MAHARSHI DAYANAND UNIVERSITY, ROHTAK- 124 001, INDIA

(NAAC Accredited 'A' Grade State University established under Haryana Act No. XXV of1975)

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
M.Sc. Zoology programme
(As per Choice based Credit System w.e.f. the academic year 2016–2018)

Program Specific Outcomes

PSO1: Students would gain expertise in theoretical and practical knowledge in basic and applied areas of Zoology.

PSO2: Students would be trained for the academic and professional fields of Zoology.

PSO3: Students would gain proficiency in research methodology and assessment techniques in animal science.

PSO4: Students would gain competencies and professional skills for working and conducting research in the field of Zoology and related areas of life science research.

PSO5: Students would gain mastery in advanced Animal technologies.

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
TOTAL	**72**	**12**	**6**	**2**	**20**	**112**

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

CORE COURSE	=72
DISCIPLINE SPECIFIC ELECTIVE	=12
OPEN ELECTIVE	=06
FOUDATION ELECTIVE	=02
DISSERTATION	=20
TOTAL	**=112**

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

SEMESTER I						
Course No.	**Nomenclature of Paper**	**Credit**	**Hours**	**MM** (Max Marks)	**IA** (Internal Assessment)	**TM** (Total marks)
Core Courses						
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
Lab Course						
16ZOO21CL1	Lab Course (16ZOO21C1 to C3)	4	8	100	-	100
16ZOO21CL2	Lab Course (16ZOO21C4 & C5)	4	8	100	-	100
	Total Credits	**28**				
SEMESTER II						
Course No.	**Nomenclature of Paper**	**Credit**	**Hours**	**MM**	**IA**	**TM**
Core Courses						
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
Discipline Specific Elective (Any One)						
16ZOO22DA1	Aquaculture	4	4	80	20	100
16ZOO22DA2	Evolutionary Biology	4	4	80	20	100
Open Elective						
	Open Elective*	3	3			
Foundation Elective						
	Foundation Elective**	2	2			
Lab Course						
16ZOO22CL	Lab Course (16ZOO22C1 to C2)	4	8	100	-	100
16ZOO22DL	Lab Course (16ZOO22C3 and DA1/DA2)	4	8	100	-	100
	Total Credits	**29**				
SEMESTER III						
Course No	**Nomenclature of Paper**	**Credit**	**Hours**	**MM**	**IA**	**TM**
Core Courses						
17ZOO23C1	Immunology	4	4	80	20	100
17ZOO23C2	Biology of Vertebrates	4	4	80	20	100
Discipline Specific Elective						
Group-A (Any One)						
17ZOO23DA1	Animal Behavior and Taxonomy	4	4	80	20	100
17ZOO23DA2	Molecular endocrinology	4	4	80	20	100
Group-B (Any One)						
17ZOO23DB1	Biology of Population	4	4	80	20	100
17ZOO23DB2	Environmental Biology	4	4	80	20	100
Open Elective						
	Open elective*	3	3			
Lab Course						
17ZOO23C3	Lab Course (17ZOO23C1 & C2)	4	8	100	-	100
17ZOO23DL	Lab Course (17ZOO23DA1/DA2 and DB1/DB2)	4	8	100	-	100
	Total Credits	**27**				
SEMESTER IV						
Course No	**Nomenclature of Paper**	**Credit**	**Hours**	**MM**	**IA**	**TM**
Core Courses						
17ZOO24C1	Biosafety & Ethics in Science	4	4	80	20	100
17ZOO24C2	Advances in Vermiculture	4	4	80	20	100
Dissertation						
17ZOO24C3	Dissertation	20	40	300	-	300
	Total Credits	**28**				

*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

MAHARSHI DAYANAND UNIVERSITY ROHTAK
DEPARTMENT OF ZOOLOGY
M.Sc. ZOOLOGY w.e.f. session 2016-17

Semester-I

Course no.: 16ZOO21C1 **MM: 80**
Course Title: Animal Biochemistry and Metabolism **Time: 3Hr**

Course Outcomes

CO1: Students would gain general understanding of the major types of biochemical molecules, including small, large and super molecular components found in cells;

CO2: Students would be expertise in basic energy metabolism of cells and identify some of common reaction mechanisms in biochemical process.

CO3: Students would be expertise to develop understanding of biological processes at chemical, biochemical and molecular level to perform wide range of analytical techniques to explore biological activities.

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, Stablizing 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.

MAHARSHI DAYANAND UNIVERSITY ROHTAK
DEPARTMENT OF ZOOLOGY
M. Sc. ZOOLOGY w.e.f. session 2016-17

Semester-I

Course no.: 16ZOO21C2 **MM: 80**
Course Title: Techniques in Animal Sciences **Time: 3Hr**

Course Outcomes

CO1: Students would be trained in various tools and techniques used to gain insight into biological processes.

CO2: Students would be expertise techniques used for imaging, isolation, purification and characterization of various biological substances.

CO3: Students would gain basic knowledge of the underlying principles and practical strategy of the analytical and preparative techniques that are fundamental to study and understanding of life processes.

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. Randhir Singh. Practicals in Biochemistry
4. A Biologists Guide to Principles and Techniques of Practical Biochemistry, K. Wilson & K.H. Goulding, ELBS Edn.
5. Molecular Cell Biology, J. Darnell, H. Lodish and D. Baltimore Scientific American Book, Inc., USA.
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.

MAHARSHI DAYANAND UNIVERSITY ROHTAK
DEPARTMENT OF ZOOLOGY
M. Sc. ZOOLOGY w.e.f. session 2016-17

Semester-I

Course no.: 16ZOO21C3 **MM: 80**
Course Title: Animal Cell Biology **Time: 3Hr**

Course Outcomes

CO1: Students would gain expertise in the ultra structural information of animal cell besides the detailed views of the cell interior revealing the various events and actions of cell at the molecular level.

CO2: The study will help the students to understand the new discoveries about the structure and internal functioning of the cell due to technological improvements.

CO3: The study will help the students to increase powerful means of visualization in the field of cell biology.

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

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

MAHARSHI DAYANAND UNIVERSITY ROHTAK
DEPARTMENT OF ZOOLOGY
M. Sc. ZOOLOGY w.e.f. session 2016-17

Semester-I

Course no.: 16ZOO21C4 **M: 80**
Course Title: Molecular Biology **Time: 3Hr**

Course Outcomes

CO1: Students would gain expertise in understanding the complex molecular mechanisms occurring in cell and the applications of molecular technologies.

CO2: The study of molecular biology provides the necessary information about the chemistry of life to allow the students to understand the basis of life.

CO3: The study of biology stands as a tribute to human curiosity for seeking to discover and to human creative intelligence for devising the complex instruments and elaborate techniques by which these discoveries can be made

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

MAHARSHI DAYANAND UNIVERSITY ROHTAK
DEPARTMENT OF ZOOLOGY
M. Sc. ZOOLOGY w.e.f. session 2016-17

Semester-I

Course no.: 16ZOO21C5 **MM: 80**
Course Title: Advanced Physiology **Time: 3Hr**

Course Outcomes

CO1: The aim of this paper is to impart advanced knowledge about the principles of physiology of both cells and organisms.

CO2: Students would gain expertise in physiology of different Phyla and Classes of animals

CO3: An appropriate understanding of functioning of each system of different groups of animals with their comparison will be acquainted.

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

MAHARSHI DAYANAND UNIVERSITY ROHTAK
DEPARTMENT OF ZOOLOGY
M. Sc. ZOOLOGY w.e.f. session 2016-17

Semester- I

Course no.: 16ZOO21CL1 **M.M.: 100**
Course Title: Laboratory Course **Time: 6 Hr**

Laboratory Course outcomes

CO1: Students would be expertise to develop understanding of biological processes at chemical, biochemical and molecular level to perform wide range of analytical techniques to explore biological activities.

CO2: Students would gain expertise in techniques used for imaging, isolation, purification and characterization of various biological substances.

CO3: Students would gain expertise in the ultra structural information of animal cell besides the detailed views of the cell interior revealing the various events and actions of cell at the molecular level.

CO4: The study will help the students to understand the new discoveries about the structure and internal functioning of the cell due to technological improvements.

List of practicals

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, Paramaecium* 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.

MAHARSHI DAYANAND UNIVERSITY ROHTAK
DEPARTMENT OF ZOOLOGY
M. Sc. ZOOLOGY w.e.f. session 2016-17

Semester- I

Course no.: 16ZOO21CL2 **M.M.: 100**
Course Title: Laboratory Course **Time: 6 Hr**

Laboratory Course outcomes

CO1: Students would gain expertise in understanding the complex molecular mechanisms occurring in cell and the applications of molecular technologies.
CO2: The study of molecular biology provides the necessary information about the chemistry of life to allow the students to understand the basis of life. .
CO3: Students would gain expertise in physiology of animals
CO4: A suitable understanding of execution of each system of different groups of animals with their up to date comparison.

List of practicals

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 $1mm^3$ volume of blood.
15. To estimate the WBC count present in $1mm^3$ 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.

MAHARSHI DAYANAND UNIVERSITY ROHTAK
DEPARTMENT OF ZOOLOGY
M. Sc. ZOOLOGY w.e.f. session 2016-17

Semester-II

Course no.: 16ZOO22C1 **MM: 80**
Course Title: Developmental Biology **Time: 3Hr**

Course Outcomes

CO1: Students would gain expertise in explaining how a variety of interacting processes generate an organism's heterogeneous shapes, size and structural features that arise on the trajectory from embryo to adult or more generally throughout a life cycle.

CO2: Students would have a systematic and organized learning about the knowledge and concepts of growth and development of organisms.

CO3: Developmental biology displays a rich array of material and conceptual practices that could be analysed to better understand the scientific reasoning exhibited in experimental life sciences

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. 8th 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.

MAHARSHI DAYANAND UNIVERSITY ROHTAK
DEPARTMENT OF ZOOLOGY
M. Sc. ZOOLOGY w.e.f. session 2016-17

Semester-II

Course no.: 16ZOO22C2 **MM: 80**
Course Title: Molecular Cytogenetics **Time: 3hrs**

Course Outcomes

CO1: Students will be able to study the comprehensive biology of the chromosomes and clinical anomalies with their pedigree patterns.
CO2: Students would be aware about the molecular composition of the chromosomes.
CO3: They will gain knowledge about the behaviour of chromosomes during different phases of the cell cycle.

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, flourescence *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.

MAHARSHI DAYANAND UNIVERSITY ROHTAK
DEPARTMENT OF ZOOLOGY
M. Sc. ZOOLOGY w.e.f. session 2016-17

Semester-II

Course no.: 16ZOO22C3 **MM: 80**
Course Title: Biology of Invertebrates **Time: 3Hr**

Course Outcomes

CO1: Make students to understand how life evolved from simple to complex organization by division of labour & enhancing efficiency in Invertebrates.
CO2: The study of invertebrates reveals progressive evolutionary history of organisms
CO3: Students would be able to understand adaptations of huge complex and diverse life forms.

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, Echinodermeta
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.

MAHARSHI DAYANAND UNIVERSITY ROHTAK
DEPARTMENT OF ZOOLOGY
M. Sc. ZOOLOGY w.e.f. session 2016-17

Semester-II

Course no.: 16ZOO22DA1 **MM: 80**
Course Title: Aquaculture **Time: 3Hr**

Course Outcomes

CO1: To acquaint the students about biology of fish which are important contributors to food as good source of protein.
CO2: Students will gain knowledge about aquaculture practices that will be helpful in applied areas.
CO3: The study of Aquaculture will also be helpful in acquainting with methods of conserving fish diversity.

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

MAHARSHI DAYANAND UNIVERSITY ROHTAK
DEPARTMENT OF ZOOLOGY
M. Sc. ZOOLOGY w.e.f. session 2016-17

Semester-II

Course no.: 16ZOO22DA2 **MM: 80**
Course Title: Evolutionary Biology **Time: 3Hr**

Course Outcomes

CO1: To explore the origin of life, evolutionary transitions of eukaryotes and multicellularity and diversity of forms of life on earth with new scientific evidences.
CO2: To develop a better understanding about the nature and origin of life
CO3: Leading to the diversity of various living forms with unifying characteristic relationships between themselves and environment.

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 Unvieristy Press.
2.Dobzhansky, Th., F.J. Ayala, G.L. Stebbines and J.M. Valentine. Evolution. Surjeet Publication, Delhi.
3. Futuyama, D.J. Evolutinary Biology, Suinuaer Associates, INC Publishers, Dunderland.
4.Haiti, 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 chromosomar change. The Cambridge University Press, Cambridge.
7.Merrel, D.J. Evolution and Genetics. Holt, Rinchart and Winston, Inc.
8.Smith, J.M. Evolutinary Gentics. Oxford University Press, New York.

MAHARSHI DAYANAND UNIVERSITY ROHTAK
DEPARTMENT OF ZOOLOGY
M. Sc. ZOOLOGY w.e.f. session 2016-17

Semester- II

Course no.: Zoo-16ZOO22CL **M.M.: 100**
Course Title: Laboratory Course **Time: 6 Hr**

Laboratory Course outcomes

CO1: Students would gain suitable understanding based on learning contents of embryology
CO2: Developmental biology displays a rich array of material and conceptual practices that could be analysed to better the scientific reasoning exhibited in experimental life sciences
CO3: Students would be aware about the molecular composition of the chromosomes.
CO4: They will gain knowledge about the behaviour of chromosomes during different phases of the cell cycle.

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.*
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_4 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

MAHARSHI DAYANAND UNIVERSITY ROHTAK
DEPARTMENT OF ZOOLOGY
M. Sc. ZOOLOGY w.e.f. session 2016-17

Semester- II

Course no.: Zoo-16ZOO22DL **M.M.: 100**
Course Title: Laboratory Course **Time: 6 Hr**

Laboratory Course outcomes

CO1: Students would be able to understand adaptations of huge complex and diverse life forms
CO2: Students will gain knowledge about aquaculture practices that will be helpful in applied areas.
CO3: The study of Aquaculture will also be helpful in acquainting with methods of conserving fish diversity
CO4: To explore the origin of life, evolutionary transitions of eukaryotes and multicellularity and diversity of forms of life on earth with new scientific evidences.
CO5: Leading to the diversity of various living forms with unifying characteristic relationships between themselves and environment.

List of practicals

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, & Earthwarm 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 Arthrophoda
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, Arthrophoda, 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.

MAHARSHI DAYANAND UNIVERSITY ROHTAK
DEPARTMENT OF ZOOLOGY
M. Sc. ZOOLOGY w.e.f. session 2016-17
Semester-III

Course no.: 17ZOO23C1 **MM: 80**
Course Title: Immunology **Time: 3Hr**

Course Outcomes

CO1: To provide an understanding of fundamental immunology and the immunological basis of treatments of some common diseases.
CO2: The students will have understanding about the immune system and various related mechanisms of cells and molecules involved in fighting pathogens.
CO3: Students would understand the cellular and molecular basis of inflammatory response
CO4: They will also gain knowledge about the autoimmune disorders and their preventions

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. Totora et al. Microbiology
4. Pelczar. A text book of microbiology
5. I.M. Roitt. Essential Immunology, ELBS Edition.

MAHARSHI DAYANAND UNIVERSITY ROHTAK
DEPARTMENT OF ZOOLOGY
M. Sc. ZOOLOGY w.e.f. session 2016-17

Semester-III

Course no.: 17ZOO23C2 **MM: 80**
Course Title: Biology of Vertebrates **Time: 3Hr**

Course Outcomes

CO1: Students will have the knowledge and skills to critically examine the origin and diversification history of vertebrate animals, with a particular focus on Indian vertebrates, through lectures and practicals.

CO2: Critically examine and describe the taxonomic diversity and major patterns of morphological diversity of vertebrate animals, through lectures and practicals.

CO3: Demonstrate an advanced understanding and appreciation of how detailed natural history knowledge facilitates research through lectures.

CO4: Demonstrate an advanced understanding of the diversity of Indian research on vertebrate animals through lectures and apply this knowledge through a group presentation.

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.

MAHARSHI DAYANAND UNIVERSITY ROHTAK
DEPARTMENT OF ZOOLOGY
M. Sc. ZOOLOGY w.e.f. session 2016-17

Semester-III

Course no.: 17ZOO23DA1 **MM: 80**
Course Title: Animal Behavior and Taxonomy **Time: 3Hr**

Course Outcomes

CO1: Students would gain insight into the important concept of animal behavior and conservation. This paper also deals with theory and practice of taxonomic arrangement and classification of animal diversity
CO2: It will boost students for betterment of diversified resources and life forms for better conservational measures with keen understanding.
CO3: It also helps the students in understanding the overall biodiversity of the world and their application in all the fields of biological sciences.

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

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

MAHARSHI DAYANAND UNIVERSITY ROHTAK
DEPARTMENT OF ZOOLOGY
M. Sc. ZOOLOGY w.e.f. session 2016-17

Semester-III

Course no.: 17ZOO23DA2 **MM: 80**
Course Title: Molecular Endocrinology **Time: 3Hr**

Course Outcomes

CO1: Students would gain insight in to the molecular approaches to study the mechanism of action of hormones and related molecules involved in various physiological processes.
CO2: Students will be able to describe major signaling pathways in target cells for each hormone including feedback relationships.
CO3: Students will be able to identify the organs involved in the endocrine function and an understanding of appropriate key human endocrine disorder will also be developed.
CO4: Students would be able to understand the current developments in design and production of hormonal contraceptives.
CO5: Students would be able to understand the mechanisms involved in production of recombinant protein hormones and their application in regulation of fertility in farm animals and humans.

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

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.

MAHARSHI DAYANAND UNIVERSITY ROHTAK

DEPARTMENT OF ZOOLOGY

M. Sc. ZOOLOGY w.e.f. session 2016-17

Semester-III

Course no.: 17ZOO23DB1 **MM: 80**

Course Title: Biology of Population **Time: 3Hr**

Course Outcomes

CO1: To make students understand the relationship between the variations, inheritance and the various evolutionary forces.

CO2: To appreciate the understanding of the integration of principles of genetics with concept of evolution at population level.

CO3: To determine the practical implications of the evolutionary forces reflected in the change of gene frequencies in populations

Note: There shall be nine questions in total. One question will be compulsory (short answer type) covering the entire syllabuss 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. Stebbines 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.

MAHARSHI DAYANAND UNIVERSITY ROHTAK
DEPARTMENT OF ZOOLOGY
M. Sc. ZOOLOGY w.e.f. session 2016-17

Semester - III

Course no: 17ZOO23DB2 **MM: 80**
Course Title: Environmental Biology **Time: 3hrs**

Course Outcomes

CO1: Students will be able to apply the scientific method and quantitative techniques to describe, monitor and understand environmental systems.
CO2: Students will be able to use interdisciplinary approaches such as ecology, economics, ethics and policy to devise solutions to environmental problems.
CO3: Students will be able to be proficient in ecological field methods such as wildlife survey, biodiversity assessment, mathematical modeling and monitoring of ecological systems.
CO4: Students will be able to use technology, such as geographical information systems and computer programming, to assist in problem solving.
CO5: This paper will help in creating skilled personnel in the field of environment protection and research

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_2, 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
Characterisitic 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

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)

MAHARSHI DAYANAND UNIVERSITY ROHTAK
DEPARTMENT OF ZOOLOGY
M. Sc. ZOOLOGY w.e.f. session 2016-17

Semester- III

Course no.: 17ZOO23C3 **M.M.: 100**
Course Title: Laboratory Course **Time: 6 Hr**

Laboratory Course outcomes

CO1: The students will have practical knowledge to diagnose the various disorders of immune system.
CO2: Students would understand the various mechanisms of inflammatory response/autoimmune disorders etc.
CO3: Students will able to understand the comparative trends in structure and function of the organ systems of the vertebrate series.
CO4: Students would understand various life forms from most primitive to most advanced forms with respect to their habit, habitat and internal complexity.

List of practicals

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.

MAHARSHI DAYANAND UNIVERSITY ROHTAK
DEPARTMENT OF ZOOLOGY
M. Sc. ZOOLOGY w.e.f. session 2016-17
Semester- III

Course no.: 17ZOO23DL **M.M.: 100**
Course Title: Laboratory Course **Time: 6 Hr**

Laboratory Course outcomes

CO1: Students would able to perform taxonomic arrangement and classification of animal diversity.
CO2: They will also understand the behaviour of animals which are living in our locality as well as in wild nature
CO3: Students would be able to understand the mechanisms involved in production of recombinant protein hormones and their application in regulation of fertility in farm animals and humans.
CO4: Students will also determine the practical implications of the evolutionary forces reflected in the change of gene frequencies in populations

List of practicals

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_2 in variety of given samples of water.
28. Determination of dissolved O_2 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_{50} and LC_{50} b. Pesticide residue analysis of contaminated vegetable soil and water.

MAHARSHI DAYANAND UNIVERSITY ROHTAK
DEPARTMENT OF ZOOLOGY
M. Sc. ZOOLOGY w.e.f. session 2016-17

Semester-IV

Course no.: 17ZOO24C1 **MM: 80**
Course Title: Biosafety & Ethics in Science **Time: 3hrs**

Course Outcomes

CO1: To explain the social and ethical issues such as genetic discrimination, foeticide, sex and genetic engineering involving human beings.
CO2: The focus is also on studying the use of hazardous substances with appropriate measures.
CO3: Students will develop understanding of large-scale loss of biological integrity, focusing both on ecology and human health.
CO4: Awareness about study of bioethics and biosafety, studying socio-economic aspects of biotechnologies and advising on their implementation and application.

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).

MAHARSHI DAYANAND UNIVERSITY ROHTAK

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

Semester-IV

Course no.: 17ZOO24C2 **MM: 80**
Course Title: Advances in Vermiculture **Time: 3Hr**

Course Outcomes

CO1: To explore the important of earthworms in agro-ecosystems
CO2: It will enhance students understanding of Earthworms for management of municipal/selected biomedical solid wastes
CO2: Students residing in cities can produce Vermicompost in small scale for garden/household plants

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 & Bater 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.