the sexual cycles with examples CO3: Illustrate the reproductive dysfunctions.

CO4: Diagrammatically represent the hormonal regulation of reproductive processes like pregnancy, lactation and parturition.

CO5: Prepare the flow chart to demonstrate the hormonal coordination of reproductive Processes

CO6: Justify the artificial control of reproduction.

Sr. No.	Name of the Topic	No. of Lectures allotted
1	**Unit 1: Reproductive Systems** 1.1 Anatomy of Male Reproductive System. 1.2 Accessory organs and their function Spermatogenesis, Function of Sertoli cells. 1.3 Blood Testis barriers, inhibin, Leydig cell, Capacitation. 1.4 Functions of Androgens. 1.5 Anatomy of Female Reproductive System.	(08L)
2	**Unit 2: Reproductive patterns:** 2.1 Environmental factors and breeding, continuous and seasonal breeders.	(04L)
3	**Unit 3: Sexual cycles** 3.1 Puberty, oestrous and menstrual cycles and its hormonal regulation.	(06L)

	3.2 Ovarian cycle and its hormonal regulation. 3.3 Cycling of non-pregnant uterus and vagina.	
4	**Unit 4: Hormonal regulation** 4.1 GnRH, pituitary gonadotropins, behavioral effects. 4.2 Testicular hormones, testosterone derivatives, inhibin. 4.3 Ovarian hormones: Pituitary gonadal axis. 4.4 Oestrogen, progesterone's feedback relationships. 4.5 Prostaglandins and their role in reproduction.	(08L)
5	**Unit 5: Fertilization and Gamete Transportation** 5.1 Pregnancy: conception and blastocyst formation. 5.2 Implantation and delayed implantation. 5.3 Hormonal regulation in pregnancy.	(08L)
6	**Unit 6: Placenta** 6.1 Methods of formation and significance of placentation. 6.2 Types and functions.	(06L)
7	**Unit 7: Parturition** 7.1 Birth process. 7.2 Ferguson reflex, neuroendocrine control, purperium.	(05L)
8	**Unit 8: Lactation** 8.1 Anatomy and growth of mammary glands. 8.2 Lactogenesis and galactopoiesis. 8.3 Hormonal regulation and suckling reflex.	(04L)
9	**Unit 9: Reproductive dysfunctions** 9.1 Aging and reproduction. 9.2 Climacteric, anatomical, endocrine and genetic disorders.	(03L)
10	**Unit 10: Artificial control of reproduction** 10.1 Increasing reproductive potential. 10.2 Artificial insemination: In vitro fertilization and embryo transfer. 10.3 Induced breeding.	(08L)

	10.4 Physical, physiological, surgical, chemical methods of contraception in male, female. 10.5 Infertility: its causes and treatment. 10.6 Recent advances in male and female contraception. 10.7 Prenatal diagnostic test for genetic disorders-foetal ultra-sonography, Amniocentesis, Chorionic villi sampling.	

REFERENCES:

1. Austin C.R.and Short R.V., Reproduction in mammals Books 1-5,Univ. of Cambridge
2. Hogarth P.H.biology of Reproduction,Blackie and Son, Glasgow, London.
3. Nalbandov, AV, Reproductive Physiology,Lea and Febiger ,Philadelphia
4. Turner and Bagnara .General Endocrinology Sixth Edition, W.B. Saunders Company

Course Code: ZOO64103						
Course Title: Biostatistics (Theory)						
M.Sc. SEMESTER-IV						
Teaching Pattern				**Evaluation Pattern**		
Course Type Mandatory Major	**Credits**	**Number of Teaching hours**	**Lectures per week**	**Internal Assessment**	**End Semester Exam**	**Total**
Subject 3 (under vertical 1)	**02**	**30**	**02**	**20**	**30**	**50**

Course outcomes:

After successfully completing this course, students will be able to:

CO1 : Understand the basics and significance of statistics in biology.

CO2: Explain the application of sampling in biological sciences.

CO3: Analyse and comprehend the different measures off central tendency and dispersion.

CO4 : Graphically represent the given data.

CO5 : Understand the computational procedure of testing of hypothesis.

Sr. No.	Name of the Unit	Lectures alloted
1	**Unit 1: Introduction to Biostatistics: Data acquisition and processing** 1.1 Introduction to Biostatistics 1.2 Scope and applications of biostatistics 1.3 Population and Sample, different sampling techniques	(02 L)
2	**Unit 2: Data – types and presentation** 2.1 Some important terms (Class frequency, class- limits, Class-width, class mark). 2.2Frequency distribution, Cumulative frequency, Graphical representation of data (Histogram, Pie-Diagram, Ogive-Curve).	(03 L)

3	**Unit 3: Measures of Central Tendency** 3.1 Mean, Median, Mode. 3.2 Arithmetic mean, geometric mean, combined mean. 3.3 Measures of location - Graphic method, Percentiles.	(04 L)
4	**Unit 4: Measures of Dispersion** 4.1 Concept of dispersion, absolute and relative measure of dispersion. 4.2 Different measures of dispersion (Range, Quartile- Deviation, Variance and standard-deviation, Coefficient of Variation) combined variance.	(05 L)
5	**Unit 5: Correlation and Regression** 5.1 Bivariate data, concept of correlation, Types of Correlation, Scatter diagram, Karl Pearson's coefficient of correlation and its properties. 5.2 Concept of regression, Linear regression, regression Coefficients and its Properties.	(05 L)
6	**Unit 6: Tests of hypothesis:** 6.1 Some important terms and definitions (hypothesis, types of hypothesis, Test, Critical region, acceptance region, type I error, type II error, level of significance, p-value). 6.2 Test for mean and equality of two population means, Test for proportion and equality of two population proportions. 6.3 chi-square test for goodness of fit, Unpaired and paired t test. F test for equality of two population variances, ANOVA. 6.4 Software's used for Statistical analysis- PRISM and SPSS.	(07 L)
7	**Unit 7: Use of Computers in Biological Data Management** 7.1 Use of computers. a) as applied to methods in biostatistics. b) application in community, public healthcare management. c) utility in hospitals, nursing homes and clinics of academic experts. d) asset in research in medical science.	(02 L)
8	**Unit 8: Introduction to R software and use in Life Science Research**	(02 L)

REFERENCES:

1. Fundamentals of Statistics By Gun Gupta and Das Gupta. World Press Publishers. (2016).
2. Common Statistical Tests By Anil Gore and Madhav Kulkarni. International Journal of current research. (2020).
3. Testing Statistical Hypotheses By E. L. Lehmann., Springer Press Publishers. (2005).
4. Principles and Practice of Biostatistics: Dr J.V. Dixit
5. Statistical Methods: Snedecor G.W. & Cochran W.G.
6. Statistical Methods: Dixon W.S. and Massey
7. Biostatistics for the Biological and Health Sciences, 2nd Edition by Marc M. Triola, Mario F. Triola, Jason Roy,Published by Pearson Copyright © 2018
8. Biostatistics: Basic Concepts and Methodology for the Health Sciences, 10ed, ISV by Wayne W. Daniel, Wiley Publication.
9. Biostatistics- Khan and Khanum

Course Code: ZOO64205						
Course Title: Histology and Histochemistry (Theory)						
M.Sc. SEMESTER-I						
Teaching Pattern				**Evaluation Pattern**		
Course Type Mandatory Major	**Credits**	**Number of Teaching hours**	**Lectures per week**	**Internal Assessment**	**End Semester Exam**	**Total**
Subject 5 (under vertical 2)	**02**	**30**	**02**	**20**	**30**	**50**

Course Outcomes:

After successfully completing this course, students will be able to:

CO1: Explain the fundamental tissues in details.

CO2: Describe the process of histological preparations.

CO3: Illustrate the tools used in histological preparations.

CO4: Justify the use of various stains and dyes used in histochemical detection of biomolecules.

CO5: Justify the importance of Immunohistochemistry.

CO6: Draw the structures of various tissues and label them.

Sr. No.	Name of the topic	No. of Lectures allotted
1	**Scope and importance of Histology and Histochemistr**y 1.1 Fundamentals of histology: Epithelial, connective, muscular, nervous and other specialized tissues.	(05L)
2	**Unit 2: Tools in histology** Principles, design and functioning of microtomes, automated microtomes, ultra-microtome, cryostat, problems and troubleshooting.	(04L)
3	**Unit 3: Techniques in histology** 3.1 General principles for the preparation of Tissue for Histological studies. 3.2 Fixation – Principle, Aims and Objectives of fixatives. Chemical action of fixatives	(05L)

	on cells and tissue components. 3.3 Processing of fixed samples, dehydration (procedure and significance), embedding, block making. 3.4 Temporary and permanent preparations, whole mount preparation.	
4	**Unit 4: Staining** (staining methods histochemical and immunohistological methods) 4.1 Dyes and dye binding reactive groups, mordants and mordanting.	(02L)
5	**Unit 5: Fundamentals of histochemical techniques** 5.1 Histochemical classification of Carbohydrates and Principle for the Identification of Carbohydrates- glycogen (Periodic acid/Shift method (PAS).	(02L)
6	**Unit 6: Histochemical localization of Mucopolysaccharides** by KMNO4/AB and PAS method.	(02L)
7	**Unit 7: Histochemical classification of Proteins** 7.1 Principles and mechanism for the identification of total Proteins and Glycoproteins (Bromophenol Blue & Congo red method). 7.2 Importance of Enzyme histochemistry. -Localization of enzymes in tissues, Alkaline and Acid phosphates.	(04L)
8	**Unit 8: Histochemical localization of Nucleic Acids**, DNA and RNA (Feulgen reaction &Pyronin method).	(02L)
9	**Unit 9: Application of Histochemical methods** 9.1 detection of various types of Carcinoma and Immunofluorescent techniques.	(02L)
10	**Unit 10: Histochemical classification of Lipids**. 10.1 Principle for the demonstration of Lipids in various animal tissues (Copper pthyalocyanin method and Sudan Blank- B method).	(02L)

REFERENCES:

1. Text book of Histology Roland lesson DL. WB Saunders Company, Tokyo.
2. Histology: Roland lesson and Thomas Leesan WB Saunders company Co., Canada
3. Histochemistry Vol. I II III A G E pearse Churchill Livingstone NY
4. Histochemistry in Focus,A source book of Technics and Research needs (2007), K.Shyamasundari and K.Hanmantha Rao,MJP Puplishers,Chennai.
5. An introduction to Functional Histology, Bourne, G.H. (1988), Churchil, London.
6. Histochemical Techniqes, Cassilmann,W.G.B (1988), Methuen, London

Course Code: ZOO64104						
Course Title: Practicals in Advanced Entomology and Biostatistics						
M.Sc. SEMESTER-IV						
Teaching Pattern				**Evaluation Pattern**		
Course Type Mandatory Major	**Credits**	**Number of Teaching hours**	**Practicals per week**	**Internal Assessment**	**End Semester Exam**	**Total**
Subject 4 (under vertical 1)	**02**	**30**	**02**	**20**	**30**	**50**

	Practicals in Advanced Entomology	
Sr. No	**Name of the Practical**	**Practicals allotted**
1	Histological studies of male reproductive system (Testes, Vas deferens, Ejaculatory duct and Accessory glands).	1P
2	Histological studies of female reproductive system (Ovariole, lateral oviduct, common oviduct and spermatheca).	1P
3	Early embryology of insect: cleavage, blastula, germ band, gastrula, embryo- 1 day old, 2 days old and 3 days old in suitable insect (*Drosophila*/ Housefly).	1P
4	Study of post embryonic development of insects: Collection and study of types of eggs, Nymph, naiads, larvae and pupae.	1P
5	Study of imaginal discs and effect of ligature on *Drosophila*/ Housefly larvae.	1P

Practicals in Biostatistics		
Sr. No.	**Name of the Practical**	**Practicals allotted**
1	Construction of frequency distribution and its graphical representation.	1P
2	To study the Measures of Central Tendency and Dispersion.	2P
3	To study the t- test and F-test.	1P

4	To study the Correlation and Regression.	1P
5	To study the One- way and two- way ANOVA.	2P
6	Study of Chi- square test for the goodness of fit.	2P
7	Study of programming using R- software and use of Statistical software packages	1P

REFERENCES:

1. 'The Insect- structure and Function'- by R.F. Chapman , ELBS, London
2. 'A Text book of Entomology'- by H. H. Ross (John Wiley and Sons, Ins. New York,
3. 'Imms' Text Book of Entomology- by O. W. Richards and R. G. Davies, (Methuen &Cc., London,), Vols. I & II.
4. Common Statistical Tests By Anil Gore and Madhav Kulkarni. International Journal of current research. (2020).
5. Testing Statistical Hypotheses By E. L. Lehmann., Springer Press Publishers. (2005).
6. Principles and Practice of Biostatistics: Dr J.V. Dixit
7. Biostatistics: Basic Concepts and Methodology for the Health Sciences, 10ed, ISV by Wayne W. Daniel, Wiley Publication.
8. Biostatistics- Khan and Khanum

Course Code: ZOO64106						
Course Title: Practicals in Mammalian Reproductive physiology, Histology and histochemistry						
M.Sc. SEMESTER-IV						
Teaching Pattern				**Evaluation Pattern**		
Course Type Mandatory Major	**Credits**	**Number of Teaching hours**	**Practicals per week**	**Internal Assessment**	**End Semester Exam**	**Total**
Subject 6 (under vertical 1)	**02**	**30**	**02**	**20**	**30**	**50**

	Practicals in Mammalian reproductive physiology	
Sr. No.	**Name of the Practical**	**Practicals allotted**
1.	Anatomy and histology of male reproductive system – Testis, vas deferens, epididymis, prostrate, seminal vesicle, Cowper's gland.	2P
2.	Anatomy and histology of female reproductive system - Ovary, Uterus, Fallopian tube	1P
3.	Vaginal smear technique in rat.	1P
4.	Study of placental types.	1P
5.	Study of contraceptive devices.	1P
6.	e- Demonstration of vasectomy and ovarectomy in rat/ mice.	1P
7.	Visit to Artificial insemination centre and family planning centre.	1P

	Practicals in Histology and Histochemistry	
Sr. No.	**Name of the Practical**	**Practicals allotted**
1	Study of different types of tissue with help of permanent slides.	2P
2	Preparation of different reagent/stains, Block preparation and sectioning and effect of fixatives, fixation of tissues for histology.	2P
3	Mucolpolysaccharide staining, AB pH 1.5, 2.5.	1P
4	Proteins and lipid staining by Sudan black.	1P

5	Nucleic acid staining: methyl green, pyronine, feulgen stain.	1P

REFERENCES:

1. Austin C.R.and Short R.V., Reproduction in mammals Books 1-5,Univ. of Cambridge Hogarth P.H.biology of Reproduction,Blackie and Son, Glasgow, London.
2. Nalbandov, AV, Reproductive Physiology,Lea and Febiger ,Philadelphia
3. Text book of Histology Roland lesson DL. WB Saunders Company, Tokyo.
4. Histology: Roland lesson and Thomas Leesan WB Saunders company Co., Canada
5. Histochemistry Vol. I II III A G E pearse Churchill Livingstone NY
6. Histochemistry in Focus,A source book of Technics and Research needs (2007), K.Shyamasundari and K.Hanmantha Rao,MJP Puplishers,Chennai.
7. An introduction to Functional Histology, Bourne, G.H. (1988), Churchil, London.
8. Histochemical Techniqes, Cassilmann,W.G.B (1988), Methuen, London

Note: It is mandatory for the students to complete a minimum of two courses from the given links and earn the certificate relevant to the Practical courses:

ZOO64104 : Practicals in Advanced Entomology and Biotstatistics(2C) (P)

ZOO64106: Practicals in Mammalian Reproductive Physiology, Histology and Histochemistry (2C) (P)

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https:// coursera.org/

Course Code: ZOO64407						
Course Title: Research Project (RP) (06C)						
M.Sc. SEMESTER-I						
Teaching Pattern				**Evaluation Pattern**		
Course Type RP	**Credits**	**Number of Teaching hours**	**Practicals per week**	**Internal Assessment**	**End Semester Exam**	**Total**
Subject 7 (under vertical 4)	**06**	**90**	**04**	**60**	**90**	**150**

Chairman, BOS **Principal**