

# *Department of Zoology*

## **Chaudhary Charan Singh University**

### **Meerut**



### **As per National Education Policy-2020**

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

Credits required to enter the course-: 132;  
 Attainment required to enter the course: Bachelor in Faculty  
 Total Marks of each paper=100, (CIE-25, UE-75)

Programme	Attainment at Exit/(Year (credits required)/	Semester	Course codes-Titles (credit)	Page No.
M.Sc.	Bachelor (Research) in Faculty(184 )/4 <sup>th</sup> (52)/semesters 7 & 8  Includes 1 Vocational/ Co-Curricular	7	CH1562/ H050701T Animal Diversity: Evolutionary and Taxonomic Approaches + H050701P CH1563/ H050702T Animal Diversity- Non-Chordata + H050702TP CH1564/ H050703T Biochemistry + H050703P CH1562/ H050704T Cell and Molecular Biology + H050704P Minor <a href="#">elective</a> (other Faculty) (4) <b>H050701R</b> Research project- Literature review/Question formulation (4)	<a href="#">7</a>
		8	CH2562/ H050801T Environmental Biology & Wildlife Biology + H050801P CH2563/ H050802T Animal Diversity-Chordata + H050802TP CH2564/ H050803T Animal Physiology + H050803P CH2565/ H050804T Animal Behavior and Chronobiology + H050804P	<a href="#">15</a>

			<b>H050805R</b> Research project- Data collection, Analysis, Report writing (4)	
Master in Faculty (232)/5 (48)/semesters 9 & 10	9	CH3562/ H050901T Genetics, Biostatistics & Computational Biology + H050901P CH3563/ H050902T Developmental Biology + H050902TP CH3564/ H050903TA/B/C/D/E/F Specialization paper 1 + H050903PA/B/C/D/E/F CH3565/ H050904TA/B/C/D/E/F Specialization paper 2 + H050904PA/B/C/D/E/F <b>H050905R</b> Research project- Progression to dissertation (4)	<a href="#">23</a>	
	10	CH4562/ H051001T Trends in Economic & Applied Zoology + H051001P CH4563/ H051002T Biological Techniques & Biotechnology + H051002TP CH4564/ H051003TA/B/C/D/E/F Specialization paper 3 + H051003P CH4565/ H051004TA/B/C/D/E/F Specialization paper 4 H051004PA/B/C/D/E/F <b>H051005R</b> Research project- Final dissertation writing and assessment (4)	<a href="#">27</a>	

In 9<sup>th</sup> and 10<sup>th</sup> semester, students would opt for one of the six specialisations (A/B/C/D/E/F) as listed below. The choice of specialisation being offered may depend on the resources available with the offering department/institute/college.

#### Specializations offered in 9<sup>th</sup> and 10<sup>th</sup> semesters

Group	Name of Specialization	Offered in semester	Paper code	Course Titles (credit)
A	Parasitology	9	H050903TA	Biology of Parasites – I (Protozoa, Trematoda and Cestoda)
			H050904TA	Biology of Parasites – II (Nematoda and Arthropoda)
		10	H051003TA	Physiology and Biochemistry of Parasites
			H051004TA	Immunoparasitology
B	Fish and Fisheries	9	H050903TB	General Fish Biology
			H050904TB	Morphology and Physiology
		10	H051003TB	Fish Culture and Limnology
			H051004TB	Applied Fisheries
C	Endocrinology	9	H050903TC	General Endocrinology

			H050904TC	Neuro Endocrinology
		10	H051003TC	Vertebrate Endocrinology
			H051004TC	Reproductive Physiology
D	Cell Biology	9	H050903TD	Advanced Cell Biology
			H050904TD	Chromosome and Genomic Organization
		10	H051003TD	Genomic Analysis and Immune Genetics
			H051004TD	Human and Microbial Cytogenetics and Molecular Biology
E	Entomology	9	H050903TE	General Insect Biology
			H050904TE	Anatomy and Physiology of Insects
		10	H051003TE	Applied Entomology I
			H051004TE	Applied Entomology II
F	Chronobiology	9	H050903TF	Chronobiology
			H050904TF	Photoperiodism and Seasonal Breeding
		10	H051003TF	Neuroendocrine Control of Behavior
			H051004TF	Applied Chronobiology

**MSc Zoology- Year & semester wise Structure, Paper titles, Credits & Hours**

<b>Program me/ Year</b>	<b>Semeste r</b>	<b>Course Codes</b>	<b>Paper Title</b>	<b>Credi ts</b>	<b>Teachi ng Hours</b>
4 Bachelor (Research) in Faculty(184)/ 4th (52)/semesters 7 & 8	VII	CH1562/ H050701T	Animal Diversity: Evolutionary and Taxonomic Approaches	4	60
		CH1562/ H050701P	Animal Diversity: Evolutionary and Taxonomic Approaches	2	60
		CH1563/ H050702T	Animal Diversity- Non-Chordata	4	60
		CH1563/ H050702TP	Animal Diversity- Non-Chordata	2	60
		CH1564/ H050703T	Biochemistry	4	60
		CH1564/ H050703P	Biochemistry	2	60
		CH1562/ H050704T	Cell and Molecular Biology	4	60
		CH1562/ H050704P	Cell and Molecular Biology	2	60
		(other Faculty)	Minor elective	4	60
	CHH050701R	Research project- Literature review/Question formulation	4	60	
	VIII	CH2562/ H050801T	Environmental Biology & Wildlife Biology	4	60
		CH2562/ H050801P	Environmental Biology & Wildlife Biology	2	60
		CH2563/ H050802T	Animal Diversity- Chordata	4	60
		CH2563/ H050802TP	Animal Diversity- Chordata	2	60
		CH2564/ H050803T	Animal Physiology	4	60
		CH2564/ H050803P	Animal Physiology	2	60
		CH2562/ H050804T	Animal Behavior and Chronobiology	4	60
		CH2562/ H050804P	Animal Behavior and Chronobiology	2	60
(other Faculty)		Research project	4	60	

		H050801R	Research project- Literature review/Question formulation	4	60
Master in Faculty (232)/5 (48)/semesters 9 & 10	IX	CH3562/ H050901T	Genetics, Biostatistics & Computational Biology	4	60
		CH3562/ H050901P	Genetics, Biostatistics & Computational Biology	2	60
		CH3563/ H050902T	Developmental Biology	4	60
		CH3563/ H050902TP	Developmental Biology	2	60
		CH3564/ H050903TA/B/C/D/ E/F	Specialization paper 1	4	60
		CH3564/ H050903PA/B/C/D/ E/F	Specialization paper 1	2	60
		CH3562/ H050904TA/B/C/D/ E/F	Specialization paper 2	4	60
		CH3562/ H050904PA/B/C/D/ E/F	Specialization paper 2	2	60
		H050805R	Research project- Research project- Data collection, Analysis, Report writing	4	60
	X	CH4562/ H051001T	Trends in Economic & Applied Zoology	4	60
		CH4562/ H051001P	Trends in Economic & Applied Zoology	2	60
		CH4563/ H051002T	Biological Techniques & Biotechnology	4	60
		CH4563/ H051002TP	Biological Techniques & Biotechnology	2	60
		CH4564/ H051003T H051004TA/B/C/D/ E/F	Specialization paper 3	4	60
		CH4564/ H051003PA/B/C/D/ E/F	Specialization paper 3	2	60
		CH4565/ H051004TA/B/C/D/ E/F	Specialization paper 4	4	60
		CH4565/ H051004PA/B/C/D/ E/F	Specialization paper 4	4	60
		H051005R	Dissertation writing & assessment	4	60

**Subject prerequisite**

To study Zoology in Post graduate program, student must have studied Zoology in 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> 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 of life is understood by students.
3. Students are sensitised 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.

<b>M.Sc. I</b> Bachelor (Research) in Facu	<b>PSO1</b>	To empower the students with inquisitive thinking about life and life approaches.
	<b>PSO 2</b>	To analyze the mechanisms involved in life processes up to the molecular level.
	<b>PSO 3</b>	To inculcate research specific culture among students.
	<b>PSO 4</b>	To perform the analytical experiments in various fields of biological science..
<b>M.Sc. II</b> Master i Faculty	<b>PSO1</b>	Capable of identifying scientific questions and potential research areas in Zoology.
	<b>PSO 2</b>	To identify a research problem and to formulate a scientific solution.
	<b>PSO 3</b>	In-depth understanding of biodiversity and the challenges to the nation in conservation of wildlife.
	<b>PSO 4</b>	<b>Understand and analyze the ecological and evolutionary significance of different taxa of animals.</b>

Programme/Class : Bachelor (Research) in Science	Year: Fourth; Subject: ZOOLOGY	Semester : Seventh
Course Code: CH1562/ H050701T	Course Title: Animal Diversity: Evolutionary and Taxonomic Approaches	
<p>Course outcomes:</p> <p>At the end of this course the students will be able to:</p> <ol style="list-style-type: none"> <li>1. Understand the principles and methods of taxonomy</li> <li>2. Understand the evolution of life, Homology and Analogy phylogeny of animals.</li> <li>3. Students be aware of approaches to study Paleontology i.e. Fossils and its significance</li> <li>4. To acquire knowledge on the taxonomic status of various animal groups</li> <li>5. Understand the Origin and development of animals and the Geological time scale</li> </ol>		
Credits: 4	Core: Compulsory	
Max. Marks: 25+75	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, application 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 new genes 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: 25 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks Class performance/Participation: 5 Marks	
Suggested Readings:	1.An Introduction to Taxonomy by TC Narendaran: Publisher : ZSI, India- free online on <a href="http://faunaofindia.nic.in/PDFVolumes/spb/041/index.pdf">http://faunaofindia.nic.in/PDFVolumes/spb/041/index.pdf</a> 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.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 : Ripper & Brothers	
Course Code: H050701P	<b>Evolutionary and Taxonomic approaches</b> <ul style="list-style-type: none"> <li>• Analogy &amp; Homology</li> <li>• Adaptive Radiations</li> <li>• Fossils, their models &amp; Videos</li> <li>• Convergence &amp; Divergence</li> <li>• Dichotomous Key through an example</li> <li>• Techniques of Animal preservation</li> <li>• 3-D Models of human evolution</li> </ul> <a href="https://www.biologysimulations.com/evolution">https://www.biologysimulations.com/evolution</a> <a href="https://amrita.olabs.edu.in/?sub=79&amp;brch=16&amp;sim=132&amp;cnt=4">https://amrita.olabs.edu.in/?sub=79&amp;brch=16&amp;sim=132&amp;cnt=4</a> <a href="https://education.nationalgeographic.org/resource/fossil">https://education.nationalgeographic.org/resource/fossil</a> <a href="https://www.britannica.com/science/evolution-scientific-theory/Convergent-and-parallel-evolution">https://www.britannica.com/science/evolution-scientific-theory/Convergent-and-parallel-evolution</a>	



Programme/Class: Bachelor (Research) in Science	Year: Fourth; Subject: ZOOLOGY	Semester: Seventh
Course Code: CH1563/ H050702T	Course Title: Animal Diversity- Non- Chordata	
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: 25+75	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 of Non chordate phyla up to order level Coelom formation, body symmetry and metagenesis in non-chordates Protozoa: locomotion and reproduction in protozoa Porifera: skeleton and regeneration in sponges	12
II	Cnidaria:, skeleton in coelenterates and coral reefs Ctenophora: Affinities. Helminths: Parasitism and parasitic adaptations	12
III	Annelida: Polymorphism 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 prerequisites:	To study this course, a student must have had the subject Zoology BSc 3rd year	
Suggested Continuous Evaluation Methods:	Total Marks: 25 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks Class performance/Participation: 5 Marks	
Suggested Readings:	1.A Biology of Higher Invertebrates by WD Russel-Hunter. Publisher: McMillan Co. Ltd., London. 2.Animal Parasitism by CP Read. Publisher : Prentice Hall Inc., New Jersey 3.Invertebrate structure and function by EJW Barrington. Publisher: Thomas Nelson & Sons Ltd., London 4.Invertebrates Zoology, III Edition by RD Barnes. Publisher : WB Saunders Co. Philadelphia 5.Student text book of Zoology. Vol. I, II & III by AA Sedgwick. Publisher : Central Book Depot, Allahabad 6.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 8.The invertebrates, Vol. 1 Protozoa through Ctenophora by LH Hyman. Publisher: McGraw Hill Co., New York 9.The Invertebrates. Vol. 2 Platyhelminthes and Rhynchocoela by LH Hyman. Publisher: McGraw Hill Co., New York 10.The Invertebrates. Vol. 8 Environmental Adaptations by LH Hyman. Publisher: McGraw Hill Co., New York	

<p>Course Code: H050702P</p>	<p><b>Animal Diversity: Non-chordata</b></p> <ul style="list-style-type: none"> <li>• <b>General anatomy (Dissections / Models / Charts / Computer simulation)</b> <ul style="list-style-type: none"> <li>(a) Earthworm</li> <li>(b) Prawn / <i>Squilla</i> / Crab</li> <li>(c) <i>Sepia</i> / <i>Loligo</i> / <i>Octopus</i></li> <li>(d) Cockroach</li> </ul> </li> <li>• <b>Mounting (Permanent)</b> Material Provided or material from dissected animals <b>Note: Only animals that are permitted by wildlife protection act, 1972</b></li> <li>• <b>Identification</b> <ul style="list-style-type: none"> <li>(a) Specimens representing all animal Phyla of Invertebrates</li> <li>(b) Larval forms of Platyhelminthes, Arthropoda and Echinodermata</li> <li>(c) Prepared slides through body sections from all Phyla</li> </ul> </li> </ul>	
----------------------------------	---	--

Programme/Class: Bachelor (Research in Science)	Year: Fourth; Subject: ZOOLOGY	Semester: Seventh
Course Code: CH1564/ H050703	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: 25+75	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 interactions (Vander Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.). Chemical structure and function of biomolecules 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 BSc 3rd year	
Suggested Continual Evaluation Method	Total Marks: 25 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / Term Papers/Seminar	

	10 Marks Class performance/Participation: 5 Marks	
Suggested Reading	<p>1.A Biologists Guide to Principals and Techniques of Practical Biochemistry by K Wilson &amp; KH Goulding</p> <p>2.Basic Concepts in Biochemistry: A Student's Survival Guide by Hiram F. Gilbert. Publisher: McGraw Hill Professional</p> <p>3.Biochemical Calculations by IH Segal. Publisher: John Wiley &amp; Sons</p> <p>4.Biochemistry by D Voet and JG Voet. Publisher: John Wiley &amp; Sons.</p> <p>5.Essentials of Molecular Biology.by George M Malacinski; Dav Freifelder: Publisher: Boston : Jones and Bartlett Publishers</p> <p>6.Grisham. Biochemistry by RH Garret &amp; CM Saunders. Publish College Publishers</p> <p>7.Physical Biochemistry by DWH Freifelder. Publisher: Freeman Co.</p> <p>8Practical Physiological Chemistry by PB Hawk. Publisher: P. Blakiston's Son &amp; Co</p> <p>9.Protein Structure and Molecular Properties by TEWH Creighton Publisher: Freeman &amp; Co.</p> <p>10.Tools of Biochemistry by TG Cooper. Publisher : Wiley</p>	
<b>Course code: H050703 P</b>	<p><b>Biochemistry</b></p> <ul style="list-style-type: none"> <li>• Biochemical qualitative tests for Proteins/ Lipids / Carbohydrates</li> <li>• Colorimetric quantitative estimation of Proteins &amp; Carbohydrates</li> <li>• Study of Salivary amylase, enzyme action and effect of P<sup>H</sup> and Temperature on it.</li> <li>• Paper &amp; Thin Layer Chromatography</li> <li>• 3-D Models of amino acids and structure of proteins</li> </ul> <p><a href="https://www.bbc.co.uk/bitesize/guides/z3wr2nb/revision/3">https://www.bbc.co.uk/bitesize/guides/z3wr2nb/revision/3</a></p> <p><a href="https://alevelbiology.co.uk/notes/tests-for-carbohydrates/">https://alevelbiology.co.uk/notes/tests-for-carbohydrates/</a></p> <p><a href="https://people.umass.edu/~mcclemen/581Carbohydrates.html">https://people.umass.edu/~mcclemen/581Carbohydrates.html</a></p> <p><a href="https://people.umass.edu/~mcclemen/581Proteins.html">https://people.umass.edu/~mcclemen/581Proteins.html</a></p> <p><a href="https://amrita.olabs.edu.in/?brch=18&amp;cnt=1&amp;sim=236&amp;sub=79">https://amrita.olabs.edu.in/?brch=18&amp;cnt=1&amp;sim=236&amp;sub=79</a></p> <p><a href="https://lab-training.com/thin-layer-chromatography-tlc/">https://lab-training.com/thin-layer-chromatography-tlc/</a></p> <p><a href="https://edu.rsc.org/practical/thin-layer-chromatography-practical-videos-16-18-students/4012270.article">https://edu.rsc.org/practical/thin-layer-chromatography-practical-videos-16-18-students/4012270.article</a></p> <p><a href="https://edu.rsc.org/practical/paper-chromatography-practical-videos-14-16-students/4011446.article">https://edu.rsc.org/practical/paper-chromatography-practical-videos-14-16-students/4011446.article</a></p>	

Programme/Class: Bachelor (Research) in Science	Year: Fourth; Subject: ZOOLOGY	Semester: Seventh
Course Code: CH1565/ H050704T	Course Title: Cell and Molecular Biology	
<p>Course outcomes:</p> <p>At the end of this course the students will be able to:</p> <ol style="list-style-type: none"> <li>1. Understand and explain the basics of cell biology</li> <li>2. Understand the structural and functional details of the basic unit of life at the molecular level</li> <li>3. Explain the new developments in molecular biology and its implications in human welfare</li> <li>4. Understand cellular receptor mechanisms and cell signalling</li> </ol>		
Credits: 4	Core: Compulsory	
Max. Marks: 25+75	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 cell 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. Nucleus – Nuclear envelope, nucleolus. Chromosomes (type, structure chemical composition and functions) Cytoskeleton, structure and dynamics of microtubules, action filaments (microfilaments), intermediate filaments, cilia & flagella	12
III	Prokaryotic and eukaryotic genome, fine structure of DNA, DNA Replication, DNA 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 <sup>++</sup> dependent cell-cell adhesion, Ca <sup>++</sup> 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 form plasma membrane to nucleus (signal transduction)	12
Course prerequisites:	To study this course, a student must have had the subject Zoology BSc 3rd year	
Suggested Continuous Evaluation Methods:	Total Marks: 25 House Examination/Test: 10 Marks Written Assignment/Presentation/Project/Term Papers/Seminar:10Marks Class performance/Participation: 5 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-ElsevierPublisher: 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.	

<p>Course Code: H050704P</p>	<p><b>Cell and Molecular Biology</b></p> <ul style="list-style-type: none"> <li>• Study Of Cell &amp; Cell organelles, Giant Chromosomes, DNA &amp; its replication through Photographic Plates/ Models/ Computer simulation</li> <li>• Permanent slides of Mitosis &amp; Meiosis</li> <li>• 3-D Models of DNA and RNA</li> <li>• Preparation of (a) slide of Onion root tip by Squash Technique to study 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</li> </ul> <p><a href="http://medcell.org/histology/cell_lab.php">http://medcell.org/histology/cell_lab.php</a>  <a href="https://study.com/academy/topic/cell-organelles.html">https://study.com/academy/topic/cell-organelles.html</a>  <a href="http://vlabs.iitb.ac.in/vlabs-dev/labs/mit_bootcamp/zoology/labs/exp1/procedure.php">http://vlabs.iitb.ac.in/vlabs-dev/labs/mit_bootcamp/zoology/labs/exp1/procedure.php</a>  <a href="https://cit.vfu.cz/frvs2011/?title=ukoly-cytogenetika&amp;lang=en">https://cit.vfu.cz/frvs2011/?title=ukoly-cytogenetika&amp;lang=en</a>  <a href="https://www.khanacademy.org/science/ap-biology/gene-expression-and-regulation/replication/a/molecular-mechanism-of-dna-replication">https://www.khanacademy.org/science/ap-biology/gene-expression-and-regulation/replication/a/molecular-mechanism-of-dna-replication</a>  <a href="https://bio.libretexts.org/Learning_Objects/Laboratory_Experiments/General_Biology_Labs/BIOL_1107%3A_Principles_of_Biology_I_Lab_Manual_(Burrn_and_DesRochers)/09%3A_Mitosis_and_Meiosis">https://bio.libretexts.org/Learning_Objects/Laboratory_Experiments/General_Biology_Labs/BIOL_1107%3A_Principles_of_Biology_I_Lab_Manual_(Burrn_and_DesRochers)/09%3A_Mitosis_and_Meiosis</a>  <a href="https://www.birmingham.ac.uk/teachers/study-resources/stem/biology/stem-legacy-mitosis.aspx">https://www.birmingham.ac.uk/teachers/study-resources/stem/biology/stem-legacy-mitosis.aspx</a>  <a href="https://www.leicabiosystems.com/en-in/knowledge-pathway/steps-to-better-microtomy-flotation-section-drying/">https://www.leicabiosystems.com/en-in/knowledge-pathway/steps-to-better-microtomy-flotation-section-drying/</a></p>	
----------------------------------	--	--



Programme/Class: Bachelor (Research) in Science	Year: Fourth; Subject: ZOOLOGY	Semester: Eighth
Course Code: CH2562/ H050801T	Course Title: Environmental Biology & Wildlife Biology	
<p>Course outcomes: At the end of this course the students will be able to:</p> <ol style="list-style-type: none"> <li>1. Global environmental issues, their causes, consequences and amelioration.</li> <li>2. To understand and identify behaviours in a variety of taxa.</li> <li>3. The proximate and ultimate causes of various behaviours.</li> <li>4. About the molecules, cells, and systems of biological timing systems.</li> <li>5. Conceptualizing how species profitably inhabit in the temporal environment and space out their activities at different times of the day and seasons.</li> <li>6. To interpret the cause and effect of lifestyle disorders contributing to public understanding of biological timing.</li> <li>7. To understand the importance of wildlife conservation.</li> </ol>		
Credits: 4	Core: Compulsory	
Max. Marks: 25+75	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	About Environment: 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 subject Zoology BSc 3rd year	
Suggested Continuous Evaluation Methods:	Total Marks: 25 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks Class performance/Participation: 5 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	
Course Code: H050801P	Environmental Biology & Wildlife Biology <ul style="list-style-type: none"> <li>• Measurement of climatic factors such as Temperature &amp; relative humidity</li> <li>• Estimation of Temperature, P<sup>H</sup>, Alkalinity, DO, BOD, COD, Hardness of water, soil analysis, Texture, Salinity</li> <li>• Numerical Problems of Population density</li> <li>• Determine texture of various soil samples.</li> <li>• A field study of any one of the habitat to be assigned to the group of students</li> </ul>	

	<ul style="list-style-type: none"><li>• Tour Of any Wildlife sanctuary/ Park/ Reserve to study behavioural activities of animals and prepare a short report</li><li>• Projects on wildlife- a. about Ganges Dolphin. b. Migratory birds in Hastinapur Bird Sanctuary (on animals listed as endangered species).</li></ul> <p><a href="http://amrita.olabs.edu.in/?sub=79&amp;brch=18&amp;sim=229&amp;cnt=1">http://amrita.olabs.edu.in/?sub=79&amp;brch=18&amp;sim=229&amp;cnt=1</a></p> <p><a href="http://amrita.olabs.edu.in/?sub=79&amp;brch=18&amp;sim=235&amp;cnt=1">http://amrita.olabs.edu.in/?sub=79&amp;brch=18&amp;sim=235&amp;cnt=1</a></p> <p><a href="https://www.mpcb.gov.in/sites/default/files/water-quality/reports/LSD-NEERI-%20Water%20Quality%20Analysis.pdf">https://www.mpcb.gov.in/sites/default/files/water-quality/reports/LSD-NEERI-%20Water%20Quality%20Analysis.pdf</a></p> <p><a href="https://www.shorttutorials.com/how-to-calculate-population-density/index.html">https://www.shorttutorials.com/how-to-calculate-population-density/index.html</a></p>	
--	---	--

Programme/Class: Bachelor (Research) in Science	Year: Fourth; Subject: ZOOLOGY	Semester: Eighth
Course Code: CH2563/ H050802T	Course Title: Animal Diversity- Chordata	
<p>Course outcomes: At the end of this course the students will be able to:</p> <ol style="list-style-type: none"> <li>1. Understand the Organization of vertebrate Life:, Diversity and Phylogeny of vertebrates</li> <li>2. Understand the Outline classification of Animals: Classification of animals. Understand the Levels of structural organization.</li> <li>3. Analyze the parallel evolution of vertebrate classes</li> <li>4. To understand the adaptive radiations in recent life forms.</li> </ol>		
Credits: 4	Core: Compulsory	
Max. Marks: 25+75	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. Thaliaacea and Cephalochordate. Introduction. Origin and Evolution of Vertebrates	12
II	General and Comparative Account of Integumentary System and Endoskeleton System Fish: General and Special Characters. General Organization and Affinities of Ostracoderm & Coelacanthiformes	12
III	Amphibia: General and Special Characters. Parental Care, Neoteny Reptiles: General and Special Characters. Adaptive radiation, skull, General Organization of Chelonia	12
IV	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 subject Zoology BSc 3rd year	
Suggested Continuous Evaluation Methods:	Total Marks: 25 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks Class performance/Participation: 5 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	
Course Code: H050802P	<b>Animal Diversity- Chordata</b> (a) Study of Museum specimens of animals from all Chordate groups (Protochordata to Mammals) (b) Anatomy (Models / Charts/ Computer simulation) (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 <b>(g) Osteology:</b> Comparative study of Axial & Appendicular skeleton from Fish, Amphibia, Reptiles, Aves, Mammals. Palate in Birds, Carapace & Plastron of Turtle, skull of Mammals. <b>(h) Histology:</b> Comparative study from prepared slides of skin, Ovary, Testis, Pancreas, Liver, Brain, stomach & Intestine	

	<p><b>(i) Permanent Mounting:</b> Spicules of <i>Herdmania</i>, Velum of <i>Amphioxus</i>, <i>Doliolum</i>, <i>Salpa</i>, Different types of scales in Fish, Feathers of Bird, Ampullae of Lorenzini in skate / Rayshark.</p> <p><b>Note:</b> Use of animals for Dissection/ Practical work, subjects to the condition that they are not banned under the Wildlife Protection Act &amp; UGC guidelines</p>	
--	--	--

Programme/Class: Bachelor (Research) in Science	Year: Fourth; Subject: ZOOLOGY	Semester: Eighth
Course Code: CH2564/ H050803T	Course Title: Animal Physiology & Immunology	
<p>Course outcomes:</p> <p>At the end of this course the students will be able to:</p> <ol style="list-style-type: none"> <li>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)</li> <li>2. Understand functional relationships of various organs and organ systems</li> </ol>		
Credits: 4	Core: Compulsory	
Max. Marks: 25+75	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, energy balance, BMR. Comparison of respiration in different 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, hemopoieses and formed elements, plasma function, blood volume, blood volume regulation, blood groups, haemoglobin, 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 and spinal 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	Type and Structure of Ig, Immune response, Vaccines	12
Course prerequisites:	To study this course, a student must have had the subject Zoology BSc 3rd year	
Suggested Continuous Evaluation Methods:	Total Marks: 25 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks Class performance/Participation: 5 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 & Hall Textbook of Medical Physiology by V Hall & R Kurpad. Publisher: Elsevier 8.Fundamental of Immunology by William E. Paul. Publisher: Lippincott Williams & Wilkins	
Course Code: H050803P	Animal Physiology & Immunology <ul style="list-style-type: none"> <li>• Enumeration of number of RBC/ WBC by Haemocytometer/ Blood Analyser</li> <li>• Estimation of Haemoglobin percentage by Haemometer</li> <li>• Differential leucocyte count using Leishman's Stain</li> <li>• Preparation of Haemin Crystals</li> <li>• Physiological &amp; Endocrinological disorders through charts/ Photographic plates/ computer simulation</li> </ul> <a href="https://labmonk.com/estimation-of-total-red-blood-corpuses-rbc-count">https://labmonk.com/estimation-of-total-red-blood-corpuses-rbc-count</a> <a href="https://labmonk.com/estimation-of-haemoglobin-content#:~:text=The%20graduated%20tube%20is%20filled,acid%20in%20the%20graduated%20tube.">https://labmonk.com/estimation-of-haemoglobin-content#:~:text=The%20graduated%20tube%20is%20filled,acid%20in%20the%20graduated%20tube.</a> <a href="https://www.labtestsguide.com/differential-leukocyte-count-dlc-test-procedure">https://www.labtestsguide.com/differential-leukocyte-count-dlc-test-procedure</a> <a href="https://www.ebiologylab.com/experiments/haemin-crystals">https://www.ebiologylab.com/experiments/haemin-crystals</a> <a href="https://www.ebiologylab.com/home">https://www.ebiologylab.com/home</a>	



Programme/Class: Bachelor (Research) in Science	Year: Fourth; Subject: ZOOLOGY	Semester: Eighth
Course Code: CH2565/H050804T	Course Title: Animal Behaviour and Chronobiology	
<p>1. Course outcomes:</p> <p>At the end of this course the students will be able to:</p> <ol style="list-style-type: none"> <li>1. Students acquire knowledge of key concepts and principles and overarching themes in animal behavior, animal cognition, conservation psychology/biology, animal welfare science.</li> <li>2. Scientific inquiry and critical thinking</li> <li>3. Students learn to apply ethical standards in conducting and evaluating psychological research.</li> <li>4. Students learn communication skills to disseminate research findings, and to apply psychological content and skills to a range of career goals.</li> </ol>		
Credits: 4	Core: Compulsory	
Max. Marks: 25+75	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 forms of 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 and primates	12
V	Circadian and circannual rhythms; migration, orientation and navigation in animals, biological clocks and human health	12
Course prerequisites:	To study this course, a student must have had the subject Zoology BSc 3rd year	
Suggested Continuous Evaluation Methods:	Total Marks: 25 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks Class performance/Participation: 5 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 7.Sociobiology: The New Synthesis by EO Wilson. Publisher: Harvard Univ. Press, Cambridge, Mass. USA	
Course Code: H050804P	<b>Animal Behaviour and Chronobiology</b>	

	<ul style="list-style-type: none"><li>• Study Of Photo tactic response in Housefly</li><li>• Chemical communication in Earthworm</li><li>• Imprinting in Birds</li><li>• Study of Food preferences and feeding behaviour of an insect pest</li><li>• Study of learning behaviour, shock &amp; avoidance behaviour in Rat</li><li>• Territorial behaviour</li><li>• Communication in Bees</li><li>• To study nests and nesting habits of the birds and social insects.</li><li>• Study of circadian functions in human.</li></ul> <p><a href="https://www.youtube.com/watch?v=momNvJNpf-s">https://www.youtube.com/watch?v=momNvJNpf-s</a> <a href="https://www.youtube.com/watch?v=IysBMqaSAC8">https://www.youtube.com/watch?v=IysBMqaSAC8</a></p>	
--	---	--

Programme/Class : Master in Science	Year: Fifth; Subject: ZOOLOGY	Semester: Ninth
Course Code: CH3562/ H050901T	Course Title: Genetics, Biostatistics & Computational Biology	
<p>Course outcomes:</p> <p>At the end of this course the students will be able to:</p> <ol style="list-style-type: none"> <li>1. acquire a broad understanding of current molecular genetics and genomics including current areas of research</li> <li>2. provide hands on training on various computational tools and techniques employed in Biological sequence analysis ;</li> <li>3. acquire expertise to conduct scientific experiments with statistical validation.</li> </ol>		
Credits: 4	Core: Compulsory	
Max. Marks: 25+75	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 genetic transfer – Transformation, conjugation, transduction, bacteriophages-types: structure and morphology of T4 phage	12
II	Molecular anatomy of eukaryotic chromosomes, heterochromatin and euchromatin, giant chromosomes, polytene and lampbrush chromosomes, sex 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 and MANOVA. Importance of Correlation Analysis. Types and measures of Correlation. Regression Analysis.	12
Course prerequisites:	To study this course, a student must have had the subject Zoology BSc 3rd year	
Suggested Continuous Evaluation Methods:	Total Marks: 25 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks Class performance/Participation: 5 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 CH Brase & CP Brase. Publisher: Cengage Learning	

<p><b>H050901 P</b></p>	<p><b>Genetics, Biostatistics and Computational Biology (Compulsory Paper)</b></p> <ul style="list-style-type: none"> <li>• Numerical problems based on Genetics and Population genetics</li> <li>• Pedigree analysis, Sex linked Inheritance in Man and <i>Drosophila</i></li> <li>• Genetic and Chromosomal disorders through Charts/ computer simulation</li> <li>• Blood group testing</li> <li>• Types of Bacteriophage</li> <li>• Numerical Problems based on Biostatistics: Student's t- test, Chi square test, Probability, regression Analysis, ANOVA, MANOVA, Gauseian distribution.</li> <li>• Retrieval of nucleotide and protein sequences from the database</li> <li>• Introduction to statistical software like R and SPSS</li> </ul>	
-------------------------	--	--

Programme/Class: Bachelor (Research) in Science	Year: Fifth; Subject: ZOOLOGY	Semester: Ninth
Course Code: CH2563/ H050902T	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 signalling		
Credits: 4	Core: Compulsory	
Max. Marks: 25+75	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 theories of development, theory of preformation. epigenetic theory, theory of pangenesis, 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 of development Gametes and fertilization-Spermatogenesis, oogenesis and fertilization	12
III	Early development- Cleavage and blastula, Pattern of cleavage, laws 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 processes of gastrulation concrescence and convergence	12

IV	<p>Parthenogenesis-Natural parthenogenesis, arrhenotoky, thelytoky, accidental parthenogenesis, rudimentary parthenogenesis, gynogenesis. androgenesis and significance of parthenogenesis</p> <p>Body axis formation in Drosophila, Xenopus and Chick, metamorphosis in insects and amphibians, biochemical and morphological metamorphic changes and hormonal control of metamorphosis</p> <p>Mechanism of regeneration in amphibian and Planaria</p>	12
V	<p>Teratology- Causes of abnormal development therapeutic drugs as teratogens drug testing, experimental teratology</p> <p>Neoplasia- Etiology, growth and differentiation of tumor cells, cell growth and oncogenesis, loss of homeostatic control, growth and invasiveness of placenta</p>	12
Course prerequisites:	To study this course, a student must have had the subject Zoology BSc 3rd year	
Suggested Continuous Evaluation Methods:	<p>Total Marks: 25</p> <p>House Examination/Test: 10 Marks</p> <p>Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks</p> <p>Class performance/Participation: 5 Marks</p>	
Suggested Readings:	<ol style="list-style-type: none"> <li>1. Biological Physics of the Developing Embryo by Gabor Forgacs. Publisher : Cambridge University Press</li> <li>2. Coming to Life: How Genes Drive Development by Christiane Nusslein-Volhard. Publisher : Kales Press</li> <li>3. Developmental Biology by Scott F. Gilbert. Publisher: Sinauer Associates Inc., U.S.</li> <li>4. Developmental Biology by Scott F Gilbert. Publisher: Sinauer Associates Inc.</li> <li>5. Embryology at a Glance by Samuel Webster. Publisher : John Wiley &amp; Sons</li> <li>6. First the Egg by Laura Vaccaro Seeger. Publisher : Roaring Brook Press</li> <li>7. From DNA to Diversity 2 ed by Sean B. Carroll. Publisher: Wiley-Blackwell</li> <li>8. The Triumph of the Embryo by Lewis Wolpert. Publisher : Oxford University Press</li> <li>9. Vertebrate Embryology by Milnes Marshall. Publisher : G. P. Putnam's sons, NY</li> <li>10. Vertebrate Embryology by Richard M. Eakin. Publisher : University of California Press</li> </ol>	



<b>H050902 P</b>	<b>Developmental Biology (Compulsory Paper)</b> <ul style="list-style-type: none"> <li>• Study of Development of Frog through slides/ Specimen /Models/ Computer simulation</li> <li>• Study of sections through different regions of embryonic and Larval stages of Frog by Permanent slides</li> <li>• Study of development of Chick through permanent whole mounts of successive embryonic stages up to 96 hours (18, 20, 24, 30, 72, 96)</li> <li>• Study of sections through Permanent prepared slides of different regions &amp; embryonic stages of Chick</li> <li>• Study the life cycle and developmental stages of C. elegans through permanent slides</li> <li>• Study of formalin preserved foetuses with Placenta in Humans.</li> </ul>	
------------------	--	--

Programme/Class: Master in Science	Year: Fifth; Subject: ZOOLOGY	Semester: Tenth
Course Code: CH4562/ H051001T	Course Title: Trends in Economic & Applied Zoology	
<p>Course outcomes: At the end of this course the students will be able to:</p> <ol style="list-style-type: none"> <li>1. enter into any field of biological and biomedical research provide they have interest in animals</li> <li>2. They should have good study habits, patience and perseverance.</li> <li>3. should have the ability to conduct detailed work accurately and methodically.</li> </ol>		
Credits: 4	Core: Compulsory	
Max. Marks: 25+75	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	Animals products – Fish products, dairy products, piggery, pearl, leather and wool. Domestic animals – Poultry, Cattle and Aquaculture, duck and goat farming	12
II	Economic insects – General principles and products of Apiculture, Sericulture, Lac culture; pests of common crops like paddy, cotton, wheat, sugarcane, brinjal, cauliflower, mustard etc. Integrated Pest Management-Chemical and biological Control	12
III	Microbiology	12
IV	Genomics: Accessing Molecular Genetic Information through the Internet, Managing and Distributing Genome Data, Introduction to Genome Sequencing: Shotgun	12
V	Proteomics and Metabolomics: proteomics. Gel-based proteomics. Two-dimensional gel electrophoresis. Basics of mass spectrometry. Difference between GCMS and LCMS	12
Course prerequisites:	To study this course, a student must have had the subject Zoology BSc 3rd year	
Suggested Continuous Evaluation Methods:	Total Marks: 25 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks Class performance/Participation: 5 Marks	

Suggested Readings:	<p>1.A Handbook of Economic Zoology by A Jawaid &amp; SP Sinha. Publisher: S. Chand Group Publ.</p> <p>2.Carp and Pond Fish Culture by Horvath, L., Tamas, G., Seagrave, C., Wiley-Blackwell</p> <p>3.Economic Zoology by KR Ravindranathan. Publisher: Dominant Publishers &amp; Distributors</p> <p>4.Economic Zoology by GS Shukla &amp; VB Upadhyay. Publisher: Rastogi Publications</p> <p>5.Economic Zoology 1st Edition by BS Jangi. Publisher: CRC</p>	
<b>H051001 P-</b>	<b>Trends in Economic and Applied Zoology (Compulsory Paper)</b>	
	<ul style="list-style-type: none"> <li>• Study through Permanent slides of Common pests of <ul style="list-style-type: none"> <li>(a) Paddy</li> <li>(b) Sugarcane</li> <li>(c) Cotton</li> <li>(d) Wheat</li> <li>(e) Cauliflower</li> <li>(f) Brinjal</li> </ul> </li> <li>• Study of Life cycle of Honey Bee, Silkworm and Lac insect through simulation</li> <li>• Pearl Culture Technique</li> <li>• Two-dimensional Gel- electrophoresis</li> <li>• Principle of GCMS and LCMS</li> <li>• Accessing Molecular Genetics information through Internet and its analysis</li> <li>• Physico-chemical analysis of honey.</li> <li>• Demonstration of kinds of mimicry in various groups of animals.</li> <li>• Projects on pathogens that cause life threatening damage in Meerut and nearby areas.</li> </ul>	

Programme/Class: Master in Science	Year: Fifth; Subject: ZOOLOGY	Semester : Tenth
Course Code: CH4563/ H051002T	Course Title: Techniques, Biotechnology & Computational Biology	
<p>Course outcomes: At the end of this course the students will be able to:</p> <ol style="list-style-type: none"> <li>1. Understand the Organization of invertebrate Life:, Diversity and Phylogeny of invertebrates</li> <li>2. Understand the Outline classification of Animals: Classification of animals. Understand the Levels of structural organization.</li> <li>3. Analyze the evolutionary relationship of invertebrate taxa</li> <li>4. To understand the adaptive radiations in early life forms.</li> </ol>		
Credits: 4	Core: Compulsory	
Max. Marks: 25+75	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 Database and information retrieval through ENTREZ. Global Alignment, BLAST. Gene Prediction & Analysis.	12
Course prerequisites:	To study this course, a student must have had the subject Zoology BSc 3rd year	
Suggested Continuous Evaluation Methods:	Total Marks: 25 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks Class performance/Participation: 5 Marks	

Suggested Readings:	<p>1. Bioinformatics Basics by Hooman Rashidi and Lukas K. Buehler. Publisher: CRC Press /Taylor &amp; Francis Group</p> <p>2. Bioinformatics Sequence &amp; Genome Analysis by Davit W Moont. Publisher: Cold Spring Harbor Laboratory Press</p> <p>3. DNA Cloning – A Practical approach by DM Glover &amp; BD Hames. Publisher: Oxford University Press, UK</p> <p>4. Double Helix by Nancy Werlin. Publisher: Puffin Books</p> <p>5. Genomes by TA Brown. Publisher: BIOS Scientific Publishers Ltd.</p> <p>6. Introduction to Bioinformatics by Arthur M Lesk. Publisher: Oxford University Press</p> <p>7. Molecular Biotechnology by Bernard J. Glick, Jack J. Pasternak and Cheryl L. Patten. Publisher: ASM Press, Washington DC</p> <p>8. Molecular Cloning – a laboratory manual (Vol. 1-3) by J Sambrook and DW Russell. Publisher: Cold Spring Harbor Laboratory Press, NY</p> <p>9. Principles of Gene Manipulation &amp; Genomics by Primrose and Twyman. Publisher: Blackwell Publishing, Oxford &amp; Australia</p> <p>10. The Biotech Century by Jeremy Rifkin. Publisher: Penguin Publishing Group</p>	
<b>H051002 P</b>	<p><b>Biological Techniques and Biotechnology (Compulsory Paper)</b></p> <ul style="list-style-type: none"> <li>• Study Of Principle of Light, Electron and Phase contrast Microscopy</li> <li>• Isolation of DNA</li> <li>• SDS PAGE Electrophoresis and Agarose Gel electrophoresis</li> <li>• Quantification Of Nucleic acid</li> <li>• PCR</li> <li>• Southern, Northern, Western Blotting</li> <li>• BLAST</li> <li>• NCBI – Gene prediction &amp; Analysis</li> <li>• Instruments/ Equipment's to be demonstrated <ul style="list-style-type: none"> <li>(a) Ultra-centrifuge</li> <li>(b) Spectrophotometer</li> <li>(c) Gel documentation Unit</li> </ul> </li> <li>• HPLC / GLC/ Ion exchange Chromatography</li> </ul> <p><a href="https://vlab.amrita.edu/?sub=3&amp;brch=187&amp;sim=323&amp;cnt=1">https://vlab.amrita.edu/?sub=3&amp;brch=187&amp;sim=323&amp;cnt=1</a></p> <p><a href="https://www.umassmed.edu/cemf/whatisem/">https://www.umassmed.edu/cemf/whatisem/</a></p> <p><a href="https://www.unl.edu/ncmn-cfem/xzli/em/em.htm">https://www.unl.edu/ncmn-cfem/xzli/em/em.htm</a></p> <p><a href="https://www.brainkart.com/">https://www.brainkart.com/</a></p> <p><a href="https://www.youtube.com/watch?v=1fpYBM25Qsc">https://www.youtube.com/watch?v=1fpYBM25Qsc</a></p> <p><a href="https://www.creativebiomart.net/blog/principle-and-protocol-of-sodium-dodecyl-sulphate-polyacrylamide-gel-electrophoresis-sds-page/">https://www.creativebiomart.net/blog/principle-and-protocol-of-sodium-dodecyl-sulphate-polyacrylamide-gel-electrophoresis-sds-page/</a></p> <p><a href="https://www.technologynetworks.com/analysis/articles/agarose-gel-electrophoresis-how-it-works-and-its-uses-358161">https://www.technologynetworks.com/analysis/articles/agarose-gel-electrophoresis-how-it-works-and-its-uses-358161</a></p> <p><a href="https://www.youtube.com/watch?v=yxNF17mKqws">https://www.youtube.com/watch?v=yxNF17mKqws</a></p>	

	<a href="https://www.qiagen.com/us/knowledge-and-support/knowledge-hub/bench-guide/dna/analysing-dna/quantification-of-dna">https://www.qiagen.com/us/knowledge-and-support/knowledge-hub/bench-guide/dna/analysing-dna/quantification-of-dna</a> <a href="https://www.khanacademy.org/science/ap-biology/gene-expression-and-regulation/biotechnology/a/polymerase-chain-reaction-pcr">https://www.khanacademy.org/science/ap-biology/gene-expression-and-regulation/biotechnology/a/polymerase-chain-reaction-pcr</a> <a href="https://www.khanacademy.org/science/ap-biology">https://www.khanacademy.org/science/ap-biology</a>	
--	---	--

## Specializations offered in 9<sup>th</sup> Semester

Programme/Class: Master in Science	Year: Fifth; Subject: ZOOLOGY	Semester: Ninth
Course Code: CH3564/ H050903TA	Course Title: Biology of Parasites – I (Protozoa, Trematoda and Cestoda)	
Course outcomes:		
Credits: 4	Core: Compulsory	
Max. Marks: 25+75	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; <i>Trypanosoma gambiense. Leishmania donovani</i>	12
IV	Trematoda: Introduction, General Classification, Types of Trematodes, Larval forms Trematoda: Blood flukes ( <i>Schistosoma haematobium, S. mansoni &amp; S. japonicum</i> )	12
V	Cestoda: Biology of cestodes. General Classification Cestoda: Larval forms. <i>Echinococcus granulosus,</i>	12
Course prerequisites:	To study this course, a student must have had the subject Zoology BSc 3rd year	
Suggested Continuous Evaluation Methods:	Total Marks: 25 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks Class performance/Participation: 5 Marks	

Suggested Readings:	<p>1. Biochemical Adaptation in Parasites by C Bryant &amp; C Behm. Publisher: Chapman &amp; Hall, NY</p> <p>2. Biology of Echinococcus and Hydatid Disease by RCA Thompson. Publisher : George Allen &amp; Unwin, London</p> <p>3. Biology of Eucestoda by C Armes &amp; PW Pappas. Publisher : Academic Press London</p> <p>4. General Parasitology by TC Cheng. Publisher Orlando : Academic Press</p> <p>5. Handbook of Medical Protozoology by CA Hoare. Publisher : Bailliere, Tyndall &amp; Cox, London</p> <p>6. Perspective in Trypanosomiasis Research by JR Barker. Publisher: John Wiley, UK</p> <p>7. Systema Helminthum I: Digenetic Trematodes by S Yamaguti. Publisher : Interscience Publishing Co., NY</p> <p>8. Systema Helminthum II: The Cestodes of Vertebrates by S Yamaguti. Publisher : Interscience Publishing Co., NY</p> <p>9. Systema Helminthum IV: Monogenea &amp; Aspidogastrea by S Yamaguti. Publisher : Interscience Publishing Co., NY</p> <p>10. The Biology of Trematoda by DA Erasmus. Publisher : Edward-Arnold, London</p> <p>11. The Biology of Trypanosoma &amp; Leishmania by DH Moleneux &amp; RW Ashford. Publisher : Taylor &amp; Francis, London</p>
---------------------	--

Programme/Class: Master in Science	Year: Fifth; Subject: ZOOLOGY	Semester: Ninth
Course Code: CH3562/H050904TA	Course Title: Biology of Parasites – II (Nematoda and Arthropoda)	
Course outcomes:		
Credits: 4	Core: Compulsory	
Max. Marks: 25+75	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, Biology	12
II	Family - <i>Ancylostomatidae</i> : <i>Ancylostoma duodenale</i> Family- <i>Filaridae</i> : <i>Wuchereria Bancrofti</i> .: Morphology life-cycle epidemiology and control of above.	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 sectors of human diseases (mosquitoes, lice, flies and ticks); Mode of transmission of pathogens by vectors. Insects carrying Vesication. Urtrication and Venomenization	12
Course prerequisites:	To study this course, a student must have had the subject Zoology BSc 3rd year	
Suggested Continuous Evaluation Methods:	Total Marks: 25 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks Class performance/Participation: 5 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 by Norman 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: CH3564/ H050903TB	Course Title: General Fish Biology	
Course outcomes:		
Credits: 4	Core: Compulsory	
Max. Marks: 25+75	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 of Scales	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 subject Zoology BSc 3rd year	
Suggested Continuous Evaluation Methods:	Total Marks: 25 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks Class performance/Participation: 5 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: CH3562/ H050904TB	Course Title: Morphology and Physiology	
Course outcomes:		
Credits: 4	Core: Compulsory	
Max. Marks: 25+75	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 subject Zoology BSc 3rd year	
Suggested Continuous Evaluation Methods:	Total Marks: 25 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks Class performance/Participation: 5 Marks	
Suggested Readings:		

Programme/Class: Master in Science	Year: Fifth; Subject: ZOOLOGY	Semester: Ninth
Course Code: CH3564/ H050903TC	Course Title: General Endocrinology	
Course outcomes:		
Credits: 4	Core: Compulsory	
Max. Marks: 25+75	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 of pro-hormone precursor; Sequential stages of the regulated secretory 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 determination using 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 statistical analyses	12
Course prerequisites:	To study this course, a student must have had the subject Zoology BSc 3rd year	
Suggested Continuous Evaluation Methods:	Total Marks: 25 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks Class performance/Participation: 5 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: CH3562/ H050904TC	Course Title: Neuro Endocrinology	
Course outcomes:		

Credits: 4	Core: Compulsory	
Max. Marks: 25+75	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 activity of Pituitary hormones - gigantism, acromegaly, dwarfism, syndrome of inappropriate ADH secretion.	12
Course prerequisites:	To study this course, a student must have had the subject Zoology BSc 3rd year	
Suggested Continuous Evaluation Methods:	Total Marks: 25 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks Class performance/Participation: 5 Marks	

Suggested Readings:	<p>1. Brown, R. An Introduction to Neuroendocrinology. UK: Cambridge University Press, Cambridge, 1994.</p> <p>2. Ader R. and Felten, D.L. Psychoneuroimmunology. UK: Academic Press, 2007.</p> <p>3. DeGroot L. J. and Jameson J.L. Endocrinology. USA: Saunders Elsevier Press, 2006.</p> <p>4. Endocrinology, 6th ed., Mac E. Hadley, Prentice Hall, ISBN: 0131876066</p> <p>5. Vertebrate Endocrinology, 4rd ed., David O. Norris, Academic Press, ISBN 0-12-088768-1</p> <p>6. Human Anatomy &amp; Physiology, 8th ed., Elaine N. Marieb, Benjamin Cummings, ISBN: 0321694155</p> <p>7. Vertebrate Endocrinology (2013, 5th Edition) by David O. Norris &amp; James A. Carr, Academic Press (Print Book ISBN: 9780123948151; eBook ISBN: 9780123964656) – Main Textbook</p> <p>8. Hormones (2014, 3rd Edition) by Anthony W. Norman &amp; Helen L. Henry, Academic Press (Print Book ISBN: 9780123694447; eBook ISBN: 9780080919065)</p>
---------------------	---

Programme/Class: Master in Science	Year: Fifth; Subject: ZOOLOGY	Semester: Ninth
Course Code: CH3564/ H050903TD	Course Title: Advanced Cell Biology	
Course outcomes:		
Credits: 4	Core: Compulsory	
Max. Marks: 25+75	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	<p>Cell organization</p> <p>Hierarchy in organization of cells</p> <p>Cellular organization of prokaryotes, Gram +ve and Gram -ve cell wall</p> <p>Cell Membrane in prokaryotes- structure, composition, transport, quorum sensing and its importance</p>	12
II	<p>Cytology of microflora of thermophilic, thermoacidophile, halophilic and psychrophilic bacteria, bacteriorhodopsin, signal transduction, prebiotics</p> <p>bCellular organization of eukaryotes, chemistry of Bio membrane, transmembrane proteins, channel protein, pump and receptors</p>	12

III	Electron transport system, oxidative phosphorylation, endosome, peroxisome, vesicular transport Cell-cell interaction, cell adhesion (Ca <sup>++</sup> independent cell-cell adhesion, Cadherins, selectin and integrin etc.) Cell junctions, cell-cell communication and its importance, Circadian rhythms in cells, i.e. from human supra chiasmatic nucleus and peripheral oscillators and cyanobacteria.	12
IV	Cell signaling, receptor, second messenger system, signaling from plasma membrane to nucleus, receptor tyrosine kinase Ageing cells, necrosis and apoptosis (Programmed cell death), 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 subject Zoology BSc 3rd year	
Suggested Continuous Evaluation Methods:	Total Marks: 25 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks Class performance/Participation: 5 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:CH3562/ H050904TD	Course Title: Chromosome and Genomic Organization	
Course outcomes:		
Credits: 4	Core: Compulsory	
Max. Marks: 25+75	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, nuclear scaffold). Molecular structure of telomeres (structure, synthesis and significance of telomere length) kinetochore and centromere (yeast centromere, alpha-satellite DNA, other centromere 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 control genes 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 Reassociation kinetics and “Cot” curves (chemical complexity and kinetic complexity); Sat-DNA	12
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 painting FISH, 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: 25 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks Class performance/Participation: 5 Marks	

Suggested Readings:	1.Molecular Cell Biology, Lodish et al. Scientific American Books 2.Cell and Molecular biology De Robertis and De Robertis: Saunders College Publ 3.Molecular Biology of cell Alberts et al.: Garland Publishing, 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 10.Principles of Genetics, Gardner, E.J., M.J., Simmons & D.P. Snustad John Willey and Sons. Inc. NY	
---------------------	---	--

Programme/Class: Master in Science	Year: Fifth; Subject: ZOOLOGY	Semester: Ninth
Course Code: CH3564/ H050903TE	Course Title: General Insect Biology	
Course outcomes:		
Credits: 4	Core: Compulsory	
Max. Marks: 25+75	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 and space 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 record of 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 and neck sclerites, Compound eye Thorax- Areas and sutures of tergum, sternum and pleuron, pterothorax; Wings: structure and modifications, venation; Legs: structure and modifications, Abdomen-Segmentation and appendages	12
Course prerequisites:	To study this course, a student must have had the subject Zoology BSc 3rd year	
Suggested Continuous Evaluation Methods:	Total Marks: 25 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks Class performance/Participation: 5 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: CH3562/ H050904TE	Course Title: Anatomy and Physiology of Insects	
Course outcomes:		

Credits: 4	Core: Compulsory	
Max. Marks: 25+75	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 coupling apparatus 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- Embryonic Development- 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: 25 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks Class performance/Participation: 5 Marks	

Suggested Readings:	<p>1.Chapman RF.1998. Insects: Structure and Function. ELBS Ed., London</p> <p>2.Duntson PA. 2004. The Insects: Structure, Function and Biodiversity. Kalyani Publ., New Delhi</p> <p>3.Kerkut GA &amp; Gilbert LI. 1985. Comprehensive Insect Physiology, Biochemistry and Pharmacology. Vols. I-XIII. Pergamon Press, New York</p> <p>4.Muraleedharan K. 1997. Recent Advances in Insect Endocrinology. Assoc. for Advancement of Entomology, Trivandrum, Kerala.</p> <p>5.Patnaik BD. 2002. Physiology of Insects. Dominant, New Delhi</p> <p>6.Richards OW &amp; Davies RG. 1977. Imm's General Text Book of Entomology.10 th Ed. Vol. 1. Structure, Physiology and Development. Chapman &amp; Hall, New York</p> <p>7.Richards OW &amp; Davies RG. 1977. Imm's General Text Book of Entomology. 10h Ed. Chapman &amp; Hall, London</p> <p>8.Saxena RC &amp; Srivastava RC. 2007. Entomology at a Glance. Agrotech Publ. Academy, Jodhpur</p> <p>9.Triplehorn CA &amp; Johnson NF. 1998. Borror and DeLong's Introduction to the Study of Insects</p> <p>10.Wigglesworth VB.1984. Insect Physiology. 8th Ed. Chapman &amp; Hall, New York</p>	
---------------------	---	--

Programme/Class: Master in Science	Year: Fifth; Subject: ZOOLOGY	Semester: Ninth
Course Code: CH3564/ H050903TF	Course Title: Chronobiology	
Course outcomes:		
Credits: 4	Core: Compulsory	
Max. Marks: 25+75	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 central and 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 circadian rhythms. 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 subject Zoology BSc 3rd year	
Suggested Continuous Evaluation Methods:	Total Marks: 25 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks Class performance/Participation: 5 Marks	
Suggested Readings:	1.Chronobiology Biological Timekeeping: Jay. C. Dunlap, Jennifer. J. Loros, Patricia J. DeCoursey (ed). 2004, Sinauer Associates, Inc. Publishers, Sunderland, MA, USA 2.Insect Clocks. D.S. Saunders, C.G.H. Steel, X., afopoulou (ed.)R.D. Lewis. 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: CH3562/ H050904TF	Course Title: Photoperiodism and Seasonal Breeding	
Course outcomes:		
Credits: 4	Core: Compulsory	
Max. Marks: 25+75	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-photoc 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 subject Zoology BSc 3rd year	
Suggested Continuous Evaluation Methods:	Total Marks: 25 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks Class performance/Participation: 5 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 10<sup>th</sup> Semester

Programme/Class: Master in Science	Year: Fifth; Subject: ZOOLOGY	Semester: Tenth
Course Code: CH4564/ H051003TA	Course Title: Physiology and Biochemistry of Parasites	
Course outcomes:		
Credits: 4	Core: Compulsory	
Max. Marks: 25+75	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 nematode, 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, <i>in vitro</i> 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-Host selection and its consequences. 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 and neurosecretion and behavioral coordination	12
Course prerequisites:	To study this course, a student must have had the subject Zoology BSc 3rd year	
Suggested Continuous Evaluation Methods:	Total Marks: 25 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks Class performance/Participation: 5 Marks	



Suggested Readings:	<ol style="list-style-type: none"> <li>1. Advances in Parasitology by B Dawes. Publisher: Academic Press, NY</li> <li>2. Biochemical Parasitology by G Cooms &amp; M North. Publisher : Taylor &amp; Francis, London</li> <li>3. Biochemistry and Molecular Biology of Parasite by JJ Marr &amp; M Muller. Publisher: Academic Press, NY</li> <li>4. Biochemistry of Parasites by Th Von Brand. Publisher : Academic Press NY</li> <li>5. Chemical Physiology of Endoparasitic Animals by Th Von Brand. Publisher : Academic press, NY</li> <li>6. Digestive System Physiology by PA Sanford. Publisher : Edward-Arnold, London</li> <li>7. Physiology of Gastrointestinal Tract by LR Jonston. Publisher : Raven Press NY</li> <li>8. Physiology of Parasite by Leslie H. Chappell. Publisher: Springer US</li> <li>9. The Physiology &amp; Biochemistry of Cestodes by JD Smyth &amp; DP McManus. Publisher : Cambridge University Press.</li> <li>10. The Physiology of Trematodes by JD Smyth &amp; DW Halton. Publisher : Cambridge University Press.</li> </ol>
---------------------	---

Programme/Class: Master in Science	Year: Fifth; Subject: ZOOLOGY	Semester: Tenth
Course Code: CH4565/H051004TA	Course Title: Immunoparasitology	
Course outcomes:		
Credits: 4	Core: Compulsory	
Max. Marks: 25+75	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: Barly theories of immunity, historical prospective, recognition, kinds of immunity, normal immune response, types of immunity Cells of immune system: Lymphoid cells (T-lymphocytes. B-lymphocytes), null cells, mononuclear cells, granulocytic cells, mast cells, basophils, dendritic cells. MHC molecules and compliments	12
II	Immune system: Lymphoid organs of the body, thymus, bone marrow, lymph nodes spleen. GAIT. MALT. CAIT Antigen antibody interactions: Strength of antigen-antibody interactions, cross reactivity, precipitation reaction, agglutination reaction, parasite antigen	12

III	Immunobiology of Protozoans: Malaria (Host response against Plasmodium infection, design of malaria vaccine). African sleeping sickness	12
IV	Immunobiology of trematodes: General considerations, immunological problems of trematode infection, immunological response against trematode infection, <i>Schistosomiasis</i> , <i>fascioliasis</i> , immune-diagnosis of trematodes	12
V	Immunobiology of cestodes: General consideration, immunity to larval and adult cestodes, immuno-diagnosis Vaccines: Passive immunization, active immunization, designing of vaccines for active immunization, whole organism vaccines, recombinant vector vaccines. DNA vaccines synthetic vaccines	12
Course prerequisites:	To study this course, a student must have had the subject Zoology BSc 3rd year	
Suggested Continuous Evaluation Methods:	Total Marks: 25 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks Class performance/Participation: 5 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: CH4564/ H051003TB	Course Title: Fish Culture and Limnology	
Course outcomes:.		
Credits: 4	Core: Compulsory	
Max. Marks: 25+75	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, Indian fisheries. 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 of air 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 reservoir fisheries	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, macrovegetation, 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 inland waters. Thermal stratification, its terminologies and modifications; thermal classification of inland waters and heat budget	12
Course prerequisites:	To study this course, a student must have had the subject Zoology BSc 3rd year	
Suggested Continuous Evaluation Methods:	Total Marks: 25 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks Class performance/Participation: 5 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: CH4565/ H051004TB	Course Title: Applied Fisheries	
Course outcomes:		
Credits: 4	Core: Compulsory	
Max. Marks: 25+75	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 operation Types of ponds and their management	12

II	<p>Significance of age and growth studies; methods of age determination; types and methods of determining fish growth</p> <p>Length weight relationship and condition factor</p> <p>Fecundity: determination of absolute and relative fecundity, variations in egg production potential</p> <p>Characteristics of Fish eggs</p> <p>Marking and tagging and its significance, information derived, types of tags and materials used for preparation, evolution of performance of marks/ tags</p>	12
III	<p>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</p> <p>Immunostimulants in Aquafarming</p> <p>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 &amp; chemical</p> <p>Quality Assurance – Value added products (Fish fingers, fish flakes, soup powder) By products (Fish meal, Fish oil, surgical sutures.)</p>	12
IV	<p>Fish Genetics and Biotechnology: Genetic improvement (Inbreeding and cross breeding), Chromosome manipulation, Transgenic fish and shell fish.</p> <p>Cryopreservation</p> <p>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</p> <p>Formulation of nutritionally balanced and cost effective diets</p> <p>Ornamental fishes: Types of ornamental fishes</p> <p>Types of Aquarium and their accessories</p> <p>Aquarium maintenance</p>	12

V	<p>Fish Transport and marketing: Handling and transportation of freshwater fish whole sale and retail markets. Fishery Cooperatives</p> <p>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)</p> <p>EEZ, Indian Antarctic Expedition and relevance to Fishing</p> <p>Fisheries legislation for resource management</p>	12
Course prerequisites:	To study this course, a student must have had the subject Zoology BSc 3rd year	
Suggested Continuous Evaluation Methods:	<p>Total Marks: 25</p> <p>House Examination/Test: 10 Marks</p> <p>Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks</p> <p>Class performance/Participation: 5 Marks</p>	
Suggested Readings:	<ol style="list-style-type: none"> <li>1.The Perfect Aquarium: Complete Guide to Setting Up and Maintaining an Aquarium</li> <li>2.Leo.S.Berg Classification of fishes (fossilized &amp; Recent)</li> <li>3.Francis day Vol I &amp; II Fishes of India.</li> <li>4.C.B.LShrivastava, Fish Biology.</li> <li>5.K.S.Mishra: An aid to classification of Fishes.</li> <li>6.Gopalji Shrivastava: Indian of fishes of U.P. &amp; Bihar.</li> <li>7.B.Qurashi: Identification of fishes.</li> <li>8.W.D.Rusell: Aquatic Productivity.</li> <li>9.A.J.K.Mainan: Identification of fishes.</li> <li>10.K.F.Lagler: Ichthyology.</li> <li>11.N.R.Rao: An Introduction of fishes.</li> <li>12.J.F.Norman: An History of fishes.</li> <li>13.S.S.Khanna: An Introduction of fishes.</li> <li>14.R.L.Rath: Fresh water Aquaculture.</li> <li>15.H.R.Singh: Advance in fish Biodiversity.</li> <li>16.H.D.Kumar: Sustainability &amp; Management of Aquaculture &amp; Fisheries.</li> <li>17.Arugun &amp; Natarajan: Fresh water Aquaculture.</li> <li>18.Arugun &amp; Natarajan: Santanu-Costal Aquaculture.</li> <li>19.R.Sanatham: A manual of fresh water Aquaculture.</li> </ol>	

Programme/Class: Master in Science	Year: Fifth; Subject: ZOOLOGY	Semester: Tenth
Course Code: CH4564/ H051003TC	Course Title: Vertebrate Endocrinology	

Course ouTComes:		
Credits: 4	Core: Compulsory	
Max. Marks: 25+75	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 idea of invertebrate Neuroendocrine systems: Insects, Crustaceans and Mollusca. Juvenile hormone	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, Structure and 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 subject Zoology BSc 3rd year	
Suggested Continuous Evaluation Methods:	Total Marks: 25 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks Class performance/Participation: 5 Marks	
Suggested Readings:	1.Endocrinology, 6th ed., Mac E. Hadley, Prentice Hall, ISBN: 0131876066 2.Vertebate 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: CH4565/ H051004TC	Course Title: Reproductive Physiology	
Course outcomes:		
Credits: 4	Core: Compulsory	
Max. Marks: 25+75	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 reproductive organs: Structure, and function of non-mammalian and mammalian testes, Spermatogenesis, maturation of sperm	12
II	Comparative anatomy of female reproductive organs: Structure, and function of non-mammalian and mammalian ovary, Oogenesis, ovulation, graafian follicle, Role of progesterone, Prostaglandins; luteolysis	12
III	Reproductive cycles: Estrous cycles, menstrual cycles and their hormonal regulation, Puberty, menopause	12
IV	Fertilization & Implantation: Fertilization, Implantation, Placenta, Types of placenta; parturition, lactation, Gestation; Contraception. methods of assisted fertility, cloning and sperm banks, family planning devices.	12
V	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.	12
Course prerequisites:	To study this course, a student must have had the subject Zoology BSc 3rd year	
Suggested Continuous Evaluation Methods:	Total Marks: 25 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks Class performance/Participation: 5 Marks	



Suggested Readings:	<p>1.Ganong: Review of Medical Physiology (22<sup>nd</sup> Ed 2005, Lang Medical Publications)</p> <p>2.Guyton and Hall: Text Book of Medical Physiology (11<sup>th</sup> Ed 2006, W.B. Saunders)</p> <p>3.General &amp; Comparative Physiology 2<sup>nd</sup> Edition; William S. Hoar</p> <p>4.A Text Book of Animal Physiology; R. Nagabhushnam</p> <p>5.Principle of Animal Physiology; D. Moyes</p> <p>6.General &amp; comparative endocrinology; E.J.W. Barrington</p> <p>7.An introduction to invertebrates endocrinology; A S Tombes</p> <p>8.Comparative endocrinology; U.S. Von Euler</p>
---------------------	---

Programme/Class: Master in Science	Year: Fifth; Subject: ZOOLOGY	Semester: Tenth
Course Code: CH4564/ H051003TD	Course Title: Genomic Analysis and Immune Genetics	
Course outcomes:		
Credits: 4	Core: Compulsory	
Max. Marks: 25+75	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	<p>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.</p> <p>Transposable elements in prokaryotes and eukaryotes. Role of transposable elements in genetic regulation. Genome analysis – Microbial genomes. Drosophila, yeast.</p>	12
II	<p>Genetic screening, prenatal diagnosis and genetic counseling</p> <p>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.</p>	12

III	Choice of mapping population : Simple sequence repeat loci Molecular markers in genome analysis: RFLP, RAPD and AFLP 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, Southern and northern blotting for genome analysis Chromosome walking, microarray, DNA chips, Cloning Taq polymerase production by <i>Thermus aquaticus</i>	12
Course prerequisites:	To study this course, a student must have had the subject Zoology BSc 3rd year	
Suggested Continuous Evaluation Methods:	Total Marks: 25 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks Class performance/Participation: 5 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: CH4565/ H051004TD	Course Title: Human and Microbial Cytogenetics and Molecular Biology	
Course outcomes:		
Credits: 4	Core: Compulsory	

Max. Marks: 25+75	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 chromosome segregation Numerical and structural abnormalities of human chromosomes – implications, syndromes and its consequences	12
II	Bacterial transformation, transduction, conjugation, bacterial chromosomes. Bacteriophage- types, structure and morphology of T4phage, 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, transposons 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 subject Zoology BSc 3rd year	

Suggested Continuous Evaluation Methods:	Total Marks: 25 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks Class performance/Participation: 5 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's 7.Microbiology : Prescott 8.Molecular cell biology: H. Lodish, J. Daenell, and D. Baltimore 9.Principles of Microbiology: Ronald M. Atlas and Lawrence Parks	

Programme/Class: Master in Science	Year: Fifth; Subject: ZOOLOGY	Semester: Tenth
Course Code: CH4564/ H051003TE	Course Title: Applied Entomology I	
Course outcomes:		
Credits: 4	Core: Compulsory	
Max. Marks: 25+75	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	<p>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.</p> <p>Pests of stored grains &amp; forests; Pests in polyhouses and protected cultivation.</p>	12
IV	<p>Pest outbreak- Type of pests; causes that make the insect as pest, and global factors causing pest outbreak.</p> <p>Natural control of insect pest with reference to climatic features, natural barriers &amp; enemies and insect diseases, Gut analyses of predators</p> <p>History, principles and scope of chemical control; Insecticides/ Pesticides- Nature, chemistry, mode of action and their application. Insect resistance against pesticides. Insect pheromones and their role in pest control; entomophagous aspects of Bt Cotton and Bt Brinjal</p>	12
V	<p>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</p> <p>Role of insect pathogenic nematodes, viruses, bacteria, fungi, protozoa etc., their mode of action</p> <p>Mass production of quality biocontrol agents- techniques, formulations, economics, field release/application and evaluation,</p> <p>Importation of natural enemies- Quarantine regulations</p>	12
Course prerequisites:	To study this course, a student must have had the subject Zoology BSc 3rd year	
Suggested Continuous Evaluation Methods:	<p>Total Marks: 25</p> <p>House Examination/Test: 10 Marks</p> <p>Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks</p> <p>Class performance/Participation: 5 Marks</p>	

Suggested Readings:	<p>1. Burges HD &amp; Hussey NW. (Eds). 1971. Microbial Control of Insects and Mites. Academic Press, London</p> <p>2. Butani DK &amp; Jotwani MG. 1984. Insects and Vegetables. Periodical Expert Book Agency, New Delhi</p> <p>3. Chapman JL &amp; Reiss MJ. 2006. Ecology: Principles &amp; Applications. Cambridge. Ed. Cambridge Univ. Press,</p> <p>4. De Bach P. 1964. Biological Control of Insect Pests and Weeds. Chapman &amp; Hall, New York</p> <p>5. Evans JW. 2004. Outlines of Agricultural Entomology. Asiatic Publ., New Delhi</p> <p>6. Huffaker CB &amp; Messenger PS. 1976. Theory and Practices of Biological Control. Academic Press, London</p> <p>7. Matsumura F. 1985. Toxicology of Insecticides. Plenum Press, New York</p> <p>8. Price PW. 1997. Insect Ecology. 3rd Ed. John Wiley, New York</p> <p>9. Speight MR, Hunta MD &amp; Watt AD. 2006. Ecology of Insects: Concepts and Application. Elsevier Science Publ., The Netherlands</p>	
---------------------	--	--

Programme/Class: Master in Science	Year: Fifth; Subject: ZOOLOGY	Semester: Tenth
Course Code: CH4565/ H051004TE	Course Title: Applied Entomology II	
Course outcomes:		
Credits: 4	Core: Compulsory	
Max. Marks: 25+75	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	<p>Classification of pesticides based on chemical structure, mode of entry, action, toxicity and structure activity relationship</p> <p>Mode of action and therapeutic methods for control of poisoning of chlorinated hydrocarbon, organophosphates, carbonates, natural and synthetic pyrethroids</p> <p>Systematic insecticides, phytotoxicity, compatibility, antagonism and synergism</p>	12
II	<p>Life cycle, pathogenicity and control measures of insects injurious to human beings- mosquitoes, sand flies, lice, house flies etc.</p> <p>Life cycle, pathogenicity and control measures of insects injurious to Livestock- Black flies, Horse flies, louse flies, Horse botflies etc.</p>	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 future outlook; 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 subject Zoology BSc 3rd year	
Suggested Continuous Evaluation Methods:	Total Marks: 25 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks Class performance/Participation: 5 Marks	

Suggested Readings:	<ol style="list-style-type: none"> <li>1.Dhaliwal GS, Singh R &amp; Chhillar BS. 2006. Essentials of Agricultural entomology. Kalyani Publ., New Delhi</li> <li>2.Flint MC &amp; Bosch RV. 1981. Introduction to Integrated Pest Management.1st Ed., Springer, New York</li> <li>3.Horowitz AR &amp; Ishaaya I. 2004. Insect Pest Management: Field and Protected Crops. Springer, New Delhi</li> <li>4.Ignacimuthu SS &amp; Jayaraj S. 2007. Biotechnology and Insect Pest management. Elite Publ., New Delhi</li> <li>5.Metcalf RL &amp; Luckman WH. 1982. Introduction of Insect Pest management. John Wiley &amp; Sons, New York</li> <li>6.Norris RF, Caswell-Chen EP &amp; Kogan M. 2002. Concepts in Integrated Pest Management. Prentice Hall, New Delhi</li> <li>7.Oakeshott J &amp; Whitten MA.. 1994. Molecular Approaches to Fundamental and Applied Entomology. Springer Verlag</li> <li>8.Pedigo RL. 2002. Entomology and Pest Management. 4th Ed. Prentice Hall, New Delhi</li> <li>9.Rechcigl JE &amp; Rechcigl NA. 1998. Biological and Biotechnological Control of Insect Pests. Lewis Publ., North Carolina</li> <li>10.Subramanyam B &amp; Hagstrum DW. 1995. Integrated Management of Insects in Stored Products. Marcel Dekker, NY</li> </ol>	
---------------------	---	--

Programme/Class: Master in Science	Year: Fifth; Subject: ZOOLOGY	Semester: Tenth
Course Code: CH4564/ H051003TF	Course Title: Neuroendocrine Control of Behavior	
Course outcomes:		
Credits: 4	Core: Compulsory	
Max. Marks: 25+75	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 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	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 Neuro endocrinology: Electrophysiology, immunocytochemistry, in situ hybridization, autoradiography.	12
Course prerequisites:	To study this course, a student must have had the subject Zoology BSc 3rd year	
Suggested Continuous Evaluation Methods:	Total Marks: 25 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks Class performance/Participation: 5 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: CH4565/ H051004TF	Course Title: Applied Chronobiology	
Course outcomes:		
Credits: 4	Core: Compulsory	
Max. Marks: 25+75	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 light recording; 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 of sleep 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 subject Zoology BSc 3rd year	
Suggested Continuous Evaluation Methods:	Total Marks: 25 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks Class performance/Participation: 5 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 (3rd ed) 2016
3. Circadian Medicine: Christopher Colwell (ed.) Wiley-Blackwell (2015)

<b>Programme/Class:</b> Bachelor (research) in Science	<b>Year:</b> Fourth	<b>Semester:</b> Seventh
<b>Subject:</b> ZOOLOGY (Elective)		
<b>Course Code:</b> H05 Elective	<b>Course Title:</b> Environment and Public Health	
<b>Course outcomes:</b> The student at the completion of the course will be able to: <ul style="list-style-type: none"> <li>• contribute to capacity building to limit greenhouse gases and carbon footprint.</li> <li>• take up green jobs contributing to preserve the environment, eco-sensitization programmes, emerging green sectors like renewable energy etc.</li> <li>• work in programmes addressing challenges of health and sanitation, epidemiology of communicable &amp; non-Communicable diseases</li> <li>• assist in strategizing for control of diseases of important public health problems.</li> </ul>		
<b>Credits:</b> 4	<b>Core:</b> Elective	
<b>Max. Marks:</b> 25+75	<b>Min. Passing Marks:</b> as per rules	
Total No. of Lectures-Tutorials-Practical (in hours per week): <b>L-T-P:3-0-3</b>		
<b>Unit</b>	<b>Topics</b>	<b>Total No. of Lectures (60)</b>
<b>I</b>	Ways to reduce Carbon Footprints	<b>8</b>
<b>II</b>	Attractive wildlife and its protection in India	<b>4</b>
<b>III</b>	India: A bioreserve hub	<b>8</b>
<b>IV</b>	Renewable energy: futuristic approaches	<b>8</b>
<b>V</b>	Nutrition: balanced diet and Health	<b>8</b>
<b>VI</b>	Lifestyle and Indian methods to improve health	<b>8</b>
<b>VII</b>	Sleep disorders in 24X 7 Society, after Digitization	<b>8</b>
<b>VIII</b>	Non-communicable diseases as lifestyle disorders	<b>8</b>
<b>Suggested Readings:</b> <ol style="list-style-type: none"> <li>1. Sanjay Upadhay et all; Environmental Laws in India (Vol -I, II, III), Butterworth: New Delhi:2004</li> <li>2. Raj Punjwani, Wildlife Conservation in India, Natraj; Dehradun;2000</li> <li>3. M. Zafar Mahfooz Normani, Natural resources, Law and Policy, Uppal: New Delhi-2004</li> <li>4. Health Education and Community Pharmacy for First Year Diploma in Pharmacy 3<sup>rd</sup> ed. V.N. Raje, CBS</li> <li>5. Textbook of Community Health Nursing I, S.D. Manivannan CBS Nursing</li> </ol>		
<b>Course Books published in Hindi may be prescribed by the Universities and Colleges</b>		
<b>Course prerequisites:</b> To study this course, a student must have had the subject biology in class/12 <sup>th</sup>		
Suggested Continuous Evaluation Methods:		
<b>Total Marks: 25</b>		
<b>House Examination/Test: 10 Marks</b>		
<b>Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks</b>		
<b>Class performance/Participation: 5 Marks</b>		

**Syllabus was approved after incorporating minor changes by BoS meeting held on 6<sup>th</sup> June 2022 at 10:00 a.m. Members present in the meeting –**

Members	Designation	Signatures
Prof. Mridul Kumar Gupta	Dean of Science, C.C.S University, Meerut, U.P.	
Prof. Neelu Jain Gupta	Convener and Head, Head, Department of Zoology, C.C.S University, Meerut, U.P.	
Prof. Sanjay Kumar Bhardwaj	Department of Zoology, C.C.S University, Meerut U.P.	
Prof. Anju Srivastav	Department of Zoology, University of Delhi, Delhi	
Prof. Vineeta Shukla	Department of Zoology, Maharshi Dayanand University, Rohtak	
Dr. Sushil Kumar Jha	School of Life Sciences, Jawaharlal Nehru University, Delhi	
Dr. Ranjan Kumar Nanda	Group Leader Scientist, ICGEB, New Delhi	
Dr. Dilip Kumar Gupta	Department of Zoology, Bareilly College, Bareilly, U.P.	
Dr. Neeraj Singh	Head, Department of Zoology, Meerut. College, Meerut, U.P.	
Dr. Anjula Jain	Head, Department of Zoology, D N College, Meerut, U.P.	
Dr. Seema Sharma	Department of Zoology, Meerut. College, Meerut, U.P.	
Dr. RS Gupta	Ex-Principal, RSS College Pillakhua, U.P.	