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 2020-22)

DEPARTMENT OF ZOOLOGY

http://www.mdurohtak.ac.in

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DEPARTMENT OF ZOOLOGY
M.Sc. Zoology programme
(As per Choice based Credit System w.e.f. the academic year 2020–2022)

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. 2020–2022

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.

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DEPARTMENT OF ZOOLOGY
Choice Based Credit System (CBCS)
Scheme of Examination (M.Sc. - Zoology) w.e.f. session 2020-2022

SEMESTER I (2020-2021)						
Course No.	**Nomenclature of Paper**	**Credit**	**Hours**	**MM (Max Marks)**	**IA (Internal Assessment)**	**TM (Total marks)**
Core Courses						
20ZOO21C1	Techniques in Animal Science	4	4	80	20	100
20ZOO21C2	Diversity of Life form-1	4	4	80	20	100
20ZOO21C3	Animal Cell Biology	4	4	80	20	100
20ZOO21C4	Animal Biochemistry and metabolism	4	4	80	20	100
20ZOO21C5	Molecular Biology	4	4	80	20	100
Lab Course						
20ZOO21CL1	Lab Course (20ZOO21C1 to C3)	4	8	100	-	100
20ZOO21CL2	Lab Course (20ZOO21C4 & C5)	4	8	100	-	100
	Total Credits	**28**				
SEMESTER II						
Course No.	**Nomenclature of Paper**	**Credit**	**Hours**	**MM**	**IA**	**TM**
Core Courses						
20ZOO22C1	Developmental Biology	4	4	80	20	100
20ZOO22C2	Inheritance Biology	4	4	80	20	100
20ZOO22C3	Diversity of Life form-II	4	4	80	20	100
Discipline Specific Elective (Any One)						
20ZOO22DA1	Animal Behaviour	4	4	80	20	100
20ZOO22DA2	Evolutionary Biology	4	4	80	20	100
Open Elective						
	Open Elective*	3	3			
Foundation Elective						
	Foundation Elective**	2	2			
Lab Course						
20ZOO22CL	Lab Course (20ZOO22C1 to C2)	4	8	100	-	100
20ZOO22DL	Lab Course (20ZOO22C3 and DA1/DA2)	4	8	100	-	100
	Total Credits	**29**				
SEMESTER III (2021-2022)						
Course No	**Nomenclature of Paper**	**Credit**	**Hours**	**MM**	**IA**	**TM**
Core Courses						
20ZOO23C1	Immunology	4	4	80	20	100
20ZOO23C2	Advanced Physiology	4	4	80	20	100
Discipline Specific Elective						
Group-A (Any One)						
20ZOO23DA1	Molecular Cytogenetics	4	4	80	20	100
20ZOO23DA2	Molecular endocrinology	4	4	80	20	100
Group-B (Any One)						
20ZOO23DB1	Population Biology	4	4	80	20	100
20ZOO23DB2	Environmental Biology	4	4	80	20	100
Open Elective						
	Open elective*	3	3			
Lab Course						
20ZOO23C3	Lab Course (21ZOO23C1 & C2)	4	8	100	-	100
20ZOO23DL	Lab Course (21ZOO23DA1/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						
20ZOO24C1	Biosafety & Ethics in Science	4	4	80	20	100
20ZOO24C2	Advances in Vermiculture	4	4	80	20	100
Project Report						
20ZOO24C3	Project Report	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

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DEPARTMENT OF ZOOLOGY
M.Sc. ZOOLOGY w.e.f. session 2020–2021

Semester-I

Course no.: 20ZOO21C1 **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, Confocal Microscopy, Scanning and transmission electron microscopes. pH meter, Fixation and staining of biological samples for light and electron microscopy, cryotechnology and flow cytometry.

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, MALDITOF.

Unit III

Chromatography: Principles and applications of gel filtration, ion-exchange, affinity, thin layer, gas 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), Real time PCR and reverse transcriptase PCR, ELISA, Methods for measuring nucleic acid and protein interactions.

List of Recommended Books

1. S.K. Sawhney and Randhir Singh: Introductory Practical Biochemistry
2. Bruce Alberts et al.: Molecular Biology of the Cell
3. K. Wilson and K.H. Goulding: A Biologist's guide to principles and techniques of practical biochemistry
4. Lodish et al.: Molecular Cell Biology
5. David L. Nelson , Michael M. Cox: Lehninger Principles of Biochemistry
6. B. Sivasankar: Instrumental Methods of Analysis
7. S. V. S. Rana: Biotechniques: Theory and practices
8. G. L. Ghatak: Techniques and methods in Biology

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DEPARTMENT OF ZOOLOGY
M. Sc. ZOOLOGY w.e.f. session 2020-2021
Semester- 1

Course no.: 20ZOO21C2
Course Title: Diversity of Life Forms **MM 80**

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: Protozoa, Porifera, Colenterata, Helminthes and Nematodes, General account in Porifera to Nematodes, Organisms of health and agricultural importance
Common parasites and pathogens of
Humans
Domestic animals
Crops
Damage caused and prevention

Unit-II

Salient Features and classification up to classes with reference to diversity in animal form: Annelid, Arthropoda, Mollusca and Echinodermeta.
General account in Annelida to Mollusca
Coelom;
Torsion and detorsion
Ambulacral system

Unit-III

Natural history of Indian subcontinent:
Biological diversity
Migrations of animals (fishes, birds and mammals) according to change in season:
Major habitat types of the subcontinent,
Geographic origins
Common Indian mammals, bird
Seasonality and phenology of the subcontinent

Unit-IV

Organisms of conservation concern:
Rare, endangered, threatened species etc.
Conservation strategies.
Wildlife conservation projects:
Project Tiger
Project Rhino
Project Elephant
Project crocodiles

List of Recommended Books

1. E.O. Wilson. The Diversity of Life (The College Edition), W.W. Northern & Co.
2. B.K. Tikadar. Threatened Animals of India, ZSI Publication, Calcutta.
3. The diversity of living organisms, author: Richard Stephen Kent Barnes
4. Parasitic diseases of wildlife and domestic animals by A. Alonso Aguirre

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Semester-I

Course no.: 20ZOO21C3 **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 and function of cell: Prokaryote and Eukaryote, intracellular organelles; significance of intracellular compartments.
Structure of nucleus: Nucleopore complex, nucleoplasm, nucleolus.
Genetic analysis in cell biology and genetic organisation: Nucleus, mitochondria and chloroplast.

UNIT-II

Bio membranes: molecular composition, arrangement, function and various models; Lioposomes.
Transport across cell membrane: Diffusion, Active transport and various ports; Membrane potential.
Transport across epithelium: Endocytosis, Exocytosis.
Cytoskeleton: Microtubules, intermediate filaments and microfilaments- structure and dynamics; Kinesin and dynenin- role in intracellular transport.

UNIT-III

Cell signalling- Receptors; Signal transduction; secondary messenger system, signalling pathways.
Cell- cell interaction: Occluding, adhering and communicating junction
Extracellular matrix and Cell- matrix interaction: Collagen, Fibronectin and Laminin.

UNIT-IV

Cell cycle: Mechanism of cell division; cell cycle regulation; Cyclins and CDK.
Biology of cancer: causes, types, carcinogens.
Apoptosis: mechanism and significance.

List of Recommended Books

1. Molecular Cell Biology, J. Darnell, H. Lodish and D. Baltimore Scientific American Book, Inc., USA.
2. Molecular Biology of the Cell, B.Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts, and J.D. Watson. Garland Publishing Inc., New York.
3. Cell and molecular biology Phillip Sheeler, Donald E. Bianchi Wiley, 1987

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M. Sc. ZOOLOGY w.e.f. session 2020–21

Semester-I

Course no.: 20ZOO21C4 **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.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, 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, Immobilised enzymes and their applications.

List of Recommended Books

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

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Semester-I

Course no.: 20ZOO21C5 **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 for betterment of life.

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

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Semester- I

Course no.: 20ZOO21CL1 **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 study the Fixation and staining of biological samples for light microscopy.
2. To study the Beer Lambert's law for spectrophotometry.
3. To prepare the absorbance curve for spectrophotometry.
4. To isolate chloroplast pigments from leaf by paper chromatography.
5. To isolate amino acids by paper chromatography/TLC.
6. To perform agarose gel electrophoresis.
7. To perform SDS-PAGE.
8. To stain SDS-PAGE with Coomassie brilliant blue.
9. To perform affinity column chromatography/ion exchange column chromatography
10. To perform PCR for a given sample
11. To perform ELISA
12. Numericals on half-life of radioactive isotopes
13. To study and classify representative animal specimen belonging to protozoans to Echinodermata with charts and available material.
14. To show the dissection of the representative animals like Cockroach, & Earthworm for their anatomical studies of various systems with the help of charts and CD.
15. Slides and Museum specimens: Protozoa to Echinodermata
16. Study of mouth parts of different insects with the help of charts and CD
17. To prepare the dichotomous key of the Porifera, Coelenterata, Arthropoda, Annelida, Mollusca and Echinodermata
18. Study of biological diversity of local region
19. To study diversity of nest in birds
20. To identify parasites of human
21. To identify parasites of domestic animals
22. To identify diseases in plants
23. To prepare report on Rare/endangered/threatened species of Haryana
24. To study the principle and working of Light Microscope.
25. To measure the size of prepared protozoan slides such as *Euglena, Paramaecium* by Micrometry.
26. To prepare a temporary mount of Buccal epithelial cells.
27. To observe Barr body in the Buccal Epithelial cells of human females.
28. To prepare polytene chromosomes from salivary glands of *Drosophila* larva.
29. To demonstrate the movement of water by haemolysis and crenation in blood cells.
30. To study squash technique for the study of Mitosis/Meiosis.
31. Calculation of morphometric data and preparations of ideogram.

32. To study the principle of cell fractionation for isolation of sub-cellular organelles.
33. Identification of mitotic and meiotic stages from permanent slides

MAHARSHI DAYANAND UNIVERSITY ROHTAK
DEPARTMENT OF ZOOLOGY
M. Sc. ZOOLOGY w.e.f. session 2020-21

Semester- I

Course no.: 20ZOO21CL2 **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 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 perform isolation of genomic genetic material
11. To estimate RNA in the given material/sample
12. To perform blotting to analyse the given sample
13. DNA gel extraction
14. Competent cell preparation
15. Assessment of proliferation in cultured cells by MTT assay
16. Restriction digestion analysis of genetic material.
17. To perform restriction mapping
18. To determine molecular size of DNA

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Semester-II

Course no.: 20ZOO22C1 **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; Mechanism and regulation of cleavage;
Blastula; Fate maps; Comparative account of Gastrulation (Sea urchin, Zebrafish, Xenopus, Chick)
Neurulation and ectoderm; Mesoderm and endoderm

Unit III

Cytoplasmic determinants and cell specification: 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. Subramaniam. Molecular Developmental Biology, 2nd Edition, 2013. Narosa Publishing House
6. Ethan Bier. 'The Cold Spring'. Cold Spring Harbor Laboratory Press, New York.

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Semester- II

Course no.: 20ZOO22C2 **MM 80**
Course Title: Inheritance 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**,** development and inheritance pattern among organisms.
CO3: Inheritance process displays a rich array of material and conceptual practices that could be analysed to better understand the scientific reasoning exhibited in experimental life processes.

Unit-I

Mendelian principles: Dominance, segregation, independent assortment. Concept of gene: Allele, multiple alleles, Pseudo allele, complementation tests Extra chromosomal inheritance: Inheritance of Mitochondrial and chloroplast genes, maternal inheritance.

UNIT-II

Extensions of Mendelian principles: Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters. Gene mapping methods: Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids.

UNIT-III

Microbial genetics: Methods of genetic transfers – transformation, conjugation, transduction and sex-duction, mapping genes Human genetics: Pedigree analysis, karyotypes, genetic disorders. Quantitative genetics: Polygenic inheritance, heritability and its measurements.

UNIT-IV

Structural and numerical alterations of chromosomes: Deletion, duplication, inversion, translocation, ploidy and their genetic implications. Recombination: Homologous and non-homologous recombination including transposition.

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.
9. PK Gupta. Genetics, Rastogi publications.
10. Veer balaRastogi. Organic Evolution-Evolutionary Biology, Medtec Publication.
11. Veer balaRastogi.. Genetics, KedarNathRnath Publication

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Semester- II

Course no.: 20ZOO22C3 **MM 80**
Course Title: Diversity of life forms -ll **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.

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

Taxonomic keys-different kinds of taxonomic keys, their merits and demerits, Process of typification and different Zoological types, International code of Zoological Nomenclature (ICZN) - its operative principles, interpretation and application of important rules, Zoological nomenclature; formation of scientific names of various taxa.

Unit II

Basic concepts of Biosystematics, Taxonomic procedures-taxonomic collections, preservation, curetting process of identification, Taxonomic characters: different kinds and their significance, Systematic publications: different kinds of publications.

Unit III

Classification of Chordates (Pisces to Amphibians): Salient Features and classification up to classes with reference to diversity in animal form and function, like: Habit and habitat, Support and Movement, Nutrition, Gas exchange & transport, Excretory organs Sensory system Reproductive patterns, Development and Larval characters.

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

Unit IV

Classification of Chordates (reptilians to mammals): Salient Features and classification up to classes with reference to diversity in animal form and function, like: Habit and habitat, Support and Movement, Nutrition

Gas exchange & transport, Excretory organs, Sensory system, Reproductive patterns, Development and Larval characters.

Flight adaptation in birds, Migration of birds.

List of Recommended Books

1. G.G. Simpson. Principle of animal taxonomy, Oxford IBH Publishing Company
2. E. Mayer. Elements of Taxonomy.
3. Boolotian and Stiles: College Zoology (Macmillan)
4. Marshall and Williams: Text Book of Zoology
5. Parker & Haswell: Text Book of Zoology Vol.II (Macmillan)
6. G.G. Simpson. Principle of animal taxonomy, Oxford IBH Publishing Company.
7. E. Mayer. Elements of Taxonomy.
8. E.O. Wilson. The Diversity of Life (The College Edition), W.W. Northern & Co.

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Semester-II

Course no.: 20ZOO23DA1 **MM: 80**
Course Title: Animal Behaviour **Time: 3Hr**

Course Outcomes

CO1: Students would gain insight into the important concept of animal behavior and conservation.
CO2: It also helps the students in understanding the important factors which affect the animal behaviour

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

Approaches and Methods in Study of Behaviour;
Proximate and Ultimate Causation;
Group Selection,
Kin Selection,
Altruism;

Unit I1

Concept of Learning,
Memory,
Cognition,
Sleep and Arousal;
Biological Clock.

Unit III

Development of Behaviour,
Social Communication,
Social Dominance;
Territoriality;
Mating Systems,

Unit IV

Parental Care,
Aggressive Behaviour,
Migration,
Orientation and Navigation;
Domestication and Behavioural Changes

List of Recommended Books

1. Mechanism of Animal Behaviour, Peter Marler and J. Hamilton; John Wiley & Sons, USA
2. Animal Behaviour, David McFarland, Pitman Publishing Limited, London, UK
3. Animal Behaviour, John Alcock, Sinauer Associate Inc., USA
4. Perspective on Animal Behaviour, Goodenough, McGuire and Wallace, John Wiley & Sons, USA
5. Exploring Animal Behaviour, Paul W. Sherman & John Alcock, Sinauer Associate Inc., Massachusetts, USA
6. An Introduction to Animal Behaviour, A. Manning and M.S Dawkins, Cambridge University Press, UK

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Semester-II

Course no.: 20ZOO22DA2 **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

Origin of cell and unicellular evolution: origin of basic biological molecules, abiotic synthesis of organic monomers and polymers.
Concept of Oparin and Haldane; Miller experiment; the first prokaryotic and eukaryotic cell. Origin of multicellularity.
Molecular evolution and neutral evolution.

UNIT-II

Emergence of evolutionary thought and mechanism: Lamarckism;
Darwin's concept of evolution; Adaptive radiations.
Competition and natural selection, Role of adaptations in evolution.
Modern concept/Synthetic theory of evolution.

UNIT-III

Evolutionary history and Palaeontology: evolutionary time scale, eras, period and epoch.
Major events in evolutionary time scale *w.r.t.* to animals.
Fossils and their types; dating of fossils; and significance of fossils,

UNIT-IV

Micro evolution and macro evolution: mechanism and examples.
Stages in primate evolution including *Homo*.
Origin and evolution of horse.

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 Yor

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Semester- II

Course no.: 20ZOO22CL **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. To study normal human karyotype
10. To study chromosomal abnormalities
11. To study the various human pedigrees
12. Gene mapping by TPT cross
13. Study of chromosomes slides (autosomes and sex chromosomes)
14. To study primary and secondary sexual characteristics
15. Observation of sex chromatin (Barr bodies) in buccal epithelium of Human female
16. To study the Polytene chromosomes of Chironomus larvae
17. To solve numerical problems related with the inheritance biology

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Semester- II

Course no.: 20ZOO22DL **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. Study and classify specimen up to order of various phyla of vertebrates with the help of charts
2. Study of Dissections through chart**:** Rat/ Mice /Fish, with the help of CD and Charts:
3. Digestive system,
4. Reproductive system,
5. Arterial system,
6. Venous systems,
7. Cranial nerves
8. Museum specimens and slides:
9. Protochordates
10. Fishes
11. Amphibians
12. Reptiles
13. Birds
14. Mammals
15. To prepare the taxonomic key on the basis of given characteristics.
16. Comparative study of the various systemic groups through charts etc
17. To study the geotaxis behaviour of earthworm.
18. To study the Hydrotaxis, behaviour of earthworm
19. To study the Chemotaxis behaviour of earthworm and
20. To study the Phototaxis behaviour of earthworm
21. To study phonotaxic behaviour of earthworm
22. To demonstrate antennal grooming behaviour in cockroach.
23. Demonstration of food preferences behaviour in ants
24. To study the effect of temperature on feeding behaviour of cockroach
25. To study foraging area of squirrel
26. To study food acceptance behaviour of squirrel
27. To study foraging time of insects from flower to flower
28. To study grooming behaviour in rats
29. To study dominating behaviour in rats
30. To study the stages of Evolution of the prokaryotes.
31. To study the stages of Evolution of the eukaryotes.
32. To study evolutionary history of Primates.
33. Human evolutionary tree.

34. Study of evolutionary time scale.
35. Serial homology supporting evolution.
36. Phenotypic Plasticity supporting evolution.
37. Paleontological evidences supporting evolution.
38. Study of natural Selection in action.
39. To study different examples of co-evolution between different organisms.

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Semester-III

Course no.: 20ZOO23C1 **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,
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,

Unit IV

Inflammation,
Hypersensitivity
Autoimmunity,
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.

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Semester-III

Course no.: 20ZOO23C2 **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.
Energy balance and BMR.
Dentition in mammals

Unit II
Respiratory and Circulatory System:
Organs and transport of gases, respiratory pigments, exchange of gases, neural and chemical regulation of respiration.
Structure of heart and blood vessel; Composition and Functions of body fluids and their regulation; Blood volume, blood volume regulation.
Heart Sounds, ECG – its principle and significance, Cardiac cycle, blood pressure.
Blood coagulation.

Unit III
Excretion and Osmoregulation:
Patterns of nitrogen excretion among different animal groups.
Physiology of excretion- renal regulation of acid balance,Mechanism of tubular reabsorption and urine formation, micturation, Influence of hormone in kidney functions.
Osmoregulation in different mammalian groups.

Unit IV
Muscle and Receptor physiology:
Muscles: structure and function: neural control of muscle tone and posture; Neuromuscular transmission and nerve conduction.
Gross neuro-anatomy of the brain and spinal cord, central and peripheral nervous system.
Receptor physiology – Mechanoreceptor, Photoreception, Chemoreception, Equilibrium reception.

List of Recommended Books
1. Chatterjee C C , Human Physiology. 1992.
2. Guyton, Text book of Medical Physiology, 10th Ed. W B Saunders

3. Wood, D.W. Principles and Animal physiology ,1968.
4. Hoar, W.S. General and Comparative Physiology, Prentice Hall of India.
5. Strand, F.L. Physiology: A regulatory Systems Approach. Macmillan Publishing Co., New York.
6. Pummer, L. Practical Biochemistry, Tata McGraw-Hill.
7. Prosser, C.L. Environmental and Metabolic Animal Physiology. Wiley-Liss Inc., New York.
8. Willmer, P.G. Stone, and I. Johnston. Environmental Physiology. Blackwell Sci. Oxford, UK, 644pp.
9. Newell, R.C. (ed.) 1976. Adaptation to environment. Essays on the physiology of marine animals. butterworths, London, UK, 539pp.
10. Townsend, C.R. and P. Calow. Physiological Ecology: An evolutionary approach to resource use. blackwell Sci. Publ., Oxford, UK.
11. Alexander, R.M.N. Optima for animals. Princeton Univ. Press, Princeton, NJ.
12. Louw, G.N. Physiological animal ecology. Longman Harloss, UK.
13. Sastry K V and Shukla V. Text Book of Physiology and Biochemistry, Rastogi Publication, Meerut

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Semester-III

Course no.: 20ZOO23DA1 **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.
CO4: Students will be able to analyse sources of variation

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, *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.

Unit III

Genome mapping: Genetic Mapping: single nucleotide polymorphisms, VNTRs and microsatellites
Physical mapping: restriction maps and radiation hybrid map and STS maps, FISH, DNA finger printing,

Unit IV

Molecular markers in genome analysis:
Types: RFLP, RAPD, SCARs, AFLP, ASAPs and SSRs (single sequence repeats) and CAPS.
Applications and limitations of molecular markers.
Genome analysis – *Humans and Drosophila*

List of Recommended Books

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

8. Watson, J.D., N.H. Hopkins, J.W. Roberts, J.A. Steitz and A.M. Weiner. Molecular Biology of Genes. The Benjamin/Cummings Publishing Company Inc., Tokyo.

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Semester-III

Course no.: 20ZOO23D2 **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 signalling 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 nemertean, annelids, molluscs, arthropods (Insects and crustaceans) and Echinodermata. 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; Structure and mechanism of action of peptide and protein hormones, Structure and mechanism of action of steroid hormones, 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.

List of Recommended Books
1. Mac E. Hadley, Jon E. Levine. Endocrinology, Pearson Prentice Hall, 2007
2. H. Maurice Goodman. Basic Medical Endocrinology, Fourth Edition, 2008, Academic Press, Elsevier
3. F Bolander. Molecular Endocrinology, 3rd Edition, 2004, Academic Press, Elsevier

4. E.J.W. Barrington. General and Comparative Endocrinology, Oxford, Clarendon Press.
5. P.J. Bentley. Comparative Vertebrate Endocrinology. Cambridge University Press.
6. R.H. Williams. Text Book of Endocrinology, W.B. Saunders
7. C.R. Martin. Endocrine Physiology. Oxford Univ. Press.

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Semester-III

Course no.: 20ZOO23DB1 **MM: 80**
Course Title: Population Biology **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 syllabus s 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 population: Gene pool, Genotype frequency and Allele frequency.
Hardy- Weinberg equilibrium: assumptions, predictions, application and significance.
Natural selection in action: Directional, Stabilising and Disruptive selection.
Adaptations: types and significance.

UNIT-II
Variation in natural population: nature, types and sources of variations.
Quantitative traits: characters and examples, Heritability.
Polymorphism: origin, types and salient features, phenotypic plasticity.

UNIT-III
Population ecology: Natality, mortality, fecundity, Sex ratio, Survivorship Curves.
Population growth, Growth curves, r and k strategies, carrying capacity.
Population regulation: density dependent and density independent.

UNIT-IV
Population interactions: Mutualism, Ammensalism, Commensalism, Predation, Proto-corporation, Predation.
Population diversity indices: Species richness, evenness, Simpson diversity index, Jaccard's similarity index.

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.

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Semester - III

Course no: 20ZOO23DB2 **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)

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Semester- III

Course no.: 20ZOO23C3 **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. The determine the antibody concentration by using Quantitative Precipitin Assay
2. To Detect of presence of Rheumatoid factors (RF) in given sample.
3. To detect presence of Treponemes which cause veneral disease (syphilis) by VDRL test
4. To learn the technique of latex agglutination.
5. To perform the RPR test for the detection of syphilis
6. To detect the presence of Salmonella genus using qualitative slide agglutination by Widal test
7. To count platelets in given sample
8. To study effect of different anticoagulants on platelets count.
9. Staining techniques in Haematology.
10. To prepare thin peripheral blood smear with Giemsa staining.
11. To prepare thick blood smear with Giemsa staining.
12. To study blood groups and RH factor
13. To estimate the RBC count present in $1m^{m3}$ volume of blood.
14. To estimate the WBC count present in $1mm^3$ volume of blood.
15. Determination of MCV, MCH, and MCHC.
16. Determination of colour Index of blood.
17. Demonstration of the blood clotting time.
18. Demonstration of the erythrocyte sedimentation rate.
19. Demonstration of the haemolysis.
20. To study the effect of osmolarity of solution on RBC
21. Qualitative estimation of salivary amylase
22. To study the effect of varying pH on salivary amylase
23. To determine the effects of varying temperatures on the activity of salivary amylase
24. To study the rate of respiration by aquatic animals
25. Spiro metric analysis of pollution impact on human beings and its implications.

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Semester- III

Course no.: 20ZOO23DL **MM: 80**
Course Title: Laboratory Course **Time: 3 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 identify different endocrine glands with the help of charts
2. To study the histology of endocrine glands of animals with the help of charts
3. To determine the concentration of glucose in the diabetic samples.
4. To measure concentration of corticosterone in human plasma or given sample
5. To measure serotonin level in given sample
6. Isolation of hormones from different endocrine glands.
7. To precipitate the protein hormone by ammonium sulphate precipitation method
8. To perform affinity column chromatography for purification of hormones
9. To perform ELISA for detection of hormones
10. Analysis of genetic material through RFLP, RAPD, AFLP
11. Plasmid DNA isolation
12. To study effects of temp/UV rays on Drosophila
13. To study polyteen and Lamp brush chromosomes
14. Competent cell preparation
15. To study the genetic variations in Human populations.
16. To study the genetic variability with the help of thumb impression.
17. Verification of Mendelian monohybrid ratio and its analysis.
18. Verification of Mendelian dihybrid ratio and its analysis.
19. Determination of frequency of dominant and recessive traits (alleles).
20. Determination of frequency of multiple alleles.
21. Pedigree analysis from pedigree charts.
22. To study adaptive radiation *w.r.t.* mouth parts of insects.
23. Simpson's Index calculation a tool for measuring genetic diversity in population samples.
24. Shannon Weiner Index as a diversity measurement tool for large populations.
25. Determination of dissolved COD in variety of given samples.
26. To determine the concentration of free CO_2 in variety of given samples of water.
27. Determination of dissolved O_2 of given water samples by Wrinklers method.
28. Determination of dissolved BOD in variety of given samples.
29. Determination of salinity in variety of given samples of water and soil.
30. To determine hardness content in polluted and control water and soil samples
31. To study presence of specific microbes in various normal and polluted water and soil samples.
32. Collection of phytoplankton and zooplankton from natural resources and their identification.
33. Ecological comments on wild species of different niche and habits.
34. Pollution/ Toxicology: a. Estimation of LD_{50} and LC_{50} b. Pesticide residue analysis of contaminated vegetable soil and water.

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Semester-IV

Course no.: 20ZOO24C1 **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).

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Semester-IV

Course no.: 20ZOO24C2 **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.

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Semester- II

Course no.: 20ZOO01 **M.M.: 80**
Course Title: Applied Zoology **Time: 3 Hr**

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

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

Unit-II
Life history, pathogenesis and control of *Plasmodium* sp.
Life history, Medical importance and control of *Aedes* sp.
Life history, pathogenesis and control of *Taenia* sp.
Life history, pathogenesis and control of *Ascaris* sp.

Unit-III
Sericulture: Species of silk moth (scientific names), Life history of mulberry silk worm, cocoon processing, economic importance of silk.
Apiculture: Species of honey bees in India, life history of *Apis cerana indica*, agriculture techniques, social organization of honey bee, economic importance of honey.
Lac culture: lac insect (Scientific name), life history of lac insect, host plants, composition of lac, economic importance of lac.
Wool industry: types, properties and processing of wool.

List of Recommended Books

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

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Semester- III

Course no.: 20ZOO02 **M.M.: 80**
Course Title: Wild Life and Conservation **Time: 3 Hr**

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

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

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

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

List of Recommended Books

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