KISAN POST GRADUATE COLLEGE, BAHRAICH (UP) 271801
(An Autonomous College)

Proposed Structure of syllabus for the
PROGRAM: M.Sc.
SUBJECT: Zoology

Syllabus developed/proposed by

S. No.	Name of BoS member	Designation	Department	College/University
1	Dr. Vineet Kumar	Convener	Zoology	Kisan Post Graduate College, Bahraich
2	Prof. Indu Singh	University Nominee	Zoology	Kamla Nehru Institute of Physical and Social Sciences, Sultanpur
3	Dr. Shilpa Deshpande Kaistha	Subject Expert	School of Life Sciences and Biotechnology	Chhatrapati Shahu Ji Maharaj University, Kanpur
4	Dr. Sadguru Prakash	Subject Expert	Zoology	Maharani Lal Kunwari P.G. College, Balrampur
5	Mr. Arbind Kumar	Member	Zoology	Kisan Post Graduate College, Bahraich
6	Dr. Sudha Shukla	Member	Zoology	Kisan Post Graduate College, Bahraich
7	Dr. Anjani Kumar Shukla	Member	Zoology	Kisan Post Graduate College, Bahraich
8	Dr. Brijesh Kumar Singh	Member	Zoology	K.S. Saket P.G. College, Ayodhya

Course Code		Course Title	Credits	T/P	Evaluation	
					CIE	ETE
A	B	C	D	E	F	G
SEMESTER I (YEAR I)						
B050701T	CORE	Non-Chordates: General account	5	T	25	75
B050702T	CORE	Biological Tool and Techniques	5	T	25	75
B050703T	CORE	Animal Physiology	5	T	25	75
B050704T	FIRST ELECTIVE **(Select any one)**	1) Toxicology and Animal Behavior	5	T	25	75
B050705T		2) Biostatistics, Computational Biology and Bioinformatics	5	T	25	75
B050706P	SECOND ELECTIVE **(Select any one)**	1) Practical/Field Visit/ Project Presentation	5	P	50	50
B050707P		2) Practical/Field Visit/ Project Presentation	5	P	50	50
SEMESTER II (YEAR I)						
B050801T	CORE	Chordates-General account	5	T	25	75
B050802T	CORE	Systematics and Evolution	5	T	25	75
B050803T	CORE	Cell Biology	5	T	25	75
B050804T	THIRD ELECTIVE **(Select any one)**	1) Immunology	5	T	25	75
B050805T		2) Histology and Histochemistry	5	T	25	75
B050806P	FOURTH ELECTIVE **(Select any one)**	1) Practical/Industrial Training/Project Presentation	5	P	50	50
B050807P		2) Practical/Industrial Training/Project Presentation	5	P	50	50
SEMESTER III (YEAR II)						
B050901T	CORE	Principles of Endocrinology	5	T	25	75
B050902T	CORE	Developmental Biology	5	T	25	75
B050903T	CORE	Principles of Ecology and Wildlife	5	T	25	75
B050904T	FIFTH ELECTIVE (Select any one)	1) Morphology, Physiology and Development of Fishes	5	T	25	75
B050905T		2) Insect Taxonomy, Morphology and Physiology	5	T	25	75
B050906P	SIXTH ELECTIVE (Select any one)	1) Practical Lab-IIIA/Field Visit/ Project Presentation	5	P	50	50
B050907P		2) Practical Lab-IIIB/Field Visit/ Project Presentation	5	P	50	50
SEMESTER IV (YEAR II)						
B051001T	CORE	Genetics and Molecular Biology	5	T	25	75
B051002T	CORE	Biochemistry	5	T	25	75
B051003T	SEVENTH ELECTIVE (Select any one)	1) Applied Ichthyology	5	T	25	75
B051004T		2) Applied Entomology and Pest management	5	T	25	75
B051005P	RESEARCH PROJECT / DISSERTATION	Research Project/ Dissertation	10	P	50	50

Dissertation is mandatory for each student to complete a dissertation, assigned at the end of semester II and goes on until Semester IV. It would be theoretical and not involve any laboratory components.
The dissertation will be evaluated at the end of Semester IV in two stages.
Stage I: The Evaluation Committee will consist of supervisor, one senior faculty member and the Head of the Department. After evaluation, this three-member committee will provide 'Grade' which will cover 50% of the total marks.
Stage II: The candidate will present his work to the external examiner appointed by the BOS/Principal and will cover 50% of the total marks.

Programme Outcomes (POs)

- The course has been designed in such a way to equip the students with both classical and modern aspects of Zoology.
- Master of Science majors of conservation biology and ecology, giving you an in-depth knowledge of those most closely related programmes.
- Apply the wide range of subject based skills to various fields that provide a base for future career in disciplines such as Health Sciences, Agriculture, Environmental Management, Biotechnology, Publishing, Teaching and Research.
- Perform, Assess and implement practical techniques and procedure to solve biological problems and analyze and quantify data collected during any project.
- Understand the applications of Biological techniques to various fields of biology.

Program Specific Outcomes (PSOs)

PSO1: Developing deeper understanding of key concepts of biology at biochemical, molecular and cellular level, physiology and reproduction at organismal level, and ecological impact on animal behavior.

PSO2: Developing the concept of animal adaptation by exploring the diversity of functional characteristics of various kinds of organisms which is closely related to evolutionary processes and environmental changes.

PSO3: Understanding of Mendel's principle, its extension and chromosomal basis; chromosomal anomalies and associated diseases; developing concepts of regulation of gene activity in prokaryotes and eukaryotes of transcriptional and post transcriptional level.

PSO4: Development of an understanding of animal science for its application in entomology, apiculture, aquaculture, agriculture and modern medicine.

PSO5: Develop an information about and basic concept of developmental biology elucidation of early embryonic development and organogenesis of invertebrates and vertebrates, explanation of embryonic stem cells and their application.

PSO6: To understand the basic components of computers, software (operating system) and application of software used in biological and statistical studies.

PSO7: Development of theoretical and practical knowledge in handling the animals and using them as model organism.

PSO8: By the theoretical project work is aimed to in calculate ability to develop a research question, organize relevant available literature and development of technical writing skill.

PSO9: To understand the impact of chemicals on biodiversity of microbes, animals and plants; Bio indicator and biomarkers of environmental health. Biodegradation and bioremediation of chemicals; competition and existence; intraspecific and interspecific interactions

M.Sc. Previous (SEMESTER-I)
Subject: Zoology

Paper: First	
Course Code: B050701T	**Course Title:** Non-Chordates: General account
Course outcomes: Create appreciation on diversity of life on earth. Understand different levels of biological diversity through the systematic classification of invertebrate fauna. Familiarize taxa level identification of animals. Understand the evolutionary significance of invertebrate fauna.	
Credits: 05	**Core**
Max. Marks: 25+75	**Min. Passing Marks:**

Unit	Topics
I	Nutrition and reproduction in protozoa: origin of Metazoans; Structural organization, Canal system and affinities of Porifera; Polymorphism and Colony formation in Cnidaria; Coral reefs.
II	Parasitic adaptations, General organization of Trematoda (*Fasciola*) and Cestoda (*Taenia*), Larva stages of Trematoda and Cestoda and Life cycle patterns in Platyhelminthic parasites; outlines of ecology of soil nematodes; segmental organs in Annelida; Adaptive radiations in Annelida.
III	Organization and affinities of Onychophora; Larval forms in Crustacea; Parasitism in Crustacea; Torsion in gastropods, its effect and significance.
IV	Larval forms in Echinodermata; Water vascular system in Echinodermata; Affinities of Echinodermata and Hemichordata; Brief outlines of the structure and affinities of minor phyla with special reference to ctenophore, Rotifera, and Phoronida.

Suggested Readings:

1. A life of invertebrates by W.D. Russel-Hunter, MacMillan Publishing Co. inc.,New York.
2. Advances in invertebrates' reproduction by K.G. Adiyodi and R.G. Adiyodi, Peralam-Kenoth Kerivellur, Kerala.
3. Biology of the invertebrates by Jan Pechenik, William C. Brown Publishers, Dubuque, lowa.
4. Invertebrate's zoology by A. Kaestner, Interscience Publishers.
5. Invertebrate's zoology by Alfred Kaestner, H.W.Levi & L.R. Levi, John Wiley & Sons Inc.
6. Invertebrates (Protozoa to Echinodermata) by Ashok verma, Narosa Publishing house, New Delhi.
7. Invertebrates Learning by W.C. Corning and J.A.Dayal.
8. Invertebrates Structure and Function by E.J.W.Barrington, The Camolet Press, Great Britain.
9. Invertebrates Zoology by P.A. Meglitsch & F.R. Schram; Oxford University Press.
10. Invertebrates Zoology by R.D. Barnes, V Edition. Holt Saunders International edition.
11. Principles of Comparative Anatomy of Invertebrates by W.N. Bekiemishev, University of Chicago Press.
12. Principles of Comparative Anatomy of Invertebrates by Dr J.M. Mac Lennon; Z. Kabata, Oliver and Boyd Edinburgh.
13. Textbook of Invertebrate Zoology by G.S. Sandher; H. Bhaskar, Campus book International.
14. The Invertebrates by L.H. Hymen, McGraw-Hill Book Company.
15. The Invertebrates: A New Synthesis by R.S.K Barnes, P. Calow, P.J.W. Olive, D.W. Golding, and Spicer,J.I, III Edition, Blackwell Science.

M.Sc. Previous (SEMESTER-I)

Subject: Zoology

Paper: Second

Course Code: B050702T	**Course Title:** BIOLOGICAL TOOLS AND TECHNIQUES

Course outcomes:

Provide students with a deep knowledge in biological tools and techniques. Defining and explaining the basic principles of techniques useful for biological studies. Familiarise students with biotechniques which will provide a basic understanding that can be used for further study and research.

Credits: 05	**Core**
Max. Marks: 25+75	**Min. Passing Marks:**

Unit	Topics
I	Centrifugation; Principle, types and Applications, Differential and Density Gradient centrifugation; Principle and Uses of analytical instruments; Flame photometry and Spectrophotometry.
II	Separation and identification of biomolecules by Chromatography: Paper and thin layer Chromatography, Gel exclusion Chromatography, High performance Liquid Chromatography (HPLC), Affinity Chromatography.
III	Electrophoresis techniques: General principles, Support media; Electrophoresis of proteins and nucleic acid; capillary Electrophoresis.
IV	Recombinant DNA techniques; Restriction Enzymes, Cloning Vectors, Preparation and Screening of cDNA and Genomic DNA libraries, Southern and Nothern Hybridization, PCR; Principles and Applications. Detection of Proteins, DNA-Protein and Protein-Protein interaction; Western Blotting, DNA Foot Printing, EMSA.

Suggested Readings:

1. Essential Laboratory Techniques by S.R. Gallagher, E.A. Wiley.
2. An introduction to Practical Biochemistry by D.T. Plummer.
3. Techniques in Live Sciences by D.B. Tembhare.
4. Principles and Techniques of Biochemistry and Molecular Biology, 6th Edition by Keith Wilson and John Walker, Cambridge University Press.
5. Light Microscopy in Biology: A practical Approach, 2nd Edition by Alan J. Lacey, Oxford University Press.
6. Electron Microscopy: Principles and Techniques of Biologist by John J. Bozzola, Lonnie D. Russell, Jones & Bartiett Publ.
7. Tools and Techniques of Biotechnology by Mousumi Debnath, Pointer Publishers

M.Sc. Previous (SEMESTER-I)
Subject: Zoology
Paper: Third

Course Code: B050703T	**Course Title:** ANIMAL PHYSIOLOGY

Course outcomes:

Provide students with a deep knowledge in physiology. Explaining various aspects of physiological activities of animals with special reference to humans. Familiarise students with hormonal regulation of physiological systems in several invertebrate and vertebrate systems which will provide a basic understanding of the experimental methods and designs that can be used for further study and research. The achievement of above objectives along with periodic class discussions of current events in science, will benefit students in their further studies in the biological/physiological sciences and health-related fields, and will contribute to the critical societal goal of a scientifically literate citizenry.

Credits: 05	**Core**
Max. Marks: 25+75	**Min. Passing Marks:**

Unit	Topics
I	Physiology of Digestion and Absorption of Proteins, Carbohydrates and Lipids; Secretion and regulation of various digestive fluids. Physiology of Respiration; External and Internal respiration, mechanism and regulation of breathing, gaseous exchange in terrestrial and aquatic animals, Oxygen and Carbon dioxide transport, factors affecting oxygen dissociation and respiratory pigments.
II	Excretion; Urine formation (Glomerular filtration, Tubular reabsorption and Secretion, Counter current mechanism and Hormonal regulation), acid-base balance and Homeostasis, Circulation; Blood- Composition, Blood Group and Coagulation; Heart- Structure, Origin and Conduction of heart beat and its regulation, cardiac cycle.
III	Muscles; Types, ultrastructure, chemistry and molecular mechanism of striated muscle contraction and its regulation. Nervous System- Structure of Neuron and Neuroglial cells, mechanism of conduction and transmission of nerve impulse, Synapse and synaptic transmission. Autonomic Nervous System and Reflexes
IV	Thermoregulation; Thermoregulation based animal categories, mechanism of thermoregulation and thermal acclimatisation, Physiology of sense organs; Eyes and Ears.

Suggested Readings:

1. Animal Physiology by M.Brown, Apple Academic Press.
2. Animal Physiology by R.C. Sobte, Narosa Publishing House.
3. Animal Physiology by F.R. Haninsworth
4. Comparative Animal Physiology by C.L. Prosser, W.B. Saunders Company.
5. Comparative Physiology of Animal by R.W.Hill; P.D. Sturke.
6. Environmental Physiology of Animals by P. Willmer; G. Stone, Blackwell Science Ltd.
7. General and Comparative Physiology by W.S. Hoar, Prentice Hall of India Pvt. Ltd.
8. Marshall's Physiology of Reproduction by G.E. Lamming, Churchill Liungstone.
9. Neural and Integrative Animal Physiology by C.L. Prosser, Wiley India Pvt. Ltd.
10. Principles of Animal Physiology by J.A. Wilson.

M.Sc. Previous
(SEMESTER-I)
Subject: Zoology

Paper: Fourth (Elective)	
Course Code: B050704T	**Course Title:** TOXICOLOGY AND ANIMAL BEHAVIOUR

Course outcomes:

Make the students aware of natural resources, their protection, conservation, the factors polluting the environment, their impacts and control measures. Teach the basic concepts of toxicology, their impact on human health and remedial measures. Create a consciousness regarding Biodiversity, environmental issues & conservation strategies. Study the distribution of animals on earth, its pattern, evolution and causative factors. Impart basic knowledge on animal behavioural patterns and their role.

Credits: 05	**Elective**
Max. Marks: 25+75	**Min. Passing Marks:**

Unit	Topics
I	Toxicology; Introduction, Basic concepts, Types of Toxicants (Heavy metals, Pesticides and Radioactive), Exposure of toxicants, Dose-Response relationship, Translocation of Toxicants and mechanism of action of Toxicants.
II	Selective Toxicity; Biotransformation, Bioaccumulation and Biomagnification of Xenobiotics; Antidotal Therapy; Toxicity Tests; Biomonitoring of Toxic Chemicals, Bioindicators, Toxicogenomics and Nanotoxicology.
III	Animal Behaviour; Introduction and Significance of Behaviour; Proximate and Ultimate causes of behavioural evolution; Patterns of behaviour; Communications and animal signals.
IV	Reproductive behaviour in animals; Sexual selection, mating patterns and parental care; territorial behaviour, Social behaviour with special reference to insects and Primates; Biological rhythms.

Suggested Readings:

1. Toxicology, Earnest Hodgson.
2. Toxicology and risk assessment principles. Methods and application by Anna M Fan, Louis W Chang, Marcel Dekker, inc, New York.
3. Concept of Toxicology, Dr. Omkar
4. An Introduction to Animal Behaviour by Manning and MS Dawkins Cambridge University Press, UK.
5. Animal Behaviour by John Alcock, Sinaer Association, INC.
6. Animal Behaviour in the Laboratory by P. Silverman, London. Chapman and Hall.
7. Introduction to Animal Behaviour by Rishikesh and Niraj, Campus Bools.
8. Text Book of Animal Behaviour by FB Mannl PH learning Pvt.

Paper: Fourth (Elective)	
Course Code: B050705T	**Course Title:** BIOSTATISTICS, COMPUTATIONAL BIOLOGY AND BIOINFORMATICS

Course outcomes:

Introduction to basic components of computers, Software (operating systems) and application software used in biological and statistical studies. An overview of databank search data mining, data management and interpretation. An introduction and learning of Probit Log Analysis for interpretation of toxicity data.

Credits: 05	**Elective**
Max. Marks: 25+75	**Min. Passing Marks:**

Unit	Topics
I	Basic components of computer- hardware (CPU, input, output, storage devices), software (operating systems). Application software:: introduction to M S EXCEL use of worksheet to enter data, edit data, copy data, move data; use of inbuilt statistical functions for computation of mean, S.D. ,correlation, regression coefficients, etc, use of bar diagrams, histogram, scatter plots etc. graphical tools in excel for presentation of data; introduction to MSWORD word processor- editing , copying, moving, formatting, table insertion, drawing flowcharts, etc ; Introduction to PowerPoint, image and data handling.
II	Sampling technique: methods of sampling, choices of sampling methods, sampling and non-sampling errors: tabulation and graphic representation of data; frequency distribution, tabulation, bar diagram, histogram, pie diagram; and their significance and limitations; Measures of Central tendency; Mean, Median, Mode, measures of dispersion: variance and standard variation, coefficient of variation, measures of skewness, coefficient of skewness, kurtosis; probability : theorems on probability, application of permutation and combination.
III	Measures of dispersion: variance and standard variation, coefficient of variation, measures of skewness, coefficient of skewness, kurtosis; probability: theorems on probability, application of permutation and combination, Test of significance-t, F, Chi-square test; Correlation and Linear Regression.
IV	Bioinformatics; Introduction and scope of Bioinformatics, Archiving and retrieval of information; Search engines, databases (Nucleic acid sequences, genomes, protein sequence and structure, bibliographic), Access to molecular biology databases {Entrez, Sequence retrieval system (SRS), Protein identification resource (PRI)}, Sequence alignment and Phylogenetic tree.

Suggested Readings:

1. Biostatics by P N Arora and P.K Malhan, Himalaya publishing house
2. Principles of Biostatistics by Pagano M. Gauvreau, K (2000), Duxbury press, USA
3. Fundamental of Biostatics by I A Khan and A Khanam, Ukaaz publication, Hyderabad
4. Barnes & Grey (ed): Bioinformatics for geneticists, Wiley (2003)
5. Lesk: Bioinformatics, Oxford (2003, Indian ed)
6. Westhead et al: Bioinformatics Instant Notes, Viva Books (2003, Indian ed)

Suggested Continuous Evaluation Methods in each paper based on		
S.No.	**Assessment Type**	**Max. Marks:25**
1	Examinations	10
2	Assignment/ Seminar/ Presentation/ Quizzes	15

Semester-I Practical	
Credits: 05	
Max. Marks: 50+50	
General characters and classification of the non- chordates phyla (Protozoa to Echinodermata) with the help of museum specimens and slides.	
Protozoa	**Study of prepared slides:** Balantidium, Nyctotherus, Opalina. Paramecium conjugation / binary fission, Entamoeba histolytica, Giardia, Trypanosoma, Leishmania, Trichomona.
Porifera	**Study of museum specimens/models:** Lecuosolania, Sycon, Grantia, Euplectella, Hyalonema, Oscarella, Chondrilla, Chliona, Chalina, Spongilla, Spongia, Hippospongia.
Cnidaria and Ctenophora	**Study of museum specimens/ models:** Tubularia, Bougainvillia, Pennaria, Hydractinia, Sertularia, Campanularia, Millepora, Stylaster, Physalia, Porpita, Valella, Aurelia, Rhizostoma, Tubipora, Alcyonium, Gorgonia, Corallium, Pennatula, Zoanthus, Metridium, Adamsia, Cerianthus, Fungia, Madrepora, Cestum .
Helminths	**Study of museum specimens/ whole mounts:** Convoluta, Dugesia, Bipalium, Fasciola, Paramphistomum, Schistosoma, Taenia, Moniezia, Echinococcus, Trichuris, Trichinella, Heterodera, Enterobius, Ascaris, Ancylostoma, Dracunculus, Wuchereria.
	Study of prepared slides: Scolex of tape worm ,mature and gravid proglottid of tape worm;Study of cysticercus larva, hydatid cyst, larval stage of Fasciola
Annelida	**Study of museum specimens/models:** Aphrodite, Tomopteris, Glycera, Chaetopterus, Arenicola, Sabella, Amphitrite, Serpula, Tubifex, Branchiobdella, Eisenia, Metaphire, Placobdella,pontobdella Branchellion, Polygordius,:
	Study of prepared slides: T.S. of body of leech passing through various places.
Arthropoda	**Study of museum specimen:** Limulus, Palamnaeus, Lycosa, Apus, Argulus,Balanus, Sacculina, Mysis, Gmmarus, Squilla, Prawn, Lobster, true crab, hermit crab, Julus, Scolopendra, Scutigerella, Lepisma, Mantis, stick insect, grass hopper, termites ,Forficula,Pediculus, Ranatra, Dysdercus, Musca ,Lady bird beetle, butterfly, wasp, Xenopsylla, life history of honey bee, lac insect and silk moth;
	Study of prepared slides: Mouth parts of mosquitoes, house fly, honey bee, butterfly , Sarcoptes, Ixodes, Cimex, Daphnia, Cypris, Cyclops, Pediculus, Pthirus.
Mollusca	**Study of museum specimen/models:** Chiton, Dentaliun, Pila, Aplysia, Baccinum, Doris, Lymnaea, Mytilus, Patella, Pecten, Limax, pearl oyster, Teredo, Nautilus, Loligo, Sepia, Octopus.
	Study of prepared slide Radula, T.S of shell of Unio, T.S of gill lamina of Unio, T.S of body of Unio passing through middle region; Larvae of molluscs.
Echinodermata	**Study of museums specimen/ models** Astropecten, Asterias, Ophiothrix, Opiura, Echinus, Clypeaster, Echinocardium, Thyone, Holothuria, Antedom;
	Study of prepared slides: Larvae of echinoderms: Aristotle's lantern.
Hemichordata	**Study of museum specimens** Balanoglossus, Cephalodiscus: Tornaria larva, Minor phyla: Representative specimens of Onychophora (Peripatus), Sipunculida (Sipunculus), Echiurida (Bonelia
Slide preparation	
1.	Vital staining and staining preparation of Paramecium; Permanent preparation of Ceratium, Noctiluca, Vorticella
2.	Permanent preparation of gemmules, sponging fibres and different kinds of spicules
3.	Permanent preparation of Hydra; Obelia and other hydrozoan colonies and Obelia Medusa
Dissection	
1	Nervous system of Palaemon, Unio

2	Nervous system of Pila and Squid
Tools and technique Practical	
1	Basic principles and functioning of Microtomy
2	Basic principles and functioning of Spectrophotometry
3	Basic principles and functioning of Paper chromatography
4	Basic principles and functioning of Centrifugation.
5	To identify different amino acids in a mixture using paper chromatography.
Physiology Practical	
1.	Bleeding and clotting time
2.	Preparation of Haemin crystals
3.	Determination of Haemoglobin percentage
4.	Total count of Leucocytes
5.	Differential Leucocyte Count
6.	Blood group determination
Elective : Toxicology Practical (Practical Lab IA)	
1	Effect of ammonia and mercury on rat
2	Study of geotaxis/phototaxis behavioural responses of the animal provided (Musca domestica)
Elective : Biostatistics, Computational Biology and Bioinformatics (Practical Lab IB)	
1	Measure the pre and post clitellar lengths of earthworms and calculate mean, median, mode, standard deviation etc
2	Measure the height and weight of all students in the class and apply statistical measures.
3	To learn the basics of computer applications.. To learn about Phylogenetic analysis using the programme PHYLIP.
4	To learn sequence analysis using BLAST.
5	To learn Multiple sequence alignment using CLUSTALW

Semester-I Practical	**Time: 4 hours**
Distribution of Marks:	Total Marks: 100 (50 internal evaluation + 50 external examination)
Dissection	10 marks
Technique/ Instrumentations	05 marks
Physiology Exercise	05 marks
Toxicology and Animal behavior / Biostatistics, Computational Biology and Bioinformatics	05 marks
Spotting (10 spots)	10 marks
Viva voce	10 marks
Class records	05 marks

M.Sc. Previous
(SEMESTER-II)
Subject: Zoology

Paper: First	
Course Code: B050801T	**Course Title:** CHORDATES: GENERAL ACCOUNT
Course outcomes: Acquire in depth knowledge on the diversity of chordates and their systematic position. Make them aware of the economic importance of some classes. Understand the evolutionary importance of selected chordate groups.	
Credits: 05	**Core**
Max. Marks: 25+75	**Min. Passing Marks:**

Unit	**Topics**
I	Origin and Classification of Chordate, Protochordates and Pisces: General organization and affinities of Hemichordata, Urochordata and Cephalochordata, Characterisitc features and affinities of Cyclostomes, General organization of fishes: General organization and affinities of Ostracoderms, Dipnoi and Coelocanth.
II	Amphibia: Origin of Tetrapods, General organization of Anura, Neoteny and Parental care. Reptilia: Origin and Evolution, Adaptive radiation, Dinosaurs, Crocodilia, Poisonous snakes and their venom.
III	Aves: Origin and Evolution, Flightless birds, Adaptations for flight, Migration in Birds.
IV	Mammalia: Origin of Mammals, Adaptive radiation in Eutheria, Uterus modifications, Aquatic mammals.

Suggested Readings:

1. Harvey et al: The Vertebrate Life (2006)
2. Colbert et al: Colbert's Evolution of the Vertebrates: A history of the backboned animals through time (5th ed 2002,Wiley - Liss)
3. Hildebrand: Analysis of Vertebrate Structure (4th ed 1995, John Wiley)
4. Kenneth V. Kardong (2015) Vertebrates: Comparative Anatomy, Function, Evolution McGraw Hill
5. McFarland et al: Vertebrate Life(1979, Macmillan Publishing)
6. Parker and Haswell: TextBook of Zoology, Vol. II (1978, ELBS)
7. Romer and Parsons: The Vertebrate Body (6th ed 1986, CBS Publishing Japan)
8. Young: The life of vertebrates (3rd ed 2006, ELBS/Oxford)
9. Neilsen (2012). Animal Evolution: Interrelationships amongst living Phyla. Oxford

M.Sc. Previous
(SEMESTER-II)
Subject: Zoology

Paper: Second	
Course Code: B050802T	**Course Title:** SYSTEMATICS AND EVOLUTION

Course outcomes:

Systematic course uses the lessons specifically designed to achieve student understanding of biosystematics and to move quickly beyond the knowledge level to high-level thinking. Through this course, aspirants are trained to utilize different taxonomic tools like identification keys to identify different groups of organisms. To know and understand the seven levels of classification and apply this knowledge to classify animals from the Kingdom to Species level. They obtain an academic specialty besides evolutionary trends, species and characteristics, significance of evolution. This course inculcates in students, skills required for an animal taxonomist.

Credits: 05	**Core**
Max. Marks: 25+75	**Min. Passing Marks:**

Unit	Topics
I	Basic Concept of Animal Taxonomy, A Historical review, taxonomic terms, Classification and Nomenclature; Phenon; taxon and category, α, β anγ Taxonomy Recent trends in Taxonomy: Chemotaxonomy, Cytotaxonomy, Serotaxonomy, Molecular Taxonomy Microtaxonomy: Species concepts, nominalistic species concepts, biological species concept and evolutionary species concept
II	Macrotaxonomy: Phenetics, Cladistics and Phylogenetic Variations in Systematics, Taxonomic Procedures, Keys Importance of application of systematics in Biology International Code of Zoological nomenclature (ICZN), Type concept, Law of priority, The present Scenario and the global taxonomic initiatives
III	Various Evolutionary theories, Natural Selection and its types, molecular signatures of natural selection. Adaption: its evolutionary analysis, The evolutionary time scale; Eras, periods and epoch. Speciation: allopatric, sympatric, parapatric, peripatric. Elemental Forces of evolution: Mutation, genetic drift, isolation
IV	Adaptive radiation, Divergent evolution, Convergent evolution, Co-evolution Hardy-Weinberg law and its application, Conditions for the maintenance of genetic equilibrium Concepts of neutral evolution, Molecular phylogenies, Molecular divergence, Molecular clock, Molecular tools in phylogeny, Phylogeny of Human

Suggested Readings:

1. Biology Systematics by A. Mielli, Chapmon and Hall
2. Evolution by Hall and Hallgrimsson , johnsn and Bartlett publisher
3. Evolution by mark ridley. Blackwell science
4. Evolution by barton N.H. briggs, D.E.G., Eisen J.A., Goldstein, A.E. Ptel, N.H., cold spring Harbor Laboratory press New York, U.S.A.
5. Evolution by futuyma, D.J., sinauer associates inc., sunderland , USA
6. Evolution by Hall, B.K. and Hallgrimsson, B..Jones and Bartlett publisher, Sudbury, USA
7. Evolution analysis by Freeman and Herron, Person /prentice hall
8. Methods and principle of systematic Zoology by E.Mayer , E.G.Linsley , R.L. vsinger, McGraw – Hill Book Company , ICN
9. Numerical Taxonomy by joseph felsentein, springer – verlag Berlin Heidelberg New York
10. Procedure in Taxonomy by E.T.Schenk and J.H.Mc.Masters , Standford University Press Standford , California

M.Sc. Previous
(SEMESTER-II)
Subject: Zoology

Paper: Third	
Course Code: B050803T	**Course Title:** CELL BIOLOGY

Course outcomes:

Understand the structure and function of the cell as the fundamentals for understanding the functioning of all living organisms. Make aware of different cell organelles, their structure and role in living organisms. Develop critical thinking, skill and research aptitudes in basic and applied biology.

Credits: 05	**Core**
Max. Marks: 25+75	**Min. Passing Marks:**

Unit	**Topics**
I	Structure and function of Membrane & Cytoskeleton**:** Biomembranes and architecture: lipid bilayer and protein components • Microfilaments: actin structures, myosin powered cell movements • Intermediate filaments: Organization & function • Microtubules: Organization and dynamics, Kinesin and dynein powered movements.
II	Endomembrane system and intracellular trafficking; Compartmentalization in eukaryote cells • Gated transport between nucleus & cytosol • Structure of nuclear pore complex • Signal sequences & sorting transporters • Role of monomeric GT Pases in protein sorting • Protein sorting to ER and mitochondria. • Vesicular trafficking, secretary pathways, receptor mediated endocytosis.
III	Cellular communication; General principles of cell communication • Extracellular matrix and Cell adhesion, Cell signalling • Signalling molecules and cell-surface receptors (G-protein coupled receptors, Ion-channel linked receptors, Enzyme linked receptors • Second messengers • Regulation of signalling pathways, JAK-STAT pathway, MAP Kinase pathway.
IV	Cell cycle and Cell division; Cell cycle overview and control • Checkpoints in cell-cycle regulation • Regulation of Mitosis and Meiosis • Cancer and apoptosis.

Suggested Readings:

1. Lodish et al: Molecular Cell Biology: Freeman & Co, USA (2004).
2. Alberts et al: Molecular Biology of the Cell: Garland (2002).
3. Cooper: Cell: A Molecular Approach: ASM Press (2000).
4. Karp: Cell and Molecular Biology: Wiley (2002). Pierce B. Genetics. Freeman (2004).
5. Lewin B. Genes VIII. Pearson (2004).
6. Watson et al. Molecular Biology of the Gene. Pearson (2004).

M.Sc. Previous
(SEMESTER-II)
Subject: Zoology

Paper: Fourth	
Course Code: B050804T	**Course Title:** IMMUNOLOGY
Course outcomes: Acquire knowledge about Immune System & its elaborate mechanisms. Provide scientific information about recent trends in Immune therapy in case of several diseases like cancer, hepatitis etc. Achieve a basic understanding of the experimental methods and designs that can be used for future studies and research.	
Credits: 05	**Elective**
Max. Marks: 25+75	**Min. Passing Marks:**

Unit	Topics
I	Types of Immunity (Innate, Adaptive, humoral, cell-mediated), Cells of Immune system (B & T lymphocytes, Phagocytes, Granulocytic cells, Mast cells, NK Cells, Dendritic cells), Organs of Immune system- (Primary and secondary lymphoid organs- Thymus, Bone marrow, lymph nodes, spleen, MALT), Generation of B &T cell responses.
II	Immunoglobulins (structure, Types/Classes & functions) Epitopes, Maturation differentiation and activation of BCR and TCR. Monoclonal and polyclonal antibodies. Antibody diversity Organization & Expression of Immunoglobulin genes.
III	Antigen: types, processing & presentation, Major Histocompatibility complex: classes, structure, expression, immune responsiveness, and disease susceptibility (HLA) Complement system–classical, alternative, lectin pathways, Vaccine.
IV	Antigen antibody interactions (Agglutination Reactions, Precipitation Reactions, cross reactivity, Antibody affinity and avidity, immunoflorescence, flow cytometry, western blotting, immunoelectron microscopy, RIA, ELISA and it's types).

Suggested Readings:

1. Thomas J. Kindt, Richard A. Goldsby, Barbara A. Osborne, Janis Kuby (2007) Kuby Immunology. W H Freeman
2. Delves Peter J., Martin Seamus J., Burton Dennis R., Roitt Ivan M. (2017). Roitt's Essential Immunology, 13th Edition. Wiley Blackwell
3. Immunology by Ian. R. Tizard Saunders college Publishing Chicago, New York.
4. Nandini Shetty (2005) Immunology Introductory Textbook. New Age International.

Paper: Fourth	
Course Code: B050805T	**Course Title:** HISTOLOGY AND HISTOCHEMISTRY
Course outcomes: Achieve a basic understanding of the experimental methods and designs the basic histological tools and techniques.	
Credits: 05	**Elective**
Max. Marks: 25+75	**Min. Passing Marks:**

Unit	Topics
I	Fixation and Fixatives. Types of fixatives. Chemistry of fixation. Choice of Fixatives. Tissue processing. Dehydration. Clearing and Embedding.
II	Microtomy. Types of microtomes. Sectioning paraffin blocks. Staining of paraffin sections. Principle and methods of staining. Histological stains. Haematoxylin and Eosin.
III	Principles and methods of histochemical localization and identification of the following: Carbohydrate moieties Glycogen and glycoproteins with oxidizable vicinal diols by Periodic acid Schiff method Glycoproteins with carboxyl groups and/or O-sulphate esters by Alcian blue methods, Protein end groups General proteins by Bromophenol blue method–NH2 groups by Nihydrin-Schiff method - SS groups by Performic acid –Schiff and performic acid- alcian blue methods
IV	Principles and methods of histochemical localization and identification of the following: Lipid moieties General lipids by Sudan black B method Neutral lipids by total Sudan III and Sudan IV methods Nucleic acids Methyl green pyronin for DNA and RNA Feulgen reaction for DNA Enzymes: Acid and alkaline phosphatases by Metal precipitation and Azo dye methods. Immunocytochemistry: Basic principles. Fluorescence histochemistry: Basic principles

Suggested Readings:

1. Bancroft, J.D. & Stevens, A. Theory and Practice of Histological techniques, ChurchillLivingstone, 2002
2. Casselman, W.G.B. : Histochemical techniques, John Wiley, 1959
3. Pearse, A.G.E.: Histochemistry; Theoretical and Applied (Vol. I, II & III), (4th ed.), ChurchillLivingstones, 1980-1993

Suggested Continuous Evaluation Methods in each paper based on		
S.No.	**Assessment Type**	**Max. Marks:25**
1	Examinations	10
2	Assignment/ Seminar/ Presentation / Quizzes	15

Semester-II Practical	
Credits: 05	
Max. Marks: 50+50	
General character and classification of chordate phyla	
Urochordata: study of museum specimens/whole mount: oikopleura, Herdmania, Ascidia ,pyrosoma, doliolum, salpa.	
Cephalochordate: study of museum specimen: Branchiostoma.	
Cyclostomata: study of museum specimens /models: peltromyzon, Myxine; Ammocoete larva.	
Pisces: study of museum specimens/ models: sphyrna(hammer–headed shark), Trygon,(string rays), pristis, Raja (skate), Torpedo (electric –rays), chimaera, polypterus, Acipener, polydon , Amia, Lepidosteus, hilsa, harppodon , notopyerus, labeo, catla, cyprinus, cirrhinus, heteropneustes, clorias, wallago, mystus, Anguilla, exocoteus, hippocampus, channa, amphipinous, ansbas,synaptura, echeneis,neoceratodus, protopterus, lepidosiren; study of disarticulated bone of carp.	
Amphibia: Study of museum specimen/models: Ichthyophis, uraeotyphlus, cryptobrunchus, ambystoma, axolotl, latrva , salamandra, amphiuma, triturus, proteus, Necturus , siren, alyles, bufo, hyla, rhacophorus, study of disarticulated bone to frog	
Reptilia : Study of museum specimen/models chelone, kachuga, sphenodon , hemidactylus, calotes, draco , phrynosoma , lguana, heloderma , varanus , ophisarus, typhlops, python, natrix , ptyas, dendrophis, bungarus , naja , russlle's viper, pit viper, hydrophis , cerotalus, crocodilus , alligator , gavialis, ichthyosarus, dimentron , brontosarus , tyranosarus, stegosarus, study of disarticulated bones of varanus	
Aves : Study of museum specimens / models :Arhaeopterys, Milvus (kite), gyps(vulture). Pavo(peacock), Columba (pigeon), eudynamys (koel), psittacula (parrot) , bubo (owl), coracias (nilkanth), dinopium (woodpecker), house sparrow , corvus (crow) ; study of disarticulated bones of fowl .	
Mammalians : study of museum specimens / models : echidna , ornithorhynchus , macropus , erinaceus , shrew, pteropus , bat , loris , manis , hystrix, funambulus, rattus, oryctologus or lepus, herpestes, lutra, (otter), civet cat , macacar ,study of disarticulated bones of rabbit , skull of dog.	
Cell Biology	
To study different cell types such as buccal epithelial cells, neurons, striated muscle cells using Methylene blue	
To study the different stages of Mitosis in root tip of onion	
To study the different stages of Meiosis in grasshopper testis.	
Dissection	
Cranial Nerve of *Scoliodon* and *Labio rohita or Wallago*	
Air Bladder and Webberian ossicle of Fishes	
FOURTH ELECTIVE: Immunology lab (Practical Lab IIA)	
Examination of Peripheral blood smears for blood cells	
Demonstration of Western Blot Analysis and ELISA	
Immunofluorescence staining of B and T Cells	
FOURTH ELECTIVE: Histology and Histochemistry lab (Practical Lab IIB)	
Microtomy and staining: Hematoxylin-eosin – Demonstration	
Histopathology: Study of histopathological changes (permanent slides) – gastric ulcers, cirrhosis of liver, breast tumors, cyctic follicles of ovary, pancreas in diabetics, cryptorchid testis and leukemia.	
Histochemistry: Histochemical localization of glycogen in rat/mouse liver by Bauer Feulgen technique.	

Semester-II Practical	**Time: 4 hours**
Distribution of Marks:	Total Marks: 100 (50 internal evaluation + 50 external examination)
Dissection	10 marks
Systematics and Evolution	05 marks
Cell Biology Exercise	05 marks
Immunology/ Histology and Histochemistry	05 marks
Spotting (10 spots)	10 marks
Viva voce	10 marks
Class records	05 marks

M.Sc. Final (SEMESTER-III)
Subject: Zoology

Paper: First	
Course Code: B050901T	**Course Title: Principles Of Endocrinology**

Course outcomes:

Students acquire a broad understanding of the hormonal regulation of physiological processes in invertebrates and vertebrates. Familiarise students with hormonal regulation of physiological systems in several invertebrate and vertebrate systems which will provide a basic understanding of the experimental methods and designs that can be used for further study and research.

Credits: 05	**Core**
Max. Marks: 25+75	**Min. Passing Marks:**

Unit	Topics
I	Fundamentals of Endocrinology; Introduction and evolutionary perspective of hypothalamus and structure and function (SON, PVN, POA and Arcuate nucleus). Hypophysiotropic hormones, Pituitary gland, structure and function (adenohypophysis, Neurohypophysis, pars intermedia), Thyroid gland, Biosynthesis and chemistry of thyroid hormones, Mechanism of action, biological actions of thyroid hormones, Pancreas, Insulin, glucagon and other secretions.
II	Endocrine regulatory molecules, Chemical classification of hormones, Hormone receptors, Mechanism of hormone action, Neurotransmitters and neuropeptides, Regulatory pathways.
III	Neuroendocrine integration; Hypothalamo–hypophyseal axis, Feedback mechanisms, Adrenal gland-cellular organization, Catecholamines and General Adaptation Syndrome. Pineal gland and its hormones.
IV	Endocrine regulation of homeostasis; Hormones and Homeostasis, Electrolytes and water balance (Renin-Angiotensin system), Energy homeostasis, Parathyroid gland, Calcium homeostasis, Endocrine regulation of bone morphogenesis. Gonadal Hormones.

Suggested Readings:

1. Vertebrate Endocrinology: David O. Norris, James A. Carr, 2013, 5th Edition, Academic Press
2. Williams Textbook of Endocrinology: H. M. Kronenberg, S. Melmed, K. S. Polonsky and P. R. Larsen, 2008, 11th Edition, Saunders, Elsevier
3. Comparative Vertrebrate Endocrinology: P. J. Bentley, 3rd Edition, Cambridge University Press
4. Neuroendocrinology: Charles B. Nemeroff, CRC, US
5. An Introduction to Neuroendocrinology: Richard E. Brown, 2005, Cambridge University Press
6. Endocrinology: Mac E. Hadley, Jon E. Levine, 2009, 6th Edition, Pearson Education
7. Molecular Endocrinology: F. F. Bolander, 3rd Edition, 2004, Elsevier Academic Press
8. Essential Endocrinology: Darville Brook, C.G. & Marshall, Wiley Blackwell
9. Endocrinology at a Glance: Greenstein B, Wiley Blackwell
10. Evidence-Based Endocrinology: V. M. Montori (ed.), Humama Press
11. General and Comparative Endocrinology: John B. Allard, Cunming Duan, Intelliz Press LLC (2016)

M.Sc. Final (SEMESTER-III)
Subject: Zoology

Paper: Second	
Course Code: B050902T	**Course Title: Developmental Biology**
Course outcomes: Achieve a basic understanding of the experimental methods and designs that can be used for future studies and research. Provide the students with the periodic class discussions of current events in science which will benefit them in their future studies in the biological/physiological sciences and health-related fields. Contribute to critical societal goal of a scientifically literate citizenry.	
Credits: 05	**Core**
Max. Marks: 25+75	**Min. Passing Marks:**

Unit	Topics
I	Basic concepts of development**:** Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development.
II	Gametogenesis, fertilization and early development**:** Production of gametes, cell surface molecules in sperm-egg recognition in animals; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals.
III	Morphogenesis and organogenesis in animals**:** Cell aggregation and differentiation in *Dictyostelium*; axes and pattern formation in *Drosophila*, amphibia and chick; organogenesis – vulva formation in *Caenorhabditis elegans*, eye lens induction, limb development and regeneration in vertebrates; differentiation of neurons, post embryonic development- larval formation, metamorphosis; environmental regulation of normal development; sex determination.
IV	Programmed cell death, aging and senescence

Suggested Readings:

1. Developmental Biology: T. Subramaniam, (Reprint) 2013, Narosa Publishing House Pvt. Ltd., New Delhi
2. Essential Developmental Biology: Jonathan M. W. Slack, (3rd ed.) 2012, Wiley-Blackwell.
3. Developmental Biology: From a Cell to an Organism (Genetics & Evolution) eBook: Russ Hodge, 2009, Infobase Publishing.
4. Current Topics in Developmental Biology: Roger A. Pedersen, Gerald P. Schatten, 1998 Elsevier.
5. Developmental biology: Werner A. Müller, 2012, Springer Science & Business Media.
6. Human Embryology and Developmental Biology E-Book: Bruce M. Carlson, 2018, Elsevier Health Sciences.
7. Developmental Biology: Michael J. F. Barresi, Scott F. Gilbert, 2019, Oxford University Press.

Paper: Third	
Course Code: B050903T	**Course Title:** PRINCIPLES OF ECOLOGY AND WILDLIFE

Course outcomes:

Instill the basic concepts of Environmental Sciences, Ecosystems, Natural Resources, Population, Environment and Society. Make the students aware of natural resources, their protection, conservation, and the factors polluting the environment, their impacts and control measures. Create a consciousness regarding Biodiversity, environmental issues & conservation strategies. Develop the real sense of Human rights – its concepts & manifestations.

Credits: 05	Elective
Max. Marks: 25+75	Min. Passing Marks:

Unit	Topics
I	The Environment: Physical environment; biotic environment; biotic and abiotic interactions. Habitat and Niche: Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement. Population Ecology: Characteristics of a population; population growth curves; population regulation; life history strategies (*r* and *K* selection); concept of metapopulation – demes and dispersal, interdemic extinctions, age structured populations
II	Species Interactions: Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis. Community Ecology: Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones. Ecological Succession: Types; mechanisms; changes involved in succession; concept of climax.
III	Ecosystem Ecology: Ecosystem structure; ecosystem function; energy flow and mineral cycling (C, N, P); primary production and decomposition; structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, estuarine). Biogeography: Major terrestrial biomes; theory of island biogeography; biogeographical zones of India.
IV	Applied Ecology: Environmental pollution; global environmental change; biodiversity: status, monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches. Conservation Biology: Principles of conservation, major approaches to management, Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves).

Suggested Readings:

1. What is biodiversity by James Maclaurin and Kim Sterelny, U. Chicago.Edu.
2. Schuh, R.T., and A.V.Z. Brower. 2009. Biological Systematics: Principles and Applications, 2nd Ed. Cornell University Press. 311+xi pp.
3. Wiley, E. O. and B. S. Lieberman. 2011. Phylogenetics: Theory and Practice of Phylogenetic Systematics, 2nd Ed. Wiley-Blackwell. 406+xvi pp.
4. Williams, D. M. and M. C. Ebach. 2010. Foundations of Systematics and Biodiversity. Springer. 309+xvii pp.
5. Biodiversity and Ecosystem Functioning by E.D. Shulze and H. A. Moonthy, Springer Publication.
6. Methods and Practice in biodiversity Conservation by David Hawks worth, Springer publication
7. A Text Book of Biodiversity by K.V. Krishnamurthy, CBS Publication

Paper: Fourth	
Course Code: B050904T	**Course Title: Morphology, Physiology & Development of Fishes**

Course outcomes:

The present course provides the basic concepts of fish morphology, Physiology, Development, which will enable the students to utilize the knowledge in fish biology researches, manage the fish under controlled conditions, and understand the status of fish biogenetic resources of India.

Credits: 05	Elective
Max. Marks: 25+75	**Min. Passing Marks:**

Unit	Topics
I	Trends in the classification of Fishes (Evolutionary and Genealogical) Systematics and bionomics of at least one important fish from following fish orders (with particular reference of Uttar Pradesh): Beloniformes, Clupeiformes, Mastacembeliformes lvlugiliformes, Cypriniformes (Cyprini and Siluri), Ophiocephaliformes, Perciformes
II	Outlines of functional morphology (origin of paired fins, air bladder, webberian ossicles, sound and electric organs, lateral line system).
III	Physiology of digestion, respiration, excretion, osmoregulation and reproduction (gonads, role of hypothalamo-hypophysial hormones in reproduction).
IV	Breeding Techniques: Bundh breeding: Types of bundhs: a) dry bundhs b) Wet bundhs c) Modern bundhs Artificial fertilization by stripping, Induced breeding by hypophysation:, Definition, Hormones responsible for induced breeding , Dissection and removal of pituitary gland ,Preservation and storage of pituitary gland, Preparation of gland suspension for injection and dosage. , Collection, rearing and selection of brooders, Synthetic hormones used in induced breeding.

Suggested Readings:

1. Datta-Munshi & Hughes: Air-breathing fishes of India (1992, Oxford and 1BH)
2. Evans: The Physiology of Fishes (2006, CRC Press)
3. Hoar & Randall: Fish Physiology, Series Vol. I - XIV (1979-2006, Academic Press)
4. Jhingran: Fish and Fisheries of India (1985, Hindustan Publishing Corporation)
5. Khanna and Singh: Textbook of Fish Biology and Fisheries (2003, Narendra Publishing House)
6. Lagler *et ai.,* ichthyology (2003, John Wiley)
7. Srivastava: Fishes of U.P. and Bihar (2002, Vishwavidyalaya Prakashan)
8. Pillar Aquaculture: Principles and Practices: Fishing News Books: (2005, First Indian reprint)
9. Gupta and Gupta: General and applied Ichthyology (Fish and Fisheries) (2006, Chand)
10. Bone and Moore: Fish Biology

Paper: Fourth	
Course Code: B050905T	**Course Title:** INSECT TAXONOMY, MORPHOLOGY AND PHYSIOLOGY
Course outcomes: Acquire knowledge about physiological systems of insects. Acquire basic understanding about habitat dependent change in structure of physiological systems.	
Credits: 05	**Elective**
Max. Marks: 25+75	**Min. Passing Marks:**

Unit	Topics
I	Study of the morphology, development, metamorphosis and evolution of insects.
II	Physiology of digestion, excretion; metamorphosis and diapause including endocrine aspects.
III	An outline classification of insects; characters and identification of the economically important families. Social insects and Insect hormones.
IV	The distribution and bionomics of the following order: Thysanura, Orthoptera, Diptera, Isoptera, Mallophaga, Hemiptera, Dictyoptera, Thysanoptera, Lepidoptera, Hymenoptera and Coleoptera.

Suggested Readings:

1. Chapman: The Insects: structure and function (4th ed, 1998, ELBS)
2. Imms: A general text book of entomology, 2 vols (1997, Asia Publishing House)
3. McGavin: Essential Entomology (2001, Oxford Univ Press)
4. Srivastava: A text book of applied entomology, Vol I & II (1993, Kalyani Publishers)
5. Wigglesworth: Principles of Insect Physiology (1972, ELBS)
6. Gullan and Cranston: The Insects: An outline of entomology (5th ed, 2014, Wiley Blackwell)

Suggested Continuous Evaluation Methods in each paper based on		
S.No.	**Assessment Type**	**Max. Marks:25**
1	Examinations	10
2	Assignment/ Seminar/ Presentation/ Quizzes	15

Semester-III Practical	
Credits: 05	
Max. Marks: 50+50	
ENDOCRINOLOGY PRACTICAL	
Dissect and display of Endocrine glands in laboratory bred rat	
Study of the permanent slides of all the endocrine glands	
Compensatory ovarian/ adrenal hypertrophy *in vivo* bioassay in laboratory bred rat*	
Demonstration of Castration/ ovariectomy in laboratory bred rat	
Estimation of plasma level of any hormone using ELISA	
Designing of primers of any Hormone	
DEVELOPMENTAL BIOLOGY PRACTICALS	
Study of whole mounts and sections of developmental stages of frog through permanent slides: Cleavage stages, blastula, gastrula, neurula, tail-bud stage, tadpole (external and internal gill stages)	
Study of whole mounts of developmental stages of chick through permanent slides: Primitive streak (13 and 18 hours), 21, 24, 28, 33, 36, 48, 72, and 96 hours of incubation (Hamilton and Hamburger stages)	
Study of the developmental stages and life cycle of *Drosophila* from stock culture	
Study of different sections of placenta (photomicropgraph/ slides)	
Project report on *Drosophila* culture/chick embryo development	
PRINCIPLES OF ECOLOGY PRACTICALS	
Study of life tables and plotting of survivorship curves of different types from the hypothetical/real data provided	
Determination of population density in a natural/hypothetical community by quadrate method and calculation of Shannon-Weiner diversity index for the same community	
Study of an aquatic ecosystem: Phytoplankton and zooplankton, Measurement of area, temperature, turbidity/penetration of light, determination of pH, and Dissolved Oxygen content (Winkler's method), Chemical Oxygen Demand and free CO2	
Report on a visit to National Park/Biodiversity Park/Wild life sanctuary	
Practical lab IIIA: FISH AND FISHERIES	
Morphometric and meristic characters of fishes	
Study of *Petromyzon*, *Myxine*, *Pristis*, *Chimaera, Exocoetus*, *Hippocampus,* Gambusia, Labeo, Heteropneustes, Anabas	
Study of different types of scales (through permanent slides/ photographs).	
Study of crafts and gears used in Fisheries	
Water quality criteria for Aquaculture: Assessment of pH, conductivity, Total solids, Total dissolved solids	
Study of air breathing organs in *Channa, Heteropneustes, Anabas* and *Clarias*	
Demonstration of induced breeding in Fishes (video)	
Demonstration of parental care in fishes (video)	
Project Report on a visit to any fish farm/ pisciculture unit/Zebrafish rearing Lab.	
Practical lab IIIB: ENTOMOLOGY	
Study of one specimen from each insect order	
Study of different kinds of antennae, legs and mouth parts of insects	
Study of head and sclerites of any one insect	
Study of insect wings and their venation	
Study of insect spiracles	
Methodology of collection, preservation and identification of insects	
Morphological studies of various castes of *Apis, Camponotus* and *Odontotermes*	
Study of any three insect pests and their damages	
Study of any three beneficial insects and their products	

Semester-III Practical	**Time: 4 hours**
Distribution of Marks:	Total Marks: 100 (50 internal evaluation + 50 external examination)
Dissection	10 marks
Principles of Endocrinology	05 marks
Developmental Biology	05 marks
Fishery/ Entomology	05 marks
Principles of Ecology Practicals	05 marks
Spotting (10 spots)	10 marks
Viva voce	05 marks
Class records	05 marks

M.Sc. Final (SEMESTER-IV) Subject: Zoology	
Paper: First	
Course Code: B051001T	**Course Title:** GENETICS AND MOLECULAR BIOLOGY

Course outcomes:

Basic concept of Mendelian and non-Mendelian inheritance pattern in plants and animals. Relate modern techniques to the understanding of genetics, and Hardy-Weinberg principle to explain changes in population genetics. Microbial genetic process like generation of mutants for genetic analysis as well as to get an in-depth understanding about the molecular genetics. Describe the principles of gene expression and regulation in prokaryotic and eukaryotic cells. Apprise the importance of epigenetic and methylation systems in gene regulation.

Credits: 05	**Core**
Max. Marks: 25+75	**Min. Passing Marks:**

Unit	Topics
I	Mendelian principles: Dominance, segregation, independent assortment. Concept of gene: Allele, multiple alleles, pseudo allele, complementation tests. Extensions of Mendelian principles: Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters.
II	Gene mapping methods: Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids. Extra chromosomal inheritance: Inheritance of Mitochondrial and chloroplast genes, maternal inheritance. Human genetics: Pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders. Quantitative genetics: Polygenic inheritance, heritability and its measurements, QTL mapping. Mutation: Types, causes and detection, Structural and numerical alterations of chromosomes: Deletion, duplication, inversion, translocation, ploidy.
III	DNA replication, repair and recombination (Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication, extrachromosomal replicons, DNA damage and repair mechanisms, homologous and site-specific recombination). RNA synthesis and processing (transcription factors and machinery, formation of initiation complex, transcription activator and repressor, RNA polymerases, capping, elongation, and termination, RNA processing, RNA editing, splicing, and polyadenylation, structure and function of different types of RNA, RNA transport).
IV	Protein synthesis and processing (Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, and translational proof-reading, translational inhibitors, Post-translational modification of proteins). Control of gene expression at transcription and translation level (regulating the expression of phages, viruses, prokaryotic and eukaryotic genes, role of chromatin in gene expression and gene silencing).

Suggested Readings:

1. Development genetics of higher organisms by George M. Malacinski, Maxmillan
2. Embryology by M.P.Arora , Himalaya publishing house
3. Fundamantal of human genetics by Sanjay Madsal , new central book agency, London
4. Fundaments of genetics by G.S.Migalani , norsa publishing house
5. Genetics by P.K Gupta, Rastogi publication
6. Genetics by E. Conrad, apple academics press
7. Grenetics by Ursila Goodenough, hotl-saumders international edition
8. Genetics by j. Russwll, Benjamin- Cummings publishing company, San Francisco , California.
9. Modern genetics analysis: intergrating genes and genome, by Griffiths J.F.Gelbart ,M., Lewontin,C and miller , W.H. freeman and company , New York , USA
10. Molecular genetics by guther s. Stent Richard colendar . cbs publication and distributors
11. Principles of genetics by Snustad and Simmons (4th ED.2005), John Wiley & sons. USA
12. Genes by Lewin, (9th Edition 2008), Jones and Bartlen Publishers, Boston, USA
13. Genetics (Analysis of genes and Genomes) by Denial L.Hartl, Jones and Bartlett publishers.
14. Molecular biology of The Cell by Bruce Alberts, Garland Science Taylorand Francis Group
15. Molecular Biology of the Gene by Watson et.al. (5th Ed. 2004), Pearson Education, Delhi INDIA

M.Sc. Final
(SEMESTER-IV)
Subject: Zoology

Paper: Second	
Course Code: B051002T	**Course Title:** BIOCHEMISTRY

Course outcomes:

Through this course the students are exposed to importance of biological macromolecules. They acquire knowledge in the quantitative and qualitative estimation of biomolecules. They study the influence and role of structure in reactivity of biomolecules. At the end of the course, the students have a thorough understanding on the role of biomolecules and their functions.

Credits: 05	**Core**
Max. Marks: 25+75	**Min. Passing Marks:**

Unit	Topics
I	Composition, structure and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins). Principles of biophysical chemistry (pH, buffer, reaction kinetics, thermodynamics, colligative properties).
II	Bioenergetics, glycolysis, oxidative phosphorylation, coupled reaction, group transfer, biological energy transducers. Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isozymes
III	Conformation of proteins (Ramachandran plot, secondary structure, domains, motif and folds). Conformation of nucleic acids (helix (A, B, Z), t-RNA, micro-RNA).
IV	Stability of proteins and nucleic acids. Metabolism of carbohydrates, lipids, amino acids nucleotides and vitamins.

Suggested Readings:

1. Biochemistry by J.M berg J.L.Tymoczko, W.H.Freedman Plagraue Macmillon
2. Biochemistry by Zubey; Styrer
3. Self-physiology and Biochemistry by W.D. McElory , Prentice Hall of INDIA Pvt. LTD
4. Comparative biochemistry by K.A Munday, Pergmon Press Oxford London
5. Essentials of Biochemistry by Srivastva; Lal; N.Singh, Rekha Publications
6. Essentials of Biological chemistry by Fairley Kil gour, Affiliated east -west Press
7. Harper's Biochemistry by R.K. Murray, D.K Granner, A long medical book.
8. Introduction to biochemistry by J. Awapra, Printice Hall of INDIA Pvt. LTD
9. Lehninger Principles of biochemistry D.L. Nelson, M.M.Cox W.H. Freemann Company

M.Sc. Final
(SEMESTER-IV)
Subject: Zoology

Paper: Third	
Course Code: B051003T	**Course Title:** APPLIED ICHTHYOLOGY
Course outcomes: Provide scientific knowledge of profitable fish farming. Equip the students with self-employment capabilities.	
Credits: 05	**Elective**
Max. Marks: 25+75	**Min. Passing Marks:**

Unit	Topics
I	Cold water, Estuarine and Marine Fisheries of India, Fish farming in India: Type of fish farming, Fish ponds, Physico-chemical and biological characteristics of Ponds, Manuring and fertilization of fish ponds, Control of weed and Predators.
II	Fish seed production and management: Induced Breeding; Hatcheries, Spawning, collection, rearing, stocking, and transport of fish.
III	Methods of Fishing, Fishing Gears & Crafts with particular reference to Uttar Pradesh, Important Exotic fishes; Larvivorous fishes and Public Health; Fish as food and fish by products; Diseases of food fishes.
IV	Principles and methods of Fish Preservations: Traditional and advanced methods of fish preservation- sun- drying, salt drying, pickling, smoking, chilling, freezing, canning etc, Invasive fish species and their impact on indigenous fishes. Aquarium fishes and their maintenance.

Suggested Readings:

1. Hall: Ponds and Fish Culture (1994, Agro Botanical Publishers)
2. Khanna and Singh: Textbook of Fish Biology and Fisheries (2003, Narendra Publishing House)
3. Lagler, Bardach, Miller and May Passino: Ichthyology (2003, John Wiley)
4. Nilsson & Holmgren: Fish Physiology Recent Advances (1986, Croom Helm)
5. Singh: Advances in Fish Research, Vol. **land** II (1993 and 1997, Narendra Publishing House)
6. Srivastava: A Textbook of Fishery Science and Indian Fisheries (1985, Kitab Mahal)
7. Pillay: Aquaculture; Principles and Practices: Fishing News Books; (2005, First Indian reprint)

Paper: Third	
Course Code: B051004T	**Course Title:** APPLIED ENTOMOLOGY AND ECOLOGY OF INSECTS

Course outcomes:

Acquire in depth knowledge about identification skills for all insect orders and some super families, and understanding of the interactions between the insects and ecosystem.

Credits: 05	Elective
Max. Marks: 25+75	Min. Passing Marks:

Unit	Topics
I	Principles and methods of different types of insect control with special reference to cultural, biological and chemical control. Fundamentals of chemistry, properties, formulation of insecticides; brief description of appliances employed.
II	Mode of action of insecticides and physiology of insect resistance to insecticide. Some economically important pests with particular reference to biology and control of the following: **1.** Pests of food grain and food products: Sitophylus oryzae, Phizopertha, denimida, Tragoderma, Tribolium castonium, Callosobruchus chinensis,Sitottrega cereallella, Coreyra cephalonica. **2.** Pests of cotton: Dysdercus koenijii, Pectinophora gossypiella **3.** Pests of sugarcane: Pyrilla perpusilla, Tryprhiza nivella **4.** Pests of crops yielding cereal products: Leptocorisa varicornis, Locust **5.** Pests of oilseed, fruits and vegetables: Aulacophora forvecollis, Bagrada picta, Idiocerus atkinsoni.
III	Ecological factors governing insect development and metamorphosis. Bee keeping, Lac and Silk industry in India. Plant protection and extension entomology in India.
IV	Medical Entomology: **1.** Pests of Public importance and their control- Mosquito, house fly, bed bug, lice, Fleas **2.** Insect borne diseases of man- Typhus, yellow fever, dengue, encephalitis, plague, Leishmaniasis, Sleeping sickness, Malaria, Filaria Insect venom and allergens Forensic Entomology: **1.** Insect succession on corpse **2.** Determination of time of Death

Suggested Readings:

1. David and Ramamurthy: Elements of Economic Entomology (6th ed.), Namrutha, 2011
2. Gullan & Cranston: The Insects: An Outline of Entomology (5th ed.) Wiley Blackwell, 2014
3. Imms: A General Text Book of Entomology (2 vols.), Asia Publishing House, 1997
4. Ishaaya and Degheele: Insecticides with novel modes of action: Mechanism and Application Springer-verlag, 1998
5. Ishaaya: Biochemical sites of insecticide action and resistance Springer-Verlag, 2001
6. Norris et al: Concepts in Integrated Pest Management, Prentice-Hall, 2002

Suggested Continuous Evaluation Methods in each paper based on		
S. No.	**Assessment Type**	**Max. Marks:25**
1	Examinations	10
2	Assignment/ Seminar/ Presentation / Quizzes	15