Course Structure and Syllabus

M.Sc. Zoology (2 Years)

Academic Session 2024-25 onwards

As per National Education Policy-2020

For Fourth and Fifth Years of Higher Education w.e.f. 2022-23

Credits required to enter the course-: 132
Attainment required to enter the course: Bachelor Degree

Department of Zoology

CHAUDHARY CHARAN SINGH UNIVERSITY, MEERUT

M.Sc. Zoology (2 Year Programme) Course Structure

Semester VII

Course Codes	Paper Title	Core Compulsory/elective/Value added	Theory/ Practical	Credit	Max. Marks
B050701T	**I.** Evolutionary and Taxonomic Approaches	Core compulsory	Theory	4	100
B050702T	**II.** Animal Diversity- Non-Chordata	Core compulsory	Theory	4	100
B050703T	**III.** Biochemistry	Core compulsory	Theory	4	100
B050704T	**IV**. Cell and Molecular Biology	Core compulsory	Theory	4	100
B050705P	**Practical** (Based on Evolution, Non- Chordata, Biochemistry, Cell and Molecular Biology)	Core compulsory	Practical	4	100
	Minor elective (other Faculty)	Elective	Theory	4	100

Semester VIII

Course Codes	Paper Title	Core Compulsory/elective/Value added	Theory/ Practical	Credit	Max. Marks
B050801T	**V.** Environmental & Wildlife Biology	Core compulsory	Theory	4	100
B050802T	**VI.** Animal Diversity- Chordata	Core compulsory	Theory	4	100
B050803T	**VII**. Animal Physiology	Core compulsory	Theory	4	100
B050804T	**VIII.** Animal Behavior	Core compulsory	Theory	4	100
B050805P	**Practical** (Environmental Biology, Chordata, Animal Physiology and Animal Behavior)	Core compulsory	Practical	4	100
B050806R	**Research project**- Literaturereview/Question formulation	Core compulsory	Project	4	100

Semester IX

Course Codes	Paper Title	Core Compulsory/elective/Value added	Theory/ Practical	Credit	Max. Marks
B050901T	Genetics & Biostatistics	Core compulsory	Theory	4	100
B050902T	Developmental Biology	Core compulsory	Theory	4	100
B050903T to B050913T	Specialization paper 1 **(opt from pool of specialization from Table A)**	Core compulsory	Theory	4	100
B050903T to B050913T	Specialization paper 2 **(opt from pool of specialization from Table A)**	Core compulsory	Theory	4	100
B050915T	**Practical** (Based on Genetics & Biostats Developmental Biology and Specialization paper 1&2	Core compulsory	Practical	4	100

Semester X

Course Codes	Paper Title	Core Compulsory/elective/Value added	Theory/ Practical	Credits	Max. marks
B051001T	Economic & Applied Zoology	Core compulsory	Theory	4	100
B051002T	Biological Techniques & Biotechnology	Core compulsory	Theory	4	100
B051003T to B051013T	Specialization paper 3 **(opt from pool of specialization from Table A)**	Core compulsory	Theory	4	100
B051004T to B051014T	Specialization paper 4 **(opt from pool of specialization from Table A)**	Core compulsory	Theory	4	100
B051014P	**Practical** (Based on Economic & Applied Zoology, Biological Techniques & Biotechnology and Specialization paper 1&2	Core compulsory	Practical	4	100
B051016R	Research project- Dissertation writing & assessment	Core compulsory	Project	4	100

- **In 9th and 10th semester, students would opt for one of the six specializations (A/B/C/D/E/F) as listed below. The choice of specialization being offered by department/institute/college.**

TABLE: A- Specializations offered in IX and X semesters

Group	Name of Specialization	Offered in Semester	Paper code	Course Titles (credit)	Theory	credits
A	Parasitology	9	B050903T	Biology of Parasites – I (Protozoa,Trematoda and Cestoda)	Theory	4
			B050904T	Biology of Parasites – II (Nematoda, Acanthocephala and Arthropoda)	Theory	4
		10	B051003T	Physiology and Biochemistryof Parasites	Theory	4
			B051004T	Immunoparasitology	Theory	4
B	Fish and fisheries	9	B050905T	General Fish Biology	Theory	4
			B050906T	Morphology and Physiology	Theory	4
		10	B051005T	Fish Culture and Limnology	Theory	4
			B051006T	Applied Fisheries	Theory	4
C	Endocrinology	9	B050907T	General Endocrinology	Theory	4
			B050908T	Neuro Endocrinology	Theory	4
		10	B051007T	Vertebrate Endocrinology	Theory	4
			B051008T	Reproductive Endocrinology	Theory	4
D	Cell Biology	9	B050909T	Advanced Cell Biology	Theory	4
			B050910T	Chromosome and Genomic Organization	Theory	4
		10	B051009T	Genomic Analysis and Immune Genetics	Theory	4
			B051010T	Human and Microbial Cytogenetics and Molecular Biology	Theory	4
E	Entomology	9	B050911T	General Insect Biology	Theory	4
			B050912T	Anatomy and Physiology of Insects	Theory	4
		10	B051011T	Applied Entomology I	Theory	4
			B051012T	Applied Entomology II	Theory	4

F	Chronobiology	9	B050913T	Chronobiology	Theory	4
			B050914T	Photoperiodism and Seasonal Breeding	Theory	4
		10	B051013T	Neuroendocrine Control of Behavior	Theory	4
			B051014T	Applied Chronobiology	Theory	4

Subject prerequisite

To study Zoology in Post graduate program, student must have studied Zoology in 1st, 2nd and 3rd year of BSc.

Programme Objectives (POs)

1. The Programme has been designed in such a way so that the students get the flavor of both classical and modern aspects of Zoology/Animal Sciences Students are appraised about knowledge of evolution of life and the fundamentals of animal science. They are able to understand complex interactions among living organisms at organisational level.
2. The ultrastructure of cell as a functional unit of life with integral knowledge of complexity oflife is understood by students.
3. Students are sensitized to the environment and related issues. A hand on training on techniques helps students make a choice for career.
4. Skill-based training and hand on training to acquire understanding of biodiversity.
5. Students get aware of their own health and are able to mitigate lifestyle disorders through a better understanding of circadian rhythms.

M.Sc. I	**PSO1**	To empower the students with inquisitive thinking about life and lifeapproaches.
	PSO 2	To analyze the mechanisms involved in life processes up to the molecularlevel.
	PSO 3	To inculcate research specific culture among students.
	PSO 4	To perform the analytical experiments in various fields of biologicalscience.
M.Sc. II	**PSO1**	Capable of identifying scientific questions and potential research areas inZoology.
	PSO 2	To identify a research problem and to formulate a scientific solution.
	PSO 3	In-depth understanding of biodiversity and the challenges to the nation in conservation of wildlife.
	PSO 4	Understand and analyze the ecological and evolutionary significance of different taxa of animals.

Programme/ Class: M. Sc.	Year: Fourth; Subject: ZOOLOGY	Semester: Seventh
Course Code: **B050701T**	**Course Title: Evolutionary and Taxonomic Approaches**	

Course outcomes:

At the end of this course the students will be able to:

1. Understand the principles and methods of taxonomy
2. Understand the evolution of life, Homology and Analogy phylogeny of animals.
3. Students be aware of approaches to study Paleontology i.e. Fossils and its significance
4. To acquire knowledge on the taxonomic status of various animal groups
5. Understand the Origin and development of animals and the Geological time scale

Credits: 4	Core: Compulsory	
Max. Marks: 30+70	Min. Passing Marks: 40% of MM	

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P:3-0-2

Unit	**Topics**	**Total No. of Lectures (60)**
I	Science of taxonomy- Definition, concepts, history, scope and application of biosystematics Zoological Classification – Theories of biological, hierarchies of categories and the higher taxa. Principles, applications and origin of code. Rules of Zoological nomenclature (ICZN),	12
II	Behavioral taxonomy, cytotaxonomy and molecular taxonomy. Concept of Species – Species category, different concepts and intraspecific categories	12
III	Micro and Macro Evolution, Adaptive Radiation and Modification. Fossil & Fossilization. Evolution of Man.	12
IV	Abiotic and Biotic Evolution. Theories of Organic Evolution.Distribution of Animals with Space and Time. Isolating Mechanism. Speciation, Convergent Evolution, Sexual Selection, Natural Selection and Genetics of natural selection.	12

V	Molecular Evolution: Concepts of neutral evolution, molecular divergence and molecular clocks; origin of newgenes and proteins; gene divergence	12
Course prerequisites:	To study this course, a student must have had the subject Zoology BSc 3rd year	
Suggested Continuous Evaluation Methods:	Total Marks: 30 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks Class performance/Participation/ Quiz: 10 Marks	
Suggested Readings:	1.An Introduction to Taxonomy by TC Narendaran: Publisher: ZSI, India- free online on http://faunaofindia.nic.in/PDFVolumes/spb/041/index.pdf 2. Principles of Animal Taxonomy by GG Simpson. Publisher:Columbia University Press 3.Principles of Systematic Zoology by Ernst Mayr & AD Peter. Publisher: McGraw-Hill 4.Theory and Practice of Animal Taxonomy by VC Kapoor. Publisher: Oxford & IBH Publishing Co Pvt. Ltd. 5. 5.Evolution:Principals & Processes by Brian k Hall. Publisher: Jones & Bartlett 6.Evolution: Above the species level by Rensch. Publisher:Columbia University 7.Evolution by MW Strickberger. Publisher: Jones & Bartlett 8. Introduction to Evolution by PA Moody. Publisher: Riper & Brothers	
	Practicals based on Evolutionary and Taxonomic approaches • Analogy & Homology • Adaptive Radiations • Fossils, their models & Videos • Convergence & Divergence • Dichotomous Key through an example • Techniques of Animal preservation • 3-D Models of human evolution https://www.biologysimulations.com/evolution https://amrita.olabs.edu.in/?sub=79&brch=16&sim=132&cnt=4 https://education.nationalgeographic.org/resource/fossil https://www.britannica.com/science/evolution-scientific-theory/Convergent-and-parallel-evolution	

Programme/Class: M. Sc.	Year: Fourth; Subject: ZOOLOGY	Semester: Seventh
Course Code: **B050702T**	**Course Title: Animal Diversity- Non-Chordata**	

Course outcomes:

1. At the end of this course the students will be able to:
2. Understand the Organization of invertebrate Life, Diversity and Phylogeny ofinvertebrates
3. Understand the Outline classification of Animals: Classification of animals.Understand the Levels of structural organization.
4. Analyze the evolutionary relationship of invertebrate taxa
5. To understand the adaptive radiations in early life forms.

Credits: 4	Core: Compulsory	
Max. Marks: 30+70	Min. Passing Marks: 40% of MM	

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P:3-0-2

Unit	**Topics**	**Total No.of Lectures (60)**
I	General Organization and classification ofNon chordate phyla up to order level Coelom formation, body symmetry and metagenesis in non-chordates Protozoa: locomotion and reproduction inprotozoa Porifera: skeleton and regeneration in sponges	12
II	Cnidaria: skeleton in coelenterates and coral reefs, Polymorphism Ctenophora: Affinities. Helminths: Parasitism and Parasitic adaptations	12
III	Annelida: Body segmentation and excretory system Arthropoda: Exoskeleton, Respiratory system and larval forms in crustaceans. Mollusca: Torsion and detorsion in gastropod	12
IV	Echinodermata: Skeleton and larval forms and their evolutionary significance. Hemichordata: Affinities	12
V	Minor non-coelomate phyla: Affinities of phylum Rotifer and Acanthocephalan Minor coelomate phyla: Affinities of Chaetognaths, Onychophora, Pogonophora, Phoronida and Brachiopoda.	12

Course prerequisite:	To study this course, a student must have hadthe subject Zoology BSc 3rd year	
Suggested Continuous Evaluation Methods:	Total Marks: 30 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks Class performance/Participation/ Quiz: 10 Marks	
Suggested Readings:	1. A Biology of Higher Invertebrates by WD Russel-Hunter. Publisher: McMillan Co. Ltd.,London. Animal Parasitism by CP Read. Publisher :Prentice Hall Inc., New Jersey Invertebrate structure and function by EJW Barrington. Publisher: Thomas Nelson & SonsLtd., London Invertebrates Zoology, III Edition by RDBarnes. Publisher : WB Saunders Co. Philadelphia Student text book of Zoology. Vol. I, II & IIIby AA Sedgwick. Publisher : Central Book Depot, Allahabad Text book of Zoology by TJ Parker & WA Haswell. Publisher : Macmillan Co., London 7.The Invertebrates smaller coelomate groups,Vol. V. by LH Hyman. Publisher: Mc.Graw Hill Co., New York The invertebrates, Vol. 1 Protozoa throughCtenophora by LH Hyman. Publisher: McGraw Hill Co., New York The Invertebrates. Vol. 2 Platyhelminthes and Rhynchocoela by LH Hyman. Publisher:McGraw Hill Co., New York The Invertebrates. Vol. 8 EnvironmentalAdaptations by LH Hyman. Publisher: McGraw Hill Co., New York	
	Practical based on Animal Diversity: Non-chordata • **General anatomy (Dissections / Models /Charts / Computer simulation)** (a) Earthworm (b) Prawn / *Squilla* / Crab *(c) Sepia* / *Loligo*/ *Octopus* (d) Cockroach • **Mounting (Permanent)** Material Provided or material fromdissected animals	

	Note: Only animals that are permittedby wildlife protection act, 1972 • **Identification** (a) Specimens representing all animal Phylaof Invertebrates (b) Larval forms of Platyhelminthes, Arthropoda and Echinodermata (c) Prepared slides through body sectionsfrom all Phyla	

Programme/Class: M. Sc.	Year: Fourth; Subject: ZOOLOGY	Semester :Seventh
Course code **B050703T**	**Course Title: Biochemistry**	

Course outcomes:

At the end of this course the students will be able to:

1. Acquire an understanding of chemical nature of life and life process.
2. Biological structures and importance of molecular interactions and their implication in functional aspects of life.
3. To be able to solve problems based on Biomolecules, pathways, energetics
4. Use current biochemical and molecular techniques to plan and carry out experiments.

Credits: 4	Core: Compulsory	
Max. Marks:30+70	Min. Passing Marks: 40% of MM	

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P:3-0-2

Unit	**Topics**	**Total No. of Lectures (60)**
I	Structure of molecules and chemical bonds, Stabilizing interactior (Vander Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.). Chemical structure and function of biomolecule carbohydrates, lipids, proteins, nucleic acids and vitamins.	12
II	Conformation of proteins (Ramachandran plot, secondary, tertiary and quaternary structure; domains; motif and folds), Stability of protein and nucleic acid structure. Conformation of nucleic acids(A-,B-,Z-,DNA), t-RNA micro-RNA).	12
III	Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isozymes.	12
IV	Catabolism of carbohydrates, lipids, amino acids and nucleotides Anabolic pathways: Glycogenesis, gluconeogenesis, fatty acid synthesis, cholesterol synthesis, nucleotide synthesis, synthesis of essential amino acids	12
V	Principles of biophysical chemistry (pH, buffer, reaction kinetics thermodynamics, colligative properties). Bioenergetics, oxidative phosphorylation, coupled reaction, group transfer, biological energy transducer.	12

Course prerequisite	To study this course, a student must have had the subject Zoology B. Sc 3rd year	
Suggested Continuo Evaluation Method	Total Marks: 30 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / TermPapers/Seminar: 10 Marks Class performance/Participation/ Quiz: 10 Marks	
Suggested Reading	1.A Biologists Guide to Principals and Techniques of Practical Biochemistry by K Wilson & KH Goulding 2.Basic Concepts in Biochemistry: A Student's Survival Guide by Hiram F. Gilbert. Publisher: McGraw Hill Professional 3.Biochemical Calculations by IH Segal. Publisher: John Wiley a Sons 4.Biochemistry by D Voet and JG Voet. Publisher: John Wiley & Sons. 5.Essentials of Molecular Biology.by George M Malacinski; Dav Freifelder: Publisher: Boston : Jones and Bartlett Publishers 6.Grisham. Biochemistry by RH Garret & CM Saunders. Publish College Publishers 7.Physical Biochemistry by DWH Freifelder. Publisher: Freeman Co. 8Practical Physiological Chemistry by PB Hawk. Publisher: P. Blakiston's Son & Co 9.Protein Structure and Molecular Properties by TEWH Creighto Publisher: Freeman & Co. 10.Tools of Biochemistry by TG Cooper. Publisher : Wiley	
	Practical based on Biochemistry • Biochemical qualitative tests for Proteins/ Lipids /Carbohydrates • Colorimetric quantitative estimation of Proteins &Carbohydrates • Study of Salivary amylase, enzyme action and effect of P^H and Temperature on it. • Paper & Thin Layer Chromatography • 3-D Models of amino acids and structure of proteins https://www.bbc.co.uk/bitesize/guides/z3wr2nb/revision/3 https://alevelbiology.co.uk/notes/tests-for-carbohydrates/	

	https://people.umass.edu/~mcclemen/581Carbohydrates.html https://people.umass.edu/~mcclemen/581Proteins.html https://amrita.olabs.edu.in/?brch=18&cnt=1&sim=236&sub=79https://lab-training.com/thin-layer-chromatography-tlc/ https://edu.rsc.org/practical/thin-layer-chromatography-practical-videos-16-18-students/4012270.article https://edu.rsc.org/practical/paper-chromatography-practical-videos-14-16-students/4011446.article	

Programme/Class: M. Sc.	Year: Fourth; Subject: ZOOLOGY	Semester: Seventh
Course Code: **B050704T**	**Course Title: Cell and Molecular Biology**	

Course outcomes:

At the end of this course the students will be able to:

1. Understand and explain the basics of cell biology
2. Understand the structural and functional details of the basic unit of life at the molecular level
3. Explain the new developments in molecular biology and its implications in human welfare
4. Understand cellular receptor mechanisms and cell signaling

Credits: 4	Core: Compulsory	
Max. Marks: 30+70	Min. Passing Marks: 40% of MM	

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P:3-0-2

Unit	Topics	Total No. of Lectures (60)
I	Introduction to the cell, cell theory, Ultrastructure of prokaryotic cell and eukaryotic ell organelles – Origin, structure and function of mitochondria, endoplasmic reticulum and ribosomes, Golgi complex, Endosome, (lysosomes, peroxisomes, centrosome). Cell cycle and its control systems	12
II	Bio membrane – Ultrastructure and functions, Transport across membrane. Cytoskeleton, structure and dynamics of microtubules, action filaments(microfilaments), intermediate filaments, cilia & flagella Nucleus – Nuclear envelope, nucleolus. Chromosomes (type,structure chemical composition and functions)	12

III	Prokaryotic and eukaryotic genome, fine structure of DNA, DNA Replication, DNA damage & repair Transcription & post transcriptional modifications, translation & post translational modifications, regulation of gene expression, genetic code,protein targeting, transposons	12
IV	Cell adhesion & cell junctions: cellular affinity, cell adhesion molecules (CAMS), Ca++ dependent cell-cell adhesion, Ca++independent cell-cell adhesion, cadherins, selectins, integrins, cell junctions	12
V	Cell communication: cell – cell signaling, cell surface receptors, second messenger system, kinase pathways, signaling from plasma membrane tonucleus (signal transduction)	12
Course prerequisites	To study this course, a student must have had the subject Zoology BSc3rd year	
Suggested Continuous Evaluation Methods:	Total Marks: 30 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks Class performance/Participation/ Quiz: 10 Marks	
Suggested Readings:	1. Cell & Molecular Biology by De Robertis. Publisher: EDP 2. Cell & Molecular Biology by Gerald Karp. Publisher: John Wiley 3. Cell Biology by T. D. Pollard and W. C. Earnshaw, Saunders-Elsevier Publisher: Elsevier 4. Essential of Molecular Biology by GM Malacinski. Publisher: Jones & Bartlett 5. Molecular Biology of Cell by Bruce Albert. Publisher: Taylor & Francis Inc. 6. Molecular Biology of Cell by Wilson John. Publisher: Tim Hunt 7. Molecular Biology of the Cell by Keith Roberts. Publisher: Garland Science 8. Molecular Biology of the Gene by JD Watson. Publisher: Baker Bell 9. Molecular Biology: Genes to proteins by BE Tropp. Publisher: Jones & Bartlett 10. Molecular Cell Biology by David Baltimore. Publisher: WH Freeman& Co.	

	Practical based on Cell and Molecular Biology • Study Of Cell & Cell organelles, Giant Chromosomes, DNA &its replication through Photographic Plates/ Models/ Computer simulation • Permanent slides of Mitosis & Meiosis • 3-D Models of DNA and RNA • Preparation of **(a)** slide of Onion root tip by Squash Technique tostudy stages of Mitosis (b) Slide made by Grasshopper Testis to study Stages of Meiosis (c) Slide of Buccal epithelium to observe Barr bodies Processing, fixation and Staining techniques of the treated Tissue Material http://medcell.org/histology/cell_lab.php https://study.com/academy/topic/cell-organelles.html http://vlabs.iitb.ac.in/vlabs-dev/labs/mit_bootcamp/zoology/labs/exp1/procedure.php https://cit.vfu.cz/frvs2011/?title=ukoly-cytogenetika&lang=en https://www.khanacademy.org/science/ap-biology/gene-expression-and- regulation/replication/a/molecular-mechanism-of-dna-replication https://bio.libretexts.org/Learning_Objects/Laboratory_Experiments/General_Biology_Labs/BIOL_1107%3A_Principles_of_Biology_I_Lab_Manual_(Burran_and_DesRochers)/09%3A_Mitosis_and_Meiosis https://www.birmingham.ac.uk/teachers/study-resources/stem/biology/stem-legacy-mitosis.aspx https://www.leicabiosystems.com/en-in/knowledge-pathway/steps-to-better-microtomy-flotation-section-drying/	

Programme/Class: M. Sc.	Year: Fourth; Subject: ZOOLOGY	Semester :Eighth
Course Code: **B050801T**	**Course Title: Environmental & Wildlife Biology**	

Course outcomes:

At the end of this course the students will be able to:

1. Global environmental issues, their causes, consequences and amelioration.
2. To understand and identify behaviors in a variety of taxa.
3. The proximate and ultimate causes of various behaviors.
4. About the molecules, cells, and systems of biological timing systems.
5. Conceptualizing how species profitably inhabit in the temporal environment andspace out their activities at different times of the day and seasons.
6. To interpret the cause and effect of lifestyle disorders contributing to publicunderstanding of biological timing.
7. To understand the importance of wildlife conservation.

Credits: 4	Core: Compulsory	
Max. Marks:30+70	Min. Passing Marks: 40% of MM	

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P:3-0-2

Unit	Topics	Total No. of Lectures (60)
I	Environment: Introduction, Physical environment; Biotic and abiotic interactions, Concept of habitat and niche: Remote sensing and applicability of remote sensing in India	12
II	Populations Dynamic and Community ecology: Characteristics of a population: concept of metapopulation- demes and dispersal, interdemic extinctions, age structured populations. community structure and attributes, levels of species diversity and its measurement: edges and ecotones	12

III	Ecosystem and Ecological successions: Structure and function: Energy Flow, ecological energetics, Major Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, estuarine). Types: mechanisms: changes involved in succession; concept of climax	12
IV	Biogeography: Major terrestrial biomes; biogeographical zones of India Biodiversity status, monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches. Conservation biology: Principles of conservation, Environmental Impact Assessment (EIA), Environmental Management Plan (EMP), Environmental Auditing (EA), Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves)	12
V	Environmental Pollution ecology: Environmental pollution; global environmental change; sustainable development	12
Course prerequisites :	To study this course, a student must have had the subjectZoology BSc 3rd year	
Suggested Continuous Evaluation Methods:	Total Marks: 30 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / TermPapers/Seminar: 10 Marks Class performance/Participation/ Quiz: 10 Marks	
Suggested Readings:	1. The Future of Life by Edward O. Wilson. Publisher : Abacus 2.Baumgartner, population Biology by BD Elseth & KM Van. Publisher : Nostrand Co., New York 3.Ecological Applications by Colin R. Townsend. Publisher : Wiley 4.Ecological Concepts by JM Cherrett. Publisher : Blackwell Science Publication, Oxford, U.K. 5.Ecological Methodology by CJ Krebs. Publisher : Harper and Row , New York 6.Ecology by CJ Krebs. Publisher : Harper and Row, New York 7.Essentials of Ecology by Colin R. Townsend, Michael Begon & John L. Harper. Publisher: Blackwell 8.	

	Fundamentals of ecological modelling by SE Jorgensen. Publisher: Elsevier, New York. 9.Sampling Design and Statistical Methods for Environmental Biologists by RH Green. Publisher : John Wiley & Sons, NY	
	Practical based on Environmental Biology & Wildlife Biology • Measurement of climatic factors such as Temperature& relative humidity • Estimation of Temperature, P^H, Alkalinity, DO, BOD, COD, Hardness of water, soil analysis, Texture, Salinity • Numerical Problems of Population density • Determine texture of various soil samples. • A field study of any one of the habitat to be assignedto the group of students	
	• Tour Of any Wildlife sanctuary/ Park/ Reserve to study behavioural activities of animals and prepare ashort report • Projects on wildlife- a. about Ganges Dolphin. b. Migratory birds in Hastinapur Bird Sanctuary (on animals listed as endangered species). http://amrita.olabs.edu.in/?sub=79&brch=18&sim=229&cnt=1 http://amrita.olabs.edu.in/?sub=79&brch=18&sim=235&cnt=1 https://www.mpcb.gov.in/sites/default/files/water-quality/reports/LSD-NEERI- %20Water%20Quality%20Analysis.pdf https://www.shorttutorials.com/how-to-calculate-population-density/index.html	

Programme/Class: M. Sc.	Year: Fourth; Subject: ZOOLOGY	Semester: Eighth
Course Code: **B050802T**	**Course Title: Animal Diversity- Chordata**	

Course outcomes:

At the end of this course the students will be able to:

1. Understand the Organization of vertebrate Life:, Diversity and Phylogeny of vertebrates

2. Understand the Outline classification of Animals: Classification of animals. Understand the Levels of structural organization.

3. Analyze the parallel evolution of vertebrate classes

4. To understand the adaptive radiations in recent life forms.

Credits: 4	Core: Compulsory	
Max. Marks: 30+70	Min. Passing Marks: 40% of MM	

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P:3-0-2

Unit	**Topics**	**Total No. of Lectures (60)**
I	Protochordata: Origin & Evolution of Chordate, General Organization & Affinities of Larvacea. Thaliacea and Cephalochordate.	12
II	Origin and Evolution of Vertebrates General and Comparative Account of Integumentary System and Endoskeleton System	12
III	Fish: General and Special Characters. General Organization and Affinities of Ostracoderm & Coelacanthiformes Amphibia: General and Special Characters. Parental Care, Neoteny	12
IV	Reptiles: General and Special Characters. Adaptive radiation, skull, General Organization of Chelonia Birds: General and Special Characters. Flight Adaptation, Migration and Territorial Behavior	12

V	Mammals: General and Special Characters. Organization & Affinities of Prototheria. General Organization and Affinities of Marsupialia. Aquatic Mammals and their adaptations with reference to Cetacea	12
Course prerequisites	To study this course, a student must have had the subjectZoology BSc 3rd year	
Suggested Continuous Evaluation Methods:	Total Marks: 30 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / TermPapers/Seminar: 10 Marks Class performance/Participation/ Quiz: 10 Marks	
Suggested Readings:	1.Analysis of vertebrate structure. IV. Ed by Milton Hilderbrand. Publisher: John Wiley and Sons Inc., NY 2.Biology of vertebrates by HE Walter & LD Sayles. Publisher: MacMillan & Co. New York 3.Chordata Morphology by Malcom Jollie. Publisher: East – West Pres Pvt. Ltd., New Delhi. 4.Comparative anatomy of vertebrates by CG Kent. Publisher: McGraw Hill, NY 5.Evolution of Chordate Structure by H.S. Smith. Publisher: Hold Rinchart and Winstoin Inc. New York. 6.Life of vertebrates by JZ Young. Publisher: The Oxford University Press, London 7.Outlines of Comparative Autonomy of Vertebrates by JS Kingsley. Publisher: Central Book Depot. Allahabad 8.Structure and Habit in Vertebrate Evolution by GS Carter. Publisher: Sedgwick and Jackson, London 9.Students Text Book of Zoology, Vol.II by AA Sedgwick. Publisher : BiblioLife 10. Vertebrate Body, IIIrd Ed. by AS Romer. Publisher: W.B. Saunders Co., Philadelphia	

	Practical based on Animal Diversity- Chordata (a) Study of Museum specimens of animals from all Chordate groups (Protochordata to Mammals) (b) Anatomy (Models / Charts/ Computersimulation) (c) Cranial Nerves, Afferent & efferent blood vessels of any Food fish (d) Study of differences between Poisonous & Non-Poisonous snakes and Biting mechanisms (e) Flight muscles, Perching mechanism, Air sacs of Pigeon (f) Reproductive System & Neck Nerves of Rat (g) **Osteology:** Comparative study of Axial & Appendicular skeleton from Fish, Amphibia, Reptiles, Aves, Mammals. Palate in Birds, Carapace & Plastron of Turtle, skull of Mammals. (h) **Histology:** Comparative study from prepared slides of skin, Ovary, Testis, Pancreas, Liver, Brain, stomach & Intestine	
	(i) **Permanent Mounting:** Spicules of *Herdmania*, Velum of *Amphioxus*, *Doliolum, Salpa,* Different types of scales in Fish, Feathers of Bird, Ampullae of Lorenzini in skate / Rayshark. **Note:** Use of animals for Dissection/ Practical work, subjects to the condition that they are not banned underthe Wildlife Protection Act & UGC guidelines	

Programme/Class: M. Sc.	Year: Fourth; Subject: ZOOLOGY	Semester :Eighth
Course Code: **B050803T**	**Course Title: Animal Physiology & Immunology**	
Course outcomes: At the end of this course the students will be able to: 1. Apply to clinical scenarios the concepts and knowledge of the general terminology, gross anatomy, and physiology of several organ systems (integumentary, skeletal, muscular, and nervous) 2. Understand functional relationships of various organs and organ systems		
Credits: 4	Core: Compulsory	
Max. Marks:30+70	Min. Passing Marks: 40% of MM	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P:3-0-2		

Unit	**Topics**	**Total No. of Lectures (60)**
I	Digestive & Respiratory system: physiology, Digestion, absorption, BMR. Comparison of respiration indifferent species, anatomical considerations, transport of gases, exchange of gases, waste elimination, neural and chemical regulation of respiration.	12
II	Cardiovascular System and Blood circulation: Comparative anatomy of heart structure, myogenic heart, specialized tissue, ECG-its principle and significance, cardiac cycle, heart as a pump, blood pressure, neural and chemical regulation of all above. Blood corpuscles, hematopoiesis and formed elements, plasma function, blood volume, blood volume regulation, blood groups, hemoglobin, immunity, homeostasis.	12
III	Excretory and Nervous system: Comparative physiology of excretion, kidney, urine, regulation of water balance, blood volume, blood pressure, electrolyte balance, acid-base balance.Neurons, action potential, gross neuroanatomy of the brain andspinal cord, central and peripheral nervous system, Vision, hearing and tactile response.	12

IV	Reproductive Physiology- Menstrual cycle, ovulation, pregnancy, lactation, reproductive processes, Endocrine glands, basic mechanism of hormone action, hormones and diseases; neuroendocrine regulation. Thermoregulation: Comfort zone, body temperature-physical, chemical, neural regulation, acclimatization, Stress and adaptation.	12
V	Introduction of immunology, Antigen, Immunoglobins: Type and Structure, Cells of immune system, Types of immunity, Vaccines	12
Course prerequisites :	To study this course, a student must have had the subjectZoology BSc 3rd year	
Suggested Continuous Evaluation Methods:	Total Marks: 30 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks Class performance/Participation/ Quiz: 10 Marks	
Suggested Readings:	1. BRS Physiology by Linda S. Costanzo. Publisher: Lippincott Williams and Wilkins 2. Comparative Animal Physiology by CL Prosser and FA Brown. Publisher: W.B. Sanders Co. 3. Endocrine Physiology by CR Martin. Publisher: -Oxford University Press 4. Fundamentals of Human Physiology by Stuart Ira Fox. Publisher: McGraw-Hill Education - Europe 5. Ganong's Review of Medical Physiology by Brooks, Boitano and Barman. Publisher: Mc Graw Hill 6. General & comparative Endocrinology by EJW Barrington. Publisher: Oxford, Claredon Press 7. Guyton & HallTextbook of Medical Physiology by V Hall & R Kurpad. Publisher: Elsevier 8. Fundamental of Immunology by William E. Paul. Publisher: Lippincott Williams & Wilkins	

	Practical based on Animal Physiology & Immunology • Enumeration of number of RBC/ WBC by Hemocytometer/ Blood Analyzer • Estimation of Haemoglobin percentage by Haemometer • Differential leucocyte count using Leishman's Stain • Preparation of Haemin Crystals • Physiological & Endocrinological disorders through charts/ Photographic plates/ computer simulation • ABO Blood group typing (Agglutination reaction) https://labmonk.com/estimation-of-total-red-blood-corpuscles- rbc-count https://labmonk.com/estimation-of-haemoglobin-content#:~:text=The%20graduated%20tube%20is%20filled,acid%20in%20the%20graduated%20tube. https://www.labtestsguide.com/differential-leukocyte-count-dlc- test-procedure https://www.ebiologylab.com/experiments/haemin-crystals https://www.ebiologylab.com/home	

Programme/Class: M. Sc.	Year: Fourth; Subject: ZOOLOGY	Semester :Eighth
Course Code: **B050804T**	**Course Title: Animal Behaviour**	

1. Course outcomes:

At the end of this course the students will be able to:

1. Students acquire knowledge of key concepts and principles and overarching themes in animalbehavior, animal cognition, conservation psychology/biology, animal welfare science.

2. Scientific inquiry and critical thinking

3. Students learn to apply ethical standards in conducting and evaluating psychological research.

4. Students learn communication skills to disseminate research findings, and to applypsychological content and skills to a range of career goals.

Credits: 4	Core: Compulsory	
Max. Marks:30+70	Min. Passing Marks: 40% of MM	

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P:3-0-2

Unit	**Topics**	**Total No. Lectures (60)**
I	Introduction to Animal Behaviour. classification of behavioural patterns, Evolution and ultimate causation, Genetic and environmental components in the development of behaviour. Stereotyped behavior-Taxes, reflexes, instinct and motivation and Conflict behavior	12
II	Learning, memory and Communication - Definition, forms, development and mechanism of learning, neural basis of learning, memory in animals. Study of communication, messages and their meanings, the formsof signals.	12

III	Neural structures, general pattern of nervous system in animals, hormones and their role in relation to different behavioral patterns. Pheromones. Neuroendocrine control of behavior- Endocrine secretions, neuro-endocrine control mechanism in behavioral patterns. Mechano-receptor, Photo receptor, Phono receptor, Chemo receptor, Equilibrium receptor	12
IV	Environmental perceptions and social behavior- Social structures, social dominance, domestication,advantages of groupings, group selection, kin selection, altruism, reciprocal altruism, inclusive fitness, foraging, social organization in insects andprimates	12
V	Circadian and circannual rhythms; migration, orientation and navigation in animals, biological clocks and human health	12
Course prerequisite:	To study this course, a student must have had subject Zoology BSc 3rd year	
Suggested Continuous Evaluation Methods:	Total Marks: 30 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / TermPapers/Seminar: 10 Marks Class performance/Participation/ Quiz: 10 Marks	
Suggested Readings:	1. An Introduction to Animal Behavior by Aubrey Manning & Marian Stamp Dawkins. Publisher : Cambridge University Press 2. Animal Behavior: A synthesis of Ethology and Comparative Psychology by Hinde.Publisher : McGraw-Hill, NY 3. Animal behavior: An evolutionary approach by J Alcock. Publisher: Sinauer Assoc., Sunderland, Mass. USA 4. Behavioral Ecology by JR Krebs and NB Davies. Publisher : Blackwell, Oxford, U.K 5. Perspectives on Animal Behavior By Judith Goodenough, Betty McGuire, Elizabeth Jakob. Publisher: John Wiley & Sons.	

	6. Principles of Animal Communication by Bradbury & Verhrencamp. Publisher: Sinauer Assoc., Sunderland, Mass. USA Sociobiology: The New Synthesis by EO Wilson. Publisher: Harvard Univ. Press, Cambridge, Mass. USA	
	Practical based on Animal Behaviour • Study Of Photo tactic response in Housefly • Chemical communication in Earthworm • Imprinting in Birds • Study of Food preferences and feeding behaviour of an insect pest • Study of learning behaviour, shock & avoidance behaviour in Rat • Territorial behavior • Conditioning relex • Communication in Bees • To study nests and nesting habits of the birds andsocial insects. • Study of circadian functions in human. https://www.youtube.com/watch?v=momNvJNpf-s https://www.youtube.com/watch?v=IysBMqaSAC8	

Programme/Class Master in Science	Year: Fifth; Subject: ZOOLOGY	Semester: Ninth
Course Code: **B050901T**	**Course Title: Genetics & Biostatistics**	
Course outcomes: At the end of this course the students will be able to: 1. acquire a broad understanding of current molecular genetics and genomics including current areasof research 2. provide hands on training on various computational tools and techniques employed in Biologicalsequence analysis; 3. acquire expertise to conduct scientific experiments with statistical validation.		
Credits: 4	Core: Compulsory	
Max. Marks: 30+70	Min. Passing Marks: 40% of MM	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P:3-0-2		

Unit	**Topics**	**Total No. of Lectures (60)**
I	Fine concept of gene, Mendelism and deviations from mendelian inheritance. Methods of gene transfer – Transformation, conjugation, transduction, bacteriophages-types: structure and morphology of T4 phage	12
II	Molecular anatomy of eukaryotic chromosomes, heterochromatin and euchromatin, sex chromosomes Special chromosomes- giant chromosomes, polytene and lampbrush chromosomes, Concept of recombination, linkage map, levels and significance of gene mapping	12

III	Population genetics – Gene pool and gene frequencies, Hardy-Weinberg law of genetic equilibrium and changes in gene frequencies. Genetic disorders – chromosomal disorders, inborn errors of metabolism, tay-sachs disease, albinism, phenylketonuria, lesch-nyhan syndrome	12
IV	Biostatistics – Basic concepts. Qualitative & Quantitative Variables, Collection, Classification, Tabulation & Presentation of data, Mean, Median, Mode, Dispersion, Standard Deviation.	12
V	Chi-square test & 't' test. Analysis of variance, Probability Distribution and normal distribution (Gaussian Distribution). ANOVA. Importance of Correlation Analysis. Types and measures of Correlation. Regression Analysis.	12
Course prerequisite:	To study this course, a student must have had the subject Zoology BSc 3rd year	
Suggested Continuous Evaluation Methods:	Total Marks: 30 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / TermPapers/Seminar: 10 Marks Class performance/Participation/ Quiz: 10 Marks	
Suggested Readings:	1.An Introduction to Modern Genetics by GH Waddington. Publisher: George Allen and Unwin Ltd., London 2.Basic Statistics by Mary B Harris. Publisher: Allyn & Becon, London Sydney 3.Genetics by MW Strickberger. Publisher: Phi Learning 4.Genetics by PK Gupta. Publisher: Rastogi Publications 5.Genetics by RJ Brooker by RJ, Mc Graw Hill Book Co., Inc., NY 6.Genetics: a conceptual approach by BA Pierce. Publisher: Mc Milan 7.Principle of Genetics by EW Sinnott, LC Dunn &T Dobzhansky. Publisher: Mc Graw Hill Book Co., Inc., NY 8.Principles of Genetics by EJ Gardner. Publisher: Wiley Eastern (Pvt.) Ltd., New Delhi 9.The Elements of Genetics by Darlington and Mathew. Publisher: Allan & Unwip Ltd., London	

	10. Understandable statistics: Concept & Methods by CHBrase & CP Brase. Publisher: Cengage Learning	
	Practical based on Genetics and Biostatistics • Numerical problems based on Genetics and Population genetics • Pedigree analysis, Sex linked Inheritance in Man and *Drosophila* • Genetic and Chromosomal disorders through Charts/computer simulation • Types of Bacteriophages • Numerical Problems based on Biostatistics: Student'st- test, Chi square test, Probability, regression Analysis, ANOVA, Gaussian distribution. • Graphical presentation of Data • Introduction to statistical software like R and SPSS	

Programme/Class: M. Sc.	Year: Fifth; Subject: ZOOLOGY	Semester :Ninth
Course Code: **B050902T**	**Course Title: Developmental Biology**	

Course outcomes:

At the end of this course the students will be able to:

1. Understand and explain the basics of cell biology
2. Understand the structural and functional details of the basic unit of life at the molecular level
3. Explain the new developments in molecular biology and its implications in human welfare
4. Understand cellular receptor mechanisms and cell signaling

Credits: 4	Core: Compulsory	
Max. Marks:30+70	Min. Passing Marks: 40% of MM	

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P:3-0-2

Unit	**Topics**	**Total No. of Lectures (60)**
I	Theories of development: Introduction, preformation, epigenetic theory, pangenesis theory, recapitulation theory, germplasm theory, mosaic theory, regulated theory, gradient theory and theory of organizers. Regulation in sea urchin egg and *C. elegans*	12
II	Basic concepts of development: Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages: stem cells: genomic equivalence and the cytoplasmic determinants; imprinting mutants and transgenics in analysis ofdevelopment Gametes and fertilization-Spermatogenesis, oogenesis and fertilization	12
III	Early development- Cleavage and blastula, Pattern of cleavage, types of cleavage, effect of yolk on cleavage, physiology of cleavage, morula and blastula Gastrulation-Process of gastrulation. invagination, involution, infiltration, delamination and mechanisms, Accessory processesof gastrulation concrescence and convergence	12

IV	Parthenogenesis-Natural parthenogenesis, arrhenotoky, thelytoky, accidental parthenogenesis, rudimentary parthenogenesis, gynogenesis. androgenesis and significance ofparthenogenesis Body axis formation in Drosophila, Xenopus and Chick, metamorphosis in insects and amphibians, biochemical and metamorphic changes and hormonal control of metamorphosis Mechanism of regeneration in amphibian and Planaria	12
V	Teratology- Causes of abnormal development therapeutic drugsas teratogens, experimental teratology Neoplasia- Etiology, growth and differentiation of tumor cells, cell growth and oncogenesis, loss of homeostatic control, growth and invasiveness of placenta	12
Course prerequisites	To study this course, a student must have had the subjectZoology BSc 3rd year	
Suggested Continuous Evaluation Methods:	Total Marks: 30 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / TermPapers/Seminar: 10 Marks Class performance/Participation/ Quiz: 10 Marks	
Suggested Readings:	1.Biological Physics of the Developing Embryo by Gabor Forgacs. Publisher : Cambridge University Press 2.Coming to Life: How Genes Drive Development by Christiane Nusslein-Volhard. Publisher : Kales Press 3.Developmental Biology by Scott F. Gilbert. Publisher: Sinauer Associates Inc.,U.S. 4.Developmental Biology by Scott F Gilbert. Publisher: Sinauer Associates Inc. 5.Embryology at a Glance by Samuel Webster. Publisher : John Wiley & Sons 6.First the Egg by Laura Vaccaro Seeger. Publisher: Roaring Brook Press 7.From DNA to Diversity 2 ed by Sean B. Carroll. Publisher: Wiley-Blackwell 8.The Triumph of the Embryo by Lewis Wolpert. Publisher: Oxford University Press	

	9. Vertebrate Embroyology by Milnes Marshall. Publisher: G. P. Putnam's sons, NY 10. Vertebrate Embryology by Richard M. Eakin. Publisher: University of California Press	
	Practical based on Developmental Biology (Compulsory Paper) • Study of Development of Frog through slides/Specimen / Models/ Computer simulation • Study of sections through different regions of embryonic and Larval stages of Frog by permanent slides. • Study of development of Chick through permanent whole mounts of successive embryonic stages up to 96 hours (18, 20, 24, 30, 72, 96) • Study of sections through Permanent prepared slides of different regions & embryonic stages of Chick • Study the life cycle and developmental stages of C. elegans through permanent slides • Study of formalin preserved fetuses with Placenta in Humans.	

Programme/Class: Master in Science	Year: Fifth; Subject: ZOOLOGY	Semester :Tenth
Course Code: **B051001T**	**Course Title: Economic & Applied Zoology**	
Course outcomes: At the end of this course the students will be able to: 1. enter into any field of biological and biomedical research provide they have interest in animals 2. They should have good study habits, patience and perseverance. 3. should have the ability to conduct detailed work accurately and methodically.		
Credits: 4	Core: Compulsory	
Max. Marks: 30+70	Min. Passing Marks: 40% of MM	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P:3-0-2		

Unit	**Topics**	**Total No. of Lectures (60)**
I	Animal products – Fish products, dairy products, piggery, pearl, leather and wool. Domestic animals – Poultry, Cattle and Aquaculture, duck and goat farming	12
II	Apiculture, Sericulture, Lac culture, Pearl culture, Prawn culture; pests of common crops likepaddy, cotton, wheat, sugarcane, brinjal, cauliflower, mustard etc. Integrated Pest Management-Chemical and biological Control	12
III	Insect vectors of human diseases & their control (Mosquitos, lice, ticks, flies, bugs and tse – tse fly)	12
IV	Earthworm diversity: Classification, earthworm type: White worm behavior of earthworms as indicators of soil fertility, earthworms as bioreactors, earthworms and plant growth, organic matter dynamics and nutrient cycling, food and feeding habit	12
V	Vermicomposting: Advantages of vermicomposting, vermicomposting in daily life, vermiculture vs vermicomposting, Chemical composition of vermicompost, vermicomposting at home and agricultural farm, Interaction of vermicompost earthworm	12

Course prerequisites	To study this course, a student must have had the subjectZoology BSc 3rd year	
Suggested Continuous Evaluation Methods:	Total Marks: 30 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks Class performance/Participation/ Quiz: 10 Marks	
Suggested Readings:	1. Handbook of Economic Zoology by A Jawaid & SP Sinha. Publisher: S. Chand Group Publ. 2. Carp and Pond Fish Culture by Horvath, L., Tamas, G.,Seagrave, C., Wiley-Blackwell 3. Economic Zoology by KR Ravindra Nathan. Publisher:Dominant Publishers & Distributors 4. Economic Zoology by GS Shukla & VB Upadhyay. Publisher: Rastogi Publications 4. Economic Zoology 1st Edition by BS Jangi. Publisher: CRC	
	Practical based on Economic & Applied Zoology (CompulsoryPaper) • Study through Permanent slides of Common pests of (a) Paddy (b) Sugarcane (c) Cotton (d) Wheat (e) Cauliflower (f) Brinjal • Study of Life cycle of Honey Bee, Silkworm and Lac insect through simulation • Pearl Culture Technique • Physico-chemical analysis of honey. • Projects on pathogens that cause life threatening damagein Meerut and nearby areas. • Study through Permanent slides of insect vectors of human diseases (a) Cimex	

	(b) Pediculus (c) Mosquitos (d) Lice (e) Ticks • Preparation of waste mix of or vermicomposting	

Programme/Class: Master in Science	Year: Fifth; Subject: ZOOLOGY	Semester : Tenth
Course Code: **B051002T**	**Course Title: Techniques, Biotechnology & Computational Biology**	

Course outcomes:

At the end of this course the students will be able to

1. Understand the Organization of invertebrate Life, Diversity and Phylogeny of invertebrates

2. Understand the Outline classification of Animals: Classification of animals. Understand the Levels of structural organization.

3. Analyze the evolutionary relationship of invertebrate taxa

4. To understand the adaptive radiations in early life forms.

Credits: 4	Core: Compulsory	
Max. Marks: 30+70	Min. Passing Marks: 40% of MM	

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P:3-0-2

Unit	**Topics**	**Total No. of Lectures (60)**
I	Chromatography (paper, thin layer, ion exchange, GLC, HPLC), spectrophotometry, ultracentrifugation, amino acid sequencing, enzyme immobilization.	12
II	Cytometry, flow cytometry, cell fractionation; Light, Electron and Phase contrast microscopy x-ray diffraction, autoradiography, Gram staining	12
III	DNA isolation, Electrophoresis, Microinjection, Electroporation, Hybridization technology, Cloning, PCR, DNA sequencing, FISH, GISH, Chromosome walking, microarray Application of Biotechnology	12
IV	Basic concepts of genetic engineering, vectors, cell & tissue culture. DNA recombination expression in bacterial cell,	12
V	Introduction to Sequence Databases (EMBL, Gene bank). DNA Data Base of Japan (DDBJ), SWISS-PROT, Submitting sequence to	12

	Database and information retrieval through ENTREZ. Global Alignment, BLAST. Gene Prediction & Analysis.	
Course prerequisites :	To study this course, a student must have had the subject ZoologyBSc 3rd year	
Suggested Continuous Evaluation Methods:	Total Marks: 30 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks Class performance/Participation/ Quiz: 10 Marks	
Suggested Readings:	1. Bioinformatics Basics by Hooman Rashidi and Lukas K. Buehler. Publisher: CRC Press /Taylor & Francis Group 2. Bioinformatics Sequence & Genome Analysis by Davit W Moont. Publisher: Cold Spring Harbor Laboratory Press 3. DNA Cloning – A Practical approach by DM Glover & BD Hames. Publisher: Oxford University Press, UK 4. Double Helix by Nancy Werlin. Publisher: Puffin Books 5. Genomes by TA Brown. Publisher: BIOS Scientific Publishers Ltd. 6. Introduction to Bioinformatics by Arthur M Lesk. Publisher: Oxford University Press 7. Molecular Biotechnology by Bernard J. Glick, Jack J. Pasternak and Cheryl L. Patten. Publisher: ASM Press, Washington DC 8. Molecular Cloning – a laboratory manual (Vol. 1-3) by J Sambrook and DW Russell. Publisher: Cold Spring Harbor Laboratory Press, NY 9. Principles of Gene Manipulation & Genomics by Primrose and Twyman. Publisher: Blackwell Publishing, Oxford & Australia 10. The Biotech Century by Jeremy Rifkin. Publisher: Penguin Publishing Group	

Practical based on Biological Techniques and Biotechnology (Compulsory Paper)

- Study Of Principle of Light, Electron and Phase contrast Microscopy
- Isolation of DNA
- SDS PAGE Electrophoresis and Agarose Gel electrophoresis
- Quantification Of Nucleic acid
- PCR
- Southern, Northern, Western Blotting
- BLAST
- NCBI – Gene prediction & Analysis
- Instruments/ Equipment's to be demonstrated
  (a) Ultra-centrifuge
  (b) Spectrophotometer
  (c) Gel documentation Unit
- HPLC / GLC/ Ion exchange Chromatography

https://vlab.amrita.edu/?sub=3&brch=187&sim=323&cnt=1
https://www.umassmed.edu/cemf/whatisem/
https://www.unl.edu/ncmn-cfem/xzli/em/em.htm
https://www.brainkart.com/
https://www.youtube.com/watch?v=lfpYBM25Qsc
https://www.creativebiomart.net/blog/principle-and-protocol-of-sodium-dodecyl-sulphate-polyacrylamide-gel-electrophoresis-sds-page/
https://www.technologynetworks.com/analysis/articles/agarose-gel- electrophoresis-how-it-works-and-its-uses-358161

https://www.youtube.com/watch?v=yxNF17mKqws
https://www.qiagen.com/us/knowledge-and-support/knowledge-hub/bench-guide/dna/analysing-dna/quantification-of-dna
https://www.khanacademy.org/science/ap-biology/gene-expression- and-regulation/biotechnology/a/polymerase-chain-reaction-pcr https://www.khanacademy.org/science/ap-biology

Specializations offered in 9th Semester

Programme/Class: Master in Science	Year: Fifth; Subject: ZOOLOGY	Semester :Ninth
Course Code: **B050903T**	**Course Title: Biology of Parasites – I (Protozoa, Trematoda and Cestoda)**	
Course outcomes:		
Credits: 4	Core: Compulsory	
Max. Marks:30+70	Min. Passing Marks: 40% of MM	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P:3-0-3		
Unit	**Topics**	**Total No. of Lectures (60)**
I	Animal Associations & Categories: Introduction. Basic Principles & Concepts. Symbiosis, Parasitism, Commensalisms. Types of Parasites, Parasitic Adaptation: Evolution of Parasitism, Fate of Parasites.	12
II	Host parasite Relationship: Host specificity: (molecular approach), (Endoparasite: 1. Larval stages parasitic & adult free living: ii. Adult parasitic & larval stages free living)}- Action of Parasite upon their Host- (Effects of parasites on invertebrates, Effects of parasites on Vertebrates)	12
III	Parasitic Protozoa: Introduction, General Classification; *Trypanosoma gambiense. Leishmania donovani*	12
IV	Trematoda: Introduction, General Classification, Types of Trematodes, Larval forms Trematoda: Blood flukes (*Schistosoma haematobium, S, mansoni & S. japonicum)*	12
V	Cestoda: Biology of cestodes. General Classification Cestoda: Larval forms. *Echinococcus granulosus,*	12
Course prerequisites:	To study this course, a student must have had the subjectZoology BSc 3rd year	

Suggested Continuous Evaluation Methods:	Total Marks: 30 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / TermPapers/Seminar: 10 Marks Class performance/Participation/ Quiz: 10 Marks	
Suggested Readings:	1. Biochemical Adaptation in Parasites by C Bryant & C Behm. Publisher: Chapmann & Hall, NY 2. Biology of Echinicoccus and Hydatid Disease by RCA Thompson. Publisher : George Allen & Unwin, London 3. Biology of Eucestoda by C Armes & PW Pappas. Publisher : Academic Press London 4. General Parasitology by TC Cheng. Publisher Orlando : Academic Press 5. Handbook of Medical Protozoology by CA Hoare. Publisher : Bailliere, Tyndall & Cox, London 6.Perspective in Trypanosomiasis Research by JR Barker.Publisher: John Wiley, UK 7.Systema Helminthum I: Digenetic Trematodes by S Yamaguti. Publisher : Interscience Publishing Co., NY 8.Systema Helminthum II: The Cestodes of Vertebrates by S Yamaguti. Publisher : Interscience Publishing Co., NY 9.Systema Helminthum IV: Monogenea & Aspidogastrea by S Yamaguti. Publisher : Interscience Publishing Co., NY 10.The Biology of Trematoda by DA Erasmus. Publisher : Edward-Arnold, London 11.The Biology of Trypanosoma & Leishmania by DH Moleneux & RW Ashford. Publisher : Taylor & Francis,London	

Programme/Class: Master in Science	Year: Fifth; Subject: ZOOLOGY	Semester :Ninth
Course Code: **B050904T**	**Course Title: Biology of Parasites – II (Nematoda, Acanthocephala andArthropoda)**	
Course outcomes:		
Credits: 4	Core: Compulsory	
Max. Marks:30+70	Min. Passing Marks: 40% of MM	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P:3-0-3		
Unit	**Topics**	**Total No. of Lectures (60)**
I	Nematode- Body organization. Classification. life cycle pattern, Parasitic Adaptation. Nematology: Introduction, General Morphology, Economic importance, Types of Plant nematodes, Host Range	12
II	Family - *Ancyclostomatidae: Ancylostoma duodenale* Family- Filaridae: *Wuchereria bancrofti:* Morphology, epidemiology and control of life-cycle	12
III	Techniques in Nematology: Methods of sampling (samples), Methods of extracting nematodes from soil & plant samples, Methods of processing nematodes for observation, Plant Nematode Relationship: Host parasite relationship, Interaction with other microorganism Root knot and Cyst Nematodes. Brief Structure. Life Cycle. Epidemiology. Pathogenicity and Control.	12
IV	Acanthocephala - General Organization and Classification	12
V	Medically Important Insects: Arthropods and vectors of human diseases (mosquitoes, lice, flies and ticks); Mode of transmission of pathogens by vectors. Insects carrying Vesication. Urtication and Venomization	12
Course prerequisites:	To study this course, a student must have had the subjectZoology BSc 3rd year	

Suggested Continuous Evaluation Methods:	Total Marks: 30 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / TermPapers/Seminar: 10 Marks Class performance/Participation/ Quiz: 10 Marks	
Suggested Readings:	1.Handbook of Parasitology by AK Awasthi and BD Patnaik. Publisher : Dominant Publishers & Distributors India 2.Veterinary Parasitology by MA Taylor and R. L. Coop& RL Wall. Publisher : John Wiley & Sons, USA 3.Modern Parasitology: A Textbook of Parasitology by FEG Cox. Publisher : John Wiley & Sons, USA 4.Arthropod Born Diseases by Carlos Brisola Marcondes(ed.). Publisher : Springer 5.Tylenchida: Parasites of Plants and Insects by Mohammad Rafiq Siddiqi. Publisher : CABI Publishing, UK 6.Imm's General Textbook of Entomology by OW Richard & RG Davies. Publisher : Chapman & Hall, London 7.An Ecological Approach to Acanthocephalan Physiology by DWT Crompton. Publisher : Cambridge University Press 8.Nematode Parasites of Domestic Animals and man byNorman D Levine. Publisher: Burgess Publishing Co., London 9.Plant Nematology: , 2nd Edition by Roland N Perry, Maurice Moens. Publisher: CABI 10.Entomopathogenic Nematology by Randy Gaugler. Publisher: CABI	

Programme/Class: Master in Science	Year: Fifth; Subject: ZOOLOGY	Semester :Ninth
Course Code: **B050905T**	**Course Title: General Fish Biology**	
Course outcomes:		
Credits: 4	Core: Compulsory	
Max. Marks:30+70	Min. Passing Marks: 40% of MM	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P:3-0-3		

Unit	**Topics**	**Total No. of Lectures (60)**
I	Classification of Fishes with special emphasis on Berg's Scheme. Origin, Affinities, General characters and important examples of Cyclostomata, Elasmobranchii, Bradyodonti,Actinopterygii, Crossopterygii and Dipnoi. Geographical distribution of fishes, Freshwater and marine fish fauna of India. Outline classification of local Ichthyofauna	12
II	Migration in Fishes- Types of migration with examples, courses of migration, Homing, territorial behavior and schooling Locomotion in fishes- Locomotory muscles, red and white muscle types, organization of myonemes, types of swimming and hydromechanics of propulsion, significance of swim bladder in swimming and buoyancy	12
III	Body form and its diversity – Types of fins, origin of unpaired and paired fins, modifications and functions of fins; Integument and exoskeleton – Types and modifications ofScales	12
IV	Endoskeleton and musculature – Vertebral column, Types of Jaw suspension in fishes, Structure, arrangement and homology of Weberian ossicles, lateral musculature and respiratory musculature Coloration- Chromatophores, types of chromatophores. Morphological, physiological and biological significance of coloration in fishes	12

V	Adaptation in Fishes – Deep Sea adaptations, cave adaptations, hill stream fishes, freezing avoidance,symbiosis and Parasitism. Fish venoms – Poisonous Fishes, venom apparatus, Pharmacology & Toxicology of fish venoms	12
Course prerequisites:	To study this course, a student must have had the subjectZoology BSc 3rd year	
Suggested Continuous Evaluation Methods:	Total Marks: 30 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / TermPapers/Seminar: 10 Marks Class performance/Participation/ Quiz: 10 Marks	
Suggested Readings:	1.Leo.S.Berg Classification of fishes (fossilized & Recent) 2.C.B.LShrivastava, Fish Biology. 3.K.S.Mishra: An aid to classification of Fishes. 4.B.Qurashi: Identification of fishes. 5.A.J.K.Mainan: Identification of fishes	

Programme/Class: Master in Science	Year: Fifth; Subject: ZOOLOGY	Semester :Ninth
Course Code: **B050906T**	**Course Title: Morphology and Physiology**	
Course outcomes:		
Credits: 4	Core: Compulsory	
Max. Marks:30+70	Min. Passing Marks: 40% of MM	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P:3-0-3		

Unit	**Topics**	**Total No. of Lectures (60)**
I	Food, digestion and nutrition – Food and Feeding habits of different groups of fishes. Methods of determining food and feeding habits, Analysis of Gut content, alimentary canal in fishes, physiology of digestion Blood vascular system – Heart and circulatory vessels, Blood and blood forming organs, Body temperature	12
II	Respiratory system- Structure and function of gills, morphology of the gill epithelia, gaseous exchange at the gill surface, fish blood as gas carrier, water and ion transport across the gills. Air Breathing Fishes – causes, adaptation for air breathing, accessory respiratory organs, morphology and function of Pseudo branch	12
III	Excretion- Structure and function of kidney, Osmoregulatory and excretory organs, excretory products, endocrine control of excretion and Osmoregulation Nervous System & Sense Organs: Brain and Spinal Cord, Cranial and Autonomic nervous system, supporting tissues of CNS and sense organs in fishes Reproduction & development – Types of reproduction, Reproductive system, reproductive cycles and breeding season and spawning, Parental care and development	12

IV	Endocrine Glands in Fishes – Pituitary, Thyroid, Gonads, adrenal, Corpuscles of stannous, Pancreas, Ultimobranchial gland, Cells and tissues of fish immune system	12
V	Electric organs in fishes – Types of electric fishes, origin, structure and function of electric organs. Location of electric organs, evolution of electroreceptors and electric organs Luminescent organs in Fishes – Location, structure and control of luminescent organs, physiological and biological significance of luminescence	12
Course prerequisites:	To study this course, a student must have had the subjectZoology BSc 3rd year	
Suggested Continuous Evaluation Methods:	Total Marks: 30 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / TermPapers/Seminar: 10 Marks Class performance/Participation/ Quiz: 10 Marks	

Programme/Class: Master in Science	Year: Fifth; Subject: ZOOLOGY	Semester :Ninth
Course Code: **B050907T**	**Course Title: General Endocrinology**	
Course outcomes:		
Credits: 4	Core: Compulsory	
Max. Marks:30+70	Min. Passing Marks: 40% of MM	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P:3-0-3		

Unit	**Topics**	**Total No. of Lectures (60)**
I	Endocrinology: history and scope; overview of general organization of mammalian endocrine system	12
II	Hormones I- molecular aspects of synthesis, secretion and mechanism of action: synthesis of peptide hormones; synthesis of steroid hormones; synthesis of thyroid hormone; Synthesis, processing and sorting opro-hormone precursor; Sequential stages of the regulated secretary pathway; mechanism of hormone action, Pheromones	12
III	Hormones II- Hormones and diseases: diabetes, acromegaly, Addison's disease, Cushing's syndrome, Graves' disease, Hashimoto's thyroiditis, hyperthyroidism, hypothyroidism, and prolactinoma. Autoimmune diseases	12
IV	A brief overview and working principles of techniques: ELISA, Isolation of DNA and RNA, qualitative and quantitative analysis. PCR amplification and agarose electrophoresis; Protein and nucleotide sequence analysis; Basis of molecular analyses-using UV/visible, fluorescence, circular dichroism, NMR and ESR spectroscopy, Molecular structure determinationusing X-ray diffraction and NMR.	12

V	Statistical Methods: Measures of central tendency and dispersal; Sampling distribution; Difference between parametric and non-parametric statistics; Confidence Interval; Errors; Levels of significance; Regression and Correlation; t-test; ANOVA; Basic introduction to digital statisticalanalyses	12
Course prerequisites:	To study this course, a student must have had the subject Zoology BSc 3rd year	
Suggested Continuous Evaluation Methods:	Total Marks: 30 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / TermPapers/Seminar: 10 Marks Class performance/Participation/ Quiz: 10 Marks	
Suggested Readings:	1.General Endocrinology C. Donnell Turner Pub- Saunders Toppan 2.Endocrinology: An Integrated Approach; Stephen Nussey and Saffron Whitehead. Oxford: BIOS Scientific Publishers; 2001. 3. Hadley, M.E. and Levine J.E. 2007. Endocrinology, 6th Edition. Pearson Prentice-Hall, Pearson Education Inc., New Jersey	

Programme/Class: Master in Science	Year: Fifth; Subject: ZOOLOGY	Semester :Ninth
Course Code: **B050908T**	**Course Title: Neuro Endocrinology**	
Course outcomes:		
Credits: 4	Core: Compulsory	
Max. Marks:30+70	Min. Passing Marks: 40% of MM	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P:3-0-3		
Unit	**Topics**	**Total No. of Lectures (60)**
I	Basic neurobiology: Structure and properties of neurons; Propagation of nerve impulses; Synapses and its types; Neurotransmitters, Different types of neurotransmitters– catecholamines, amino acidergic and peptidergic neurotransmitters; Transmitter gated channels; G-protein coupled receptors and effectors, neurotransmitter receptors;Ionotropic and metabotropic receptors.	12
II	Hypothalamus, Pituitary gland and hypothalamo-hypophyseal axis: Structure of Hypothalamus, Pituitary gland and hypothalamo-hypophyseal axis: Overview of releasing and release inhibiting and trophic hormones. Concepts of feed-back in regulation of hormone secretion	12
III	Neural control hormone secretion: Regulation of thyroid, adrenal and gonadal secretion. Regulation of oxytocin and vasopressin.	12
IV	Hormonal regulation of behaviors: Regulation of motivational system. Control of feeding and drinking. Hormonal influence of activity behavior; neuroendocrine control of sleep.	12
V	Lactogenic hormones. Glycoprotein hormones of the POMC family, endorphins, MSH, Hypo and hyper activityof Pituitary hormones - gigantism, acromegaly, dwarfism, syndrome of inappropriate ADH secretion.	12
Course prerequisites:	To study this course, a student must have had the subjectZoology BSc 3rd year	

Suggested Continuous Evaluation Methods:	Total Marks: 30 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / TermPapers/Seminar: 10 Marks Class performance/Participation/ Quiz: 10 Marks	
Suggested Readings:	1.Brown, R. An Introduction to Neuroendocrinology. UK: Cambridge University Press, Cambridge, 1994. 2.Ader R. and Felten, D.L. Psychoneuroimmunology. UK: Academic Press, 2007. 3.DeGroot L. J. and Jameson J.L. Endocrinology. USA: Saunders Elsevier Press, 2006. 4.Endocrinology, 6th ed., Mac E. Hadley, Prentice Hall, ISBN: 0131876066 5.Vertebrate Endocrinology, 4rd ed., David O. Norris, Academic Press, ISBN 0-12-088768-1 6.Human Anatomy & Physiology, 8th ed., Elaine N. Marieb, Benjamin Cummings, ISBN: 0321694155 7.Vertebrate Endocrinology (2013, 5th Edition) by David O. Norris & James A. Carr, Academic Press (Print Book ISBN: 9780123948151; eBook ISBN: 9780123964656) – Main Textbook 8.Hormones (2014, 3rd Edition) by Anthony W. Norman & Helen L. Henry, Academic Press (Print Book ISBN: 9780123694447; eBook ISBN: 9780080919065	

Programme/Class: Master in Science	Year: Fifth; Subject: ZOOLOGY	Semester :Ninth
Course Code: B050909T	**Course Title: Advanced Cell Biology**	
Course outcomes:		
Credits: 4	Core: Compulsory	
Max. Marks:30+70	Min. Passing Marks: 40% of MM	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P:3-0-3		

Unit	**Topics**	**Total No. of Lectures (60)**
I	Cell organization Hierarchy in organization of cells Cellular organization of prokaryotes, Gram +ve and Gram –ve cell wall, Cell Membrane in prokaryotes- structure, composition,transport, quorum sensing and its importance	12
II	Cytology of microflora of thermophilic, thermoacidophile, halophilic and psychrophilic bacteria, bacteriorhodopsin, signal transduction, prebiotics Cellular organization of eukaryotes, chemistry of Bio membrane, transmembrane proteins, channel protein, pump and receptors	12
III	Electron transport system, oxidative phosphorylation, endosome, peroxisome, vesicular transport, Cell-cell interaction, cell adhesion (Ca++ independent cell- cell adhesion, Cadherins, selectin and integrin etc.) Cell junctions, cell-cell communication and its importance.	12
IV	Cell signaling, receptor, second messenger system, signaling from plasma membrane to nucleus, receptor tyrosine kinase, Ageing cells, necrosis and apoptosis (Programmed celldeath), cancer biology	12
V	Principles, working and applications of flow cytometry; ultracentrifugation; Light, SEM, TEM, Phase contrast & florescence microscopy and Fluorescence Recovery After Photobleaching (FRAP) Sterilization and Gram staining	12

Course prerequisites:	To study this course, a student must have had the subjectZoology BSc 3rd year	
Suggested Continuous Evaluation Methods:	Total Marks: 30 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / TermPapers/Seminar: 10 Marks Class performance/Participation/ Quiz: 10 Marks	
Suggested Readings:	1. Cell and Molecular biology De Robertis and De Robertis: Saunders College Publ 2. Cell and molecular biology, Karp Gerald 3. Cell and molecular biology, Thorpe 4. Molecular Cell Biology, Lodish *et al*. : Scientific American Books 5. Principles of biochemistry, Lehninger 6. The Cell, Alberts et al.: Garland Publishing, USA	

Programme/Class: Master in Science	Year: Fifth; Subject: ZOOLOGY	Semester :Ninth
Course Code: **B050910T**	**Course Title: Chromosome and Genomic Organization**	
Course outcomes:		
Credits: 4	Core: Compulsory	
Max. Marks:30+70	Min. Passing Marks: 40% of MM	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P:3-0-3		

Unit	**Topics**	**Total No. of Lectures (60)**
I	History and scope of chromosome study, Chromosomes (Ultrastructure: Nucleosome and solenoid model, nuclearscaffold). Molecular structure of telomeres (structure, synthesis and significance of telomere length) kinetochore and centromere (yeast centromere, alpha-satellite DNA, othercentromere sequences. Molecular structure of euchromatin and heterochromatin,Giant Chromosome: Polytene & Lamp brush chromosome, somatic cell genetics	12
II	Genic balance theory of sex determination (Drosophila, Lymantria and Caenorhabditis elegans), X/A ratio, multiple numerator elements, sex linked master controlgenes and autosomal regulatory genes. Sex determination and sex differentiation in mammals (including human), Dosage compensation in organism with heterogametic males, Genetic imprinting	12
III	Prokaryotic genomic organization, plasmid, phage genome, chromosomal organization of genes and non-coding DNA, mobile DNA; Eukaryotic genomic organization, molecular structure of a eukaryotic gene	12

	Reassociation kinetics and "Cot" curves (chemical complexity and kinetic complexity); Sat-DNA	
IV	Concept of totipotency vis-a-genome constancy. Amphibians: Serial nuclear transplants Development significance of fluctuations in genomic DNA content (rDNA amplification)	12
V	Automated Karyotyping Chromosome banding and chromosome paintingFISH, GISH	12
Course prerequisites:	To study this course, a student must have had the subject Zoology BSc 3rd year	
Suggested Continuous Evaluation Methods:	Total Marks: 30 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / TermPapers/Seminar: 10 Marks Class performance/Participation/ Quiz: 10 Marks	
Suggested Readings:	1. Molecular Cell Biology, Lodish et al. Scientific American Books 2. Cell and Molecular biology De Robertis and DeRobertis: Saunders College Publ 3. Molecular Biology of cell Alberts et al.: GarlandPublishing, USA 4. Genetics, Strickberger : Macmillan 5. The Science of Genetics, Atherly et al.:Saunders College Publ. NY 6. Principles of Genetics, Snustad, D.P. and M. Simmons:John Wiley & Sons, NY 7. Genetics, Brooker, R.J.:Benjamin/Cummings USA 8.Genetics, Gupta P.K.: Rastogi Publ., Meerut 9.Genetics, Farnsworth: Harper & Row 8. Principles of Genetics, Gardner, E.J., M.J., Simmons & 9. D.P. Snustad John Willey and Sons. Inc. NY	

Programme/Class: Master in Science	Year: Fifth; Subject: ZOOLOGY	Semester :Ninth
Course code **B050911T**	**Course Title: General Insect Biology**	
Course outcomes:		
Credits: 4	Core: Compulsory	
Max. Marks:30+70	Min. Passing Marks: 40% of MM	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P:3-0-3		

Unit	**Topics**	**Total No. of Lectures (60)**
I	General Principles of insect taxonomy, General characters and classification of insects up to families. Affinities of different orders of Apterygota and Pterygota with special reference to Odonata, Orthoptera, Blattaria, Mantodean, Isoptera, Thysanoptera, Hemiptera, Coleoptera, Hymenoptera, Lepidoptera and Diptera	12
II	Origin, Evolution and Distribution of insects in time andspace Ecological Dynamics, Effect of biotic and abiotic factors on abundance and diversity of insects, dispersal and migration in insects. Phylogenetic analysis; Universal tree of life; fossil recordof insects; evolution and speciation; genomes and phylogenies of insects	12
III	Methods of insect collection and their preservation. Maintenance of insect museum, Insect rearing	12
IV	Structure and function of insect integument, cuticular outgrowths, Coloration and modifications of integument, Molting	12

V	Head- Origin, structure and modification; types of mouthparts and antennae, cranial structure: tentorium andneck sclerites, Compound eye Thorax- Areas and sutures of tergum, sternum and pleuron, pterothorax; Wings: structure and modifications, venation; Legs: structure and modifications, Abdomen-Segmentationand appendages	12
Course prerequisites:	To study this course, a student must have had the subjectZoology BSc 3rd year	
Suggested Continuous Evaluation Methods:	Total Marks: 30 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / TermPapers/Seminar: 10 Marks Class performance/Participation/ Quiz: 10 Marks	
Suggested Readings:	1.Blackwelder RE. 1967. Taxonomy - A Text and Reference Book. John Wiley & Sons, New York. 2.Chapman RF. 1998. The Insects: Structure and Function.Cambridge Univ. Press, Cambridge. 3.David BV & Ananthkrishnan TN. 2004. General and Applied Entomology. Tata-McGraw Hill, New Delhi. 4.Duntson PA. 2004. The Insects: Structure, Function and Biodiversity. Kalyani Publ., New Delhi. 5.Kapoor VC. 1983. Theory and Practice in Animal Taxonomy. Oxford & IBH, New Delhi. 6.Mayr E. 1971. Principles of Systematic Zoology. Tata McGraw-Hill, New Delhi. 7.Richards OW & Davies RG. 1977. Imm's General Text Book of Entomology. 10h Ed. Chapman & Hall, London. 8.Ross HH.1974. Biological Systematics. Addison Wesley Publ. Co. 9.Snodgross RE. 1993. Principles of Insect Morphology. Cornell Univ. Press, Ithaca. 10.Triplehorn CA & Johnson NF. 1998. Borror and DeLong's Introduction to the Study of Insects	

Programme/Class: Master in Science	Year: Fifth; Subject: ZOOLOGY	Semester :Ninth
Course Code: **B050912T**	**Course Title: Anatomy and Physiology of Insects**	
Course outcomes:		
Credits: 4	Core: Compulsory	
Max. Marks:30+70	Min. Passing Marks: 40% of MM	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P:3-0-3		

Unit	**Topics**	**Total No. of Lectures (60)**
I	Anatomy and Physiology of Digestive system, Respiratory system, Circulatory system and Excretory system, Nervous system and Sense organs	12
II	Musculature, adaptations in insects, Wing couplingapparatus and mechanism of flight Bioluminescence and Sound Production	12
III	Exocrine Glands- structure and function.Endocrine Glands and their hormones. Neural control of Endocrine system in insects.Pheromones and their glands.	12
IV	Male and Female Reproductive systems and their endocrine control. Genitalia and their modifications,Vitellogenesis and hermaphroditism. Gametogenesis, Insemination, Fertilization. Early Embryonic and Embryonic Development. Post- EmbryonicDevelopment-Growth, Metamorphosis and their neural & hormonal control. Sex determination; dosage compensation; genetic control programs	12
V	Insect nutrition- role of vitamins, proteins, amino acids, carbohydrates, lipids, minerals and other food constituents;Extra and intracellular micro- organisms and their role in physiology; artificial diets	12

Course prerequisites:	To study this course, a student must have had the subject Zoology BSc 3rd year	
Suggested Continuous Evaluation Methods:	Total Marks: 30 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / TermPapers/Seminar: 10 Marks Class performance/Participation/ Quiz: 10 Marks	
Suggested Readings:	1.Chapman RF.1998. Insects: Structure and Function. ELBS Ed., London 2.Duntson PA. 2004. The Insects: Structure, Function and Biodiversity. Kalyani Publ., New Delhi 3.Kerkut GA & Gilbert LI. 1985. Comprehensive Insect Physiology, Biochemistry and Pharmacology. Vols. I-XIII. Pergamon Press, New York 4.Muraleedharan K. 1997. Recent Advances in Insect Endocrinology. Assoc. for Advancement of Entomology, Trivandrum, Kerala. 5.Patnaik BD. 2002. Physiology of Insects. Dominant, New Delhi 6.Richards OW & Davies RG. 1977. Imm's General Text Book of Entomology.10 th Ed. Vol. 1. Structure, Physiology and Development. Chapman & Hall, New York 7.Richards OW & Davies RG. 1977. Imm's General Text Book of Entomology. 10h Ed. Chapman & Hall, London 8.Saxena RC & Srivastava RC. 2007. Entomology at a Glance. Aggrotech Publ. Academy, Jodhpur 9.Triplehorn CA & Johnson NF. 1998. Borror and DeLong's Introduction to the Study of Insects 10.Wigglesworth VB.1984. Insect Physiology. 8th Ed. Chapman & Hall, New York	

Programme/Class: Master in Science	Year: Fifth; Subject: ZOOLOGY	Semester :Ninth
Course Code: **B050913T**	**Course Title: Chronobiology**	
Course outcomes:		
Credits: 4	Core: Compulsory	
Max. Marks:30+70	Min. Passing Marks: 40% of MM	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P:3-0-3		

Unit	**Topics**	**Total No. of Lectures (60)**
I	Introduction to biological clocks: astrophysical basis; Common aspects of plants and animals; historical perspective; Evolution and adaptive significance; Types of Rhythms - circadian, ultradian, and infradian rhythms. Importance of rhythms 24x7 life.	12
II	Clock system in prokaryotes/invertebrates: Clock in bacteria with example Cyanobacteria. Circadian pacemaker system in invertebrates with Drosophila as example.	12
III	Vertebrate Clock System: Suprachiasmatic nucleus (SCN) and Anatomical basis of circadian clocks in mammals and their entrainment to light. Concept of centraland peripheral clocks; Importance of time of eating.	12
IV	Molecular basis of circadian rhythms: Cell autonomous clocks; core-clock and clock-controlled genes, feedback loops; TTFL and Redox rhythms	12
V	Melatonin, sleep and healthy aging: Sleep across animal strata; structure, synthesis, secretion, and functions of melatonin, Importance of sleep to circadianrhythms. Aging, Factors affecting aging; Introduction to neurodegeneration with brief examples of Parkinson's, Alzheimer's, psychological disorders, addiction, etc.	12
Course prerequisites:	To study this course, a student must have had the subjectZoology BSc 3rd year	

Suggested Continuous Evaluation Methods:	Total Marks: 30 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / TermPapers/Seminar: 10 Marks Class performance/Participation/ Quiz: 10 Marks	
Suggested Readings:	1.Chronobiology Biological Timekeeping: Jay. C. Dunlap, Jennifer. J. Loros, Patricia J. DeCoursey (ed). 2004, Sinauer Associates, Inc. Publishers, Sunderland, MA, USA2.Insect Clocks. D.S. Saunders, C.G.H. Steel, X., afopoulou (ed.)R.D. Lewis. 2002 Barnes and Noble Inc. New York, USA 3.Biological Timekeeping: Clock, Rhythms and Behaviour, Vinod Kumar (ed. 2017)	

Programme/Class: Master in Science	Year: Fifth; Subject: ZOOLOGY	Semester :Ninth
Course Code: **B050914T**	**Course Title: Photoperiodism and Seasonal Breeding**	
Course outcomes:		
Credits: 4	Core: Compulsory	
Max. Marks:30+70	Min. Passing Marks: 40% of MM	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P:3-0-3		

Unit	**Topics**	**Total No. of Lectures (60)**
I	Photoreception: Eye; Vision (image and non-image forming vision); Extra-retinal photoreception and Pineal gland. Retinal ganglion cell (RGCs), Opsins and their types.	12
II	Photoperiod and Photoperiodic time measurement PTM: LD cycles, actograms, Phase shift, Running Period, Phase response curve (PRC). Zeitgeber, Masking and Entrainment. Models explaining PTM. PTM protocols- night break, T-cycle, and resonance cycles.	12
III	Seasonality and its regulation, Concept of seasonality, Proximate and Ultimate factors. Role of photic and non-photic cues in regulation of seasonality; Cues-principal and supplementary cues, Seasonal migration in fishes. Hibernation.	12
IV	Circannual rhythms and migration in birds: Seasonal breeding in birds, migration and its types. An Overview and Factors Affecting bird Migration; Spring and autumn migration; Orientation and navigation.	12
V	Methods to study seasonal rhythms: Locomotor activity, feeding rhythm, calculation of phase, period and amplitude; calculating PRC, consequences of LAN.	12
Course prerequisites:	To study this course, a student must have had the subjectZoology BSc 3rd year	

Suggested Continuous Evaluation Methods:	Total Marks: 30 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / TermPapers/Seminar: 10 Marks Class performance/Participation/ Quiz: 10 Marks	
Suggested Readings:	1.The Physiology of Reproduction, Vol 1 and 2, Ernst Knobil and Jimmy D. Neil, (ed), Raven Press. 2. Sturkie's Avian Physiology, 7th Ed. (Eds: Colin Scanes, Sami Dridi) eBook ISBN: 9780323853514 3. Biological Rhythms: Vinod Kumar (ed 2002) Narosa Publishing House, Delhi/ Springer-Verlag, Germany	

Specializations offered in 10th Semester

Programme/Class: Master in Science	Year: Fifth; Subject: ZOOLOGY	Semester :Tenth
Course Code: **B051013T**	**Course Title: Physiology and Biochemistry of Parasites**	
Course outcomes:		
Credits: 4	Core: Compulsory	
Max. Marks:30+70	Min. Passing Marks: 40% of MM	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P:3-0-3		

Unit	**Topics**	**Total No. of Lectures (60)**
I	Nutrition-Uptake and digestion in protozoa, Trematoda, Cestoda and Nematoda, Metabolism- Carbohydrate, metabolism and energy Nucleic acids in parasites- Composition, synthesis and catabolism	12
II	Parasitic reproduction- Asexual and sexual, reproduction, Synchronization of parasite with host reproduction, *in vitro* cultivation of parasites, Egg shell-formation in helminthes, role of mehli's glands	12
III	Excretion- Nitrogen excretion, water and ionic regulation in parasites	12
IV	Parasite transmission- Host selection, penetration and circadian rhythm. Ecology of parasitism- negative interaction, problems of escape and dispersal, problem of mate finding, niche biology, population dynamics, Growth and establishment of parasite-Hatching,establishment, site selection. migration	12
V	Nervous system and sense organs- Morphology of nervous system and sense organs, Nervous transmission, neurosecretion and behavioral coordination	12
Course prerequisites:	To study this course, a student must have had the subjectZoology BSc 3rd year	

Suggested Continuous Evaluation Methods:	Total Marks: 30 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / TermPapers/Seminar: 10 Marks Class performance/Participation/ Quiz: 10 Marks	
Suggested Readings:	1. Advances in Parasitology by B Dawes. Publisher: Academic Press, NY 2. Biochemical Parasitology by G Cooms & M North. Publisher: Taylor & Francis, London 3. Biochemistry and Molecular Biology of Parasite by JJ Marr & M Muller. Publisher: Academic Press, NY 4. Biochemistry of Parasites by Th Von Brand. Publisher: Academic Press NY 5. Chemical Physiology of Endoparasitic Animals by Th Von Brand. Publisher: Academic press, NY 6. Digestive System Physiology by PA Sanford. Publisher: Edward-Arnold, London 7. Physiology of Gastrointestinal Tract by LR Jonston. Publisher: Raven Press NY 8. Physiology of Parasite by Leslie H. Chappell. Publisher: Springer US 9. The Physiology & Biochemistry of Cestodes by JD Smyth & DP McManus. Publisher: Cambridge University Press. 10. The Physiology of Trematodes by JD Smyth & DW Halton. Publisher : Cambridge University Press.	

Programme/Class: Master in Science	Year: Fifth; Subject: ZOOLOGY	Semester :Tenth
Course Code: **B051004T**	**Course Title: Immunoparasitology**	
Course outcomes:		
Credits: 4	Core: Compulsory	

Max. Marks:30+70	Min. Passing Marks: 40% of MM	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P:3-0-3		
Unit	**Topics**	**Total No. of Lectures (60)**
I	Introduction: Early theories of immunity, historical prospective, recognition, kinds of immunity, normal immune response, types of immunity	12
II	Cells and organs of immune system: Lymphoid cells (T-lymphocytes. B-lymphocytes), null cells, mononuclear cells, granulocytic cells, mast cells, basophils, dendritic cells. Lymphoid organs of the body, thymus, bone marrow, lymph nodes spleen. GALT, MALT, CALT MHC molecules and compliments	12
III	Antigen-antibody interactions: Strength of antigen-antibody interactions, cross reactivity, precipitation reaction, agglutination reaction, parasite antigen	12
IV	Immunobiology of Protozoans: Malaria (Host response against Plasmodium infection and African sleeping sickness Immunobiology of trematodes: Immunological response against trematode infection, *Schistosomiasis, fascioliasis*, immune-diagnosis of trematodes Immunobiology of cestodes: Immunity to larval and adult cestodes, immuno-diagnosis	12
V	Vaccines: Passive immunization, active immunization, designing of vaccines for active immunization, whole organism vaccines, recombinant vector vaccines. DNA vaccines synthetic vaccines, Design of malaria vaccine	12
Course prerequisites:	To study this course, a student must have had the subjectZoology BSc 3rd year	
Suggested Continuous Evaluation Methods:	Total Marks: 30 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / TermPapers/Seminar: 10 Marks Class performance/Participation/ Quiz: 10 Marks	

Suggested Readings:	1. Fundamental of Immunology by William E. Paul. Publisher: Lippincott Williams & Wilkins 2. How helminthes alter immunity to infection by William Horsnell. Publisher: Springer 3. How the Immune System Works 4th Edition by L Sompayrac. Publisher: Willey Blackwell. 4. Immunoparasitology by Phillip Scott. Publisher: Blackwell Munksgaard 5. Immunity to Parasites: How Animal Controls Infections by D Wakelin Publisher: Edward Arnold, London 6. Immunoparasitology by André R.G. Capron. Publisher: Saunders, Philadelphia 7. In vitro cultivation of Parasitic Helminths by JD Smyth. Publisher: CRC Press, Boca Raton, USA 8. Introductory Immunology by Jeffrey K. Actor. Publisher: Academic Press 9. Malaria Immunology by P Perlmann & M Troye-Blomberg. Publisher: Karger 10. Parasite Antigens in Protection, Diagnosis and Escape by R.M.E. Parkhouse. Publisher: Springer Science & Business Media	

Programme/Class: Master in Science	Year: Fifth; Subject: ZOOLOGY	Semester :Tenth
Course Code: **B051005T**	**Course Title: Fish Culture and Limnology**	
Course outcomes:		
Credits: 4	Core: Compulsory	
Max. Marks:30+70	Min. Passing Marks: 40% of MM	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P:3-0-3		
Unit	**Topics**	**Total No. of Lectures (60)**
I	Introduction and history of fishery science in India, Inland, Marine, capture and culture fisheries, Indianfisheries. World fisheries Cultivation of fish – Freshwater fish culture in India. Types of culture systems. Bionomics and Culture of Indian major carps (Rohu, Catla, Mrigal), Exotic carps (common carp, Grass carp, Silver carp) Tilapia. Culture ofair breathing fishes (*Heteropneustes*, *Clarias, Channa* and *Anabas*)	12
II	Riverine Fisheries – Ecology and fisheries of the major river systems of India, Production and Potential of Riverine Fisheries. Reservoir Fisheries – Ecology of lakes and reservoirs, development, exploitation and management of reservoirfisheries	12
III	Cold water Fisheries – Ecology of high altitude streams, lakes and reservoirs, important cold water fisheries, present status and scope of development in India Marine capture Fisheries – Capture fisheries of Sardines, Mackerel: Bombay duck, ribbon fish, Pomfret, Tuna and Sole. Culture of pearl Oyster and Bivalves. Present status and potential of mariculture in India Crustacean Fisheries – Prawn Fisheries, lobster fisheries and crab fisheries, development and exploitation of Crustacean fishery resources	12

IV	Ecology and Productivity – of a freshwater, pond lake and river, Biota, algal blooms, benthos, macro-vegetation, nutrient cycle and productivity Pollution of aquatic ecosystems, effects of water pollution on fishes Methods of Fishing – Fishing effort, crafts and gears used in India for fishing, Recent advances in fishing methods – electrical fishing, light fishing, fish finders (echosounder and sonar) and their uses	12
V	Limnology - History and scope of Limnology – past,present and future Distribution of inland waters and their origin; Morphology and morphometry of inland waters, Light conditions, factors influencing light penetration, color, transparency and turbidity and its causes Thermal properties; annual temperature cycle in inlandwaters. Thermal stratification, its terminologies and modifications; thermal classification of inland waters andheat budget	12
Course prerequisites:	To study this course, a student must have had the subjectZoology B. Sc 3rd year	
Suggested Continuous Evaluation Methods:	Total Marks: 30 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / TermPapers/Seminar: 10 Marks Class performance/Participation/ Quiz: 10 Marks	
Suggested Readings:	1. Francis day Vol I & II Fishes of India. 2. Gopalji Shrivastava: Indian of fishes of U.P. & Bihar. 3.W.D.Rusell: Aquatic Productivity	

Programme/Class: Master in Science	Year: Fifth; Subject: ZOOLOGY	Semester :Tenth
Course Code: **B051006T**	**Course Title: Applied Fisheries**	
Course outcomes:		
Credits: 4	Core: Compulsory	
Max. Marks:30+70	Min. Passing Marks: 40% of MM	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P:3-0-3		

Unit	**Topics**	**Total No. of Lectures (60)**
I	Pisciculture – Objectives in South east Asia & India Fish Breeding and Hatchery technology – Induced Breeding and its significance in Aquaculture. Methods of Induced breeding. Types of Hatchery and their operationTypes of ponds and their management	12
II	Significance of age and growth studies; methods of age determination; types and methods of determining fish growth Length weight relationship and condition factor Fecundity: determination of absolute and relativefecundity, variations in egg production potential Characteristics of Fish eggs Marking and tagging and its significance, information derived, types of tags and materials used for preparation, evolution of performance of marks/ tags	12

III	Fish Pathology: Symptoms, etiology, Prophylaxis and treatment of common diseases of cultivable fishes. Viral, Bacterial Fungal and algal infections and their control: epizootic ulcerative syndrome. Disease caused by protozoan and helminth parasites and methods of their control Immunostimulants in Aquafarming Fish Processing Technology – Methods of Preservation of Fish and Prawn (Chilling, Freezing, Quick freezing, Salting drying, freeze drying, smoking, canning. Rigor mortis in Fish, Fish spoilage – bacterial & chemical Quality Assurance – Value added products (Fish fingers, fish flakes, soup powder) By products (Fish meal, Fish oil, surgical sutures.)	12
IV	Fish Genetics and Biotechnology: Genetic improvement (Inbreeding and cross breeding), Chromosome manipulation, Transgenic fish and shell fish. Cryopreservation Fish Nutrition and Feed technology: feed formulation strategies and methods, types of feed and their ingredients. Formulation of feed for larvae, fry, fingerlings, adults and brood stock. Formulation of nutritionally balanced and cost effective diets Ornamental fishes: Types of ornamental fishes Types of Aquarium and their accessories Aquarium maintenance	12
V	Fish Transport and marketing: Handling and transportation of freshwater fish whole sale and retailmarkets. Fishery Cooperatives Fishery education and management: Objectives and function of Central Institute of Fisheries education (CIFE, Mumbai), Central Inland Captured Fisheries Research Institute (CICFRI), Central Institute of Freshwater Aquaculture (CIFA), Central Marine Fisheries Research Institute (CMFRI, Kochi) EEZ, Indian Antarctic Expedition and relevance toFishing Fisheries legislation for resource management	12
Course prerequisites:	To study this course, a student must have had the subjectZoology BSc 3rd year	

Suggested Continuous Evaluation Methods:	Total Marks: 30 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / TermPapers/Seminar: 10 Marks Class performance/Participation/ Quiz: 10 Marks	
Suggested Readings:	1.The Perfect Aquarium: Complete Guide to Setting Up and Maintaining an Aquarium 2.Leo.S.Berg Classification of fishes (fossilized & Recent) 3.Francis day Vol I & II Fishes of India. 4.C.B.LShrivastava, Fish Biology. 5.K.S.Mishra: An aid to classification of Fishes. 6.Gopalji Shrivastava: Indian of fishes of U.P. & Bihar. 7.B.Qurashi: Identification of fishes. 8.W.D.Rusell: Aquatic Productivity. 9.A.J.K.Mainan: Identification of fishes. 10.K.F.Lagler: Icthyology. 11.N.R.Rao: An Introduction of fishes. 12.J.F.Norman: An History of fishes. 13.S.S.Khanna: An Introduction of fishes. 14.R.L.Rath: Fresh water Aquaculture. 15.H.R.Singh: Advance in fish Biodiversity. 16.H.D.Kumar: Sustainability & Management of Aquaculture & Fisheries. 17.Arugun & Natarajan: Fresh water Aquaculture. 18.Arugun & Natarajan: Santanu-Costal Aquaculture. 19.R.Sanatham: A manual of fresh water Aquaculture.	

Programme/Class: Master in Science	Year: Fifth; Subject: ZOOLOGY	Semester :Tenth
Course Code: **B051007T**	**Course Title: Vertebrate Endocrinology**	
Course out Comes:		
Credits: 4	Core: Compulsory	
Max. Marks:30+70	Min. Passing Marks: 40% of MM	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P:3-0-3		

Unit	**Topics**	**Total No. of Lectures (60)**
I	Neuroendocrine systems in vertebrates: Introduction, components, Neuroendocrine communication and regulation, functions of Neuroendocrine system and Neuroendocrine interactions	12
II	Structure and function of endocrine glands-I: thyroid and parathyroid glands- T3, T4 and catecholamines. Adrenal gland- glucocorticoids, mineralocorticoids adrenaline noradrenaline.	12
III	Structure and function of endocrine glands-II: Structure and function of pancreas- Insulin, Glucagon, leptin, Ghrelin, somatostatin. Diabetes Mellitus, Structureand function of pineal and melatonin hormone.	12
IV	Hormone hyper/ hypo secretions and related disorders: thyrotoxicosis, goiter, hypothyroidism, Graves' disease, Hashimoto's thyroiditis Hormone based effects of stress on homeostatic systems. obesity, sports “doping”.	12
V	Principles and application of techniques in endocrinology: Spectrometry, ELISA, Electrophysiology, immunocytochemistry, in situ hybridization, autoradiography.	12
Course prerequisites:	To study this course, a student must have had the subjectZoology BSc 3rd year	

Suggested Continuous Evaluation Methods:	Total Marks: 30 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / TermPapers/Seminar: 10 Marks Class performance/Participation/ Quiz: 10 Marks	
Suggested Readings:	1. Endocrinology, 6th ed., Mac E. Hadley, Prentice Hall, ISBN: 0131876066 2. Vertebrate Endocrinology, 4rd ed., David O. Norris, Academic Press, ISBN 0-12-088768-1 3. Human Anatomy & Physiology, 8th ed., Elaine N. Marieb, Benjamin Cummings, ISBN: 0321694155	

Programme/Class: Master in Science	Year: Fifth; Subject: ZOOLOGY	Semester :Tenth
Course Code: **B051008T**	**Course Title: Reproductive Endocrinology**	
Course outcomes:		
Credits: 4	Core: Compulsory	
Max. Marks:30+70	Min. Passing Marks: 40% of MM	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P:3-0-3		

Unit	**Topics**	**Total No. of Lectures (60)**
I	Comparative anatomy of male and female reproductive organs of mammals; Spermatogenesis, Oogenesis	12
II	Reproductive cycles: Estrous cycles, menstrual cycles and their hormonal regulation, Puberty, menopause, Fertilization & Implantation; Types of Placenta; parturition, lactation, Gestation; Contraception.	12
III	Mammary glands: Physiology of nursing; milk and its production; endocrinology of nursing Hormonal effects on maternal-infant bonding; effects of nursing on spacing of births. Reproductive Physiology (Including clinical correlates) Mechanism of action of hormones and receptors concerned with reproduction Neuroendocrine control of reproduction and feedback mechanism	12
IV	Reproductive Disorders: Menstrual disorders – Precocious, delayed or absent puberty; Amenorrhea Fertility disorders – Sexual dysfunction; Infertility; Spontaneous pregnancy loss Pregnancy disorders – Pre-eclampsia, IUGR (Intra-Uterine Growth restriction), Labour abnormalities	12

	Endocrine disorders – Hyperprolactinemia	
V	Reproductive Techniques & Recent Advances: Semen analysis; Ovulation induction; Oocyte retrieval; Artificial Insemination (IUI), In vitro maturation; In vitro fertilization; ICSI, GIFT etc. Cryopreservation of gametes & embryos; Vitrification Embryo hatching; Pre-implantation genetic diagnosis (PGD)	12
Course prerequisites:	To study this course, a student must have had the subjectZoology BSc 3rd year	
Suggested Continuous Evaluation Methods:	Total Marks: 30 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / TermPapers/Seminar: 10 Marks Class performance/Participation/ Quiz: 10 Marks	
Suggested Readings:	1.Ganong: Review of Medical Physiology (22"d Ed 2005, Lang Medical Publications) 2.Guyton and Hall: Text Book of Medical Physiology (l lth Ed 2006, W.B. Saunders) 3.General & Comparative Physiology 2"d Edition; William S. hoor 4.A Text Book of Animal Physiology; R. Nagabhushnam 5.Principle of Animal Physiology; D. Moyes 6.General & comparative endocrinology; E.J.W. Barrington 7.An introduction to invertebrates endocrinology; A STombes 8.Comparative endocrinology; U.S. Von Euler	

Programme/Class: Master in Science	Year: Fifth; Subject: ZOOLOGY	Semester :Tenth
Course Code: **B051009T**	**Course Title: Genomic Analysis and Immune Genetics**	
Course outcomes:		
Credits: 4	Core: Compulsory	
Max. Marks:30+70	Min. Passing Marks: 40% of MM	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P:3-0-3		
Unit	**Topics**	**Total No. of Lectures (60)**
I	C-value paradox, detailed account of various models of prokaryotic genomes, viral genome and eukaryotic genomes. Organization genes in organelle genomes. Molecular analysis of genomic DNA in yeast or any other eukaryote. Transposable elements in prokaryotes and eukaryotes.Role of transposable elements in genetic regulation. Genome analysis – Microbial genomes. Drosophila, yeast.	12
II	Genetic screening, prenatal diagnosis and genetic counseling Prenatal screening methods; fetal screening: new born screening; carrier screening; pre-implantation screening.History and methods of genetic counseling; need to seek genetic counseling, ethical and legal aspects.	12
III	Choice of mapping population: Simple sequence repeat loci, Molecular markers in genome analysis: RFLP, RAPD andAFLP analysis. Applications of Molecular markers in forensics, disease diagnosis, genetic counseling, germplasm maintenance and taxonomy.	12

IV	Immunoglobulin gene structure Multigene organization of Ig genes Mechanisms of DNA rearrangements and generation of antibody diversity DNA rearrangements and expression of T-cell receptors, DNA vaccines	12
V	DNA & RNA isolation, PCR, DNA sequencing, Southernand northern blotting for genome analysis Chromosome walking, microarray, DNA chips, Cloning Taq polymerase production by *Thermus aquaticus*	12
Course prerequisites:	To study this course, a student must have had the subjectZoology BSc 3rd year	
Suggested Continuous Evaluation Methods:	Total Marks: 30 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / TermPapers/Seminar: 10 Marks Class performance/Participation/ Quiz: 10 Marks	
Suggested Readings:	1.Molecular Cell Biology. J. Daenell, H. Lodish and D. Baltimore, Scientific American Book, Inc., USA 2.Molecular Biology of the Cell. B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts, and J.D. Watson, Garland Publishing, Inc., New York. 3.Genes, VI. Lewin, B.Oxford University Press, Oxford, New York, Tokyo. 4.Biotechnology, BD Singh 5.Biotechnology, PK Gupta 6.Recombinant DNA technology, Watson	

Programme/Class: Master in Science	Year: Fifth; Subject: ZOOLOGY	Semester :Tenth
Course Code: **B051010T**	**Course Title: Human and Microbial Cytogenetics and Molecular Biology**	
Course outcomes:		
Credits: 4	Core: Compulsory	
Max. Marks:30+70	Min. Passing Marks: 40% of MM	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P:3-0-3		

Unit	**Topics**	**Total No. of Lectures (60)**
I	Human genetics Heterokaryon-selecting hybrids and chromosomesegregation Numerical and structural abnormalities of humanchromosomes – implications, syndromes and its consequences	12
II	Bacterial transformation, transduction, conjugation,bacterial chromosomes. Bacteriophage- types, structure and morphology ofT4phage, morphogenesis. Cytogenetic effects of ionizing and non-ionizing radiation.	12
III	RNA & DNA polymorphisms, DNA replication in prokaryotic and eukaryotic cells, DNA damage and repair Transcription in prokaryotic and eukaryotic cells, RNA processing (capping, polyadenylation, splicing) The translation machinery in prokaryotes and eukaryotes,Genetic code	12

IV	Regulation of gene expression in prokaryotes and eukaryotes Post translational modification in proteins (folding, glycosylation), protein targeting (nucleus, plasma membrane, rough endoplasmic reticulum), genetics of cell cycle and cyclin dependent kinases, molecular basis of cellular check points Mode of action and structure of Diphtheria & Cholera toxin, transposones Molecular basis of neoplasia (cancer) Oncogenes and tumour suppressor genes.	12
V	x-ray diffraction, autoradiography, NMR, AA spectrophotometry Sterilization, media preparation, SDS PAGE, Gel documentation, laminar air flow hood Setting, maintenance and precautions in cytology and cytogenetics laboratory	12
Course prerequisites:	To study this course, a student must have had the subjectZoology BSc 3rd year	
Suggested Continuous Evaluation Methods:	Total Marks: 30 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / TermPapers/Seminar: 10 Marks Class performance/Participation/ Quiz: 10 Marks	
Suggested Readings:	1.Cell and molecular biology: Albert 2.Cell and molecular biology: Gerald Karp 3.Cell and molecular biology: PK Gupta 4.Cell Biology – Townsend 5.Cell physiology- Grise 6.Genes VIII: Benjamin Levi's7.Microbiology : Prescott Molecular cell biology: H. Lodish, J. Daenell, and D. Baltimore 8.Principles of Microbiology: Ronald M. Atlas and Lawrence Parks	

Programme/Class: Master in Science	Year: Fifth; Subject: ZOOLOGY	Semester :Tenth
Course Code: **B051011T**	**Course Title: Applied Entomology I**	
Course outcomes:		
Credits: 4	Core: Compulsory	
Max. Marks:30+70	Min. Passing Marks: 40% of MM	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P:3-0-3		

Unit	**Topics**	**Total No. of Lectures (60)**
I	Insect Population, Population change and factors affecting insect population. Symbiosis in relation to parasitism, commensalism and mutualism. Social adaptations in insects. Locust Phase theory- Monitoring and control measures.	12
II	Insect - plant Interaction-Theory of co-evolution. Phytophagous insects and host plant selection. Tritrophic interactions. Allelochemicals mediated interactions. Chemically mediated interactions. Defense mechanisms of plants against insects. Responses of insects to chemical defense. Establishment and adaptation of insect population on a plant. Insects as vectors of plant diseases.	12
III	Systematic position, identification, distribution, host range, bionomics, nature and extent of damage, seasonal abundance and management of insect- pests of cereals (wheat, paddy, maize), fruits (mango, guava, litchi, papaya), and vegetables (brinjal, mustard, tomato, lady's finger, spinach), sugarcane and cotton. Pests of stored grains & forests; Pests in polyhouses and protected cultivation.	12

IV	Pest outbreak- Type of pests; causes that make the insectas pest, and global factors causing pest outbreak. Natural control of insect pest with reference to climatic features, natural barriers & enemies and insect diseases,Gut analyses of predators History, principles and scope of chemical control; Insecticides/ Pesticides- Nature, chemistry, mode of action and their application. Insect resistance againstpesticides. Insect pheromones and their role in pest control; entomophagous aspects of Bt Cotton and BtBrinjal	12
V	History, principles and scope of biological control; important groups of parasitoids, predators and pathogens;Biology, adaptation, host seeking behavior of predatory and parasitic groups of insects Role of insect pathogenic nematodes, viruses, bacteria,fungi, protozoa etc., their mode of action Mass production of quality biocontrol agents- techniques, formulations, economics, field release/application and evaluation, Importation of natural enemies- Quarantine regulations	12
Course prerequisites:	To study this course, a student must have had the subjectZoology BSc 3rd year	
Suggested Continuous Evaluation Methods:	Total Marks: 30 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / TermPapers/Seminar: 10 Marks Class performance/Participation/ Quiz: 10 Marks	
Suggested Readings:	1.Burges HD & Hussey NW. (Eds). 1971. Microbial Control of Insects and Mites. Academic Press, London 2.Butani DK & Jotwani MG. 1984. Insects and Vegetables. Periodical Expert Book Agency, New Delhi 3.Chapman JL & Reiss MJ. 2006. Ecology: Principles & Applications. iCambridge. Ed. Cambridge Univ. Press, 4. De Bach P. 1964. Biological Control of Insect Pests and Weeds. Chapman & Hall, New York	

	5. Evans JW. 2004. Outlines of Agricultural Entomology. Asiatic Publ., New Delhi 6. Huffaker CB & Messenger PS. 1976. Theory and Practices of Biological Control. Academic Press, London 7. Matsumura F. 1985. Toxicology of Insecticides. Plenum Press, New York 8. Price PW. 1997. Insect Ecology. 3rd Ed. John Wiley, New York 9. Speight MR, Hunta MD & Watt AD. 2006. Ecology of Insects: Concepts and Application. Elsevier Science Publ., The Netherlands	

Programme/Class: Master in Science	Year: Fifth; Subject: ZOOLOGY	Semester :Tenth
Course Code: **B051012T**	**Course Title: Applied Entomology II**	
Course outcomes:		
Credits: 4	Core: Compulsory	
Max. Marks:30+70	Min. Passing Marks: 40% of MM	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P:3-0-3		

Unit	**Topics**	**Total No. of Lectures (60)**
I	Classification of pesticides based on chemical structure, mode of entry, action, toxicity and structure activity relationship, Mode of action and therapeutic methods for control of poisoning of chlorinated hydrocarbon, organophosphates, carbonates, natural and synthetic pyrethroids Systematic insecticides, phytotoxicity, compatibility, antagonism and synergism	12
II	Life cycle, pathogenicity and control measures of insects injurious to human beings-mosquitoes, sand flies, lice, house flies etc. Life cycle, pathogenicity and control measures of insects injurious to Livestock- Black flies, Horse flies, louse flies, Horse botflies etc.	12
III	Distinguishing features of lac-insect, silk worm and honey bees- their biology, management, principles, products, agricultural and industrial importance. Genetically modified disease resistant lac-insect, silk worm and honey bees. Regulatory laws related to release of genetically modified insects into the environment Insects as pollinator and bioindicators, Biological control of weeds using insects	12

IV	Principles of pests sampling and surveillance; database management and computer programming, simulation techniques and system analysis and modelling, Case histories of national and international programmes, their implementation, adoption and criticisms, global trade and risk of invasive pests, Genetic engineering and new technologies- their progress and limitations in IPM programmes. transgenic insects, artificial selection, transgenesis, TE vectors Para transgenesis, endosymbionts	12
V	Deployment of benevolent alien genes for pest management- case studies; scope and limitations of bio-intensive and ecological based IPM programmes. Application of IPM to farmers' real- time situations (IPM modules of important crops), Challenges, needs and futureoutlook; dynamism of IPM under changing cropping systems and climate; insect pest management under protected cultivation; strategies for pesticide resistance management. Decision making areas, cost-benefit ratio, ecological sound approaches for the insect pest control	12
Course prerequisites:	To study this course, a student must have had the subjectZoology BSc 3rd year	
Suggested Continuous Evaluation Methods:	Total Marks: 30 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / TermPapers/Seminar: 10 Marks Class performance/Participation/ Quiz: 10 Marks	
Suggested Readings:	1.Dhaliwal GS, Singh R & Chhillar BS. 2006. Essentials of Agricultural entomology. Kalyani Publ., New Delhi 2.Flint MC & Bosch RV. 1981. Introduction to Integrated Pest Management.1st Ed., Springer, New York 3. Horowitz AR & Ishaaya I. 2004. Insect Pest Management: Field and Protected Crops. Springer, New Delhi 4.Ignacimuthu SS & Jayaraj S. 2007. Biotechnology and Insect Pest management. Elite Publ., New Delhi 5.Metcalf RL & Luckman WH. 1982. Introduction of	

	Insect Pest management. John Wiley & Sons, New York 6.Norris RF, Caswell-Chen EP & Kogan M. 2002. Concepts in Integrated Pest Management. Prentice Hall,New Delhi 7.Oakeshott J & Whitten MA. 1994. Molecular Approaches to Fundamental and Applied Entomology.Springer Verlag 8.Pedigo RL. 2002. Entomology and Pest Management. 4th Ed. Prentice Hall, New Delhi 9.Rechcigl JE & Rechcigl NA. 1998. Biological and Biotechnological Control of Insect Pests. Lewis Publ., North Carolina 10.Subramanyam B & Hagstrum DW. 1995. Integrated Management of Insects in Stored Products. Marcel Dekker, NY	

Programme/Class: Master in Science	Year: Fifth; Subject: ZOOLOGY	Semester :Tenth
Course Code: **B051013T**	**Course Title: Neuroendocrine Control of Behavior**	
Course outcomes:		
Credits: 4	Core: Compulsory	
Max. Marks:30+70	Min. Passing Marks: 40% of MM	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P:3-0-3		
Unit	**Topics**	**Total No. of Lectures (60)**
I	Basic neurobiology: Using terms- Neuroscience; Neuroanatomy, Neurophysiology, and Systems Neurobiology; Structure and properties of neurons; Propagation of nerve impulses; Synapses and its types; Neurotransmitters, Different types of neurotranmitters– catecholamines, amino acidergic and peptidergic neurotransmitters; Transmitter gated channels; G-protein coupled receptors and effectors, neurotransmitter receptors; Ionotropic and metabotropic receptors.	12
II	Hypothalamus, Pituitary gland and hypothalamo-hypophyseal axis: Structure of Hypothalamus, Pituitary gland and hypothalamo-hypophyseal axis: Overview of releasing and release inhibiting and trophic hormones. Concepts of feed-back in regulation of hormone secretion	12
III	The control hormone secretion: Regulation of thyroid, adrenal and gonadal secretion. Regulation of oxytocin and vasopressin. Pancreas as exocrine and endocrine gland.	12

IV	Hormonal regulation of behaviors: Regulation of motivational system. Control of feeding and drinking. Hormonal influence of activity behavior; neuroendocrine control of sleep.	12
V	Principles and application of techniques in Neuroendocrinology: Electrophysiology, immunocytochemistry, in situ hybridization, autoradiography.	12
Course prerequisites:	To study this course, a student must have had the subjectZoology BSc 3rd year	
Suggested Continuous Evaluation Methods:	Total Marks: 30 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / TermPapers/Seminar: 10 Marks Class performance/Participation/ Quiz: 10 Marks	
Suggested Readings:	1.An Introduction to Neuroendocrinology, Brown R., (1994), Cambridge University Press, Cambridge, UK 2.Psychoneuroimmunology, Ader R, Felten D.L. and edited by Nicholas C. (4th Ed., 2007), Academic Press, UK 3.John Alcock, Animal Behaviour, Sinauer Associate Inc., USA.	

Programme/Class: Master in Science	Year: Fifth; Subject: ZOOLOGY	Semester :Tenth
Course Code: **B051014T**	**Course Title: Applied Chronobiology**	
Course outcomes:		
Credits: 4	Core: Compulsory	
Max. Marks:30+70	Min. Passing Marks: 40% of MM	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P:3-0-3		
Unit	**Topics**	**Total No. of Lectures (60)**
I	Ambulatory methods to study rhythms in humans: Ambulatory measurement of heartbeat, blood pressure, body temperature, Actigraphy, ambient lightrecording; Chronotype, MCTQ questionnaire and analysis; Continuous Glucose Monitoring CGM. Time series analysis.	12
II	Sleep and rhythms: Molecular basis of sleep regulation, Napping, sleep disorders- excessive sleepiness, poor sleep ability, sleep apnea and other sleep disorders.Functions of sleep. REM sleep. Occupational hazards ofsleep disruption- Shift work.	12
III	Human Lifestyle, health and metabolism: Sleep disruption; Disruption of clocks and cancer; Diabetes, Cardiovascular diseases. Preventing lifestyle disorders-Intermittent fasting.	12
IV	Monitoring rhythms for better health: hematological analysis; Liver function test, kidney function test, thyroid function test, cardiovascular markers-lipid profile, Introduction to biomarkers	12

V	Biological clocks in human welfare – Chronomedicine and importance of time of medication, Chronopharmacology and drug delivery; physiological benefits of yoga and exercise. Chronotherapy	12
Course prerequisites:	To study this course, a student must have had the subjectZoology BSc 3rd year	
Suggested Continuous Evaluation Methods:	Total Marks: 30 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / TermPapers/Seminar: 10 Marks Class performance/Participation/ Quiz: 10 Marks	
Suggested Readings:	1. Biologic Rhythms in Clinical and Laboratory Medicine. Touitou, Yvan; Haus, Erhard (Eds.) Springer-Verlag, 1992 2. Circadian Physiology: Roberto Refinetti, CRC Press (3rded) 2016 3. Circadian Medicine: Christopher Colwell (ed.) Wiley-Blackwell (2015)	

Programme/Class: Master in Science	**Year**: Fourth	**Semester**: Seventh
Subject: ZOOLOGY (Elective)		
Course Code:	**Course Title: Environment and Public Health**	

Course outcomes:

The student at the completion of the course will be able to:

- contribute to capacity building to limit greenhouse gases and carbon footprint.
- take up green jobs contributing to preserve the environment, eco-sensitization programmes, emerging green sectors like renewable energy etc.
- work in programmes addressing challenges of health and sanitation, epidemiology of communicable & non-Communicable diseases
- assist in strategizing for control of diseases of important public health problems.

Credits: 4	**Core:** Elective
Max. Marks: 30+70	**Min. Passing Marks:** as per rules

Unit	Topics	Total No. of Lectures (60)
I	**Environmental Toxicants**: Definition; Common environmental toxicants; Sources and their effects on life and environment; Pesticides & Harmful Chemicals: Types, uses and harmful effect of pesticides; Carcinogenic Chemicals	10
II	**Environmental Occupational Health:** Indicator & Determinants of health (Physical, Chemical & Biological) Occupational hazards: lead poisoning (plumbism), Occupational cancer, Occupational dermatitis, Radiation hazards.	12
III	**Climate Change and Implications on Public Health:** Global warming, Use of non-biodegradable materials like plastics, aerosols, refrigerants, pesticides etc.; Manifestations of Climate change on Public Health- Burning of Fossil fuels, automobile emissions and Acid rain.	12
IV	**Communicable diseases**: Mode of transmission -epidemic and endemic diseases. Infectious diseases: Role of sanitation and poverty case studies on Tuberculosis, diarrhea, Typhoid, malaria, viral diseases (Dengue, Chicken guinea, COVID-19 etc.). **Non-communicable diseases:**	14

	Role of Lifestyle and built environment. Diabetes and Hypertension.	
V	**Environmental Management Policies and Practices**: Municipal solid waste management: Definition, sources, characterization collection and transportation and disposal methods. Solid waste management system in urban and rural areas. Policies and practices with respect to Environmental Protection Act, Forest Conservation Act, Wild life protection Act, Water and Air Act, Industrial, Biomedical and E waste disposal rules.	**10**

Suggested Readings:

1. Sanjay Upadhay et all; Environmental Laws in India (Vol -I, II, III), Butterworth: NewDelhi:2004
2. Raj Punjwani, Wildlife Conservation in India, Natraj; Dehradun;2000
3. M. Zafar Mahfooz Normani, Natural resources, Law and Policy, Uppal: New Delhi-2004
4. Health Education and Community Pharmacy for First Year Diploma in Pharmacy 3rd ed. V.N. Raje, CBS
5. Textbook of Community Health Nursing I, S.D. Manivannan CBS Nursing

Course prerequisites: To study this course, a student must have had the subject biology in class/12th

Suggested Continuous Evaluation Methods:

Total Marks: 30

House Examination/Test: 10 Marks

Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks

Class performance/Participation: 10 Marks