Syllabus based on NEP 2020 and developed by the Board of Studies of Zoology

J.S. University, Shikohabad

MASTERS IN ZOOLOGY

PROPOSED SYLLABUS OF THE CORE/ELECTIVE PAPERS FOR M.Sc. ZOOLOGY

(Based on Choice Based Credit System)

Subject: Zoology

Session: 2022-23

NATIONAL EDUCATION POLICY – 2020 J.S. UNIVERSITY, SHIKOHABAD PAPER CODING AND CREDIT DISTRIBUTION M.Sc. (ZOOLOGY)					
S.No.	**Name of Degree**	**Semester**	**Title of Paper**	**Credits**	**Code Number**
1	Bachelor (Research) of Science in Zoology	VII	Systematic and Structure and Function of Invertebrate	4	B050701T
			Molecular and Cell Biology	4	B050702T
			Biological Techniques and Instrumentation	4	B050703T
			Microbiology and Immunology	4	B050704T
			Practical	4	B050705T
			Research Project		
2		VIII	Chordates Anatomy	4	B050801T
			Genetics and Biotechnology	4	B050802T
			Animal Physiology and Biochemistry	4	B050803T
			Development Biology	4	B050804T
			Practical	4	B050805T
			Research Project	8	B050806T
		One Minor Paper to be selected form OTHER FACULTY in VII or VIII Semester		4/5/6	
3	Master of Science in Zoology	IX	Biostatistics and Computer Application	4	B050901T
			Animal Behaviour	4	B050902T
			Chronobiology (Choose any Two)	4	B050903T
			Genomics	4	B050904T
			Bioinformatics	4	B050905T
			Insect Pest Management	4	B050906T
			Human Population & Pollution	4	B050907T
			Vector and Vector borne Diseases	4	B050908T
			Fish Culture	4	B050909T
			Apiculture	4	B050910T
			Biodiversity Conservation	4	B050911T
			Conservation of Endangered Species	4	B050912T
			Aquaculture	4	B050913T
			Sericulture	4	B050914T
			Practical	4	B050915T
			Research Project		
4		X	**Choose Any One Course (A/B/C/D)**		
			OPTIONAL COURSE A-ENTOMOLOGY		
			Insect Morphology and anatomy	4	B051001T
			Insect Physiology and	4	B051002T

			Development		
			Insect Systematics	4	B051003T
			Ecology and Applied Entomology	4	B051004T
			Practical	4	B051005P
			Research Project	8	B051006R
			OPTIONAL COURSE B-ICHTHYOLOGY		
			Systematics and Morphology of fishes	4	B051007T
			Physiology and Embryology Fishes	4	B051008T
			Aquaculture and fisheries	4	B051009T
			Pisciculture and economic importance	4	B051010T
			Practical	4	B051011P
			Research Project	8	B051012R
5	Master of Science in Zoology		**OPTIONAL COURSE C-PARASITOLOGY**		
			General Parasitology	4	B051013T
			Biology of Parasite	4	B051014T
			Parasitological Technique	4	B051015T
			Host Parasites Interaction	4	B051016T
			Practical	4	B051017P
			Research Project	8	B051018R
			OPTIONAL COURSE D-WILDLIFE AND ENVIROMENTAL BIOLOGY		
			Wildlife Ecology	4	B051019T
			Wildlife Biodiversity and Conservation	4	B051020T
			Enviromental Physiology	4	B051021T
			Enviromental Pollution and Management	4	B051022T
			Practical	4	B051023P
			Research Project	8	B051024R
5	P.G.D.R.	XI	Application of Biostatistics in Research	6	
			Instrumentation in Applied Research	6	
			Research Methodology	4	
			Research Project	Qualifying	B051104R

Students of Science Faculty may choose MINOR paper from Faculty of Commerce/Arts, Humanities and Social Sciences/Languages/Fine Art and Performing Art/ Education/Rural Science.

PROPOSED YEAR WISE STRUCTURE OF PG PROGRAM IN ZOOLOGY
SEMESTER-WISE TITLE OF THE PAPERS AND CODE FOR M.Sc. ZOOLOGY (IV and V Year)

Year	Name of Degree	SEM	Code Number	Title of Paper	Maximum Marks		Total Marks	Credits	Credits per Semester	Total Credits
4th	(Research) of Science	VII	B050701T	Systematic and Structure and Fucntion of	75	25	100	4	20	52

				Invertebrate						
			B050702T	Molecular and Cell Biology	75	25	100	4		
			B050703T	Biological Techniques and Instrumentation	75	25	100	4		
			B050704T	Microbiology and Immunology	75	25	100	4		
			B050705P	Practical	75	25	100	4		
				Research Project						
		VIII	B050801T	Chordates Anatomy	75	25	100	4	20	
			B050802T	Genetics and Biotechnology	75	25	100	4		
			B050803T	Animal Physiology and Biochemistry	75	25	100	4		
			B050804T	Developmental Biology	75	25	100	4		
			B050805P	Practical	75	25	100	4		
			B050806R	Research Project				8	8	
		One Minor Paper to be selected from OTHER FACULTY in VII or VIII Semester						4/5/6	4	
5th	Master of Science in Zoology	IX	B050901T	Biostatistics and Computer Application	75	25	100	4	20	48
			B050902T	Animal Behaviour	75	25	100	4		
			B050903T	Chronobiology	75	25	100	4		
			B050904T	Genomics	75	25	100	4		
			B050905T	Bioinformatics	75	25	100	4		
			B050906T	Insect Pest Management	75	25	100	4		
			B050907T	Human Population & Population	75	25	100	4		
			B050908T	Vector and Vector borne Diseases	75	25	100	4		
			B050909T	Fish Culture	75	25	100	4		
			B050910T	Apiculture	75	25	100	4		
			B050911T	Biodiversity Conservation	75	25	100			
			B050912T	Conservation of Endangered Species	75	25	100	4		
			B050913T	Aquaculture	75	25	100	4		
			B050914T	Sericulture	75	25	100	4		

			B050915P	Practical	75	25	100	4		
5th		X		Choose Any One Course (A/B/C/D)					28	
				OPTIONAL COURSE A-ENTOMOLOGY						
			B051001T	Insect Morphology and anatomy	75	25	100	4		
			B051002T	Insect Physiology and Development	75	25	100	4		
			B051003T	Insect Systematics	75	25	100	4		
			B051004T	Ecology and Applied Entomology	75	25	100	4		
			B051005P	Practical	75	25	100	4		
			B051006R	Research Project				8		
				OPTIONAL COURSE B-ICHTHYOLOGY						
			B051007T	Systematics and Morphology of fishes	75	25	100	4		
			B051008T	Physiology and Embroyology Fishes	75	25	100	4		
			B051009T	Aquaculture and fisheries	75	25	100	4		
			B051010T	Pisciculture and economic importance	75	25	100	4		
			B051011P	Practical	75	25	100	4		
			B051012R	Research Project				8		
4	Master of Science in Zoology	X		OPTIONAL COURSE C-PARASITOLOGY						
			B051013T	General Parasitology	75	25	100	4		
			B051014T	Biology of Parasite	75	25	100	4		
			B051015T	Parasitological Technique	75	25	100	4		
			B05106T	Host Parasites Interaction	75	25	100	4		
			B051017P	Practical	75	25	100	4		
			B051018R	Research Project				8		
				OPTIONAL COURSE D-WILDLIFE AND ENVIROMENTAL BIOLOGY						
			B051019T	Wildlife	75	25	100	4		

				Ecology						
			B051020T	Wildlife Biodiversity and	75	25	100	75		
			B051021T	Environmental Physiology	75	25	100	75		
			B051022T	Enviromental Pollution and Management	75	25	100	75		
			B051023P	Practical	75	25	100	75		
			B051024R	Research Project				8		
5		XI	B051101T	Application of Biostatistics in Research				6		
			B0501102T	Instrumentation in Applied Research				6	16	16
			B051103T	Research Methodology				4		
			B051104R	Research Project				Qualifying		

ELECTIVE COURSES (Select any two in the IX semester)

1. Chronobiology (course code B050903T)
2. Genomics (course code B050904T)
3. Bioinformatics (course code B050905T)
4. Insect pest management (course code B050908T)
5. Human population and Pollution
6. Vector and vector borne diseases (B050908T)
7. Fishculture (B050909T)
8. Apiculture (B050910T)
9. Biodiversity conservation (Course code B050911T)
10. Conservation of endangered species (course code B050912)
11. Aquaculture (course code B050914)
12. Sericulure (course code B050914)

M.Sc. Zoology Semester VII

Paper Code- B050701T: **Systematic and Structure And Function of Invertebrates**	**Total Marks : 25+75**

Course Objective	• To develop interest in the students for invertebrate diversity • To create an understanding of structural and functional diversity in invertebrate • To develop awareness of phylogenetic relationships in invertebrate groups	
Course Outcomes	1. Described General characteristics, classification of invertebrates. 2. Described General characteristics, classification and systematic portion of Minor phyla. 3. Understand the Classification and Phylogeny of Animals, Protozoa to Annelida. 4. Described the general biology of few selected non-chordates which are useful to mankind. 5. knowledge on Nutrition in Protozoa; Reproduction in Protozoa; Salient features of parasitism in helminthes; Life cycle patterns in helminthes parasites; Adaptive radiation in Polychaeta; Segmental organs in Annelida. Origin of Metazoa; Organization and affinities of Porifera; Polymorphism in Coelenterata; Colony formation in Coelenterata;	
Unit	**Topics**	**Total No. Of Lectures**
I	**Principles of animal taxonomy and basic concept of biosystematics :** • Species concept, International Code of Zoological Nomenclature. • Taxonomic procedure: new trends in taxonomy • Taxonomy collections, Preservations and Curetting process of identification, different kinds of taxonomy keys and their merits and demerits	**10**
II	**Organization of Coelom :** • Acoelomates • Pseudocoelomates • Coelomates : protostomia and deuterostomia.	**10**
III	**Nutrition and Digestion :** • Patterns of feeding and digestion in lower metazoan • Filter feeding in Polychaeta, Mollusca and Echinodermata. • Parasitic mode of feeding	**10**
IV	**Excretion and Respiration :** • Structural and functional organization of excretory system in various invertebrates (Coelom, Coelomoducts, Nephridia and Malpighian tubules) and various excretory products met within them. • Osmoregulation • Structural and functional organization of respiratory organs (gills, lungs and trachea) and mechanism in invertebrates.	**10**

V	**Parasites of Protozoa and helminths and Invertebrate Larvae :** • Larval forms of free living Invertebrates • Strategies and evolutionary significance of larval forms. • Description of protozoan and helminth parasites.	**10**
VI	**Minor Phyla** • Concept and significance. • Organization and general characters. • Affinities of Rotifera and Hemichordata	**10**

M.Sc. Zoology Semester VII

Paper Code- B050702T: Molecular and Cell Biology		**Total Marks: 25+75**
Course Objective	• To make aware to the student about macromolecule like DNA,RNA and protein that define their structure and function • It will provide solid foundation in cell biology, molecular biology and molecular genetics •	
Course Outcomes	1. Understand the cell biology and molecular biology. 2. Understand the various cell types and cell divisions. 3. Understand the structure and function of the cells. 4. Understand the Tools and Techniques in Molecular Biology. 5. Study about Structure of DNA and types of DNA, DNA replication : prokaryotic and eukaryotic DNA replication, DNA damage and DNA repair.	
Unit	**Topics**	**Total No. of Lectures**
I	**History and scope of molecular Biology :** • Structure of DNA and types of DNA • DNA replication : prokaryotic and eukaryotic DNA replication, DNA damage and DNA repair • Nucleosome and structure of chromatin	10
II	**DNA- Transcription and Translation:** • Transcription : Pro and Eukaryotic transcription, RNA polymerases • Three dimensional structure of t-RNA, clover leaf model, L type model. • Regulation of gene expression: Prokaryotic organisms, Lacoperon, Trp operon. • Role of ribosomes in protein synthesis, operon model.	10

III	**Cell Biology** • Modern concepts of structure and functions of biomembranes. • Transport across the cell membrane: Diffusion, Active Transport and Pumps • Membrane potential.	10
IV	**Cell Organelles:** • Structural and functional organization of cell organelles (Mitochondria, Lysosomes, Golgi Apparatus and Endoplasmic Reticulum) • Molecular structure of chromosomes, Heterochromatin and Giant Chromosomes. • Cilia and flagella.	10
V	**Cell Cycles:** • Cellular differentiation and cell cycle. • Mitosis and Meiosis. • Significance of cell cycles.	10
VI	**Cellular Origin of Diseases:** • Cellular origin of diseases: cancer, glycogen storage disease, lipid storage disease • Inborn errors of metabolism Phenyl Ketonuria, Galactosaemia, Thalassemia, and Sickle cell anamia.	10

M.Sc. Zoology Semester VII

Paper Code- B0550703T : Biological Techniques and Instrumentation		**Total Marks : 25+75**
Course Objective	• To make aware to the student to understand the principle of microscopy • To enable the students to learn structure and functioning of various biological instruments • To get enlightened in different biochemical methods	
Course Outcomes	1. Understand the Significance and importance of Various types of microscope. 2. Describe Principle and chemical basis of fixation. 3. Understand Cytology and Haematological techniques. 4. Knowledge about Centrifugation types and their applications. 5. X-ray diffraction method.	
Unit	**Topics**	**Total No. Of Lectures**
I	**Fixation :** • Principle and chemical basis of fixation. • Fixation by formaldehyde, gluteraldehyde, chromium salts, mercury salt tetra oxide, alcohol and acetone. • Freeze drying , Freeze freeze fracturing and substitution techniques.	10
II	**Cytology and Haematological techniques :** • Measurement of cell size • Haematological methods: Total Leucocyte Count, Total Erythrocytes , PVC , ESR, and Res Cell indices.	10
III	**Chemical basis of staining :** • Embedding . • Block making and Sectioning. • Staining : PAS, Metachromasia, Feulgen, lipid and Protein staining.	10
IV	**Bioloigical Instrument and tools :** • Various types of microscope. • Phase contrast, interference, fluorescence, polarized microscope. • Transmission and scanning microscope.	10
V	**Techniques of separation :** • Centrifugation types and their applications. • Electrophoresis types and their applications	10
VI	**Techniques of separation :**	10

	• Chromatography types and their applications. • Autoradiography and their applications . • X-ray diffraction method.	

M.Sc. Zoology Semester VII

Paper Code – B050704T: Microbiology and Immunology		Total Marks: 25+75
Course Objectives	• To impart basic knowledge and principles of microbiology i.e. Bacteriology, Virology and Mycology • It contributes to the better understanding of infectious diseases and host immune response • To enable the student to learn anti microbial therapy and vaccines	
Course Outcomes	1. Understand the molecular biology and its history. 2. Understand the Tools and Techniques in Molecular Biology. 3. Knowledge of Basic concept of immunity, Types of immunity, Phagocytosis, Inflammation. 4. Study of Cells and molecules of the immune system, functions of immune response. 5. Understand Microbial Disease, Deficiency and Antibodies.	
Unit	**Topics**	Total No. of Lectures
I	**History and scope of Microbiology :** • Recognition of microbial role of diseases. • Microbial effects on organic and inorganic matter, the composition of microbial world and scope and relevance of microbiology. • Virus - Concept, general properties, cultivation, purification, Assay, Structure and structural properties.	10
II	**Microbial Taxonomy:** • Morphological, Physiological, metabolic. • Ecological and molecular characterstics. • Aerobic, motile and non-motile gram negative bacteria, anaerobic gram negative and gram positive bacteria.	10
III	**Basic concept of immunology:** • Basic concept of immunity, Types of immunity, Phagocytosis, Inflammation • Cells and molecules of the immune system, functions of immune response. • The adaptive immune response- T cell immunity, properties, cytotoxicity.	10
IV	**Nature of symbiotic microbial association:** • Types of Interactions : Symbiosis, Commensalism, Mutalism and Host Parasite relationships. • Microbiota of human body.	10

	• Microorganism as components of environment • Microorganism in Aquatic Ecosystem.	
V	**Microbial Diseases and Deficiency:** • Viral-Air borne, Direct contact, Food borne and water borne diseases. • Bacterial- Air borne and direct contact. • Fungal and Protozoan diseases. • Deficiency of immune system, autoimmune diseases, allergy and hypersensitivity	10
VI	**Antibodies:** • Antibody production and their function. • Structure of antibody with specific antigens. • Antigen recognition by T lymphocyte and Antibody production by B lymphocyte.	10

Books recommended:

1. Darawn. C. – Origin of Species, Watts & Co. 5 and 6 Johnson's court, Fleet street, E.C. 4, London.
2. Swanson, C.P. - Cytology and Cytogenetics, Macmilliam& Co. Ltd., London.
3. White, M.I.D.- Animal Cytology and Evolution.
4. Waddington, G.H., An Introduction to Modern Genetics, George Allen and Unwin Ltd., London.
5. 23-Sinnott, EW. And Dunn, LC. – Dobzhansky. T. Principle of Genetics, McGraw Hill Book Co., Inc., New York (fifth and later editions).
6. Gardner, E.J.- Principles of Genetics, Wiley Eastern (Pvt.) Ltd., New Delhi.
7. T.0. Cabperson, W.E.- Cell growth, cell Function and Cytochemical Study, Norton and Co.
8. E.V. Cowdry-Laboratory Techniques on Biology and Medicine.
9. H Giese-Cell Physiology.
10. Laskin - Advance in Applied Microbiology.
11. Banwart- Basic Food Microbiology.
12. Campbell- Microbial Ecology.
13. Wistreich- Microbiology.
14. E.Mayer & Peter D.Ash lock- Principles of Systematic Zoology.
15. Introduction of Instrumental Analysis- Robert Brouse. Mc Grove Hills International Editions.
16. K.Wilson & K.H. Goulding A Biologists Guide to Principles and Techniques of Practical Biochemistry.
17. Gerald Karp- Cell and Molecular Biology.
18. Molecular Cell Biology, Lodish et al. Scientific American Books (1995).
19. Principles of cell and Molecular Biology, Kleinsmith U& Kish VM, Harper Collins College Publishers (1995).
20. Molecular Biology, Friedfelder D, Jones and Bartlett Publication, (1998).
21. Cell and Molecular Biology. Karp G. John Wiley and Sons (1999).
22. Molecular Biology of Cell, Alberts B et al. Garland Publishers, (2001).
23. Principles and Techniques in biochemistry and molecular biology Wilson and Walkes.

24. Techniques in microscopy and cell Viology. Tata-Me Craw Hil.
25. Robert Braun Introduction to instrumental analysis-Mc.Crew.Hil.
26. Bisen&Mathw. Tools and Techniques in Life Sciences,- CBS Publishers & distributors.
27. Structure and Function of Invertbrates by Barrington.
28. Invertebrate by Barns.
29. Invertbrate Series by Hyman.
30. Microbiology by Presscott.
31. Immunology by Kuby.

M .Sc. Zoology Semester VII

Paper Code – B050705P : Practicals		**Total Marks: 100**
Course Outcomes	1. Performed and understood the anatomy and physiology of animals by dissection. 2. Described the structural study and mounting of organs. 3. Came to knowing the rules of taxonomy and the principle of animal classification. 4. General classification and survey of the structure or organization of the Non-Chordate phyla. 5. Came to know the permanent preparation of slide of different organs	
Unit	**Topics**	**Total No. of Lectures**
I	**1: Specimens and Slides (Invertebrates)** **(a) Protozoa:** Entamoebahistolytica, Entamoebagingivalis Trypanosoma, Leishmania, Trichomonas, Plasmodium. **(b) Poripera :** Euplectella Spongilla, Cliona, Euspongia, Prepared Sides : LS Sycon , Gemmule, Amphiblastula Larva. **(c) Coelenterata :** Tubularia Companularia, Setularia , Millipora , Physalia, Porpita, Tubipora, Alcyonium, Adamsia, Madrepora, Fungia, Medusa Of Obelia, Ephyra larva, Scyphistoma larva. **(d) Platyhelminthes :** Planaria, Polystoma, Schistosoma, Echinococcusgranulosus, TS Planaria, Sporocyst, Miracidium, Redia and Cercaria larva of F.hepatica , Scolex of Taeniasolium , Mature Proglottid of T. solium, Gravid proglottid of T. solium , Cysticercus larva of T. Solium.	12
II	**(e)Aschelmenthes :** Ancylostoma, Wuchereriabancrofti, Trichinellaspiralis Trichuries, Enterobiusermicularis, T.S. through the body of Male Ascaris, T.S. through the body of female Ascaris. **(f) Annelida** : Heteronereis, Glycera Chaetopterus Arenicola, Amphitrite, Pontobdella, Hirudinaria, TS Pheretima through Pharynx, TS Pheretima through Typhlosolar region ,	

	Prapodium of Nereis, Parapodium of Heteronereis , Trochoppore Larva of Nereies, TS. Hirudinaria through Crop with/ without Diverticula. **(g) Mollusca:** Chiton, Dentalium Aplysia, Doris Mytilus, Pinctada, Tredo,Loligo , Octopus, Naurilus, Radula of Pila, Gill Lamina of Unio, Glochidium Larva of Unio..	
III	**(H) Arthropoda :** Balanus, Sacculina,Eupagurus, Scolopendra , Julus Peripatus, Limulus, Lepisma, Collemabola , Melanopus, Gryllotalpa, Mantis, Pediculus, Trmite, Dragon Fly , Belostoma, Cicada, Butterfly, Moth, Xenopsylla, Head and Mouth parts of male Anopheles, Head and mouth parts of female Anopheles, Head and mouth part of male Culex , Head and mouth parts of female culex , Head and mouth parts of Butterfly mouth parts of Apis , Sting Apparatus of Apis . **(I) Echinodermata :** Antedon, Cucumaria, Holothuria, Asteriasophithrix, Echinus, Clypeaster, Bipinnaria larva , Brachiolaria larva, Ophiopluteus larva, Echinipluteus larva. **(j) Hemichordata :** Balanoglossus, T.S . of Balanoglossus through Proboscis, TS Balanoglossus through collar, Tornaria larva of Balanoglossus. **(k) Minor phyla :** Echiurus,Bonellia, Sipunculus , Bugula, Sagitta.	
IV	**Dissections (Major and Minor)** 1. **Pheretimaposthuma (Earthworm) (i)** External Features (ii) General Anatomy (Septal Nephridia) (iii) Reproductive organs (Ovary) (iv) Nervous System 2. **Unio: (i)** External Features (ii) General anatomy (iii) Nervous System 3. **Mytilus** (i) Nevous System 4. **Sepia(cuttle Fish)**(i) Nervous System 5. **Loligo**(i) Nervous System 6. **Pila :** (i) External Features (ii) General anatomy (iii)Nervous System 7. **Palaemon (i)** External features (ii) Appendages (iii Nervous System) 8. **Cockroach:** (i) External features (ii) General anatomy (iii) Reproductive System (iv) Nervous System **SELECTED MOUTING :** **(i)** **Phylum protozoa :**Ameba,Paramecium Eugelena, Balantidium. **(ii)** **Phylum porifera:** Sponge Spicules, Sponge Gemmules **(iii)** **Phylum Coelenterata :** Hydra, Oneliamedusa, other small Coelenterates. **(iv)** **Phylum Annelida :** Planaria, Faciola & Nematodes. **(v)** **Phylum – Arthropoda :** (a) palemon- Hastate Plate, Statocyst **(b)** Cyclops, Daphnia and other Crustacean	

	Larvae. **(c)** Scorpion – Book Lungs. **(d)** Cockroach – Salivary Glands, Trachea, Mouth parts **(e)** Mouth parts of insects. **(vi) Phylum- Echinodermata :** Tube Feet and Pedicellariae of Starfish	
V	**(II) Mulecular Biology :** 1. StudyoftenechromosomesfromChironomus/Drosophilarvae 2. Studyandinaterpretationofelectromicrgraphs/photographshowing (a) DNA replication (b) Transcription **(iii) Cell Biology :** **1.** Study of human karyo type (normaland abnormal) **2.** To study different cell typs suchas buccale pitheleal cells , neurons, striated muscle cell suning Methylenebule. **3.** To study the different Stages of Mitosisinroottip of onion. **(iv) Techniques and Instrumentation :** **1.** To study the working principle of various lab equipment such as ph meter, Electronic balance,use of glass and micropipettes, Laminar floe, Incubator, Waterbath, Centrifuge, Chromatography apparatus , etc	
Vi	**(v) Microbiology :** **1.** To study the different phases of bacterial growth and to plot Standard growth curve of Staphy lococcusaureus. 2. Gram Stain Technique. 3. Staining of Bacterial smear **(vi) Immunology :** **1.** Determination of ABOBlood group **2.** To study primary and secondary immuneorgan so fart **3.** Histological study of spleen , the musandlymph nodethrough slides/ photographs **4.** Preparation of stained blood film To study various types of blood cells.	

J.S. UNIVERSITY, SHIKOHABAD

M.Sc. ZOOLOGY

SEVENTH SEMESTER

Marks distribution of Zoology Practical Examination :

Duration : 5 Hours **Maximum Marks : 75**

1.	Major Dissection	15
2.	Minor Dissection	05
3.	Permanent Preparation	07
4.	Identification and Comment upon 8 Spots	20
5.	Microbiology/Immunology	07
6.	Tools and Techniques/Molecular Biology	07
7.	Viva-Voce	07
8.	Practical Records	07

Total 75

M.Sc. Zoology Semester VIII

Paper Code: B050801T **Chordate Anatomy**		**Total Marks:** **25+75**
Course Objectives	• To understand the basic anatomical features of the chordates • The study will enable the students to learn basic physiology and evolutionary trends among the chordates	
Course Outcome	**After completion of this course students able to learn following points :** 1. Outline classification of various classes of chordates 2. Origin, Evolution, adaptation and parental care in amphibia 3. Characters and affinities of Rhynchocephalia, Ratitae and affinities of Prototheria and Metatheria 4. Chordate integuments and its derivatives, Evolution of heart, aortic arches and portal systems 5. Comparative account of jaw suspensorium, vertebral column ofChordates	
Unit	**Topics**	**Total no. of lectures**
I	• Outline classification of various classes of chordates • Concept of Protochordates	10
II	• General organization and affinities of Cephalochordatata, Cyclostomata, Holocephali and Deipnoi • Origin, Evolution, adaptation and parental care in amphibia	10
III	• Characters and affinities of Rhynchocephalia • Characters and affinities of Ratitae, palate in birds, migration and aerial adaptation in birds • Characters and affinities of Prototheria and Metatheria • Adaptive radiation in Mammals	10
IV	• Chordate integuments and its derivatives • Evolution of heart, aortic arches and portal systems • Comparative account of respiratory organs of Chordates	10

V	• Comparative account of jaw suspensorium, vertebral column of Chordates • Evolution of Urinogenital systems in Chordates	10
VI	• Organs of olfaction and taste • Lateral line systems, electroreception • Comparative anatomy of brain and spinal cord in relation to its functions in Chordates	10
	Books Recommended: Ali,Salim, 1995.The Book Of Indian Birds. Bombay Nat. His. Soc. Bombay. *Berrill, N.J. 1955. The Origin Of Vertebrates. London* **Colbert,E.H. 1955. Evolution Of The Vertebrates. New York** *Goodrich E.S. 1958. Studies on the Structures and Development of Vertebrates. vol I&II. New York* **Hegnar,R.W. &Steiles,K.A. 1963. College Zoology. Oxford & IBH**	

	---*Kingsley, J.S. 1958. Outline of Comparative Anatomy of Vertebrates.* Allahabad **Neumann,H.H. 1958. PhyllumChordata. Macmillam, London** **Parker,T.J.&Haswell,W.A 1967 A Textbook Of Zoology, Vol.II ,Revised by A.J. Marshall, Macmillan, London** **Romer,A.S. 1965 The Vertebrate Body. Vakils, Fafer and Simons** **Storer,T.I.& Usinger,R.I.1965 General Zoology. Tata-Mc-graw-H. Bombay, New Delhi** **Young,J.Z. 1962 The Life Of Vertebrates. Oxford Uni. press**	

M.Sc. Zoology Semester VIII

Paper Code: B050802T **Genetics and Biotechnology**		**Total Marks:** **75+25**
Course Objectives	• The course offers various aspects of heredity and variations, which enable students to understand concept of similarity and dissimilarity among different living creatures, expression of various traits and transmission of characters from parents tooffspring. • The course also offers various aspects of technology where living organisms are being used for the welfare of mankind.	
Course Outcome	**After completion of this course students able to learn following points :** 1. Mendel's laws of inheritance, Limitations of Mendelism (incomplete dominance, codominance,epistasis, polygenes, lethal genes) 2. Linkage and crossing over, Gene and chromosome mapping ,Variations in chromosome number and structure 3. Human genetic disorders 4. Structures of nucleic acids, Replication of DNA, DNA repair mechanisms 5. DNA recombination technology, PCR, Gel electrophoresis, Southern, northern and western blotting, Autoradiography, Gene guns	
Unit	**Topics**	**Total no. of lectures**
I	**Basics concepts and Mendelism** • Genetic terms and concepts • Mendel's laws of inheritance • Limitations of Mendelism (incompletedominance, codominance, epistasis, polygenes, lethal genes) • Linkage and crossing over	10
II	**Chromosomal basis of inheritance** 3 Gene and chromosome mapping 4 Variations in chromosome number and structure 5 Human genetic disorders 6 Concept of gene 7 Basic concepts of bacterial genetics	10

III	**Molecular Basis of Inheritance** • Genetic material • Experiments to support DNA as genetic material • Structures of nucleic acids • Replication of DNA • DNA repair mechanisms	10
IV	**Gene Expression** • Concept of modern central dogma andflow of genetic information • Genetic codes • Transcription and translation in prokaryotes and eukaryotes • Operon model and gene regulation in bacteria • Gene regulation in eukaryotes	10

Biotechnology and basics of DNA recombination • Meaning of scope of biotechnology • DNA recombination technology • PCR • Gel electrophoresis • Southern, northern and western blotting • Autoradiography • Gene guns	10
Biotechnology and its applications • Biotechnical waste water and sewagetreatment • New medicines using biotechnicalmethods • Single cell proteins and bio-fortified food • Genetically modified organisms • Biotechnology and environment	

Suggested Reading –

1. Snustad, Simmons., Principals of genetics. John Wiley & Sons, Inc.
2. Robert H. Tamarin., Principals of genetics. Robert H. Tamarin.
3. D.L. Hartl, E. W. Jones., Genetics - Principles and Analysis. Bartlett Publishers, Massachusetts.
4. John E. Smith., Biotechnology. Cambridge University Press.
5. A.J. Nair., Introduction to biotechnology and genetic engineering. Infinity science press, MassachusettsNew Delhi, India.

M.Sc. Zoology Semester VIII

Paper Code: B050803T **Animal Physiology and** **Course objective**		**Total Marks:** **75+25**
Course Objectives	• The course offers various aspects of animal physiology and biochemical setup. • The course enables the students understanding thedetails of various systems in animal body including, digestive, nervous, endocrine, cardio-vascular, respiratory, muscular and reproductive systems.	
Course Outcome	**After completion of this course students able to learn following points :** 1. structure and functions of Carbohydrates, Amino acids, protein, Fatty acids, lipids and steroids 2. Enzymes, classification, action mechanism, inhibition, hormones, types and mechanism of action 3. Alimentary canal and associated glands, Digestive juices, enzymes and their action. Absorption and assimilation of food 4. Structure and functions of Brain, spinal cord , Reflex actions and their types. Structure of eye and ear 5. Mechanism of urine formation and urine concentration mechanism. Human male and female reproductive system	
Unit	**Topics**	**Total no. of lectures**
I	**Biochemical setup** • Carbohydrates, structure and functions • Amino acids and protein structure • Fatty acids, lipids and steroids • Nucleotides and nucleic acids	8
II	**Biomolecules of physiological importance** • Enzymes, classification, action mechanism, inhibition • Hormones, types and mechanism of action • bioenergetics (Glycolysis, Kreb's cycle, Beta oxidation, PPP and ETS)	10

III	**Digestion and respiration** • Alimentary canal and associated glands • Digestive juices, enzymes and theiraction • Absorption and assimilation of food • Structure of lungs and thoracic cavity • Inhalation and exhalation mechanism • Transport of gases within the body	10
IV	**Neural and chemical control** • Neurons, types and impulse conduction • Synaptic transmission • Structure and functions of Brain, spinalcord and associated nerves • Reflex actions and their types • Autonomic control • Structure of eye and ear • Important endocrine glands and theirsecretion	12

V	**Muscles, skeleton and excretion** • Various types of muscles • Detailed structure of a skeletal muscle and mechanism of contraction • Details of human skeleton (Axial and appendicular skeleton). • Pectoral girdles in different vertebrates • Pelvic girdles in different vertebrates • Modes of excretion in different vertebrates • Mechanism of urine formation and urine concentration mechanism • RAAS and hemodialysis	8
VI	**Cardiovascular system and reproduction** • Heart in different vertebrates • Detailed structure and functioning ofhuman heart • Blood pressure, Arteries and veins • Human male and female reproductivesystem • Menstruation and pregnancy • Human and chick embryology • Foetal membranes and placenta	12

Suggested Reading -

1. Denis e R. Ferrier, Lippincott's Illustrated Reviews: Biochemistry.Lippicott Williams and Wilikins
2. David L. Nelson, Michael M. Cox.. Lehninger Principles of Biochemistry
3. Harper's Illustrated Biochemistry. Lange Medical Books
4. Guyton, Hall. Text book of Medical Physiology. Elsevier Sounders
5. Lauralee Sherwood. Human Physiology - From Cells to Systems. Brooks/Cole
6. Agrawal P. K. Simplified Biochemistry. Pragati Prakashan. Meerut
7. Ganong's Review of Medical Physiology. Lange Medical book

M.Sc. Zoology Semester VIII

Paper Code: B050804T **Developmental Biology**		**Total Marks:** **25+75**
Course Objectives	• The student should be able to learn embryonic development, growth, differentiation and the process of fertilization • The course will help to understand the process of blastulation and gastrulation • The student should be able to understand the fate of embryo and organ development and formation of extra-embryonic membrane and placenta	
Course Outcome	**After completion of this course students able to learn following points :** 1 . Gametogenesis: spermatogenesis,and Oogenesis, Fertilization: Significance of Fertilization for development 2. Different types of eggs in Chordates, Different types of cleavage 3. Development and physiology of extraembryonic membranes (foetal membranes) in amniotes 4. Development types and physiology of mammalian placenta 5. Organogenesis: Brain, aortic arches, hearts, eyes in mammals	
Unit	**Topics**	**Total no. of lectures**
I	• Theories of Development: Preformation of Epigenesis • Gametogenesis: Spermatogenesis and Oogenesis • Fertilization: Significance of Fertilization for development, Pre and Post Fertilization and Biochemistry of Fertilization	10
II	• Biochemistry of Semen: Semen composition and formation, assessment of sperm function and sperm structure • Different types of eggs in Chordates • Different types of cleavage	10
III	• Early embryonic development: Patterns of cleavage, Blastulation and Gastrulation in Chordates (Tunicates to Mammals), fate maps, morphogenic movements, mechanics and significance of gastrulation • Casual basis of development: primitive embryonic induction, concepts of potencies, prospective fates progressive determination, Speman's primary organization, nature and regionally specific properties of inductor	10
IV	• Organogenesis: Brain, aortic arches, hearts, eyes in mammals • Development and physiology of extraembryonic membranes (foetal membranes) in amniotes	10

V	3. Development types and physiology of mammalian placenta 4. Metamorphosis in amphibian: Structural and physiological changes during metamorphosis, endocrine control of metamorphosis 5. Environmental regulations of animal development	10

VI	• Competence, determination, differentiation and regeneration • Regeneration: types of regeneration (physiological, reparative andcompensatory, hypertrophy), regenerative ability in Chordates morphological and histological process in amphibian limb regeneration, origin of cells for regeneration and differentiation	10
	Books Recommended: *Balinsky,B.I. Introduction To Embryology. Saunders, Philadelphia* *Berril,N.J.& Karp,G. Development Biology. McGraw Hill, New York* Gilbert,S.F. Developmental Biology. 10th Edition, Sinauer Associated Inc., Massachusetts Hamburger, V& Hamilton,H.L. Handbook of Chick development stages. Saunders Publications	

M.Sc. Zoology Semester VIII

Paper Code: B050805P **Practicals**		**Total Marks:** **100**
Course Outcome	**After completion of this course students able to learn following points :** 1. Histological slides of various organ systems from Protochordata and class Cyclostomata to class Mammalia 2. Afferent Branchial Arteries, Efferent Branchial Arteries and Cranial nerves of Scoliodon 3. Preparation of permanent slides from amphioxus-oralhood /wheelorgan/pharyngeal wall. 4. Genetical Exercise :- Incomplete Dominance, Law Of Independent Assortment, Multiple Alleles 5. Sex-Linked Inheritance, Pedigree Analysis. 6. Cell culture study	
Unit	**Topics**	**Total no. of lectures**
I	**Specimens and Slides (Chordates)** (a) Chordate specimen from Protochordata and class Cyclostomata to class Mammalia	12
II	(b) Histological slides of various organ systems from Protochordata and class Cyclostomata to class Mammalia (c) Osteology of Vertebrates i.e Amphibia to Mammals.	12
III	**Dissection: Major And Minor** Major dissection: 1. Afferent Branchial Arteries of(dogfish) Scoliodon. 2. Efferent Branchial Arteries of (dogfish) Scoliodon. 3. Cranial nerves of Scoliodon. Minor dissection: 1. Exposure of internal ear of Scoliodon in situ. **Permanent mounting:** 1. Preparation of permanent slides from amphioxus-oralhood/wheel organ/pharyngeal wall. 2. Preparation of permanent slide of placoid scales from scoliodon.	12

IV	**Genetics and Biotechnolgy Exercise:** Genetical Exercise basesd on basic principles of heredity: 1.Incomplete Dominance 2.Law Of Independent Assortment 3.Multiple Alleles 4. Sex-Linked Inheritance. 5. Pedigree Analysis. Biotechnological exercise (on the basis of availability): 1.Cell culture study 2.Primary cell line and Secondary cell line culture study 3.Verrni culture 4.Transgenic animals and their models.	12

V	**Physiology and Biochemistry Exercise:** 1. Counting of RBC and WBC's using Heamocytometer. 2.Study formed element of mammalian blood (cell types) mammalian by making leismann stain blood smear. 3.Monitering of muscle activity by electromyography. 4.To study the technique of two dimensional paper chromatography to separate amino acids, calculate Rf value. 5.Identification of lipids in a given sample by Thin layer Chromatography..	12

SEMESTER-VIII

Marks distribution of Zoology Practical Examination

Duration: 5 Hours	**Maximum**	**Marks: 75**
1. Major Dissection		15
2. Minor Dissection		05
3. Permanent Preparation		07
4. Identification and Comment upon 8 Spots		20
5. Genetics/Biotechnology Exercise		07
6. Physiology/ Biochemistry Exercise		07
7. Viva-voce		07
8. Practical Records		07
	Total	**75**

M.Sc. Zoology Semester IX

Paper Code: B050901T **BIOSTATISTICS AND COMPUTER APPLICATION**		**Total Marks: 25+75**
Course Objectives	• The student shall learn the basic information of Biostatistics application • The student shall be able to learn basic application of the computer and the biological signs • They shall also learn various computer programs used in the study of life sciences	
Course outcomes	**1.** Describe the structural properties of atoms and molecules. **2.** Explain the principles, procedure and applications of bioinstruments. **3.** Explain the bio- statistical tools for data analysis and its important. **4.** Describe the principles, concepts of thermodynamic laws **5.** Explore the fundamentals of computer and application in biology.	
Unit	**Topics**	**Total no. of lectures**
I	• Introduction to biostatistics- definition, terms, applications and role of biostatistics in modern research; sampling techniques and data representation.	10
II	• Measures of central tendency and distribution, measures of dispersion, probability and chi square test.	10
III	• Correlation and linear regression, test of significance, experimental design and analysis of variance.	10
IV	• Basic components of computer- hardware (CPU, input, output storage devices), software (operating systems), introduction to MS EXCEL- use of worksheet to enter data, edit data, copy data, move data and graphical tools in EXCEL for presentation of data.	10
V	• MS WORD- editing, copying, moving, formatting, table insertion, drawing flowcharts etc.; introduction to power point, image, data handling and graphical tools in PPT for presentation, introduction to internet- basics and applications of internet, internet working, internet access.	10
VI	• Understanding the world wide web (WWW); searching tools world search engines, search directories and encyclopedias; online safety- spyware and viruses.	10
	Books Recommended: • Snedecor, G. W. and W. G. Cochran, statistical methods, Iowa state university, press biometry by W. H Freeman and Francisco. • Salaria, R. S. (2017). Computer fundamentals I edition.	

M.Sc. Zoology Semester IX

Paper Code: B050902T **Animal Behaviour**		**Total Marks: 25+75**
Course outcomes	**1.** Analyse the evolutionary relationship of different animal taxa **2.** Understand the complexity of animal behaviour and its relation to other biological sciences **3.** Have research aptitude in the field of behavioural and evolutionary science **4.** Understand the basic principles and theories of evolution **5.** Describe Communication patterns in animals	
Unit	**Topics**	**Total no. of lectures**
I	• Introduction to ethology;patterns of animal behaviour, taxis ;kinesis;reflexes; tropisms Stereotyped behaviour, Innate releasing mechanism, Instinct;habituation;Conflict behaviour, fixed action pattern, Motivation, Learning,conditioning and memory- classical learning, types development and mechanism of learning.	10
II	• Aggressive behavior; development of behavior; physiology of behaviour, habitat selection and optimality in foraging; group feeding, dorsal- light reaction; migration, sun-compass; orientation and navigation; Domestication and behavioural changes.	10
III	• Approaches and methods in study of behaviour; Proximate and ultimate causation; Evolution of behaviour, selection, competition, altruism and - group selection, Kin selection; Reciprocal altruism; Evolution of eusocial behaviour	10
IV	• Perception of the environment -Mechanical, Electrical, Chemical, Olfactory, Auditory, visual; Evolution of animal signals. Social communication; Social dominance;Use of space and territoriality; range, social organization in insects and primates; Mating systems, Parental investment and Reproductive success; Breeding behaviour; Parental care.	10
V	• Communication patterns in animals; cues, and forms of signals, means of communication, ultrasonic communication; Attractants, marker, alarm, metamorphosis and maturation pheromones; pheromones and behaviour; hormones and behaviour, basic Concepts of behavioural genetics, Maze test.	10
VI	• Role of neuro-endocrines in behaviour and learning, memory, cognition, sleep and arousal; hormones in relation to different behavioural patterns; Basic concepts of Chronobiology, Biological clocks; Biological rhythms, types of biological rhythms, Suprachiasmatic nucleus (SCN) as the main vertebrate clock.	10

	Books recommended: Animal Behaviour- 1. Alocock, J. Animal behaviour: An evolutionary approach. Sinauer Assoc., Sunderland, Mass, USA 9780878930050 2. Bradbury, J.W. and S.I. Vehrencamp, Principles of animal communication. Sinauer Assoc. 3. Drickamer & Vessey: Animal Behaviour -Concepts, Processes and Methods (2nd ed.), Wadsworth, 1986. 3. Clutton-Brock, T.H. The evolution of parental care. Princeton Univ. Press, Princeton, N.J., USA. 4. Goodenough et al: Perspectives on Animal Behaviour, Wiley, 1993. 5. Gould, J.L. The mechanisms and evolution of behaviour. 6. Lehner: Hand Book of Ethological Methods.(2nd ed.) Garland, 1996. 7. Manning Aubrey and Martin Stamp Dawkins .,an introduction to Animal behaviour -,6th edition, Cambridge University Press India Limited. ISBN 9781316614860 8.M P Arora,animal behaviour-, himalaya publishing house, ISBN 935142555X 9. Niko Tinbergen,animal behaviour,,Littlehampton book services, Itd.ISBN 9780705401203 10. Hauser, M. The evolution of communication. MIT Press, Cambridge, Mass, USA. 11. Silverman,P Animal Behaviour in the Laboratory by London. Chapman and Hall.	

M.Sc. Zoology Semester IX (Elective Course-1)

Paper Code: B050903T **CHRONOBIOLOGY**		**Total Marks:** **25+75**
Course outcomes	**1.** Understand History and Adaptive significance, Introduction to biological clocks 2. Describe Clock system in prokaryotes/invertebrates 3. Understand Vertebrate Clock System 4. Describe Measurement of rhythms in physiology and metabolism 5. Undrestand Biological clocks in human welfare Clock and Human health, Chronopharmacology, Chronomedicine and Chronotherapy	
Unit	**Topics**	**Total no. of lectures**
I	History and Adaptive significance, Introduction to biological clocks: Temporal organization. Evolution and adaptive significance; Types of biological rhythms and their properties. Circadian rhythms. Circannual rhythms. Ultradian rhythms, Tidal/Lunar rhythms. Peripheral clocks.Photoperiodism: Photoreception, phototransduction;Geophysical environment-Organisms in the cyclic environment	10
II	Properties of biological clocks: Characteristics, Phase shift, phase angle difference, Phase response curve (PRC). Masking and concept of zeitgeber. Entrainment-parametric and non-parametric entrainment.	10
III	Clock system in prokaryotes/invertebrates: Clock in bacteria with example Cyanobacteria. Circadian pacemaker system in invertebrates with Drosophilaas example. Circadian clock in humans: Organization of clock system in humans. Central and peripheral clock.	10
IV	Vertebrate Clock System: Suprachiasmatic nucleus (SCN), Molecular biology of the circadian pacemaker system with examples from birds and mammals. Melatonin and human physiology: Bio-synthesis and regulation of melatonin, role of melatonin in regulation of diseases. Sleep and diseases in human.	10
V	Biological clocks in human welfare Clock and Human health, Chronopharmacology, Chronomedicine and Chronotherapy. Proximate and Ultimate factors. Role of proximate factor in regulation of physiology and behavior. Disruption of clocks and diseases viz. Diabetes, Cardiovascular diseases. Ageing and sleep disorders.	10
VI	Photoperiodic time measurement; Methods for the study of rhythms in humans: Measurement of rhythms in physiology and metabolism (e.g. heartbeat), blood pressure, body temperature, liver metabolism.Clock regulation of metabolism.	10

	Suggested Readings: 1. Chronobiology Biological Timekeeping: Jay. C. Dunlap, Jennifer. J. Loros, Patricia J. DeCoursey (ed). 2004, Sinauer Associates, Inc. Publishers, Sunderland, MA, USA 2. Insect Clocks. D.S. Saunders, C.G.H. Steel, X., afopoulou (ed.)R.D. Lewis. (3rd Ed). 2002, Barens and Noble Inc. New York, USA 3. Biological Rhythms: Vinod Kumar (ed 2002) Narosa Publishing House, Delhi/ Springer- Verlag, Germany. 4. Chronobiology Biological Timekeeping: Jay. C. Dunlap, Jennifer. J. Loros, Patricia J. DeCoursey (ed). 2004, Sinauer Associates, Inc. Publishers, Sunderland, MA, USA 5. Biologic Rhythms in Clinical and Laboratory Medicine. Touitou, Yvan; Haus, Erhard (Eds.) Springer-Verlag, 1992	

M.Sc. Zoology Semester IX (Elective Course-2)

Paper Code: B050904T **GENOMICS**		**Total Marks: 25+75**
Course outcomes	**1.** Give an Introduction of genomics and its scope **2.** Understand Protein structure: primary, secondary and tertiary, processing, andtransport **3.** Understand Methods of DNA and protein analysis 4. Describe Repetitive DNA-satellite DNAs and interspersed repeatedDNAs,transposable elements **5.** Describe Polymerase Chain Reaction (PCR): Concept of PCR, Variouskinds ofPCR, Real Time PCR. RT-PCR	
Unit	**Topics**	**Total no. of lectures**
I	• An Introduction of genomics and its scope. • Nucleic acids, genes and chromosome relationship • DNA as molecular database, structure and replication. DNAcontent in in different animals. C Value paradox. DNA estimation. • RNA, structure, types and synthesis. • Basics of protein structure.	12
II	• Central dogma and genetic codes. • Transcription and translation. • Protein structure: primary, secondary and tertiary, processing, and transport. • Various approaches in prokaryotic and eukaryotic genecontrol.	12
III	• Genome organization in viruses, prokaryotes and eukaryotes • Organization of nuclear and organellar genomes • Repetitive DNA-satellite DNAs and interspersed repeatedDNAs, transposable elements • LINES, SINES, Alu family and their application in genomemapping. • Variation at the genetic level: DNA markers -VNTR, STR,microsatellite, SNP and their detection techniques	12

IV	• Methods of DNA and protein analysis: Electrophoretic techniques, Southern and Northern blotting, Preparation of probes, Isolation and purification of DNA, RFLP analysis, DNAfingerprinting and its application, Native PAGE, SDS-PAGE and two-dimensional PAGE analysis of proteins, Western Blotting. • Polymerase Chain Reaction (PCR): Concept of PCR, Variouskinds of PCR, Real Time PCR. RT-PCR. • RAPD fingerprinting, Ligation Chain Reaction, Applications of PCR. • Construction of DNA libraries: Vectors used in the construction of cDNA versus genomic DNA libraries.	12

V	• Genome sequencing: DNA sequencing by Sanger's method, Physical mapping, Whole genome shotgun sequencing, Preparation of BAC/YAC library, Genome annotation at different levels, Comparative genome sequencing. • Protein engineering and proteome analysis: Insertional and deletion mutagenesis, Site-directed mutagenesis, Proteome analysis, Protein arrays and their applications. • Mammalian tissue culture, cell line transfections, functional assays, Use of model organisms, methods for generation of transgenic animals, RNAi approach.	12

Suggested Readings:

1. Concepts of Genetics	Klug W. S. and Cummings	M. R Prentice-Hall
2. Genetics-a Conceptual Approach	Pierce B. A.	Freeman
3. Genetics- Analysis of Genes and Genomes	Hartle D. L. and Jones E. W	Jones & Bartlett
4. An Introduction to Genetic Analysis	Griffith A. F. et al	Freeman
5. Principles of Genetics	Snustad D. P. and Simmons.	John Wiley & Sons.
6. Genetics	Strickberger M. W.	Prentice-Hall
7. Essential Cell Biology	Alberts B. et al.	Garland
8. Molecular Biology of The Cell	Alberts B et al.	Garland
9. Advanced Genetic Analysis	Hawley & Walker	Blackwell
10. Genes IX	Lewin B	Pearson
11. Molecular Cell Biology	Lodish, H. et al,	Freeman
12. Cell and Molecular Biology	De Robertis & De Robertis	Lippincott Wilkins & Imes

M.Sc. Zoology Semester IX (Elective Course-3)

Paper Code: B050905T **BIONFORMATICS**		**Total Marks:** **25+75**
Course Outcomes	1. Describe Basic components of computer , hardware and software 2. Understand use of bar diagram, histogram,scatter plots, etc., Graphical tools in EXCEL forpresentation of data. 3. Introduction to MS- WORD word processor- editing, copying, moving, formatting, table insertion, drawing flow charts 4. Introduction to Power Point,image and data handling and software likeEndnote 5. Describe Probability and distributions- definition of probability (frequency approach), independent events.	
Unit	**Topics**	**Total no. of lectures**
I	Introduction to bioinformatics, computational genomics and proteomics. Genomics and proteomics databases - Nucleic acid sequencedatabases: Genbank, EMBL, DDBJ. Protein sequencedatabases: Swiss-prot, PDB,TrEMBL. Metabolic pathway database: KEGG, EcoCyc, and MetaCyc. Small molecule databases: PubChem, Drug Bank, ZINC, CSD.	12
II	BLAST, BLAST vs FASTA, file formats- FASTA,GCG and ClustalW. Databank search- data mining, data management andinterpretation. Multiple sequence alignment of genes and primer designing. Phylogenetic analysis with the program PHYLIP, DISTANCES, and GROWTREE. Basics of designing a microarray, image analysis and | normalization,annotations.	12
III	Basic components of computer- hardware (CPU, input, output, storage devices), Software (operating systems), Application software. Introduction toMSEXCEL- use of worksheet to enter data, edit data, copy data, move data. Use of in- built statistical functions for computations of mean, S. D.,correlation, regression coefficients etc. Use of bar diagram, histogram,scatter plots, etc., Graphical tools in EXCEL for presentation of data. Introduction to MS- WORD word processor- editing, copying, moving, formatting, table insertion, drawing flow charts. Introduction to Power Point,image and data handling and software like Endnote.	12

IV	Biostatistics- population, sample, variable, parameter, primary andsecondary data, screening and representation of data, frequencydistribution, tabulation, bar diagram, histograms, pie diagram, mean,median, mode, quartiles and percentiles, variance, standard deviation,coefficient of variation; Probability and distributions- definition of probability(frequency approach), independent events. Addition and multiplication rules. conditional probability, examples- binomial, poisson and normal distributions; Chi-square test, Z test, t-Test P- value of the statistic, confidence limits.Introduction to one-way and two-way analysis of variance.	12
V	Proteins, secondary structure and folding, RNA secondary structures, protein prediction tools- protein secondary structure, molecular modelling,identification and characterization of protein mass fingerprint, world-widebiological databases. Protein modelling, protein structure analysis, docking,ligplot interactions. Introduction to the latest modern softwares and technologies.	12

M.Sc. Zoology Semester IX (Elective Course-4)

Paper Code: B050906T **INSECT PEST MANAGEMENT**		**Total Marks:** **25+75**
Course Objectives	**The course offers variety of interacting processes to study the factors responsible for achieving pest status,plant-insect interactions, different methods of pest management and integration of pest management in best possiblemanner in order to environment ecofriendly**	
Course outcomes	1. Understand Insect, abundance and its diversity 2. Describe Concept of IPM, history and Ecological method of pest management 3. Describe Economic injury level (EIL) economic threshold, action threshold 4. Understand Pest spectrum, pest complex 5. Knowledge of Predators, Parasites, Parasitoids and Entomopathogenic Nematodes	
Unit	**Topics**	**Total no. of lectures**
I	**Basics of insect, pest and its categories** • Insect, abundance and its diversity • Insect classification based on economic importance • Insect pest, origin of insect pest • Pest status and factors • Economic injury level (EIL) economic threshold, action threshold • Pest spectrum, pest complex	10
II	**Principals of pest management and history** • Concept of IPM, history • Ecological method of pest management • Legal, Cultural, Physical, Mechanical control of pest	10
III	**Biological Control** • Predators • Parasites • Parasitoids • Microbes-Fungi, Bacteria and Viruse • Entomopathogenic Nematodes	10

IV	**Chemical Control** • Plant protection Equipment • Pharmacodynamics • Nomenclature • Classification • Mode of action • Different insecticide groups • Types of formulation	10

11. Upadhyay R.K., Mukharji, K.G. and Rajak, R.L. (1999) IPM System in Agriculture vol. -3 - vol. -7 Eds. Aditiya Books Pvt. Ltd. New Delhi.

12. Horowitz A.R. and I shaaya (2004) Insect Pest Management. Field and Protected Crops, Springer, New Delhi.

13. Atwal A.S. and Dhaliwal G.S. (2009) Agricultural pests of South Asia and their Management, Kalyani Publication, New Delhi.

14. Saxena A.B. (2003) Biological control of Insect Pests, Anmol Publication New Delhi. 15. Dhaliwal, G.S. and cuperus, G.W., (2004) Integrated Pest Management : Potential, Constraints and Challenges, CABI Publishing.

16. Srivastava, K.P, A Textbook of Applied Entomology, Kalyani Publishers, New Delhi.

M.Sc. Zoology Semester IX (Elective Course-5)

Paper Code: B050907T **Human Population and Pollution**		**Total Marks:** **25+75**
Course outcomes	1. Introduction to human population biology 2. Understand Population genetics 3. Describe Human fertility and Models of human senescence 4. Describe Pollution and its sources 5. Understand Ozone hole and international efforts	
Unit	**Topics**	**Total no. of lectures**
I	**Introduction to human population biology** • Variation within and among populations. • Views on an evolutionary time scale. • The structure of human populations - Vital statistics. • Past and present human population sizes. The age structure of populations	12
II	**Population genetics** • The genetic basis of evolution of human population. • Hardy-Weinberg law and random mating effect • Genetic drift. • Mutation. Migration. Inbreeding. • Population growth and regulation • Models of population growth and regulation. Density dependent population regulation.	12
III	**Human fertility** • Birth spacing and the reproductive span. • Natural fertility. • The proximate determinants of fertility. • Reproductive aging and post-reproductive life. Human aging and mortality • Models of human senescence. Pandemic diseases and human population	12
IV	**Pollution and its sources** • Air pollution and air quality index • Water pollution and aquatic life • Land and soil pollution. • Waste management (waste water, plastic waste, electronic waste and hazardous waste)	12

V	**Addressing pollution** • Global challenges and opportunities in the context of the 2030 Agenda • Government initiatives and various laws related to pollution International summits and conferences and their outcome • Ozone hole and international efforts • Greenhouse gases management • Sustainable development and green planet	12

Suggested Readings:

- The Population Bomb — Paul R. Ehrlich
- Population Genetics: A Concise Guide — John H. Gillespie
- Demography: The Study of Human Population — D. Yaukey, L. Anderton, J. H. Lundquist
- Living Within Limits — Garrett Hardin
- Human Population Genetics — John Relethford
- Environmental pollution and control — P. Aarne Vesilind
- Environmental Pollution Control Engineering — C. S. Rao
- Waste management practices — John Pichtel

M.Sc. Zoology Semester IX (Elective Course-6)

Paper Code: B050908T **Vectors and Vector Borne Diseases**		**Total Marks:** **25+75**
Course Objective	The course enables you to learn basics of vector ecology and behavior, the pathogens they transmit, the diseases caused by those pathogens and also about current methods being implemented around the globe to control vector borne disease transmission.	
Course Outcomes	1. Basic introduction to arthropods and insects 2. Understand Mosquito biology, ecology and behavior 3. Describe Tick biology, ecology, and behavior 4. Describe Protozoan pathogens 5. Understand Epidemiology of Vector-Borne Diseases	
Unit	**Topics**	**Total no. of lectures**
I	**Basic introduction to arthropods and insects** A Brief History of Medical-Veterinary Entomology, Identification and Systematics of Arthropods of Medical- Veterinary Importance, Types of Problems Caused by Arthropods **Arthropod Toxins and Venoms**	10
II	**Mosquito biology, ecology and behavior** **Tick biology, ecology, and behavior**	10
III	**Epidemiology of Vector-Borne Diseases** Components of Transmission Cycles, Modes of Transmission, Vertical Transmission,Horizontal Transmission,Transmission Cycles, Inter-seasonal Maintenance, Vector Incrimination, Surveillance, Emerging Vector-Borne Diseases	10
IV	**Bacterial pathogens** Ticks and Borellia,Ticks and Rickettsia, Lice and fleas **Viral pathogens** Mosquitoes and Togaviridae/Bunyaviridae, Mosquitoes and Flaviviridae, Ticks and viruses	10
V	**Protozoan pathogens:** Mosquitoes and Plasmodium, Tsetse flies, Trypanosomes Kissing bugs and Sand flies **Nematodes and Trematode pathogens:** Mosquitoes and filarial worms, Snails and Schistosoma	10

VI	• Ethical and ecological considerations in public health entomology • Vector control and prevention of vector borne disease transmission • WHO "Core Vector Control Methods" • Molecular Tools Used in Medical and Veterinary Entomology- Molecular Techniques,Non-molecular Techniques, Genomics: Sequencing, Cataloging, and Study of an Organism's Genes	

Suggested Reading -

1. Eldridge, B. F., & Edman, J. D. (2004). Medical entomology: A textbook on public health and veterinary problems caused by arthropods. Kluwer Academic Publishers.

2. Mullen, G. R., & Durden, L. A. (n.d.). Medical and Veterinary Entomology. Academic Press, an imprint of Elsevier.

3. WHO. (n.d.). Ethical issues associated with vector-borne diseases: Report of a who scoping meetingWWWHO. World Health Organization. Retrieved September 11, 2022, from https://www.who.int/publications/i/item/ethical-issues-associated-with-vector-borne-diseases- report-of-a-who-scoping-meeting

M.Sc. Zoology Semester IX (Elective Course-7)

Paper Code: B050909T **FISHCULTURE**		**Total Marks:** **25+75**
Course outcomes	**1.** Understand identification and aim of Pisciculture **2.** Describe Quality of culturable fishes and types of cultivable fishes **3.** Describe By-products of Pisciculture industry and their utilization **4.** Understand Methods of fishing **5.** Describe fishing industry in India	
Unit	**Topics**	**Total no. of lectures**
I	Pisciculture- definition and aim of Pisciculture, history of Pisciculture in India, types of Pisciculture and methods.	10
II	Quality of culturable fishes, types of cultivable fishes, factors affecting pisciculture, management of pisciculture: breeding pond- types of breeding (natural and induced), fish seed, hatching pit, transport of fish fry to nursery pond, rearing ponds, stocking ponds, harvesting.	10
III	Methods of fishing, fishing industry in India.	10
IV	Diseases in fishes- fungal diseases, bacterial diseases, protozoan diseases and fluke diseases; prophylactic measures for the prevention of fish diseases.	10
V	Pisciculture and water pollution; economic importance of Pisciculture.	10
VI	By-products of Pisciculture industry and their utilization, Employment potential and income generation.	10

Books recommended:

1. Lagler KF, Bardach, JE, Miller, RR, Passino DRM. 1977. Freshwater Fishery Biology by Ichthyology, 2ndEd. John Wiley & Sons, New York

2. Santosh Kumar and Manju Tembhre. 2011. Fish and Fisheries.

M.Sc. Zoology Semester IX (Elective Course-8)

Paper Code: B050910T **Apiculture**		**Total Marks:** **25+75**
Course outcomes	1. Introductory knowledge of Apiculture 2. Knowledge of Bee behaviour and communication 3. Describe Morphology of honey bee 4. Understand Mechanism of separation of honey 5. Knowledge of Mechanism of separation of honey	
Unit	**Topics**	**Total no. of lectures**
I	• Introduction to Apiculture • *Study of habit, habitat and nesting behaviour of Apisdorsata, Apis indica, Apisfloera, Apis mellifera.*	10
II	• Life cycle, Colony organization and division of labour. • Bee behaviour and communication.	10
III	• Morphology of honey bee, itspollen basket and the sting apparatus. • Mechanism of separation of honey and pollen in the gut of honey bee	10
IV	• Bee keeping equipment: Bee box, Honey extractor, Smoker, Bee-veil, Gloves and other hive tools • Bee keeping and seasonal management	10
V	• Collection, composition and the use of the bee products: Honey, Wax, Venom, Royal jelly and Pollen. • Diseases and enemies of Bees: a) Bee diseases- Protozoan, Bacterial, viral, Fungal. b) Bee pests- Wax moth (Greater and Lesser), wax beetle. c) Bee predators- Bee eater, King crow, Wasp, Lizard, Bear, Man.	10
VI	• Bee pollination and management of bee colonies for pollination. • Mechanism of separation of honey	10

Books:

- Bee and Bee Keeping, 1978, Roger A. Morse, Conell University Press, London.
- The Behaviour and social Life of Honey Bees, C. R. Ribbandas. Dover Publication inc. New York.
- Chapman, R.F. (1998) The insects Structure and function. Cambridge University Press, Cambridge
- Tembhare, D. B. (1997). Modern Entomology. Himalaya Pub. House, Mumbai.
- Kohls, R. L. ;Uhl, J. N. (2002)Marketing of agricultural products.Prentice-Hall Inc. USA
- Robert W. Matthews, Janice R. Matthews (2010) Insect BehaviorJohn Wiley & Sons, Inc. USA,
- Brian, M.V. (1983) Social Insects, Ecology and Behavioral Biology. University Press, Cambridge, UK

M.Sc. Zoology Semester IX (Elective Course-9)

Paper Code: B050911T **Apiculture**		**Total Marks:** **25+75**
Course outcomes	1. Knowledge of Fundamental concepts and history of biodiversity 2. Introductory knowledge to Ecological Economics 3. Describe Theories of distribution, Endemism and Community concept 4. Understand Phytogeography and zoogeographical regions 5. Understanding different levels of population exploitation on of genetic diversity.	
Unit	**Topics**	**Total no. of lectures**
I	Fundamental concepts and history of biodiversity, Biodiversity- definition, levels. (Four main levels of biodiversity are species, genetic, ecosystem, and global biodiversity) and types;Scope and Constraints of Biodiversity Science, Composition and Scales of Biodiversity: Genetic Diversity, Species/Organismal Diversity, Ecological/Ecosystem Diversity, Landscape/Pattern Diversity, Agrobiodiversity, Bicultural Diversity and Urban Biodiversity; Factors promote high diversity, latitudinal and altitudinal gradients of biodiversity; biodiversity extinctions.Instrumental/Utilitarian value and their categories, Direct use value; Indirect/ Non-consumptive use value, Introduction to Ecological Economics; Monetizing the value of Biodiversity; IntrinsicValue;Ethical and aesthetic values, Anthropocentrism, Biocentrism, Ecocentrism and Religions; Intellectual Value;Deep Ecology.	09
II	Phytogeography and zoogeographical regions, Introduction of species, Theories of distribution, Endemism, Community concept; Community composition, qualitative and quantitative characters of community; methods of studying vegetation; Techniques for survey and assessment of endangered and threatened plant species, species diversity and stability relationship; Diversity indices, Plant and animal communities in forest, grassland, desert and mangrove ecosystems; high altitude communities; zonation and stratification of plant and animal communities.Measuring genetic diversity: The Hardy-Weinberg law; genetically effective populations size, Gene flow-Genetic pollution and gene erosion; Genetic drift: Wahlund effect, Inbreeding depression, Out breeding depression, Mutation, Natural selection: Genetic load and Mutation-selection balance; Time scale of concern in species revival; Use of genetic information in identification and prioritization of groups for conservation, for designing and implementation of reproductive strategies in plants and animals, and in population estimation; Understanding different levels of population exploitation on of genetic diversity.	15

III	Biodiversity values-evolutionary, economic, social, cultural and intrinsic values, threats to biodiversity-Indian context, important threatened/endemic plant and animal taxa of India, biodiversity and ecosystem services. Habitat Destruction, Fragmentation, Transformation, Degradation and Loss: Causes, Patterns and consequences on the Biodiversity of Major Land and Aquatic Systems Invasive Species: their introduction pathways, biological impacts of invasive species on terrestrial and aquatic systems Pollution: Impacts of Pesticide pollution, Water pollution and Air Pollution on biodiversity; Overexploitation: Impacts of Exploitation on Target and Non-target Terrestrial and Aquatic species and Ecosystems Extinction: Types of Extinctions, Processes responsible for Species Extinction, Current and Future Extinction Rates, IUCN Threatened Categories, Sixth Extinction/Biological Crisis.	08

IV	Climate change and biodiversity; Biodiversity of Indian subcontinent: biodiversity hotspots, their characteristic flora and fauna, Ecological Succession & climax ecosystems (e.g. Sholas) Maximizing usage of Habitat resources by populations Insular habitats & insular flora & fauna Extreme Habitats and their flora & fauna (Dark Caves, deep sea etc.Concept of Home range, Familiar areas Manipulating Home ranges to increase population density Territoriality and Habitat utilization in animals Concept of niches, its realization & its continuity Micro-Habitats: Fallen Log, Treetop-puddles etc.Biodiversity resources of north-east India, threatened vascular plant species in India; Threatened categories, biological invasions and Biodiversity, Biodiversity and Biotechnology, Biopiracy. Buffer zones, Wildlife corridors,Strategies to reduce human-wildlife interactions.	10
V	Biodiversity conservation strategies: in situ conservation: Biosphere reserve, sanctuaries, national parks, ex situ conservation: botanical garden, zoological garden, in vitro conservation: germplasm or gene bank, tissue culture; Global approaches to biodiversity conservation, Indigenous approaches to biodiversity conservation, biodiversity &ethnomedicinal resources, Indian initiatives in biodiversity conservation-biodiversity act 2002, Biodiversity Rules 2004, national biodiversity strategy and action plan (NBSAP), Plant Varieties Protection and Farmer's Rights Act, 2001, National biodiversity authority (NBA) etc; protected area network (PAN)-biosphere reserves, national park, sanctuary, community conservation area, important bird areas in India, ecological sensitive zone; traditional knowledge digital library(TKDL). Role of NGOs in conservation ,International NGOs; UNEP, GEF, WCS, Bird Life International, Important NGOs in India & their contributions, WWF, ATREE, BNHS, WTI, Kalpavrikshaetc., Important NGO movements, Chipko movement, Narmada Bachavo Aandholan, PaniPanchayats, Seed Movement etc.	09
VI	History,Establishment,types and management of Protected Area-comprehensive global area systems, National and bioregional reserve system, Systemic Reserve selection method, Planning process for establishment of Protected Area, Threats to Protected Area Community conserved Areas (CCAS) - Range sand significance of CCAs, Legal and policy context, Limitation and problems, Management principles; IUCN Protected Area management.International programmes for biodiversity conservation, convention on biological diversity (CBD), CITES, ITTA, UNFCCC, Kyoto Protocol, TRIPS, Ramsar Convention on Wet Lands, Cartagena Protocol on Bio-Safety 2000 (CPB); The Basel Convention, on the Control of Transboundary Movement of Hazardous Wastes and their Disposal, The Montreal Protocol, IPR.	09

Books Recommended:

1. Groom, M. J., Meffe, G. R. and C. R. Carroll. 2006. Principles of Conservation Biology. Sinauer Associates, Inc., USA.

2. Primack, R. 2006. Essentials of Conservation Biology.Sinauer Associates, Inc., USA.

3. Hambler, C. 2004. Conservation. Cambridge University Press.

4. Van Dyke,F.2008.Conservation Biology Foundations, Concepts, Applications 2nd Edition, Springer.

5. Lockwood, M., Vorboys, G. and Kothari A. (Ed.). Managing Protected Areas

6. Stuart, C., Spalding, M and Jenkins, M. the world's Protected Areas: Status, Values and prospects in 21st century

7. Turner, M.G., Gardner, R. H. and ONeill, R. V. Landscape ecology in theory and practice: pattern and process

8. Chapin, F.S. Pamels, A. M. and Vitousek, P Principles of terrestrial Ecosystem ecology 14 Scheme of Examination and Syllabus Passed Through Academic Council Sub-Committee Meeting Held on 31.07.2015

9. Perrow, M. R. and Davy, A. J. Handbook of ecological Restoration Vol I Principles of restoration

10. Groom, M. J., Meffe, G. R. and Carroll, C. R. 2006. Principles of Conservation Biology, Sinauer Associates, Inc., USA.

11. Gardner, E. J. 1975. Principles of Genetics. John Wiley and Sons.

12. Hamilton, M. 2009. Population Genetics. Wiley-Blackwell Publications, USA

13. Hedrick, P. W. 1999. Genetics of Population. Jones and Bartlet Publishers, Inc., London.

14. Gaston, K.J and Spicer, J.I. 2004. Biodiversity: An Introduction. Blackwell Publishing Company, USA.

15. Richard. B. Primack. 1998. Essentials of conservation biology. Sinauer Associates, Inc. USA.

16. Ray S. and Ray A.K. 2010. Biodiversity and biotechnology. New central book Agency (P) Ltd. Kolkata.

17. Nautiyal, S and Kaul, A.K. 1999. Forest Biodiversity and its conservation Practices in India. Oriental Enterprises, Dehradun.

18. Ian. F. Spellberg. 1992. Evaluation and Assessment for Conservation. Chapman Hall, London, UK.

19. Stanley, A.H., 2002. Managing our wildlife resource. Prentice-Hall, USA.

20. Edward, O.G., 2004. Ex situ plant conservation. Island Press, Washington, DC

M.Sc. Zoology Semester IX (Elective Course-10)

Paper Code: B050912T **Conservation of Endangered Species**		**Total Marks:** **25+75**
Course outcomes	1. Definition of Wildlife and Biodiversity 2. Describe Conservation methods 3. Describe Wildlife management Legislative, administrative and ecological approaches in India, Forest Acts, Wildlife Act, other relevant acts 4. Introductory Knowledge of Wetland ecosystems 5. Describe Wildlife Toxicology and Wildlife Crimes	
Unit	**Topics**	**Total no. of lectures**
I	Definition of Wildlife and Biodiversity Concept, approach and significance Causes of wildlife species depletion; Economic importance of wildlife; need for wildlife conservation; rare, endangered, threatened and endemic species of fishes, amphibians, reptiles, birds and mammals in India- India as a mega wildlife diversity country.Endangered species: Their status in various states of India - Endangered species of World. (Marine turtles, crocodiles & other reptiles, birds, whales, dolphins, Dugongs and other mammals and their management). IUCN criteria for allocation into different Red List classes. Significance,Depletion, Wildlife values, Major threats	08
II	Conservation methods - Special conservation programmes. Wildlife management Legislative, administrative and ecological approaches in India, Forest Acts, Wildlife Act, other relevant acts, schedules, latest amendments, different organizations and supporting agencies. National and International Agencies and conventions concerned with wildlife and conservation. Wildlife projects sponsored in India.; Role of Government and Non-Governmental organizations in conservation -Study of different Govt. and other important projects of world to protect endangered species, eg- Project Tiger. Measures Taken For Conservation of Tigers under the Wildlife Act, 1972. Tiger Task Force, Core and Buffer Zones., The Gir Lion Sanctuary Project, Himalayan Musk Deer Project, The Manipur Brow-antlered Deer Project, Project Hangul, Crocodile Breeding Project, Project Snow Leopard, Project Elephant,Elephant Corridors. in-situ and ex-situ conservation: Wildlife Sanctuaries, National Parks, Tiger Reserves, Vulture and Biosphere reserves: Definition, formation, management and administration; Zoos and Zoological Parks:Definition- Aims of Zoos- Formation and Management of Zoos and Zoological Parks- Central Zoo Authority of India; Captive breeding: Aims, Principles, methods; germplasm or gene bank, tissue culture; Global approaches to biodiversity conservation, Indigenous approaches to biodiversity conservation, biodiversity and ethnomedicinal resources.	13

III	Conservation methods and trials for sustainable development - Natural resource management and conservation - Importance and performance of joint forest management (JFM) Role of NonGovernment Organizations (NGO). Indian initiatives in biodiversity conservation-biodiversity act 2002, Biodiversity Rules 2004, national biodiversity strategy and action plan (NBSAP), Plant Varieties Protection and Farmer's Rights Act, 2001, National biodiversity authority (NBA) etc; protected area network (PAN)-biosphere reserves, national park, sanctuary, community conservation area, important bird areas in India, ecological sensitive zone; traditional knowledge digital library(TKDL). Role of NGOs in conservation ,International NGOs; UNEP, GEF, WCS, Bird Life International, Important NGOs in India & their contributions, WWF, ATREE, BNHS, WTI, Kalpavriksha etc., Important NGO movements, Chipko movement, Narmada BachavoAandholan, PaniPanchayats, Seed Movement etc.	09

IV	Wetland ecosystems: Freshwater Bodies - Impact and significance of Human Intervention on Biodiversity, Threatened flora and fauna and conservation methods (Kondakarla Lake as a case study) – Modern methods of documentation of wildlife (still and video photography), Zoogeography: Geographical distribution of animals - Oriental, Palaearctic, Nearctic, Neotropical, Ethiopian and Australian Regions.	09
V	Infectious wildlife diseases and their treatment: Viral diseases: Rabies-Rinderpest- Foot and Mouth -Viralencephalitis-Yellow fever- Bacterial disease: Anthrax- Brucellosis Clostridiosis -Listeriosis.Protozoan disease: Trypanosomiasis Toxoplasmosis-Babesiosis Coccidiosis.Helminth disease: Fasciolopsis Schistosomiasis - Taeniosis - HydatidosisNon-infectious diseases of wild animals: Diseases of the digestive system:Stomatitis-catarrhal, gastroenteritis-haemorrhagic gastroenteritis; Respiratorysystem: Catarrhal, bronchopneumonia-exudative pleurisy; Excretory system:Paralysis of urinary bladder-urolithiasis. People and conservation -Traditions & cultures, Women in conservation, Traditional Societies (e.g. Bishnois),Human – wildlife interactions	12
VI	Wildlife Crimes: Wildlife forensics and its applications in detecting wildlife crimes; Wildlife Toxicology: Types of contaminants, methods of toxicity evaluation, bioconcentration- bioaccumulation and biomagnifications; impacts of pesticides and heavy metals on birds and mammals; CAMP and PHVA - Analyses and Reports; Environmental Impact Assessment (EIA) methods and their role in wildlife Conservation; Administrative set up - Advisory bodies-National Board for Wildlife -Wildlife (Protection) Act, 1972 and its Amendments; Wildlife trade and regulations; Biodiversity Act 2000; Eco-Development, Eco- Restoration and Ecotourism programmes; Anti poaching operations -Village Forest Council (VFC).	09

Books Recommended:

1. Groom, M. J., Meffe, G. R. and C. R. Carroll. 2006. Principles of Conservation Biology. Sinauer Associates, Inc., USA.

2. Krishnamurthy, K. V. 2003. Textbook of Biodiversity. Science Publication.

3. Primack, R. 2006. Essentials of Conservation Biology.Sinauer Associates, Inc., USA.

4. Hambler, C. 2004. Conservation. Cambridge University Press.

5. Van Dyke,F.2008.Conservation Biology Foundations, Concepts, Applications 2nd Edition, Springer.

6. Groom, M. J., Meffe, G. R. and Carroll, C. R. 2006. Principles of Conservation Biology, Sinauer Associates, Inc., USA.

7.Gardner, E. J. 1975. Principles of Genetics.John Wiley and Sons.

8.Groom, M. J., Meffe, G. R. and C. R. Carroll. 2006. Principles of conservation biology. Sinauer associates, Inc., USA.

9.Hamilton, M. 2009. Population Genetics. Wiley-Blackwell Publications, USA

Hedrick, P22. W. 1999. Genetics of Population. Jones and Bartlet Publishers, Inc.,London.

10.Gaston, K.J and Spicer, J.I. 2004. Biodiversity: An Introduction. Blackwe

ll Publishing Company, USA.II. Ray S. and Ray A.K. 2010. Biodiversity and biotechnology. New central book Agency (P) Ltd. Kolkata.

12. Agarwal, S.K. 2002. Biodiversity conservation. Rohini Publishers, Jaipur.?

13. Robert S Shumaker2020Saving Endangered Species: Lessons in Wildlife Conservation from Indianapolis Prize Winners, Johns Hopkins University Press

14Elizabeth Kolbert,2019,National Geographic The Photo Ark Vanishing: The World's Most Vulnerable Animals, Natinal Geographic.

M.Sc. Zoology Semester IX (Elective Course-11)

Paper Code: B050913T **Aquaculture**		**Total Marks:** **25+75**
Course outcomes	1. Knowledge to aquaculture- scope and definition 2. Describe Sustainability and environmental management of aquaculture 3. Understand Integration of aquaculture with crop and livestock 4. Understand Polyculture bivalves and sea weeds in marine farming 5. Knowledge about Aquaculture practices	
Unit	**Topics**	**Total no. of lectures**
I	Introduction to aquaculture- scope and definition, branches of aquaculture; history of aquaculture and its present state with special reference to India.	08
II	Selection of sites for aquaculture, selection of species for aquaculture, design and construction for aquafarms; nutrition and feeds, health and diseases in aquaculture.	13
III	Sustainability and environmental management of aquaculture; control of weeds, pest and predators in aquaculture.	09
IV	Aquaculture practices: fishes- carps, salmons, trouts, catfishes, tuna, cod and eels; shrimps and prawns; cray fish and crabs; oysters and mussels; clamps and scallops and sea weeds.	
V	Integration of aquaculture with crop and livestock farming: rice fiels aquaculture; integrated farming of fish and duck.	
VI	Polyculture bivalves and sea weeds in marine environment; National planning of aquaculture development.	

Books recommended:

1. De Silva SS & Anderson TA. 1995. Fish Nutrition in Aquaculture. Chapman & Hall Aquaculture Series.

2. Ojha JS. 2005. Aquaculture Nutrition and Biochemistry. Daya Publ.

3. Rath RK. 2000. Freshwater Aquaculture. Scientific Publ. 12. Landau M. 1992. Introduction to Aquaculture. John Wiley & Sons.

4. Pilley, TVR and Dill, WMA. 1979. Advances in Aquaculture. Fishing News Books, Ltd. England. 11.

5. Pillay TVR and Kutty MN. 2005. Aquaculture- Principles and Practices. Blackwell.

M.Sc. Zoology Semester IX (Elective Course-12)

Paper Code: B050914T **Sericulture**		**Total Marks:** **25+75**
Course outcomes	1. Knowledge History of Sericulture in India 2. Understand Popular silkworm races of India 3. Describe Common diseases of the silk worms 4. Knowledge on Entrepreneurship development 5. Understand By-products of sericulture industry and their utilization	
Unit	**Topics**	**Total no. of lectures**
I	• History of Sericulture in India • Introduction to the mulberry and non- mulberry silk worms Mulberry cultivation and soil fertility	08
II	• Life cycle of Bombyx mori • Popular silkworm races of India • Anatomy of the silk gland and silk spinneret • Common diseases of the silk worms	13
III	• Silk worm rearing: Rearing house and equipment; disinfection, Rearing operations - brushing, young and late-age silkworm rearing, moulting, mounting and spinning. • Cocoon harvesting, Cocoon preservation and storage. • Post harvesting technology: silk reeling, weaving and dyeing.	09
IV	• Silk worm seed production • Entrepreneurship development	
V	• By-products of sericulture industry and their utilization: • Employment potential and income generation	
VI	• Sericulture organization in India • Marketing of sericulture products	

Books recommended:

- Devaiah M.C et al. (2001); Advances in Mulberry Sericulture. Dept. of Sericulture, UAS, Bangalore
- Tanaka Y. (1964); Sericology, Central Silk Board Publication, Bangalore.
- Ganga, G., and J. SulochanaChetty. (1991) an introduction to sericulture. Oxford &ibh publishing company.
- HisaoArguo 1994 Principle of Sericulture, Oxford and Co
- FAQ Manual of Sericulture. Vol-I Mulberry Cultivation, Vol- II Silkworm Rearing. Central Silk Board, Bangalore.

- Kohls, R. L. Uhl, J. N. (2002)Marketing of agricultural products.Prentice-Hall Inc.USA

Brian, M.V. (1983) Social Insects, Ecology and Behavioral Biology. University Press, Cambridge, UK

Paper code: B050915P

M.Sc. Zoology Semester IX

Course Outcomes	1. Understand determination of mean, mode and median 2. Knowledge of Animal behaviour 3. Knowledge of Presentation of data 4. Understand Biostatistics And Computer Application 5. Understand graphs,pie charts,line charts,bar graphs, frequency,polygons andogives.

Practical

1. Biostatistics And Computer Application Exercise.

- Presentation of data from frequency tables.
- Presentation of data in the form of graphs,pie charts,line charts,bar graphs,frequency,polygons andogives.
- Determination of mean, mode and median in the given grouped data.
- Determination of standard deviation in the grouped data.
- Determination of T-Test and significance level.
- Estimation of correlation.

2. Animal behaviour

- Determination of taxes (Phototaxes of Drosophila)
- Determination of kinesis (Chemotaxes in Paramecium) Feeding behaviour
- Grooming behaviour
- Death feigning behavior in Coccinellidae Beetle
- Maze Test

3. Exercise from elective course C13.

4. Exercise from elective course C14.

Marks Distribution Of Practical Exam SEMESTER- IX

Duration: 5 hours **Maximum Marks: 75**

1. Exercise from biostatistics/computer application	15
2. Exercise from animal behavior	15
3. Exercise from elective course C13.	15
4. Exercise from elective course C14.	15

5. Viva-voce		07
6. Sessional record		08
	Total	75

OPTIONAL COURSE A – ENTOMOLOGY

SEMESTER X		
Paper Code B051001T	**INSECT MORPHOLOGY AND ANATOMY**	
Course Objectives	• To learn the external morphology of insects in order to identify the various kinds. • To study specialization and adaptability of their external and internal structures.	
Course outcome	**On completion of the M.Sc. with Zoology, students will be able to following points...** • Insect morphology and anatomy. • Structure of insect abdomen. • Respiratory system: basic structure of trachea, spiracles and air sacs, respiration in terrestrial, aquatic and parasitic insect. • Nervous system and its associated organ. • Circulatory system of Insects.	
Unit	**Topics**	**Total no. of lectures (60)**
I	Morphology: Integument, structure of insect head, orientation of insect head, sulci and areas; Appendages - structure and types of antennae, types of mouth parts; Structure of insect thorax- sulci and areas of thorax, thorax as a locomotory organ, structure, articulation and coupling of wings, constock needhem, nomenclature of insect wing venation, structure and functioning of insect legs.	12
II	Structure of insect abdomen: pregenital abdominal appendages, male genitalia and their modifications, female ovipositor genitalia and its modifications, substitute and oviposition.	08
III	Anatomy: Digestive system - basic structure of digestive system including musculature, cardiac and pyloric valves, peritrophic membrane, filter chamber, rectal pads. Excretory system- malpighian tubules, other excretory glands.	12
IV	Respiratory system- basic structure of trachea, spiracles and air sacs, respiration in terrestrial, aquatic and parasitic insect. Circulatory system- structure of heart and aortae, blood or haemolymph along with other cells.	12
V	nervous system- central nervous system, peripheral nervous system, sensory cells and sense organs, somatogastric nervous seytem.	10
VI	Reproductive system- male internal reproductive organs, female reproductive organs.	06

SEMESTER X

Paper Code B051002T	INSECT PHYSIIOLOGY AND DEVELOPMENT	
Course Objectives	• To understand the insect body organization and function • To obtain the knowledge of insect reproduction, fertilization, metamorphosis and hormonal control.	
Course outcome	**On completion of the M.Sc. with Zoology, students will be able to following points...** • Insect physiology. • Production and reception of sound. • Types of metamorphosis and significance of metamorphosis. • Ecdysis and diapause. • Developments various types of stages.	
Unit	**Topics**	**Total no. of lectures (60)**
I	Insect physiology: physiology of digestion, physiology of excretion.	10
II	Production and reception of sound: physiology of photoreception and light production.	10
III	Insect eye and theory of mosaic vision, hormones, their control and neurosecretions.	10
IV	Development: structure of egg, embryonic development types of insect larvae and pupae.	10
V	Types of metamorphosis and significance of metamorphosis, hormonal control of metamorphosis.	10
VI	Ecdysis and diapause	10

SEMESTER X

Paper Code B051003T	**INSECT SYSTEMATICS**	
Course Objectives	• To become familiar to the rules of zoological nomenclature to learn evolutionary history of insects • To develop understanding of insect taxonomic techniques of description and learning of identification of insects.	
Course outcome	**On completion of the M.Sc. with Zoology, students will be able to following points...** • Concept of hexapoda and apterygota with special reference to ectognatha and entognatha. • Exopterygota Orders and Endopterygota Orders. • Lineous hierarchy. • Systematics. • Distribution of insects.	
Unit	**Topics**	**Total no. of lectures (60)**
I	Systematics: knowledge of international code of nomenclature with special references to law of priority concept of holotype, allotype, paratype and lectotype. Lineous hierarchy, taxonomic characters, evolution of insects and fossil insects, history of entomology in India.	06
II	Concept of hexapoda and apterygota with special reference to ectognatha and entognatha:Order Aptera, Protura, Collembola and Thysanura	06
III	ExopterygotaOrders: Ephemeroptera,Plecoptera, Odonata, Orthoptera Families:Acrididae, Gryllidae, Tettigonidae, locust and phase theory of locust. Phasmida, Dermaptera, Blattaria, Mantoidea, Isoptera.	12
IV	Exopterygota Orders: Phthiraptera- Anopleura and Mallophaga; Psocoptera, Thysanoptra, Heteroptera Families- Pentatomidae, Coreidae, Pyrrhocoridae, Reduviidae, Lygaeidae, Tingidae, Belostomatidae, Nepidae, Gerridae; Homoptera Families: Membracidae, Jassidae, Aleyrodidae, Psyllidae, Aphididae, Coccidae.	12
V	Endopterygota Orders: Coleoptera Families Carabidae, Dytiscidae, Dermastidae, Hydrophillidae, Chrysomelidae, Meloidae, Coccinellidae, Buprestidae, Tenebrionidae, Cerambycidae, Scarabaeidae, Curculionidae; Trichoptera.	12
VI	Endopterygota Orders: Lepidoptera Families Noctuidae, Sphingidae, Pyralidae, Bombycidae, Papilionidae, Nymphalidae, Pieridae; Hymenoptera Families Ichneumonidae, Braconidae, Chalcididae, Vespidae, Apidae, Formicidae; Diptera Families- Tipulidae, Psychodidae, Chironomidae, Simuliidae, Cecidomyiidae, Tabanidae, Asilidae, Syrphidae, Agromyzidae, Muscidae, Trypetidae, Hippoboscidae;Order Siphonaptera	12

SEMESTER X		
Paper Code B051004T	**ECOLOGY AND APPLIED ENTOMOLOGY**	
Course Objectives	• The student will be able to learn the biology of harmful and useful insects and their control • To understand the intimated biology of insect vectors and their capacity to disperse the vectors.	
Course outcome	**On completion of the M.Sc. with Zoology, students will be able to following points...** • Ecology of insects. • Parental care of insects. • Applied Entomology. • Life cycle of insect's pests. • Role of ecological factors on insects.	
Unit	**Topics**	**Total no. of lectures (60)**
I	Ecology of insects: Abiotic factors influencing insect life, effect of temperature on insect development; Biotic factors- insect parasitism, entomophagus insects, social life in termites, bees and ants	12
II	Parental care, myrmecophily and termitophily	06
III	Applied Entomology- economic importnace of insects, concept of insect control by use of insecticides, concept of biological control and male sterility.	12
IV	Apiculture,sericulure and lac culture in India.	08
V	Life history, damage and control of the main pests of: sugarcane crop, paddy crop, cotton crop, stored grains.	12
VI	Insect vectors of various discases llike malaria, dengue, filariasis, kalaazar, yellow fever, sleeping sickness, loaloa etc., transmitted to cattle and man and their control measures.	10

Books Recommended:

- Atkins, Michael D. Introduction to insect behaviour. Macmillan Publishing Co., Inc., 1980.
- Atwal, A. S.: agricultural pests of India and South-East Asia. Kalyani publication. New Delhi 1988.
- Chapman, Reginald Frederick, and Reginald Frederick Chapman. The insects: structure and function. 4th edition, Cambridge university press, 1998.
- Davies, R. G. "Insect structure and function." Outlines of Entomology. Springer, Dordrecht, 1988. 7-96.
- Essig, E. O. "College Entomology (Indian Print)." Satish Book (1982).
- Fox, R. M. and Fox, J. W. introduction to comparative entomology. Aff. East-West Press Pvt. Ltd. New Delhi 1968.
- Gllott, C. Entomology. Plenum Press, New York, 1982.
- Gullan, P. J.: The insects: An Outline of Entomolgy, 3rd edition. BlacwhalePublishing, Oxford U.K., 2005.
- Lefroy, H. M. Indian Insect Life. JagmanderBook Agency, New Delhi, 1984.

- Metcalf, Clell Lee, Wesley Pillsbury Flint, and Robert Lee Metcalf. "Destructive and useful insects." Destructive and useful insects. Edn 3 1951.
- Nayar, K. Karunakaran, Taracad N. Ananthakrishnan, and B. Vasantharaj David. "General and applied entomology." (1976).
- Pradhan, Shyamsunderlal. "Agricultural entomology and pest control." Agricultural entomology and pest control. (1983).

- Richards, O. W. and Davies, R. G. :Imm's General Textbook of Entomolgy. 10th edition vol. 1 and 2, Chapman and Hall, London 1976.
- Roy, D. N. "Entomology (Medical And Veterinary).-." (1970).
- Snodgrass, R. E. Principles Of Insect Morphology. Tata Mcgraw Hill Publications.New
- Delhi, 1998.
- Tembhare, D. B. Textbook of Insect Morphology, Physiology and Endocrinology, S. Chand. and Co. Ltd. New Delhi, 1984

WiggiEsworth, V. B.: The Evolution Of Insect Wings And Flight. Nature 246: 127-29, 1973.

OPTIONAL COURSE A: PRACTICAL ENTOMOLOGY

Semester X

Paper Code B051005P

Practical

1. Anatomy of common grasshopper, cockroach, honey bee, wasp and dysdercus, mylabris, belestoma (giant water bugs).

2. Dissection and mounting of-

- Sting apparatus of honey bee and wasp.
- Tympanal organs of grasshopper
- Testes of cockroach
- Aristate antennae of housefly
- Different types of mouth parts of insects.
- Different types of wings and antennae of insects.
- Tentorium of grasshopper

3. Identification and comment on insects of different orders and families.

4. Identification with the help of dichotomous keys of common insects from different orders and families.

5. Study of prepared permanent slides of insect morphology and anatomy.

Guidelines for marks distribution of practical exam

Duration: 5 hours **Maximum Marks: 75**

1. Major dissection	15
2. Minor dissection	05
3. Permanent stained preparations	05
4. Identification and comment upon eight spots	24
5. Special identification and comment with the help of dichotomous key	10
6. Viva- voce	04
7. Sessional records:	
• Practical record book	04
• Permanent microscopic preparation exhibits	04
• Collection as a result of field studies	04
Total Marks	75

OPTIONAL COURSE B – ICHTHYOLOGY

SEMESTER X		
Paper Code B051007T	**SYSTEMATICS AND MORPHOLOGY OF FISHES**	
Course Objectives	• To learn origin, classification of fishes and their adaptive radiation. • To understand their morphology and their various habitats.	
Course outcome	**On completion of the M.Sc. with Zoology, students will be able to following points...** • Systematics and classification of fishes. •Origin and evolution of fishes. •Adaptive radiation in fishes. •Morphology of fishes. • Nitration of insects.	
Unit	**Topics**	**Total no. of lectures (60)**
I	Systematics: Classification- evolutionary classification, merits and demerits of Berg's classification; Ostracoderms, Placoderms.	12
II	Origin and evolution of fishes: Elasmobranches, bony fishes.	08
III	Adaptive radiation in fishes - elasmobranches and bony fishes; Hill stream adaptations and deep sea adaptations.	10
IV	Morphology: integument - scales and coloration; Fins and their origin, locomotion, electric and light producing organs.	10
V	Nutrition- food, feeding habits, alimentary canal in relation to its physiology of digestion.	08
VI	Respiration- structure of gills in elasmobranches and bony fishes, gill ventilation; Fish blood as oxygen carrier; Air breathing fishes; Swim bladder and Weberian ossicles.	12

SEMESTER X C – 17		
Paper Code B051008T	**PHYSIOLOGY AND EMBRYOLOGY OF FISHES**	
Course Objectives	• To study the phenomenon of integrated functioning of fishes and to learn their developmental process.	
Course outcome	**On completion of the M.Sc. with Zoology, students will be able to following points...** • Physiology of fishes. • Osmoregulation and mechanism of fishes. • Circulation, excretory and nervous system. • Embryology reproductive system. • Life cycles of fishes.	
Unit	**Topics**	**Total no. of lectures (60)**
I	Physiology: stato-acoustic and lateral line system, chemoreceptors, organ of sight, and organ of smell.	06
II	Osmoregulation and mechanism of water salt balance in fresh water and marine water fish; migration and parental care.	12
III	Circulation, excretory and nervous system.	12
IV	Embryology reproductive system	06
V	Structure and kind of eggs, maturation cleavage an early embryonic development; hatching and post embryonic development including fundamentals of morphogenesis.	14
VI	Endocrine glands: neuro-endocrine and co-ordination.	10

SEMESTER X

Paper Code B051009T	AQUACULTURE AND FISHERIES	
Course Objectives	• To study the culture of economically important aquatic animals under control environmental conditions.	
Course outcome	**On completion of the M.Sc. with Zoology, students will be able to following points...** • Indian aquaculture. • Pearl oyster fishing. • Fisheries. • Induced breeding. • Fish preservation and processing.	
Unit	**Topics**	**Total no. of lectures (60)**
I	Indian aquaculture: composite prawn culture, oyster culture; oyster fishery sea mussels.	08
II	Pearl oyster fishing, fishery, spat collection; culture methods: raft methods, long line methods, rack method, pole culture, bottom culture method, harvesting, cleaning and marketing.	08
III	Net and craft of inland and marine water, electric fishing and eco sounders, effect of lights, temperature, turbidity, dissolved gases and solids in water, types of planktons and their role, maintenance of fresh water aquarium.	10
IV	Fisheries: pond culture and its management, principle cultivable fishes- brief account of indigenous and exotic fishes; Procurement of seed collection, identification and transport of seed.	10
V	Induced breeding- stripping, hypophysation techniques; Special culture: composite fish culture, fish culture in paddy fields, sewage fish culture and integrated fish culture; Fish diseases and their control- fungal diseases, bacterial diseases, protozoan disease induced by pollutants, prophylactic measures.	12
VI	Fish preservation and processing- causes of spoilage, methods of preservation and their merits and demerits, fish pollution and toxicity, age and growth, length and weight relationship, tagging of fish.	12

SEMESTER X		
Paper Code B051010T	**PISCICULTURE AND ECONOMIC IMPORTANCE**	
Course Objectives	• To study the breeding, rearing and transplanting of fishes by artificial means involving raising of fishes commercially in enclosures for food • To understand the economic importance of fishes.	
Course outcome	**On completion of the M.Sc. with Zoology, students will be able to following points...** • Pisciculture. • Quality of culturable fishes. • Methods of fishing. • Diseases in fishes. • Economic importance of Pisciculture.	
Unit	**Topics**	**Total no. of lectures (60)**
I	Pisciculture- definition and aim of Pisciculture, history of Pisciculture in India, types of Pisciculture and methods.	10
II	Quality of culturable fishes, types of cultivable fishes, factors affecting pisciculture, management of pisciculture: breeding pond- types of breeding (natural and induced), fish seed, hatching pit, transport of fish fry to nursery pond, rearing ponds, stocking ponds, harvesting.	10
III	Methods of fishing, fishing industry in India.	10
IV	Diseases in fishes- fungal diseases, bacterial diseases, protozoan diseases and fluke diseases; prophylactic measures for the prevention of fish diseases.	10
V	Economic importance of Pisciculture.	10
VI	By-products of Pisciculture industry and their utilization, Employment potential and income generation.	10

Books: Suggested readings

1. Jhingran VG. 1991. Fish and Fisheries of India, Hindustan Publishing Corporation.

2. A Hatchery Manual for the Common, Chinese and Indian Major Carps by V.G. Jhingran and R.S.V. Pullin, Asian Development Bank, ICLARM, Manila, Philippines

3. Reid GR.1961. Ecology and Inland waters and Estuaries. Rein Hold Corp., New York.

4. Pilley, TVR and Dill, WMA. 1979. Advances in Aquaculture. Fishing News Books, Ltd. England. 11.

5. Pillay TVR and Kutty MN. 2005. Aquaculture- Principles and Practices. Blackwell.

6. Nikolsky GV. 1963. Ecology of Fishes, Academic Press.

7. Norman JR and Greenwood PH. 1975. A History of Fishes, Halsted Press.

8. Potts GW and Wootten RJ. 1984. Fish Reproduction: Strategies and Tactics, Academic Press.

9. De Silva SS & Anderson TA. 1995. Fish Nutrition in Aquaculture. Chapman & Hall Aquaculture Series.

10. Ojha JS. 2005. Aquaculture Nutrition and Biochemistry. Daya Publ.

11. Rath RK. 2000. Freshwater Aquaculture. Scientific Publ.

12. Landau M. 1992. Introduction to Aquaculture. John Wiley & Sons

OPTIONAL COURSE B: PRACTICAL ICHTHYOLOGY

Semester X

Paper Code B051011P

Practical

1. A) anatomy of scoliodon, sting ray, electric ray, wallago and macronis.

   B) accessory respiratory organs of sacobranchus, clarias and anabas.
2. Osteology of a fresh water teleost.

   A) mounting: permanent preparation of different kinds of scales, Ampulla of Lorenzini and fish tissue. skin, muscles, T S of vertebra).

   B) preparation of: (i) girdles (ii) pectoral and pelvic (iii) vertebra and tail fin
3. Examination of prepared slides and whole mount of fishes.
4. Identification and comment on museum specimens of various groups both marine and fresh water fishes.
5. Identification of fresh water fishes.
6. Various structure used in age determination of fishes..
7. Fish physiology:
   (i) Preparation of the stained blood film of fish
   (ii) Differential count of corpuscles
   (iii) Identification of planktons in given samples of water
   (iv) Examination of gut contents
   (v) Adaptation in fishes
8. Survey of fish resources, candidates would be required to have excursions to the coastal regions and fresh water system.

Guidelines for marks distribution of practical exam

Duration: 5 hours **Maximum Marks: 75**

1. Major dissection	15
2. Minor dissection	05
3. Permanent stained preparations	05
4. Identification and comment upon eight spots	24
5. Special identification and comment with the help of fauna and atlas (2 Nos.)	10
6. Viva- voce	04
7. Sessional records:	
• Practical record book	04
• Permanent microscopic preparation exhibits	04
• Collection as a result of field studies	04
Total Marks	75

OPTIONAL COURSE C – PARASITOLOGY

SEMESTER X		
Paper Code B051013T	**PARASITOLOGY – GENERAL PARASITOLOGY**	
Course Objectives	• Provide knowledge about concepts of parasitology, diseases spread by parasites, their cure and prevention. • To provide knowledge of parasitic classification and transmission.	
Course outcome	**On completion of the M.Sc. with Zoology, students will be able to following points...** • Introduction and definition of parasites. • General Classification of protozoan parasites. • Taxonomy and classification of helminthes and Platyhelminthes. • Other zooparasites of Mesozoa. • Various types of diseases.	
Unit	**Topics**	**Total no. of lectures (60)**
I	Introduction and definition of parasitic mode of life, study of parasites, life cycles, host-parasite interactions, invasion, adaptations and their etiology, transmission of parasites, diseases caused by parasites;Types of Parasites.	08
II	Introduction to Broad areas of parasitology: Systematic Parasitology, Parasites of man, livestock, pets and wild animals. Agriculture, Veterinary, Medical Fisheries and, Aquaculture Parasites; Evolution of Parasitism, Vectors of parasites; Applications of Parasitology;	07
III	**Parasitic Protozoa:** General Classification, Classification of parasitic protozoa,General characters of parasitic protozoa. Identification characters, Location, host range, morphology, Structure, life cycle, pathogenecity, epdemiology, treatment and control of: Human Parasitic protozoa:Entamoeba spp., Giardia, Trichomonas, Naeglaria spps, Trypanosoma, Leishmania, Plasmodium, Toxoplasma gondii Balantidium spp.(in herbivorous reptiles,humans), Acanthamoeba spp Acanthamoeba keratitis, Balamuthia mandrilaris ana Sappinia pedata.	14
IV	**Protozoa Parasites of fishes:** Myxozoa, Microsporidia, Ichthyopthirius, Opalinida spp.(in reptiles,amphibians and fishes) and Haemogregarina; Parasites of poultry :Eimeria tenella and Haemoproteus; Parasites of cattle :Babesia and Theileria; Invertebrate protozoa parasites:Gregarina spp; Parasites of Herbivorous reptile etc:Nyctotherus	14
V	Other zooparasites of Mesozoa, porifera, coelenterata, ctenophora, nematomorpha, rotifer, rhyncocoela, annelida, mollusca, crustacea, pycogonida, tardygrada, pentastomatida, echinoderms and vertebrates.	07

VI	**Helminthes:** Taxonomy and classification and characters- Nematodes - secernentea,Aphasmidia/Adenophora; Platyhelminthes-classification and characters of monogenia (ectoparasites of fishes),turbellaria (planarians), trematoda(flukes) and cestoda (tapeworms), larval stages of helminthes, structure and types of larvae.	10

Books recommended-

1.Hyman,LH,The invertebrates. Voll, Protozoa through ctenophora, McGrawHill Book Co. New York

2.parasitic protozoa, vol8, edited Byjulius p Kreier, Springer, Academic press,6 april 1993

3.Read OP Animal Parasitism, Prentice hall, Englewood, New Jersey, USA

4.Baker, JR,Parasitic Protozoa (Hutchinson University Library: Biological Sciences.) Pp. 176.

(Hutchinson: London, November 1969.) Hardback 33s; paperback 14s.

5. Thomas C Cheng, General parasitology, 2nd edition,Academic press, ISBN-13:978-0121707552,Kindle e textbook store.

6. Read OP,Animal Parasitism, Prentice hall, Englewood, New Jersey, USA

SEMESTER X

Paper Code B051014T	PARASITOLOGY – BIOLOGY OF PARASITES	
Course Objectives	• Provide knowledge about concepts of parasitology, diseases spread by parasites, their cure and prevention. • To give concepts which can be used professionally.	
Course outcome	**On completion of the M.Sc. with Zoology, students will be able to following points...** •Taxonomy, characters & General Pattern of life cycle of Nematodes. •Morphology,, Host Range Biology. •Biology of Platyhelminthes parasites. •General characters and Classification of Trematoda. • Host and parasites interactions.	
Unit	**Topics**	**Total no. of lectures (60)**
I	Taxonomy, characters & General Pattern of life cycle of Nematodes (animals, plant parasitic &Entomopathogenic), General Organization, -and morphology Morphology,, Host Range Biology; Specialized structures associated with the cuticle, digestive, excretory system, reproductive system and sense organs. Nematodes and diseases; behavior of nematodes. Pathogenesis, mortality/lethality caused by nematodes, Economic importance,Diseases Caused by Nematodes;Management of Nemic Diseases;Nematicides and their Uses;Life cycle, pathogenecity and control of -Trichinellaspiralis, Trichuristrichiura,Oesophagostomum, Toxocara, Draunculusmediensis, Strongyloidesstercoralis forms of Haemonchus, Ancylostomaduodenale, Ascarislumbricoides, Wuchereriabancrofti, Enterobius vermicularis. Wuchereriabancrofti, Enterobius, Angiostrongyluscantonensis.	09
II	Biology of Platyhelminthes parasites; Egg containing organs in cestodes. ultrastructure of tegument. Hosts and its types, Life cycle,; Parasitic adaptations in structures and physiology. Adhesive organs in General organisation, Ultrastructure of tegument in Trematodes,Morphology,Structure, adhesive organs, life cycle, larval Fasciola hepatica (onchomeracedium,miracidium,cercaria,metacercaria), pathogenecity, diseases and control of- Polystoma, Diplozooan, Gyrodectulus	07
III	Trematoda: General characters and Classification, Types of Trematodes, Larval forms; Identification characters, morphology ,Structure, adhesive organs,lifecycle,(onchomeracedium,miracidium,cercaria,metacercaria),pathoge necity, diseases and control of- digenetic trematodes: Chlonorchissinensis, Paragonimuswestermani and Blood flukes (Schistosomahaematobium, Schistosomamansoni and Schistosomajaponicum),Fasciolabuski, Opisthorchis, Paramphistomum, Cotylophoron and Dicrocoelium	10
IV	Cestoda: General characters and Classification, Types and Larval forms; Identification characters, morphology,Structure, adhesive organs, par uterine organ, life cycle, larval forms (metacestodes),pathogenecity and control of- Hymenolepis nana and Hymenolepisdiminuta, Diphyllobothriumlatum, Taeniasolium, T. saginata,Moniezia, Echinococcusgranulosus, Dipylidiumspp, Spirometraspp.,Acanthocephala-Macracanthorhynchushirudinaceus.	10

V	Arthropods: Insects and human diseases. Role of insects in transmission of parasitic diseases.;; Identification characters, morphology, structure, biology, life cycle, pathogenecity and diseases caused and control of-Bugs-Cimex, lice-Pediculus, Haematopinus flies, flesh flies, ticks, mites, fleas, maggots of fly spp. Causing 'myiasis' and Anopheles, Culex and Aedes, clinical and medical importance, insect vectors, its control and disease mitigation	09
VI	Nutrition Uptake and digestion in protozoa, trematoda, cestoda and nematode. Metabolism- Carbohydrate, protein metabolism and energy assimilation and utilzation; Physiology of respiration in protozoa, trematoda, cestoda and nematode; Excretion -Excretory and lymphatic systems in termatodes; body waste excretion, Nitrogen excretion and water and ionic regulation in parasites. Nervous system and sense organs- Morphology of nervous system and sense organs, nervous transmission and neurosecretion and behaviouralcoordination Parasiticreproduction- Asexual, sexual, reproduction, synchronization of parasite with host reproduction,Eggshell- Formation in helminthes, development of eggs and chemistry of egg shell formation, role of Mehli's glands, larvae its transfer with in host body, host to animals, animals to man, antibiotics, its use and resistance. Sporulation or encystment, parasitic castration	15

Books recommended-

1. Read OP,Animal Parasitism, Prentice hall, Englewood, New Jersey, USA

2. Cheng TC,The biology of Animal Parasites, WB Saunders an Co., Philadelphia and London.

3. Hyman,LH,The Invertebrates, vol II and III,McGraw Hill, NY.

4. Dawes, B. The Trematoda. Cambridge University Press

5. Chatterjee: Parasitology, Chatterjee Medical Publishers, 1981.

6. Chandler & Read: Introduction to Parasitology, Wiley, 1970.

7. Noble & Noble: Parasitology, Lea &Febiger, 1973. 4. Smith: Animal Parasitology, Cambridge University Press, 1996.

8. Roberts L.S. and Janovy J. Foundations of Parasitology,, McGraw-Hill Publishers, New York, USA.

9. Cheng TC,The biology of Animal Parasites, WB Saunders an Co., Philadelphia and London.

SEMESTER X

Paper Code B051015T	PARASITOLOGY – PARASITOLOGICAL TECHNIQUE	
Course Objectives	• Provide knowledge about concepts of Parasitology, diseases spread by parasites, their cure and prevention. • To provide knowledge of parasitic diagnosis and various techniques used in parasitology.	
Course Outcome	**On completion of the M.Sc. with Zoology, students will be able to following points...** • Tools and techniques of routine diagnostic use. • Techniques for preservation and examination. • Immunity and parasitic populations Immunodiagnosis. • Quantitative analysis of Parasites. • Biotechnology in the development of vaccines for animal parasites.	
Unit	**Topics**	**Total no. of lectures (60)**
I	Tools and techniques of routine diagnostic use, microscopic methods used for morphological study of parasites. Methods and Laboratory techniques for collection, preservation and examination of protozoa. Blood, soil and stool tests, in vitro cultivation of parasites. Various Technologies that are significant for routine diagnostic use, microsopic and morphological analysis of parasites. Methods of collection, preservation and preparation of helminthes parasites and their identification.	07
II	Techniques for preservation and examination of helminth parasites; blood and stool tests, in vitro cultivation of parasites; Diagnostic tools for the detection of specific blood-borne and intestinal parasitic diseases: DHA or IHA: direct or indirect hemagglutination assay; RDT: rapid diagnostic test; PCR: polymerase chain reaction; RT-PCR: real-time polymerase chain reaction; QT-NASBA: quantitative nucleic acid sequenced-based amplification; RT-QT-NASBA: real-time quantitative nucleic acid sequenced-based amplification; LAMP: loop-mediated isothernal amplification; OC-PCR: oligochromatography Polymerase chain reaction; LDMS: laser desorption mass MALDI-TOF: matrix-assisted spectrometry; desorption/ionization time of flight; SELDI-Tof: surface- enhanced laser desorption/ionization time of flight, ss	16
III	Immunity and parasitic populations Immunodiagnosis, intradermal tests and their significance, immunopathology in parasitic infections. Vaccination and parasitism, vaccines against protozoan and helminth parasites. Role of Biotechnology in the development of vaccines for animal parasites; Approaches and Diagnostic tools for the detection of specific blood-borne and intestinal parasitic diseases: FAST-ELISA: Falcon assay screening test; RIPA-ELISA: radioimmunoprecipitation assay; DFA or IFA: direct or indirect immunofluorescence assay; LIPS: luciferase immunoprecipitation system; CATT: Card Agglutination test for Trypanosomiasis; Immunoelectrophresis, IFA: immunofluorescent assay, EIA: Enzyme immunoassay, RT- PCR: Real time PCR, IB: immunoblot.	16

IV	Technologies that are significant for routine diagnostic use, microscopic and morphological analysis of parasites; Methods and Laboratory techniques for collection preservation and examination of helminth and arthropod parasites; blood and stool tests, in vitro cultivation of parasites, Culturing, Harada-Mori technique culture method (Strongoloides), media used, suspension and agar plate culture.	07

V	Diagnostic tools for the detection of specific intestinal parasitic diseases:Random Amplified Polymorphic DNA (RAPD),Amplified Fragment Length Polymorphism (AFLP),Restriction Fragment Length Polymorphism (RFLP), microsatellite marker method, LuminexxMAP-based technology.	08
VI	Quantitative analysis of Parasites: Use of statistical analysis in Aggregated distribution of parasites among host individuals-Chi- Square Test, Fisher's Exact Test, Bootstrap test, Mood's median test, stochastic equality test.	06

Books recommended-

1.Cobb,NA, Nematodes and their relationships, Year book, US Deptt. Of Aquaculture, 1914:457-490

2.Corfton, HB,Nematodes,Hutchinson University Library,London.

3. Dewes, B. The Trematoda, Cambridge University Press.

4. Smyth., The Animal Parasitology,Cambridge University Press.

5.Chandeler,AC., Introduction to Parasitology, J.Wily and Sons.

6. Thomas C Cheng, General parasitology, 2" edition, Academicpress,ISBN-13:978-0121707552,Kindle e textbook store.

7. 1.Read OP,Animal Parasitism, Prentice hall, Englewood, New Jersey, USA

8.Cheng TC,The biology of Animal Parasites, WB Saunders an Co., Philadelphia and London.

9.Hyman,LH,The Invertebrates, vol II and III, McGraw Hill, NY.

SEMESTER X

Paper Code B051016T	PARASITOLOGY – HOST PARASITES INTERACTION	
Course Objectives	• Provide knowledge about concepts of parasites interactions. • To provide knowledge of parasitic relationships.	
Course outcome	**On completion of the M.Sc. with Zoology, students will be able to following points...** • Host-Parasite Relationship. • Taxonomy and phylogenetic relationships of Parasites. • Plant Nematode Relationship. • Population ecology. • Vectors of human diseases.	
Unit	**Topics**	**Total no. of lectures (60)**
I	Host-Parasite Relationship, Parasite Specificity, parasitic associations, Introduction and effect of parasites on hosts, toxic and poisonous secretion, utilization of host, nutrition, parasitic induced alterations, host specificity, Diversity between parasitic organisms.	10
II	Taxonomy and phylogenetic relationships of Parasites; Recent developments in DNA based diagnostic methods to identify species and to investigate the relationship between groups at various taxonomic scales; Taxonomic relationships of host variety in vertebrates and invertebrates, Parasitic adaptations, Host Resistance, Host parasite interplay, Nematode Interactions with Micro-Organisms,Mutualism.	10
III	Plant Nematode Relationship: Host parasite relationship, Mechanism involved in injury & histopathology of infected tissue, Interaction with other microorganism; Soil and plant parasitic nematodes with special reference to Meloidogyne ,Aphelenchoides. Types of Plant nematodes. Structure, Life Cycle, Epidemiology, Pathogenecity and Control of Root knot and Cyst Nematodes. Crop losses and economic damage.	10
IV	Population ecology; host selection, specialized traits and life- history strategies, stabilization of parasitic life, and colonization inside hosts. Parasite-avoidance strategies employed by hosts; Conservation biology of parasites; Degenerative characters of parasites; Fate of Parasite, Parasitic Adaptations; Disguising relationships between species- Host Parasite Relationship: Host specificity {(Ectoparasite: 1. Larval stages parasitic and adult free living, 2. Adult parasitic and larval stages free living, 3.. Both larva and adult parasitic); (Endoparasite: 1. Larval stages parasitic and adult free living; 2. Adult parasitic and larval stages free living)}, Action of Parasite upon their Hosts (Effects of parasites upon Invertebrates, Effects of parasites upon Vertebrates).	12
V	vectors of human diseases ;Mode of transmission of pathogens by vectors, Chemical, biological and environmental control of anthropoid vectors; Insects carrying Vesication, Urtrication and envenomation, venom toxins, Arachnida-Biology, importance, diseases caused and bio-control	8

VI	Parasite transmission- Mechanism of host selection, penetration and circadian rhythm. Periodicity in parasites; ecology of parasitism- Host finding and selection and its consequences, negative interaction, problems of escape and dispersal, problem of mate finding, niche biology, population dynamics, crowding effect., microenvironment and phases of parasitism; Growth and establishment of parasite- Hatching, establishment, site selection, migration.	10

Books recommended-

1. Chandeler,AC., Introduction to Parasitology,J.Wily and Sons.

2. Thomas C Cheng, General parasitology, 2nd edition, Academic press, ISBN-13:978-0121707552, Kindle e textbook store.

3. Read OP,Animal Parasitism, Prentice hall, Englewood, New Jersey, USA

4. Hyman, LH,The Invertebrates, vol II and III,McGraw Hill, NY.

5. Edited By Gert Flik, Geert Wiegertjes-Host-Parasite Interactions, ISBN 9781859962985 Published July 1, 2004 by Taylor & Francis

OPTIONAL COURSE C: PRACTICAL PARASITOLOGY

SEMESTER X		
Paper Code B051017P	**PARASITOLOGY – PRACTICAL**	
Unit	**Topics**	**Total no. of lectures (60)**
I	Spotting- Identify and comment Trichuristrichiura, Oesophagostomum, Toxocara, Draunculus mediensis, Haemonchus, Strongyloidesstercoralis Ancylostomaduodenale, Ascarislumbricoides, Wuchereriabancrofti, Enterobiusvermicularis.Ascaris, Wuchereriabancrofti, Enterobius, Angiostrongyluscantonensis. Polystoma, Diplozooan, Gyrodectulus, Paragonimuswestermani, Schistosoma Chlonorchissinensis, sp., Diphylobothrium, Acanthocephala, Macracanthorhynchushirudinaceus Liver flukes, Fasciola hepatica and Dicrocoeliumdendriticum, egg of Fasciola, a typical larval stage and the adults, Taenia tapeworm eggs, Types of larval tapeworms, the cysts such as cysticercus of Taeniasaginata, coenurus of Taeniamulticeps, hydatid of Echinococcus, Adult tapeworms of different sizes and shapes such as Dipylidiumcaninum, Echinococcusgranulosus, Anoplocephala, Taneiapisiformis. Entamoebahistolytica, Giardia, Trichomonas, Naeglariaspps, Trypanosoma, Leishmania, Plasmodium, Toxoplasma gondii, Balantidium spp. (in herbivorous reptiles, humans), Acanthamoebaspp, Acanthamoeba keratitis, BalamuthiamandrilarisanaSappiniapedata; Myxozoa, Microsporidia, Ichthyopthirius, Opalinida,Haemogregarina, Eimeria ,Tenella, Haemoproteus,Babesia, Theileria, Nyctotherus. WM, TS and LS of above mentioned parasites, as applicable	11
II	Routine diagnosis microscopic study for morphology of protozoa. Collection, preservation and examination of protozoan parasites. Blood, soil and stool tests, in vitro cultivation of parasites. Protozoan parasites of the *Periplanetaamericana, earth worm and human faeces.*	11

III	Diagnosis for nematodes,their eggs and cysts in poultry faeces, microsopic and morphological analysis of parasites. Diagnostic tests of, Soil for nematodes,their eggs and cysts, microsopic and morphological analysis of parasites. Field Collection of nematodes: Extracting nematodes from soil and plant samples, their identification, Collection, preservation and preparation; theirstudy and sampling (soil and plant samples). Processing nematodes for observation- Identification, study of their morphology and structures associated with cuticle, digestive system Observation of Asexual, sexual, reproduction, synchronization of parasite with host reproduction, in vitro cultivation of parasites; Egg shell	12
IV	Platyhelminthes -Blood and stool tests for Diagnosis and detection of specific blood-borne and intestinal parasitic diseases. in vitro cultivation of Platyhelminthes parasites-Hatching in vitro of oncospheres/hexacanth larvae of Hymenolepisdiminuta or any other parasite.	10
V	Platyhelminthes-Glycogen utilisation and deposition in flatworm parasites Study of parasitic damage such as as fluke infected liver and a lung with Echinococcus cysts.	05
VI	Quantitative analysis of Parasites: Use of statistical analysis in Aggregated distribution of parasites among host individuals-Chi-Square Test, Fisher's Exact Test, Bootstrap test, Mood's median test, stochastic equality test.	11

Books recommended-

1.Cobb,NA, Nematodes and their relationships, Year book, US Deptt. Of Aquaculture, 1914:457-490

2.Corfton, HB,Nematodes,Hutchinson University Library,London.

3. Dewes, B. The Trematoda, Cambridge University Press.

4. Smyth., The Animal Parasitology, Cambridge University Press.

5.Chandeler,AC., Introduction to Parasitology,J.Wily and Sons.

6. Thomas C Cheng, General parasitology, 2nd edition, Academicpress, ISBN-13:978-0121707552,Kindle e textbook store.

7. 1.Read OP,Animal Parasitism, Prentice hall, Englewood, New Jersey, USA

8. Cheng TC,The biology of Animal Parasites, WB Saunders an Co.,Philadelphia and London.

9.Hyman, LH,The Invertebrates, vol II and III,McGraw Hill,NY.

Marks Distribution Of Practical Exams:- As per the format given in course Entomolgy Practical

OPTIONAL COURSE D WILDLIFE AND ENVIRONMENTAL BIOLOGY

SEMESTER X		
Paper Code B051019T	**WILDLIFE ECOLOGY**	
Course Objectives	• **This course is designed to imparts the knowledge about the basic concept and structure of the wildlife ecology, ecosystem, concept of community, animal habitat interaction, behavioural aspects |such as feeding ecology, frugivory and predation. Food selection and pattern of habitat utilization.** • **Group size and mate selection.**	
Course outcome	**On completion of the M.Sc. with Zoology, students will be able to following points...** • Population Ecology. • Habitat Ecology. • Behavioural Ecology. • Community Ecology. • Factors governing species diversity.	
Unit	**Topics**	**Total no. of lectures (60)**
I	**Population Ecology:** Demographic and life history parameters, r & K selection, allometry, aging and sexing. Life tables, age and stage structures models, methods of estimation of life history parameters. Population dynamics: exponential, logistic and other forms of growth of population, density dependent and independent growth, predator-prey systems, carrying capacity,	15
II	**Habitat Ecology:** Historical, ecological & evolutionary perspectives of Habitat Ecology, basic concepts. Ecology of major terrestrial Grasslands, Wetlands, Forests. habitats: Deserts, Habitat diversity: edge, ecotones, interspersion and juxtaposition. Physical and anthropogenic factors influencing terrestrial habitats. Habitat degradation and fragmentation. Successional changes and wildlife habitat. Evaluation and monitoring of wildlife habitat parameters, use and availability of habitatresources.	15

III	**Behavioural Ecology:** Proximate and ultimate mechanisms, causal and functional explanations in animal behaviour. Group living: costs, benefits and optimal group size. Predator prey relationships and evolutionary arms race. Competition for resources: ideal free distributions and resource defence. Concept of optimality in decision making in animals; optimal foraging theory. Sexual selection; parental care and mating systems. Cooperation and helping in mammals, birds and fishes	15
IV	**Community Ecology:** Definition and nature of communities; scale and approaches. Measurementofspecies richness; diversity;evenness. Community structure, organization and its stability (guilds, resource partitioning, niche, competitive exclusion). Factors governing species diversity. Models of competition; simple community models. Concept and measurement of niche. Trophic processes. interactions; top-down and bottom-up Energy and productivity and its implications for species diversity. Functional diversity and food webs. Evolution of communities and neutral theory.	15

Suggested Readings:

1. Elements of ecology and Filed Biology by R.L. Smith
2. Ecology and our endangered life support system by Eugene, P. Odum
3. The Science of Ecology by Roufg Garden and Ehrlich
4. Concept of Ecology by Edward.J. Kormondy
5. Community Ecology: Pattern and Process by Anderson and Kikkawa
6. Ecological Concept by J.M. Cherrett
7. Comparative Ecology by Jiro Kikkawa
8. Population Ecology: A unified study of Animals and Plants by M. Begon.
9. Ecology of Populations by Boughy and S. Arthur
10. Viable Population for Conservation by Michael E. Soule
11. An Introduction to Plant Population Ecology by J. Silvertown
12. Guide to the Study of Animal Population by J. T. Tanner
13. An Introduction to the Study of Animal Population by H. G. Andrewartha
14. Population Growth Estimation by E. S. Marks

Suggestive digital platforms web links-

1. Pubmed [www.ncbi.nlm.nih.gov/pubmed]
2. Science direct [www.sciencedirect.com]
3. Nature publishing group [www.nature.com]
4. Cochrane library [www.cochranelibrary.org]
5. High wire [www.stanfordhighwire.org]

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SEMESTER X

Paper Code B051020T	WILDLIFE BIODIVERSITY AND CONSERVATION	
Course Objectives	• The course is expected to help students to study classification and morphological, physiological adaptation and reproductive strategies of wildlife in Indian sub-continent. • Course will help to know the initiatives taken by the government of India for the conservation and protection.	
Courseo utcome	**On completion of the M.Sc. with Zoology, students will be able to following points...** • Introduction of Indian Wildlife. • Causes of wildlife depletion. • Principle and Management grasslands. • National and International conventions & summits on conservation. • National and international zoological institutes.	
Unit	**Topics**	**Total no. of lectures (60)**
I	Introduction of Indian Wildlife, wildlife distribution in ecological subdivision of India, IUCN categories of wildlife. Protected area network: National parks, Wildlife sanctuaries, Biosphere reserves and Zoos in India Gene pool, habit, habitat and breeding biology of endangered mammals.	15
II	Causes of wildlife depletion: Habitat fragmentation, habitat destruction, commercial wildlife exploitation, overgrazing etc. Wildlife conservation policies and programmes, special projects for endangered species: Project Tiger, Asiatic Lion Reintroduction Project, Crocodile conservation Project, Project elephant, Project snow leopard, Project | hangul.	15
III	Principle and Management grasslands. practice of wildlife management: of special habitats; riparian zones, Introduction to conservation biology, conservation values and ethics of conservation of natural resources. Conservation of biodiversity, patterns and processes, concepts of biodiversity, levels of biodiversity, genetic diversity, intra specific diversity, species richness, richness of higher taxa, ecosystem and biome diversity.	15
IV	National and International conventions & summits on conservation, Ex-situ and in-situ conservation, conservation breeding| strategies. Institutions and their role in conservation: Zoos, Natural History Museums and Collections, Zoological Survey of India. National and international zoological institutes, societies and academic bodies. Brief account of Wildlife Acts and their amendments in India and World. Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).	15

Suggested Readings:

1. Asish Ghosh. 2007, Biodiversity Conservation. APH Publishing Corporation, New Delhi,

2. Kasthuri Reddy, 2010. Biodiversity and Land Conservation. Pacific Publication, New Delhi.

3. Pawan Kumar 'Bharti', Avinash Chauhan, Kaoud, H.A.H. 2013. Aquatic Biodiversity and Pollution. Discovery Publishing House, New Delhi.

4. Pullaiah, T. 2006. Biodiversity in India. Regency Publications, New Delhi.

5. Sharma, B.D, Indian Wildlife Resources Ecology and Development, Daya Publishing House, Delhi.

6. Trivedi, P. R. 2004. Natural Resources Conservation. APH Publishing Corporation, New Delhi. 7. Bose, N.K. 2009. Wildlife Management in India. Cyber Tech Publications, New Delhi.

8. Hosetti, B. B and M. Venkateshwaralu. 2001. Trends in Wildlife Biodiversity

9. Conservation and management. Daya Publishing House, New Delhi.

10. John M. Fryxell, Anthony R. E. Sinclair and Graeme Caughley. 2014, Wildlife

11. Ecology, Conservation and Management. Wiley-Blackwell, US.

12. Mallapureddi Vikram Reddy. 2008. Wildlife Biodiversity Conservation. Daya Publishing House, New Delhi.

13. Nithin Patil. 2016. Models for Planning Wildlife Conservation in Large Landscapes. Agrotech Press, Jaipur, New Delhi.

14. Ranga, M.M. 2012. Wildlife Management and Conservation. Agrobios (India).

15. Sharama, B.D., Indian Wildlife Resources Ecology and Development. Daya Publishing House, New Delhi.

Suggestive digital platforms web links-

1. Pubmed [www.ncbi.nlm.nih.gov/pubmed]

2. Science direct [www.sciencedirect.com]

3. Nature publishing group [www.nature.com]

4. Cochrane library [www.cochranelibrary.org]

5. High wire [www.stanfordhighwire.org]

SEMESTER X

Paper Code B051021T	ENVIRONMENTAL PHYSIOLOGY	
Course Objectives	• This paper aims to build on conceptual understanding of students by exposing them to the basic principles behind various environmental processes. The course is expected to help students to understand to study about environment, properties, structure and composition of atmosphere. • Course will help to know about the Mass and energy, Biogeochemical cycles, climates, natural resources etc which are major aspects of environment.	
Course outcome	**On completion of the M.Sc. with Zoology, students will be able to following points...** • Definition of Environment, Earth, Man and Environment. • Geographical classification, Distribution and zones. • Natural resources and its types of natural resources. • Role of an individual in conservation of natural resources. • Natural resources: Types of natural resources.	
Unit	**Topics**	**Total no. of lectures (60)**
I	Environment: Definition of Environment, Earth, Man and Environment, Evolution of environment, Physico-chemical and Biological Characteristics of environment. Structure and composition of atmosphere, hydrosphere, lithosphere and biosphere. Geographical classification, Distribution and zones.	15
II	Mass and energy: Transfer of mass and energy across various interfaces. First and second laws of thermodynamics, heat transfer processes, Biochemical cycles, gaseous and sedimentary turnover rate and turnover item, General relationship between landscape and climate. Climates of India, Indian monsoon, Drought, Tropical cyclones and western disturbances. Atmosphere stability and instability, temperature inversion and mixing heights, heat balance of the earth- atmosphere system, global climate change.	15
III	Natural resources: Types of natural resources, Forest resources: use and over-exploitation, deforestation, timber extraction, mining, dams and their effects on forests and tribal people. Water resources: use and utilization of surfaces and ground water, floods drought, dams-benefits problems. Mineral resources: environmental effects of extracting and using mineral sources. Food resources: World food problems overgrazing, effects of modern agriculture, fertilizers-pesticides problems, Water logging, salinity. Land resources: Land as a resource, Land degradation, man induced landslides, soil erosion and desertification	15

IV	Energy resources: Concept and demand of energy, Growing energy needs, Renewable and nonrenewable sources, use of alternate energy sources, Wind energy, Solar energy, water as source of energy, Biofuels prodution, use and sustainability, use and over exploitation of energy sources and associated problems. Role of an individual in conservation of natural resources. Equitable use resources for sustainable lifestyles.	15

Suggested Readings:

- Renewable Energy - Environment and Development: M. Dayal; Konark Pub. Pvt. Ltd.
- Alternative Energy: S. Vandana; APH Publishing Corporation
- Nuclear Energy - Principles, practice and prospects: S. K. Agarwal; APH Publishing Corporation
- S. Glassstone, D. Van Nastrand, Source book on atomic energy, 3rd Edition, Germany, 1967
- M. Eisendbud, Environmental radioactivity. Academic Press
- E.D.Enger, B.E. Smith, Environmental Sciences- Astudy of Inter relationships, WCB Publication
- Bio-Energy Resources: Chaturvedi; Concept Pub.
- National Energy-policy, crisis and growth: V S. Mahajan; Ashis Publishing House
- Geography and Energy - Commercial energy systems and national policies: J. D. Chapman

Suggestive digital platforms web links-

- Pubmed [www.ncbi.nlm.nih.gov/pubmed]
- Science direct [www.sciencedirect.com]
- Nature publishing group [www.nature.com]
- Cochrane library [www.cochranelibrary.org]
- High wire [www.stanfordhighwire.org]

SEMESTER X

Paper Code B051022T	ENVIRONMENT POLLUTION AND MANAGEMENT	
Course Objectives	• Paper deals with different aspects of environmental contamination, which have adverse effects on human health. • It will lay emphasis on understanding mechanisms of pollutants impacting human health by developing an understanding of different types of pollutants, their sources and mitigation measures.	
Course outcome	**On completion of the M.Sc. with Zoology, students will be able to following points...** • Air pollution and its types. • Toxicology. • Environmental Impact Assessment (EIA). • Environmental clearance for establishing industries. • Radioactive pollution: Sources and hazards.	
Unit	**Topics**	**Total no. of lectures (60)**
I	Air pollution: Types and sources, Effects of SO2, NO2, 03, HF, photochemical smog and particulates on plants and human health, aeroallergens and allergies. Ozone layer depletion: Causes and consequences. Noise pollution: Types, sources and effects on human health. Water Pollution: Types and sources; Effects on water quality, plants and human health; Thermal pollution. Soil pollution: Types and sources, Radioactive pollution: Sources and hazards. Solid waste: Sources and effects. Bio-monitoring and bio-indication.	15
II	Toxicology: Principles of toxicology, dose-response relationships, Chronic and acute toxicity; Effective concentration, LD50, Median tolerance limit and Margin of safety; Toxicity testing (Holistic and Numeric approach). Uptake, bioaccumulation, bio-transformation and excretion of xenobiotics. Role of temperature and humidity in human health. Effects of pesticides and heavy metals on ecosystems, mechanisms of metal toxicity, metallophytes.	15
III	Environmental Management: Principles and strategies. Indicators of environmental quality, environmental cost- benefit analysis; Environmental management system (EMS): ISO-14000; Environmental audit; Environmental clearance for establishing industries;	15

IV	Environmental Impact Assessment (EIA); EIA guidelines 1994, Environmental taxes. International trade and environment; Trade Related Intellectual Properties (TRIPS), Intellectual Property Rights (IPRs), Corporate environmental ethics.	15

Suggested Readings:

- A.K. De. (3rd Ed). 2008 Environmental Chemistry. New Age Publications India Ltd.
- C. Shaw and J. Chadwick. 1997. Principles of Environmental Toxicology. Taylor& Francis Ltd.
- S.C. Santra. 2011. Environmental Science. New Central Book Agency.
- Ira. S. Richards. 2008. Principles and Practices of Toxicology in Public Health.
- C. N. Sawyer, P. L. McCarty and G. F. Parkin. 2002. Chemistry for Environmental Engineering and Science. John Henry Press.
- H. H. Rump. 2000. Laboratory Manual for the Examination of Water, Waste water and soil. Wiley-VCH.
- R. K. Sapru. 1987. Environmental Management in India (Vol. I & II). Ashish Publishing House.

Suggestive digital platforms web links-

- Pubmed [www.ncbi.nlm.nih.gov/pubmed]
- Science direct [www.sciencedirect.com]
- Nature publishing group [www.nature.com]
- Cochrane library [www.cochranelibrary.org]
- High wire [www.stanfordhighwire.org]

OPTIONAL COURSE D: PAPERCode

B051023P

PRACTICAL WILDLIFE ANDENVIRONMENTAL BIOLOGY

Max. Marks: 100	Min. Passing Marks: as per university schedule	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-4.		
Unit	**Topics**	**Total no. of lectures (60)**
I	**Any two tour** **Orientation Tour** Orientation to field biology and natural history. Observations and collection of study material, wildlife signs and evidences. **Techniques Tour (Ecology, Study Techniques, Wildlife & Vegetation Studies).** Exercise on wildlife population parameters and census methods for various species. Vegetation studies. Studies on animal ecology. **National Park Tour }** Visit a well known National Park (Corbett, Kanha, Ranthambore, Bharatpur) **Specialized Techniques Tour** Visit important wetlands in the country, the appraisal of the habitat, waterfowl census, and documentation of threats to wetlands.	15
II	Study of Social Organization in termites. Exercise to understand differential niches of two related taxa. Exercise to determine home-range of species. Sampling techniques for collection and observation of planktons. Application of transect and quadrat methods for animal abundance estimation. Life tables exercise and Population structure exercise. Estimation of abundance of wild cimals by Line transects method.	15

	Demonstration and study of the working principles of common instruments used in wildlife studies. Adaptations in animals: use pictures or photographs with suitable labels. Examination and drawing of museum materials: skulls, feet, beak and eggs Study and identification of pugmark and tracing. Identification and observation of Invertebrate.. Following the individual animal to mark its home range. Study of epidermal derivatives; comparative morphology of dentition and skull. Examination and drawing of museum materials: skins, skulls, feet, eggs and nests of characteristic species. Study of Birds skin preparation and measurement of specimens. Study of morphology and identification of birds based on their feathers. Study and identification of birds based on their calls. Study of different bird nesting pattern. Study of composition of abandone bird nest: contents and weights in priority The role of zoos, aquariums and botanic gardens in conservation. On a map of India locate & demar ate major tiger reserves/ national parks/wildlife sanctuaries. Using photographs / paintings / colored drawings identify and study distribution and ecological role of Endangered species of India Using photographs / paintings / colored drawings identify and study distribution and ecological role of Endemic species of Uttar Pradesh. Using photographs / paintings/colored drawings identify and study the extinct species. Exercise on human wildlife conflict; questionnaire survey. Study of lab vertebrate specimens. Comparative morphology of denti ion. Comparative morphology of skull. Mapping the distribution of primates, carnivores and ungulates in India. Study on different wild animal coats.	15
III	Mapping and distribution of 'mates, carnivores and ungulates.	
	Test of Soil samples for- pH, Texture, Total organic content. Test of Soil samples for- N. P, K contents. Test of Water samples for- Dissolved Oxygen, BOD, and COD. Test of Water samples for- Salinity, pH, hardness, Calcium, Magnesium, pH, conductivity, TLS etc.	15
IV	Demonstration of LC50 & LD50.	

Suggested Readings:

- Arora B. M., Editor, Indian Wildlife Yearbook, AIZ & WV, Bareilly and Central ZooAuthority, New Delhi, 2002
- Brander, A.A, Wild Animals in Central India, Natraj Publisher, Dehradun.
- Bruce, C. Glavovic, Mic Kelly Robert Kay and Ailbhe Travers. 2015. Climate Change and the Coast. CRC Press, Taylor and Francis Group.

- Kadambari Sharma. 2010. Human Conflict and Wildlife Conservation. New Delhi,Jnanada Prakashan.
- Mallapureddi Vikram Reddy. 2008. Wildlife Biodiversity Conservation, New Delhi,Daya Publishing House.
- Elements of ecology and Filed Biology by R.L. Smith
- Ecology and our endangered life support system by Eugene, P. Odum
- The Science of Ecology by Roufg Garden and Ehrlich
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- An Introduction to Plant Population Ecology by J. Silvertown
- Guide to the Study of Animal Population by J. T. Tanner
- An Introduction to the Study of Animal Population by H. G. Andrewartha
- Population Growth Estimation by E. S. Marks
- Ali, Salim (1997). The Book of Indian Birds, Oxford University Press, Mumbai.
- Bhamarh, H.S and Kavita Juneja. 2002. Introduction to Birds. Anmol Publication pvtltd. India.
- Gurudarshan Singh and H. Bhaskar, 2003. An Introduction to Birds. Campus Book.New Delhi.
- Khanna, D.R and P.R, Yadav, 2005. Biology of Birds. Discovery Publishing House.New Delhi.
- Rahmani, Asad R. & Ugra, Gayatri, Birds of Wetlands and Grasslands. BombayNatural History Society, Mumbai.
- Sirsat CV. 2017. The Birds. Oxford Book Company, New Delhi.

Suggestive digital platforms web links-

- Pubmed [www.ncbi.nlm.nih.gov/pubmed]
- Science direct [www.sciencedirect.com]
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- Cochrane library [www.cochranelibrary.org]
- High wire [www.stanfordhighwire.org]

Marks distribution of practical exams:- As per the format given in Entomolgy Practical