DEPARTMENT OF ZOOLOGY
Credit matrix for M.Sc. Zoology programme w.e.f. 2015-16

<table>
<thead>
<tr>
<th>Semester</th>
<th>Core paper (C)</th>
<th>Soft core Elective (E)</th>
<th>Foundation (F)</th>
<th>Open elective (OE)</th>
<th>Dissertation/Project Work(D)/Seminar(S)</th>
<th>Total</th>
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<tr>
<td>I</td>
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REQUIRED CREDITS FOR M.SC ZOOLOGY (TWO YEAR COURSE):
CORE PAPER = 86
SOFT CORE = 12
OPEN ELECTIVE = 2
FOUADATION COURSE = 2
DISSERTATION = 20
TOTAL = 124

INSTRUCTION FOR THE STUDENTS

Course Types:

- **Hard Core (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.
- **Soft Core Elective (E):**- Soft core 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 Course (F):**- The Foundation Course is based upon the content that leads to Knowledge enhancement. It is mandatory as per course curriculum.
- **Interdisciplinary Course/Open Elective (OE):**- Open elective course may be from an unrelated discipline. It is Interdisciplinary/Open Elective & mandatory as per course curriculum.
### DEPARTMENT OF ZOOLOGY
Choice Based Credit System (CBCS)
Scheme of Examination (M.Sc. - Zoology) w.e.f. session 2015-16

#### SEMESTER I

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Nomenclature of Paper</th>
<th>Credit</th>
<th>Hours</th>
<th>MM (Max Marks)</th>
<th>IA (Internal Assessment)</th>
<th>TM (Total marks)</th>
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<tbody>
<tr>
<td>Zoo-101C</td>
<td>Animal Biochemistry and metabolism</td>
<td>4</td>
<td>4</td>
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<tr>
<td>Zoo-102C</td>
<td>Techniques in Animal Science</td>
<td>4</td>
<td>4</td>
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<tr>
<td>Zoo-103C</td>
<td>Animal Cell Biology</td>
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<tr>
<td>Zoo-104C</td>
<td>Immunology</td>
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<tr>
<td>Zoo-105C</td>
<td>Advanced Physiology</td>
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<th>Credit</th>
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<td>Zoo-201C</td>
<td>Developmental Biology</td>
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<td>Zoo-202C</td>
<td>Evolutionary Biology</td>
<td>4</td>
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<td>Zoo-203C</td>
<td>Molecular Biology</td>
<td>4</td>
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<td>Zoo-204C</td>
<td>Biology of Invertebrates</td>
<td>4</td>
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<td>Zoo-205E</td>
<td>Parasitology</td>
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<td>Entomology</td>
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<td>Biostatistics and Computer</td>
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<td>Zoo-208E</td>
<td>Wildlife and Conservation</td>
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<td>Zoo-210F</td>
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<td>Zoo-301C</td>
<td>Biology of Vertebrates</td>
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<td>Molecular Cytogenetics</td>
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<td>Zoo-305E</td>
<td>Animal Behavior And Taxonomy</td>
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<td>Zoo-306E</td>
<td>Aquaculture</td>
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<td>Zoo-307E</td>
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<td>Biosafety &amp; Ethics in Science</td>
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<td>Zoo-402C</td>
<td>Fundamental of Vermiculture</td>
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<td>Zoo-403D</td>
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**GRAND TOTAL**

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<tr>
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Semester-I
Course no.: Zoo-101C  
Course Title: Animal Biochemistry And Metabolism  
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
- 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
5. D. Freifelder, Essentials of Molecular Biology.
8. Hawk. Practical Physiological Chemistry.
Semester-I

Course no.: Zoo-102C  MM: 80
Course Title: Techniques in Animal Sciences  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
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
3. Shukla and Upadhyaya. Experimental Science
4. Randhir Singh. Practicals in Biochemistry
Semester-I

Course no.: Zoo -103C  MM: 80
Course Title: Animal Cell Biology  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
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++ 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 Cyclines and cyclin dependent kinases and Regulation of CDK-cycline activity; Biology of cancer, Biology of aging and Apoptosis-definition, mechanism and significance

List of Recommended Books
Course no.: Zoo-104C  
Course Title: Immunology  

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.
3. Totora et al. Microbiology
Semester-I

Course no.: Zoo-105C
Course Title: Advanced Physiology

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
14. Sastry KV and Shukla V. Text Book of Physiology and Biochemistry, Rastogi Publication, Meerut
Semester- 1
Course no.: Zoo-107 LC
Course Title: Laboratory Course
List of Practicals
1. To separate and identify sugar by TLC
2. To prepare casein from milk
3. To plot the calibration curve for protein estimation by Lowry method
4. To plot standard curve for estimation of carbohydrate by anthrone method
5. Estimation of creatinine in blood
6. Colorimetric estimation of DNA and RNA
7. Separation and identification of amino acids by paper chromatography
8. To test the urine for urea, proteins, ketones and sugar
9. To determine the protein concentration in the given albumin by Biuret method
10. Qualitative estimation of salivary amylase
11. To investigate the effect of temperature on enzyme catalysed reaction
12. To investigate the effect of varying pH on the activity of salivary amylase
13. To study the principle, working and applications of Phase Contrast Microscope.
14. To study the principle, working and applications of Fluorescence Microscope
15. To study the principle, working and applications of Transmission Electron Microscope
16. To prepare wax blocks of biological material for light microscopy
17. To prepare permanent slides from wax blocks and their staining
18. To perform spectrophotometric measurement of glucose (Bradford method)
19. To isolate Genomic DNA by cTAB method
20. To perform PCR for a given sample
21. To perform western blotting to analyse the given protein sample
22. Numericals on half life of radioactive isotopes
23. To study the rate of respiration by aquatic animals
24. To determine the concentration of free CO\textsubscript{2} in variety of given samples
25. Determination of dissolved O\textsubscript{2} of given samples by Wrinklers method
26. Isolation of monocytes
27. To study the effect of osmolarity of solution on RBC
28. To study the knee jerk reflex in man
29. To find the blood group of own blood
30. To find the Rh factor of own blood group
31. To estimate the amount of Hb present in human blood
32. To estimate the TLC present in 1mm\textsuperscript{3} volume
33. To estimate the RBC present in 1mm\textsuperscript{3} volume
34. Quantitative assay of precipitation
35. Haemagglutination test
36. To perform gel chromatography for analysis of given sample
37. Separation of molecules using ion exchange chromatography
38. Separation and identification of amino acids by radial chromatography
39. To study different stages of mitosis in onion root tips
40. To perform protein estimation test with the help of Bradford method
Course no.: Zoo-201C
Course Title: Developmental Biology

MM: 80
Time: 3hrs

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
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, Larval formation,
Metamorphosis, Environmental regulation of normal development,
Sex determination

List of Recommended Books
4. L. W. Browder et. al. Developmental Biology, 3rd Edition; Saunders College Publishing,
   Philadelphia ISBN 0-03-013514-1
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
Semester-II

Course no.: Zoo -203C
Course Title: Molecular 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
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
MAHARSHI DAYANAND UNIVERSITY ROHTAK  
DEPARTMENT OF ZOOLOGY  
M. Sc. ZOOLOGY w.e.f. session 2015-16

Semester-II  
Course no.: Zoo-204 C  
Course Title: Biology of Invertebrate  
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  
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 Coelenterata, 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
2. Boolotian and Stiles: College Zoology (Macmillan)  
3. Campbell: Biology (Benjamin)  
5. Wolfe: Biology the Foundations (Wadsworth)’  
7. Prescott: Cell (Jones & Bartlett).  
Semester-II

Course no.: Zoo -205 E
Course title: Parasitology
MM: 80
Time: 3 Hrs

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 Parasitology; Host parasite associations (Symbiosis, commensalism, phoresis, mutualism etc); parasite hosts and co-evolution of parasites and their hosts, advantages and limitations of parasitic life style. Factors contributing Parasitism.

Unit II

Unit III

Unit IV
Immune response and self-defense mechanisms, immune evasion and biochemical adaptations of parasites; Useful parasites: in maintaining healthy immune system and biological control.

List of Recommended Books
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
Classification and diagnostic features of insects.
Insect Predation and parasitism
Insect societies: subsociality in insect; Eusociality in insect (Colony and Castes in Hymenoptera and Isoptera); Evolution of eusociality.
Insect defense.

Unit-II
Metamorphosis: Types and Hormonal control
Diapause: diagnosis, ecological causes and its role
Mounting of insects

Unit-III
Digestive system: Alimentary canal: Digestion (Including unusual food materials); Absorption; Nutrition.
Circulatory system: Circulatory organs; Haemolymph; circulation of blood; Immune system
Respiratory system: Tracheal system, Spiracles; Gaseous exchange; Respiration in aquatic and endoparasitic insects.
Excretory system: Malpighian tubules; Nitrogenous excretion; Urine production; fat body and other haemocoelic tissues.

Unit-IV
Reproductive system: male and female reproductive organs; Spermatozoa and sperm transfer; ovulation and fertilization; types of reproduction.
Nervous system: Central nervous system (brain in brief); sympathetic nervous system; Controlling behaviour.
Endocrine system: Endocrine glands; Major hormones; Regulation of hormone titer; Mode of action of hormones.
Sensory system and behavior: Mechanical stimuli; Sound reception and sound production; Chemical stimuli; Semichemicals-Pheromones, Kairomones allomones and synomones: Insect vision.

List of Recommended Books
3. The Insect an outline of Entomology- by P.G. Gullan and P.S. Cranston.
4. A Text Book Of Insect Studies by Dr.Shashi Kanta
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
Collection, classification and tabulation of data. Frequency distribution, Diagrammatic and Graphical presentation of statistical data, Sampling techniques. Central tendency, Dispersion, coefficient of variation; Standard error; Confidence limits; Skewness and Kurtosis

Measures of Relationship: Correlation, Regression, Non-parametric tests

Unit II
Probability: Approaches to measurement of Probability, Random experiments, sample space, events. Mathematical definition of probability of an event. Probability distributions: Distribution of Binomial, Poisson and Normal Distributions and their properties; (including problems).

UNIT III
Testing of Hypothesis, Chi-square test, ‘t’ and ‘f’ test. Analysis of variance for one-way classified data, and two-way classified data.

UNIT IV
Computer peripherals and hardware description- computer system design, recognition and structure of different components of a computer system and their respective usage. Input/output and storage devices. Introduction of internet. Office application: MS office 2000 including MS word, MS excel and MS power point Overview of Windows XP. Number system and flow charts in computing language. DOS internal and external commands. Generations of programming languages, system and application software; Introduction of programming in BASIC.

Suggested Reading Material
4. Computer fundamentals: concepts, systems and application by PK Sinha. BPB publications
5. Computer fundamentals (Paperback) by Ashok Arora, Shefali Bansai and Shefali Bansal. Excel Books
6. Discovering computers: fundamentals (paperback) by Gary B. Shelly. Pub: Course technology
8. Computer fundamentals architecture and organization (paper back) by B Ram. Pub: New age publications (academic)
MAHARSHI DAYANAND UNIVERSITY ROHTAK
DEPARTMENT OF ZOOLOGY
M. Sc. ZOOLOGY w.e.f. session 2015-16

Semester-IV

Course no.: Zoo- 208E

Course Title: Wildlife and Conservation

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
Wildlife: Definition, significance and wildlife zones of the world and India, Wildlife Map of the world, Wildlife map of India, Protected Area Systems, Present status of National PA-Systems.

Unit-II
Theory and Practice of Biosphere Reserves of the world: Biosphere Reserves of India. Natural Heritage Sites of the world, Natural Heritage sites in India. Important National Park and Wildlife Sanctuaries of India Wildlife and livelihood; Wildlife and illegal trade & control;

Unit-III
Wildlife Damage, its nature and definition, 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 definition and implications, conducting anti-poaching operations, Evidence in poaching cases.

Unit-IV

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
5. Wildlife in India by V.B. Saharia Natraj Publishers, Dehradun.
Semester-II

Course no.: Zoo- 209 OE
Course Title: Applied Zoology

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
Common parasites and pathogens of humans, domestic animals and crops
- Viral- Rabies,
- Japanese encephalitis;
- Bacterial- Brucellosis, Plague;
- Ricketsial- Ricketial zoonosis, Q fever, Scrub typhus
Common parasites and pathogens of domestic animals
Common parasites and pathogens of crops

Unit-II
Piggery industry
Dairy industry
Bioresources
Uses of Biodiversity
Wool and fur industry,
Leather industry.
Pharmaceuticals from animals.

List of Recommended Books
1. Dent, D. Insect Pest Management
5. Thomas W.M. Cameron, Parasites and Parasitism, Billing and Sons ltd. London,
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DEPARTMENT OF ZOOLOGY
M. Sc. ZOOLOGY w.e.f. session 2015-16

Semester-II

Course no.: Zoo- 210 F
Course Title: Communication skills in Life-science

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

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.
5. Llyod M., Bor R., Communication skills for medicine, Elsevier press, Churchill Liverstone Elsevier.
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DEPARTMENT OF ZOOLOGY  
M. Sc. ZOOLOGY  w.e.f. session 2015-16

Semester- II

Course no.: Zoo-211 LC
Course Title: Laboratory Course  

List of Practicals

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 melanogaster* with the help of charts
3. To study the various developmental stages of life cycle of Frog with the help of charts
4. To study the Mammalian development (Human) with the help of charts
5. To study various developmental stages of chick embryo with the help of the permanent slides.
6. To dissect out *Drosophila* larvae and to take out the imaginal discs.
7. Immuno-histochemical staining to study the expression pattern of gap and pair- rule gene proteins.
8. To study and classify representative animal specimen belonging to protozoans to echinodermata with charts and available materials.
9. To study the permanent slides belonging to protozoans to echinodermata
10. To show the dissection of the representative animals like leech, pila and grasshopper for their anatomical studies of various systems with the help of charts and CD.
11. To study the microscopic fauna from various samples
12. To prepare the dichotomous key of the Porifera
13. To prepare the dichotomous key of the Coelenterata
14. To prepare the dichotomous key of the Arthropoda
15. To study the life cycle of parasites: Diagnosis, Identification, Anatomy, Biochemistry, Physiology etc
16. Stages of Evolution of the eukaryotes
17. Stages of Evolution of the prokaryotes
18. Stages of Possible archaeal origins of eukaryotic genes.
19. Primate evolutionary tree
20. Human evolutionary tree
21. Study of evolutionary time scale
22. To perform extraction of nucleic acids
23. To perform isolation of DNA
24. To separate DNA sample by agarose gel electrophoresis
25. To perform western blotting to analyse the given protein sample
26. DNA gel extraction
27. Discuss the problems based on central tendency mean, median, mode, geometric mean, range and standard deviation
28. Correlation and regression analysis
29. Graphical representation of data
30. Parametric and non parametric tests
31. Study computer hardware and its parts
32. Application of MS office in interpretation of biological data
33. Programming in BASIC/C
34. Wild life report
Semester-III

Course no.: Zoo-301C  MM: 80
Course Title: Biology of Vertebrates  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
Introduction to chordates with their general characters:
- Origin of chordates
- Classifications of vertebrate’s up to 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)
4. Wolfe: Biology the Foundations (Wadsworth)'
5. Parker & Haswell: Text Book of Zoology Vol.II (Macmillan)
Course no.: Zoo-302C  
Course Title: Molecular Endocrinology

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
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 nemerteans, 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
6. R.H. Williams. Text Book of Endocrinology, W.B. Saunders
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
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 (N₂, P, C and S); Ecological pyramids and recycling; Community structure and organisation;

**Unit II**

**Unit III**
- Environmental pollution. 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 metapoulations: demes and dispersals and interdemic extinctions
- Age structured population
- Biogeographical realms of India

**List of Recommended Books**
4. Odum : Ecology (Amerind)
5. Odum : Fundamentals of Ecology (W.B. Saunders)
7. Turk and Turk : Environmental Science (W.B. Saunders)
Course no.: Zoo-305E
Course Title: Animal Behaviour and Taxonomy

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
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, curetting 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

2. E. Mayer. Elements of Taxonomy.
5. Mechanism of Animal Behaviour, Peter Marler and J. Hamilton; John Wiley & Sons, USA
7. Animal Behaviour, John Alcock, Sinauer Associate Inc., USA
8. Perspective on Animal Behaviour, Goodenough, McGuire and Wallace, John Wiley & Sons, USA
10. An Introduction to Animal Behaviour, A. Manning and M.S Dawkins, Cambridge University Press, UK
Semester-III

Course no.: Zoo- 306E
Course Title: Aquaculture

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

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
3. Aquaculture and Fisheries Biotechnology Genetic Approaches, Dunham, R. A., CABI Publishing, USA
Semester-III

Course no.: Zoo-307E
Course Title: Biology of Population
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
- Concept of evolution: Darwinism and Neo-Darwinism
- Hardy-Weinberg law of genetic equilibrium
- A detailed account of destabilizing forces: (i) Natural selection (ii) Mutation (iii) Genetic drift (iv) Migration

Unit II
- Quantifying genetic variability
- Genetic structure of natural populations
- Phenotypic variation
- Models explaining changes in genetic structure of populations
- Factors affecting human disease frequency
- Mendelian basis of transmission of disease

Unit III
- Molecular population genetics
- Patterns of change in nucleotide and amino acid sequences
- Ecological significance of molecular variations
- Emergence of Non-Darwinism-Neutral Hypothesis

Unit IV
- Genetics of quantitative traits in populations
- Quantitative traits and natural selection
- Estimation or heritability
- Inbreeding depression and heterosis
- Molecular analysis of quantitative traits
- Phenotypic plasticity

Suggested Reading Material
Semester- III

Course no.: Zoo-309 LC

Course Title: Laboratory Course

M.M.: 150

Time: 6

1. Study of Dissections through chart: Rat/ Lab Mice /Fish.
2. Digestive system,
3. Reproductive system,
4. Arterial system,
5. Venous systems,
6. Cranial nerves and
7. Museum specimens and slides :
8. Protochordates –
9. fishes
10. Amphibians
11. Reptiles
12. Birds
13. Mammals
14. To identify different endocrine glands with the help of charts
15. To study the histology of endocrine glands of animals with the help of charts
16. To determine the concentration of glucose in the diabetic samples.
17. To Isolate and purify a protein hormone and demonstration of bioactivity in an in vivo bio-assay (e.g. FSH)
18. To perform ELISA for any one hormone
19. To measure conc. of corticosterone in human plasma or given sample
20. In vitro biochemical assay for a hormone (LH or PRL).
21. Steroid and thyroid hormone assay by ELISA.
22. Calcium estimation following fluorometry in PTH/Calcitriol treated rats.
23. Observation of sex chromatin (Barr bodies) in buccal epithelial cells of human female
24. To study the effect of UV rays on the Drosophila melanogaster
25. To analyse the restriction pattern by agarose gel electrophoresis and to map restriction plasmid sites on plasmid DNA
26. To prepare ligation lambda/E CORI digest using T4 DNA ligase and amylase ligated sample by agarose gel electrophoresis
27. To study normal human karyotype
28. To study chromosomal abnormalities
29. To study the various human pedigrees
30. Gene mapping by TPT cross
31. Study of chromosomes slides (autosomes and sex chromosomes)
32. To study primary and secondary sexual characteristic
33. To determine dissolved O2, free CO2, BOD, COD, salinity and hardness content in polluted and control samples
34. To study presence of pollutants specific microbes in samples
35. To determine physiochemical characteristics of polluted water and soil
36. To study concentration of air pollutant with the help of high volume sampler in the air
37. To study concentration of air pollutant with the help of personal sampler around the person
38. Spirometric analysis of pollution impact and its implications
39. To prepare a phylogenetic tree on the basis of taxonomic characteristics of annelid
40. To prepare phylogenetic tree on the basis of taxonomic character revealing their heirarchial position of Echinodermata
41. To prepare phylogenetic tree on the basis of taxonomic character revealing their heirarchial position of Mollusca
42. Learning/ Conditioning
43. Memory
44. Identification of eggs, spawn, fry and fingerlings of cultivable fishes of India.
45. Collection and identification of aquatic weeds and aquatic insects.
46. Study of feeding habits of fishes by gut content analysis.
47. Aquarium design and maintenance.
48. Formulation and preparation of artificial fish food for Indian major carps and Prawns.
49. Analysis of proximate composition of fish and processed products.
50. visit to freshwater/ marine fish farm.
51. To study normal human karyotype
52. To study chromosomal abnormalities
53. To study the various human pedigrees
54. Gene mapping by TPT cross
55. Study of chromosomes slides (autosomes and sex chromosomes)
56. To study primary and secondary sexual characteristics
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
2. Radioisotope Laboratory Techniques by R. A. Faires, etc. and G. G. J. Boswell (Dec 1980).
4. Radioisotopes in Biology (Practical Approach Series) by Robert J. Slater (Feb 1, 2002).
Semester-IV

Course no.: Zoo- 402C
Course Title: Vermiculture

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:
Introduction to earthworms, their taxonomy and nomenclature. Distribution, ecology and the food habits of earthworms.

UNIT-II:
Vermiculture-the use of earthworms and their influence on soil structure, composition and infiltration.

UNIT-III:
Role of earthworms in agro-ecosystems, land reclamation and sustainable soil fertility.

UNIT-IV:
Methods of vermicomposting, changes during vermicomposting, chemical composition of vermicast and the economics of vermiculture.

List of Recommended Books