Savitribai Phule Pune University

(Formerly University of Pune)

Two Year Degree Program in Zoology

(Faculty of Science & Technology)

Revised Syllabi for

M.Sc. (Zoology) Part-II

(for Colleges Affiliated to Savitribai Phule Pune University)

Choice Based Credit System Syllabus

To be implemented from Academic Year 2020-2021

Title of the Course: M.Sc. (Zoology)

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 Savitribai Phule Pune University with a tangible understanding of what is needed from zoologists and what zoologists need to pursue as a skilled career. 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 Genetics, Animal Physiology and Entomology 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. A total of 210 hours for theory lectures and 180 hours for laboratory work have been prescribed in each semester including a research project (advisable to be start at the first year in consultation with the department staff) to inculcate the research culture amongst students. 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.

M.Sc. Zoology - Course structure & Distribution of Credits

M.Sc. Zoology, Part –I,

Semester-I

Sr. No.	Core Compulsory Theory Paper (CCTP)	Choice Based Optional Paper (CBOP)	Theory/ practical	Credit	Core Compulsory Practical Paper (CCPP)	Credit
1	**ZOUT 111** Biochemistry and Biochemical Techniques	-			-	4
2	**ZOUT 112** Cell Biology and Developmental Biology	-			-	4
3	**ZOUT 113** Genetics and English in Scientific Communication.	-			-	4
4	-	**ZODT 114** Theory. ---------- **ZODP 114** Practical	Biostatistics/ Freshwater Zoology Zoology Practical Paper-1	2 2	-	4
5	-	-			**ZOUP 115** Basic Zoology Lab-I	4
	Total Credit of Semester 1					**20**

M.Sc. Zoology, Part-I, Semester-II

Sr. No.	Core Compulsory Theory Paper (CCTP)	Choice Based Optional Paper (CBOP)	Theory/ practical	Credit	Core Compulsory Practical Paper (CCPP)	Credit
1	**ZOUT 121** Molecular Biology and Bioinformatics	-			-	4
2	**ZOUT 122** Endocrinology and Parasitology	-			-	4
3	**ZOUT 123** Comparative Animal Physiology and Environmental Biology.	-			-	4
4	-	**ZODT 124** Theory. ---------- **ZODP 124** Practical	Metabolic pathways / Ichthyology	2	-	4
			Zoology Practical Paper-2	2		
5	-	-			**ZOUP 125** Basic Zoology Lab- II	4
		Total Credit of Semester 2				**20**

M.Sc. Zoology, Part-II, Semester - III

Sr. No.	Core Compulsory Theory Paper (CCTP)	Choice Based Optional Paper (CBOP)	Theory/ practical	Credit	Core Compulsory Practical Paper (CCPP)	Credit
1	ZOUT 231 Special Paper (any one) Animal Physiology-I/ Entomology-I/ Genetics-I	-			-	4
2	ZOUT 232 Fundamentals of Systematics and Economic Zoology	-			-	4
3	ZOUT 233 Research Methodology and Insect Physiology and Biochemistry	-			-	4
4	-	ZODT 234 Theory --------- ZODP 234 Practical	Immunology/ Genetic Toxicology/ Zoology Practical Paper- 3	2 2	-	4
5	-	-			ZOUP 235 Special Lab I	4

M.Sc. Zoology, Part II, Semester – IV

Sr. No.	Core Compulsory Theory Paper (CCTP)	Choice Based Optional Paper (CBOP)	Theory/ practical	Credit	Core Compulsory Practical Paper (CCPP)	Credit
1	ZOUT 241 Special Paper-Any One- Animal Physiology-II/ Entomology-II/ Genetics-II	-			-	4
2	ZOUT 242 Mammalian Reproductive Physiology and Aquaculture				-	4
3	-	ZODT 243 Theory	Histology and Histochemistry/ Pest Control	2	-	4
		ZODP 243 Practical	Zoology Practical Paper-4 (Practicals corresponding to ZOUT 241and ZODT 243)	2		
4	-	ZODT 244 Theory	Pollution Biology/ Apiculture	2	-	4
		ZODP 244 Practical	Zoology Practical Paper-5 (Practicals corresponding to ZOUT 242 and ZODT 244)	2		
5	-	-			ZOUP 245 (Project)	4
	Total Credit of Semester 4					**20**

Equivalence of Previous Syllabus:

Semester-I

Old Course (2013 Pattern)	New Course (2019 Pattern)
ZY101T: Biochemistry-I	ZOUT 111 Biochemistry and Biochemical Techniques
ZY102T: Cell Biology	ZOUT 112 Cell Biology and Developmental Biology
ZY103T: Genetics	ZOUT 113- Genetics and English in Scientific Communication.
ZY104T: Biostatistics	ZODT 114 Biostatistics
ZY105T: Skills in scientific communication and Writing	ZOUT 113 Genetics and English in Scientific Communication.
ZY106T: Freshwater Zoology	ZODT 114 Freshwater Zoology
ZY101P:Practicals in Biochemistry	ZOUP 115 Basic Zoology Lab-I
ZY102P: Practicals in Cell Biology	
ZY103P: Practicals in Genetics	
ZY105P: Practicals in Skills in scientific communication and writing	
ZY106P: Practicals in Fresh water zoology	ZODP 114 Zoology Practical-1
ZY104P: Practicals in Biostatistics	
Old Course (2013 Pattern)	
ZY101T: Biochemistry-I	
ZY102T: Cell Biology	
ZY103T: Genetics	
ZY104T: Biostatistics	
ZY105T: Skills in scientific communication and Writing	
ZY106T: Freshwater Zoology	
ZY101P:Practicals in Biochemistry	
ZY102P: Practicals in Cell Biology	
ZY103P: Practicals in Genetics	
ZY105P: Practicals in Skills in scientific communication and writing	
ZY106P: Practicals in Fresh water zoology	
ZY104P: Practicals in Biostatistics	

Semester-II

Old Course (2013 Pattern)	New Course (2019 Pattern)
ZY201T: Biochemistry-II	ZODT 124Metabolic pathways
ZY202T: Molecular Biology	ZOUT 121 Molecular Biology and Bioinformatics
ZY203T: Developmental Biology	ZOUT 112 Cell Biology and Developmental Biology
ZY204T: Endocrinology	ZOUT 122 Endocrinology and Parasitology
ZY205T: Comparative Animal Physiology	ZOUT 123 Comparative Animal Physiology & Environmental Biology
ZY206T: Biochemical Techniques/Ichthyology	ZOUT 111 Biochemistry & Biochemical Techniques ZODT 124 Ichthyology
ZY201P:Practicals in Biochemistry-II	ZOUP 125 Basic Zoology Lab-II
ZY202P: Practicals in Molecular Biology	
ZY203P: Practicals in Developmental Biology	
ZY204P: Practicals in Endocrinology	
ZY205P: Practicals in Comparative Animal Physiology	

Semester-III

Old Course (2013 Pattern)	New Course (2019 Pattern)
ZY 301**T** Animal Physiology I (special)	ZOUT 231 Special Paper Animal Physiology-I
ZY 301**T** Entomology I (special)	ZOUT 231 Special Paper Entomology-I
ZY 301**T** Genetics I (special)	ZOUT 231 Special Paper Genetics-I
ZY 302**T** Immunology	ZODT 234 Immunology
ZY 302**T** Environmental Biology	---
ZY 303**T** Genetic toxicology	ZODT 234 Genetic toxicology

ZY 303**T** Aquaculture	ZOUT 242- Aquaculture
ZY 304**T** Insect Physiology and Biochemistry	ZOUT 233- Insect Physiology and Biochemistry
ZY 305**T** Research methodology	ZOUT 233- Research methodology
ZY 306**T** Parasitology	--
ZY 307**T** Fundamentals of Systematics	ZOUT 232- Fundamentals of Systematics
ZY 308**T** Insect Ecology	--
ZY 309**T** Toxicology I	--
ZY 301P Practicals in Animal Physiology I (special)	ZOUP 235 Special Lab I
ZY 301 P Practicals in Entomology I (special)	
ZY 301 P Practicals in Genetics I (special)	ZODP 234 Practical
ZY 302 P Practicals in Immunology	
ZY 302 P Practicals in Environmental Biology	
ZY 303 P Practicals in Genetic toxicology	
ZY 303P Practicals in Aquaculture	
ZY 304P Practicals in Insect Physiology and Biochemistry	
ZY 305P Practicals in Research methodology	
ZY 306**P** Practicals in Parasitology	
ZY 307P Practicals in Fundamentals of Systematics	
ZY 308P Research Project	
ZY 309P Practicals in Toxicology I	

Semester-IV

Old Course (2013 Pattern)	**New Course (2019 Pattern)**
ZY 401**T** Animal Physiology II (special)	ZOUT 241- Animal Physiology II (special)
ZY 401**T** Entomology II (special)	ZOUT 241- Entomology II (special)
ZY 401**T** Genetics II (special)	ZOUT 241- Genetics II (special)
ZY 402**T** Economic Zoology	ZOUT 232- Economic Zoology
ZY 402**T** Bacteria and phage Genetics	--

ZY 403**T** Mammalian Reproductive Physiology	ZOUT 242- Mammalian Reproductive Physiology
ZY 403**T** Biodiversity assessment	--
ZY 404**T** Histology and Histochemistry	ZODT 243 Histology and Histochemistry
ZY 405**T** Pollution Biology	ZODT 244 Pollution Biology
ZY 406**T** Apiculture	ZODT 244 Apiculture
ZY 407**T** Pest control	ZODT 243 Pest control
ZY 408**T** Toxicology II	--
ZY 401 P Practical Animal Physiology II	ZODP 243 Practical ZODP 244 Practical ZOUP 245 (Project)
ZY 401 P Practical Entomology II	
ZY 401 P Practical Genetics II	
ZY 402 P Practical Economic Zoology	
ZY 402 P Practical Bacteria and phage Genetics	
ZY 403 P Practical Mammalian reproductive physiology	
ZY 403 P Practical Biodiversity assessment	
ZY404 P Practical Histology and histochemistry	
ZY405 P Practical Pollution biology	
ZY406 P Practical Apiculture	
ZY308 P Research Project	
ZY 408 P Practicals in Toxicology II	

Detailed Syllabus with Recommended Books:

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.

PO6. **The Postgraduate and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. **Environment and sustainability**: 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.

PO8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the work/research practice.

PO9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. **Communication**: Communicate effectively on complex life activities with the scientific community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11. **Project management and finance**: Demonstrate knowledge and understanding of Zoology and management principles and apply these to one's own work, as a member and leader in a team.

PO12**. Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Following is the syllabus of each course along with the course outcomes:

M.Sc. Zoology, Part II, Semester – III

Course Code and Course Name:

ZOUT231: Animal Physiology- I (Special Paper) (4 Credits: 60 Lectures)

Semester III

After successfully completing this course, students will be able to: CO1:

CO1: Explain the membrane physiology and its dynamics.

CO2: Explain the concept of nutrition and digestion.

CO3: Explain the structure, contraction and types of contraction of muscle.

CO4: Illustrate bioluminescence and animal electricity with examples and its significance

CO5: Correlate the organisms Internal and external environments with homeostasis and biological Clocks.

CO6: Diagrammatically represent the mechanism of respiration, gas exchange and transport of O_2 and CO_2

Sr. No.	Name of the topic	Lectures allotted
1.	**External and Internal environment** 1.1 External environment: the atmosphere, aquatic & terrestrial environment 1.2 Internal environment: Extracellular and intra cellular environment 1.3 Homeostasis and regulation: tolerance and resistance, acclimatisation and acclimation, regulatory mechanism. 1.4 Biological clock and their regulation: Circadian rhythms lunar and tidal rhythm, circa annual rhythm, photoperiodism.	**(08L)**
2.	**Membrane Physiology** 2.1 Membrane structure, membrane permeation, diffusion mediated transport, dynamics of semi permeable membrane. 2.2 Resting membrane potential, diffusion, equilibrium potential, Goldman-Hodkin- Katz potential, conductance, current, capacitance 2.3 Excitable cell membrane: action potential, role of various ion channels, role of Na+ K+ pump, properties of action potentials	**(10L)**
3.	**Physiology of Digestion** 3.1 Nutritive requirements (concept of balanced diet), Regulation of hunger, satiety 3.2 Digestion and absorption in the G.I tract: carbohydrate, lipids & protein 3.3 Control and regulation of digestion 3.4 Calorimetry and BMR	**(09L)**
4.	**Respiration** 4.1 Internal and external respiration; Anatomy of respiratory system 4.2 Pulmonary respiration: Partial pressure, inspiration and expiration, Lung volume and capacities	**(10L)**

	4.3 Gas exchange across the pulmonary and systemic capillaries 4.4 Gas transport; O2 transport, CO2 transport and abnormalities in the blood gas content 4.5 Neuronal control of respiration, role of central and peripheral receptors 4.6 Other functions of respiratory system, waste elimination	
5.	**Muscle Physiology** 5.1 Structure of skeletal muscle and molecular basis of skeletal muscle contraction, types of contraction, twitch summation and tetanus, relation between muscle length and tension, velocity of contraction 5.2 Chemical basis of muscle contraction 5.3 Innervation of muscles, excitation and contraction coupling 5.4 Skeletal muscle fiber types, contractile machinery of smooth muscle	**(09L)**
6.	**Bioluminescence and Animal electricity** 6.1 Bioluminescence: phyletic distribution, structure of luminescent organs, biochemical and molecular mechanism. 6.2 Animal electricity: electro receptors electro organs and their structure and functions	**(08L)**
7.	**Buoyancy** 7.1 Definition, density reduction 7.2 Gas floats with examples 7.3 Swim bladder with example	**(06L)**

REFERENCE BOOKS:

1. Animal Physiology: Adaptation and Environment (1997) Knut Schmidt-Nielsen Publisher: Cambridge University Press.
2. Principles of Animal Physiology (2006), C. D. Moyes and P. M. Schulte. Publisher - Pearson Education Inc. and Dorling Kindersley Publishing Inc.
3. Text book of Medical Physiology 10th edition (2001), A. C. Guyton and J. E. Hall. Publisher - W. B. Saunders Company, Philadelphia. –
4. Principles of Anatomy and Physiology, 11th edition (2006), G. J. Tortora and B. Derrickson. Publisher-John Wiley and Sons Inc.
5. Endocrinology, 5th edition (2008), Mac. E. Hadley. Publisher-Pearson Education Inc. and Dorling Kindersley Publishing Inc.
6. Comparative Vertebrate Endocrinology 3rd edition (1998), P. J. Bentley. Publisher Cambridge University Press.
7. Vertebrate Endocrinology 3rd edition (1997), D. O. Norris. Publisher- Academic Press: An imprint of Elsevier.
8. The World of the Cell, 7th edition, (2005), Wayne M. Becker, Lewis J. Kleinsmith, Jeff Hardin., Publisher - Benjamin Cummings.
9. Principles of Animal Physiology (2nd Edition) (2007) Christopher D. Moyes , Patricia M.

Schulte

10. Animal Physiology, Third Edition (2012) Richard W. Hill, Gordon A. Wyse, Margaret Anderson
11. Functional Anatomy and Physiology of Domestic Animals 4th Edition (2009) William O. Reece Animal Physiology 2nd Edition Richard W. Hill Publisher: Sinauer Associates, Incorporated
12. Eckert's Animal Physiology (2004) Roger Eckert, D.J. Randall, Warren Burggren, Kathleen French Publisher: W.H.Freeman & Co Ltd
13. Principles of Animal Physiology (2013) Christopher D. Moyes, Patricia M. Schulte • Publisher: Pearson Education Limited
14. Environmental Physiology of Animals (2004) Pat Willmer, Graham Stone, Ian Johnston • Publisher: Blackwell Publishing Ltd
15. Introduction to Animal Physiology (1998) Ian Kay Publisher: Bios Scientific Publishers Ltd

Note: Use the latest editions of the recommended books

Course Code and Course Name:

ZOUT 231 : Entomology- I (Special Paper) **4 Credits: 60 Lectures**

Semester III

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.

CO6: Explain the location structure and functions of various Endocrine and Exocrine glands.

CO7: Explain the location and structure of Light and Sound producing organs in various insects

Sr. No.	Name of the topic	Lectures allotted
1.	Introduction to Entomology: Definition, Origin, Evolution and Inter-relationship of insects with other arthropods.	**(04L)**
2.	General outline of Classification and Phylogeny of insects up to family : Aptrygote insects (4 orders), Exopterygote insects (16 orders) and Endopterygote insects (9 orders).	**(19L)**
3.	Integument : Structure, chemical composition and functions. Derivatives of Integument: Cuticular appendages & Processes.	**(02L)**
4.	Comparative study of : Head and its appendages; Thorax and its appendages ; Abdomen and its appendages.	**(09L)**
5.	Comparative anatomical and histological study of the following : Digestive system, Respiratory system, Circulatory system, Excretory system, Reproductive system, Nervous system and Sense organs.	**(20L)**
6.	Endocrine and Exocrine glands and Hormonal action.	**(04L)**
7.	Light and Sound producing organs.	**(02L)**

REFERENCE BOOKS:

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).

Note: Use the latest editions of the recommended books

Course Code and Course Name:

ZOUT 231 : Genetics- I (Special Paper) (4 Credits: 60 Lectures)

Semester III

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

CO1: Define the basic terminologies in Genetics

CO2: Elaborate the advantages of model organisms used in genetic studies

CO3: Apply molecular methodologies in genetic analysis

CO4: Estimate gene frequencies

Sr. No.	Name of the topic	Lectures allotted
1.	Model Genetic System: Life cycles, genetic nomenclature and advantages of the following organisms commonly used in genetic studies: 1.1 T phages 1.2 *E.coli* *1.3 Saccharomyces cerevisiae* and *Schizosaccharomyces pombe* *1.4 C. elegans* *1.5 Drosophila* 1.6 Zebra fish 1.7 Mouse	6L
2.	Advanced Population Genetics: 2.1 Recapitulation of basic concepts and Hardy-Weinberg law. 2.2 Estimation of gene frequencies in population through mutation, migration and selection, selection-mutation equilibrium, derivation and genetic equations for above. 2.3 Assortative mating, inbreeding and genetic drift.	12L
3.	Quantitative genetics: 3.1 Concept of continuous variation, phenotypic variance and its partitioning into subcomponents. 3.2 Co-variance, correlation and regression, degree of genetic determination, measurement of heritability, quantitative inheritance in humans.	12L
4.	Evolutionary Genetics: 4.1 Genetic polymorphism. 4.2 Selection strategies and effects. 4.3 Genetics of speciation: classical and modern concepts. 4.5 Use of molecular information in understanding phylogenetic relationship.	12L
5.	Applications of Molecular methodologies in genetic analysis: 5.1 Introduction to gene localization on chromosomes. 5.2 Chromosomal Probes and Paints. 5.3 Gene Therapy: *Ex vivo* and *In vivo* gene therapy and two examples of gene delivery system. 5.4 Reverse Genetics.	12L

	5.5 History of Human genome project: Strategies, methodologies, and current status.	
6.	Genetics in Toxicology: 6.1 History of genetic toxicology and role of FDA, EPAand its guidelines and regulation. 6.2 Role of model organisms in genetic toxicology studies. 6.3 Screening tests: use of test systems- Bacterial, Yeast, *Drosophila* and Mammalian system.	06L

REFERENCE BOOKS:

1. An Introduction to Genetic Analysis – A.J.F. Griffiths, J. Doebley, C. Peichel, D.A. Wassarman (12th ed.) W.H. Freeman Publ. 2020.
2. Concepts of Genetics – W.S. Klug and M.R. Cummings (12th ed.) Pearson Publ. 2019.
3. Genetics : A conceptual approach – B.A. Pierce (6th ed.) W.H. Freeman Publ. 2016.
4. Lewin's GENES XII – J.E. Krebs, E.S. Goldstein, S.T. Kilpatrick. Jones and Bartlett Publ. 2018.
5. Human Molecular Genetics – T. Strachan and A. Read (5th ed.) Garland Science Publ. 2018.
6. Genetics – M.W. Strickberger (3rd ed.) Pearson India Publ. 2015
7. Principles of Genetic Toxicology – D. Brusick. Springer (reprint of Basic Book Publ) 2013.
8. Principles of Genetics – E.J. Gardner, M.J. Simmons, D.P. Snustad (8th ed.) John Wiley & Sons 2006.
9. Genetics: Analysis of Genes and Genomes – D.L. Hartl and E.W. Jones (6th ed.) Jones & Bartlett Publ. 2004.
10. Strickberger's Evolution – B. Hall (4th ed.) Jones and Bartlett Publ. 2008.

Note: Use the latest editions of the recommended books

Course Code and Course Name:

ZOUT 232 : Fundamentals of Systematics and Economic Zoology (4 Credits: 60 Lectures)

Semester III

After successfully completing this course, students will be able to: CO1:

Fundamentals of Systematics

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.

Economic Zoology

CO1: Illustrate the lac culture, apiculture, prawn culture, vermiculture, Poultry, dairy industry and Piggery.

CO2: Explain the role of insects of economic importance.

CO3: Explain parasitic roundworms of animal and plants.

CO4: Signify the role of parasitic and soil protozoan in human welfare.

CO5: Justify the use of animals in pharmaceutical research.

CO6: Explain coral reef and its significance.

Sr. No.	Name of the topic	Lectures allotted
	Fundamentals of Systematics	
1.	Fundamental of Systematics: Biological classification, Hierarchy of Categories and taxa.	2L
2.	Taxonomic keys: Types of taxonomic keys, their merits and demerits. International code of Zoological nomenclature: Its operative principles, interpretation and application of important rules, zoological nomenclature, formation of names	7L
3.	Taxonomic procedures: taxonomic collection preservation, curetting process and identification.	3L
4.	Species concepts: Definition and types (Allopatric, sympatric, parapatric, sibling etc.)	2L
5.	Kingdoms of Life: General outline of kingdoms including Monera & Protista. Broad outline & Diversity in kingdom Animalia (Major and Minor phyla).	5L
6.	Methodologies in systematics: Morphology based taxonomy, Numerical taxonomy, Cyto-taxonomy and chemotaxonomy, Molecular systematic, DNA fingerprinting & Molecular markers for detection/evaluation of polymorphism, RFLP, RAPD etc.	8LL

7.	Molecular phylogenetics and phylogeography.	3L
	Economic Zoology	
1.	Animal husbandry: Poultry, Piggery, Dairy industry and wool industry.	08L
2.	Economic importance of insects: Apiculture, Lac culture, Sericulture, House hold insect and stored grain pest and Agricultural pest.	10 L
3.	Economic importance of amphibian, reptiles and birds.	02 L
4.	Vermiculture industry in India.	01 L
5.	Prawn culture	01 L
6.	Nematodes- parasitic roundworms of animals and plants.	01 L
7.	Helminthes as human and animal parasites.	02 L
8.	Concept of Coral reef and its significance.	01 L
9.	Sponge culture and its importance in industry.	01 L
10.	Parasitic protozoan's and their role in human welfare, soil protozoan's and their role in agriculture.	02 L
11.	Model animals in pharmaceutical industry.	01 L

REFERENCE BOOKS:

Fundamentals of Systematics :

1. Kato., The biology of biodiversity, Springer.
2. Avise J.C., Molecular markers, Natural history and evolution, Chapman and Hill, NY.
3. Wilson A.O., biodiversity, Academic Press, Washington.
4. Principals of systematic Zoology by Ernst Mayr.

Economic Zoology :

1. Economic Zoology: An Introductory Text-Book in Zoology, with Special Reference to Its Applications in Agriculture, Commerce, and Medicine, Herbert Osborn, Ulan Press (August 31, 2012)
2. Economic Zoology-Shukla and Upadhaya, Rastogi Publication, 2017
3. A Textbook of Economic Zoology, Dr Sanjeev Jain, Indian Books and Periodicals 2018.
4. Economic Zoology-Manju Yadav , Discovery Publication 2013
5. Economic Zoology-K.R.Ravindranathan , Om Publications 2013
6. Textbook of Economic Zoology- P.R.Venkitaraman Sudharsana Puubl. Kochi 1983
7. A Handbook on Economic Zoology , Dr Jawaid Ahsan And Dr Subhas Prasad Sinha S. Chand Group.
8. Encyclopedia of Economic Zoology, A.A. Khan. Anmol Publications
9. Economic Zoology by. Manju Yadav, Discovery Publishing House Pvt. Limited. Economic Zoology by Malhotra ,Prakash, Adhyayan Puhlishers & Distributers
10. Introduction to Economic Zoology, Sarkar, Kundu and Chaki, New Central Book Agency; New edition edition (14 May 2014)

Course Code and Course Name:

ZOUT 233 : Research Methodology and Insect Physiology and Biochemistry

(4 Credits: 60 Lectures)

Semester III

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

Research Methodology

CO1: demonstrate knowledge of research processes (reading, evaluating, and developing)

CO2: perform literature reviews using print and online databases.

CO3: select and define appropriate research problem and parameters to prepare a project proposal.

CO4: identify, explain, compare, and prepare the key elements of a research proposal/report.

CO5: compare and contrast quantitative and qualitative research paradigms

CO6: Use sampling methods, measurement scales and instruments, and appropriate uses of each.
CO7: Justify the rationale for research ethics,

Insect Physiology and Biochemistry

CO1: Explain the structure, Chemistry of integument and sclerotization.

CO2: Describe the process of digestion and metabolism

CO3: Explain the characteristics of haemolymph and types of haemocytes.

CO4: illustrate the structure, physiology and biochemistry of flight muscle.

CO5: Demonstrate the process of excretion, detoxification and water balance

CO6: Justify the role of insect hormones in physiological processes.

Sr. No.	Name of the topic	Lectures allotted
	Research Methodology	
1.	Research: Meaning, Objectives, Types of research, Planning research project – Identifying Research problems, selection of problem – formulation of a problems. Literature review- Collection of literature- Books - Journals. Digital library and search of articles - Key words and search - Internet – Google Scholar – Pub med – Inflibnet – Medline	04L
2.	Data Collection: Meaning, Methods and Tools of Data Collection Hypothesis Sampling, Data Processing, Analysis and Interpretation of Data.	03L
3.	Research Design: Meaning and Objectives, Characteristics of good research design, components of the research design & steps in scientific research process.	02L
4.	Quantitative methods**:** Biostatistics used for analysis of Biological data	02L

5.	Computer application**:** bioinformatics, databases and their applications	03L
6.	Tools and techniques**:** • Techniques used Purification and characterization of biomolecules: Recapitulation of centrifugation, chromatography and electrophoresis. • NMR, MALDI-TOF, X-ray crystallography, Circular Dichroism CD • Microscopic techniques including Fluorescence microscopy, Confocal microscopy, Atomic force microscopy and live cell imaging FACS analysis.Real time PCR, DNA microarray, New generation DNA sequencing, Protein Microarray.	10L
7.	Dissertation structure –Components - Writing Introduction – review of literature – Materials & Methods – Presentation of results – Discussion of Results based on literature – Arriving conclusions – Briefing of Summary – Arrangement and how to quote reference in thesis -Appendix.	02L
8.	Publishing of Articles in National and International Journals - Selection of Journals – ISSN Number – Peer reviewed Journals – Science citation index – impact factor and its importance.	01L
9.	Intellectual property rights and patent law – Trade Related aspects of Intellectual Property Rights – Reproduction of published material – Plagiarism - Citation and acknowledgement Patent Criteria and procedure of patenting, patenting biological material.	03L
	Insect Physiology and Biochemistry	
10.	Integument: Structure, Chemistry, sclerotization, functions.	03 L
11.	Digestion and absorption of proteins, Carbohydrates and lipids.	03 L
12.	Fat body: Structure, physiology, biochemistry, functions. Integration of carbohydrate, fat and acid metabolism	04 L
13.	Ventilatory mechanisms and their control	03 L
14.	Haemolymph: Physico-chemical characteristics of plasma: types and structure of haemocytes, functions.	03 L
15.	Muscle: structure, physiology and biochemistry of flight muscles	03 L
16.	Excretion and water balance: Structure and function of Malpighian tubules. Water balance and nitrogen excretion.	04 L
17.	Endocrines, neurosecretory hormones, chemistry, function and mechanism of hormone action, moulting and juvenile hormones; chemistry and physiology, other peptide and steroid hormones	04 L
18.	Microsomal and extra-microsomal enzymes insecticide degradation and detoxification.	03 L

REFERENCE BOOKS:

Research Methodology

1. Kothari, C.R. (1985): Research Methodology: Methods and Techniques, Wiley Eastern.
2. Dominowski, R.L. (1980): Research Methods, Prentice Hall Inc., New Jersey.
3. Mishra, R.P. (1980): Research Methodology, Handbook Concept Publishing Company, New Delhi.
4. IIPS (1996): Research Methodology, IIPS, Mumbai.
5. Research and Writtings – By-P. Ramdas , A.Wilson srunai M.J.Publisher (2009).
6. Scientific thesis writings and Paper presentations-N.Gurumani. M.J.Publisher (2010).
7. Anderson, Durston&Polle 1970: Thesis and assignment, writing Wiley Eastern Limited

8. G. Vijayalakshmi and C. Sivapragasam. (2008) Research Methods –Tip & Techniques, MJP
9. Publishers, Chennai. WWW.mjppublishers.com
10. Malter K, 1972: Statistical analysis in Biology, Chapmen Hall, London.
11. Cohen, L. Lawrence, M., & Morrison, K. (2005). Research Methods in Education (5th edition). Oxford: Oxford University Press.
12. Leedy, P. D. (1980). Practical Research: Planning and design. Washington: Mc Millan Publishing Co., Inc.
13. Singh, Y. K. (2006). Fundamental of Research Methodology and Statistics. New Delhi. New International (P) Limited, Publishers

Insect Physiology and Biochemistry

1. Fundamentals of insect physiology, Blum N.S., John Wiley and sons, NY
2. An introduction to insect physiology, Bursell, e. academic press, NY
3. Insect biochemistry and function Candy D.J. and Kilby D.A. Chapman and hall, London
4. Comprehensive insect physiology, biochemistry and pharmacology, Kerkut G.A and Gilbert L.I., Vol 1 to 13 Pergamon press, Oxford, NY
5. The Insects: Structure and Function. Forth ed., Chapman R. F. (1998), Cambridge University Press, UK.
6. Insect Physiology. Prakash, M. (2008), Discovery Publishing House Pvt. Ltd., New Delhi.
7. Physiological Systems in Insects. Second ed., Klowden, Marc (2007), Elsevier, USA
8. The Principles of Insect Physiology, Seventh ed. Wigglesworth, V.B. (1972), Chapman and Hall, London.

Course Code and Course Name:

ZODT 234 : Immunology (2 Credits: 30 Lectures)

Semester III

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

CO1: List the primary and secondary immune organs.

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

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

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

CO5: Illustrate the events and dynamics of inflammation

CO6: Compare the MHC molecules and diseases associated with HLA.

CO7: Differentiate between active and passive immunization

CO8: Compare the three pathways of complement fixation pathway.

Sr. No.	Name of the topic	Lectures allotted
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. 1.5. Concept of immunity (self- non self, antigen) and active and passive immunization (natural and artificial)	07L
2.	Antibody structure, antibody classes, subclasses, structure-function relationship, iso, idio and allo types., T cell receptors.	04L
3.	Theories of antibody synthesis, generation of antibody diversity (molecular basis), antibody class switching.	03L
4.	MHC, HLA and disease association, immune deficiencies and disorders. Antigen processing & Immunogenetics.	05L
5.	Immunological Tolerance, Autoimmunity	02L
6.	Hypersensitivity.	01L
7.	Immunological memory, types of vaccines and vaccination	02L
8.	Immunotechniques: Antigen-antibody reaction and complement system and complement fixation test.	02L
9.	Hybridoma principle and application, ELISA, immunofluorescence, immunoelectrophoresis, RIA and monoclonal-polyclonal antibody and its application.	04L

REFERENCE BOOKS:

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 and Course Name:

ZODT 234 : Genetic Toxicology (2 Credits: 30 Lectures)

Semester III

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

CO1: Define genotoxicity test systems.

CO2: Describe basic toxicological principles and describe how different chemicals are taken up by, processed in and eliminated from the body

CO3: Inspect physical and chemical genotoxic agents being exposed in his/her environment

CO4: Illustrate physical and chemical genotoxic agents.

CO5: Explain efficiency mechanisms of physical chemical genotoxic agents

CO6: Relate genotoxicity and DNA repair mechanisms and relate types of mutation and DNA repair

CO7: Judge about proper genotoxicity test for mutation types

Sr. No.	Name of the topic	Lectures allotted
1.	Toxicology: Definition and its subdivisions, scope and significance of genetic toxicology	03L
2.	Mutations at molecular, functional and chromosomal levels. Mechanisms of Mutagenesis End point mutations and its function, carcinogenicity and transformation. Biological significance of mutagenesis	07L
3.	Mutagenic agents in human environment. Applications of genetic toxicology to human and environmental monitoring	05L
4.	Methodologies used in detection of mutation, functional, cytogenetic effects. Use of Ames test, mammalian systematics, Drosophila etc.	05L
5.	Screening chemicals for genotoxic properties: Screening tests, hazard assessment, Risk analysis tests. Common assays used for testing mutagenic activity using bacteria, yeasts, insects, plants, animals.	07L
6.	Genetic toxicology and its role in the study of congenital malformations	03L

REFERENCE BOOKS:

1. Chemical mutagens- principles and methods for their detection, Ed. Hollander, A. Vol. 1-5, Plenum press
2. Chemical mutagenesis in mammals and men. Eds. Vogel, F. and Rohtborn, G. Springer Verlag

3. Mutagenic effects of Environmental contaminants, Eds. Suttoa, H.E. and Harris, M.I., Academic press
4. Mutation research (section on genetic toxicology testing)
5. Genetic Toxicology: Principles and methods, Parry J.M., Parry E.M. (eds) Springer Publ. (2012)
6. Principles of Genetic Toxicology, Second Edition, David Brusick, Springer Science+Business Media New York

Course Code and Course Name:

ZODP 234 : Zoology Practical Paper-3 (Immunology) (2 Credits: 60 Hours)

Semester III

Note: A total of 15 practicals are to be conducted. 1 practical is of 4 clock hour duration.

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

CO1: Identify the pattern of identity of antigen- antibody reaction.

CO2: Identify the microscopic structure of the lymphoid organs.

CO3: Demonstrate immunoelectrophoresis technique.

CO4: Demonstrate the double diffusion techniques.

CO5: Detect the human blood groups by antigen -antibody reactions

CO6: Prepare the human blood smear to identify various blood cells.

Sr. No.	Name of the topic	Lectures allotted
1.	Double diffusion or Ouchterlony technique (using kit). **(Compulsory)**	(2P)
2.	Demonstration of Immunoelectrophoresis (using kit). **(Compulsory)**	(2P)
3.	Separation of e gamma globulins from the serum using native PAGE.	(2P)
4.	Histology of lymphoid organs: skin, spleen, thymus, ileum lymph node and bone marrow. **(Compulsory)**	(1P)
5.	To study the differential count of WBCs. **(Compulsory)**	(1P)
6.	Cell counting and viability testing using splenocytes (from goat spleen)	(2P)
7.	To estimate the antigen concentration by rocket electrophoresis (kit using). **(Compulsory)**	(2P)
8.	To study the immunology of blood transfusion (universal donor, universal recipient, Bombay blood group and erythroblastosis foetalis). **(Compulsory)**	(1P)
9.	Blood group analysis with reference to cross matching.	(1P)
10.	Demonstration of Various routes of egg inoculations for vaccine production using dye. (amniotic, yolk sac, allantoic and chorio-amniotic)	(1P)
11.	Enzyme detection: acid phosphatase, alkaline phosphatase, esterase	(1P)

Course Code and Course Name:

ZODP 234 : Zoology Practical Paper-3 (2 Credits: 60 Hours)

Semester III

Note: A total of 15 practicals are to be conducted. 1 practical is of 4 clock hour duration.

Sr. No.	Name of the topic	Lectures allotted
1.	Dominant lethal test in *Drosophila* **(Compulsory)**	2 P
2.	Sex linked recessive lethal test in *Drosophila* **(Compulsory)**	2 P
3.	Micronucleus test in mouse	2 P
4.	Bone marrow chromosome analysis in mouse	2P
5.	Auxotroph mutation induction in Bacteria	2P
6.	Ame's test **(Compulsory)**	2P
7.	Study of Drosophila mutants and maintaining *Drosophila* culture. **(Compulsory)**	2P
8.	DNA analysis using electrophoretic technique	2P
9	Temporary stained preparation of blood smear	1p

Course Code and Course Name:+

ZOUP 235 : Special Lab I (4 Credits: 120 Hours)

Semester III

Note: A total of 30 practicals are to be conducted. 10 practicals from each module are to be conducted. 1 practical is of 4 clock hour duration.

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

Module-I: Animal Physiology-I

CO1: Demonstrate the effect of body size and salinity on oxygen consumption in given animal.

CO2: Demonstrate the effect of starvation on liver and muscle glycogen in given animal

CO3: Demonstrate the effect of exercise on breathing, pulse rate and blood lactate level.

CO4: Demonstrate the effect of pH, temperature and inhibitors on salivary amylase.

CO5: Map the taste buds on human tongue

Module-II: Fundamentals of Systematics and Economic Zoology

CO1: Identify museum specimen/pictures of minor phyla, Invertebrates, Protochordates and Vertebrates.
CO2: Identify animals with the help of taxonomic keys.
CO3: Collect and preserve animal samples using common methods.

CO4: Write scientific report of field/ institutional visit.

CO5: Compare the methods of collection and curation of insects.

CO6: Identify the poultry breeds.

CO7: Identify edible freshwater fish from nearby area.

CO8: Demonstrate the apiculture equipment.

CO9: Demonstrate the methods of prawn culture.

CO10: Compare various fishing tools, crafts and gears.

Module-III: Research Methodology and Insect Physiology and Biochemistry

CO1: Use MS excel in presentation and analysis of data using common statistical tests.
CO2: Suggest a suitable title for a research article.
CO3: Write the abstract, key words, result, discussion, conclusion and citations of references.

CO4: Write a research project to seek funding.

CO5: Conduct a scientific survey.

CO6: Perform protein purification experiment.

CO7: Demonstrate the heart and haemocytes of cockroach.

CO8: Demonstrate the effect of starvation on glycogen in insects.

CO9: Demonstrate the effect of temperature on water loss in cockroach.

CO10: Detect the amino acids in insect haemolymph by chromatographic method.

CO11: Determine the oxygen consumption in dragon fly nymph

CO12: Perform the assay of amylase activity in midgut of insect

Sr. No.	Name of the Practical	No. of Practicals
	Module-I: Practical Animal Physiology-I	
1.	Body size and oxygen consumption in aquatic animals **(Compulsory)**	**1P**
2.	Estimation of Respiratory Quotient by Warburg's Respirometer	**1P**
3.	Effect of salinity on oxygen consumption in aquatic animals **(Compulsory)**	**1P**
4.	Effect of exercise on breathing rate, pulse rate and blood lactate of man **(Compulsory)**	**1P**
5.	Effect of pH, temperature and incubation on human salivary amylase activity. **(Compulsory)**	**1P**
6.	Absorption spectra of blood pigment **(Compulsory)**	**1P**
7.	Mapping of taste areas on human tongue. **(Compulsory)**	**1P**
8.	Carbohydrates in mammalian gut **(Compulsory)**	**1P**
9.	Effect of starvation on liver and muscle glycogen in mouse **(Compulsory)**	**1P**

10.	Preparation of glycerinated muscle fibers and study of its properties. **(Compulsory)**	**1P**
11.	Phosphagen kinase in mouse and crab muscle phosphagen	**1P**
12.	Effect of load on muscles contraction in frog	**1P**
13.	LDH isoenzymes isolation and detection using agarose gel electrophoresis in heart / skeletal muscle of rat	**1P**
14.	Determination of Body Mass Index (BMI)	**1P**
	Module-I: Practical Entomology- I	
1.	Method of collection, preservation & presentation of insects.	**(02P)**
2.	Study of Taxonomy and diagnostic features up to family of Apterygote, Exopterygote and Endopterygote insects (at least one insect from each order). **(Compulsory- 3)**	**(06P)**
3.	Study of generalized insect: Grasshopper/ Cockroach i. Systematic position, Habit, Habitat and Important morphological features. ii. Dissection so as to study: Digestive, Nervous and Reproductive system and Retro-cerebral complex. **(Compulsory)**	**(03P)**
4.	Temporary mounting of mouth parts, antenna, legs, wings, spiracles and tympanum of a generalized insect. **(Compulsory)**	**(01P)**
5.	Dissection of an insect pest (Plant bug or any insect pest as per local availability and legal permissibility) so as to study taxonomy, diagnostic features and anatomy pertaining to digestive, nervous and reproductive systems.	**(03P)**
6.	Study of head capsule: Structure of head capsule, head orientations and modifications. Study of types of mouthparts and antennae. **(Compulsory- 1)**	**(02P)**
7.	Study of general structure of legs and their modifications. Study of general structure of a wing and its modifications. **(Compulsory)**	**(02P)**
8.	Study of abdominal appendages.	**(01P)**
	Module-I: Practical Genetics- I	
1.	Analysis of metric trait and estimation of phenotypic variance.	**[1P]**
2.	Partitioning of phenotypic variance in genetic and non-genetic components in a simulated population. Estimation of DGD.	**[1P]**
3.	Detection of polymorphism in a population – Biochemical (Enzyme, protein etc.)	**[1P]**
4.	To study population cage experiments using *Drosophila*: a) Genetic Drift b) Artificial selection- Experimental simulation and modeling.	**[1p]**
5.	Extraction of Genomic DNA (*Drosophila*).	**[2P]**
6.	*In-silico* design of PCR primers for a gene of interest.	**[1P]**
7.	Chromatography of *Drosophila* eye colour pigments (wild type and/ or eye colour mutants).	**[1p]**
8.	Microbial genetics: Basic methodology, colony count and growth curve.	**[2P]**
9.	Microbial genetics: Isolation of Auxotroph (Estimation of frequency) Replica plate technique.	**[2P]**
10.	Microbial genetics: Bacterial transformation and blue white selection. Calculation of transformation efficiency.	**[1P]**
11.	Study of conventions of nomenclature of genes, genotypes and gene products in different model systems.	**[2P]**
12.	Sex-linked recessive lethal test in *Drosophila*.	**[1P]**

	Module-II: Practical Fundamentals of Systematics and Economic Zoology	
	Practical Fundamentals of Systematics	
1.	To Study specimens of Minor phyla. **(Compulsory)**	**1**
2.	Study of museum specimens and slides of invertebrates, (2 examples from each phyla). **(Compulsory)**	**2**
3.	Study of museum specimens (protochordates and chordates,1or 2 examples of each phyla) **(Compulsory)**	**2**
4.	Identification of animals with the help of keys-House fly, Honey bee etc. **(Compulsory)**	**1**
5.	Identification of animals with the help of keys- Cockroach, Earthworm.	**1**
6.	Method of collection, Preservation, and Curetting of any insect Specimen **(Compulsory)**	**2**
7.	Visits to Scientific Institute like Zoological Survey of India/ Animal Museum and Report writing.	**2**
	Practical Economic Zoology	
1.	Study of Prawn culture on commercial basis.	**1P**
2.	Study of Apiculture equipments. **(Compulsory)**	**1P**
3.	Study of Poultry breeds, feeding utensils in poultry. **(Compulsory)**	**2P**
4.	Study of Fishing tools: crafts and gear **(Compulsory)**	
5.	Study of economic importance of freshwater fishes- *Catla*, Rohu, *Labeo*, *Mrigala*, *Notopterus*, *Mystus* sp., Clarius, *Channa*, *Heteropneustes*, *Reba*, *Wallago*. **(Compulsory)**	**2P**
6.	Collection and identification of locally available/cultured fishes.	**2P**
7.	A visit to piggery/ poultry/ pearl culture centre/ apiculture centre/ sericulture centre and report writing **(Compulsory)**	**1P**
	Module-III: Practical Research Methodology and Insect Physiology and Biochemistry	
	Practical Research Methodology	
1.	Selecting a title for the paper, writing the abstract and key words. **(Compulsory)**	**1P**
2.	Writing the Discussion Conclusions and Results: Citation of references **(Compulsory)**	**1P**
3.	Importance of scientific surveys, primary data and secondary data in research.	**1P**
4.	Writing a project proposal to a funding agency **(Compulsory)**	**1P**
5.	Use of MS Excel in data presentation.	**1P**
6.	Examples of some common statistical tests. **(Compulsory)**	**2P**
7.	Purification of a biomolecule.	**1P**
8.	Making a ICT enabled scientific presentation. **(Compulsory)**	**1P**
9.	Microscopic techniques.	**1P**
10.	Presentation of any ONE research paper. **(Compulsory)**	**1P**
	Practical Insect Physiology and Biochemistry	
1.	Kymographic study of ventilatory movement in beetle	**1P**
2.	Oxygen consumption in dragon fly nymph **(Compulsory)**	**1P**
3.	Study of heart and haemocytes of cockroach **(Compulsory)**	**1P**
4.	To determine the trehalase activity in haemolymph of any insect	**1P**
5.	Amino acid in haemolymph of any insect by chromatographic technique	**2P**

6.	Study of fat body glycogen of cockroach and effect of starvation **(Compulsory)**	**1P**
7.	Effect of temperature on water loss in cockroach **(Compulsory)**	**1P**
8.	Von Wisselinghs test for presence of chitin in insect cuticle **(Compulsory)**	**1P**

M.Sc. Zoology, Part II, Semester – IV

Course Code and Course Name:

ZOUT 241: Animal Physiology- II (Special Paper) **(4 Credits: 60 Lectures)**

Semester IV

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

CO1: Explain the composition of blood, types of blood cells, vascular dynamics and clotting.

CO2: Illustrate the anatomy and physiology of heart and cardiac cycle

CO3: Describe the excretory system, nitrogenous wastes and renal regulation

CO4: Illustrate the osmoregulatory mechanism in Invertebrates and Vertebrates

CO5: Discuss the neuronal physiology and various potentials.

CO6: Justify the location and structure of eye, ear and taste buds to their functions.

CO7: Justify energy utilization in physiological and metabolic activities.

Sr. No.	Name of the topic	Lectures allotted
1.	**Blood and blood vessels:** a) Blood composition and function, Haematopoiesis b) Blood clotting and it's molecular mechanism c) Blood vessels and blood pressure: Blood vessel types, Arteries, role as pressure reservoir and arterial pressure: Aeteriole:role in distribution in cardiac output and maintainance of arterial blood pressure, Capillaries and it's functions, veins:its role as blood reservoir and venous return d) Blood pressure-Hypertension and Hypotension	(08L)
2.	**Cardiac Physiology:** a) Anatomy of heart	(09L)

	b) Electrical activity of the heart pace makers, spread of cardial coupling, action potential of cardiac cells c) Elecrocardiography d) Mechanism events of cardiac cycle, Heart sound e) Neuronal and Hormonal control of heart f) Cardiovascular response of exercise	
3.	**Excretion & Osmoregulation:** a) Nitrogenous waste- ammonia and its excretion, urea, urea cycle, uric acid and its excretion, products of nucleoprotein metabolism, miscellaneous end product of nitrogen metabolism. b) Organ of excretion and urine formation c) Renal regulation and acid –base balance. d) Maintaining water and electrolyte balance and its regulation in aquatic invertebrates & vertebrate, moist skinned animals, arthropods, terrestrial, vertebrate and marine air breathing vertebrates.	(09L)
4.	**Neuronal Physiology:** a) Nerve cells : Structure & Function b) Excitation and conduction of nerve fiber: Resting membrane potential, Action potential, all or none law, electronic potential, saltatory conduction c) Ionic basis of excitation and conduction d) Neurotransmitter types and receptors: Metabolism of neurotransmitters, Neuropeptides e) Synapse and Neuronal integration f) Impact of drugs and disease on synaptic transmission	(8L)
5.	**Sensory Physiology**: a) Receptor types, receptor potential and receptor adaptation b) Eye-structure and physiology of vision c) Ear-Hearing and equilibrium, sound waves and it's characters, structure of ear and physiology of hearing and equilibrium d) Chemical senses : Taste and smell e) Tactile sensation / response	(09L)
6.	**Energy metabolism:** a) Metabolic rate b) Energy storage: Fat and glycogen c) Effect of O2 concentration: acclimation to low O2 level, anaerobic metabolism, lactic acid and glycolysis d) Problem of diving and deep sea hydro thermal vent e) Metabolic rate and body size: mammals, birds, marsupials & monotremes f) Energy cost of locomotion: running, swimming, flying g) Effect of high altitude	(12L)
7.	**Stress & Adaptation:** a) The Autonomic nervous system & HPA axis coordinate the stress response to an acute threat. b) The HPA axis modulates the immune system. c) Chronic stress causes deleterious effects. d) Plasma glucocorticoid concentration shows seasonal variations.	(05L)

REFERENCE BOOKS:

1. Principles of animal physiology. (2006), C. D. Moyes and P. M. Schulte. Publisher - Pearson Education Inc. and Dorling Kindersley Publishing Inc.
2. Text book of Medical Physiology. 10th edition (2001),. A. C. Guyton and J. E. Hall. Publisher - W. B. Saunders Company, Philadelphia.
3. Principles of Anatomy and Physiology, 11th edition (2006), G. J. Tortora and B. Derrickson. Publisher-John Wiley and Sons Inc.
4. Endocrinology, 5th edition (2008), Mac. E. Hadley. Publisher-Pearson Education Inc. and Dorling Kindersley Publishing Inc.
5. Comparative Vertebrate Endocrinology. 3rd edition (1998), P. J. Bentley. Publisher-Cambridge University Press.
6. Vertebrate Endocrinology. 3rd edition (1997), D. O. Norris. Publisher- Academic Press: An imprint of Elsevier.
7. The World of the Cell, 7th edition, (2005), Wayne M. Becker, Lewis J. Kleinsmith, Jeff Hardin., Publisher - Benjamin Cummings.
8. Molecular Cell Biology, 6th edition (2007). Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Matthew P. Scott, Anthony Bretscher, Hidde Ploegh, Paul Matsudaira, Publisher-W. H. Freeman.
9. Molecular Biology of the Cell, 5th edition (2007). Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter. Publisher - Garland Science.
10. An Outline of Energy Metabolism in Man, Gordon L. Atkins, William Heinemann Medical Books Limited, London 1981
11. Stress Physiology in Animals, Paul H.M. Balm, Blackwell; 1 edition (20 August 1999).
12. Sensory Systems: Anatomy, Physiology and Pathophysiology, Aage R. Moller, Academic Press 2003.

Course Code and Course Name:

ZOUT 241: Entomology- II (Special Paper) **(4 Credits: 60 Lectures)**

Semester IV

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	Lectures allotted
1.	**Gametogenesis :** Spermatogenesis, Seminal transfer and spermatophore formation; Oogenesis, Structure and Types of insect eggs. Fertilization and oviposition.	**(08L)**
2.	**Insect embryonic development:** Cleavage and Blastoderm formation, Germ band formation, Gastrulation, Embryonic membranes, Blastokinesis, Dorsal closure and dorsal organ, Fate/ differentiation of germ layers, Segmentation, Appendages formation and organogenesis in brief.	**(18L)**
3.	**The post embryonic development:** Eclosion from the egg. The developmental stages: Nymph, Naiad, larva, Pupa, Emergence from the pupa/ cocoon. Metamorphosis and Growth.	**(20L)**
4.	**Specialized reproductive mechanism:** Oviparity, viviparity, polyembryony, paedogenesis and parthenogenesis.	**(04L)**
5.	Hadorn's experiments with imaginal disc, Regeneration and Aging.	**(06L)**
6.	**Diapause:** Occurrence, Initiation and Preparations for diapauses. Diapause development and Controls.	**(04L)**

REFERENCE BOOKS:

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 and Course Name:

ZOUT 241: Genetics- II (Special Paper) (4 Credits: 60 Lectures)

Semester IV

Sr. No.	Name of the topic	Lectures allotted
1.	Solving problems (Numerical: Probability estimation) of Mendelian and non-mendelian genetics.	02L
2.	Basic Human Genetics: 2.1 History of Human Genetics 2.2 Pedigree- Gathering Family history, pedigree symbols, construction of pedigrees, Autosomal inheritance- Dominant &Recessive, Monogenic traits(Sex Linked inheritance, Sex Limited & Sex-influenced traits, mitochondrial traits), MIM number. 2.3 presentation of molecular genetic data in pedigrees 2.4 Complications to the basic pedigree patterns- non penetrance, variable expressivity, pleiotropy, late onset, dominance problems, genetic heterogeneity, genomic imprinting & uniparental disomy, spontaneous mutations, mosaicism & chimerism, male lethality, X- inactivation. 2.5 Parametric and non-parametric analysis, identifying recombinants & non recombinants in pedigree, two- point mapping- LOD score analysis, genetic & physical map distances, genetic markers.	12L
3.	Clinical Genetics : 3.1 Monogenic diseases- 3.1.1 Cystic Fibrosis 3.1.2 Tay-Sachs syndrome 3.1.3 Marphan syndrome 3.2 Triplet repeat based disorders 3.3 Inborn metabolic errors-	15L

	3.3.1 Disorders of carbohydrate metabolism 3.3.2 Disorders of nucleic acid metabolism 3.3.3 Disorders of lipid metabolism 3.3.4 Lysosomal storage disorders 3.3.5 Peroxisomal disorders 3.4 Disorders of Hematopoietic systems- 3.4.1 Overview of blood cell types & haemoglobin 3.4.2 Sickle cell anemia 3.4.3 Thalassemia 3.4.4 Hemophilia's 3.5 Prenatal and pre-implantation diagnosis 3.5.1 Indications for prenatal diagnosis 3.5.2 Indications for chromosomal testing 3.5.3 Non- invasive methods 3.5.4 Invasive methods	
4.	Epigenetics: concept and applications	2L
5.	Physical mapping methods: 5.1 Low resolution mapping- cell hybrids, radiation hybrid mapping, synteny homology. 5.2 Restriction maps, clone contig maps, STS map, EST map, DNA sequence map.	3L
6.	Immunogenetics: 6.1 Genetic basis of antibody diversity. 6.2 Regeneration of TCR diversity. 6.3 HLA polymorphism and disease association.	3L
7.	Oncogenetics : 7.1 Concepts of oncogenes and tumor suppressor genes. 7.2 Role of oncogenes. 7.3 Cytogenetic studies.	3L
8.	Behavioural Genetics: 8.1 Rothenbuhler's experiment on genetics of Bee behavior (hygienic and non-hygienic Trait). 8.2 Nature-nurture and behavior- 8.2.1 Genetic experiments to investigate animal behavior- 8.2.1.1 Selection studies. 8.2.1.2 Inbred strain studies. 8.3 Identifying genes for controlling behavior- 8.3.1 Induced mutations 8.3.2 Quantitative trait loci. 8.3.3 Synteny orthology. 8.4 Twin and adoption study designs. 8.5 Environmental influence- shared and non-shared environment. 8.6 Genetics of human behavioural defects- Schizophrenia.	5L
9.	Neurogenetics: 9.1 Genetics of Circadian rhythm (sleep-wake cycle), learning and memory mutants in *Drosophila*. 9.2 Psychopathology- Alzheimer's disease	3L

10.	*Drosophila* genetics: 10.1 History of *Drosophila* genetics. 10.2 Genetic basis of Sex determination and dosage compensation in *Drosophila.* 10.3 Maternal genes and formation of body axis. 10.4 Segmentation genes. 10.5 Homeotic gene functions. 10.6 Regulation of Hox- gene expression	6L
11.	Bacterial and phage genetics: 11.1 Bacteriophage lambda: morphology and structure of nucleic acids, lytic cycle and lysogeny. 11.2 T even and odd phages: bacteriophage T2, T4 and T7 morphology, nucleic acid structure and life cycle. Special features compared to lambda 11.3 RNA phages: Q beta and MS2, replication and concept of overlapping genes	6L

REFERENCE BOOKS:

1. An Introduction to Genetic Analysis – A.J.F. Griffiths, J. Doebley, C. Peichel, D.A. Wassarman (12th ed.) W.H. Freeman Publ. 2020.
2. *i*-Genetics : A molecular Approach – P.J. Russell. Pearson Publ. 2016.
3. Concepts of Genetics – W.S. Klug and M.R. Cummings (12th ed.) Pearson Publ. 2019.
4. Lewin's GENES XII – J.E. Krebs, E.S. Goldstein, S.T. Kilpatrick. Jones and Bartlett Publ. 2018.
5. Genetics – M.W. Strickberger (3rd ed.) Pearson India Publ. 2015
6. Genetics : The continuity of Life – D.J. Fairbanks and W.R. Andersen. Thomson Brooks / Cole Publ. 1999.
7. Principles of Genetics – E.J. Gardner, M.J. Simmons, D.P. Snustad (8th ed.) John Wiley & Sons 2006.
8. Genetics: Analysis of Genes and Genomes – D.L. Hartl and E.W. Jones (6th ed.) Jones & Bartlett Publ. 2004.
9. Developmental Biology – S.F. Gilbert (10th ed.) Sinauer Associates Inc. 2013.
10. Medical Genetics – L.B. Jorde, J.C. Carey, M.J. Bamshad (5th ed.) Elsevier 2015.
11. Genetics in Medicine (Thomson & Thomson) – R.L. Nussbaum, R.R. McInnes, H.F. Willard (8th ed.) Elsevier 2016.
12. Behavioral Genetics – V.S. Knopik, J.M. Neiderhiser, J.C. DeFries, R. Plomin (7th ed.) Worth Publ. 2016. An Introduction to Genetic Analysis – A.J.F. Griffiths, J. Doebley, C. Peichel, D.A. Wassarman (12th ed.) W.H. Freeman Publ. 2020.

Course Code and Course Name:

ZOUT 242: Mammalian Reproductive Physiology and Aquaculture

(4 Credits: 60 Lectures)

Semester IV

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

Mammalian Reproductive Physiology

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.

Aquaculture

CO1: Identify the fish diseases and the causative organisms

CO2: Mention the various composite fish culture with significance of each type.

CO3: Describe the methods of freshwater prawn culture and its management.

CO4: Explain the methods of pearl culture and pearl harvesting.

CO5: Illustrate the preparation and management of fish culture ponds.

CO6: Demonstrate the methods of packaging and transport of fish and brood fish.

CO7: Illustrate techniques of fish harvesting, preservation & processing.

CO8: Compare the techniques used in fishery development.

Sr. No.	Name of the topic	Lectures allotted
	Mammalian Reproductive Physiology	
1.	Reproductive Systems: Anatomy of Male Reproductive System, Accessory organs and their function Spermatogenesis, Function of Sertoli cells, Blood Testisbarriers, inhibin, Leydig cell, Capacitation. Functions of Androgens.	05L

	Anatomy of Female Reproductive System.	
2.	Reproductive patterns: Environmental factors and breeding, continuous and seasonal breeders.	02L
3.	Sexual cycles: puberty, oestrous and menstrual cycles and its hormonal regulation. Ovarian cycle and its hormonal regulation. Cycling of non-pregnant uterus and vagina.	04L
4.	Hormonal regulation: GnRH, pituitary gonadotropins, behavioural effects, testicular hormones, testosterone derivatives, inhibin, ovarian hormones: Pituitary gonadal axis, Oestrogen, progesterone's feedback relationships Prostaglandins and their role in reproduction.	04L
5.	Fertilization, Gamete Transportation Pregnancy: conception and blastocyst formation, implantation and delayed implantation, hormonal regulation in pregnancy.	04L
6.	Placenta: formation, types and functions,	02L
7.	Parturition; birth process, Ferguson reflex, neuroendocrine control, purperium	02L
8.	Lactation: Anatomy and growth of mammary glands, Lactogenesis and galactopoiesis. Hormonal regulation and suckling reflex	02L
9.	Reproductive dysfunctions: Aging and reproduction. Climacteric, anatomical, endocrine and genetic disorders.	01L
10.	Artificial control of reproduction: increasing reproductive potential, artificial insemination, in vitro fertilization and embryo transfer, induced breeding, physical, physiological, surgical, chemical methods of contraception in male, female. Infertility: its causes and treatment, Recent advances in female contraception. Prenatal diagnostic test for genetic disorders-foetal ultra-sonography, Amniocentesis, Chorionic villi sampling,	04L
	Aquaculture	
1.	**Aquaculture concept and its scope** Nutritional value of fish	(1L)
2.	**Physicochemical parameter of water for fish culture** pH, Calcium, Total Alkalinity, Nitrate, Ammonia, Total hardness of fresh water	(3L)
3.	**Construction and management of fish culture pond:** Construction of ponds, management of ponds, Predatory and weed fishes and their control, Aquatic weeds and their control, Aquatic insects and their control, fish feeding: natural and artificial.	(3L)
4.	**Fish breeding: natural and induced.** Natural breeding in pond water, Induced breeding- Pituitary extract, selection of breeders, injection of pituitary extract, spawning, Advantages of induced breeding.	(2L)
5.	**Transport of fish seed and Brood fish**: causes of mortality in transport, methods for packaging and transport, open systems, closed systems, use of chemicals in live fish transport, anesthetic drugs, antiseptics & antibiotics.	(3L)
6.	**Fish culture:**Selection of cultivable fish, monoculture, composite culture, culture of Indian major carps, Culture of common carps, culture of cat fishes, paddy cum fish culture, mari culture, cage culture, integrated fish farming	(7L)
7.	**Fish preservation, processing and byproducts.** Fish preservation techniques, fish biproducts.	(2L)

8.	**Fish pathology:** bacterial, fungal, protozoan and worm diseases of fish.	(2L)
9.	**Fresh water prawn culture (*Macrobracium rosenbegii)*:** Seed procurement from natural resources, breeding and larval rearing of fresh water prawn, management of cultural ponds, harvesting and marketing.	(2L)
10.	**Pearl Culture:** Composition & quality of pearl, collection of oysters, rearing of oysters, insertion of nucleus, pearl formation, harvesting of pearls.	(2L)
11.	**Technologies in Fisheries development:** Geographic Information System (GIS) technology, Use of Information Communication Technology (lCT) in fishes: production aspects, marketing aspects.	(2L)

References:

Mammalian Reproductive Physiology

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,

Aquaculture

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, Marine Biological 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.
9. Sinha, V.R.P. 1999. **Rural Aquaculture in India**. RAP Publications, 21, Bankok, Thhailand.
10. Srivastava, C.B.L. 2005, **A textbook of Fisheries and Indian Fish**.
11. Tamot/P, Mishra,R, Somdutta (2008). Proceeding of taal, 2007 : In 12th Lake Conference : 318-324.

Course Code and Course Name:

ZODT 243: Histology and Histochemistry (2 Credits: 30 Lectures)

Semester IV

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	Lectures allotted
1.	Scope and importance of Histology and Histochemistry Fundamentals of histology: Epithelial, connective, muscular, nervous and other specialized tissues.	05L
2.	Tools in histology: Principles, design and functioning of microtomes, automated microtomes, ultra-microtome, cryostat, problems and troubleshooting.	04L
3.	Techniques in histology: General principles for the preparation of Tissue for Histological studies. Fixation – Principle, Aims and Objectives of fixatives. Chemical action of fixatives on cells and tissue components Processing of fixed samples, dehydration (procedure and significance), embedding, block making, Temporary and permanent preparations, whole mount preparation	05L
4.	Staining (staining methods histochemical and immunohistologial methods) dyes and dye binding reactive groups, mordants and mordanting	02L
5.	Fundamentals of histochemical techniques: Histochemical classification of Carbohydrates and Principle for the Identification of Carbohydrates- glycogen (Periodic acid/Shift method (PAS)	02L
6.	Histochemical localization of Mucopolysaccharides by KMNO4/AB and PAS method.	02L
7.	Histochemical classification of Proteins- Principles and mechanism for the identification of total Proteins and Glycoproteins (Bromophenol Blue & Congo red method). Importance of Enzyme histochemistry. -Localization of enzymes in tissues, Alkaline and Acid phosphates.	04L
8.	Histochemical localization of Nucleic Acids, DNA and RNA (Feulgen reaction &Pyroninmethod).	02L

9.	Application of Histochemical methods for the detection of various types of Carcinoma and Immunofloroscent techniques	02L
10.	Histochemical classification of Lipids. Principle for the demonstration of Lipids in various animal tissues (Copperpthyalocyanin method and Sudan Blank- B method)	02L

Reference books: -

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 and Course Name:

ZODT 243: Pest Control **(2 Credits: 30 Lectures)**

Semester IV

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

CO1: Explain the Pest, nature of damage caused by pests and pest control.

CO2: Explain medical, veterinary, Household and stored grain pests.

CO3: Explain the Principles and methods of pest control including Biological control measures.

CO4: Explain the Integrated pest management (IPM)

CO5: Explain the Non- insect pest and their control: Rat, Bandicoots, Crabs, Snails, Slugs, Birds and Squirrels.

CO5: Explain the principle and working of pesticide appliances.

Sr. No.	Name of the topic	Lectures allotted
1.	Introduction of the pest control : Pest, pest control, types of pests and their importance and damage caused by pests.	**02L**
2.	Brief outline of medical and veterinary entomology with reference to important measures to control the vectors. Household and stored grain pest and their control measures.	**06L**
3.	Principles and methods of pest control: Cultural control measures, Physical control measures, Mechanical Control measures, Chemical control measures. Types and mode of action. Insecticidal formulations and dilutions. Drawbacks of chemical control.	**12L**

	Biological control measures: History, principles and scope of biological control. Biological agents: important groups of Parasitoids, predators and pathogens. Advantages and Drawbacks of Biological control, Biological Control Management.	
4.	Autocidal control : Chemosterilants and radiations for sterilization, Male sterile Theory, Hormones and Pheromones, Attractants and Repellants. Integrated pest management (IPM) : Principles and application	**06L**
5.	Non- insect pest and their control: Rat, Bandicoots, Crabs, Snails, Slugs, Birds and Squirrels.	**02L**
6.	Pesticide- Appliances: Sprayers and Dusters, Hazards of Pesticides and Antidotes.	**02L**

Reference Books

1. "Pest control- A Survey" By A. Woods. (McGraw-Hill, London, 1974).
2. Pest control" – By W. W. Kilgore and R. L. Doutt (Academic Press, New York, 1967).
3. Integrated Pest Management- By J. L. Apple and R. E. Smith, Plenum Publication Co., New Delhi.
4. An Introduction of Biological Control- By R.V.D. Boarscho, P. S. Y. Messenger and A. P. Gaiter, Plenum Publication Co.
5. Insect Pests and their Control- By Evans J.W., Asiatic Publ., New Delhi.
6. Applied Entomology, Vol- 1, 2nd Edition- By K.P. Srivastava, Kalyani Publishers, New Delhi.

Course Code and Course Name:

ZODP 243: Zoology Practical Paper- 4 (2 Credits: 60 Hours)

Semester IV

Note: A total of 15 practicals are to be conducted. 10 practicals from module I (Practicals corresponds to ZOUT 241) and 5 practicals from module II (Practicals corresponds to ZODT 243) are to be conducted. 1 practical is of 4 clock hour duration.

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

Animal Physiology- II

CO1: Determine the bleeding and clotting time of human blood.

CO2: Demonstrate the invertebrate heart.

CO3: Calculate the heartbeats of Daphnia/*Drosophila* larva.

CO4: Determine serum urea and protein and glucose in human blood and urine.

CO5: Justify the effects of various physical and chemical factors on frog heart and muscle.

Entomology- II

CO1: Identify the histological structure of male and female reproductive system of insect.

CO2: Identify the eggs of different insects.

CO3: Identify the different embryonic stages of insects.

CO4: Identify the different post-embryonic stages of insects.

CO5: demonstrate various body organs, systems and appendages of housefly and butterfly.

Histology and Histochemistry

CO1: Identify the various tissues with the help of permanent slides.

CO2: Demonstrate the effect of fixatives on tissues.

CO3: Detect the biomolecules with histochemical staining methods.

CO4: Sketch and label the microscopic details of tissues.

CO5: Prepare the permanent histological slides.

Pest Control

CO1 : Identify beneficial and harmful insects.

CO2 : Identify and classify insect pest of agricultural, veterinary and public health importance.

CO3 : Know the effects of contact insecticides and fumigants on behavior of insect pests.

CO4 : Determine the LD_{50}

CO5 : Behavior of insects to repellants and attractants.

CO6 : Know the principle and working of pesticide appliances.

CO7 : Identify and know the role of biological controlling agents.

CO8 : Know the non-insect pests.

Sr. No.	Name of the Practical	No. of Practicals
	Module- I : Practical Animal Physiology- II	
1.	Determination of bleeding time and clotting time in man **(Compulsory)**	1P
2.	Study of invertebrate (earthworm and crab) heart	1P
3.	Ionic effects on perfused heart of frog (with the help of ICT tool/ Charts/diagrams.)	1P
4.	Effect of adrenalin and acetylcholine on perfused heart of frog (with the help of ICT tool/ Charts/diagrams.) **(Compulsory)**	1P
5.	Osmotic stress and volume change in earthworm	1P
6.	Effect of temperature on water loss in cockroach **(Compulsory)**	1P
7.	Detection and measuring of heart beats (Manually) in Drosophila larva/Daphnia.	1P
8.	Detection of allantoin in mammalian urine **(Compulsory)**	1P
9.	Study of Glomerular filtration rate by creatinine clearance	1P
10.	Study of Types of heart (Myogenic and Neurogenic)	1P
11.	Estimation of SGOT/SGPT from blood sample (Source of blood**:** Local recognized pathology laboratory	1P
12.	Determination of protein, glucose in Urine. **(Compulsory)**	1P
13.	Determination of protein, glucose in Urine from diabetic patient. **(Compulsory)**	1P
14.	Qualitative Analysis: 1) Preparation and study of Urine crystals. 2)Estimation of serum urea. **(Compulsory)**	1P
15.	Normal & abnormal constituents of human urine **(Compulsory)**	1P
16.	Quantitative estimation of salt gain and salt loss by fresh water Crab.	1P
17.	Total RBC, WBC and Different WBC count- A comparative study of fish, goat and human. **(Compulsory)**	1P
18.	Estimation of blood Sodium, potassium, Calcium	1P
19.	Estimation of blood alkaline & acid phosphatases	1P
20.	Estimation serum uric acid **(Compulsory)**	1P
	Module- I : Practical Entomology- II	
1.	Histological studies of male reproductive system (Testes, Vas deference, Ejaculatory duct, Accessory gland and spermatogenesis). **(Compulsory)**	**(01P)**
2.	Histological studies of female reproductive system (Ovariole, lateral oviduct, common oviduct, Accessory glands, bursa copulatrix, spermatheca). **(Compulsory)**	**(01P)**
3.	Study of types of Eggs in insects. **(Compulsory)**	**(01P)**
4.	Early embryology of insect: cleavage, blastula, germ band, gastrula, embryo- 1 day old, 2 day old and 3 day old in suitable insect.	**(01P)**
5.	Study of post embryonic development of insects: Collection and study of types of Nymph, naiads, larvae and pupae. **(Compulsory)**	**(02P)**

6.	Dissection of House fly: The digestive system, Nervous system, Male and Female Reproductive System; Temporary mountings of antenna, halter, legs and ovipositor. **(Compulsory)**	**(03P)**
7.	Dissection of butterfly: The digestive system, Nervous system, Male and Female Reproductive System, Temporary mountings of antenna, scales and ovipositor. **(Compulsory- 2)**	**(03P)**
	Module- I : Practical Genetics- II	
1.	Methodology for constructing Human Pedigree.	**[1P]**
2.	Analysis and construction of typical pedigrees for autosomal dominant and recessive genes, sex linked dominant and recessive genes.	**[1P]**
3.	Preparation of metaphase chromosomal spreads from any vertebrate model system.	**[1P]**
4.	G banding and C banding on mouse metaphase spread	**[2P]**
5.	Study of courtship behavior in wild type and mutant *Drosophila*.	**[1P]**
6.	Study of maternal effect mutants : Bicoid and Nanos.	**[1P]**
7.	Preparation of metaphase chromosomal spread of 3rd instar larva of *Drosophila* (from brain Ganglion).	**[2P]**
8.	Measurement of olfaction activity in *Drosophila* larvae and Adult Fly [The olfaction trap assay for behavioural genetics and screening].	**[1P]**
9.	Measurement of Locomotory activity in *Drosophila* larvae and Adult Fly [flight escape assay for behavioural genetics and screening].	**[1P]**
10.	Larval mechanosensation assay in *Drosophila*.	**[1P]**
11.	Concept of genetic disorder databases and demonstration of use of OMIM.	**[1P]**
12.	Open field Activity test and Elevated plus maze test for anxiety levels in laboratory mice.	**[1P]**
	Module- II : Practical Histology and Histochemistry	
1.	Study of different types of tissue with help of permanent slides **(Compulsory)**	(2P)
2.	Preparation of different reagent/stains for histology **(Compulsory)**	(2P)
3.	Block preparation and sectioning **(Compulsory)**	(2P)
4.	Effect of fixatives, fixation of tissues	(1P)
5.	Comparative study of effect of fixative on a given tissue	(1P)
6.	Mucolpolysaccharide staining, AB pH 1.5, 2.5 **(Compulsory)**	(1P)
7.	Proteins and lipid staining by Sudan black **(Compulsory)**	(1P)
8.		
9.	Nucleic acid staining: methyl green, pyronine, feulgen stain **(Compulsory)**	(1P)
10.	Effect of fixatives on tissue sections- liver	(1P)
	Module- II : Practical Pest Control	
1.	Morphological and taxonomic study of insect pest of agricultural importance. (Any 10).	**(01)**
2.	Study of insect pests of veterinary and public health importance. **(Compulsory)**	**(01)**
3.	Study of Household and stored grain pests. **(Compulsory)**	**(01)**

4.	Study of effects of contact poison on pests: Chlorinated hydrocarbons, Organophosphates and Carbamate.	**(01)**
5.	Calculation of LD_{50} and effects on behavior. **(Compulsory)**	**(01)**
6.	Study of respiratory poisons (fumigants)- Carbon tetrachloride, ethylene dichloride and Nicotine. **(Compulsory)**	**(01)**
7.	Study of Pesticide appliances: Sprayers and Dusters.	**(01)**
8.	Study of Parasitoids, predators and pathogens in biological control.	**(01)**
9.	Study of Non- insect pests : Rat, Bandicoots, Crabs, Snails, Slugs, Birds and Squirrels.	**(01)**
10.	Study of insect attractants and repellants (any two). **(Compulsory)**	**(01)**

Course Code and Course Name:

ZODT 244: Pollution Biology **(2 Credits: 30 Lectures)**

Semester IV

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

CO1: Explain the organization of biosphere.

CO2: Explain in details the types of pollution.

CO3: Describe the pollution monitoring strategies.

CO4: Illustrate the bioassay methods.

CO5: Elucidate the methods to study the impact of pollutants.

CO6: Justify the importance of biomedical waste management.

Sr. No.	Name of the topic	Lectures allotted
1.	Biosphere: Introduction, hydrosphere, lithosphere, atmosphere. (2L)	2L
2.	Pollution: Types of pollution (Air, Water, Agricultural), pollutants and effect of pollution on health, on biosphere and on economy. Eutrophication: Definition, Limnology of lake, process of eutrophication (3L)	3L
3.	Noise pollution: Characteristics of sound, source, effects and control measures of noise pollution.	3L
4.	Pesticide pollution: Pesticides and their kinds, possible sources and pathways of pesticide Pollution. Impact of pesticides on living organisms	2L
5.	Radioactive pollution: Types, sources and effects, radioactivity assessments and control.	3L
6.	Bioassay: Purpose of bioassay, selection and test organisms, pollutant bioassay using fish	2L
7.	Pollution monitoring: strategies for water, soil, noise.	2L
8.	Histological, biochemical and physiological methods to study Impact of pollutants on animals.	3L

9.	Bioconcentration, Bioaccumulation and Biomagnifications of pollutants- Causes and Consequences.	3L
10.	Biological methods for assessment of environmental quality.	3L
11.	Biomedical waste – Handling and Management.	2L
12.	Environment protection act 1986	2L

References

1. Ecology, E.P. Odum, Amerind publ.
2. Environmental biology, P.D. Sharma, Rastogi Publ.
3. Environmental pollution, H.M. Dix, John Wiley Publ.
4. Pesticides in aquatic environment, M.A. Q. Khar, Plenum Press.
5. Environmental pollution and its control under international law, R.A. Malviya , Chay Publ.
6. Ecology, Ricklefs, freeman, W.H.
7. Limnology, Welch McGrew Hill Publ.
8. Practical Ecology – K.S. Rao, Ujjain (M.P) Anmol Publ. New Delhi (India)

Course Code and Course Name:

ZODT 244: Apiculture (2 Credits: 30 Lectures)

Semester IV

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

CO1: Explain the basic concepts of apiculture like systematics, colony organization, polymorphism, morphology and foraging.

CO2: Explain the tools and management of apiary.

CO3: Explain the importance of institutions pertinent to apiculture.

CO4: Discuss the setup of beekeeping business.

CO5: Illustrate the bee keeping as occupation.

CO6: Justify the presence of bees to increase the agriculture productivity.

Sr. No.	Name of the topic	Lectures allotted
1.	Biology of Bees : History, Classification and Biology of Honey Bees. Social Organization of Bee Colony.	05L
2.	Rearing of Bees : Introduction to apiculture practices and handling of Beehives. Artificial Bee rearing (Apiary), Beehives – Newton and Langstroth Bee Pasturage Selection of Bee Species for Apiculture Bee Keeping Equipment Methods of Extraction of Honey (Indigenous and Modern)	11L
3.	Diseases and Enemies Bee Diseases and Enemies Control and Preventive measures, Hormones in Apiculture.	06L
4.	Bee Economy : Products of Apiculture Industry and its Uses (Honey, Bees Wax, Propolis), Pollen etc.	03L

5.	Entrepreneurship in Apiculture Bee Keeping Industry – Recent Efforts, Modern Methods in employing artificial Beehives for cross pollination in horticultural gardens	05L

References:

1) Bees and Beekeeping D. P. Abrol ,Kalyani Publisher, New Delhi. 51
2) A Comprehensive guide to Bees and Beekeeping. D. P. Abrol. Scientific Publisher, New Delhi.
3) Honey bees and their management S. B. Withhead. Axis books Publisher, Jodhpur.
4) Honey bees: Diseases, Parasites, Pests, Predator and their management. N. Nagaraja and D. Rajagopal , M.J.P Publisher, Chennai.
5) A Handbook of Beekeeping Dharamsing and D. P. Singh (Agrobios India (Publisher), Jodhpur.
6) Prost, P. J. (1962). Apiculture. Oxford and IBH, New Delhi.
7) Bisht D.S., Apiculture, ICAR Publication.
8) Singh S., Beekeeping in India, Indian council of Agricultural Research, NewDelhi.
9) Introduction to disease of bee –Bailey, L
10) World of honeybee –Butter C. G.
11) Beekeeping in India –Sardar Sing (ICAR).
12) The Principle of Insect Physiology-Wigglesworth, V.S.
13) Applied Zoology- B. B. Waykar, A. Y. Mahajan, B. C. More . (Prashant Publication Jalgaon)
14) D.K. Belsare Beekeeping for livelihood

Course Code and Course Name:

ZODP 244 : Zoology Practical Paper- 5 (*Practicals corresponding to ZOUT 242 and ZODT 244*)

(2 Credits: 60 Hours)

Semester IV

Note: A total of 15 practicals are to be conducted. 5 practicals from each module (**Module- I :** Practicals corresponding to ZOUT 242 MRP, **Module- II :** Practicals corresponding to ZOUT 242 Aquaculture and **Module- III :** Practicals corresponding to ZODT 244 Pollution Biology/ Apiculture) are to be conducted. 1 practical is of 4 clock hour duration.

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

Mammalian Reproductive Physiology

CO1: Identify the histological slides of reproductive organ/tissues.

CO2: Explain the various types of placenta in mammals.

CO3: Comment on merits and demerits of contraceptive devices/methods.

CO4: Illustrate the technique of gonadectomy.

CO5: Perform vaginal smear technique to identify the phases of oestrous cycle.

CO6: Distinguish the male and female anatomical features of reproductive system in mammals.

Aquaculture

CO1: Identify Indian oysters.

CO2: Identify the common freshwater fish used in culture farming.

CO3: Demonstrate the processing and storing methods for fish and prawn.

CO4: Test the freshness of fish/prawn by histological methods.

CO5: Test the freshness of fish/prawn by biochemical methods.

CO6: Prepare the culture of Daphnia and rotifers.

CO7: Estimate the productivity of water bodies.

Pollution Biology

CO1: Identify the bioindicators from given water sample.

CO2: Write a report on eutrophication of water body.

CO3: Determine the LC50 value for the given compound

CO4: Determine the biomass of given sample.

CO5: Analyze pH and salinity of given sample.

CO6: Estimate calcium and magnesium, sulphate from polluted water.

Apiculture

CO1: Identify the honey bees

CO2: explain the bee morphology and behaviour

CO3: Illustrate the bee enemies

CO4: Justify the rearing techniques and bee management

Sr. No.	Name of the Practical	No. of Practicals
	Module- I : Practical Mammalian Reproductive Physiology	
1.	Anatomy of male and female reproductive system in rat/Mouse **(Compulsory)**	1P
2.	Study of histological slides of male reproductive System-Testis, Vas deferens, Epididymis, Prostate, Seminal vesicle, Cowper's gland **(Compulsory)**	1P
3.	Study of histological slides of female reproductive System-Ovary, Uterus fallopian tube **(Compulsory)**	1P
4.	Vaginal smear technique in Rat	1P
5.	Study of placental types **(Compulsory)**	1P
6.	Study of Uterine smooth muscles	1P
7.	Study of contraceptive devices **(Compulsory)**	1P
8.	E-Demonstration of Orchiectomy or Vasectomy or Epididymoctomyin rat/ Mice	1P
9.	E-Demonstration of Ovariectomy in rat/Mice	1P
10.	Visit to artificial insemination Centre and family planning Centre.	1P
	Module- II : Practical Aquaculture	
1.	To Study Physico-chemical parameters of fresh water –pH, Turbidity, Calcium, Nitrate, Ammonia. **(Compulsory)**	1P
2.	Determination of total alkalinity and total hardness of fresh water.	1P
3.	Determination of dissolved oxygen (DO), biological oxygen demand (BOD), chemical oxygen demand (COD) of fresh water. **(Compulsory)**	1P
4.	Study of conventional method for testing the soil of fresh water pond.	1P
5.	Study of control methods of aquatic weeds.	1P
6.	Study of induced breeding techniques by using pituitary extract.	1P
7.	Study of Indian major carps, prawns, and oysters. **(Compulsory)**	1P
8.	Study of fish disease (bacterial, fungal, protozoan), head and lateral line erosion and eye disease. **(Compulsory)**	1P
9.	Use of Geographic Information Technique (GIS) and Information and communication technology (ICT).	1P
10.	Visit to fish farm/ fish industry. **(Compulsory)**	1P
	Module- III : Practical Pollution Biology	
1.	Study of bio – indicators of pollution. **(Compulsory)**	1P
2.	Analysis of CO, CO_2, NO pollution level data in collaboration with district pollution dept. of Maharashtra state.	1P
3.	Study of Eutrophic ponds /lakes /river.	1P
4.	Visit to water filtration plant/Pollution. **(Compulsory)**	1P
5.	Analysis of pH and salinity from water /soil sample.	1P
6.	Determination of LC_{50} / LD_{50} for insecticide / pollution/molluscicide etc. **(Compulsory)**	1P
7.	Estimation of Biomass by:- i)Wet weight and ii) Dry weight.	1P
8.	Estimation of calcium and magnesium in polluted water. **(Compulsory)**	1P

9.	Soil analysis for calcium carbonate. **(Compulsory)**	1P
10.	Estimation of sulphate in polluted water.	1P
	Module- III : Practical Apiculture	
1.	Study of Honey bee species, Castes and Bee morphology. **(Compulsory)**	(3P)
2.	Study of Beekeeping equipment: Bee box and tools. **(Compulsory)**	(2P)
3.	Study of Bee products: Honey, Bees wax, Pollens, Royal Jelly, Propolis and Bee venom. **(Compulsory)**	(2P)
4.	Study of diseases and enemies of honeybee. **(Compulsory)**	(2P)
5.	Study of bee flora in the locality and observations on bee foraging Behaviour. **(Compulsory)**	(1P)
6.	A compulsory visit to an Apiary or Central Bee Research and Training Institute or a Beekeeper to gain a firsthand experience in handling bees.	(2P)