



**MAHARSHI DAYANAND UNIVERSITY,  
ROHTAK- 124 001, INDIA**

**(NAAC Accredited 'A' Grade State University established under Haryana  
Act No. XXV of 1975)**

**SCHEME & SYLLABUS**

**M.Sc. Zoology  
(2 Year Program)**

**Choice Based Credit System (CBCS)**

**(w.e.f. Academic Session 2016-17)**

**DEPARTMENT OF ZOOLOGY**

**<http://www.mdurohtak.ac.in>**

**DEPARTMENT OF ZOOLOGY**  
**Credit matrix for M.Sc. Zoology programme w.e.f. 2016-17**

Semester	Core Courses (C)	Discipline specific course (D)	Open elective (O)	Foundation Elective (F)	Dissertation/Project Work/Seminar	Total
I	28	-	-	-	-	28
II	20	4	3	2	-	29
III	16	8	3	-	-	27
IV	8	-	-	-	20	28
<b>TOTAL</b>	<b>72</b>	<b>12</b>	<b>6</b>	<b>2</b>	<b>20</b>	<b>112</b>

**REQUIRED CREDITS FOR M.SC ZOOLOGY (TWO YEAR COURSE):**

CORE COURSE	=72
DISCIPLINE SPECIFIC Elective	=12
OPEN ELECTIVE	=06
FOUDATION Elective	=02
DISSERTATION	=20
<b>TOTAL</b>	<b>=112</b>

**INSTRUCTION FOR THE STUDENTS**

**Course Types:**

- **Core Course (C):-** There are Core Courses in every semester. These courses are to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study.
- **Discipline specific elective (D):-** Discipline specific course is a course which can be chosen from a pool of papers. It will be supportive to the discipline of study & mandatory as per course curriculum.
- **Foundation Elective (F):-** The Foundation Course is based upon the content that leads to Knowledge enhancement. It is mandatory as per course curriculum.
- **Open Elective (O):-** Open elective course may be from an unrelated discipline. It is Open Elective and mandatory as per course curriculum.

**DEPARTMENT OF ZOOLOGY**  
**Choice Based Credit System (CBCS)**

Scheme of Examination (M.Sc. - Zoology) w.e.f. session 2016-17

<b>SEMESTER I</b>						
<b>Course No.</b>	<b>Nomenclature of Paper</b>	<b>Credit</b>	<b>Hours</b>	<b>MM (Max Marks)</b>	<b>IA (Internal Assessment)</b>	<b>TM (Total marks)</b>
<b>Core Courses</b>						
16ZOO21C1	Animal Biochemistry and metabolism	4	4	80	20	100
16ZOO21C2	Techniques in Animal Science	4	4	80	20	100
16ZOO21C3	Animal Cell Biology	4	4	80	20	100
16ZOO21C4	Molecular Biology	4	4	80	20	100
16ZOO21C5	Advanced Physiology	4	4	80	20	100
<b>Lab Course</b>						
16ZOO21C6	Lab Course (16ZOO21C1 to C3)	4	8	100	-	100
16ZOO21C7	Lab Course (16ZOO21C4 & C5)	4	8	100	-	100
	<b>Total Credits</b>	<b>28</b>				
<b>SEMESTER II</b>						
<b>Course No.</b>	<b>Nomenclature of Paper</b>	<b>Credit</b>	<b>Hours</b>	<b>MM</b>	<b>IA</b>	<b>TM</b>
<b>Core Courses</b>						
16ZOO22C1	Developmental Biology	4	4	80	20	100
16ZOO22C2	Molecular Cytogenetics	4	4	80	20	100
16ZOO22C3	Biology of Invertebrates	4	4	80	20	100
<b>Discipline Specific Elective (Any One)</b>						
16ZOO22D1	Aquaculture	4	4	80	20	100
16ZOO22D2	Evolutionary Biology	4	4	80	20	100
<b>Open Elective</b>						
	Open Elective*	3	3			
<b>Foundation Elective</b>						
	Foundation Elective**	2	2			
<b>Lab Course</b>						
16ZOO22C4	Lab Course (16ZOO22C1 to C2)	4	8	100	-	100
16ZOO22C5	Lab Course (16ZOO22C3 and D1/D2)	4	8	100	-	100
	<b>Total Credits</b>	<b>29</b>				
<b>SEMESTER III</b>						
<b>Course No</b>	<b>Nomenclature of Paper</b>	<b>Credit</b>	<b>Hours</b>	<b>MM</b>	<b>IA</b>	<b>TM</b>
<b>Core Courses</b>						
16ZOO23C1	Immunology	4	4	80	20	100
16ZOO23C2	Biology of Vertebrates	4	4	80	20	100
<b>Discipline Specific Elective</b>						
<b>Group-A (Any One)</b>						
16ZOO23D1	Animal Behavior and Taxonomy	4	4	80	20	100
16ZOO23D2	Molecular endocrinology	4	4	80	20	100
<b>Group-B (Any One)</b>						
16ZOO23D3	Biology of Population	4	4	80	20	100
16ZOO23D4	Environmental Biology	4	4	80	20	100
<b>Open Elective</b>						
	Open elective*	3	3			
<b>Lab Course</b>						
16ZOO23C3	Lab Course (16ZOO23C1 & C2)	4	8	100	-	100
16ZOO23C4	Lab Course (16ZOO23D1/D2 and 16ZOO23D3/D4)	4	8	100	-	100
	<b>Total Credits</b>	<b>27</b>				
<b>SEMESTER IV</b>						
<b>Course No</b>	<b>Nomenclature of Paper</b>	<b>Credit</b>	<b>Hours</b>	<b>MM</b>	<b>IA</b>	<b>TM</b>
<b>Core Courses</b>						
16ZOO24C1	Biosafety & Ethics in Science	4	4	80	20	100
16ZOO24C2	Advances in Vermiculture	4	4	80	20	100
<b>Dissertation</b>						
16ZOO24C3	Dissertation	20	40	300	-	300
	<b>Total Credits</b>	<b>28</b>				

\*To be chosen from pool of Open Elective Courses provided by the university

\*\* To be chosen from pool of Foundation Elective Courses provided by the university

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**DEPARTMENT OF ZOOLOGY**  
**M.Sc. ZOOLOGY w.e.f. session 2016-17**

**Semester-I**

**Course no.: 16ZOO21C1**

**Course Title: Animal Biochemistry and Metabolism**

**MM: 80**

**Time: 3Hr**

Note: There shall be nine questions in total. One question will be compulsory (short answer type) covering the entire syllabus and remaining eight questions will be set two from each unit. Students are required to attempt one from each unit.

**Unit I**

Biomolecular foundations of biology: pH, pK, acids, bases, buffers, Stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction) , Structure of soluble biomolecular pool of cells – aminoacids and peptides; monosaccharides, oligosaccharides and polysaccharides; nucleotides, vitamins and Lipids

**Unit II**

Proteins Structure -primary, secondary, tertiary and quaternary. Lysozyme and Carboxypeptidase. Conjugated proteins-structure and functions. Analysis of proteins: Western blotting; Reverse turns and Ramachandran plots, Nucleic acids: - types, structural and conformation of nucleic acids, Physicochemical techniques and macromolecular analysis,

**Unit III**

Energy metabolism (concept of free energy); Thermodynamic principles in biology, group transfer; dissociation and association constants; Biological energy transducers, Degradation of palmitic acid, phenylalanine, tryptophan and nucleotides. Glycolysis and TCA cycle; Glycogen breakdown and synthesis; Interconversion of hexoses and pentoses. Energy metabolism and high energy compounds: mitochondrial electron transport chain, Oxidative phosphorylation & coupled reactions.

**Unit IV**

Biosynthesis of triglycerides; Biosynthesis of urea, proline, aspartic acid, Uridylic acid, adenylic acid, . Classification and nomenclature of enzymes; Regulation of enzymatic activity; Coenzymes: Activators and inhibitors, isoenzymes, allosteric enzymes; Ribozyme and abzyme, Enzyme Kinetics (negative and positive cooperativity), Immobilised enzymes and their applications.

**List of Recommended Books**

1. D.Voet and J.G. Voet. Biochemistry, John Wiley & Sons.
2. D. Freifelder. Physical Biochemistry, W.H. Freeman & Company
3. I.H. Segal. Biochemical Calculations, John Wiley & Sons.
4. T.E. Creighton. Proteins-structure and Molecular Properties, W.H. Freeman & Company.
5. D. Freifelder, Essentials of Molecular Biology.
6. K. Wilson and K.H. Goulding. A Biologist's guide to principles and techniques of practical biochemistry.
7. T.G. Cooper. Tools of Biochemistry.
8. Hawk. Practical Physiological Chemistry.
9. R.H. Garrett and CM. Grisham. Biochemistry, Saunders College Publishers.

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**Semester-I**

**Course no.: 16ZOO21C2**

**Course Title: Techniques in Animal Sciences**

**MM: 80**

**Time: 3Hr**

Note: There shall be nine questions in total. One question will be compulsory (short answer type) covering the entire syllabus and remaining eight questions will be set two from each unit. Students are required to attempt one from each unit.

**Unit I**

Microscopy: Principles and applications of light, phase contrast, fluorescence microscopes, scanning and transmission electron microscopes. X-ray diffraction, pH meter, Fixation and staining; cryotechnology and flow cytometry, Confocal Microscopy.

**Units II**

Spectroscopy: Fluorescence, UV, visible, NMR and ESR spectroscopy; X-ray diffraction. Tracer Biology: Principles and applications of tracer techniques in biology; radioactive isotopes and half-life of isotopes; autoradiography, GCMS spectroscopy.

**Unit III**

Chromatography: Principles and applications of gel filtration, ion-exchange, affinity, thin layer, gas chromatography and high pressure liquid chromatography (HPLC). Electrophoresis and centrifugation: Principles and applications of agarose and polyacrylamide gel electrophoresis; ultracentrifugation (velocity and buoyant density).

**Unit IV**

Molecular biology techniques: Sequencing of proteins and nucleic acids; southern, northern and western blotting techniques, polymerase chain reaction (PCR), ELISA, MALDITOF. Methods for measuring nucleic acid and protein interactions, Real time PCR and reverse transcriptase PCR.

**List of Recommended Books**

1. Animal Cell Culture - A practical approach, Ed. John R.W. Masters, IRL Press.
2. Introduction to Instrumental analysis, Robert Braun. McGraw Hill International Editions.
3. Shukla and Upadhyaya. Experimental Science
4. Randhir Singh. Practicals in Biochemistry
5. A Biologists Guide to Principles and Techniques of Practical Biochemistry, K. Wilson & K.H. Goulding, ELBS Edn.

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**Semester-I**

**Course no.: 16ZOO21C3**

**Course Title: Animal Cell Biology**

**MM: 80**

**Time: 3Hr**

Note: There shall be nine questions in total. One question will be compulsory (short answer type) covering the entire syllabus and remaining eight questions will be set two from each unit. Students are required to attempt one from each unit.

**Unit I**

Structure of pro-and eukaryotic cells; Structure and function of cells and intracellular organelles of both prokaryotes and eukaryotes); Significance of intracellular compartments;  
Structure of nucleus; Genetic analysis in Cell Biology: Nucleus; Mitochondria and chloroplasts and their genetic organization; Evolution of aerobic respiration.

**Unit II**

Biomembranes: Molecular composition and arrangement functional consequences; Model membranes; Liposomes. Transport across cell membrane-Diffusion, active transport and pumps, uniports, symports and antiports; Membrane potential; Co-transport by symporters or antiporters; Transport across epithelia.  
Cytoskeleton: Microfilaments and microtubules-structure and dynamics; Microtubules and mitosis; Cell movements-intracellular transport, role and kinesin and dynein; Cilia and Flagella

**Unit III**

Cell-Cell signaling:  
Signal transduction mechanisms;  
Cell surface receptors;  
Second messenger system;  
MAP kinase pathways;  
Cell-cell interaction.  
Cell-Cell matrix, adhesion and communication  
Ca<sup>++</sup> dependent & independent homophilic cell-cell adhesion; Gap junctions and connexins  
Cell matrix adhesion: Integrins, Collagen, Non-collagen components & Cellulose fibril synthesis and orientation

**Unit IV**

Cell cycle: Mechanism of cell division including (mitosis and meiosis) and cell differentiation Cyclins and cyclin dependent kinases and Regulation of CDK-cyclin activity;  
Biology of cancer, Biology of aging and Apoptosis-definition, mechanism and significance

**List of Recommended Books**

1. Molecular Cell Biology, J. Darnell, 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. Cell and molecular biology Phillip Sheeler, Donald E. Bianchi Wiley, 1987

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**Semester-I**

**Course no.: 16ZOO21C4**

**Course Title: Molecular Biology**

**MM: 80**

**Time: 3Hr**

Note: There shall be nine questions in total. One question will be compulsory (short answer type) covering the entire syllabus and remaining eight questions will be set two from each unit. Students are required to attempt one from each unit.

**Unit I**

History and Scope of Molecular Zoology

DNA replication: Prokaryotic and eukaryotic DNA replication, Mechanics of DNA replication, Enzymes and accessory proteins involved in DNA replication

**Unit II**

Transcription: Prokaryotic and Eukaryotic transcription; RNA polymerases; General and specific transcription factors; Regulatory elements and mechanisms of transcription regulation

Post-transcriptional modifications in RNA: 5'-Cap formation; Transcription termination; 3'-end processing and polyadenylation; Splicing, Editing; mRNA stability and Transcriptional and post-transcriptional gene silencing.

**Unit III**

Translation: Prokaryotic and eukaryotic translation; The translational machinery; Mechanisms of initiation, elongation and termination; Regulation of translation; Genetic code and Co- and post-translational modifications of proteins ; the signal hypothesis.

**Unit IV**

Recombination and repair: Holiday junction, excision repair; RecA and other recombinases and DNA repair mechanisms. Biomaterials and their significance.

**List of Recommended Books**

1. Molecular Biology of the Gene, J.D. Watson, N.H. Hopkins, J.W. Roberts, J.A. Steitz and A.M. Weiner. The Benjamin/Cummings Pub. Co., Inc., California.
2. Molecular Cell Biology, J. Darnell, H. Lodish and D. Baltimore Scientific American Books, Inc., USA.
3. Molecular Biology of the Cell, B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts and J.D. Watson. Garland Publishing Inc., New York.
4. Gene VI, Benjamin Lewin, Oxford University Press, U.K.
5. Molecular Biology and Biotechnology. A comprehensive desk reference, R.A. Meyers (Ed.), VCH Publishers, Inc., New York.
6. Molecular Cloning: a Laboratory Manual, J. Sambrook, E.F. Fritsch and T. Maniatis, Cold Spring Harbor Laboratory Press, New York.
7. Introduction to Practical Molecular Biology, P.D. Dabre, John Wiley & Sons Ltd., New York.
8. Molecular Biology LabFax, T.A. Brown (Ed.), Bios Scientific Publishers Ltd., Oxford

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**Semester-I**

**Course no.: 16ZOO21C5**

**Course Title: Advanced Physiology**

**MM: 80**

**Time: 3Hr**

Note: There shall be nine questions in total. One question will be compulsory (short answer type) covering the entire syllabus and remaining eight questions will be set two from each unit. Students are required to attempt one from each unit.

**Unit I**

Digestive system:

Feeding mechanisms and regulation

Physiology of mammalian ingestion, digestion, absorption, assimilation and egestion;

Dentition in mammals

**Unit II**

Respiratory system:

Respiratory organs and respiratory pigments;

Control of respiration;

Structure of heart and blood vessel;

Circulation and composition of body fluids and their regulation;

Blood coagulation.

**Unit III**

Excretion and osmoregulation:

Patterns of nitrogen excretion among different animal groups;

Physiology of excretion;

Osmoregulation in different mammalian groups;

**Unit IV**

Muscle and Receptor physiology:

Receptor physiology -

Mechanoreception

Photoreception

Chemoreception

Equilibrium reception

Muscles: structure and function;

Neuromuscular transmission and nerve conduction.

**List of Recommended Books**

1. Hoar, W.S. General and Comparative Animal Physiology, Prentice Hall of India.
2. Strand, F.L. Physiology: A regulatory Systems Approach. Macmillan Publishing Co., New York.
3. Pummer, L. Practical Biochemistry, Tata McGraw-Hill.
4. Prosser, C.L. Environmental and Metabolic Animal Physiology. Wiley-Liss Inc., New York.
5. Willmer, P.G. Stone, and I. Johnston. Environmental Physiology. Blackwell Sci. Oxford, UK, 644pp.
6. Newell, R.C. (ed.) 1976. Adaptation to environment. Essays on the physiology of marine animals. Butterworths, London, UK, 539pp.
7. Townsend, C.R. and P. Calow. Physiological Ecology: An evolutionary approach to resource use. Blackwell Sci. Publ., Oxford, UK.
8. Alexander, R.M.N. Optima for animals. Princeton Univ. Press, Princeton, NJ.
9. Louw, G.N. Physiological animal ecology. Longman Harloss, UK.
10. Sastry KV and Shukla V. Text Book of Physiology and Biochemistry, Rastogi Publication, Meerut



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**Semester- I**

**Course no.: 16ZOO21C6**  
**Course Title: Laboratory Course**

**M.M.: 100**  
**Time: 6 Hr**

1. To plot the calibration curve for protein estimation by Lowry method
2. To separate and identify sugar by Thin Layer Chromatography
3. To adjust the pH of given buffer by pH meter
4. To prepare casein from milk
5. To plot standard curve for estimation of carbohydrate by anthrone method.
6. Estimation of creatinine in blood.
7. To test the urine for urea, proteins, ketones and sugar.
8. To determine the protein concentration in the given albumin by Biuret method
9. Qualitative estimation of given enzyme by colorimetric method.
10. To investigate the effect of temperature on enzyme catalysed reaction
11. To investigate the effect of varying pH on enzyme catalysed reaction
12. To study the Beer Lambert's law for spectrophotometry.
13. To prepare the absorbance curve.
14. To isolate chloroplast pigments from leaf by paper chromatography.
15. To isolate amino acids by paper chromatography/TLC.
16. To perform agarose gel electrophoresis.
17. To perform SDS-PAGE.
18. To stain SDS-PAGE with Coomassie brilliant blue.
19. To dry SDS-PAGE.
20. To perform affinity column chromatography
21. To perform ion exchange column chromatography
22. To perform PCR for a given sample
23. To perform ELISA
24. Numericals on half life of radioactive isotopes
25. To study the principle and working of Light Microscope.
26. To measure the size of prepared protozoan slides such as *Euglena*, *Paramecium* by Micrometry.
27. To prepare a temporary mount of Buccal epithelial cells.
28. To observe barr body in the Buccal Epithelial cells of human females.
29. To prepare polytene chromosomes from salivary glands of *Drosophila* larva.
30. To demonstrate the movement of water by haemolysis and crenation in blood cells.
31. To study squash technique for the study of Mitosis/Meiosis.
32. Calculation of morphometric data and preparations of ideogram.
33. To study the principle of cell fractionation for isolation of sub-cellular organelles.
34. Identification of mitotic and meiotic stages from permanent slides.

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**Semester- I**

**Course no.: 16ZOO21C7**  
**Course Title: Laboratory Course**

**M.M.: 100**  
**Time: 6 Hr**

1. To perform extraction of nucleic acids
2. To perform SDS PAGE
3. To perform isolation of genomic genetic material
4. To estimate RNA in the given material/sample
5. To perform blotting to analyse the given sample
6. DNA gel extraction
7. Competent cell preparation
8. Microscopy applications
9. Solutions and Buffers preparation
10. To estimate DNA in the given material/sample
11. Assessment of proliferation in cultured cells by MTT assay
12. To find the blood group and Rh factor of own blood
13. To estimate the amount of Hb present in human blood
14. To estimate the RBC count present in  $1\text{mm}^3$  volume of blood.
15. To estimate the WBC count present in  $1\text{mm}^3$  volume of blood.
16. Determination of MCV, MCH, and MCHC.
17. Determination of colour Index of blood.
18. Demonstration of the blood clotting time.
19. Demonstration of the erythrocyte sedimentation rate.
20. Demonstration of the haemolysis.
21. To study the effect of osmolarity of solution on RBC
22. Qualitative estimation of salivary amylase
23. To study the effect of varying pH on salivary amylase
24. To determine the effects of varying temperatures on the activity of salivary amylase
25. To study the rate of respiration by aquatic animals
26. Spiro metric analysis of pollution impact on human beings and its implications.

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**Semester-II**

**Course no.:** 16ZOO22C1

**Course Title:** Developmental Biology

**MM:** 80

**Time:** 3Hr

Note: There shall be nine questions in total. One question is compulsory (short answer type) covering the entire syllabus and remaining eight questions will be set two from each unit. Students are required to attempt one from each unit.

**Unit I**

Developmental patterns in metazoans; Development in unicellular eukaryotes;  
Molecular basis of spermatogenesis, Oogenesis and fertilization

**Unit II**

Cell fate and Cell lineages; Stem cells; Cleavage types and significance;  
Blastula; Fate maps; Comparative account of Gastrulation (sea urchin, zebrafish, xenopus, chick)  
Neurulation and ectoderm; Mesoderm and endoderm

**Unit III**

Cytoplasmic determinants, Cell commitment, specification, induction, competence, determination and differentiation, Cell specification in nematodes  
Germ cell determinants, Germ cell migration, Cell-Cell interaction,  
Mutants and transgenics in analysis of development

**Unit IV**

*Caenorhabditis*: Vulva formation  
Genetics of axis specification in *Drosophila*, *amphibia* and *chick*  
Eye lens induction, limb development and regeneration in vertebrates,  
Differentiation of neurons, HOX genes  
Metamorphosis, Environmental regulation of normal development,  
Sex determination

**List of Recommended Books**

1. S.F. Gilbert. Developmental Biology. 8<sup>th</sup> Edition Sinauer Associates Inc., Massachusetts.
2. L. Wolpert et. al. Principles of Development; Oxford University Press; 2002
3. Jonathan M. W. Slack. Essential Developmental Biology, 3rd Edition. 2012, Wiley-Blackwell
4. L. W. Browder et. al. Developmental Biology, 3rd Edition; Saunders College Publishing, Philadelphia ISBN 0-03-013514-1
5. T. Subramonium. Molecular Developmental Biology, 2nd Edition, 2013. Narosa Publishing House
6. Ethan Bier. 'The Coild Spring'. Cold Spring Harbor Laboratory Press, New York.

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**Semester-II**

**Course no.:** 16ZOO22C2

**Course Title:** Molecular Cytogenetics

**MM:** 80

**Time:** 3hrs

Note: There shall be nine questions in total. One question will be compulsory (short answer type) covering the entire syllabus and remaining eight questions will be set two from each unit. Students are required to attempt one from each unit.

**Unit I**

Biology of Chromosomes:

Molecular anatomy of eukaryotic chromosomes

Metaphase chromosome: Centromere, Kinetochore, Telomere and its maintenance

Heterochromatin and Euchromatin Giant chromosomes: Polytene and lampbrush chromosomes.

Sex chromosomes, sex determination and dosage compensation in *C. elegans*, *Drosophila* & Humans

**Unit II**

Cytogenetic implications and consequences of structural changes and numerical alterations of chromosomes.

Human Cytogenetics:

Techniques in human chromosome analysis - molecular cytogenetic approach.

Human Karyotype - banding - nomenclature

Numerical and structural abnormalities of human chromosomes - syndromes.

Mendelian and chromosome based heritable diseases in humans.

**Unit III**

Genome mapping: cytoplasmic, fluorescence *in situ* hybridization

Genetic Mapping: single nucleotide polymorphisms, VNTRs and microsatellites

Physical mapping: restriction maps and radiation hybrid map and STS maps.

DNA finger printing,

**Unit IV**

Molecular markers in genome analysis:

Types : RFLP, RAPD, SCARs, AFLP, ASAPs and SSRs (single sequence repeats) and CAPS.

Applications and limitations of molecular markers.

Genome analysis – *Humans and Drosophila*

**List of Recommended Books**

1. Atherly, A.G., J.R. Girton and J.F. McDonald. The Science of Genetics. Saunders College Publishing, Harcourt Brace College Publishers, NY.
2. Brooker, R.J. Genetics: Analysis and Principles. Benjamin/Cummings, Longman Inc.
3. Fairbanks, D.J. and W.R. Anderson. Genetics - The Continuity of Life. Brooks/Cole Publishing Company ITP, NY, Toronto.
4. Gardner, E.J., M.J. Simmons and D.P. Snustad. Principles of Genetics. John Wiley and Sons. Inc., NY.
5. Griffiths, A.J.F., J.H. Miller, D.T. Suzuki, R.C. Lewontin and W.M. Gelbart. An introduction to genetic analysis. W.H. Freeman and Company, New York.
6. Lewin, B. Genes. VI. Oxford University Press, Oxford, New York, Tokyo.
7. Snustad, D.P. and M.J. Simmons. Principles of Genetics. John Wiley and Sons. Inc., NY.
8. Watson, J.D., N.H. Hopkins, J.W. Roberts, J.A. Steitz and A.M. Weiner. Molecular Biology of Genes. The Benjamin/Cummings Publishing Company Inc., Tokyo.

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**Semester-II**

**Course no.:** 16ZOO22C3  
**Course Title:** Biology of Invertebrates

**MM:** 80  
**Time:** 3Hr

Note: There shall be nine questions in total. One question will be compulsory (short answer type) covering the entire syllabus and remaining eight questions will be set two from each unit. Students are required to attempt one from each unit.

**Unit I**

Salient Features and classification up to classes with reference to diversity in animal form and function of Protozoa, Porifera,

General account: Aquiferous and skeleton system in Porifera;

**Unit II**

Salient Features and classification up to classes with reference to diversity in animal form and function of Colenterata, Helminthes, Nematodes,

General account: Polymorphism in cnidarians; parasitic adaptations in helminthes; Larval form and their significance.

**Unit III**

Salient Features and classification up to classes with reference to diversity in animal form and function of Annelid, Arthropoda,

General account: Larval form and their significance in Arthropoda

**Unit IV**

Salient Features and classification up to classes with reference to diversity in animal form and function of Mollusca, Echinodermata

General account: Larval form and their significance in Echinodermata; Coelom; Torsion and detorsion in Mollusca; Ambulacral system

**List of Recommended Books**

1. Kettle, D.S: Medical Veterinary Entomology (CAB International).
2. Boolotian and Stiles: College Zoology (Macmillan)
3. Campbell: Biology (Benjamin)
4. Marshall and Williams: Text Book of Zoology
5. Wolfe: Biology the Foundations (Wadsworth)'
6. Parker & Haswell: Text Book of Zoology Vol.II (Macmillan)
7. Prescott: Cell (Jones & Bartlett).
8. M.Kato. The Biology of Biodiversity, Springer.
9. J.C. Avise. Molecular Markers, Natural History and Evolution, Chapman & Hall, New York.
10. E.O. Wilson. Biodiversity, Academic Press, Washington.

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**Semester-II**

**Course no.:** 16ZOO22D1

**Course Title:** Aquaculture

**MM: 80**

**Time: 3Hr**

Note: There shall be nine questions in total. One question will be compulsory (short answer type) covering the entire syllabus and remaining eight questions will be set two from each unit. Students are required to attempt one from each unit.

**Unit-I**

Different systems for aquaculture: pond culture, cage culture, raceway culture.

Culture of important fish species (Mayer carps, common carps, Chinese carps, cat fish culture and Tilapia culture).

**Unit-II**

Integrated Aquaculture and waste water aquaculture

Pearl Culture

Frog culture

Prawn culture-Fresh and brackish water

**Unit-III**

Impact of Aquaculture on Environment

Methods of Fishing : Crafts and gear technology

Nutrition in Aquaculture: Nutrient and non-nutrient diet components, Preparation and processing of feed, feed formulae, Natural and supplementary feed and their utilization

**Unit-IV**

Role of genetics in aquaculture– gynogenesis, androgenesis, triploidy, tetraploidy, hybridization, sex reversal and breeding, production of transgenic fish, impact of GMOs on aquatic biodiversity.

**List of Recommended Books**

1. Fishponds in Farming Systems, Zijpp, V. D., Verreth, J. A. J., Tri, L. Q., van Mensvoort, M. E. F., Bosma, R. H., and Beveridge, M. C. M., Wageningen Academic Publishers, Netherlands
2. Aquaculture Principles and Practices, Pillay, T. V. R., Blackwell Publishing, USA
3. Aquaculture and Fisheries Biotechnology Genetic Approaches, Dunham, R. A., CABI Publishing, USA

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**Semester-II**

**Course no.:** 16ZOO22D2  
**Course Title:** Evolutionary Biology

**MM: 80**  
**Time: 3Hr**

Note: There shall be nine questions in total. One question will be compulsory (short answer type) covering the entire syllabus and remaining eight questions will be set two from each unit. Students are required to attempt one from each unit.

**Unit I**

Emergence of evolutionary thoughts and mechanisms:  
Lamarck; Darwin's concepts of variation,  
Adaptation, struggle, fitness and natural selection;  
Mendelism; spontaneity of mutations; the evolutionary synthesis.

**Unit II**

Origin of cells and unicellular evolution:  
Origin of basic biological molecules; abiotic synthesis of organic monomers and polymers;  
Concept of Oparin and Haldane; experiment of Miller (1953); the first cell;  
Evolution of: unicellular eukaryotes; prokaryotic and eukaryotic cells

**Unit III**

Paleontology and evolutionary history:  
The evolutionary time scale; Eras, periods and epoch;  
Major events in the evolutionary time scale;  
Origins of unicellular and multicellular organisms;  
Stages in primate evolution including Homo

**Unit IV**

Molecular Evolution:  
Concepts of neutral evolution,  
Molecular divergence and molecular clocks;  
Molecular tools in phylogeny, classification and identification;  
Protein and nucleotide sequence analysis;  
Origin of new genes and proteins;

**List of Recommended Books**

1. Dobzhansky, Th. Genetics and Origin of Species. Columbia University Press.
2. Dobzhansky, Th., F.J. Ayala, G.L. Stebbins and J.M. Valentine. Evolution. Surjeet Publication, Delhi.
3. Futuyama, D.J. Evolutionary Biology, Sinauer Associates, INC Publishers, Sunderland.
4. Hartl, D.L. A Primer of Population Genetics. Sinauer Associates, Inc, Massachusetts.
5. Jha, A.P. Genes and Evolution. John Publication, New Delhi.
6. King, M. Species Evolution-The role of chromosomal change. The Cambridge University Press, Cambridge.
7. Merrel, D.J. Evolution and Genetics. Holt, Rinehart and Winston, Inc.
8. Smith, J.M. Evolutionary Genetics. Oxford University Press, New York.

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**Semester- II**

**Course no.:** Zoo-16ZOO22C4

**M.M.: 100**

**Course Title:** Laboratory Course

**Time: 6 Hr**

1. To study the various developmental stages of life cycle of *Caenorhabditis elegans* with the help of charts
2. To study the various developmental stages of embryogenesis and life cycle of *Drosophila*.
3. To study the various developmental stages of life cycle of Frog.
4. To study various developmental stages of chick embryo with the help of the permanent slides.
5. To dissect out *Drosophila* larvae and to take out the imaginal discs
6. To study Influence of temperature on insect development
7. To study Influence of mutagens on insect development
8. To study Development and Preservation of chick Embryo.
9. Observation of sex chromatin (Barr bodies) in buccal epithelial cells of human female
10. To study the effect of UV rays on the *Drosophila melanogaster*
11. To analyse the restriction pattern by agarose gel electrophoresis and to map restriction plasmid sites on plasmid DNA
12. To prepare ligation lambda/E CORI digest using T<sub>4</sub> DNA ligase and amylase ligated sample by agarose gel electrophoresis
13. To study normal human karyotype
14. To study chromosomal abnormalities
15. To study the various human pedigrees
16. Gene mapping by TPT cross
17. Study of chromosomes slides (autosomes and sex chromosomes)
18. To study primary and secondary sexual characteristics



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**Semester- II**

**Course no.: Zoo-16ZOO22C5**

**M.M.: 100**

**Course Title: Laboratory Course**

**Time: 6 Hr**

1. To study and classify representative animal specimen belonging to protozoans to echinodermata with charts and available material.
2. To show the dissection of the representative animals like leech, pila and grasshopper ,Cockroach, & Earthworm for their anatomical studies of various systems with the help of charts and CD.
3. To prepare the dichotomous key of the Porifera
4. To prepare the dichotomous key of the Coelenterata
5. To prepare the dichotomous key of the Arthropoda
6. Slides and Museum specimens:
  - i. Protozoa
  - ii. Porifera
  - iii. Cnidaria
  - iv. Annelida
  - v. Arthropoda
  - vi. Mollusca
  - vii. Echinodermata
7. Study of mouth parts of different insects with the help of charts and CD
8. To prepare the dichotomous key of the Porifera, Coelenterata, Arthropoda, annelida, Mollusca and Echinodermata.
9. Estimation of ovarian egg counts.
10. Culture of live food organisms and estimation of population density of live food organisms.
11. Identification of eggs, spawn, fry and fingerlings of cultivable fishes of India.
12. Collection and identification of aquatic weeds.
13. Collection and identification of aquatic insects.
14. Study of feeding habits of fishes by gut content analysis.
15. Aquarium design and maintenance.
16. Formulation and preparation of artificial fish food
17. Analysis of proximate composition (protein and fat) of fish
18. Analysis of proximate composition (protein and fat) of artificial fish food
19. To study the stages of Evolution of the prokaryotes.
20. To study the stages of Evolution of the eukaryotes.
21. To study evolutionary history of Primates.
22. Human evolutionary tree.
23. Study of evolutionary time scale.
24. Serial homology supporting evolution.
25. Phenotypic Plasticity supporting evolution.
26. Paleontological evidences supporting evolution.
27. Study of natural Selection in action.
28. To study different examples of co-evolution between different organisms.

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**Semester-III**

**Course no.:** 16ZOO23C1  
**Course Title:** Immunology

**MM: 80**  
**Time: 3Hr**

Note: There shall be nine questions in total. One question will be compulsory (short answer type) covering the entire syllabus and remaining eight questions will be set two from each unit. Students are required to attempt one from each unit.

**Unit I**

Innate and adaptive immune system  
Cells and molecules involved in innate and adaptive immunity,  
Effector mechanisms in immunity  
Antigens, antigenicity and immunogenicity.  
B and T cell epitopes,  
Structure and function of antibody molecules,  
Generation of antibody diversity,

**Unit II**

Monoclonal antibodies,  
Antibody engineering,  
Antigen-antibody interactions,  
MHC molecules,  
Antigen processing and presentation,  
Activation and differentiation of B and T cells,

**Unit III**

B and T cell receptors,  
Humoral and cell-mediated immune responses,  
Primary and secondary immune modulation,  
The complement system,  
Toll-like receptors,  
Cell-mediated effector functions

**Unit IV**

Inflammation,  
Hypersensitivity  
Autoimmunity,  
Immune response during bacterial (tuberculosis), parasitic (malaria) and viral (HIV) infections, Congenital Acquired immunodeficiencies, Vaccines.

**List of Recommended Books**

1. Kuby. Immunology, W.H. Freeman, USA.
2. W. Paul. Fundamentals of Immunology.
3. Tatora et al. Microbiology
4. Pelczar. A text book of microbiology
5. I.M. Roitt. Essential Immunology, ELBS Edition.

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**Semester-III**

**Course no.:** 16ZOO23C2

**MM: 80**

**Course Title:** Biology of Vertebrates

**Time: 3Hr**

Note: There shall be nine questions in total. One question will be compulsory (short answer type) covering the entire syllabus and remaining eight questions will be set two from each unit. Students are required to attempt one from each unit.

**Unit I**

Introduction to chordates with their general characters:

Origin of chordates

Classifications of vertebrate's upto order

**Unit II**

Salient Features and classification up to classes with reference to diversity in animal form and function of

Protochordata

Urochordata

Hemichordata

**Unit III**

Salient Features and classification up to classes with reference to diversity in animal form and function of

Pisces

Amphibia

General account: Dipnoi; Migration of fishes; Parental care in fishes and amphibians;

**Unit IV**

Salient Features and classification up to classes with reference to diversity in animal form and function, like:

Reptilia

Aves

Mammals

General account: Flight adaptation in birds; Migration of birds. Evolution of Horse and man.

**List of Recommended Books**

1. Boolotian and Stiles: College Zoology (Macmillan)
2. Campbell: Biology (Benjamin)
3. Marshall and Williams: Text Book of Zoology
4. Wolfe: Biology the Foundations (Wadsworth)
5. Parker & Haswell: Text Book of Zoology Vol.II (Macmillan)
6. Prescott: Cell (Jones & Bartlett).
7. M.Kato. The Biology of Biodiversity, Springer.
8. J.C. Avise. Molecular Markers, Natural History and Evolution, Chapman & Hall, New York.
9. E.O. Wilson. Biodiversity, Academic Press, Washington.
10. G.G. Simpson. Principle of animal taxonomy, Oxford IBH Publishing Company.
11. E. Mayer. Elements of Taxonomy.
12. E.O. Wilson. The Diversity of Life (The College Edition), W.W. Northern & Co.
13. B.K. Tikadar. Threatened Animals of India, ZSI Publication, Calcutta.

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**Semester-III**

**Course no.: 16ZOO23D1**

**Course Title: Animal Behavior and Taxonomy**

**MM: 80**

**Time: 3Hr**

Note: There shall be nine questions in total. One question will be compulsory (short answer type) covering the entire syllabus and remaining eight questions will be set two from each unit. Students are required to attempt one from each unit.

**Unit I**

Definition and basic concepts of biosystematics and taxonomy, Species concepts - species category, different species concepts; sub-species and other infra-specific categories. Principles and theories of biological classification, hierarchy of categories. Taxonomic keys-different kinds of taxonomic keys, their merits and demerits.

**Unit II**

International code of Zoological Nomenclature (ICZN) - its operative principles, interpretation and application of important rules, Zoological nomenclature; formation of scientific names of various taxa. Chemotaxonomy, Cytotaxonomy, Molecular taxonomy Taxonomic procedures-taxonomic collections, preservation, curation process of identification. Taxonomic characters: different kinds and their significance, Systematic publications: - different kinds of publications.

**Unit III**

Approaches and Methods in Study of Behavior; Proximate And Ultimate Causation; Altruism and Evolution-Group Selection, Kin Selection, Reciprocal Altruism; Concept Of Learning, Memory, Cognition, Sleep And Arousal; Biological Clock.

**Unit IV**

Development of Behavior, Social Communication, Social Dominance; Territoriality; Mating Systems, Parental Care, Aggressive Behavior, Migration, Orientation And Navigation; Domestication and Behavioral Changes

**List of Recommended Books**

1. G.G. Simpson. Principle of animal taxonomy, Oxford IBH Publishing Company
2. E. Mayer. Elements of Taxonomy.
3. E.O. Wilson. The Diversity of Life (The College Edition), W.W. Northern & Co.
4. B.K. Tikadar. Threatened Animals of India, ZSI Publication, Calcutta.
5. Mechanism of Animal Behaviour, Peter Marler and J. Hamilton; John Wiley & Sons, USA
6. Animal Behaviour, David McFarland, Pitman Publishing Limited, London, UK
7. Animal Behaviour, John Alcock, Sinauer Associate Inc., USA
8. Perspective on Animal Behaviour, Goodenough, McGuire and Wallace, John Wiley & Sons, USA
9. Exploring Animal Behaviour, Paul W. Sherman & John Alcock, Sinauer Associate Inc. ,Massachusetts, USA
10. An Introduction to Animal Behaviour, A. Manning and M.S Dawkins, Cambridge University Press, UK

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**Semester-III**

**Course no.: 16ZOO23D2**

**Course Title: Molecular Endocrinology**

**MM: 80**

**Time: 3Hr**

Note: There shall be nine questions in total. One question will be compulsory (short answer type) covering the entire syllabus and remaining eight questions will be set two from each unit. Students are required to attempt one from each unit.

**Unit I**

Definition and scope of endocrinology; Structure of various endocrine glands; Phylogeny of endocrine glands; Hormones: Classification, structure and function; Endocrine control of various physiological mechanisms in nemertean, annelids, mollusks, arthropods (Insects and crustaceans) and echinodermates. Techniques for quantitation, purification and characterization of hormones.

**Unit II**

Biosynthesis and secretion of hormones: Biosynthesis of steroid hormones *de novo*; Biosynthesis and amino-acid derived small size hormones (eg:T4, Epinephrine, etc.); Biosynthesis, storage and secretion of protein hormones: Transcriptional and post-transcriptional mechanisms of hormone biosynthesis and secretion; Regulation of biosynthesis and secretion; Inhibitors of hormone biosynthesis and their use.

**Unit III**

Hormone action and regulation: Hormone receptors - identification, quantitation purification and physico-chemical properties; Membrane receptors - structure and signal transduction mechanisms, G-proteins; Nuclear receptors - structure and function, Orphan receptors; Receptor antagonists and their applications; Metabolic and developmental hormones.

**Unit IV**

Neuroendocrine regulation: Neuroendocrine regulation of immune system, Stress hormones and immune responses, Regulation of systemic homeostasis by nervous and immune system interactions; Hormones as therapeutic agents: Current developments in design and production of hormonal contraceptives, Recombinant protein hormones-production and application in regulation of fertility in farm animals and humans.

**List of Recommended Books**

1. Mac E. Hadley, Jon E. Levine. Endocrinology, Pearson Prentice Hall, 2007
2. H. Maurice Goodman. Basic Medical Endocrinology, Fourth Edition, 2008, Academic Press, Elsevier
3. F. Bolander. Molecular Endocrinology, 3rd Edition, 2004, Academic Press, Elsevier
4. E.J.W. Barrington. General and Comparative Endocrinology, Oxford, Clarendon Press.
5. P.J. Bentley. Comparative Vertebrate Endocrinology. Cambridge University Press.
6. R.H. Williams. Text Book of Endocrinology, W.B. Saunders
7. C.R. Martin. Endocrine Physiology. Oxford Univ. Press.

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**Semester-III**

**Course no.: 16ZOO23D3**

**Course Title: Biology of Population**

**MM: 80**

**Time: 3Hr**

Note: There shall be nine questions in total. One question will be compulsory (short answer type) covering the entire syllabus and remaining eight questions will be set two from each unit. Students are required to attempt one from each unit.

**Unit I**

Genetic structure of natural populations: Gene pool, Genotype frequency and Allele frequency

Hardy-Weinberg law of genetic equilibrium.

Assumptions, predictions, applications and significance of Hardy-Weinberg law

Conditions when Hardy-Weinberg law might not apply

**Unit II**

Various destabilizing forces of natural populations:

(i) Natural selection (ii) Mutation (iii) Genetic drift (iv) Migration

Bottlenecks and founder effects

Nature, types and sources of variations in natural populations.

**Unit III**

Polymorphism as cause of variability in populations:

Salient features and types Polymorphism

Origin of Polymorphism

Mechanisms to maintain polymorphism within populations

Adaptive advantages of polymorphism

**Unit IV**

Genetics of quantitative traits in populations

Quantitative traits and natural selection

Inbreeding depression, Phenotypic plasticity

Concept of Biodiversity in populations

**Suggested Reading Material**

1. Dobzhansky, Th., F.J. Ayala, G.L. Stebbins and J.M. Valentine. Evolution. Surjeet Publication, Delhi.
2. Futuyama, D.J. Evolutinary Biology, Suinuaer Associates, INC Publishers, Dunderland.
3. Haiti, D.L. A Primer of Population Genetics. Sinauer Associates, Inc, Massachusetts.
4. Jha, A.P. Genes and Evolution. John Publication, New Delhi.
5. King, M. Species Evolution-The role of chromosomal change. The Cambridge University Press, Cambridge.
6. Dobzhansky, Th. Genetics and Origin of Species. Columbia University Press.

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**Semester - III**

**Course no: 16ZOO23D4**

**Course Title: Environmental Biology**

**MM: 80**

**Time: 3hrs**

Note: There shall be nine questions in total. One question will be compulsory (short answer type) covering the entire syllabus and remaining eight questions will be set two from each unit. Students are required to attempt one from each unit.

**Unit I**

Interactions between environment and biota; Concept and types of ecosystem, Stability and complexity of ecosystems; Productivity and biodegradation in different ecosystems; Limiting factor; food chain and energy flow, productivity and biogeochemical cycles (N<sub>2</sub>, P, C and S); Ecological pyramids and recycling; Community structure and organisation;

**Unit II**

Wild life: Speciation and extinctions; Magnitude and distribution of biodiversity, economic value, wildlife biology, conservation strategies. Wildlife and livelihood; Wildlife and illegal trade & control. Animal trafficking and poaching.

**Unit III**

Global environmental change; biodiversity, status, monitoring and documentation; Major drivers of biodiversity change, biodiversity management approach. Microbiology of water, air, soil and sewage

**Unit IV**

Characteristic of population: population growth curves

Concept of metapopulations: demes and dispersals and interdemec extinctions

Age structured population

Biogeographical realms of India

**List of Recommended Books**

1. Jorgensen, S.E. Fundamentals of ecological modeling. Elsevier, New York.
2. Lendren, D. Modelling in behavioral ecology. Chapman & Hal, London, UK.
3. Sokal, R.R. and F.J. Rohlf. Biometry. Freeman, San Francisco.
4. Odum : Ecology (Amerind)
5. Odum : Fundamentals of Ecology (W.B. Saunders)
6. Ricklefy : Ecology, (WH Freeman)
7. Turk and Turk : Environmental Science (W.B. Saunders)

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**Semester- III**

**Course no.: 16ZOO23C3**

**Course Title: Laboratory Course**

**M.M.: 100**

**Time: 6 Hr**

1. Isolation of mononuclear cell by lymphocyte separation
2. The study of antigen antibody reaction by Quantitative Precipitin Assay
3. Study of rapid agglutination of antibody coated latex particles by specific antigen
4. Determination of titre value of antibody present in sample by Widal test
5. To demonstrates the precipitation of antigen-antibody complex.
6. Detection of presence of Rheumatoid factors
7. Detection of presence of reagin antibody in the serum
8. Identification of *Treponemes* by VDRL test
9. Study of lymphoid organs in mice by CD
10. Study of permanent slides of lymphoid organs
11. Study and classify specimen up to order of various phyla of vertebrates with the help of charts
12. Study of Dissections through chart: Rat/ Mice /Fish, with the help of CD and Charts :
  - Digestive system,
  - Reproductive system,
  - Arterial system,
  - Venous systems,
  - Cranial nerves
13. Museum specimens and slides :
  - Protochordates –
  - Fishes
  - Amphibians
  - Reptiles
  - Birds
  - Mammals
14. To prepare the taxonomic key on the basis of given characteristics.
15. Comparative study of the various systemic groups through charts etc.



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**Semester- III**

**Course no.: 16ZOO23C4**

**Course Title: Laboratory Course**

**M.M.: 100**

**Time: 6 Hr**

1. To study the geotaxis behaviour of earthworm.
2. To study the Hydrotaxis, behaviour of earthworm
3. To study the Chemotaxis behaviour of earthworm and
4. To study the Phototaxis behaviour of earthworm
5. To demonstrate antennal grooming behaviour in cockroach.
6. Demonstration of food preferences behaviour in ants
7. To study the effect of temperature on feeding behaviour of cockroach
8. Preparation of taxonomic keys of given invertebrates
9. Identification and classification of given animal
10. To identify different endocrine glands with the help of charts
11. To study the histology of endocrine glands of animals with the help of charts
12. To determine the concentration of glucose in the diabetic samples.
13. To measure concentration of corticosterone in human plasma or given sample
14. To measure serotonin level given sample
15. To perform affinity column chromatography
16. To perform ELISA
17. To study the genetic variations in Human populations.
18. To study the genetic variability with the help of thumb impression.
19. Verification of Mendelian monohybrid ratio and its analysis.
20. Verification of Mendelian dihybrid ratio and its analysis.
21. Determination of frequency of dominant and recessive traits (alleles).
22. Determination of frequency of multiple alleles.
23. Pedigree analysis from pedigree charts.
24. To study adaptive radiation *w.r.t.* mouth parts of insects.
25. Simpson's Index calculation a tool for measuring genetic diversity in population samples.
26. Shannon Weiner Index as a diversity measurement tool for large populations.
27. To determine the concentration of free CO<sub>2</sub> in variety of given samples of water.
28. Determination of dissolved O<sub>2</sub> of given water samples by Wrinklers method.
29. Determination of dissolved BOD in variety of given samples.
30. Determination of dissolved COD in variety of given samples.
31. Determination of salinity in variety of given samples of water and soil.
32. To determine hardness content in polluted and control water and soil samples
33. To study presence of specific microbes in various normal and polluted water and soil samples.
34. Collection of phytoplankton and zooplankton from natural resources and their identification.
35. Ecological comments on wild species of different niche and habits.
36. Pollution/ Toxicology: a. Estimation of LD<sub>50</sub> and LC<sub>50</sub> b. Pesticide residue analysis of contaminated vegetable soil and water.

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**Semester-IV**

**Course no.: 16ZOO24C1**

**Course Title: Biosafety & Ethics in Science**

**MM: 80**

**Time: 3hrs**

Note: There shall be nine questions in total. One question will be compulsory (short answer type) covering the entire syllabus and remaining eight questions will be set two from each unit. Students are required to attempt one from each unit.

**UNIT I**

Mechanism of Radioactive Decay, Interactions of beta and gamma radiation with matter, electron capture, Decay schemes and energy level diagrams. Physical, biological and effective half lives, Radionuclide hazards. Radiation measurement instruments; Contamination monitoring; Exposure – Internal and External exposure Safe handling of radioactive sources.

**UNIT II**

**Social issues:** genetic discrimination: insurance and employment, human cloning, foeticide, sex determination.

**Ethical issues:** somatic and germ line gene therapy, clinical trials, ethical committee function. Social and ethical issues

**UNIT III**

Bio-safety-Definition, Requirement, Bio-safety containment facilities, Bio-safety against infectious agents/microorganism; bio-safety levels for infectious agents and infected food/animals; introduction of biological safety cabinets; biohazards, Biosafety for human health and environment; designing and management of laboratory and culture room as per the norm of GLP, GMP and FDA.

**UNIT IV**

Bio-safety issues related with GMOs; the risk of introducing genetically engineered organism to environment-ecological safety; Indian government bio-safety guidelines; role of RCGM (review committee on genetic manipulation), role of GEAC (genetic engineering approval committee), role of IBSC (institute bio-safety committee) in research and development of GMOs (transgenics), in medicine, food and agriculture; guidelines for environmental release of GMOs; risk assessment, risk management;.

**List of Recommended Books**

1. Radioisotope Gauges for Industrial Process Measurements (Measurement Science and Technology) by Geir Anton Johansen and Peter Jackson (Jul 26, 2004).
2. Radioisotope Laboratory Techniques by R. A. Faires, etc. and G. G. J. Boswell (Dec 1980).
3. Radiotherapy in Practice: Radioisotope Therapy by Peter J. Hoskin (Mar 22, 2007).
4. Radioisotopes in Biology (Practical Approach Series) by Robert J. Slater (Feb 1, 2002).
5. Clinical Use of Radioisotopes by William Beierwaltes (1957).
6. Biological Safety: Principles And Practices (Biological Safety: Principles & Practices) by Diane O., Ph.D. Fleming and Debra Long Hunt (Aug 30, 2006).

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**Semester-IV**

**Course no.: 16ZOO24C2**  
**Course Title: Advances in Vermiculture**

**MM: 80**  
**Time: 3Hr**

Note: There shall be nine questions in total. One question will be compulsory (short answer type) covering the entire syllabus and remaining eight questions will be set two from each unit. Students are required to attempt one from each unit.

**Unit – I**

Earthworms: Taxonomic position and diversity.

Type: morphological and ecological grouping – Epigeic species, Endogeic species and Anecics.

Ecological and economic importance of earthworms; Useful species of earthworms. Local species of earthworms.

**Unit – II**

Vermiculture – definition, scope and importance.

Exotic species of earthworm-Biology of *Eisenia fetida* & *Eudrilus eugeniae*-Taxonomy Anatomy, physiology and reproduction .

Culture methods: indoors and out door; Monoculture and polyculture

**Unit – III**

Applications of Vermiculture /Vermiculture Bio-technology.

Vermicomposting, Chemical composition of vermicastings.

Use of Earthworms as feed/bait for capture/culture fisheries.

**Unit – IV**

Role of earthworms in agro-ecosystems

Land reclamation and sustainable soil fertility; forest regeneration

Earthworms for management of municipal/selected biomedical solid wastes.

**List of Recommended Books**

1. Edwards CA & Bate JE. 1977. Biology of Earthworms. Chapman & Hall.
2. Edwards CA. 1998. Earthworm Ecology. CRC Press.
3. Sultan Ahmed Ismail, 2005. The Earthworm Book, Second Revised Edition. Other India Press, Goa, India.



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**Semester- II**

**Course no.:** Zoo-16ZOO220

**M.M.:** 80

**Course Title:** Applied Zoology

**Time:** 3 Hr

Note: There shall be seven questions in total. One question will be compulsory (short answer type) covering the entire syllabus and remaining six questions will be set two from each unit. Students are required to attempt compulsory question and 04 more questions selecting at least selecting one from each unit.

**Unit-I**

Host – Definitive and intermediate, Parasitism, Symbiosis, Commensalism, Reservoir.  
Transmission, prevention and control of diseases: Tuberculosis and Swine flu  
Principles and applications of ECG, MRI, PET, and CAT.

**Unit-II**

Life history and pathogenesis of *Plasmodium* sp.  
Life history, Medical importance and control of *Aedes* sp.  
Life history, pathogenesis and control of *Taenia* sp.  
Principles and applications of brain activity recording, and pharmacological testing.

**Unit-III**

Preservation of gametes in animal and artificial insemination.  
Principles and management of Poultry.  
Introduction and management of pisciculture  
Genetic improvement in animals; Induced breeding in aquaculture.

**List of Recommended Books**

1. Dent, D. Insect Pest Management
2. Hill, D.S., Timber Press. Agricultural Entomology
3. David, B. V. & Ananthakrishnan. General and Applied Entomology . T. N., TataMcGraw-Hill Publishing.
4. Asa C. Chandler, Clark P. Read, Introduction to Parasitology, John wiley and Sons., Inc.,New York.
5. Thomas W.M. Cameron, Parasites and Parasitism, Billing and Sons ltd. London,
6. Elmer R. Noble, Glenn A. Noble; Parasitology: The Biology of Animal Parasites, Lea and Febiger, Washington.
7. R.P. Hall, Protozoology, Prentice-Hall, Inc. Engteewood diffs. N.J. Charles E. Tuttle Company, Tokya
8. E.O. Wilson. The Diversity of Life (The College Edition), W.W. Northern & Co.
9. Molecular Biology of the Cell, B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts and J.D. Watson. Garland Publishing Inc., New York.
10. Molecular Biology and Biotechnology. A comprehensive desk reference, R.A. Meyers (Ed.), VCH Publishers, Inc., New York.
11. Molecular Cloning: a Laboratory Manual, J. Sambrook, E.F. Fritsch and T. Maniatis, Cold Spring Harbor Laboratory Press, New York.
12. Gray's Clinical Neuroanatomy by Mancall **New** Medical Pharmacology at a Glance (7th Ed.)
13. Medicine at a Glance (3rd Ed.)
14. Oxford Handbook of Neurology (2nd Ed.)

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**Semester- II**

**Course no.:** Zoo-16ZOO22F  
**Course Title:** Communication Skills

**M.M.:** 40  
**Time:** 3 Hr

Note: There shall be five questions in total. One question will be compulsory (short answer type) covering the entire syllabus and remaining four questions will be set selecting two questions from each unit. Students are required to attempt question No.1 and 02 more questions selecting one from each unit.

**Unit I**

Research process- scientific method, Criteria for good research,  
Research design- Meaning and need for research design, features of good design.  
Paragraph writing: proper use of verb, Nouns, pronouns, tense, use of MS office, excel, powerpoints for preparing a scientific report.  
Mechanical and stylistic aspects of scientific writing- Precision and clarity of language,  
Writing style, presentation of numerical data and scientific figures,  
Usage of line, bar-graphs, charts to describe the results.

**Unit II**

Scientific presentation: Preparation and Order of material, Use of web information,  
Different ways to make impressive presentations: General gesture for presentations, Speed, loudness, clarity during presentations, Use of appropriate vocabulary during presentation, General discussion.  
Scientific paper and review writing; correspondence with editors and reviewers,  
Appropriate citations, copyright and Ethical issues in drafting, Acknowledgment,  
Keywords, usage of different softwares for manuscript preparation,

**List of Recommended Books**

1. Rastogi, B.C., Bioinformatics, Concept, Skills & Applications, CBS Publications.
2. Richard Ellis, Communication Skills: Stepladders to success for professional, Gutenberg Press, Malta.
3. John W. Davis, Communication skills: a guide for engineering and applied science students, Prantics Hall, 2001.
4. Gupta S., Communication skills and Functional Grammar, University Science Press, New Delhi 110002.
5. Lloyd M., Bor R., Communication skills for medicine, Elsevier press, Churchill Livingstone Elsevier.

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**Semester- III**

**Course no.:** Zoo-16ZOO230  
**Course Title:** Wild Life And Conservation

**M.M.:** 80  
**Time:** 3 Hr

Note: There shall be seven questions in total. One question will be compulsory (short answer type) covering the entire syllabus and remaining six questions will be set two from each unit. Students are required to attempt question 1 and 4 more selecting atleast one from each unit.

**Unit-I**

Wildlife: Definition, significance and wildlife zones of the world and India, Protected Area Systems, Present status of National PA-Systems. Theory and Practice of Biosphere Reserves of the world: Biosphere Reserves of India. Natural Heritage sites, Wildlife and livelihood; Wildlife and illegal trade & control.

**Unit-II**

Wildlife Damage, electric fences for wildlife damage control, Basic electric fence design, Trench design, line trapping, Mist netting, Rocket netting Chemical capture: Equipment, Drugs, Plan of operation. Poaching: Its implications, conducting anti-poaching operations.

**Unit-III**

Wildlife conservation techniques, role of WWF, IUCN, UNEP, Red Data Book; Categories of Endangered Wildlife Species. National Projects: Project Tiger, Project elephant, Project Rhinoceros, Project Crocodiles.

**List of Recommended Books**

1. Techniques for wildlife Census in India by W.A. Rogers (A field manual); Wildlife Institute of India, Dehradun.
2. Wildlife Wealth of India by T.C. Majupuria; Tecpress Services, L.P., 487/42-SOL Wattenslip, Pratunam Bangkok, 10400, Thailand
3. Ali, S. Ripley S.D. Handbook of Birds of India, Pakistan 10-Vols. Oxford University Press, Bombay.
4. The Book of Indian Animals by S.H. Prater, BNHS-Publication, Bombay.
5. Wildlife in India by V.B. Saharia Natraj Publishers, Dehradun.
6. E.P. Gee, The Wildlife of India.