DEPARTMENT OF ZOOLOGY

ONE YEAR M.SC. PROGRAMME

BASED ON FYUGP+1 SYLLABUS

Semester III

Course code	Course Name	Course type	Credit	Marks
ZOO-301	Ecology, Environment and Biodiversity	Compulsory	04	100
ZOO-302	Systematic Zoology & Evolution	Compulsory	04	100
ZOO:P-303	Practicals in Ecology and Systematic Zoology	Compulsory	02	50
ZOO-304	MOOCS	Compulsory	02	50
ZOO-305	Internship	Compulsory	02	50
ZOO-306*	Fishery	Specialization	04	100
ZOO:P-307	Practicals in Fishery	Specialization	02	50
ZOO-308*	Entomology	Specialization	04	100
ZOO:0-309	Practicals in Entomology	Specialization	02	50
ZOO-310*	Advances in Cell & Molecular Biology	Specialization	04	100
ZOO:P-311	Practicals in Advances in Cell & Molecular Biology	Specialization	02	50

Course No 306+307, 308+309 and 310+311 are based on CBCS elective course.

**Students may choose one course from specialization section, either ZOO-306 + ZOO:P-307* OR *ZOO-308+ ZOO:P-309* OR *ZOO-310+ ZOO:P-311*

Semester IV

Course code	Course Name	Course type	Credit	Marks
ZOO-401	Project Work	Compulsory	20	500

Programme Outcomes

1. The program has been designed to provide in-depth knowledge of applied subjects, ensuring the inculcation of employment skills in diverse fields. This will provide them with ample opportunities to explore different career avenues.
2. On completion of the programme, the students will be well-versed in the concepts of classical zoology and its applied aspects.
3. Apart from knowledge of animals and their behaviours, the students will be abreast ofthe latest concepts in cell biology, immunology, molecular biology, genetics, biochemistry, developmental biology, and physiology.
4. Moreover, skills acquired in both the theoretical and practical aspects, as well as field studies and excursions, will imprint the concepts of teamwork for life outside of academia.

Programme Specific Outcomes

1. The program will enhance the chances of students to progress to higher education like M.Sc., B.Ed. and Ph.D. The other dimension is that the programme is versatile enough to ensure that students are successful in different competitive examinations.
2. They will have acquired complete knowledge of disciplinary as well as allied biological sciences, like practical skills in analytical biochemistry, biotechnology, biostatistics, bioinformatics, genetics, molecular biology, microscopy, enzymology etc. As a result, they will have the expertise that will give them a competitive advantage in pursuing higher education in India or abroad, as well as qualify them for jobs in academia, research, industry, and administration.
3. Some job avenues they would be particularly well suited for would be as scientists in the drug development industry, clinical and research laboratories, animal behaviourists, conservationists, wildlife biologists, zoo curators, wildlife educators, forensic experts, lab technicians, veterinarians, etc. This is apart from avenues like the Indian Forest Service and other allied services like Governmental Environmental Agencies etc.
4. Skill enhancement courses like aquaculture, sericulture, and apiculture will help them in starting their ventures and generating self-employment making them successful entrepreneurs.

Semester	Course No	Course Name	Course outcome
III	ZOO-301	Ecology, Environment & Biodiversity	• Students will attain a solid foundation on principles of ecology. • Students will learn the biogeographic zones of the world. • Students will understand the role of abiotic factors in different ecosystems. • Students will develop an understanding of how species interaction is important in development of communities. • Students will understand the impact of humans on the entire processes of ecosystem and the environment. • Students will be well aware of biodiversity and the need for conservation for sustainability.
	ZOO-302	Systematic Zoology & Evolution	• Students will be learning the how living forms diversified, and how life originated onearth and factors which led to evolution. • Students will be able to understand general taxonomic rules on animal classification andwill apply it for species description. • Students will know about population genetics, human evolution, various concepts about origin of species, extinctions, phylogenetic tree making.
	ZOO-306	Fishery	• Students will be able to set up fish farms, including selecting suitable sites, designing aquaculture ponds, and operating hatcheries effectively. • Students will understand various methods of fish culture, such as extensive, semi-intensive, and intensive culture, and learn about different forms of fish feeds. • Pond Management: Students will gain proficiency in pond management, including maintaining optimal physico-chemical properties of water and soil, fertilization techniques, and controlling predators, weeds, and aquatic vegetation. • Students will comprehend fish reproduction processes, including the anatomy of reproductive organs, maturation, spawning, fertilization, hatching, and larval development. • Students will learn to identify common fish diseases, understand their symptoms, and apply appropriate treatments and preventive measures to ensure fish health and well-being in aquaculture systems.
	ZOO-308	Entomology	• Students will attain a solid foundation in insect biology. • Students will be able to differentiate insects based on their morphological structures.

	ZOO-310	Advances in Cell & Molecular Biology	• Upon completion of the course, students will be able to describe the basic structure and chemistry of nucleic acids, DNA and RNA. • To compare and contrast DNA replication machinery and mechanisms in prokaryotes and eukaryotes. • To elucidate the molecular machinery and mechanism of information transfer processes– transcription and translation-in prokaryotes and eukaryotes

Semester III

COURSE NAME: ECOLOGY, ENVIRONMENT AND BIODIVERSITY

Course Code: ZOO-301

Credit: 04

Course Contents:

Unit I: 12 hours

Concept of ecology: introduction to ecology; Biosphere, Atmosphere, Lithosphere and Hydrosphere; Biogeography-major biomes of the world, biogeographical zones of India; Limiting factors-Shelford's law of tolerance and Leibig's law of minimum; Ecological niche, niche overlap, and separation; Concept of communities- population density, and indices of relative abundance, frequency, ecological dominance, carrying capacity, species composition, richness, and species diversity; Succession- types, and changes involved in succession, and concept of climax and stability

Unit II 12 hours

Ecosystem ecology and energy flow: concept, structure, and function of ecosystem; Types of ecosystem and their biotic communities, some terrestrial and aquatic ecosystems of India; Energy flow and Lindemann's trophic dynamic concept; trophic relationship and ecological efficiencies; Concept of productivity-primary and secondary productivity; biogeochemical cycles.

Unit III 11 hours

Population ecology and species interaction: Growth pattern; natality and mortality; life tables & Survivorship curve; density-dependent and density-independent factors; Life history strategies-k and r selection; Population age distribution and sex ratio; Population fluctuations and cyclic oscillations; Species interactions-positive and negative interactions.

Unit IV 10 hours

Biodiversity: Biological diversity: concepts and levels, role of biodiversity in ecosystem functions and stability; Biodiversity: status, monitoring, and documentation; major drivers of biodiversity change; biodiversity management approaches.resource management, restoration ecology; biodiversity hotspots, NE region as biodiversity hotspot; Keystone and umbrella species, endangered and endemic species; biodiversity conservation, in situ and ex-situ conservation; sustainable development.

Suggested books:

1. Chapman, J. L. and Reiss M. J. (1998). Ecology: principles and applications. 2nd Edition.
2. Cambridge; New York, NY: Cambridge University PressMcGill T E (1973) Reading in Animal behavior, Holt Rwnchart and Winston Inc., New York

3. Jelte Van Andel and James Aronson (2006). restoration Ecology, Blackwell Science Ltd. 2006.
4. R.B. Baird , A.D. Eaton, E.W. Rice (2017). Standard Methods for the Examination of Water and Wastewater, 23rd Edition. American Water Works Association (AWWA, WEF and APHA).

COURSE NAME: SYSTEMATIC ZOOLOGY & EVOLUTION

Course Code: ZOO-302
Credit: 04
Course Contents:

Unit I **11 hours**

Biosystematics: definition, concepts and approaches-morphotaxonomy, cytotaxonomy, chemotaxonomy, molecular taxonomy, numerical taxonomy, differential taxonomy; speciation- mode of speciation, factors responsible for speciation; Concept of species and hierarchical taxa.

Unit II **11 hours**

Biological classification: theories and criteria for classification; taxonomic characters-concepts and weighting of characters; Intra population variations-non genetic and genetic variations; International code of zoological nomenclature; Taxonomic procedures-collection, preservation, cataloguing, curetting, identification, and publication.

Unit III **12 hours**

Origin of life and Evolutionary history: concept and theories of organic evolution; Chemical evolution; Prebiotic molecules (Amino acid and nucleic acid base); Evolution of Prokaryotes and Eukaryotes; Evolutionary time scale- major events and human evolution; Phylogenetic tree.

Unit IV **11 hours**

Molecular evolution: neutral evolution; Evolution as seen in proteins; Molecular divergence and molecular clock; Molecular tools in phylogeny; gene duplication and divergence; Population genetics – populations, gene pool, gene frequency; Hardy-Weinberg Law; Factors responsible for evolution- mutation, genetic variation, and genetic drift; Isolating mechanisms; Convergent evolution.

COURSE NAME: PRACTICALS IN ECOLOGY & SYSTEMATIC ZOOLOGY

Course Code: ZOO:P-303
Credit: 02

Practical **60 hours**

1. Analysis of pH and specific conductivity of soil and water samples.
2. Estimation of moisture and thermal profile of soil.
3. Estimation of organic content of soil samples.
4. Estimation and comparison of dissolved oxygen.
5. Estimation of biomass by harvest method in a grassland ecosystem.
6. Estimation of population by quadrate method in a natural ecosystem.
7. Identification and classification of soil micro-arthropods of a grassland/soil habitat.
8. Identification and classification of common freshwater fish species, amphibian species.
9. Identification and classification of Zoometric communities.
10. Preparation of permanent mounts of various taxa.
11. Collection, identification, and submission of local/regional collections.

Suggested books:

1. Sokal, Robert R. (1963). Principles of numerical taxonomy. San Francisco: W. H. Freeman
2. Minelli, A. (1993). Biological Systematics, Chapman & Hall.
3. Mayr, E. (1980). Principles of Systematic Zoology, Tata McGraw Hill Publishing company Limited.
4. Kimura. M (1983). The natural History of Molecular Evolution, Cambridge Univ press.

COURSE NAME: MOOCS

Course Code: ZOO-304
Credit: 02
Students may take one courses from MOOC, in consultation with department MOOC co-ordinator.

COURSE NAME: INTERNSHIP

Course Code: ZOO-305
Credit: 02
Students should complete an internship for at least 2 weeks to 4 weeks from the 1st to 3rd semester (at any time), but the credit will be added in the 3rd semester only. It would be completed in any industry/ research institute/university/ NGOs/ civil societies for upgrading skills. Department may also customize it.

COURSE NAME: FISHERY

Course Code: ZOO-306
Credit: 04
Course Contents:

Unit I **12 hours**

Fish farm: Definition-Site selection, design and construction of aquaculture pond, Formulation and operation of different types of hatcheries, Hatchery management, Criteria for selecting the candidate species for aquaculture - Types and methods: Extensive, semi-intensive and intensive culture. Forms of feeds: wet feeds, dry feeds, pelleted feeds, floating and sinking pellets.

Unit II **11 hours**

Pond management: Physico-chemical properties of pond water and soil and their maintenance, Manuring (organic and inorganic) and liming, Composite fish farming and polyculture, Predatory and weed fishes and their eradication, Aquatic vegetation and its control, biological means of increasing production.

Unit III **12 hours**

Reproduction and Development: Male and female reproductive organs, Histology of the testis, seasonal changes in the testes, Maturation and spawning, Maturity stages in the female fish, Length-weight relationship, Fecundity, Ovulation and fertilization, Hatching and larval development, Parasitic and non-parasitic diseases, Symptoms, Treatments and prophylactic measures.

Unit IV **10 hours**

Induced breeding and Biofloc technology: Factors responsible for induced breeding, Hypophysation, Use of different synthetic and natural hormones, their formulation and

mechanism of action, Bundh breeding, Hapa breeding, Hatchery breeding; Fish seed collection, transport of brood fishes and fish seed. Biofloc technology: principle design and components of Biofloc technology system.

COURSE NAME: PRACTICALS IN FISHERY

Course Code: ZOO:P-307
Credit: 02
Practical **60 hours**

1. Collection and preservation of water sample & Estimation of dissolved oxygen content in a water body.
2. Estimation of carbon dioxide, total solids, total dissolved solids and suspended solids of water sample.
3. Estimation of total alkalinity and total Hardness of water.
4. Determination of fecundity in major carp and catfish.
5. Determination of fertilization rate of carp.
6. Determination of final oocyte maturation by scoring germinal vesicle breakdown.
7. Study of functional morphology of testes and ovary by preparing permanent stained slides belonging to different reproductive phases.
8. Determination of gonosomatic index and hepatosomatic index and their relations with regard to gonadal and body growth.
9. Study of length weight relationship of major carp and catfish.
10. To study the different common diseases of fishes caused by virus, bacteria, protozoan and helminthes.
11. Field visit to local fish farm and submission of fieldwork reports.

Suggested books:

1. Gupta and Gupta: General and Applied Ichthyology (Fish and Fisheries) (2006, S. Chand)
2. Srivastava: Fishes of U.P. and Bihar (2002, Vishwavidyalaya Prakashan)
3. Parihar: Fish Biology and Indian Fisheries (1999, Central publishing House Allahabad)
4. Singh: Advances in Fish Research, Vol. I, II and III (Fisheries and Fish Biology: Ed Datta Munshi) (1993, 1997 and 2004, Narendra Publishing House Delhi)

COURSE NAME: ENTOMOLOGY

Course Code: ZOO-308
Credit: 04
Course Contents:

Unit I **10 hours**

Structure and physiology insect integument; chemistry of cuticle; synthesis and degradation of chitin; biochemistry of sclerotization and tanning; types of insect mouthparts; antenna structure; polymorphism in insect antennae; types of antennae; mechanism of olfaction; types of insect muscles and their ultrastructure; neuromuscular control; physiology of flight muscles.

Unit II **12 hours**

Structure of digestive organs; digestive secretions; digestion and assimilation of nutrients; open and closed types of respiratory system; mechanism of gaseous exchange in insects; structure of excretory organs – basic and cryptonephridial systems; types of maphigian tubule-rectal cycling systems; physiology of excretion; synthesis of uric acid; nervous system types – CNS and VNS.

Unit III **12 hours**

Neuroendocrine system in insects; morphogenesis; role of hormones in growth, differentiation, metamorphosis, diapause and reproduction; biosynthesis and mode of action.

Unit IV **12 hours**

Structure and variation of insect male and female genitalia; ovipositors -appendicular and substitutional types; ovarioles – polytrophic, telotrophic and panoistic; vitellogenesis and its hormonal control; pheromone types – releaser and primer pheromones with examples; different classes of exocrine glands; biochemistry of haemolymph; types and functions of haemocytes.

COURSE NAME: PRACTICALS IN ENTOMOLOGY

Course Code: ZOO:P-309

Credit: 02

Practical **60 hours**

1. Permanent slide preparation of mouthparts of cockroach, housefly, honeybee, mosquitoes and honeybee.
2. Study of antennae of some representative insect orders.
3. Study and dissection of digestive system of grasshopper/cockroach.
4. Dissection of respiratory system of cockroach/grasshopper.
5. Study of external genitalia of some representative orders.
6. Study and study of male and female reproductive systems (cockroach).
7. Histological preparation of testis and ovary of some insects.
8. Structure of insect wing: types and venation.
9. Study of central nervous system of adult (grasshopper/coackroach) and larval stages of silkworm.
10. Study of neuroendocrine system of grasshopper/cockroach and larval stages of silkworm.
11. Detection of uric acid in the malphigian tubules.
12. Uptake of dye in the malphigian tubules.

Suggested books:

1. Gullan P.J. and Cranston P.S. (2010). The Insects: An Outline of Entomology. Wiley-Blackwell.
2. Hill D.S. (1994). Agricultural Entomology, Oregon Timber Press.
3. Iatrou, K., Gill, S.S. and Gilbert L.I. (2005). Comprehensive Molecular Insect Science, Vol. 1-7, Pergamon Press.
4. J.L. Nalian (2001) Insects Physiology and Biochemistry, C.R.C., Boca Raton, London,

COURSE NAME: ADVANCES IN CELL & MOLECULAR BIOLOGY

Course Code: ZOO-310

Credit: 04

Course Contents:

Unit I: **10 hours**

Mitosis and meiosis, their regulation, steps in cell cycle, and control of cell cycle. Regulation of Cell cycle progression: Maturation promoting factors (MPF), Cyclins and Cyclins dependent kinases, growth factors and growth inhibitory factors. Cell death and apoptosis.

Unit II: **11 hours**

The genetic material - Structure of nucleic acids - folding motifs, conformation flexibilities, super-coiling of DNA; Packaging of DNA in the nucleus- structure of chromatin, Function of the genetic material. Evolution of genetic material; 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).

Unit III: **12 hours**

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).

Unit IV: **12 hours**

Constitutive, Inducible and Repressible gene expression; Positive and Negative control of gene expression, Lac, Tryptophan, arabinose operons; lysogenic repression in lambda bacteriophage; Eukaroytic genome organization, Proteins involved in the control of transcription; Post-transcriptional gene control mechanism and nuclear transport - Processing of the 5' and 3' ends of eukaryotic mRNA; Types of introns and their splicing, Micro RNA and other noncoding RNAs; Transport across the nuclear envelope- Structure of the nuclear membrane and the nuclear pore complexes; DNA methylation, Cell Signaling, Ligand binding to membrane receptors. .

COURSE NAME: PRACTICALS IN ADVANCES IN CELL & MOLECULAR BIOLOGY

Course Code: ZOO:P-311

Credit: 02

Practical **60 hours**

1. DNA Isolation Techniques for Eukaryote
2. RNA Isolation Techniques for both Prokaryote and Eukaryote
3. Chromosome Isolation Techniques
4. FISH (Fluroscence In-situ Hybridization Technique).
5. DNA and RNA Staining Techniques.
6. Plasmid DNA Isolation and Genomic DNA Isolation.
7. PCR and its application
8. Electrophoresis Techniques in Genetics.
9. Protein Isolation techniques.
10. Cell Culture Techniques.
11. Preparation of loading dye, tracking dye and buffers for molecular biology.
12. HPLC methods for determination of amino acids.
13. Staining method to determine nucleic acid.
14. Role of Gel Doc in genetic study.

Suggested books:

1. Lewin, B. 2000. Genes VIII Oxford University, Press, New York
2. Alberts, B. Bray, D., Lewis, J. Raff, M., Roberts, K. and Watson, J.D. 1999, Molecular biology of the cell. Garland Publishing, Inc. New York.
3. Wolfe, S.L. 1993, Gruissem, W. and Jones, R.L. 2000, Biochemistry and molecular biology of plants, American society of plant physiologists, Maryland, USA
4. Frifelder, D. Molecular Biology. John and Bartlett Publishers, inc., Boston, USA

Semester IV

COURSE NAME: PROJECT WORK

Course Code: ZOO-401
Credit: 20
Based on the specialization of the project guide.