Mohanlal Sukhadia University
Udaipur

Department of Zoology

Syllabus and Scheme of Examination
For
M.Sc. Zoology
(As per NEP)

Effective from July, 2023

Table 1: CBCS Course structure for M.Sc. (Two Year Program), Total credits 96.

	SEM-1	SEM-II	PG Diploma	SEM-III	SEM-IV
Core Courses	DCC-1-Th (4 Cr) DCC-2 Th (4 Cr) DCC-3 Th (4 Cr) DCC-4 Th (4 Cr) DCC-1 Th/Lab (4 Cr) DCC-2 Th/Lab (4 Cr)	DCC-5-Th (4 Cr) DCC-6 Th (4 Cr) DCC-7 Th (4 Cr) DCC-3 Lab (4 Cr) DCC-4 Lab (4 Cr)	Student who opt to exit after completion of the 1 year securing 48 credits will be awarded a PG Diploma in the relevant subject.	DCC-8-Th (4 Cr) DCC-9 Th (4 Cr)	DCC-10-Th (4 Cr)
Discipline Specific Elective/ Generic Elective Courses	-	GEC-(1-4) Th (4 Cr)		DSE-(5-8) Th (4 Cr) DSE-(9-12) Th (4 Cr) DSE-(1-4) Lab (4 Cr) GEC-(5-8) Lab (4 Cr)	DSE-(13-16) Th (4 Cr) DSE-(17-20) Th (4 Cr) DSE-(21-24) Th (4 Cr) DSE-(9-12) Lab (4 Cr) DSE-(13-16) Lab (4 Cr)
	24+00=24	**20+4=24**		**8+16=24**	**4+20=24**
	56(DCC)+40(DSE/GEC)=96				

1. **Discipline Specific Elective (DSE):** In this table four electives are proposed for a given DSE/GEC course (in the parentheses note the 4 options of each elective i.e., 1-4, or 5-8 or 13-16 etc). Currently, at least two i.e., the first two are to be proposed in each of the ten DSE/GEC courses. Two additional numbers are reserved for two more electives which may be proposed in future.
2. A DSE course opted by a student from his/her parent Department, will be the DSE for him/her. Else the course will be the GEC.
3. A student can opt 2-3 GEC which are under the DSE courses of other faculty.
4. Wherever there are only theory papers the courses can be of either 6 or 4 credits only. . In case of 6 credit for each course the number of courses given in above table will reduce accordingly.
5. In some of the disciplines it can be (2L+2P+2T) or (2L+4P).

Course Structure

NEP based CBCS Scheme of Syllabus for M.Sc. Zoology

Level	Sem	Course Type	Course code	Nature of course	Title of the Course	Delivery type			Total hours	Credit	External exam	Internal assessment	Total
						L	T	P					
8	I	DCC	ZOO8000T	Theory	Biosystematics, structure & functions of invertebrates	L	T		60	4	80	20	100
			ZOO8001T	Theory	Ethology and Evolution	L	T		60	4	80	20	100
			ZOO8002T	Theory	Instrumentation and Techniques in Biology	L	T		60	4	80	20	100
			ZOO8003T	Theory	Cell and Molecular Biology	L	T		60	4	80	20	100
			ZOO8004P	Practical	Practical Lab- 01			P	120	4	80	20	100
			ZOO8005P	Practical	Practical Lab-02			P	120	4	80	20	100
	II	DCC	ZOO8006T	Theory	Toxicology	L	T		60	4	80	20	100
			ZOO8007T	Theory	Developmental Biology	L	T		60	4	80	20	100
			ZOO8008T	Theory	Animal Physiology and Immunology	L	T		60	4	80	20	100
			ZOO8009P	Practical	Practical Lab-3			P	120	4	80	20	100
			ZOO8010P	Practical	Practical Lab -4			P	120	4	80	20	100
		GEC	ZOO8100T	Theory	Mushroom Culture	L	T	P	60	4	80	20	100
			ZOO8101T	Theory	Sericulture	L	T	P	60	4	80	20	100
9	III	DCC	ZOO9011T	Theory	Origin and Evolution of Vertebrates	L	T		60	4	80	20	100
			ZOO9012T	Theory	Biostatistics, Advance Genetics & Bioinformatics	L	T		60	4	80	20	100
		DSE	ZOO9101T	Theory	Entomology-I (Systematic Entomology and Insect Organization)	L	T		60	4	80	20	100
			ZOO9102T	Theory	Wildlife Biology-I (Biodiversity & Wildlife Ecology)	L	T		60				
			ZOO9103T	Theory	Limnology & Fisheries-I (Limnology)	L	T		60				
		DSE	ZOO9104T	Theory	Entomology-II (Physiology of Insects)	L	T		60	4	80	20	100
			ZOO9105T	Theory	Wildlife Biology-II (Conservation Biology)	L	T		60				
			ZOO9106T	Theory	Limnology & Fisheries Practical -II (Freshwater Aquaculture and Its Management)	L	T		60				
		DSE	ZOO9107P	Practical	Entomology Practical-I			P	120	4	80	20	100
			ZOO9108P	Practical	Wildlife Biology Practical-I			P	120				
			ZOO9109P	Practical	Limnology & Fisheries Practical-I			P	120				
		GEC	ZOO9110P	Practical	Vermitechnology and Solid Waste Management	L	T	P	120	4	80	20	100
			ZOO9111P	Practical	Aquarium fish keeping	L	T	P	120	4	80	20	100
		DCC	ZOO9013T	Theory	Applied Zoology & Animal Biotechnology	L	T		60	4	80	20	100
		DSE	ZOO9112T	Theory	Entomology-III (Medical Entomology)	L	T		60	4	80	20	100
			ZOO9113T	Theory	Wildlife Biology- III (Wildlife of India and Rajasthan)	L	T		60				

	IV		ZOO9114T	Theory	Limnology and Fisheries-III (Fisheries Management)	L	T		60				
		DSE	ZOO9115T	Theory	Entomology-IV (Insect Pest Management and Toxicology)	L	T		60	4	80	20	100
			ZOO9116T	Theory	Wildlife Biology-IV (Wildlife Census and Management)	L	T		60				
			ZOO9117T	Theory	Limnology and Fisheries-IV (Fish and Fisheries Biology)	L	T		60				
		DSE	ZOO9118T	Theory	Entomology-V (Insect Ecology, Commercial and Forensic Entomology)	L	T		60	4	80	20	100
			ZOO9119T	Theory	Wildlife Biology-V (Fundamentals of Ornithology)	L	T		60				
			ZOO9120T	Theory	Limnology and Fisheries-V (Post-Harvest Technology in Fisheries)	L	T		60				
			ZOO9121S	Practical	Dissertation	L	T	P	60	4	80	20	100
		DSE	ZOO9122P	Practical	Entomology Practical-II			P	120	4	80	20	100
			ZOO9123P	Practical	Wildlife Biology Practical –II			P	120				
			ZOO9124P	Practical	Limnology & Fisheries Practical-II			P	120				
		DSE	ZOO9125P	Practical	Entomology Practical-III			P	120	4	80	20	100
			ZOO9126P	Practical	Wildlife Biology Practical -III			P	120				
			ZOO9127P	Practical	Limnology & Fisheries Practical-III			P	120				

Note: In case of theory course, the mode of teaching would be lectures and tutorials, while in case of lab, the mode of teaching would be practical and hand-on demo.

Core Courses

Semester	Course Code	Title of the Course
I	ZOO8000T	Biosystematics, Structure & Functions Of Invertebrates
	ZOO8001T	Ethology and Evolution
	ZOO8002T	Instrumentation and Techniques in Biology
	ZOO8003T	Cell and Molecular Biology
	ZOO8004P	Practical Lab 1
	ZOO8005P	Practical Lab 2
II	ZOO8006T	Toxicology
	ZOO8007T	Developmental Biology
	ZOO8008T	Animal Physiology and Immunology
	ZOO8009P	Practical Lab 3
	ZOO8010P	Practical Lab 4
III	ZOO9011T	Origin and Evolution of Vertebrates
	ZOO9012T	Biostatistics, Advance Genetics & Bioinformatics
IV	ZOO9013T	Applied Zoology & Animal Biotechnology

GEC Theory Courses

Semester	Course Code	Title of the Course
II	ZOO8100T	Mushroom Culture
	ZOO8101T	Sericulture

GEC Practical Courses

Semester	Course Code	Title of the Course
III	ZOO9110P	Vermitechnology and Solid Waste Management
	ZOO9111P	Aquarium fish keeping

Discipline Specific Electives:

DSE Theory List

Semester	Course Code	Title of the Course
III	ZOO9101T	Entomology-I (Systematic Entomology and Insect Organization)
	ZOO9102T	Wildlife Biology-I (Biodiversity & Wildlife Ecology)
	ZOO9103T	Limnology & Fisheries-I (Limnology)
	ZOO9104T	Entomology-II (Physiology Of Insects)
	ZOO9105T	Wildlife Biology-II (Conservation Biology)
	ZOO9106T	Limnology & Fisheries-II (Freshwater Aquaculture and Its Management)
IV	ZOO9112T	Entomology-III (Medical Entomology)
	ZOO9113T	Wildlife Biology- III (Wildlife of India and Rajasthan)
	ZOO9114T	Limnology and Fisheries-III (Fisheries Management)
	ZOO9115T	Entomology-IV (Insect Pest Management and Toxicology)
	ZOO9116T	Wildlife Biology-IV (Wildlife Census and Management)
	ZOO9117T	Limnology And Fisheries-IV (Fish and Fisheries Biology)
	ZOO9118T	Entomology-V (Insect Ecology, Commercial and Forensic Entomology)
	ZOO9119T	Wildlife Biology-V (Fundamentals of Ornithology)
	ZOO9120T	Limnology And Fisheries-V (Post-Harvest Technology in Fisheries)
	ZOO9121T	Dissertation

DSE Lab List -1

Semester	Course Code	Title Of The Course
III	ZOO9107P	Entomology Practical-I
	ZOO9108P	Wildlife Biology Practical-I
	ZOO9109P	Limnology & Fisheries Practical-I
IV	ZOO9122P	Entomology Practical-II
	ZOO9123P	Wildlife Biology Practical –II
	ZOO9124P	Limnology & Fisheries Practical-II
	ZOO9125P	Entomology Practical-III
	ZOO9126P	Wildlife Biology Practical -III
	ZOO9127P	Limnology & Fisheries Practical-III

Dissertation:

Semester	Code	Description
IV	ZOO9121S	Credit hours for Dissertation and marking schemes is equivalent to other DSEs. Students have to submit a hardcopy of dissertation and give a presentation of minor research work for evaluation. Details of dissertation proforma and marking scheme is enclosed.

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR
Department of Zoology
M. Sc. Zoology
Semester – I

Code of the course	ZOO8000T
Title of the course	Biosystematics, Structure & Functions Of Invertebrates
Level of the Course	NHEQF Level 6.0
Credit of the Course	4
Type of the Course	DCC
Prerequisites	Zoology course in B. Sc. degree at any central/ state/Open University level

Objectives of the Course

The main objective of this paper is to define the concept of classification and its significance in the diversity of Invertebrates. Also, to introduce their distinguishing characteristics and ecological significance to students.

Learning outcomes

1. Through the course, students will acquire a comprehensive understanding of the concept and importance of classification in biology.
2. They will develop a sound knowledge of the major taxonomic categories and hierarchical structure used in classifying invertebrates.
3. They will gain the ability to analyze the evolutionary relationships, physiological and phylogeny of major invertebrate groups using cladistics and molecular phylogenetics.

Syllabus

UNIT-1 (Lecture hours: 12)

Biosystematics: Basic concepts of taxonomy, Rules of nomenclature, Basis of invertebrate classification, Hierarchy of categories, Molecular and Cyto- taxonomy, Importance of cytology and genetics in taxonomy.

UNIT- 2 (Lecture hours: 12)

Body plans, Coelom, Symmetry, Metamerism, Locomotor mechanisms: Amoeboid locomotion; Ciliary locomotion; Flagellar locomotion; Non-jointed and Jointed appendages.

UNIT- 3 (Lecture hours: 12)

Feeding apparatus of Invertebrates. Feeding and digestion: Microphagy, Macrophagy; Herbivores, Omnivores, Carnivores, Filter feeding, Ciliary feeding. Digestion: intracellular and extracellular digestion.

UNIT- 4 (Lecture hours: 12)

Endocrine system: Neurosecretory cells, Endocrine structures in invertebrates, Role of hormones in moulting and metamorphosis in Insects and Crustaceans.

UNIT- 5 (Lecture hours: 12)

Reproduction: Asexual reproduction, Parthenogenesis, and Sexual reproduction. Metagenesis in Coelenterates. Regeneration in Invertebrates. Larval forms of invertebrates and their significance.
Scheme of Examination Internal and External of as per NEP scheme.
Suggested Books and References: • Barrington EJW. 2012. Invertebrate structure and function. Affiliated East-West Press LTD, New Delhi • Barnes RD. 2006. Invertebrate Zoology: A functional evolutionary approach. 7th edition. Cengage Publication. • Moore J. 2001. An introduction to the Invertebrates. Cambridge University Press. • Pechenik J. 2014. Biology of the invertebrates. McGraw Hill Higher Education. • Brusca RC, Moore W and Shuster SM. 2016. Invertebrates. Sinauer Associates, Oxford University Press.
Suggested E-resources • https://manoa.hawaii.edu/exploringourfluidearth/biological/invertebrates/structure-and-function • https://www.zoologytalks.com/category/structure-and-functions-of-invertebrates/ • https://deb.ugc.ac.in/Uploads/SelfLearning/HEI-P-U-0482/HEI-P-U-0482_SelfLearning_20230331142843.pdf

Code of the course	ZOO8001T
Title of the course	**Ethology and Evolution**
Level of the Course	NHEQF Level 6.0
Credit of the Course	4
Type of the Course	DCC
Prerequisites	Zoology course in B. Sc. degree at any central/ state/Open University level

Objectives of the Course

The paper is design to make an understanding of students to the fundamental principles of ethology and its connection to evolution. So that they can analyze adaptive behaviours in diverse ecological contexts and assess their evolutionary significance.

Learning outcomes

1. Students will gain a comprehensive grasp of animal behavior's evolution, providing insights into the adaptive strategies developed over time.
2. Students will develop the ability to critically evaluate behaviors within ecological contexts, enhancing your analytical skills in interpreting complex patterns.
3. Students will acquire practical skills in designing and conducting ethological research, preparing you for empirical studies in various settings.
4. Blend concepts from ethology, evolution, ecology, and genetics, enabling students to approach biological questions from a holistic perspective.
5. Hone students ability to communicate scientific concepts effectively, equipping you to share insights and contribute to academic discussions and research endeavors.

Syllabus

UNIT-1 (Lecture hours: 12)

Concept of Ethology–(SS, ASE, ARM, IRM), Flush Toilet Model. Definition and Historical outline (Three Nobel Laureate), Patterns of Behaviour, Fixed Action Pattern, Reflex action, Sign stimulus, Orientation, Kinesis and Taxis. Methods of studying behavior.

UNIT- 2 (Lecture hours: 12)

Social organization and its advantages. Eusociality, Insect Societies, Primate Societies, Parental care in Fishes, Amphibians and Mammals.

UNIT- 3 (Lecture hours: 12)

Learning- Types of Learning, Biological Rhythms, Reproductive Behaviour –Display, Courtship, Sexual Selection and Mating Systems. Ecological Behavior – Altruism and kin selection. Hormones and pheromones influence on animals behaviour.

UNIT- 4 (Lecture hours: 12)

General concepts of evolution (Lamarkism, Darwinism and Neo Darwinism). Detailed account of destabilizing forces of evolution: Natural selection, Genetic drift, Meiotic drive, Hardy-Weinberg law of genetic equilibrium, calculating allele, gene and Genotype

frequency, mathematical calculation of frequency changes in mutation. Geological Time Scale.

UNIT- 5 (Lecture hours: 12)

Concept of Species and Speciation, Isolation and Isolating Mechanism, Factors responsible for Speciation, Modules of Speciation (Sympatric, Allopatric and Parapatric), Micro and Macro-evolution. Human evolution: Human Evolutionary History, Placing Humans on Tree of Life, Genomics and Human Evolution, Current Issues in Human Evolution.

Scheme of Examination

Internal and External of Semester Examination as per NEP scheme

Suggested Books and References:

- Mechanism of Animal Behaviour, Peter Marler and J. Hamilton; John Wiley & Sons, USA
- Animal Behaviour, David McFarland, Pitman Publishing Limited, London, UK
- Animal Behaviour, John Alcock, Sinauer Associate Inc., USA
- Animal Behaviour,Reena Mathur, Rastogi Publications , Meerut.
- Exploring Animal Behaviour, Paul W. Sherman & John Alcock, Sinauer Associate Inc.Mssachusetts, USA
- An Introduction to Animal Behaviour, A. Manning and M.S Dawkins, Cambridge University Press.
- Evolution, Hall, B. K. and Hallgrimsson, B., Jones and Bartlett Publisher, Sudbury, USA
- Evolution,Stricburger,M.W.Jones and Barlantt Publishers,Boston ,London, UK.

Suggested E-resources

- https://ocw.mit.edu/courses/9-20-animal-behavior-fall-2013/pages/lecture-notes/
- https://perpus.univpancasila.ac.id/repository/EBUPT190509.pdf
- https://www.gutenberg.org/ebooks/54462
- https://www.pdfdrive.com/animal-behavior-books.html
- https://monoskop.org/images/3/37/Lorenz_Konrad_The_Foundations_of_Ethology_1981.pdf

Code of the course	ZOO8002T
Title of the course	Instrumentation and Techniques in Biology
Level of the Course	NHEQF Level 6.0
Credit of the Course	4
Type of the Course	DCC
Prerequisites	Zoology course in B. Sc. degree at any central/ state/Open University level

Objectives of the Course

Develop a deep understanding of instrumentation techniques used in biological research. To have an insight about working principle and application of techniques in biology. To gain knowledge about advanced techniques used in biological research and their principles.

Learning outcomes

1. To study the principle, working mechanism and application of various types of microscopes like electron, phase contrast, atomic absorption etc., used in biological experiments.
2. To study the principle, working mechanism and application of various types of instruments like spectrophotometer, electrophoresis etc., used in biological experiments.
3. To know the different types of separation techniques of centrifugation and chromatography.
4. To understand the technique of histological slide preparation by knowing the concepts of fixation, staining techniques, and get aware about section cutting using microtome, cryostat etc.,
5. To know about radioisotopes, autoradiography and various immuno- techniques.

Syllabus

UNIT-1 (Lecture hours: 12)

Microscopy Techniques and Basic Instrumentation: Principles, Techniques and Application of Phase Contrast, Fluorescence, Transmission, Scanning, Confocal and Atomic Force Microscopes. Micrometry.

UNIT- 2 (Lecture hours: 12)

Spectroscopic Techniques and Its Applications in Biology - Colorimeter, UV-Visible and FT-IR NMR - Principle and Applications. Electrophoresis (Paper, Agarose, PAGE): General Principles, Horizontal & Vertical Gel Electrophoresis, Iso Electric Focusing, 2D Electrophoresis.

UNIT- 3 (Lecture hours: 12)

Centrifugation Techniques: Basic Principles, Different Types of Centrifuges, Analytical and Preparative Ultracentrifugation Methods, Sonication. Chromatography Techniques in Biological Analysis: Paper Chromatography, Thin Layer Chromatography, Ion-

Exchange Chromatography, Column Chromatography, Affinity Chromatography, HPLC.

UNIT- 4 (Lecture hours: 12)

Tissue Sectioning and Analysis: Fixation (Principle, Methods of Fixation, Chemicals Used as Fixatives and Their Preparation, Chemical Basis of Fixation), Decalcification, Cryopreservation. Microtomy (Dehydration, Clearing and Infiltration, Embedding Methods, Trimming, Sectioning), Different Types of Microtome. Stains and Staining Techniques: Cellular Organelles Stain (Mitochondria, Golgi Apparatus, ER, Nuclear and Cytoplasmic Stains), Concepts of Double and Triple Stain. Cryostat Sectioning and Mounting. Mounting Media. Freezing Techniques (Freeze Drying, Freeze Fracture and Itching)

UNIT- 5 (Lecture hours: 12)

Radioisotope and Their Biological Applications. Scintillation Techniques, and Autoradiography. Immunological Techniques: Immunodiffusion (Single & Double) and Immunoelectrophoresis, Immunocytochemistry, Immunohistochemistry, Immunoprecipitation, Immunoblotting, Immunodetection, Immunofluorescence, RIA, ELISA. Antibody Generation, and Flow Cytometry.

Scheme of Examination

Internal and External of Semester Examination as per NEP scheme

Suggested Books and References:

- Bajpai, P.K. 2006. Biological Instrumentation and methodology. S. Chand & Co. Ltd.
- Freifelder D., Physical Biochemistry, Application to Biochemistry and Molecular Biology, W.H. Freeman and Company, San Fransisco.
- Wilson, K. and Walker, J. Principles and Techniques of Practical Biochemistry Cambridge University Press.
- Pattabhi V and Gautham N. Biophysics, Kluwer Academic Publishers.
- Narayanan P. Essentials of Biophysics, New Age International Pvt Ltd.
- Volkenshtein, M.V. General Biophysics Academic Press, Inc.
- Daniel, M. Basic Biophysics for biologists Agrobios.
- Van, Holde, Johnson, K. E., Cutis, W. and Shing Ho, P. Principles of physical biochemistry, Pearson education Pvt. Ltd.
- Braun,R.(1988)Introduction to instrumental analysis, J. Chem. Educ., 65 (12), pp A336.
- Boyer, R.F. (1993) Modern Experimental Biochemistry, 2nd edition, BenjaminCummings.
- Clark, J.M. and Swizer R.L. (2000) Experimental Biochemistry, 3rd edition, W.H. Freeman & Co Ltd.

Suggested E-resources

- https://nptel.ac.in/courses/102107028
- https://byjus.com/chemistry/differential-extraction-chromatography/
- https://archive.nptel.ac.in/content/storage2/courses/102103047/PDF/mod4.pdf
- https://www.cellimagelibrary.org/
- https://nptel.ac.in/courses/103105060
- https://www.open.edu/openlearn/science-maths-technology/advanced-techniques-cell-and-molecular-biology/content-section-0?active-tab=content-tab
- https://courseware.cutm.ac.in/wp-content/uploads/2020/06/mod5.pdf
- https://archive.nptel.ac.in/courses/102/107/102107028/
- https://www.coursera.org/learn/advanced-imaging-methods.

Code of the course	ZOO8003T
Title of the course	Cell and Molecular Biology
Level of the Course	NHEQF Level 6.0
Credit of the Course	4
Type of the Course	DCC
Prerequisites	Zoology course in B. Sc. degree at any central/ state/Open University level

Objectives of the Course

The course is design to develop an in-depth knowledge about the cell and molecular biology and various cellular mechanisms and also equip students with knowledge about various mechanism of cellular and intracellular transport, cell cycle regulation, cell death, DNA repair etc.

Learning outcomes

1. To gain insight into how processes are integrated at the molecular level to create a functional eukaryotic cell.
2. To provide knowledge about the biomembranes, transport across them.
3. To know the principles of cell communication and adhesion and cell- cell signaling.
4. To acquire advanced knowledge of molecular biology of cell cycle, its regulation and the checkpoints.
5. To study the biology of aging, genetic mechanism of cell death in terms of necrosis and apoptosis.
6. To have an insight into the intracellular transport mechanism, protein trafficking and their regulation.
7. To know about chromatin, karyotype, somatic cell genetics, DNA repair, RNA synthesis etc.

Syllabus

UNIT-1 (Lecture hours: 12)

Biomembranes: Basic Structure, Transport Across Cell Membranes, Diffusion, Osmosis (Uniports, Symports and Antiports), Ion Channels, Active Transport and Membrane Pumps, Electrical Properties of Biomembranes and Membrane Potential.

UNIT- 2 (Lecture hours: 12)

Cell Adhesion and Communication: Tight Junctions, Gap Junctions, Connexins, Desmosomes and Spot Desmosomes. Cell–Cell Signalling: Second Messenger System, Camp, Cell Surface Receptors and Intra Cellular Receptors. Protein Mediated Signalling in Mammalian and Bacterial System (G-Proteins, Tyrosine Kinase, Serine/Threonine Kinase)

UNIT- 3 (Lecture hours: 12)

Cell Cycle and Its Regulation, Role of Microtubules in Cell Cycle. Cyclines and Cycline Dependent Kinases, Regulation of CDK – Cyclin Activity; Check Points of Cell Cycle.

Biology of Aging: Maximum Life Span and Life Expectancy, Causes of Aging, Genetic Instability, Free Radicals, Oxidative Damage and Antioxidants, Telomerase. Cell Death: Necrosis and Apoptosis; Genes Involved in Apoptosis.

UNIT- 4 (Lecture hours: 12)

Intracellular Transport: Intracellular Protein Trafficking, Signal Hypothesis. Golgi Sorting: Post and Co-Transitional Modifications. Lysosomal Polymorphism. Regulation of Intracellular Transport.

Metabolic Pathways and Its Network: A Broad Outline of Metabolic Pathways and Their Linkage, Metabolism of Primary Metabolites – Monosaccharaides, Lipids, Essential Amino Acids and Nucleotides.

UNIT- 5 (Lecture hours: 12)

DNA Repair and Recombination. Control of Gene Expression at Transcription and Translation Level. C-Value Paradox, Euchromatin and Heterochromatin. Human Karyotype, Chromosomal Banding (Paris Conference Nomenclature). Somatic Cell Genetics: Cell Fusion and Hybrid Agents, Mechanism of Fusion, Formation of Heterokaryon (Hybrid Selection and Chromosomal Segregation). Applications of Hybridoma Technology.

Scheme of Examination

Internal and External of Semester Examination as per NEP scheme.

Suggested Books and References:

- Molecular Cell Biology, Lodish et. al.,, W.H. Freeman and Company, New York, USA
- Molecular Biology of the Cell, Alberts et. al.,Garland Science, Taylor & Francis Group, New York, USA.
- Cell Physiology Source Book : A Molecular approach, Sperelakis, Academic Press, New York, USA.
- De Robertis, EDP and De Robertis EMF. (2006) Cell and Molecular Biology. 8th edition. Lipincott Williams and Wilkins, Philadelphia.
- Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. 5th Edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
- Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H.Freeman
- Nelson D. L. and Cox M.M. (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H. Freeman and Company
- Voet, D. and Voet J.G. (2004) Biochemistry 3rd edition, John Wiley and Son
- Sharma, V. K. (1991) Techniques in microscopy and cell biology. Tata McGraw Hill
- Reimer, L. and Kohl, H. (2008) Transmission electron microscopy. Springer.

Suggested E-resources

- National Center for Biotechnology Information (NCBI) - Offers access to a vast collection of molecular biology databases, including PubMed, GenBank, and Gene Expression Omnibus (GEO). Website: https://www.ncbi.nlm.nih.gov/
- The Cell: An Image Library (Cell Image Library) - Provides a collection of microscopy images representing various cellular structures and processes. Website: http://www.cellimagelibrary.org/
- Molecular Biology of the Cell (MBoC) - An online resource accompanying the textbook of the same name, featuring additional learning materials, animations, and study guides. Website: https://www.molbiolcell.org/
- Nature Reviews Molecular Cell Biology - A journal that publishes reviews and research articles covering various aspects of molecular cell biology. Website: https://www.nature.com/nrm/
- Cold Spring Harbor Laboratory (CSHL) - Provides a range of resources including protocols, courses, and symposia related to cell and molecular biology. Website: https://www.cshl.edu/
- The European Molecular Biology Laboratory (EMBL) - Offers access to research articles, seminars, and courses covering molecular biology and related fields. Website: https://www.embl.org/

Code of the course	ZOO8004P
Title of the course	Practical Lab- 01
Level of the Course	NHEQF Level 7.0
Credit of the Course	4
Type of the Course	DCC-Lab
Prerequisites	Zoology course in B. Sc. degree at any central/ state/Open University level

Objectives of the Course

To develop a practical skill for identification of invertebrates and also to develop the ability to analyze and synthesize ethological and evolutionary concepts.

Learning outcomes

1. Students will gain a comprehensive understanding of diverse invertebrate taxa, enabling you to identify and classify various species based on behavioral and evolutionary characteristics.
2. To develop the skills to analyze and interpret the behavioral patterns exhibited by invertebrates, exploring how these behaviors contribute to their survival and reproductive success.
3. Evolutionary Understanding: Acquire a deep appreciation of the evolutionary mechanisms shaping invertebrate behaviors, fostering insights into the adaptive strategies developed over time.
4. Research Competence: Develop practical research skills in studying invertebrate ethology and evolution, equipping you to design and conduct empirical studies in the field and laboratory.
5. Interdisciplinary Integration: Synthesize knowledge from ethology, evolutionary biology, and ecology, allowing you to comprehend the complex interplay between behavior and evolutionary processes in non-vertebrate organisms.

Syllabus

1. Study of museum specimens
    a. Protozoa: *Amoeba proteus* w.m., *Paramecium* .w.m., *Paramecium* fission *Paramecium* conjugation, *Plasmodium* (signet ring), *Vorticella* w.m., *Nyctotherus* w.m., *Entamoeba histolytica* w.m., Radiolarian ooze, *Ceratium w.m.*, *Volvox* w.m., *Monocystis* trophozites
    b. Porifera: *Hyalonema, Euplectella, Leucosolenia, Cliona, Spongilla, Chalina, Euspongia, Sycon, Hircinia, Grantia Olynthus*
    c. Coelenterata: *Physalia, Porpita, Gorgonia, Metridiun, Aurelia, Corallium, Adamsia, Edwardsia, Cerianthus, Fungia, Pennatula, Madrepora, Vallela, Sagarita, Renilla, Zoanthus, Favia, Virgularia, Millepora, Alcyonium*
    d. Platyhelminthes and Aschelminthes: *Taenia, Fasciola, Echinococcus, Ascaris* (male and female), *Dracunculus, Dugesia*

e. Annelida: *Polynoe, Phoronis, Chaetopterus, Pontobdella, Nereis, Heteronereis, Hirudinaria, Glycera, Eunice, Terebella, Arenicola, Bonelia, Aphrodite, Eurythoe*
f. Arthropoda: *Squilla, Palaemon, Scolopendra Julus,* Queen termite, *Papillio, Bombyx mori, Vespa, Sacculina* on Crab, *Locust, Carcinus, Limulus, Hermit crab, Balanus, Peripatus,Pediculus, Lepisma, Phyllum, Mantis religiosa, Palamnaeus, Cimex, Lepas.*
g. Mollusca: *Sepia, Laviculus, Teredo, Chiton, Aplysia, Doris, Dentalium, Octopus, Ligula, Mytilus, Pila, Margertifera, Turbinella, Ostrea, Pinctada, Solen, Loligo, Limax, Pecten, Nautilus, Patella.*
h. Echinodermata: *Asterias, Ophioderma, Clypeaster, Echinus, Holothuria, Antedon, Ophiothrix.*

2. Study of permanent slides
   a. Porifera: L.S. of *Grantia,* T.S. of *Sycon,* L.S. of *Sycon, Leucosolenia,* Spongin fibres, Gemmule, Spicules
   b. Coelenterata: Hydra with bud, T.S. of Hydra, L.S. of Hydra, T.S. of Testes Hydra, T.S. of Ovary of Hydra, Obelia colony.
   c. Platyhelminthes and Aschelminthes: *Schistosoma* W.M., *Taenia* immature proglottid, *Taenia* mature proglottid, *Taenia* gravid proglottid, Miracidium larvaW.M., Sporocyst larva W.M., Cercaria larva W.M., Redia larva W.M., T.S. of gonads of *Fasciola*, T.S. of *Planaria*, T.S. of *Ascaris* female, T.S. of *Ascaris* female, *Trichinella spiralis* cyst W.M., *Enterobius* W.M., *Ancylostoma* W.M.
   d. Annelida: *Tubifex* W.M., septal nephridia of *Pheretima*, L.S. of anterior region of *Pheretima*, T.S. through Pharynx of *Pheretima*,T.S. of typhlosolar region of *Pheretima*, T.S. through gizzard of *Pheretima*, T.S. through prostate gland of *Pheretima*, T.S through stomach of *Pheretima*,W.M. of jaw of *Hirudinaria*, T.S. of *Neries*, W.M. of *Glossiphonia*.
   e. Arthropoda: W.M. of Culex male, W.M. of Culex female, W.M. of pupae of Culex, W.M. of pupae of Anopheles, W.M. of Anopheles male, W.M. of Anopheles female, Mouth parts of male Culex, Mouth parts of female Culex, Mouth parts of male Anopheles, Mouth parts of female Anopheles, Different types of mouth parts, Different types of legs: jumping, clinging, running, pollinating, W.M. of Pediculus, W.M. of Xenopsylla, W.M. of Lucifer, W.M. of Zoea larva, W.M. of Nauplius larva, W.M. of Metanauplius, W.M. of Mysis, W.M. of Caprella, W.M. of Cypris, W.M. of Alima larva, W.M. of trachea of *Periplaneta*, W.M. of salivary glands of *Periplaneta*, W.M. of larva of Anopheles.

f. Mollusca: T.S. of Lamellidens, T.S. of Lamellidens through foot, T.S. gill of Lamellidens, Glochidium larva, Valiger larva, W.M. of radula Pila, T.S. of osphradium of Pila.
g. Echinodermata: C.S. of arm Asterias, T.S. of tube feet of Asterias, W.M. of pedicellaria of Asterias, W.M., Bipinnaria larva, W.M. of Echinopluteus larva.

3. Permanent preparations of the following:
   a. Protozoa: Preparation of culture of various protozoans, mounting of various protozoans including parasiticforms
   b. Porifera: Gemmules, spicules, spongin fibers
   c. Coelenterata: Obelia colony medusa, Pennaria, Sertularia, Pluniularia, Companularia, Hydra, Hydra with gonads.
   d. Helminthes: Immature, mature and gravid proglottids, Scolex of Taenia larval forms
   e. Annelida: *Pheretima*: Ovary, septal nephridium, seta (*in situ*) spermatheca. *Neries* and *Heteroneries*: Parapodia trochophore larva, *Hirudinaria*: Jaws and testicular nephridia.
   f. Arthropoda: Apis- Sting apparatus. Periplaneta- Salivary glands, testes, spermatheca. Mounting of various types of mouth parts. Mounting of various larval forms.
   g. Mollusca: Pila: Mounting of gill, Osphradium and radula, Lamellidens: Gill lamella
   h. Echinodermata: Mounting of larval forms.
4. Virtual dissections/Drawing and labelling
   a. Annelida: General anatomy, alimentary canal and reproductive system of Pheretima and Hirudinaria.
   b. Mollusca: General anatomy and nervous system of Mytilus, Aplysia, Sepia and Loligo.
   c. Arthropoda: Nervous system of Squilla, Vespa and Apis. General anatomy, alimentary canal nervous system and reproductive system of Schistocerca.
   d. Echinodermata: Holothuria: Flag labelling of various organs. Echinus: Aristotle's lantern.
5. Ethological and evolution exercises (Practical/Visual demonstration):
   a. Antennal grooming behavior of Cockroach.
   b. Learning (Trial and Error, classical conditioning, and latent learning).
   c. Food preference in stored product pests.
   d. Maternal and nest building behaviour in rat/mice.
   e. Habituation behaviour.
   f. Exploratory behaviour in Rat/Mice.

g. To study the orientational responses of larvae to volatile and nonvolatile stimuli.
h. Estimation of gene and genotype frequency in the light of Hardy Weinberg Law based on facial traits, blood group (ABO) and PTC
i. Demonstration of density dependent selection in plants and animal population.
j. Pedigree analysis (autosomal, X linked and Y linked traits only).

Scheme of Examination

Internal and external of semester examination as per NEP scheme

Suggested Books and References:

- S.S. Lal. Practical Zoology: Invertebrate. Rastogi Publication
- P.S. Verma. A manual of Practical Zoology Invertebrates. S. Chand Publication.
- Agarwal and Jindal. Practical Invertebrate Zoology. Pragati Prakashan.

Suggested E-resources

- https://manoa.hawaii.edu/exploringourfluidearth/biological/invertebrates/structure-and-function
- https://www.zoologytalks.com/category/structure-and-functions-of-invertebrates/
- https://deb.ugc.ac.in/Uploads/SelfLearning/HEI-P-U-0482/HEI-P-U-0482_SelfLearning_20230331142843.pdf

Code of the course	ZOO8005P
Title of the course	Practical Lab- 02
Level of the Course	NHEQF Level 6.0
Credit of the Course	4
Type of the Course	DCC-Lab
Prerequisites	Zoology course in B. Sc. degree at any central/ state/Open University level

Objectives of the Course

To impart practical and hands on training about various instruments and techniques and cell & molecular biology.

Learning outcomes

- To demonstrate the practical usage of various instruments.
- To prepare paraffin block, perform sectioning, and prepare double stained slide.
- To know and prepare different solutions, fixatives and stains.
- To prepare slides of mitosis and meiosis to demonstrate cell division.
- To know about advanced methods of demonstration of macromolecules.
- To study human karyotype and sex chromatin.

Syllabus

1. Demonstration of practical usage of:
    i. Colorimeter
    ii. Spectrophotometer
    iii. Centrifuge
    iv. Fluorescence microscope
2. Preparation of paraffin blocks of given tissue: sectioning and staining
3. Preparation of cryostat section and staining
4. Preparation of molar solutions, buffers, mounting media, fixatives
5. Single and double staining of paraffin sections
6. Standardisation of Oculometer and measurements of tubular diameter cell heights, nuclear diameters etc.
7. Use of Ocular grid- Standardisation and counting of cells or nuclei in cross section of epithelium.
8. Separation of DNA and proteins by Agarose gel Electrophoresis.
9. Separation of amino acids by paper chromatography
10. Separation of phospholipids by TLC.
11. Tissue homogenisation and fractionation by differential centrifugation for isolation of mitochondria, nuclei and cytosol and use of marker enzymes for assessment of components.

12. Permanent slides: Mitosis, Meiosis, cancer, Bone marrow, Thymus, lymph nodes, Squamous cell, cuboidal cell, columnar cell, muscle cell, nerve cell, various stages of cancer cells.
13. Preparation of human Karyotype.
14. Euchromatin and heterochromatin staining in onion cells.
15. Transportation across RBC membrane using isotonic, hypotonic, and hypertonic solution.
16. Sex chromatin in squamous cell epithelium of oral cavity.
17. Preparation of chromosomes.
18. Cytochemistry of carbohydrates – PAS method, Alcian Blue method
19. Cytochemistry of proteins- mercury bromophenol method, Ninhydrin method
20. Cytochemistry of nucleic acids- Feulgen method, Methyl green-Pyronil method
21. Determination of pK values of buffer.
22. Determination of optimum concentration of enzymes for kinetic studies.
23. Determination of Michaelis - Menten K_m and V^{max} for an enzyme by Thumer's method.
24. Preparation of salivary gland chromosomes of Drosophila/ Chironomous larvae and stain with acetocarmine/ aceto-orcein/ Feulgen.

Scheme of Examination

Internal and External of Semester Examination as per existing CBCS scheme

Suggested Books and References:

- K. Wilson and K.H. Goulding: A biologists guide to principals and techniques of Practical biochemistry, ELBS Pub.
- Robert Braun: Introduction to instrumental analysis, McGraw Hill Intern.
- Nigel Jenkings: Animal cell biotechnology, methods and Protocols, Humana Press
- R.Ralph: Methods in experimental Biology. Blackie Pub

Suggested E-resources

- https://webstor.srmist.edu.in/web_assets/srm_mainsite/files/files/BT0213%20-%20CELL%20BIOLOGY%20PRACTICAL%20MANUAL.pdf
- https://www.researchgate.net/publication/330654692_Cell_Biology_Practical_Manual
- https://www.rug.nl/infonet/studenten/umcg/celweb/manualworkshopscelbiology-eng.pdf

Semester – II

Code of the course	ZOO8006T
Title of the course	Toxicology
Level of the Course	NHEQF Level 6.0
Credit of the Course	4
Type of the Course	DCC
Prerequisites	Zoology course in B. Sc. degree at any central/ state/Open University level

Objectives of the Course

To provide a comprehensive understanding of the field of toxicology, its scope, and its applications in various sectors such as environmental, occupational, pharmaceutical, and forensic toxicology.

Learning outcomes

By the end of this course, students should be able to:

1. Define and explain the scope of toxicology and its applications in different sectors.
2. Discuss the historical milestones and influential figures in the development of toxicology.
3. Analyze and interpret dose-response relationships, factors influencing toxicity, and routes of exposure and toxicokinetics.
4. Evaluate and describe the cellular and molecular mechanisms of toxicity, including DNA damage, protein dysfunction, apoptosis, and biotransformation.
5. Assess and analyze the effects of toxicants on various organ systems, including the nervous system, liver, kidneys, lungs, cardiovascular system, and reproductive and developmental health.
6. Identify and evaluate the impact of environmental pollutants, pesticides, heavy metals, endocrine-disrupting chemicals, and carcinogens on human health.
7. Discuss and analyze emerging trends in toxicology, including nanotoxicology, epigenetics, toxicogenomics, computational toxicology, alternative testing methods, and ethical considerations in toxicology research.

Syllabus

UNIT-1 (Lecture hours: 12)

Introduction to Toxicology: Definition and scope of toxicology, Historical overview of toxicology, Principles of dose-response relationships, Factors influencing toxicity (age, sex, species, etc.), Routes of exposure and toxicokinetics, Toxicity testing methods and regulatory considerations.

UNIT- 2 (Lecture hours: 12)

Environmental and Occupational Toxicology: Environmental toxicants and pollution, Pesticides and herbicides, Heavy metals and metalloids, Endocrine-disrupting chemicals, Carcinogens and mutagens, Risk assessment and management.

UNIT- 3 (Lecture hours: 12)

Cellular and molecular mechanisms of toxicity: Reactive oxygen species and oxidative stress, DNA damage and mutagenesis, Protein dysfunction and cellular signaling disruption, Apoptosis and cell death pathways, Metabolism and biotransformation of toxicants.

UNIT- 4 (Lecture hours: 12)

Organ Systems Toxicology: Neurotoxicity and behavioral effects, Hepatotoxicity and liver injury, Nephrotoxicity and renal dysfunction, Pulmonary toxicity and respiratory system effects, Cardiovascular toxicity and circulatory system effects, Reproductive and developmental toxicity.

UNIT- 5 (Lecture hours: 12)

Emerging Trends in Toxicology: Nanotoxicology and engineered nanomaterials, Epigenetics and gene-environment interactions, Toxicogenomics and biomarkers of toxicity, Computational toxicology and predictive modeling, Adverse drug reactions and pharmacovigilance, Regulatory and ethical considerations in toxicology research.

Scheme of Examination

Internal and External of Semester Examination as per NEP scheme.

Suggested Books and References:

- "Casarett & Doull's Toxicology: The Basic Science of Poisons" by Curtis Klaassen, John Watkins, and Louis Casarett
- "Principles of Toxicology: Environmental and Industrial Applications" by Stephen M. Roberts, Robert C. James, and Phillip L. Williams
- "Introduction to Environmental Toxicology: Molecular Substructures to Ecological Landscapes" by Wayne G. Landis, Ruth M. Sofield, and Ming-Ho Yu.
- "Toxicology: Principles for the Industrial Hygienist" by Jeffrey K. Aronson and Timothy D. Brooks
- "Handbook of Toxicology" edited by Michael J. Derelanko and Mannfred A. Hollinger
- "Textbook of Forensic Medicine and Toxicology" by Dr. V.V. Pillay
- "Handbook of Forensic Toxicology for Medical Examiners" by Dr. D.R. Rao
- "Principles of Toxicology: Environmental and Industrial Applications" by Dr. Philip Abraham
- "Textbook of Medical Toxicology" by Dr. R.C. Gupta
- "Introduction to Forensic Medicine and Toxicology" by Dr. Gaurav Agnihotri

Suggested E-resources

- ToxLearn (National Library of Medicine): Provides online modules and resources on various topics in toxicology. Available at: https://toxlearn.nlm.nih.gov/

- Agency for Toxic Substances and Disease Registry (ATSDR): Offers educational resources, fact sheets, and toxicological profiles on hazardous substances. Available at: https://www.atsdr.cdc.gov/
- The National Toxicology Program (NTP): Provides information on toxicology research, testing methods, and reports on chemical hazards. Available at: https://ntp.niehs.nih.gov/
- European Chemicals Agency (ECHA): Offers resources on chemicals, including hazard assessment, classification, and regulations. Available at: https://echa.europa.eu/
- Society of Toxicology (SOT): Provides access to publications, webinars, and educational resources on toxicology. Available at: https://www.toxicology.org/.

Code of the course	ZOO8007T
Title of the course	Developmental Biology
Level of the Course	NHEQF Level 6.0
Credit of the Course	4
Type of the Course	DCC
Prerequisites	Zoology course in B. Sc. degree at any central/ state/Open University level

Objectives of the Course

To provide a comprehensive understanding of the field of toxicology, its scope, and its applications in various sectors such as environmental, occupational, pharmaceutical, and forensic toxicology.

Learning outcomes

- To get knowledge about gametogenesis, fertilization and its mechanism.
- To know about the mechanism of cleavage, blastulation and gastrulation in different animals.
- To have an insight into mechanisms of induction, competence and differentiation.
- To know how animals achieve symmetry and axis.
- To study morphogenesis and organogenesis and their genetic mechanism.
- To know how evolution has changed the development process in the phylogeny.
- To gain knowledge about modern techniques of developmental biology and socio ethical issues.

Syllabus

UNIT-1 (Lecture hours: 12)

Differentiation of gonads in Mammals. Production of male and female gametes and its hormonal control. Organization of egg cytoplasm. Types of Ova and sperm and their basis.

UNIT- 2 (Lecture hours: 12)

Fertilization, Biochemistry of fertilization. Cell surface molecules in sperm-egg recognition. Parthenogenesis. Cleavage, Blastulation and Gastrulation. Fate maps.

UNIT- 3 (Lecture hours: 12)

Commitment, specification, Embryonic Induction (induction of primitive nervous system and eye lens induction), Competence, determination and differentiation. Establishment of symmetry. Axes and pattern formation Drosophila, Amphibia and Chick.

UNIT- 4 (Lecture hours: 12)

Morphogenesis of the Brain. Neural crest cells and their derivatives. Differentiation of neurons. Development of eyes, heart, alimentary canal and its accessory organs. Metamorphosis in Amphibia and Insects and its hormonal control. Vulva formation in *Caenorhabditis elegans*.

UNIT- 5 (Lecture hours: 12)

Evolution of cleidoic egg and viviparity. Extra embryonic membranes. Implantation and Placentation. Stem cells and potency. Environmental regulation of normal development. Animal cloning and its socio-ethical issues. Modern techniques of developmental biology: their uses and misuses.

Scheme of Examination

Internal and External of Semester Examination as per NEP scheme.

Suggested Books and References:

- Developmental Biology, Gilbert, (8th Ed., 2006) Sinauer Associates Inc., Massachusetts, USA.
- Principles of Development, Wolpert, Beddington, Brockes, Jessell, Lawrence, Meyerowitz, (3rd Ed., 2006), Oxford University Press, New Delhi, INDIA.
- Analysis of Biological Development, Kalthoff, (2nd Ed., 2000), McGraw-Hill Science, New Delhi, INDIA

Suggested E-resources

- https://onlinecourses.nptel.ac.in/noc20_bt35/preview
- https://study.com/academy/lesson/drosophila-development-pattern-formation-of-the-body-plan.html
- https://letstalkacademy.com/drosophila/
- https://www.studyandscore.com/studymaterial-detail/phylum-arthropoda-metamorphosis-in-insects
- https://www.studyandscore.com/study-material/developmental-biology
- https://www.yourarticlelibrary.com/science/process-of-metamorphosis-in-amphibians-and-its-hormonal-control/23158
- https://arxiv.org/ftp/arxiv/papers/2207/2207.10861.pdf
- https://www.researchgate.net/publication/233865235_Mechanisms_of_Brain_Morphogenesis

Code of the course	ZOO8008T
Title of the course	Animal Physiology and Immunology
Level of the Course	NHEQF Level 6.0
Credit of the Course	4
Type of the Course	DCC
Prerequisites	Zoology course in B. Sc. degree at any central/ state/Open University level

Objectives of the Course

To provide a comprehensive understanding of the field of toxicology, its scope, and its applications in various sectors such as environmental, occupational, pharmaceutical, and forensic toxicology.

Learning outcomes

- To help the students in understanding how the body functions adapts with respect to its external and internal environment.
- To study about thermoregulation, osmotic balance, hormonal regulation in relation to the environment.
- To understand the all areas of immunology and study the innate and adaptive immunity, antigens and antibodies.
- To know about the immune deficiency diseases, hypersensitivity and vaccines.

Syllabus

UNIT-1 (Lecture hours: 12)

Endotherms and ectotherms; counter current heat exchangers; torpor, hibernation and aestivation. Ionic and Osmotic balance: Osmoregulators and osmoconformers; Osmoregulation in aquatic and terrestrial environments; Counter current mechanism (mechanism for concentration of urine and its excretion) and hormonal control of regulation of water and salt balance.

UNIT- 2 (Lecture hours: 12)

Sensing the environment: Photoreception; Chemoreception; Mechanoreception; echolocation; Chromatophores and bioluminescence. Basic concept of stress physiology and management.

UNIT- 3 (Lecture hours: 12)

Gas exchange and acid base balance: Mechanism of inspiration and expiration in aquatic and terrestrial animals; O_2 and CO_2 transport in blood; Role of Haemoglobin in regulation of body pH; Chloride shift, Haldane Effect. ECG – its principle and significance, Cardiac cycle; Types of synapse; Neurotransmitters; Signal transmission between nerves and muscles; Neuroendocrine regulation of endocrine glands.

UNIT- 4 (Lecture hours: 12)

Immunology: Types of immunity; Cells and organs of immune system; Lymphatic system and organs; Antigens and antibodies; antigen-antibody interactions; Immunogens (Antigenicity and Immunogenicity).

UNIT- 5 (Lecture hours: 12)

Major histocompatibility complex: Types and Structures; antigen processing and presentation, activation and differentiation of B and T cells, B and T cell receptors, primary and secondary immune modulation, the complement system, Immunodeficiency disease and autoimmunity; Hypersensitivity; Vaccines and their types.

Scheme of Examination

Internal and External of Semester Examination as per NEP scheme.

Suggested Books and References:

- General and Comparative Animal Physiology, Hoar W. S. (ed), Prentice Hall, India
- Comparative Physiology (Handbook of Physiology): Vol. 1, 2, Dantzler, W.H. (ed.) Oxford University Press, New York, USA
- Animal Physiology: Adaptation and Environmental, Nelson K. S. (ed) Cambridge University Press, Cambridge, UK
- Kuby Immunology, Richard, Thomas, Barbara, Janis, (5th Ed., 2003), W. H. Freeman and company, New York, USA.
- Immuno Biology- The immune system in health and disease, Janeway, Travers, Walport and Shlomchik, (6th Ed., 2005), Garland Science Publishing, New York, USA.
- Immunology, David, Brostoff and Roitt, (7th Ed., 2006), Mosby & Elsevier Publishing, Canada, USA.

Suggested E-resources

- https://www.studocu.com/en-gb/document/university-of-leeds/animal-physiology-from-ants-to-whales/animal-physiology-lecture-notes-blgy2293/578042
- https://edisciplinas.usp.br/pluginfile.php/5553647/mod_resource/content/1/Eckert%20Animal%20Physiology_%20Mechanisms%20and%20Adaptations%20%28Fourth%20Edition%29%20%20%20%28%20PDFDrive.com%20%29.pdf
- https://www.cartercenter.org/resources/pdfs/health/ephti/library/lecture_notes/health_science_students/physiologypti.pdf
- https://archive.nptel.ac.in/courses/102/104/102104058/

Code of the course	ZOO8009P
Title of the course	Practical Lab - 3
Level of the Course	NHEQF Level 6.0
Credit of the Course	4
Type of the Course	DCC-Lab
Prerequisites	Zoology course in B. Sc. degree at any central/ state/Open University level

Objectives of the Course

This practical paper aims to introduce students to the interdisciplinary field of Toxicology and Developmental Biology by investigating the impact of specific toxins on the embryonic development of a model organism. Through practical experiments, students will gain insights into the intricate relationship between toxic exposure and developmental outcomes, enhancing their understanding of the potential risks posed by environmental agents during critical developmental stages.

Learning outcomes

1. Understanding of Developmental Processes: Students will grasp the fundamental principles of embryonic development and gain insight into the intricate stages of tissue formation, organogenesis, and morphogenesis.
2. Application of Toxicological Concepts: Through practical experiments, students will learn to apply toxicological concepts by assessing the effects of specific toxins on developmental outcomes, linking theoretical knowledge to real-world scenarios.
3. Critical Analytical Skills: By collecting and analyzing experimental data, students will develop critical analytical skills, enabling them to interpret results and draw conclusions about the impact of toxic exposures on embryonic development.
4. Awareness of Environmental Risks: Students will deepen their awareness of the potential risks posed by environmental toxins during crucial stages of development, contributing to a broader understanding of environmental health and public safety.
5. Interdisciplinary Perspective: Engaging with both developmental biology and toxicology, students will gain an interdisciplinary perspective, fostering the ability to integrate knowledge from different fields to address complex biological questions and challenges.

Syllabus

1. Preparation of serial dilution of doses and study of bio-safety equipment.
2. Pesticide Residue analysis using TLC.
3. Bacterial Examination of water for portability, microorganisms, E-coli, Staphylococci faecalis as an indicator of pollution MPN index.
4. Ames test to determine mutagenicity in liver homogenate.
5. Acute toxicity testing using Daphnia/Drosophila larvae
6. Determination of LC50 and LC 90 using insect as a model
7. Bioassay of different bio-pesticides with different mode of actions against pests/vectors

8. Toxicity and adulteration testing in food products
9. Residual toxicity test with bio insecticide.
10. Effect of toxicants on chromosomes of animal
11. Effect of toxicants on animal tissues (histopathology)
12. Report on any one type of Occupational hazardous event of past
13. Study of permanent slides :
    - I. T.S. of mammalian ovary and testis
    - II. Chick embryo w.m. and T.S. of 18 hours, 24 hours, 36 hours, 48 hours and 72 hours.
    - III. W.M. of mammalian sperm
    - IV. Cleavage, blastula and gastrula of frog.
14. Preparation of permanent mount of chick embryo of different hours stages.
15. Preparation of Permanent Mount of eggs, Cleavage, Blastula, Gastrula of amphibian/Fish/suitable organism.
16. Study of developmental stages and Metamorphosis of Insects: Mosquitoes, Cockroach, Butterfly/ Moth, Drosophila
17. Study of living tadpole larvae and its metamorphosis

Scheme of Examination

Internal and External of Semester Examination as per NEP scheme.

Suggested Books and References:

- "Casarett & Doull's Toxicology: The Basic Science of Poisons" by Curtis Klaassen, John Watkins, and Louis Casarett
- "Principles of Toxicology: Environmental and Industrial Applications" by Stephen M. Roberts, Robert C. James, and Phillip L. Williams
- "Introduction to Environmental Toxicology: Molecular Substructures to Ecological Landscapes" by Wayne G. Landis, Ruth M. Sofield, and Ming-Ho Yu.
- "Toxicology: Principles for the Industrial Hygienist" by Jeffrey K. Aronson and Timothy D. Brooks
- "Handbook of Toxicology" edited by Michael J. Derelanko and Mannfred A. Hollinger
- "Textbook of Forensic Medicine and Toxicology" by Dr. V.V. Pillay
- "Handbook of Forensic Toxicology for Medical Examiners" by Dr. D.R. Rao
- "Principles of Toxicology: Environmental and Industrial Applications" by Dr. Philip Abraham
- "Textbook of Medical Toxicology" by Dr. R.C. Gupta
- "Introduction to Forensic Medicine and Toxicology" by Dr. Gaurav Agnihotri

Suggested E-resources

- ToxLearn (National Library of Medicine): Provides online modules and resources on various topics in toxicology. Available at: https://toxlearn.nlm.nih.gov/

- Agency for Toxic Substances and Disease Registry (ATSDR): Offers educational resources, fact sheets, and toxicological profiles on hazardous substances. Available at: https://www.atsdr.cdc.gov/
- The National Toxicology Program (NTP): Provides information on toxicology research, testing methods, and reports on chemical hazards. Available at: https://ntp.niehs.nih.gov/
- European Chemicals Agency (ECHA): Offers resources on chemicals, including hazard assessment, classification, and regulations. Available at: https://echa.europa.eu/
- Society of Toxicology (SOT): Provides access to publications, webinars, and educational resources on toxicology. Available at: https://www.toxicology.org/.

Code of the course	ZOO8010P
Title of the course	Practical Lab- 4
Level of the Course	NHEQF Level 6.0
Credit of the Course	4
Type of the Course	DCC-Lab
Prerequisites	Zoology course in B. Sc. degree at any central/ state/Open University level

Objectives of the Course

Train students with recent and updated technology in biological science.

Learning outcomes

- Laboratory Proficiency: Develop advanced practical skills in conducting experiments related to animal physiology and immunology, including techniques for analyzing physiological processes and immune responses.
- Data Interpretation: Gain the ability to collect and analyze physiological and immunological data, allowing you to interpret experimental results and draw meaningful conclusions.
- Integration of Concepts: Synthesize knowledge from various disciplines such as physiology, immunology, and molecular biology to understand how physiological processes and immune mechanisms are interconnected.
- Critical Thinking in Research: Apply critical thinking to design experimental protocols, troubleshoot issues, and adapt methodologies, enhancing your ability to contribute to scientific research in the field.
- Practical Application: Translate theoretical concepts into practical applications by understanding how animal physiological functions and immune responses impact overall health, disease resistance, and ecological interactions.

Syllabus

1. Study of permanent slides of various cells of immune system.
2. Study of permanent slides of various immune organs viz spleen, thymus, bone-marrow, kidney, lymph nodes, MALT.
3. Demonstration of Vital capacity.
4. Virtual Dissection of various organs and glands associated with immune system.
5. Demonstration of clotting time.
6. Demonstration of bleeding time.
7. Preparation of haematin crystals.
8. Determination of ESR under various disease conditions.
9. Determination of Packed Cell Volume (PCV) and mean corpuscular volume (MCV)
10. Determination of health status of self on the basis of analysis of blood smear.

Scheme of Examination

Internal and External of Semester Examination as per NEP scheme.

Suggested Books and References:

- General and Comparative Animal Physiology, Hoar W. S. (ed), Prentice Hall, India
- Comparative Physiology (Handbook of Physiology): Vol. 1, 2, Dantzler, W.H. (ed.) Oxford University Press, New York, USA
- Animal Physiology: Adaptation and Environmental, Nelson K. S. (ed) Cambridge University Press, Cambridge, UK
- Kuby Immunology, Richard, Thomas, Barbara, Janis, (5th Ed., 2003), W. H. Freeman and company, New York, USA.
- Immuno Biology- The immune system in health and disease, Janeway, Travers, Walport and Shlomchik, (6th Ed., 2005), Garland Science Publishing, New York, USA.
- Immunology, David, Brostoff and Roitt, (7th Ed., 2006), Mosby & Elsevier Publishing, Canada, USA.

Suggested E-resources

- https://www.studocu.com/en-gb/document/university-of-leeds/animal-physiology-from-ants-to-whales/animal-physiology-lecture-notes-blgy2293/578042
- https://edisciplinas.usp.br/pluginfile.php/5553647/mod_resource/content/1/Eckert%20Animal%20Physiology_%20Mechanisms%20and%20Adaptations%20%28Fourth%20Edition%29%20%20%20%28%20PDFDrive.com%20%29.pdf
- https://www.cartercenter.org/resources/pdfs/health/ephti/library/lecture_notes/health_science_students/physiologypti.pdf
- https://archive.nptel.ac.in/courses/102/104/102104058/

Code of the course	ZOO8100T
Title of the course	Mushroom Culture
Level of the Course	NHEQF Level 6.0
Credit of the Course	4
Type of the Course	GEC-Th
Prerequisites	Zoology course in B. Sc. degree at any central/ state/Open University level

Objectives of the Course

To provide students with a comprehensive understanding of the principles, techniques, and factors involved in mushroom cultivation, enabling them to develop expertise in sustainable and efficient methods for growing various mushroom species for food, medicine, and industrial applications.

Learning outcomes

1. Mushroom Lifecycle Mastery: Understand the complete lifecycle of mushrooms, from spawn preparation to fruiting body production, and demonstrate proficiency in each cultivation stage.
2. Variety Selection and Management: Evaluate different mushroom species for cultivation suitability, and apply specialized techniques to optimize growth conditions for specific varieties.
3. Substrate Preparation: Develop skills in preparing and sterilizing substrates, understanding the importance of substrate composition and nutrition for successful mushroom cultivation.
4. Disease and Pest Management: Identify common diseases and pests affecting mushroom crops, and implement effective control strategies to maintain healthy and productive cultures.
5. Commercial Viability: Apply economic principles to assess the viability of mushroom cultivation as a business venture, considering market demand, production costs, and potential profitability.

Syllabus (Credit -4)

1. Introduction of mushroom science.
2. Mushroom biology including edible and poisonous mushrooms.
3. Brief history of mushroom cultivation.
4. Importance of mushrooms, Nutritional and medicinal aspects.
5. Preparation of spawn.
6. Pure culture
7. Mother spawn.
8. Spawn
9. Maintenance of Mushroom lab and equipment.
10. Design, equipment and register.

11. Economics.
Scheme of Examination Internal and External of Semester Examination as per NEP scheme.
Suggested Books and References: • Handbook on Mushrooms by Nita Bahl Published by Oxford & IBH publishing Company. • Mushroom Cultivation by J.N. Kapoor published by ICAR, New Delhi. • A handbook of cultivated mushrooms by Dr. Ashok Ghanekar. • Handbook of Horticulture IARI, New Delhi.
Suggested E-resources • https://extension.psu.edu/six-steps-to-mushroom-farming • https://www.pashudhanpraharee.com/step-by-step-procedure-for-mushroom-farming-in-india/ • https://krishijagran.com/agripedia/a-complete-guide-to-profitable-mushroom-farming-in-india-read-composting-harvesting-techniques/ • https://agricoop.nic.in/sites/default/files/ICAR_8.pdf • https://dmrsolan.icar.gov.in/ • https://tractorgyan.com/tractor-industry-news-blogs/980/different-types-of-mushroom-cultivation-in-india

Code of the course	ZOO8101T
Title of the course	Sericulture
Level of the Course	NHEQF Level 6.0
Credit of the Course	4
Type of the Course	GEC-Th
Prerequisites	Zoology course in B. Sc. degree at any central/ state/Open University level

Objectives of the Course

To equip students with the fundamental knowledge and practical skills necessary to successfully cultivate silkworms, rear them through their life cycle, and harvest high-quality silk, fostering sustainable sericulture practices for economic development and ecological conservation.

Learning outcomes

1. Upon completing the sericulture course, participants will demonstrate a comprehensive understanding of the complete life cycle of silkworms, including egg incubation, larval rearing, pupation, and moth emergence, enabling them to effectively manage each stage of the silkworm's development.
2. Participants will acquire hands-on skills in silk cocoon harvesting, cocoon boiling, and the reeling process, resulting in the production of high-quality silk threads, thereby enhancing their ability to contribute to the sericulture industry.
3. Students will develop the capability to identify common pests and diseases that affect silkworms and cocoon production. They will also learn preventative and remedial measures to ensure healthy silkworm populations and minimize production losses.
4. Learners will gain knowledge about sustainable sericulture practices, including environmentally friendly methods for mulberry cultivation, water conservation techniques, and responsible pesticide usage, with a focus on reducing the environmental impact of sericulture operations.
5. Participants will be equipped with the skills to assess market demand for silk and silk products, calculate production costs, and explore marketing strategies, enabling them to make informed decisions about entering the sericulture industry or optimizing their existing sericulture enterprises.

Syllabus (Credit -4)

UNIT-I

Sericulture: Definition, history and present status; Silk route. Types of silkworms, Distribution and Races, Hybrids. Exotic and indigenous races. Mulberry and non-mulberry Sericulture

UNIT-II

Life cycle of *Bombyx mori*. Structure of silk gland and secretion of silk. Sex linked traits

UNIT-III

Mulberry silkworm rearing: Selection of mulberry variety and establishment of mulberry garden. Rearing house and rearing appliances.

Disinfectants: Formalin, bleaching powder, RKO.

Silkworm rearing technology: Early age and Late age rearing.
Types of mountages.
Spinning, harvesting and storage of cocoons.
Non mulberry silkworm rearing: Host plants of non-mulberry silkworm, maintenance of host plants of *Anthereae assama*, rearing technology of *Anthereae spp* and *Samia cynthia ricini*.

UNIT-IV

Pests of silkworm: Uzi fly, dermestid beetles and vertebrates.
Pathogenesis of silkworm diseases: Protozoan, viral, fungal and bacterial.
Control and prevention of pests and diseases.

UNIT-V

Prospectus of Sericulture in India: Sericulture industry in different states, Employment, potential in mulberry and non-mulberry sericulture.
Visit to various sericulture centres.

Scheme of Examination

Internal and External of Semester Examination as per NEP scheme.

Suggested Books and References:

- Handbook of Practical Sericulture: S.R. Ullal and M.N. Narasimhanna CSB, Bangalore
- Appropriate Sericulture Techniques; Ed. M. S. Jolly, Director, CSR & TI, Mysore.
- Handbook of Silkworm Rearing: Agriculture and Technical Manual-1, Fuzi Pub. Co. Ltd., Tokyo, Japan1972.
- Manual of Silkworm Egg Production; M. N. Narasimhanna, CSB, Bangalore 1988.
- Silkworm Rearing; Wupang—Chun and Chen Da-Chung, Pub. By FAO, Rome 1988.
- A Guide for Bivoltine Sericulture; K. Sengupta, Director, CSR & TI, Mysore 1989
- Improved Method of Rearing Young age silkworm; S. Krishnaswamy, reprinted CSB, Bangalore, 1986.

Suggested E-resources

- https://byjus.com/chemistry/sericulture/#:~:text=Sericulture%20is%20the%20process%20of,used%20silkworm%20species%20in%20sericulture.
- https://agritech.tnau.ac.in/sericulture/seri_index.html
- https://www.sciencedirect.com/science/article/pii/S2772801322000094
- https://www.india.gov.in/topics/agriculture/sericulture

Semester - III

Code of the course	ZOO9011T
Title of the course	Origin and Evolution of Vertebrates
Level of the Course	NHEQF Level 6.5
Credit of the Course	4
Type of the Course	DCC
Prerequisites	Zoology course in B. Sc. degree at any central/state/open University level

Objectives of the Course

To provide students with a deep theoretical knowledge of vertebrate taxonomy and evolutionary relationships, allowing them to critically analyze the diversity, adaptations, and phylogenetic history of vertebrate species.

Learning outcomes

1. **Demonstrate Taxonomic Proficiency:** Classify vertebrate species into appropriate taxonomic groups based on their morphological, anatomical, and genetic characteristics.
2. **Explain Evolutionary Concepts:** Describe key evolutionary principles and mechanisms that have contributed to the diversification and adaptation of vertebrate species over geological time.
3. **Analyze Phylogenetic Relationships:** Interpret phylogenetic trees and diagrams to understand the evolutionary relationships and ancestry among different vertebrate taxa.
4. **Critically Evaluate Adaptations:** Assess how specific anatomical, physiological, and behavioral adaptations have arisen in response to ecological niches, environmental pressures, and selective forces.
5. **Synthesize Comparative Studies:** Integrate knowledge of vertebrate classification and evolution to analyze the significance of shared and divergent traits across vertebrate groups, highlighting patterns of convergence and divergence.

Syllabus

UNIT-1 (Lecture hours: 12)

Outline classification of the chordates and characters; Origin and adaptive radiation of chordates; Origin and Evolution of Agnatha: Ostracoderms and Cyclostomes and early Gnathostomes (Placoderms), Phylogeny of vertebrate.

Origin, evolution and affinities of Pisces; Origin, evolution and adaptive radiation of Amphibia; Neoteny and Paedogenesis

UNIT- 2 (Lecture hours: 12)

Origin, evolution and affinities of Reptiles; Mesozoic reptiles; Dinosaurs; Living reptiles; Rhynchocephalia; Chelonia, Crocodilia and Squamata; Archaeopteryx.

Origin, evolution and affinities of Aves; Flightless birds; Origin of flight

UNIT- 3 (Lecture hours: 12)

Origin, evolution, affinities and adaptive radiation of Mammals (Prototheria and Metatheria); Evolution of Placenta; Cenozoic Mammals.

UNIT- 4 (Lecture hours: 12)

A comparative account of integuments and its derivatives, exoskeleton, digestive system, Arotic arches, and heart in different classes of vertebrates.

UNIT- 5 (Lecture hours: 12)

A comparative account of brain structure, respiratory system, urinogenital system in different classes of vertebrates.

Scheme of Examination

Internal and External of Semester Examination as per NEP scheme.

Suggested Books and References

- Colbert E.H. (2015). Evolution of the Vertebrates. 3rd edition. Scientific Publisher, Jodhpur.
- Prothero D.R. (2022). Vertebrate evolution: from origin to dinosaurs and beyond. CRC Press.
- Kardong K. (2014). Vertebrates: comparative anatomy, function, evolution. McGraw-Hill Education.
- Parker B, McKenzie W. (2020) Origin and evolution of Vertebrates. Ed-Tech Press.
- Kent, G.C. and Carr R.K. (2000). Comparative Anatomy of the Vertebrates. IX Edition. The McGraw-Hill Companies.
- Hilderbrand, M and Gaslow G.E. Analysis of Vertebrate Structure, John Wiley and Sons
- Walter, H.E. and Sayles, L.P; Biology of Vertebrates, Khosla Publishing House.
- Weichert C.K and William Presch (1970). Elements of Chordate Anatomy, Tata McGraw Hills

Suggested E-resources

- https://study.com/academy/lesson/evolution-of-vertebrates.html
- https://portals.iucn.org/library/efiles/documents/2010-057.pdf

Code of the course	ZOO9012T
Title of the course	Biostatistics, Advance Genetics & Bioinformatics
Level of the Course	NHEQF Level 6.5
Credit of the Course	4
Type of the Course	DCC
Prerequisites	Zoology course in B. Sc. degree at any central/ state/Open University level

Objectives of the Course

The objective of the course in Biostatistics, Advanced Genetics, and Bioinformatics is to provide students with a comprehensive understanding of the fundamental principles and practical applications of statistical analysis, advanced genetic concepts, and bioinformatics tools in the field of biological sciences.

Learning outcomes

- Apply Statistical Methods: Utilize advanced statistical techniques to analyze biological data, interpreting and drawing conclusions from experimental results with statistical rigor.
- Integrate Genetic Concepts: Synthesize and apply advanced genetic principles, such as gene regulation, epigenetics, and molecular genetics, to understand complex biological processes.
- Utilize Bioinformatics Tools: Competently use bioinformatics software and databases to analyze genetic and genomic data, extracting meaningful insights and identifying patterns.
- Evaluate Genetic Variation: Analyze genetic variation within populations and its implications for disease susceptibility, evolution, and personalized medicine.
- Integrate Disciplinary Knowledge: Combine concepts from biostatistics, advanced genetics, and bioinformatics to address multifaceted biological questions, fostering a holistic understanding of genetic and genomic phenomena.

Syllabus

UNIT-1 (Lecture hours: 12)

Introduction to Biostatistics, Scope, Importance and Application of Biostatistics; Data: Types, Collection and Tabulation, Frequency distribution, Diagrammatic and graphical representation of statistical data, Sampling techniques, measures of central tendencies.

UNIT- 2 (Lecture hours: 12)

Standard deviation and standard error, Correlation and regression, Basic idea of testing significance, level of significance, Students T test, Chi-Square test, F test, Analysis of variance (ANOVA), Skewness Kurtosis.

UNIT- 3 (Lecture hours: 12)

Probability distributions (Binomial, Poisson and Normal). Statistical designing of experiments, purpose of research design and characteristics of good research designing,

Biasness, Placebo effect, types of statistical errors, risk in statistical testing, Factorial design, Variables, Controls and standards.

UNIT- 4 (Lecture hours: 12)

Regulation of phages, viruses, prokaryotic and eukaryotic gene expression, role of chromatin in regulating gene expression and gene silencing. Gene mapping methods: Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids

Polygenic inheritance, heritability and its measurements, QTL mapping.

UNIT- 5 (Lecture hours: 12)

Introduction to Bioinformatics, Principals of bioinformatics - useful sites for researchers, Bioinformatics in life sciences; brief idea of Microarray; Introduction to genomics and proteomics; Protein prediction tools and docking. World-wide biological databases - Nucleic acid and Protein sequence database. Bioinformatics in India.

Scheme of Examination

Internal and External of Semester Examination as per existing CBCS scheme

- Suggested Books and References:

- Banerjee PK. 2013. Introduction to Biostatistics (A textbook of Biometry). S. Chand & Company, New Dehli.
- "An Introduction to Medical Statistics" by Martin Bland
- "Mathematics and Statistics for the Biosciences" by G Eason
- “Biostatistics For Dummies" by John Pezzullo
- "Biostatistics for the Biological and Health Sciences" by Marc M Triola and Mario F Triola
- "Clinical Biostatistics and Epidemiology Made Ridiculously Simple" by Ann Weaver and Stephen Goldberg
- Klug W.S. et. Al. Concepts of Genetics. Peason Publication.
- Pierce B.A. Genetics: A conceptual approach. W.H. Freeman.
- Brooker R.G. Genetics: analysis and principles. McGraw Hill Publication.

Suggested E-resources

- http://www.statisticslectures.com/
- https://minerva.it.manchester.ac.uk/~saralees/lecturenotes.pdf
- https://bookdown.org/mcbroom_j/Book/introduction-to-statistics.html
- https://www.studocu.com/row/document/chinhoyi-university-of-technology/introduction-to-statistics/full-notes-introduction-to-statistics/4513774
- https://www.cliffsnotes.com/study-guides/biology/biology/classical-mendelian-genetics/introduction-to-genetics#:~:text=Genetics%20is%20the%20study%20of,that%20code%20for%20particular%20proteins.
- https://microbenotes.com/category/genetics/
- https://www.biologydiscussion.com/biodiversity/bioinformatics/notes-on-bioinformatics-genetics/38224
- https://www.worldscientific.com/doi/pdf/10.1142/9789811212895_0001?download=true

Code of the course	ZOO9101T
Title of the course	Entomology-I (Systematic Entomology and Insect Organization)
Level of the Course	NHEQF Level 6.5
Credit of the Course	4
Type of the Course	DSE
Prerequisites	Zoology course in B. Sc. degree at any central/ state/Open University level

Objectives of the Course

The objective of this course is to teach students the principles of systematic entomology, phylogeny, evolution and basis of classification of insects; modern techniques in insect taxonomy; description and illustration of insects and use of identification keys.

Learning outcomes

1. Developing an understanding of the classification and identification of insects based on their morphology, behavior, and ecology.
2. Understanding the diversity, distribution, and abundance of insects and their role in ecosystems.
3. Learning about the anatomy of insects.
4. Developing skills in collecting, preserving, and identifying insect specimens.
5. Understanding the importance of entomology in agriculture, public health, and conservation.

Syllabus

UNIT-1 (Lecture hours: 12)

Origin and Evolution of insects with special reference to fossil insects, Causes of success of insects on earth. Basis of classification of insects, Classification of insects up to orders, Use of taxonomic key in insect identification.

UNIT- 2 (Lecture hours: 12)

Detailed classification of insects up to super families in following economical important groups: Orthoptera, Lepidoptera, Diptera and Hymenoptera.

UNIT- 3 (Lecture hours: 12)

External Morphology of insects: Integument- Structure & Composition; Cuticular outgrowths, Colouration and special integumentary structures in insects.

Morphology of Head- Structure; sutures and area of cranium, tentorium, gnathal appendages, types of mouthparts and antennae.

UNIT- 4 (Lecture hours: 12)

Morphology of Thorax-areas and sutures of tergum, sternum and pleuron, Legs; structure and their modifications, Wings; structure and modifications, wing venation and wing coupling in insects. Morphology of abdomen; Segmentation and appendages; Genitalia and their modifications

UNIT- 5 (Lecture hours: 12)

Knowledge and use of equipment for the collection and preservation of insects, Insect collection equipments.

Insect Society**:** Evolution of Sociality, Eusociality, Social organization and social behavior in honey bee, ants and termites. Altruism in relation to social insects.

Scheme of Examination

Internal and External of Semester Examination as per NEP scheme.

Suggested Books and References:

- A general text book of entomology, Imms, A. D., Chapman and Hall, UK
- Introduction to the study of insects, Borror, D. J., Triplehorn, C. A., and Johnson, N. F.,M Saunders College Publication, USA
- Dr. Rajendra Singh Elements of Entomology Publisher: Rastogi Publications Edition: 2, 2018
- The Insect Societies, Wilson, E. O., Harward Univ. Press, UK
- Host Selection by Phytophagous insects, Bernays, E. A., and Chapman, R. F., Chapman and Hall, New York, USA
- Insect Plant Biology, Schoonhoven, L. M., van Loop, J. A., and Dicke. M. Pub. Oxford Univ. Press. USA
- Principles of Insect Morphology, Snodgrass, R. E., Cornell Univ. Press, USA \
- Handbook of Entomology. Dr. T. V. Prasad. New Vishal Publications.

- https://assets.cambridge.org/97805218/21490/frontmatter/9780521821490_frontmatter.pdf
- https://csauk.ac.in/wp-content/uploads/2021/08/PG.pdf
- https://www.ndsu.edu/pubweb/~rider/Pentatomoidea/Teaching%20Structure/Lecture%20Notes/Week%2002d%20Integument.pdf
- https://link.springer.com/content/pdf/10.1007/978-1-4615-6918-3_11.pdf
- https://extension.oregonstate.edu/sites/default/files/documents/9591/external-morphology.pdf
- http://www.jnkvv.org/PDF/070420202012306420 1202.pdf
- https://www.ndsu.edu/pubweb/~rider/Pentatomoidea/Teaching%20Structure/Lecture%20Notes/Week%2005a%20Thorax.pdf
- https://content.patnawomenscollege.in/zoology/Social%20life%20in%20Insects-Honey%20Bee.pdf
- http://rcscollegemanjhaul.org/rcs/assets/uploads/assignment/assignment-1590246088-sms.pdf
- https://www.ars.usda.gov/ARSUserFiles/80420580/CollectingandPreservingInsectsandMites/collpres.pdf

Code of the course	ZOO9102T
Title of the course	Wildlife Biology-I (Biodiversity & Wildlife Ecology)
Level of the Course	NHEQF Level 6.5
Credit of the Course	4
Type of the Course	DSE
Prerequisites	Zoology course in B. Sc. degree at any central/ state/Open University level

Objectives of the Course

To provide students with a deep understanding of biodiversity dynamics and wildlife interactions, enabling them to analyze and contribute to effective conservation and management strategies.

Learning outcomes

1. Assess Biodiversity Patterns: Analyze and interpret biodiversity patterns across different ecosystems, understanding factors influencing species richness, evenness, and distribution.
2. Understand Ecological Interactions: Grasp the complexities of ecological interactions within wildlife communities, including predator-prey dynamics, competition, and mutualism.
3. Evaluate Conservation Strategies: Critically assess conservation approaches for maintaining biodiversity and mitigating threats to wildlife populations and their habitats.
4. Interpret Ecosystem Dynamics: Understand how wildlife species contribute to ecosystem functioning and stability, and predict the ecological consequences of their absence or decline.
5. Synthesize Socio-Ecological Context: Incorporate social, economic, and ethical considerations to develop comprehensive wildlife management and conservation strategies that balance ecological health with human interests.

Syllabus

UNIT-1 (Lecture hours: 12)

History of Biogeography, Biological processes in biogeography, Endemism, Refugia. Ecology of dispersal and faunal exchange. Biogeographic classification of India. Concepts of Biodiversity, types and different species concepts: Key stone species, Umbrella species, Indicator species, Flagship species, and Exotic/introduced. Value of biodiversity and ecosystem services.

UNIT- 2 (Lecture hours: 12)

Population ecology: Demography, life history and dynamics parameters, evolution of life history: r & K selection, allometry, aging and sexing; Population simulation, Predator-prey relationship. **Population genetics:** history, process, and applications.

Biological community ecology– organization, stability or competition (guilds, resource partitioning, niche and competitive exclusion), ecological dominance, ecotone, edge effect, and trophic interactions. Evolution of ecological communities.

UNIT- 3 (Lecture hours: 12)

Habitat Ecology: Ecology of major habitats- Deserts, Grasslands, wetlands and Forests. Map overlay approach in habitat evaluation. Key habitat attributes for habitat measuring and monitoring. Carrying capacity of habitats. Animal home ranges, territories and their estimators.

Concept and types of biological corridors. Physical and anthropogenic factors influencing terrestrial habitats.

UNIT- 4 (Lecture hours: 12)

Behavioural Ecology: Evolutionary approaches to animal behavior. Group living: costs, and benefits. Predators-prey interactions. Competition for resources, sexual selection; mating system and parental care. Selfishness and altruism. Co-operation and helping in mammals and fishes.

UNIT- 5 (Lecture hours: 12)

Forest ecology: Forest soils- classification of soils, factors affecting soil formation, physical and chemical properties, causes of soil erosion and conservation methods. Ecological and physiological factors influencing vegetation; natural and artificial regeneration of forests – nursery techniques and seed technology (collection, storage, pre-treatment and germination)

Forest mensuration – methods of measuring diameter/girth, height and canopy cover of trees.

Scheme of Examination

Internal and External of Semester Examination as per existing CBCS scheme

Suggested Books and References:

- Gaston KJ, Spicer JI. 2004. Biodiversity: an introduction. 2nd edition. Blackwell Publishing.
- Magurran AE. Measuring biological diversity. Wiley-Blackwell.
- Wilson D. 2015. Wildlife of the world. DK Publication.
- Leopold BD. 2018. Theory of wildlife population ecology. Waveland Press, Inc.
- Zak DR, Barnes BV et al. 2023. Forest Ecology. Wiley.
- Binkley D. 2021. Forest ecology: an evidence-based approach. Wiley-Blackwell.
- Davies NB, Krebs J, West SA.2012. An introduction to behavioural ecology. Wiley-Blackwell.

Suggested E-resources

- https://www.researchgate.net/profile/Arvind-Singh-21/post/Any_related_literature_on_biodiversity_teaching/attachment/59d64edf79197b80779a8234/AS%3A494919505465344%401495009413879/download/Biodiversity+-+An+Introduction.pdf
- https://archive.nptel.ac.in/courses/102/104/102104068/

Code of the course	ZOO9103T
Title of the course	Limnology & Fisheries-I (Limnology)
Level of the Course	NHEQF Level 6.5
Credit of the Course	4
Type of the Course	DSE
Prerequisites	Zoology course in B. Sc. degree at any central/ state/Open University level

Objectives of the Course

To equip students with a comprehensive understanding of aquatic ecosystems, their dynamics, and sustainable fisheries management principles, fostering expertise in the conservation and utilization of freshwater resources.

Learning outcomes

1 Analyze Aquatic Ecosystems: Understand the physical, chemical, and biological components of freshwater ecosystems, evaluating their health and functioning.

2 Apply Fisheries Management: Apply principles of sustainable fisheries management, including stock assessment, regulation, and conservation measures, to ensure responsible resource utilization.

3 Assess Water Quality: Evaluate water quality parameters and their impact on aquatic organisms, identifying potential pollution sources and their ecological implications.

4 Understand Aquatic Biodiversity: Grasp the diversity of aquatic species and their ecological roles, recognizing the importance of biodiversity in maintaining ecosystem stability.

5 Integrate Multidisciplinary Knowledge: Synthesize knowledge from biology, ecology, hydrology, and policy to address complex issues in limnology and fisheries, contributing to informed decision-making for aquatic resource management.

Syllabus

UNIT-1 (Lecture hours: 12)

Definitions of lakes. Benefits of lakes. Origin of Lakes. Lake classification Morphometric features of Lake and their importance in tropho genecity of Lakes.

UNIT- 2 (Lecture hours: 12)

Physical factors of Lake water with particular reference to- Temperature: Thermal stratification and heat budget; Light; Turbidity; Density; Waves and currents (a brief account).

UNIT- 3 (Lecture hours: 12)

Chemical factors of Lake water with particular reference to-pH; Dissolved gases, BOD and COD; Nitrates and Nitrogen Cycle; Phosphates and Phosphorus cycle; CO2 and carbon cycle.

UNIT- 4 (Lecture hours: 12)

Definition, classification, distribution and limnological significance of plankton, nekton and benthos. Biological productivity and Energy flow.

UNIT- 5 (Lecture hours: 12)

Indices of Lake Productivity, Eutrophication- causes and control. Water purification techniques. Wet lands – definition, brief account and conservation measures.

Scheme of Examination

Internal and External of Semester Examination as per existing CBCS scheme

Suggested Books and References:

- Datta J & Munshi JD. 2015. Fundamentals of Limnology. Astral Publication.
- Dodds W.K., Whiles M.R. Freshwater ecology: concepts and environmental applications of limnology. Academic Press.
- Wetzel R.G. 2001. Limnology: Lake and river ecosystems. 3rd edition. Academic Press.
- Cole G.A., Weihe P.E. 2015. Textbook of Limnology. Waveland Press, Inc.
- Dodson S. 2004. Introduction to limnology. McGraw-Hill Education.
- Horne A, Goldman C. 1994. Limnology. McGraw-Hill Science.

Suggested E-resources

- https://study.com/learn/lesson/limnology-study-importance.html#:~:text=Limnology%20is%20the%20study%20of%20the%20waters%20found%20within%20continents,ponds%2C%20marshes%2C%20and%20more.
- https://cfpub.epa.gov/watertrain/pdf/limnology.pdf
- https://ocd.lcwu.edu.pk/cfiles/Zoology/Z-FAQ-705/
- http://ecoursesonline.iasri.res.in/mod/page/view.php?id=39482
- https://wgbis.ces.iisc.ernet.in/energy/monograph1/Limpage2.html

Code of the course	ZOO9104T
Title of the course	Entomology-II (Physiology of Insects)
Level of the Course	NHEQF Level 6.5
Credit of the Course	4
Type of the Course	DSE
Prerequisites	Zoology course in B. Sc. degree at any central/ state/Open University level

Objectives of the Course

The course aims to teach students about the functions and structures involved in selected physiological systems in insects, as well as the basic principles of the mechanics of insect physiology.

Learning outcomes

- Students will learn about the general overview of the internal structure and physiology of insects, including digestive, circulatory, respiratory, muscular, endocrine, and nervous systems, as well as sensory organs, temperature control, flight, and molting.
- Understand the functions and structures involved in selected physiological systems in insects.
- Learn basic principles of the mechanics of insect physiology.
- Gain an in-depth understanding of the principal physiological and biochemical functions of insects.
- Develop knowledge of the physiological diversity in insects and its ecological and evolutionary contexts.

Syllabus

UNIT-1 (Lecture hours: 12)

Nutrition: Nutritional requirement of Insects, adaptations to liquid diet, role of microorganisms (Bacteria, Protozoa, Fungi) in digestion

Digestive System: Alimentary canal and physiology of digestion

UNIT- 2 (Lecture hours: 12)

Circulatory System: Morphology and physiology, composition of haemolymph

Respiratory System: Structure of respiratory organs and physiology, adaptations for aquatic respiration

UNIT- 3 (Lecture hours: 12)

Excretory System: structure of excretory organs, cryptonephridial system and physiology of excretion

Muscular System**:** cephalic, thoracic abdominal and flight muscles, mechanism of flight in insects

UNIT- 4 (Lecture hours: 12)

Nervous System: morphology and physiology

Neuro -Endocrine System: Morphology and physiology

Sense Organs: auditory organs sound and light producing organs, visual organs and physiology of vision

UNIT- 5 (Lecture hours: 12)

Reproductive Systems**:** structure and physiology, male and female reproductive organs; spermatogenesis and oogenesis, structure of insects egg, Types of larvae, pupae and metamorphosis, role of endocrines in growth and development, parthenogenesis. Biochemical adaptations to environmental stresses (Metamorphosis; Diapause, polymorphism etc.)
Scheme of Examination Internal and External of Semester Examination as per NEP scheme
Suggested Books and References: • A general text book of entomology, Imms, A. D., Chapman and Hall, UK • Introduction to the study of insects, Borror, D. J., Triplehorn, C. A., and Johnson, N.F.,M Saunders College Publication, USA • Principles of Insect Morphology, Snodgrass, R. E., Cornell Univ. Press, USA • Elements of Entomology Dr. Rajendra Singh Publisher: Rastogi Publications • The Insects: An Outline of Entomology. P.J. Gullan and P.S. Cranston. Blackwell Publishing.
Suggested E-resources • https://www.ndsu.edu/pubweb/~rider/Pentatomoidea/Teaching%20Structure/Lecture%20Notes/Week%2011a%20Digestive%20System.pdf • https://www.ndsu.edu/pubweb/~rider/Pentatomoidea/Teaching%20Structure/Lecture%20Notes/Week%2013a%20Circulatory%20System.pdf

Code of the course	ZOO105T
Title of the course	Wildlife Biology-II (Conservation Biology)
Level of the Course	NHEQF Level 6.5
Credit of the Course	4
Type of the Course	DSE
Prerequisites	Zoology course in B. Sc. degree at any central/ state/Open University level

Objectives of the Course

To provide students with a profound understanding of the principles, methods, and ethical considerations in conservation biology, empowering them to analyze and contribute to the preservation and sustainable management of biodiversity and ecosystems.

Learning outcomes

1. Evaluate Biodiversity Loss: Assess the causes and consequences of biodiversity decline, understanding the ecological, economic, and societal impacts of species extinction and habitat degradation.
2. Apply Conservation Strategies: Apply a range of conservation approaches, from habitat restoration and protected area management to species recovery plans, to mitigate threats and enhance biodiversity conservation.
3. Analyze Human Impact: Analyze the complex interactions between human activities and the environment, identifying strategies to promote sustainable resource use and reduce ecological footprints.
4. Ethical Considerations: Grasp the ethical dilemmas associated with conservation decisions, integrating cultural, social, and economic factors into discussions about wildlife protection and ecosystem management.
5. Interdisciplinary Collaboration: Collaborate across disciplines, combining ecological knowledge, policy understanding, and community engagement to address conservation challenges holistically and contribute to the long-term health of ecosystems and species.

Syllabus

UNIT-1 (Lecture hours: 12)

Introduction to conservation biology, conservation of biodiversity – patterns and processes. **Ex situ conservation** – role of biological parks and aquariums. **In situ conservation** – national parks and wildlife sanctuaries – formation and management, protection and administration. International conservation bodies – IUCN, UNDP, FAO, WWF.

UNIT- 2 (Lecture hours: 12)

National parks of India – Ranthambore, Ghana, Kaziranga, Kanha, Bandipur, Gir, Corbett, Silent Valley; Marine National Parks of India – Mannar, Gulf of Kutch**.**

Biospheres of India and their concept**.** Wildlife Sanctuaries in India – Periyar, Mudumalai, Sariska, Jaisamand, Kumbhalgarh, Sitamata, Phulwari ki Nal.

UNIT- 3 (Lecture hours: 12)

Zoological Parks: formation, management, food and feeding of captive animals and zoo sanitation. Community reserves and sacred groves. **Red data book and IUCN categories**: Extinct, Extinct in wild, critically endangered, endangered, vulnerable, near threatened, least concern, data deficient and not evaluated.

UNIT- 4 (Lecture hours: 12)

Some important reptilian species: Marsh crocodile (*Crocodylus palustris*), Indian Python (*Python molurus*), Red Crowned Roofed Turtle (*Kachuga kachuga*).

Important bird species: Indian peafowl (*Pavo cristatus*), Siberian white crane (*Grus leucogeranus*), White-rupmed vulture (*Gyps bengalensis*)

Important mammalian species: Asiatic lion (*Panthera leo*), Tiger (*Panthera tigris*), Leopard (*Panthera pardus*), Indian pangolin (*Manis crassicaudata*), Sloth bear (*Melursus ursinus*), Gaur (*Bos gaurus*), Asian elephant (*Elephas maximus*)

UNIT- 5 (Lecture hours: 12)

Captive breeding and propagation, rehabilitation of animals. Wildlife forensics: Nature of wildlife crimes, investigations and scientific processes. Mammalian pug and hair analysis. DNA banks for endangered animals. Molecular markers used in wildlife forensics. Conservation ethics and values.

Scheme of Examination

Internal and External of Semester Examination as per NEP scheme.

Suggested Books and References:

- Hunter ML, Gibbs JP, Popescu VD. 2021. Fundamentals of Conservation Biology. 4th edition. Wiley-Blackwell.
- Vardinale B, Primack R, Murdoch J. 2019. Conservation Biology. 1st edi. Oxford University Press.
- Sher A. 2022. An introduction to conservation biology. 3rd edition. Oxford University Press
- Primack RB, Sher A. An introduction to conservation biology. 1rd edition. Oxford University Press
- Sodhi NS, Ehrlich PR. 2010. Conservation Biology for all. Oxford University Press.
- Dyke FV. 2008. Conservation Biology: Foundation, concepts, applications. Springer.

Suggested E-resources

- https://elphick.lab.uconn.edu/intro-to-conservation-biology/
- https://www.wii.gov.in/
- https://old.amu.ac.in/emp/studym/100005960.pdf
- https://www.slideshare.net/Bikramsingh106/conservation-biology-note-pdf
- https://conbio.org/images/content_publications/ConservationBiologyforAll_reducedsize.pdf

Code of the course	ZOO9106T
Title of the course	Limnology & Fisheries-II (Freshwater Aquaculture and Its Management)
Level of the Course	NHEQF Level 6.5
Credit of the Course	4
Type of the Course	DSE
Prerequisites	Zoology course in B. Sc. degree at any central/ state/Open University level

Objectives of the Course

To equip students with a comprehensive understanding of the principles, techniques, and sustainable practices of freshwater aquaculture, enabling them to effectively manage and contribute to the responsible cultivation of aquatic organisms for food production and conservation.

Learning outcomes

1. Aquaculture Principles: Understand the fundamental principles of freshwater aquaculture, including water quality management, nutrition, breeding, and disease control.
2. Sustainable Practices: Apply ecologically responsible and resource-efficient aquaculture practices, ensuring the long-term viability of aquatic ecosystems and minimizing negative environmental impacts.
3. Species Selection and Management: Evaluate the suitability of different aquatic species for aquaculture, and demonstrate the ability to manage their growth, reproduction, and health.
4. Economic and Social Implications: Analyze the economic feasibility of aquaculture operations and the potential socio-economic impacts on local communities, considering both benefits and challenges.
5. Regulatory Compliance: Understand and adhere to relevant legal and regulatory frameworks governing aquaculture activities, ensuring compliance with standards for environmental protection and food safety.

Syllabus

UNIT-1 (Lecture hours: 12)

Aquaculture: Introduction and scope in India Extensive, intensive and semi intensive culture. Different varieties of exotic and indigenous ornamental fishes. Principles of a balanced aquarium. Fabrication, setting up and maintenance of freshwater aquarium. Water quality management. Water filteration system-biological, mechanical and chemical. Types of filters. Aquarium plants and their propagation methods. Lighting and

aeration. Aquarium accessories and decorative. Aquarium fish feeds. Dry, wet and live feeds. Breeding and rearing of ornamental fishes. Broodstock management.

UNIT- 2 (Lecture hours: 12)

Cold water fishes- Trout, Tench and golden Mahseer. Brackish water fishes mullets, Lates calcarifer and Chanos chanos. Fisheries of economically important fishes: Sardine; Bombay duck; Mackerel; Hilsa.

UNIT- 3 (Lecture hours: 12)

Freshwater weeds- Importance, harmful effects and methods of eradication. Predatory fishes, weed fishes and their control. Blue revolution.

UNIT- 4 (Lecture hours: 12)

Planning, construction and maintenance of fish farm. Different type of hatcheries. Site selection and culturable fish selection. Fish Preservation and conservation.

UNIT- 5 (Lecture hours: 12)

Composite fish culture, Integrated Fish Farming, Monosex culture, Pen culture and Cage culture. Induced breeding- Hypophysation. Ovaprim, cryopreservation of gametes and embryos. Fish Behavior: Migration in fishes; Reproductive and shoaling behavior; Parental care; Orientation and homing.

Scheme of Examination

Internal and External of Semester Examination as per NEP scheme.

Suggested Books and References:

- Rath RK. 2011. Freshwater aquaculture. Scientific Publishers, India.
- Templeton RG. 1995. Freshwater fisheries management. Wiley-Blackwell.
- Ahmed SH, Singh AK. 2011. Freshwater aquculture. Daya Publishing House.
- Ahilan B. 2013. Textbook on freshwater aquaculture. Daya Publishing House.
- McLarney W. 2013. Freshwater quaculture: a handbook for small scales fish culture in north America. Echo Point Book & Media.
- Bandyopadhyay BK. 2022. Freshwater Aquaculture: a functional approach. CRC Press.

Suggested E-resources

- https://www.researchgate.net/profile/Arvind_Singh56/post/What-are-good-aquaculture-practices-GAPs-in-oxbow-lakes/attachment/59d64d6f79197b80779a6ff8/AS%3A488132433977345%401493391249892/download/2.pdf
- http://ecoursesonline.iasri.res.in/course/view.php?id=425
- https://sist.sathyabama.ac.in/sist_coursematerial/uploads/SBT1608.pdf
- https://www.fao.org/3/t8598e/t8598e05.htm
- https://www.notesonzoology.com/india/aquaculture/aquaculture-characters-types-and-qualities/657
- https://www.ircwash.org/sites/default/files/272.3-78FR.pdf

Code of the course	ZOO9107P
Title of the course	Entomology Practical-I
Level of the Course	NHEQF Level 6.5
Credit of the Course	4
Type of the Course	DSE-Lab
Prerequisites	Zoology course in B. Sc. degree at any central/ state/Open University level

Objectives of the Course

The course aims to provide students with a solid foundation in insect biology, including general entomology, basic systematics, morphology, physiology, and biodiversity in the field as well as in the laboratory.

Learning outcomes

Students will be able to learn the identification and techniques associated with identification, setting and presentation techniques, quantitative methods, and understanding the development, anatomy, physiology, life history, behavior, environment, and classification of insects. The practical's also aim to increase understanding and change public attitudes about environmental issues.

Syllabus

1. **PERMANENT SLIDE PREPARATION:** Different types of mouth parts, antennae, legs, wings and other body appendages,
2. **Whole mounts (w.m.)** of various small insects
3. Knowledge and use of equipment for the collection and preservation of insects- insect net, killing bottle, spreading board, insect box device for inflating larva, light trap, etc.
4. Field trips for collection and preservation of insects of various orders.
5. Collection of seasonal insects, nocturnal insects, aquatic insects, crop pests, stared grain pests and insects of medical and veterinary importance.
6. Collection of various types of social insects and their nests
7. Identification of insects (Using identification keys) of various orders prescribed for study in the syllabus.
8. To study antennal grooming behavior in Cockroach.
9. To study the blood cells in insects
10. To study meiosis and Polytene chromosomes in insects
11. To study the food preference Tribolium of any other insect

DISSECTIONS (DIGITAL):

1. Cockroach- Digestive, Circulatory, Reproductive systems and Neuro endocrine complex.

2. Grasshopper- Digestive, Circulatory, Reproductive systems and Neuroendocrine complex
3. Honey bee/Wasp: Digestive and Nervous system and sting apparatus.
4. Demonstration of Sting apparatus of honey bee
5. Demonstration of Pollen basket of honey bee
6. Demonstration of Tympanum and spiracle of grasshopper
7. Microtomy (Internal organs of insects)

Scheme of Examination

Internal and External of Semester Examination as per NEP scheme

Suggested Books and References:

- Textbook of Entomology By Packard,Publisher: New York, The Macmillan company; London, Macmillan andco., ltd.
- Borror and DeLong's Introduction to the Study of Insects by Norman F. Johnson and Charles A. Triplehorn (May 19, 2004)
- The Insects: An Outline of Entomology by Professor P. J. Gullan and P. S. Cranston (Mar 2, 2010)
- Integrated Pest Management : Concepts, Tactics, Strategies and Case Studies Academic press.Edited by: Edward B. Radcliffe, University of Minnesota
- Photographic Atlas of Entomology and Guide to Insect Identification [Spiral-bound] James L. Castner (Author)
- How to Identify Insects to Order - How to Make an Awesome Insect .extension.entm.purdue. - United States
- Introduction to Integrated Pest Management [Hardcover]Mary Louise Flint (Author), Robert van den Bosch (Author) Castner, published by Feline Press, Gainesville, FL (2000)
- The Insects: An Outline of Entomology 4th Edition (2010)P.J. Gullan and P.S. Cranston ISBN# 978-1-4443-3036-6, Blackwell Publishing.
- A Field Guide to the Insects of North America North of MexicoPeterson Field Guide Series, Borror and White.
- Elementary Text-book of Entomology. Kirby, W.F. (1885) W. Swan Sonnenschein and Co. Paternoster Square. London.
- Text Book Of Entomology :A.D.IMMS,
- Biopesticides: A Biotechnological Approach::S.R.JOSHI ,New Age International.

Suggested E-resources

- https://uomustansiriyah.edu.iq/media/lectures/6/6_2019_12_04!07_46_28_PM.pdf
- https://www.ars.usda.gov/ARSUserFiles/80420580/CollectingandPreservingInsectsandMites/collpres.pdf
- https://www.youtube.com/watch?v=GHicoyCLbaI

- https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1469-185X.1939.tb00933.x#:~:text=Insects%20have%20a%20haemocoele%2C%20in,development%2C%20assuming%20many%20different%20forms.
- https://www.chgrupo3.com/not/Pathway_Microtomy_and_Paraffin_Section_Preparation.pdf
- https://www.govinfo.gov/content/pkg/GOVPUB-A9c3910aa26692253653799072b867d15/pdf/GOVPUB-A9c3910aa26692253653799072b867d15.pdf

Code of the course	ZOO9108P
Title of the course	Wildlife Biology Practical-I
Level of the Course	NHEQF Level 6.5
Credit of the Course	4
Type of the Course	DSE-Lab
Prerequisites	Zoology course in B. Sc. degree at any central/ state/Open University level

Objectives of the Course

To provide students with hands-on experience in applying field and laboratory techniques for biodiversity assessment and conservation, enabling them to develop practical skills in data collection, analysis, and interpretation to support effective conservation strategies**.**

Learning outcomes

1. Field Assessment Skills: Develop proficiency in conducting field surveys and sampling methods to quantify and document biodiversity in various ecosystems.
2. Data Collection and Analysis: Acquire practical skills in collecting, processing, and analyzing biodiversity data using appropriate statistical and computational tools.
3. Species Identification: Gain expertise in identifying different species of plants, animals, and microorganisms, contributing to accurate biodiversity documentation.
4. Conservation Techniques: Apply practical techniques for habitat assessment, monitoring, and restoration, contributing to the implementation of effective conservation strategies.
5. Report and Presentation: Effectively communicate findings through well-structured reports and presentations, translating field and laboratory data into actionable insights for biodiversity conservation efforts.

Syllabus

1. Spotting
    a. **Amphibians**: Common Indian toad (*Duttaphrynus melanostictus*), Purple frog (*Nasikabatrachus sahyadrensis*), Indian skipper frog (*Euphlyctis cyanophlyctis*), Indian Bullfrog (*Hoplobatrachus tigerinus*)
    b. **Reptiles:** Gharial (*Gavialis gangeticus*), Mugger crocodile (*Crocodylus palustris*), Termite hill gecko (*Hemidactylus whitakeri*), House Gecko (*Hemidactylus frenatus*), Indian Rock Python (*Python molurus*), Red-crowned roofed turtle (*Batagur kachuga*), Oriental garden lizard (*Calotes versicolor*), Bengal Monitor (*Varanus bengalensis*), Red Sand Boa (*Eryx johnii*), Indian Trinket Snake (*Coelognathus helena*), Indian rat snake (*Ptyas mucosa*), Indian Krait (*Bungarus caeruleus*), Spectacled cobra (*Naja naja*)
    c. **Aves:** White-rumped vulture (*Gyps bengalensis*), Indian Peafowl (*Pavo cristatus*), River tern (*Sterna aurantia*), Great hornbill (*Buceros bicornis*), Lesser florican (*Sypheotides indicus*), Sociable lapwing (*Vanellus gregarius*)

d. **Mammals:** Indian Lion (*Panthera leo*) Tiger (*Panthera tigris*), Snow leopard (*Panthera uncia*), Four-horned antelope (*Tetraceros quadricornis*), Indian pangolin (*Manis crassicaudata*), Indian Gazelle (*Gazella bennetii*), Gaur (*Bos gaurus*), Asian Elephant (*Elephas maximus*), Hoolock Gibbons, Red Panda (*Ailurus fulgens*), Indian Wild Ass (*Equus hemionus khur*), Nilgiri Tahr (*Nilgiritragus hylocrius*), Lion-tailed Macaque (*Macaca silenus*)

e. Flora: Semal (*Bombax ceiba*), Siris (*Albizia lebbeck*), Arjun (*Terminalia arjuna*), Bargad (*Ficus benghalensis*), Chilbil (*Holoptelelea integrifolia*), Kadamb (*Mitragyna parvifolia*), Palas (*Butea monosperma*)

2. Visit to a zoological garden. Student should submit the report on the study covering various aspects like animals observed, their food preparation and presentation
3. Designing the animal housing, enclosures and kraal.
4. Study of different types of cages.
5. Review of zoo-working plans and maps
6. Limnological study of wetlands.
7. Determination of species dominance and frequency using quadrant/plot method.
8. Analysis of habitat characteristics (gbh/dbh, tree height, canopy).
9. Analysis of vegetation in given area.
10. Analysis of species diversity using diversity indices.
11. Soil analysis: Physical: temperature, colour, texture. Chemical: moisture content, carbonates, nitrates, pH.

Scheme of Examination

Internal and External of Semester Examination as per NEP scheme

Suggested Books and References:

- Menon V. 2023. Indian Mammals. Hachette India.
- Grimmett R et al. 2016. Birds of the Indian Subcontinent: India, Pakistan, Sri Lanka, Nepal, Bhutan, Bangladesh and Maldives. Bloomsbury India.
- Johnsingh AJT et al. 2012. The mammals of south Asia. Volume I and II. Oriental BlackSwan.
- Daniel JC. 2002. The book of Indian reptiles and amphibians. Oxford University Press.
- Khaire N. 2015. Indian snakes: a field guide. Jyotsna Prakashan.
- Krishen P. 2014. Jungle trees of central India: a field guide for tree spotters. Penguin India.

Suggested E-resources

- https://www.mammalsofindia.org/
- https://www.indianreptiles.org/
- https://www.birdsofindia.org/
- http://www.ecoindia.com/flora/trees/
- https://frienvis.nic.in/KidsCentre/Common-Trees-of-India_1499.aspx
- http://www.flowersofindia.net/treeid/index.html

Code of the course	ZOO9109P
Title of the course	Limnology & Fisheries Practical-I
Level of the Course	NHEQF Level 6.5
Credit of the Course	4
Type of the Course	DSE-Lab
Prerequisites	Zoology course in B. Sc. degree at any central/ state/Open University level

Objectives of the Course

To provide students with hands-on experience in applying field and laboratory techniques related to limnology and fisheries, allowing them to develop practical skills in assessing aquatic ecosystems, understanding fish populations, and contributing to responsible fisheries management.

Learning outcomes.

1. Field Sampling Proficiency: Develop practical competence in conducting field sampling of aquatic ecosystems, including water quality assessment, plankton collection, and habitat characterization.
2. Fisheries Assessment Skills: Acquire expertise in fish population sampling, data collection, and analysis, allowing for informed assessments of fish stocks and their ecological status.
3. Water Quality Analysis: Gain hands-on experience in analyzing physical and chemical parameters of water, contributing to understanding the health and dynamics of aquatic environments.
4. Fisheries Management Techniques: Apply practical methods for sustainable fisheries management, including stock assessment, size and age analysis, and conservation measures.
5. Report and Presentation: Effectively communicate findings through comprehensive reports and presentations, translating field and laboratory data into actionable insights for limnology and fisheries management practices.

Syllabus

1. Measurement of the area of the lake.
2. To calculate shoreline and shore line development index of a lake.
3. To measure following parameters.
    a. Water temperature
    b. Depth of visibility
    c. pH
4. Estimation of total alkalinity in a water sample.
5. Estimation of chlorides in the water sample.
6. Estimation of dissolved oxygen in the water sample.

7. Estimation of gross primary productivity and BOD of water by dark and light bottle method.
8. Identification of various fishing crafts, all type of Hapas and gears.
9. Identification of various aquatic insects.
10. Identification of various freshwater planktons.
11. Identification of various freshwater aquatic weeds and Aquatic plants.
12. Qualitative and quantitative estimation of plankton sample.
13. Identification and writing comments on various limnological instruments.
14. Visit to various lakes and polluted streams.
15. Identification of common ornamental fishes and plants. Fabrication of all glass aquarium. Setting up and maintenance of Aquarium accessories and equipment. Conditioning and packing of ornamental fishes. Preparation of feed. Setting up of breeding tank for live bearers, barbs, goldfish, tetras, chiclids, gouramis, fighters and catfishes.

Scheme of Examination

Internal and External of Semester Examination as per existing CBCS scheme

Suggested Books and References:

- Das SM. 1990. Handbook of Limnology and Water Pollution: with practical methodology. South Asia Books.
- Koli VK. 2021. Practical Zoology. Himanshu Publication, Udaipur.

Suggested E-resources

- https://lms.fas.sjp.ac.lk/pluginfile.php/69786/mod_resource/content/1/Water%20quality%20analysis_Basic%20Limnology.pdf
- http://limnology.missouri.edu/sops/pdf/lmvp/LMVP%20Procedure%20Manual.pdf
- http://ecoursesonline.iasri.res.in/course/view.php?id=272
- https://link.springer.com/book/10.1007/978-1-4757-4098-1
- http://www.jlakes.org/ch/book/978-1-4757-3250-4.pdf

Code of the course	ZOO9110P
Title of the course	Vermitechnology and Solid Waste Management
Level of the Course	NHEQF Level 6.5
Credit of the Course	4
Type of the Course	GEC-Lab
Prerequisites	Zoology course in B. Sc. degree at any central/ state/Open University level

Objectives of the Course

Develop proficiency in the principles and techniques of vermitechnology, enabling students to effectively manage organic waste through the cultivation and utilization of earthworms for sustainable soil enrichment and waste reduction.

Learning outcomes

1. Understand Vermiculture Principles: Comprehend the underlying concepts of vermicomposting, including the role of earthworms in organic waste decomposition and nutrient cycling.
2. Implement Effective Vermicomposting Techniques: Demonstrate the ability to set up and manage vermicomposting systems, optimizing conditions for earthworm activity and organic waste conversion.
3. Evaluate Soil Enrichment: Assess the quality and nutritional value of vermicompost produced, and understand its benefits in enhancing soil structure, water retention, and plant growth.
4. Apply Sustainable Waste Management: Apply vermitechnology skills to reduce organic waste in various settings, such as households, community gardens, and small-scale agricultural operations.
5. Promote Environmental Awareness: Advocate for the environmental benefits of vermicomposting, contributing to waste reduction, soil health improvement, and the overall sustainability of ecosystems and communities.

Syllabus (Credit - 4)

UNIT-1

Vermitechnology- Definition, history, growth and development in other countries & India, significance, excretory & nervous system.

UNIT- 2

Vermiculture – definition, scope and importance; common species for culture; Environmental parmeters; culture methods – wormery – breeding techniques.

UNIT- 3

Vermicomposting of wastes in field pits, ground heaps, tank method, roof shed method, static pile windrows & bin method, harvesting of the compost, storage. Vermiwash- Preparation and application.

UNIT- 4

Applications of vermiculture – Vermiculture Bio-technology, vermi- composting, use of vermicastings in organic farming/horticulture, earthworms for management of municipal/selected biomedical solid wastes; as feed/bait for capture/culture fisheries.

UNIT- 5

Future perspectives – Predator / pathogen control in wormeries; Potentials and constraints for vermiculture in India. Marketing the products of vermiculture – quality control. Market research and techniques – creating the demand by awareness and demonstration, advertisements, packaging, transport, direct marketing. Visit to relevant Labs/Field Visits.

Scheme of Examination

Internal and External of Semester Examination as per NEP scheme.

Suggested Books and References

- Sultan Ahmed Ismail, 2005. The Earthworm Book, Second Revised Edition. Other India Press, Goa, India.
- Bhatnagar & Patla, 2007. Earthworm vermiculture and vermin-composting, Kalyani Publishers, New Delhi
- Mary Violet Christy, 2008. Vermitechnology, MJP Publishers, Chennai.
- Aravind Kumar, 2005. Verms & Vermitechnology, A.P.H. Publishing Corporation, New Delhi.
- Sultan Ahmed Ismail, 2005. The Earthworm Book, Second Revised Edition. Other India Press, Goa, India.
- Bhatnagar & Patla, 2007. Earthworm vermiculture and vermin-composting, Kalyani Publishers, New Delhi.
- Jordan & Verma, 2009. Invertebrate Zoology, Chand & Company Ltd.
- Edwards, C.A & P.J Bohlen, 1996. Biology and ecology of earthworms III Edn. Chapman & Hall N.Y.U.S.A.
- Lee, K.E. 1985. Earthworms their ecology and relationships.

Suggested E-resources

- https://www.researchgate.net/publication/339310580_Lecture_14_Vermicompost#fullTextFileContent
- https://www.brainkart.com/article/Vermitechnology_39993/
- https://www.vedantu.com/biology/vermiculture
- https://downloads.hindawi.com/journals/specialissues/585020.pdf

Code of the course	ZOO9111P
Title of the course	Aquarium Fish Keeping
Level of the Course	NHEQF Level 6.5
Credit of the Course	4
Type of the Course	GEC-Lab
Prerequisites	Zoology course in B. Sc. degree at any central/ state/Open University level

Objectives of the Course

Upon completing this aquarium fish keeping skill course, participants will acquire the skills and knowledge needed to maintain optimal water quality in their aquariums, promoting the well-being and vitality of their fishes.

Learning outcomes

- Participants will be able to assess and maintain critical water parameters such as pH levels, ammonia, nitrite, and nitrate concentrations, ensuring a stable and healthy aquatic habitat.
- Students will understand the specific needs and behaviors of various fish species, enabling them to create harmonious and balanced community aquariums.
- Learners will acquire knowledge about common fish diseases, their causes, prevention strategies, and treatment options, equipping them to handle health issues in their aquariums effectively.
- Participants will develop the skills to create aesthetically pleasing and natural-looking aquatic environments through proper aquascaping techniques, including substrate selection, plant placement, and decor arrangement.
- Students will gain an understanding of sustainable aquarium practices, including responsible sourcing of fish and plants, ethical considerations in the hobby, and conservation efforts to protect aquatic ecosystems.

Syllabus (Credit - 4)

UNIT-1

Introduction to aquarium fish keeping: The potential scope of Aquarium Fish Industry as a Cottage Industry, Exotic and Endemic species of Aquarium Fishes.

UNIT- 2

Biology of aquarium fishes: Common characters and sexual dimorphism of Fresh water and Marine Aquarium fishes such as Guppy, Molly, Sword tail, Gold fish, Angel fish, Blue morph, Anemone fish and Butterfly fish, Botia, Gourami.

UNIT- 3

Food and feeding of aquarium fishes: Use of live fish feed organisms. Preparation and composition of formulated fish feeds.

UNIT- 4

Live fish transport: Fish handling, packing and forwarding techniques.

UNIT- 5

Maintenance of aquarium: General aquarium maintenance: Budget for setting up an aquarium fish farm as a cottage industry.

Scheme of Examination

Internal and External of Semester Examination as per NEP scheme.

Suggested Books and References

- Bailey M. 2015. Ultimate encyclopedia of Aquarium fish and fish care. Southwater, 1st edition.
- Pearson A. 2021. Aquarium maintenance tips and fish care guide. Royce Publishing.
- Larson P. 2020. Aquarium maintenance. Patricia Larson Publication.
- Newton A. 2020. Aquarium maintenance. Amy Newton.
- James S. Aquariums: Aquariums Box Set (3 in 1): Freshwater aquarium+ Reef aquarium setup & maintenance guide for fish, Reef aquarium.
- James W. 2021. Freshwater aquarium Planner & Logbook. Admore Publishing.

Suggested E-resources

- https://timesproperty.com/news/post/affordable-vastu-fishes-for-home-aquarium-blid2373
- https://mpeda.gov.in/?page_id=791
- https://www.freshwatersystems.com/blogs/blog/how-to-maintain-a-freshwater-aquarium
- https://www.academia.edu/20810163/Complete_Guide_to_Freshwater_Aquarium

Semester - IV

Code of the course	ZOO9013T
Title of the course	Applied Zoology & Animal Biotechnology
Level of the Course	NHEQF Level 6.5
Credit of the Course	4
Type of the Course	DCC
Prerequisites	Zoology course in B. Sc. degree at any central/ state/Open University level

Objectives of the Course

The objective of the course is to equip students with a comprehensive understanding of the principles, techniques, and applications of biotechnology. The course intends to familiarize students with the diverse applications of biotechnology in different fields. Students will learn about the fundamental concepts and theories that underpin biotechnology.

Learning outcomes

1. Study will learn about various protozoans, helminthes and insects in relation to the human diseases they cause. They will acquire information on beneficial insects, sericulture and apiculture.
2. Students are introduced to vector biology and are imparted knowledge regarding different vector borne diseases especially in humans and their recent facts.
3. Syllabus will provide an insight into the various aspects of biotechnology, rDNA technology and genetic engineering.
4. To provide knowledge about dealing with different procedures involving genes viz., isolation, sequencing, labeling, probing, cloning techniques etc.
5. To study different hybridization techniques, DNA fingerprinting, blotting techniques etc.
6. To study the mechanism of gene regulation, gene targetting, gene therapy and human genome project.

Syllabus

UNIT-1 (Lecture hours: 12)

Protozoans, Helminths and human Diseases:

Life history and pathogenicity of *Entamoeba histolytica* and *Plasmodium vivax.*

Life history and pathogenicity of *Ancylostoma duodenale* and *Wuchereria bancrofti.*

Life history of medically important insects: Mosquitoes, Flea, Ticks and Mites; and their control.

UNIT- 2 (Lecture hours: 12)

Apiculture: Different species and life cycle of honey bees. Behaviour and communication in bee colony, Bee keeping: Modern methods and industries in India.

Sericulture: Types, Life cycle and rearing of silkworm, Reeling of silk yarn, Brief idea of diseases of silkworm.

Lac culture**:** life cycle and culture technique of lac insect, economic importance of lac culture.

UNIT- 3 (Lecture hours: 12)

Fundamentals of Biotechnology: An overview of biotechnology and milestones in the development of recombinant DNA technology. Tools of genetic engineering: restriction endonucleases, cloning vectors, expression vectors, insertion vectors. Isolation, synthesis, and sequencing of genes. Gene amplification, labelling of nucleic acids, molecular probes. Cloning techniques and formation of recombinant DNA. Gene transfer methods: transgenic, transfection, recombinant selection and screening.

UNIT- 4 (Lecture hours: 12)

Molecular Techniques in Genetic Analysis: Nucleic acid hybridization, genomic and c-DNA library. Fluorescent In Situ Hybridization (FISH), electrophoresis, blotting techniques, dot blots, slot bots. DNA fingerprinting techniques: RFLP, RAPD, DNA fingerprinting, chromosome walking. Reporter genes and marker genes in genetic analysis

UNIT- 5 (Lecture hours: 12)

Biotechnological Applications: Studying transcript of a cloned gene, post-transcriptional and translational processing. Gene targeting, regulation of gene expression. Human Genome Project, gene therapy. Principles and applications of CRISPR-Cas9, CRISPR screening techniques. Role of biotechnology in healthcare: vaccine production, biotechnology in diagnosis. Ethical and social implications of gene technology: patenting laws, IPR, bio-safety regulations

Scheme of Examination

Internal and External of Semester Examination as per NEP scheme.

Suggested Books and References:

- "Molecular Biotechnology: Principles and Applications of Recombinant DNA" by Bernard R. Glick and Jack J. Pasternak
- "Genetic Engineering: Principles and Methods" by Jane K. Setlow
- "Animal Biotechnology: Models in Discovery and Translation" by Ashish S. Verma
- "Biotechnology: An Introduction" by Susan R. Barnum
- "Genomes" by T.A. Brown
- "Introduction to Industrial and Environmental Biotechnology" by Patnaik

Suggested E-resources

- National Centre for Biotechnology Information (NCBI): www.ncbi.nlm.nih.gov
- https://study.com/learn/lesson/dna-cloning-process-examples.html
- https://iastate.pressbooks.pub/genagbiotech/chapter/recombinant-dna-technology/
- https://www.igntu.ac.in/eContent/MSc-Biotech-02Sem-ProfBhuminathTripathi.pdf

- https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=t5vt4STquHRj94mcOBMr5g==
- https://www.mlsu.ac.in/econtents/44_Introduction%20to%20BIOTECHNOLOGY.pdf
- Biotechnology and Biological Sciences Research Council (BBSRC): www.bbsrc.ukri.org
- https://www.youtube.com/watch?v=nMaBbO0JhFQ&pp=ygUKcHJvdG96b2Fucw%3D%3D
- http://apps.who.int/iris/bitstream/10665/41519/1/WHO_TRS_666.pdf
- https://egov.uok.edu.in/elearning/tutorials/1011020512BR15103CR15Apiculture%20Lac%20culture%20and%20%20sericultureapiculture%20lac%20culture%20and%20%20sericulture%20upload.pdf

Code of the course	ZOO9112T
Title of the course	Entomology-III (Medical Entomology)
Level of the Course	NHEQF Level 6.5
Credit of the Course	4
Type of the Course	DSE
Prerequisites	Zoology course in B. Sc. degree at any central/ state/Open University level

Objectives of the Course

The course aims to examine the role of insects as vectors of diseases and their effects on human populations and to identify the potential impact of different insect species on human health, and society in general, and to be knowledgeable about potential control strategies

Learning outcomes

1. Students will attain a solid foundation in insect biology, including general entomology, basic systematics, morphology, physiology, and biodiversity.
2. Students should be able to design, carry out and evaluate vector control interventions using specialized knowledge and skills, as well as communicate scientific information and findings effectively.
3. Students will learn about the basic biology and ecology of arthropods of public health importance and comprehend the surveillance tools and control strategies used to manage them.

Syllabus

UNIT-1 (Lecture hours: 12)

Mosquitoes: Morphology and Life cycle of medically important mosquitoes (*Anopheles*, *Aedes* and *Culex*), their role in disease transmission (Malaria, Dengue, Chikungunya and filariasis), Control of mosquitoes

UNIT- 2 (Lecture hours: 12)

House Flies**:** Morphology, life cycle and role in disease transmission, Case studies – Myasis and Control strategy

Black Flies: Morphology and life cycle, their role in disease transmission

Sandflies: Classification, morphology and life cycle, their role in disease transmission (Kala azar), Control of sand flies

UNIT- 3 (Lecture hours: 12)

Fleas: Morphology, Life cycle, Role in plague transmission, Control strategy

Ticks: General consideration, Soft and Hard ticks-External morphology, Life cycle, Disease relationship (Kyasanur Forest Disease (KFD) and Tick Typhus) and control measures.

Mites: Morphology, Life cycle, transmission of Scrub typhus disease and Control strategy

UNIT- 4 (Lecture hours: 12)

Lice: Classification, Morphology and life cycle of lice

Cockroaches: Distribution and morphological characteristics and life cycle; Importance of cockroaches - mechanical carriers of parasite/pathogens, Environmental and chemical control

Venomous Arthropods: Hazards posed by spiders, scorpions, ants, bees, wasps

UNIT- 5 (Lecture hours: 12)

Chemical and Biological control of insect vectors, integrated vector management, Surveillance and outbreak of vector borne diseases in tropical countries.

Global warming and disease outbreak.

WHO guidelines for vector surveillance and control

Malaria Control agencies and programmes in India – NMCP, NMEP, UMS, RBM, EMCP, NVBDCP, NCDC, NIMR, ICMR and WHO.

Scheme of Examination

Internal and External of Semester Examination as per NEP scheme.

Suggested Books and References:

- Medical Entomology: A Textbook on Public Health and Veterinary Problems Caused by Arthropods. B.F. Eldridge and J.D. Edman. Springer.
- Medical Entomology for Students. Mike Service. Cambridge University Press.
- The Biology of Blood-Sucking in Insects. M. J. Lehane. Cambridge University Press.
- Handbook of Medical Entomology. William Albert Riley. Legare Street Press.
- Park, K. (2007). Preventive and Social Medicine. XVI Edition. B.B Publishers

Suggested E-resources

- https://www.pubs.ext.vt.edu/content/dam/pubs_ext_vt_edu/ENTO/ENTO-137/ENTO-137-pdf.pdf
- https://extension.entm.purdue.edu/publications/E-251.pdf
- http://zoology.uok.edu.in/Files/cae2d08f-4f62-428e-b6ea-cf46cdccbf42/Custom/Sand%20fly.pdf
- https://entomology.ca.uky.edu/files/ef602.pdf
- https://www.pubs.ext.vt.edu/content/dam/pubs_ext_vt_edu/444/444-221/ENTO-502.pdf
- https://ipm.ucanr.edu/pdf/pestnotes/pncockroaches.pdf

Code of the course	ZOO9113T
Title of the course	Wildlife Biology- III (Wildlife of India and Rajasthan)
Level of the Course	NHEQF Level 6.5
Credit of the Course	4
Type of the Course	DSE
Prerequisites	Zoology course in B. Sc. degree at any central/ state/Open University level

Objectives of the Course

To equip students with a thorough knowledge of the rich biodiversity of wildlife in India and Rajasthan, encompassing their ecological significance, conservation status, and the unique regional factors influencing their habitat, behavior, and management.

Learning outcomes

1 Species Proficiency: Identify and describe various wildlife species native to India and Rajasthan, including their physical characteristics, behavior, and habitat preferences.
2 Ecological Understanding: Comprehend the ecological roles of different wildlife species in their respective ecosystems, recognizing their contributions to biodiversity and ecosystem functioning.
3 Conservation Knowledge: Evaluate the conservation status of wildlife in India and Rajasthan, and demonstrate an awareness of the threats they face and the strategies employed for their protection.
4 Regional Context: Understand the distinct factors shaping wildlife populations and habitats in Rajasthan, considering geographical, climatic, and socio-cultural influences.
5 Wildlife Management: Apply theoretical insights to develop informed recommendations for sustainable wildlife management, advocating for conservation measures that balance human needs with ecological preservation.

Syllabus

UNIT-1 (Lecture hours: 12)

Zoogeographical regions of India and their fauna: Himalayan, Eastern and Western ghats, Thar, Deccan plateau, Gangetic plains.

Important faunal species of the Thar Desert: Chinkara (*Gazella bennettii*), Four-horned antelope (*Tetraceros quadricornis*), Indian fox (*Vulpes bengalensis*), Black buck (*Antilope cervicapra*), Great Indian Bustard (*Choriotis nigriceps*), Brilliant ground agama (*Trapelus agilis*).

Protected area network of India and Rajasthan.

UNIT- 2 (Lecture hours: 12)

Status, distribution, physical characteristics of some threatened plants of India: Khejri (*Prosopis cineraria*), Siris (*Albizia lebbeck*), Neem (*Azadirachta indica*), Ashwagandha (*Withania somnifera*), Gugal (*Commiphora wightii*)

Special Wildlife programs: Project Tiger, Project Elephant, Operation Rhino, Project Crocodile, Project Great Indian Bustard, Project Cheetah.

UNIT- 3 (Lecture hours: 12)

Wildlife of Rajasthan, Ramsar convention, Ramsar sites of India (Chilka lake, Bhoj Wetland, Wular Lake, Deepor Beel, Point Calimere Wildlife and Bird Sanctuary), Ramsar sites of Rajasthan (Keoladeo National Park, Sambhar lake)

UNIT- 4 (Lecture hours: 12)

Wildlife Institutes in India: WII, BNHS, ZSI, IIFM, FSI, CAZRI, Central Zoo Authority of India

Wildlife legislation: Wildlife Protection Act, 1972; National Wildlife Action Plan, 2002; National Biodiversity Act, 2002.

UNIT- 5 (Lecture hours: 12)

Human-wildlife interaction: Introduction, types, damages caused by wildlife, factors influencing conflict and management measures.

Wildlife trade and trafficking Damages caused by wildlife- their identification and control Snake bite, venom, anti-venom, first aid and management of snake bite cases.

Scheme of Examination

Internal and External of Semester Examination as per NEP scheme.

Suggested Books and References:

- Menon V. 2023. Indian Mammals. Hachette India.
- Grimmett R et al. 2016. Birds of the Indian Subcontinent: India, Pakistan, Sri Lanka, Nepal, Bhutan, Bangladesh and Maldives. Bloomsbury India.
- Sharma BK, Kulshreshtha S, Rahmani AR. 2016. Faunal heritage of Rajasthan, India: Conservation and management of Vertebrates. Volume I & II. Springer.
- Johnsingh AJT et al. 2012. The mammals of south Asia. Volume I and II. Oriental BlackSwan.
- Daniel JC. 2002. The book of Indian reptiles and amphibians. Oxford University Press.
- Khaire N. 2015. Indian snakes: a field guide. Jyotsna Prakashan.
- Krishen P. 2014. Jungle trees of central India: a field guide for tree spotters. Penguin India.

Suggested E-resources

- https://www.mammalsofindia.org/
- https://www.indianreptiles.org/
- https://www.birdsofindia.org/
- http://www.ecoindia.com/flora/trees/
- https://frienvis.nic.in/KidsCentre/Common-Trees-of-India_1499.aspx
- http://www.flowersofindia.net/treeid/index.html

Code of the course	ZOO9114T
Title of the course	Limnology and Fisheries-III (Fisheries Management)
Level of the Course	NHEQF Level 6.5
Credit of the Course	4
Type of the Course	DSE
Prerequisites	Zoology course in B. Sc. degree at any central/ state/Open University level

Objectives of the Course

To equip students with an in-depth comprehension of fisheries management principles, strategies, and sustainable approaches, enabling them to make informed decisions for the effective utilization and conservation of aquatic resources, while considering ecological, economic, and social factors.

Learning outcomes

1 Resource Assessment: Evaluate fish stocks and aquatic ecosystems to determine their health and sustainability, utilizing data analysis and population assessment techniques.

2 Sustainable Practices: Apply knowledge of fisheries biology, ecology, and regulation to design and implement sustainable harvesting strategies that prevent overexploitation.

3 Ecosystem Understanding: Grasp the interconnectedness of aquatic ecosystems, recognizing the influence of environmental factors on fish populations and their interactions.

4 Policy and Regulation: Interpret and analyze fisheries policies and regulations, understanding their implications for resource management and conservation.

5 Stakeholder Engagement: Develop skills to collaborate with diverse stakeholders, including fishing communities, scientists, and policymakers, to foster effective fisheries management practices that balance environmental conservation and socio-economic needs.

Syllabus

UNIT-1 (Lecture hours: 12)

Fisheries and classification of fisheries; Lacustrine fisheries; Riverine fisheries – Ganga River system; Coastal and Deep sea fisheries.

UNIT- 2 (Lecture hours: 12)

Fisheries of Rajasthan. Fisheries of economically important fishes: Sardine; Bombay duck; Mackerel; Hilsa

UNIT- 3 (Lecture hours: 12)

Pre and Post-harvest Technology: Food of culture fishes, supplementary feed. Probiotics; live- fish transport; Fish spoilage; Fish preservation; Fishery by-products

UNIT- 4 (Lecture hours: 12)

Fish Biotechnology: Application of genetics and biotechnology in fisheries; Importance of fish genetics and hybridization; Androgenesis. Gynogenesis, Production of transgenic fishes

UNIT- 5 (Lecture hours: 12)

Aquatic Pollution: Types and sources; Impact of pollution on fishes; Treatment of waste water; Bioremediation.

Scheme of Examination

Internal and External of Semester Examination as per existing CBCS scheme

Suggested Books and References:

- Roy D. 2017. Freshwater fisheries management. Oxford Book Company.
- Hunter W. 2021. Fisheries management and conservation. Apple Academic Press.
- Motos L, Wilson D. 2006. The knowledge base for fisheries management: Vol 36 (Developments in Aquaculture and Fisheries Science). Elsevier Science.
- Misra RN. 2016. Fishery management. Discovery Publishing House Pvt Ltd.
- Pontecorvo G, Schrank WE. 2009. Fisheries management: Pandemic failure, workable solutions. Emerald Goup Publishing Limited.

Suggested E-resources

- https://www.fao.org/3/y3427e/y3427e03.htm
- https://nsglc.olemiss.edu/Fisheries/fishman.pdf
- http://ledhyane.lecture.ub.ac.id/files/2015/09/HartReynolds_2002-HandbookOfFishBiologyAndFisheriesVol2.pdf
- https://www.scribd.com/presentation/376287293/Fundamentals-of-Fisheries-Mgt-Ramon#

Code of the course	ZOO9115T
Title of the course	Entomology-IV (Insect Pest Management and Toxicology)
Level of the Course	NHEQF Level 6.5
Credit of the Course	4
Type of the Course	DSE
Prerequisites	Zoology course in B. Sc. degree at any central/ state/Open University level

Objectives of the Course

The objective of the course to illustrate the principles of integrated pest management (IPM), which involves using a combination of cultural, mechanical, biological, and chemical methods to manage pest. The course also covers the benefits and limitations of different methods of pest management.

Learning outcomes

Student will be able to learn:

- The different modes of action of insecticides, such as cholinesterase inhibition or growth regulation.
- The risks associated with the use of insecticides and the importance of proper application and precautions.

Syllabus

UNIT-1 (Lecture hours: 12)

Pests of economic importance and their management: Identification, damage symptoms, life cycle and management of important insect pests of vegetables fruits and stored grains

Assessment of pest status; EIL and ETL

Pheromones and other attractants, repellents and chemosterillants

UNIT- 2 (Lecture hours: 12)

Insect pest management: Definition and concept of IPM, Tools of pest management and their integration: legislative, cultural, physical and mechanical methods

Principles and scope of biological control; important groups of parasitoids, predators and pathogens.

Herbal and Microbial Biopesticides and their applications. Biotechnology in insect control.

UNIT- 3 (Lecture hours: 12)

Toxicology (Insecticides): classification of insecticides; Mode of entry, Mode of action. Chemical nature, Concept of Ist, IInd, IIIrd generation of insecticides.

Structure and mode of action of Organochlorides, Organophosphates, Carbamates, Pyrethroids, Insect growth regulators, Botanicals (natural pyrethroids, rotenone, neem products, nicotine).

UNIT- 4 (Lecture hours: 12)

Principles of Toxicology, Basic concepts: (Toxicants, Toxicity, Effects and Responses, Dose-response relationship).

Evaluation of insecticide toxicity: Methods of toxicity testing: Acute toxicity, Sub-acute toxicity, chronic toxicity,

Bioassay of Insecticides in the laboratory (Lethality Test: LC50, LC90, LD50 & LD90).

Insecticide metabolism: Detoxification enzyme and their role in metabolism, Pest resistance to Insecticides, mechanism and types of resistance, insecticide resistance Management and pest resurgence.

UNIT- 5 (Lecture hours: 12)

Biomagnifications, Insecticide residues, maximum residue limit. Insecticide Act, Labeling, packing, storage and disposal; Impact of insecticide misuse. Methods of diluting insecticide to a recommended level. Safe use of insecticides: diagnosis and treatment of insecticide poisoning, Application equipments. Host Plant Resistance-Resistance mechanisms, Transgenic crops in pest management.

Scheme of Examination

Internal and External of Semester Examination as per NEP scheme.

Suggested Books and References:

1. A Textbook of Insect Toxicology. Rp Srivastava, RC Saxena. Himanshu Publications.
2. Principles of Toxicology Testing. Frank A. Barile. CRC Press.
3. Safe use of pesticides: 14th report of the WHO Expert Committee on Vector Biology and Control (Technical report series, 813). World Health Organization.
4. Optimizing Pesticide Use: 8 (Wiley Series in Agrochemicals & Plant Protection). MF Wilson. John Wiley & Sons Inc.
5. Handbook of Entomology. Dr. T. V. Prasad. New Vishal Publications.
6. Microbes for Sustainable lnsect Pest Management: Hydrolytic Enzyme & Secondary Metabolite – Volume 2.Md. Aslam Khan, Wasim Ahmad.Springer Nature Switzerland AG
7. Insect Pest Management. David Dent, Dr Richard Binks. CABI Publishing.
8. Integrated Insect Pest Management-Physiological & Molecular Approaches. Dadala Mary Mamatha, Sreedevi Kolla. VDM Verlag
9. Insect Pest Management: Field and Protected Crops. A. Rami Horowitz, Isaac Ishaaya. Springer.

Suggested E-resources

- https://extension.entm.purdue.edu/landscapelab/cliffs_notes/powerpoint/general/Insect_Orders_1.pdf
- https://tmnehs.gov.in/writereaddata/Chap-14.pdf
- https://www.rlbcau.ac.in/pdf/PGCourse/Entomology/Toxicology%20of%20insecticides%20_APE506.pdf
- https://www.researchgate.net/publication/354919846_Insecticide_Toxicity_Consumption_Assessment_Methodologies_and_Safety_Issues_in_India
- https://www.researchgate.net/publication/327212384_pesticide_metabolism

Code of the course	ZOO9116T
Title of the course	Wildlife Biology-IV (Wildlife Census and Management)
Level of the Course	NHEQF Level 6.5
Credit of the Course	4
Type of the Course	DSE
Prerequisites	Zoology course in B. Sc. degree at any central/ state/Open University level

Objectives of the Course

To equip students with a thorough comprehension of wildlife census methodologies, data analysis techniques, and effective management approaches, enabling them to actively contribute to the evaluation and conservation of wildlife populations and their respective environments.

Learning outcomes

1 Census Techniques: Demonstrate proficiency in employing various wildlife census methods, from direct observations to advanced technologies, for accurately assessing animal populations.
2 Data Analysis Skills: Analyze collected census data using statistical tools, identifying population trends, distribution patterns, and demographic changes.
3 Conservation Strategies: Develop effective wildlife management plans based on census findings, considering habitat requirements, species interactions, and threats to formulate conservation measures.
4 Ethical Considerations: Evaluate the ethical implications of wildlife management decisions, considering the welfare of species, ecosystems, and local communities.
5 Policy and Advocacy: Apply learned knowledge to advocate for evidence-based wildlife management policies and practices, contributing to the preservation and sustainable utilization of biodiversity.

Syllabus

UNIT-1 (Lecture hours: 12)

History and cultural background of Indian Wildlife, Needs and values of wildlife protection. Types of wildlife management, Significance of wildlife conservation, Management policies and their implementation. Factors injurious to wildlife and forests. Invasive species and its threat to native species

UNIT- 2 (Lecture hours: 12)

Wildlife census and sampling: Total count, index count, types of sampling, invasive (trapping, drive count, line and strip transect method, point count, mark-recapture method) and non-invasive sampling (pellet count, time species count, track count method). Concept of double count/observation. Basic concept of occupancy modelling.

Animal behavior study techniques: Random/haphazard sampling, ad-libitum sampling, focal animal sampling, all occurrence, sequence sampling, one zero sampling and scan sampling.

Geographic Information System (GIS), and Elementary idea of radio telemetry.

UNIT- 3 (Lecture hours: 12)

Forest and wildlife management: Types of wildlife management, Management policies and their implementation. Practices of forest management - water hole management, fire lines, grassland management, and parapet covering of wells. Introduction and types of social forestry. Forest laws- Necessary general principles- Indian Forest Act 1927, Forests Conservation Act 1980.

UNIT- 4 (Lecture hours: 12)

Social forestry: Objectives of social forestry programmes and their implementation in India, Types of social forestry: farm forestry, community forestry or rural forestry, extension forestry or urban forestry, wasteland management. Need of Social forestry programs, Involvement of common people, Extension and education, ecotourism, finance in wildlife management

UNIT- 5 (Lecture hours: 12)

Introduction to scientific method and hypothesis testing. Types of data distribution and its salient features. Null and alternative hypothesis. Level of significance. Types of statistical errors. One-tailed and two-tailed tests. Parametric and non-parametric test of significance. Data transformation, bootstrap and Jack-knife procedure.

Scheme of Examination

Internal and External of Semester Examination as per existing CBCS scheme

Suggested Books and References:

- Skalski JR, Robson DS. 2012. Techniques in Wildlife Investigations: design and analysis of capture data. Academic Press.
- Sutherland WJ. 2006. Ecological census techniques: a handbook. Cambridge University Press.
- Sutherland WJ, Newton I and Green R. 2004. Bird ecology and conservation: a handbook of techniques (Techniques in ecology and conservation 1). OUP Oxford.
- Mathur R. 2018. Wildlife conservation and management. Rastogi Publications.

Suggested E-resources

- https://www.geographynotes.com/wildlife-census/how-to-conduct-wildlife-census-3-methods-geography/5963#:~:text=This%20lead%20to%20the%20systematic,community%20is%20called%20as%20census.
- https://wwfeu.awsassets.panda.org/downloads/counting_wildlife_mozambiqe_english.pdf

Code of the course	ZOO9117T
Title of the course	Limnology and Fisheries-IV (Fish and Fisheries Biology)
Level of the Course	NHEQF Level 6.5
Credit of the Course	4
Type of the Course	DSE
Prerequisites	Zoology course in B. Sc. degree at any central/ state/Open University level

Objectives of the Course

To provide students with a comprehensive understanding of fish biology, ecology, and fisheries management principles, enabling them to analyze the dynamics of fish populations, their interactions with aquatic ecosystems, and contribute to sustainable fisheries practices.

Learning outcomes

1 Fish Biology Mastery: Understand the anatomical, physiological, and reproductive aspects of fish, grasping their diversity and adaptations to aquatic environments.
2 Ecological Insights: Analyze the ecological interactions between fish species and their habitats, recognizing their roles in aquatic ecosystems and food webs.
3 Population Dynamics: Apply knowledge of population biology to assess and predict changes in fish populations, considering factors such as growth, mortality, and recruitment.
4 Fisheries Management: Utilize learned principles to develop effective fisheries management strategies, balancing sustainable resource utilization with conservation goals.
5 Interdisciplinary Integration: Integrate concepts from biology, ecology, and fisheries science to address complex challenges in fish biology and fisheries management, fostering a holistic understanding of aquatic ecosystems.

Syllabus

UNIT-1 (Lecture hours: 12)

Origin and taxonomy of fishes: origin and evolution of major groups of fishes; Classification of fishes, bio-geographical distribution of fishes.

UNIT- 2 (Lecture hours: 12)

Fish physiology: Respiratory system: Gill and aerial respiration; Air bladder in fishes; Weberian ossicles; Lateral line system, Excretion and osmoregulation in fishes, Types of fins and scales in fishes.

UNIT- 3 (Lecture hours: 12)

Fish physiology: Reproductive system and its endocrine regulation; light and sound production in fishes; Electric organs and electro-receptors in fishes; Age and growth in fishes

UNIT- 4 (Lecture hours: 12)

Fish pathology and population studies: Bacterial diseases; Fungal diseases; Worm infection; Prevention and cure of fish diseases.

UNIT- 5 (Lecture hours: 12)

Fish behavior: Migration in fishes; reproductive and shoaling behavior; Parental care; Orientation and homing.

Scheme of Examination

Internal and External of Semester Examination as per NEP scheme.

Suggested Books and References:

- Khanna SS, Singh HR. 2014. Textbook of fish biology and fisheries. Narendra Publishing House.
- Burton D and Burton M. 2017. Essential fish biology: diversity, structure and function. Oxford University Press.
- Kyle HM. 2008. Biology of fishes. Biotech Books.
- Stubbs P. 2018. Essentials of fish biology. Larsen and Keller Education.
- Kumar A. 2005. Fish biology. APH Publishing Corporation.

Suggested E-resources

- https://nfdb.gov.in/PDF/Fish%20&%20Fisheries%20of%20India/1.Fish%20and%20Fisheries%20of%20India.pdf
- https://www.notesonzoology.com/india/fishery/fishery-meaning-types-and-economic-zones/646
- http://ledhyane.lecture.ub.ac.id/files/2015/09/HartReynolds_2002-HandbookOfFishBiologyAndFisheriesVol2.pdf
- https://uou.ac.in/sites/default/files/slm/MSCZO-607.pdf
- https://sciencecollegenanded.org/assets/pdf/e-content/Text%20Book%20of%20Fishery%20Science2022.pdf

Code of the course	ZOO9118T
Title of the course	Entomology-V (Insect Ecology, Commercial and Forensic Entomology)
Level of the Course	NHEQF Level 6.5
Credit of the Course	4
Type of the Course	DSE
Prerequisites	Zoology course in B. Sc. degree at any central/ state/Open University level

Objectives of the Course

The objective of this course is to develop an understanding of the distributions and abundances of organisms, including insects, and their interactions with each other and the environment. The course also deals with knowledge about the identification, biology, and importance of insects and novel techniques routinely used in research to investigate the forensic significance in insect systems and techniques that can be applied to aid in legal testimony.

Learning outcomes

- Students will be able to Identify and analyze key concepts in insect ecology, Identify biotic and abiotic ecological forces that drive insect behavior.
- Students should gain an understanding of the major orders of insects and other arthropods of economic importance. This includes learning about the economic significance of these organisms and their impact on various industries.
- Students will learn concepts of entomology in a forensic context and how their biology can be applied to help in legal investigations.
- Students will gain knowledge and skills related to the use of insects as evidence in forensic investigations.

Syllabus

UNIT-1 (Lecture hours: 12)

Insect Ecology: Effect of abiotic and biotic factors on insects, Population dynamics. Population growth and fluctuation and population regulatory mechanisms.

Host plant insect interactions: Factors influence insect host plant interactions; Plant resistance to insects and types of resistance

UNIT-2 (Lecture hours: 12)

Bee Keeping: Different species of honeybees, life cycle and division of labour in the colony, General colony management during different seasons, managing colonies for honey production and pollination.

Artificial queen rearing, pests and diseases of honey bees, Bee poisoning, production and marketing of quality honey and value added honey products, Establishment and maintenance of apiaries.

UNIT-3 (Lecture hours: 12)

Sericulture: Types of silkworms and life cycle, brief idea of sericulture, silk and its uses, pests and diseases of silkworm, silk industries in India.
Lac Culture: Lac insect; natural enemies and their management, Lac properties, Lac industries in India.

UNIT-4 (Lecture hours: 12)

Forensic entomology: Introduction, Insects of forensic importance, Use of insects and other arthropods in investigations of human and animal deaths, thefts, illegal drug trade and in court-of-law proceedings that may result from such investigations, Forensic application of Entomology.

UNIT-5 (Lecture hours: 12)

Entomological evidence identification, recording and recovery skills at a crime scene, Entomological evidence identification, and Recording in the laboratory.
Familiarization with ACPO protocol for collecting entomological evidence.

Scheme of Examination

Internal and External of Semester Examination as per NEP scheme.

Suggested Books and References:

- Textbook of Entomology By Packard, Publisher: New York, The Macmillan company; London, Macmillan and co., ltd.
- Borror and DeLong's Introduction to the Study of Insects by Norman F. Johnson and Charles A. Triplehorn (May 19, 2004)
- The Insects: An Outline of Entomology by Professor P. J. Gullan and P. S. Cranston (Mar 2, 2010)
- Integrated Pest Management: Concepts, Tactics, Strategies and Case Studies Academic press. Edited by: Edward B. Radcliffe, University of Minnesota
- Introduction to Integrated Pest Management, Mary Louise Flint (Author), Robert van den Bosch (Author) Castner, published by Feline Press, Gainesville, FL (2000)
- A Field Guide to the Insects of North America North of Mexico Peterson Field Guide Series, Borror and White.
- Elementary Text-book of Entomology. Kirby, W.F. (1885) W. Swan Sonnenschein and Co. Paternoster Square. London.
- Insect Ecology: Behavior, Populations and Communities. Peter W. Price, Robert F. Denno. Cambridge University Press.
- The Insects: An Outline of Entomology 4th Edition (2010) P.J. Gullan and P.S. Cranston Blackwell Publishing.
- The Insects: Structure and Function. RF Chapman. Cambridge University Press.

Suggested E-resources

- https://denton.agrilife.org/files/2013/08/beekeeping-basics.pdf
- https://archive.org/download/01IndustrialEtomology/01_Industrial%20Etomology.pdf
- https://www.ignfa.gov.in/document/biodiversity-cell-ntfp-related-issues4.pdf

- https://old.amu.ac.in/emp/studym/99995708.pdf
- https://www.tracenetwork.org/wp-content/uploads/2018/05/Hall-M.-Whitaker-A.-and-Richards-C.-2012.-Forensic-entomology-Chapter-8-from-Crime-Scene-to-Court-Wiley-Blackwell.pdf
- https://www.researchgate.net/profile/Lavinia-Iancu-2/post/Can-anyone-have-publication-regarding-Use-of-Insects-in-Forensic-studies/attachment/59d63cb879197b8077999a89/AS%3A416701205237760%4014763607176 65/download/SMITH+1986.pdf

Code of the course	ZOO9119T
Title of the course	Wildlife Biology-V (Fundamentals of Ornithology)
Level of the Course	NHEQF Level 6.5
Credit of the Course	4
Type of the Course	DSE
Prerequisites	Zoology course in B. Sc. degree at any central/state/open university level

Objectives of the Course

To provide students with a comprehensive foundation in the principles of ornithology, enabling them to understand the anatomy, behavior, ecology, and conservation of birds, and contribute to avian research and conservation efforts.

Learning outcomes

1 Avian Diversity: Identify and describe various bird species, comprehending their morphological characteristics, habitat preferences, and geographic distributions.
2 Behavioral Understanding: Analyze bird behaviors, including breeding, migration, foraging, and communication, to interpret their ecological roles and adaptations.
3 Ecological Insights: Grasp the interactions between birds and their environments, recognizing their contributions to ecosystem dynamics and functioning.
4 Conservation Knowledge: Evaluate the conservation status of different bird species, understanding the threats they face and applying practical measures to support their protection.
5 Scientific Inquiry: Develop research skills in ornithology, including field observations, data collection, and analysis, enabling the formulation of hypotheses and contributions to avian research.

Syllabus

UNIT-1 (Lecture hours: 12)

Introduction to avian diversity and classification. Evolution and Speciation of birds. Anatomy and morphology of birds including variation in colouration, beak and feet. Introduction to bird identification with special characters.

UNIT- 2 (Lecture hours: 12)

Basic concept of molting in birds. Flight adaptations in birds: respiratory, circulatory, gastrointestinal, excretory, reproductive system and sense organs. Bird features and plumages: Structure, types and functions. Avian Flight: Aerodynamics, power for flight, maneuvering and stability.

UNIT- 3 (Lecture hours: 12)

Life History of birds: Foraging Behaviour; Mating, and Breeding Behaviour. Bird migration. Breeding biology of birds: breeding timings, eggs, clutch size, parental/offspring recognition. Parental care in birds.

UNIT- 4 (Lecture hours: 12)

Bird nesting: Types of nests, structure, nest building and functions. Basic concepts of mixed-species flocking, bird communities and guilds composition (on the basis of diet, habitat, size, nesting). Bird census and survey techniques: point count, opportunistic bird sightings, line transects, call count, call playback. Bird trapping/capturing and marking.

UNIT- 5 (Lecture hours: 12)

Molecular techniques in ornithology. Recent avian extinctions and current threats to bird populations. Citizen science in Ornithology: e-bird, iNaturalist. Concept, criteria and distribution of Important Bird Areas (IBAs) in India.

Scheme of Examination

Internal and External of Semester Examination as per NEP scheme.

Suggested Books and References:

- Lovette, I.J and Fitzpatrick, J.W. 2016. Handbook of Bird Biology, 3rd ed. Wiley.
- Gill, F.B, and Prum, R.O. 2019. Ornithology, 4th ed. Macmillan.
- Birkhead, T. 2013. Bird Sense: What it's like to be a bird? Bloomsbury, NY.
- Birkhead, T., Wimpenny, J., and Montgomerie, B. 2014. Ten Thousand Birds: Ornithology since Darwin. Princeton University Press, Princeton, NJ.
- Sutherland WJ. 2006. Ecological census techniques: a handbook. Second edition. Cambridge University Press.
- Sutherland WJ, Newton I and Green R. 2004. Bird ecology and conservation: a handbook of techniques. Oxford University Press.
- Bibby C, Burgess N, Hill D and Mustoe S. 2000. Bird census techniques. Second edition. Academic Press
- Ali S and Ripley D. 2002. Handbook of the birds of India and Pakistan. Vol I to X. OUP India
- Ian O and Peter B. 2002. Evolutionary Ecology of Birds: Life Histories, Mating systems, and Extinction (Oxford Series in Ecology and Evolution). Oxford University Press.
- Berthold P. 2001. Bird migration a general survey. Second edition. OUP Oxford.
- Rasmussen PC et al. 2012. Birds of south Asia: the Ripley guide. I and II editions. Lynx Edition.
- Grimmett R, Inskipp C and Inskipp T. 2016. Birds of the Indian subcontinent. Bloomsbury India.

Suggested E-resources

- https://archive.nptel.ac.in/courses/127/106/127106229/
- http://people.eku.edu/ritchisong/554notes1.html
- http://www.jnkvv.org/PDF/13042020153242134201400.pdf
- https://www.studocu.com/en-ca/document/lakehead-university/ornithology/ornithology-lectures-full-set-of-lecture-notes-with-the-breakdown-of-the-final-exam-on-the-last-page/7081071

Code of the course	ZOO9120T
Title of the course	Limnology and Fisheries-V (Post-Harvest Technology in Fisheries
Level of the Course	NHEQF Level 6.5
Credit of the Course	4
Type of the Course	DSE
Prerequisites	Zoology course in B. Sc. degree at any central/ state/Open university level

Objectives of the Course

To equip students with a comprehensive understanding of the principles and practices of post-harvest technology in fisheries, enabling them to enhance the quality, safety, and value of fishery products through effective preservation, processing, and distribution methods.

Learning outcomes

1 Quality Enhancement: Apply knowledge of post-harvest techniques to improve the quality, freshness, and shelf life of fishery products, meeting consumer demands.
2 Preservation Methods: Understand various preservation methods, such as chilling, freezing, drying, and smoking, and their effects on maintaining the nutritional value and safety of fish products.
3 Value Addition: Explore value-added processing techniques, including fish product diversification, packaging innovations, and by-product utilization, contributing to economic sustainability.
4 Food Safety Compliance: Grasp the importance of adhering to food safety regulations and standards in post-harvest handling, ensuring the production of safe and hygienic fish products.
5 Sustainability Considerations: Evaluate the environmental impact of post-harvest practices and processing methods, promoting sustainable fisheries management and reducing resource wastage.

Syllabus

UNIT-1 (Lecture hours: 12)

Principles and importance of fish preservation – handling of fresh fish, post mortem changes (rigor mortis and spoilage), spoilage in marine fish, spoilage in freshwater fish. Principles of preservation- cleaning, lowering of temperature, raising of temperature, denudation, use of salt, use of fish preservatives, exposure to low radiation of gamma rays.

UNIT- 2 (Lecture hours: 12)

Traditional and advanced methods of fish preservation – Traditional- sun drying, salt curing, pickling, smoking. Advanced methods – chilling or icing, refrigerated sea water, freezing, canning, irradiation and drying.

UNIT- 3 (Lecture hours: 12)

Processing and preservation of fish and fish by-products – Fish products – fish minced meat, fish meal, fish oil, fish liquid (ensilage), fish protein concentrate, fish chowder, fish cake, fish sauce, fish salads, fish powder, pet food from trash fish, fish manure. Fish by-products – fish glue, isinglass, chitosan, pearl essence, shark fins and fish maws. Types of Shrimp/Prawn/Fish products exported from India.

UNIT- 4 (Lecture hours: 12)

Edible, Industrial, and pharmaceutical products from seaweeds – Preparation of agar, algin and carrageen. Use of seaweeds as food for human consumption, sea weeds in treatment of disease and preparation of therapeutic drugs.

UNIT- 5 (Lecture hours: 12)

Sanitation in processing plants and Quality Control – Environmental hygiene and personal hygiene in processing plants. Quality control of fish and fishery products – pre-processing control, control during processing and control after processing.

Scheme of Examination

Internal and External of Semester Examination as per NEP scheme.

Suggested Books and References:

- Balachandran KK. 2002. Post-harvest technology of fish and fish product. Daya Publishing House.
- Nambudiri NM. 2023. Advances in harvest and post-harvest technology of fish. New India Publishing Agency.
- Ravishankar N. 2021. Innovations in fishing and fish processing technologies. New India Publishing Agency.

Suggested E-resources

- https://krishi.icar.gov.in/jspui/bitstream/123456789/24972/1/RECENT%20TRENDS%20IN%20HARVEST%20AND%20POST-HARVEST_.pdf
- https://www.fao.org/fileadmin/user_upload/fao_ilo/pdf/Other_docs/JFFLS_Postharvest_WEB.pdf
- https://www.researchgate.net/publication/355090002_Postharvest_Practices_in_Small-Scale_Fisheries#fullTextFileContent
- https://slideplayer.com/slide/5705791/
- https://www.scribd.com/document/100296052/Capture-Fisheries-and-Post-Harvest-Technology

Code of the course	ZOO9121S
Title of the course	Dissertation
Level of the Course	NHEQF Level 6.5
Credit of the Course	4
Type of the Course	DSE
Prerequisites	Zoology course in B. Sc. degree at any central/ state/Open University level

Objectives of the Course

The research dissertation course aims to provide postgraduate students with a structured platform to independently conceptualize, plan, execute, and communicate a comprehensive research project. Through this course, students will develop advanced research skills, critical thinking, and the ability to contribute original knowledge to their respective academic disciplines, fostering their growth as proficient researchers and scholars.

Note: Further details is included at the end of this document

Code of the course	ZOO9122P
Title of the course	Entomology Practical-II
Level of the Course	NHEQF Level 6.5
Credit of the Course	4
Type of the Course	DSE-Lab
Prerequisites	Zoology course in B. Sc. degree at any central/ state/Open university level

Objectives of the Course

The course aims to provide a general insight into the biology, habits, and habitats of arthropods, which are important vectors of diseases. The course focus on the detailed study of insect vectors, including their life cycles, behavior, and the diseases they transmit

Learning outcomes

- Students will have the opportunity to observe and handle specimens of medically important insects, such as disease vectors.
- Students will gain knowledge and skills in designing, carrying out, and evaluating vector control interventions.
- Students will receive practical training in the biology and control of disease vectors and the human pathogens they transmit.

Syllabus

1. Permanent slide preparation: Different types of mouth parts, antennae, legs, wings and other body appendages, whole mounts (w.m.) of various small insects
2. Study of following insect vectors and causative agents through permanent slides/ photographs: *Anopheles, Aedes, Culex*, House fly (*Musca domestica*), Sand fly (*Phlebotomus argentipes*), Lice (*Pediculus*), Cockroaches, Fleas (*Xenopsylla cheopis*), Ticks and Mites, different stages of Plasmodium parasite in blood smear (i.e. schizont/ merozoite) and filarial worm.
3. Collection of mosquitoes species and their identification using taxonomic keys.
4. Identification of different stages of mosquitoes.
5. Collection and Identification of house fly, lice and cockroaches.
6. Collection and Identification of flea, ticks and mites.
7. Collection, Identification and recording of forensically important insects from animal cadavers.
8. Rearing/ life cycle of medically important insects.
9. Study of equipments used in collection of medically important insects.
10. Dissection and examination of mosquitoes for malaria parasite infection (Coventional and Molecular).
10. Demonstration of different stages of malaria parasite.
11. Study of different kinds of mouth parts of insects.
12. Study of different diseases transmitted by above insect vectors.

13. Experimental Designs in field and laboratory.
14. A tour to visit important centers of entomological studies.

Scheme of Examination

Internal and External of Semester Examination as per NEP scheme.

Suggested Books and References:

- Medical Entomology: A Textbook on Public Health and Veterinary Problems Caused by Arthropods. B.F. Eldridge and J.D. Edman. Springer.
- Medical Entomology for Students. Mike Service. Cambridge University Press.
- The Biology of Blood-Sucking in Insects. M. J. Lehane. Cambridge University Press.
- Handbook Of Medical Entomology. William Albert Riley. Legare Street Press.
- Elements of Entomology Dr. Rajendra Singh Publisher: Rastogi Publications

Suggested E-resources

- https://www.uou.ac.in/sites/default/files/slm/MSCZO-505(L).pdf
- https://portal.ct.gov/-/media/CAES/DOCUMENTS/Publications/Bulletins/b966b996pdf.pdf
- https://www.cdc.gov/dpdx/resources/pdf/benchAids/malaria/Malaria_Comparison_p7-8.pdf
- https://ncvbdc.mohfw.gov.in/WriteReadData/l892s/IVM-Manual-Draft-2015.pdf
- https://stacks.cdc.gov/view/cdc/7674/cdc_7674_DS1.pdf

Code of the course	ZOO9123P
Title of the course	Wildlife Biology Practical –II
Level of the Course	NHEQF Level 6.5
Credit of the Course	4
Type of the Course	DSE-Lab
Prerequisites	Zoology course in B. Sc. degree at any central/ state/Open university level

Objectives of the Course

To provide students with hands-on experience in the field of Indian wildlife, enabling them to apply practical skills in wildlife identification, habitat assessment, data collection, and conservation measures, contributing to their understanding of native flora and fauna and their conservation.

Learning outcomes

1. Species Identification: Demonstrate proficiency in identifying a variety of Indian wildlife species, including birds, mammals, reptiles, and plants, based on their physical characteristics and behaviors.
2. Field Observation Skills: Develop practical skills in conducting field observations, assessing animal behaviors, tracking signs, and documenting ecological interactions in natural habitats.
3. Habitat Assessment: Apply techniques to assess the health and suitability of wildlife habitats, understanding factors influencing species distribution and abundance.
4. Conservation Action: Contribute to conservation efforts by actively participating in wildlife monitoring, habitat restoration, and community engagement projects aimed at preserving India's biodiversity.
5. Environmental Awareness: Gain a deeper appreciation for the ecological significance of Indian wildlife, and recognize the importance of responsible interactions with nature for the benefit of present and future generations.

Syllabus

1. Spotting:
    a. **Amphibians:** The Indian burrowing frog (*Sphaerotheca breviceps*), Marbled balloon frog (*Uperodon systoma*), Marbled balloon frog (*Uperodon systoma*)
    b. **Reptiles**: Brooke's House Gecko (*Hemidactylus brookii*), Brilliant Ground Agama (*Trapelus agilis*) Fan-throated lizard (*Sitana ponticeriana*), Marsh crocodile (*Crocodylus palustris*), Python (*Python molurus*), Indian Star Tortoise (*Geochelone elegans*), Hardwick's Spiny-tailed lizard (*Saara hardwickii*). Russell's viper (*Daboia russelii*), Indian chameleon (*Chamaeleo zeylanicus*)
    c. **Aves:** Sarus crane (*Grus antigone*), Great Indian Bustard (*Choriotis nigriceps*), White-naped tit (*Machlolophus nuchalis*), Green munia

(*Amandava formosa*), Egyptian vulture (*Neophron percnopterus*), Demoiselle crane (*Grus virgo*)

d. **Mammals**: Leopard (*Panthera pardus*), Smooth-coated Otter (*Lutrogale perspicillata*), Sloth Bear (*Melursus ursinus*), Barasingha (*Rucervus duvaucelii*), Black buck (*Antilope cervicapra*), Indian Giant flying squirrel (*Petaurista philippensis*), Chinkara (*Gazella bennetii*)

e. **Flora**: Khejri (*Prosopis cineraria*),Guggal (*Commiphora wightii*), Ronj (*Acacia leucophloea*), Mahua (*Madhuca indica*), Sagwan or teak (*Tectona grandis*), Salar (*Boswellia serrata*), Tendu (*Diospyros melanoxylon*), Dhok (*Anogeissus pendula*), Rohida (*Teccomella undulata*)

f. **Equipments:** Laser range finder, clinometers, spotting scope

2. Visit to natural habitats and wildlife sanctuaries, desert, mountain range, wetland and especially Rajasthan for the detail study: Student should submit the report on the study covering major fauna, flora and geography and management of the visited field.
3. Visit to a wetland for birding and identification of threats to wetlands. Student should submit the report on the study.
4. POP preparation of pugmarks and footprints.
5. Identification of mammalian species using hair imprinting and scat analysis.
6. Determination of population density of animals using transect and random survey methods.

Scheme of Examination

Internal and External of Semester Examination as per existing CBCS scheme

Suggested Books and References:

- Katwal/Banerjee, Biodiversity conservation in managed and protected areas. Agrobios, India.
- Negi, S.S., Biodiversity and its conservation in India. Indus Publishing, Co., New Delhi.
- Anthony R.E. Sinclair, John M. Fryxell and Graeme Caughly, Wildlife Ecology, Conservation and Management, 2nd Edn. Blackwell Publishimg, U.S.A.
- Sharma, B.D. Indian Wildlife Resources, Ecology and Development. Daya Publishing House, Delhi.
- Tiwari, S.K. Zoogeography of India and Asia. CBS Publisher and Distributors, New Delhi.
- Ram Bramha Sanyal, A Handbook of the Management of Animals in Captivity.
- Hosetti, B.B., Concepts in Wildlife Management, Daya Publishing House, Delhi.
- Negi, S.S. Manual for Wildlife Management in India.
- Gopal, Rajesh, Fundamentals of Wildlife Management, Justice Home, Allahabad, India.

Suggested E-resources

- https://www.mammalsofindia.org/
- https://www.indianreptiles.org/
- https://www.birdsofindia.org/
- http://www.ecoindia.com/flora/trees/
- https://frienvis.nic.in/KidsCentre/Common-Trees-of-India_1499.aspx
- http://www.flowersofindia.net/treeid/index.html

Code of the course	ZOO9124P
Title of the course	Limnology & Fisheries Practical-II
Level of the Course	NHEQF Level 6.5
Credit of the Course	4
Type of the Course	DSE-Lab
Prerequisites	Zoology course in B. Sc. degree at any central/ state/Open university level

Objectives of the Course

To provide students with hands-on experience in applying fisheries management principles, techniques, and strategies, enabling them to develop practical skills in assessing fish populations, designing sustainable fishing practices, and contributing to responsible fisheries management and conservation efforts.

Learning outcomes

1. Fish Population Assessment: Demonstrate proficiency in applying various methods to assess fish populations, including sampling techniques and data analysis, to inform management decisions.
2. Sustainable Harvesting: Develop practical skills in designing and implementing sustainable fishing practices, considering factors such as fishing gear, catch limits, and size regulations.
3. Ecosystem Analysis: Apply ecological principles to analyze the interactions between fish populations and their aquatic habitats, considering the broader ecosystem implications of fisheries management.
4. Regulatory Compliance: Understand and interpret fisheries regulations and policies, ensuring compliance with legal frameworks and contributing to responsible resource utilization.
5. Stakeholder Engagement: Collaborate with local communities, fishermen, and fisheries managers to develop and implement effective fisheries management strategies that balance ecological preservation with socio-economic considerations.

Syllabus

1. Identification of fishes using morphometric characters, fin formula and to fill up the fish identification chart
2. Ova diameter measurement in the given sample of ovary.
3. Gut content analysis of any carp fish.
4. Dissection/Labeling of Weberian ossicles
5. Dissection/Labeling of pituitary gland.
6. Determination of fish age by scale method.
7. Identification of various major and minor carps
8. Identification of fry and fingerlings of fishes.
9. Identification and writing comments on commercially important indigenous fishes, exotic fishes, Prawns
10. Visits to various lakes, fish farms, landing centres and polluted streams for limnological and fisheries study.

Scheme of Examination

Internal and External of Semester Examination as per NEP scheme.

Suggested Books and References:

- Roy D. 2017. Freshwater fisheries management. Oxford Book Company.
- Hunter W. 2021. Fisheries management and conservation. Apple Academic Press.
- Motos L, Wilson D. 2006. The knowledge base for fisheries management: Vol 36 (Developments in Aquaculture and Fisheries Science). Elsevier Science.
- Misra RN. 2016. Fishery management. Discovery Publishing House Pvt Ltd.
- Pontecorvo G, Schrank WE. 2009. Fisheries management: Pandemic failure, workable solutions. Emerald Goup Publishing Limited.

Suggested E-resources

- https://www.fao.org/3/y3427e/y3427e03.htm
- https://nsglc.olemiss.edu/Fisheries/fishman.pdf
- http://ledhyane.lecture.ub.ac.id/files/2015/09/HartReynolds_2002-HandbookOfFishBiologyAndFisheriesVol2.pdf
- https://www.scribd.com/presentation/376287293/Fundamentals-of-Fisheries-Mgt-Ramon#

Code of the course	ZOO9125P
Title of the course	Entomology Practical-III
Level of the Course	NHEQF Level 6.5
Credit of the Course	4
Type of the Course	DSE-Lab
Prerequisites	Zoology course in B. Sc. degree at any central/ state/Open university level

Objectives of the Course

The objective of this course is to provide the knowledge of practical's of insect pest management and insecticide knowledge in entomology to teach people to analyze pest problems, determine if management is necessary, and make appropriate recommendations using IPM techniques. They also aim to familiarize people with different methods of pest management, their benefits, and limitations.

Learning outcomes

- Understanding the principles of Integrated Pest Management (IPM), which is an effective and environmentally sensitive approach to pest management that relies on a combination of common-sense practices.
- Knowing the life cycles of pests and their interaction with the environment, and using this information to manage pest damage by the most economical means, and with the least possible hazard to people, property, and the environment.
- Identifying pests accurately and monitoring their population levels.

Syllabus

1. Collection, identification and rearing of phytophagous pests.
2. Testing of Inseticides: Bioassay method.
3. Estimation of LD50 and LC 50 using insects.
4. Familiarity with techniques of appliances used for the application of insecticides.
5. Demonstration of applications of insecticides using suitable equipments: Sprayers including hand sprayers, Dusters.
6. Study of seasonal abundance of crop pests in nearby area.
7. Demonstration of effects of endocrine hormones on the development of insects.
8. Green house and insect rearing equipments.
9. Experimental Designs in field and laboratory.
10. Identification and characterization of agricultural chemicals in conventional and Nano formulations.
11. Size determination and quality of Nano formulations.
12. Demonstration of Biological control using Larvicidal fishes/ bacteria/ other biological agents
13. Serial dilution of insecticides
14. Demonstration of insecticide handling.

15. Demonstration of Insecticide resistance monitoring as per WHO guidelines.
16. Demonstration of sociality of honey bee.
17. Identification of different stages (from egg to adult) of silkworm.
18. Tools used in silk worm rearing.
19. Study of different stages of lac insects.
20. Field visit for entomological studies.

Scheme of Examination

Internal and External of Semester Examination as per NEP scheme.

Suggested Books and References:

- Textbook of Entomology By Packard,Publisher: New York, The Macmillan company; London, Macmillan and co., ltd.
- Borror and DeLong's Introduction to the Study of Insects by Norman F. Johnson and Charles A. Triplehorn (May 19, 2004)
- (3) The Insects: An Outline of Entomology by Professor P. J. Gullan and P. S. Cranston (Mar 2, 2010)
- Integrated Pest Management: Concepts, Tactics, Strategies and Case Studies Academic press.Edited by: Edward B. Radcliffe, University of Minnesota
- Introduction to Integrated Pest Management [Hardcover] Mary Louise Flint (Author), Robert van den Bosch (Author) Castner, published by Feline Press, Gainesville, FL (2000)
- A Field Guide to the Insects of North America North of Mexico Peterson Field Guide Series, Borror and White.

Suggested E-resources

- https://extension.entm.purdue.edu/landscapelab/cliffs_notes/powerpoint/general/Insect_Orders_1.pdf
- https://tmnehs.gov.in/writereaddata/Chap-14.pdf
- https://www.rlbcau.ac.in/pdf/PGCourse/Entomology/Toxicology%20of%20insecticides%20_APE506.pdf
- https://www.researchgate.net/publication/354919846_Insecticide_Toxicity_Consumption_Assessment_Methodologies_and_Safety_Issues_in_India
- https://www.researchgate.net/publication/327212384_pesticide_metabolism

Code of the course	ZOO9126P
Title of the course	Wildlife Biology Practical -III
Level of the Course	NHEQF Level 6.5
Credit of the Course	4
Type of the Course	DSE-Lab
Prerequisites	Zoology course in B. Sc. degree at any central/ state/Open university level

Objectives of the Course

To provide students with hands-on experience in conducting wildlife censuses, utilizing survey methods and data collection techniques, enabling them to develop practical skills in assessing wildlife populations and applying management strategies for conservation and sustainable resource utilization.

Learning outcomes

1 Census Techniques Proficiency: Demonstrate practical expertise in conducting wildlife censuses, applying diverse methods such as transect surveys, camera trapping, and acoustic monitoring.

2 Data Collection and Analysis: Develop skills in collecting, organizing, and analyzing wildlife census data, drawing meaningful insights about species abundance, distribution, and trends.

3 Conservation Planning: Apply census findings to formulate effective wildlife management plans, considering habitat requirements, population dynamics, and conservation priorities.

4 Ethical Considerations: Recognize ethical considerations related to wildlife censuses, addressing animal welfare and minimizing disturbance during data collection.

5 Stakeholder Collaboration: Collaborate with local communities, conservation organizations, and policymakers to communicate census results and contribute to evidence-based wildlife management decisions that promote species conservation and ecosystem health.

Syllabus

1. Spotting:
    a. **Amphibians:** Kottigehar Dancing Frog (*Micrixalus kottigeharensis*), Amboli Toad (*Beduka amboli*), Ornate Stream Toad (*Ghatophryne ornata*), Black Microhylid Frog (*Melanobatrachus indicus*), Green Tree Frog (*Ghatixalus variabilis*)
    b. **Reptiles**: Indian Skink (*Sphenomorphus indicus*), Indian Flapshell Turtle (*Lissemys punctata*), Olive Ridley Sea Turtle (*Lepidochelys olivacea*), Leatherback Sea Turtle (*Dermochelys coriacea*), Indian Pond Terrapin (*Melanochelys trijuga*)

c. **Aves:** Jerdons courser (*Rhinoptilus bitorquatus*), White-bellied heron (*Ardea insignis*), Spoon-billed sandpiper (*Calidris pygmaea*), Sociable lapwing (*Vanellus gregarius*), Forest owlet (*Athene blewitti*), Red-headed vulture (*Sarcogyps calvus*), Baer's pochard (*Aythya baeri*)
d. **Mammals**: Red-panda (*Ailurus fulgens*), Gangetic dolphin (*Platanista gangetica*), Golden langur (*Trachypithecus geei*), Hispid hare (*Caprolagus hispidus*), Indian hog deer (*Axis porcinus*), Pigmy hog (*Porcula salvania*), Dhole or Asiatic Wild Dog (*Cuon alpinus*)
e. **Equipments:** GPS, Sound meter, Binoculars.

2. Population density determination on the basis of mark re-captures technique.
3. Permanent preparation of barbs of different avian feathers.
4. To observe foraging behavior in squirrels/mice.
5. Field data import, Data export, Creating maps, geo-referencing and other related exercises using GIS software.
6. Statistical exercises.

Scheme of Examination

Internal and External of Semester Examination as per existing CBCS scheme

Suggested Books and References:

- Wild A., Soils and the Environment An Introduction. Cambridge Univer sity Press, Cambridge.
- Cunningham W.P. and Saigo B.W. Environmental Science A global concern Win. C. Brown Publishers, London.
- Goel MM. Sharma M.C. and Purohit N.K., Problems of Environment Management in India. Anupriya Publishing House, Jaipur.
- Enger E.D. and Smith B.F., Environmental Science (A study of interrelations) Win. C. Brown Pub. (Latest Edition).
- Botkin D. And Keller E. Environmental Science. Earth as a Living Planet, Keller.
- Smith RL. Ecology and Field Biology. Harper and Reo. Publishers.
- Berwick S.H. and Saharia, V.B.: The Development of international Principles and Practicals of wildlife research and Management: Asian and American Approaches Eds. Oxford Univ. Press, Delhi.
- VB. Saharia, Wildlife in India, Natraj Publishers, Dehradun.
- Ali S. and Ripley D.RA pictorial Guide to the birds of the'lndian Subcontinent. BNHS Publications.
- Prater S.H. The Book of Indian Animals, BNHS Publication.
- Sharma,VD.: Wild wonders of Rajasthan. Prakash Books, New Delhi.
- Ali S. Hand Book of Indian birds, BNHS Publications.
- Giles R.H. and Toschik: Wildlife Management Techniques. The Wildlife Society Washington D.C.
- SK Sharma. Ethno-Zoology.Himanshu Publication.Udaipur.

- A.Verma. Conserving biodiversity of Rajasthan (With emphasis on Wild Fauna and Flora) Himanshu Publication, Udaipur.
- Aaron, N.M. (1973). Wildlife ecology. W.H. Freeman Co. San Francisco, U.S.A.

Suggested E-resources

- https://www.mammalsofindia.org/
- https://www.indianreptiles.org/
- https://www.birdsofindia.org/
- http://www.ecoindia.com/flora/trees/
- https://frienvis.nic.in/KidsCentre/Common-Trees-of-India_1499.aspx
- http://www.flowersofindia.net/treeid/index.html

Code of the course	ZOO9127P
Title of the course	Limnology & Fisheries Practical-III
Level of the Course	NHEQF Level 6.5
Credit of the Course	4
Type of the Course	DSE-Lab
Prerequisites	Zoology course in B. Sc. degree at any central/ state/Open university level

Objectives of the Course

To provide students with hands-on experience in applying fish and fisheries biology concepts and techniques, enabling them to develop practical skills in fish identification, morphometric measurements, age determination, and data analysis for understanding fish populations and contributing to sustainable fisheries management.

Learning outcomes

1. Fish Identification: Demonstrate proficiency in identifying various fish species based on morphological characteristics, contributing to accurate species documentation.
2. Morphometric Analysis: Develop skills in measuring and analyzing fish morphometric parameters, enhancing the understanding of size variations and growth patterns.
3. Age Determination Techniques: Apply age determination techniques such as scale and otolith analysis to estimate fish age, contributing to population structure assessments.
4. Population Dynamics: Utilize collected data to analyze fish population demographics, growth rates, and recruitment patterns, providing insights into population dynamics.
5. Fisheries Management Insights: Interpret practical findings to make informed recommendations for sustainable fisheries management, considering factors such as stock assessments, harvesting regulations, and conservation measures.

Syllabus

1. Visit to various lakes and polluted streams.
2. Identification of common ornamental fishes and plants.
3. Fabrication of all glass aquarium.
4. Setting up and maintenance of Aquarium accessories and equipment.
5. Conditioning and packing of ornamental fishes.
6. Preparation of feed for aquarium fishes.
7. Setting up of breeding tank for live bearers, barbs, goldfish, tetras, chiclids, gouramis, fighters and catfishes.
8. Fish processing technology; information and demonstration by experts from universities and fish industry.

Scheme of Examination

Internal and External of Semester Examination as per existing CBCS scheme

Suggested Books and References:

- Khanna SS, Singh HR. 2014. Textbook of fish biology and fisheries. Narendra Publishing House.
- Burton D and Burton M. 2017. Essential fish biology: diversity, structure and function. Oxford University Press.
- Kyle HM. 2008. Biology of fishes. Biotech Books.
- Stubbs P. 2018. Essentials of fish biology. Larsen and Keller Education.
- Kumar A. 2005. Fish biology. APH Publishing Corporation.

Suggested E-resources

- https://nfdb.gov.in/PDF/Fish%20&%20Fisheries%20of%20India/1.Fish%20and%20Fisheries%20of%20India.pdf
- https://www.notesonzoology.com/india/fishery/fishery-meaning-types-and-economic-zones/646
- http://ledhyane.lecture.ub.ac.id/files/2015/09/HartReynolds_2002-HandbookOfFishBiologyAndFisheriesVol2.pdf
- https://uou.ac.in/sites/default/files/slm/MSCZO-607.pdf
- https://sciencecollegenanded.org/assets/pdf/e-content/Text%20Book%20of%20Fishery%20Science2022.pdf

DEPARTMENT OF ZOOLOGY (DETAILS OF DISSERTATION)

- In semester IV, students will be having dissertation (optional) in lieu of one DisciplineSpecific Elective (DSE) paper.
- The total contact hrs. for dissertation will be 8 hrs./week.
- The Dissertation can be completed within the department/ sister departmentsof this University/ any other approved institution.
- The students will have to submit a dissertation report as per the prescribedformat given.
- The total credits and marks for dissertation will be the same as for other DSE.The
- evaluation scheme of the Dissertation report is given in Annexure 1.

General Guidelines for Preparation of Dissertation Report

1. The students are advised to follow strictly the given guidelines to write their manuscript.
2. The front page of the report should be as per the format given.
3. The title should not contain any abbreviation and page should not be numbered.
4. Text should be in Times New Roman Font, with a font size of 12 point and spacing 1.5 on A 4 Size paper, with 1.5 inch margins throughout. Scientific names of the organisms should be in italics. Main headings (Summary, Introduction, Chapter details, Conclusions and References) should be bold type, justified and separated from the text.
5. The dissertation report must be of at least 50 to 75 pages.
6. Literature citation in the text should be cited in alphabetic order. The APAform and style of references should be followed.
7. The students are advised to publish their dissertation in the form of research articles in UGC care listed journals.

TITLE MUST BE IN CAPITAL LETTERS, SIZE 21 AND CENTERED, WITH SCIENTIFIC NAMES IN ITALICS

Dissertation Report

Submitted for the partial fulfillment of the

Degree of Master of Science

By

(Name of student)

[M.Sc. (ZOOLOGY), IV Semester]

Session

Logo of MLSU

DEPARTMENT OF ZOOLOGY MOHANLAL

SUKHADIA UNIVERSITY UDAIPUR

INSTITUTE NAME AND LOGO

Ref no.-……. Date -……..

CERTIFICATE

This is to certify that the dissertation report entitled "……..." Submitted to toward the partial fulfillment of the award of the degree of Master of Science of Zoology, from Mohanlal Sukhadia University, Udaipur (Rajasthan) India is the result of bonafide work compiled by Mr./Ms. ……. carried out under the guidance of Dr……. at ……in the academic year …… It is to certify that no part of the dissertation has been submitted for the award of any degree, diploma, fellowship or other similar titles or prized and that the work has not been published in part or full in any scientific or popular journals or magazines.

Date

Name & Signature of the supervisor

Seal of the supervisor

DECLARATION

I ……..Roll No. ……student of M. Sc. IV Semester Zoology (Session 20-) hereby declare that the dissertation entitled "……" is my own compilation. I have strictly adhered to the guidelines provided by the department for the preparation of the dissertation report.

Dated:

Name of student Signature of the Student

TABLE OF CONTENTS

MARKING SCHEME FOR DISSERTATION

M. Sc. ZOOLOGY Semester IV

S. No.		Maximum marks	Marks Obtained
1.	Dissertation Report i. Review of Literature ii. Methodology iii. Outcome	 15 10 15	
2.	Seminar	25	
3.	Viva voce	15	
4.	Internal Assessment	20	
5.	**Total Marks**	**100**	

INTERNAL ASSESSMENT

Name of Students:

S.No.	Technical Competence	Maximum Marks	Minimum Marks
1.	Review of Literature	5	
2.	Experimental Design & Skills	5	
3.	Data Interpretation/ Result Analysis	5	
4.	Attendance	5	
	GRAND TOTAL	**20**	

Date

Name & Signature of the supervisor

Seal of the supervisor