



**Deccan Education Society's
Fergusson College(Autonomous)**

Pune

Learning Outcomes-Based Curriculum

for 2 years M.Sc. Programme

as per guidelines of

NEP-2020

for

F. Y. M. Sc. (Zoology)

With effect from Academic Year

2023-2024

M. Sc. I Zoology Course Structure

Semester	Paper Code	Paper Title	Credits
I	ZOO-501	Cell Biology	4
	ZOO-502	Biochemistry	4
	ZOO-503	Advanced Endocrinology	4
	OR		
	ZOO-504	Animal Behaviour	
	ZOO-510	Research Methodology	4
	ZOO-520	Zoology Practical-I	2
	ZOO-521	Zoology Practical-II	2
	Total Semester Credits		
II	ZOO-551	Genetics	4
	ZOO-552	Animal Physiology	4
	ZOO-553	Comparative Anatomy of Vertebrates	4
	OR		
	ZOO-554	Ecology	
	ZOO-560	On Job Training / Field Project	4
	ZOO-570	Zoology Practical-III	2
	ZOO-571	Zoology Practical-IV	2
	Total Semester Credits		
Total PG-I Credits			40

M. Sc. II Zoology Course Structure

Semester	Paper Code	Paper Title	Credits
III	ZOO-601	Evolutionary Biology	4
	ZOO-602	Molecular Biology	4
	ZOO-603	Advanced Biostatistics	4
	OR		
	ZOO-604	Histology and Histo-chemistry	
	ZOO-605	Immunology	4
	ZOO-620	Zoology Practical-V	2
	ZOO-621	Zoology Practical-VI	2
	Total Semester Credits		20
IV	ZOO-651	Developmental Biology	4
	ZOO-653	Biological Techniques and Bioinformatics	4
	OR		
	ZOO-654	Parasitology	
	ZOO-670	Zoology Practical-VII	2
	ZOO-660	Research Project I	4
	ZOO-661	Research Project II	6
	Total Semester Credits		20
Total PG-II Credits			40

M.Sc. Semester I Major		
ZOO-501	Cell Biology	Credits: 4 Hours: 60
Course Outcomes (COs) On completion of the course, the students will be able to:		
CO1	Describe the concept of cell biology, protein sorting, cell -cell signaling, cell death, cell ageing. Identify and label components of the cells and describe their functions.	
CO2	Differentiate the concept and mechanism of programmed cell death and necrosis, cytoskeletal material and various transport processes across the cell membrane.	
CO3	Illustrate the biology of ageing, cancer and molecular approaches to cancer treatment. Outline intrinsic and extrinsic pathways of cell death, mechanism of vesicular transport.	
CO4	Identify and draw diagrams of cell membrane and cell organelles and analyse their functions.	
CO5	Review the process of cell renewal, applications of stem cells, pathways of signal transduction, signaling networks.	
CO6	Integrate the knowledge of cellular mechanism with research activities to understand and interpret the alterations happening in the cell structure and functions due to physical, chemical and ecological factors.	

Unit. No.	Title of Unit and Contents	No. of hours
I	Overview of Cells and Cell research Cell as experimental model, Tools of cell biology. Biology of Cell Membranes Chemical composition of cell membranes, membrane receptors transport across the membrane Membrane potentials and nerve impulses Extracellular matrix; cell-matrix adhesion (integrins, collagen and non-collagen compounds). Cell-cell interaction adhesion junction, tight junction, gap junction and plasma-desmata; Ca^{++} dependent and Ca^{++} independent cell-cell adhesion. Protein sorting Protein uptake into the ER, Membrane Proteins and Golgi sorting Mechanism of vesicular transport, Lysosomes, Molecular mechanism of secretory pathway.	15
II	Structural and functional organization of intracellular organelles: - Nucleus, Mitochondria, Golgi body, Lysosomes, ER and Peroxisomes, Vacuoles, Chloroplast. Cytoskeleton and cell movement- Structure and organization of actin filaments, Actin, myosin and cell movements. Structure and dynamic organizations of microtubules, Microtubule motors and movement, Intermediate filaments, Cilia and flagella.	15

III	Cell-Cell Signaling Signaling molecules and their receptors. Function of cell surface receptors. Pathways of intracellular signal transduction, Signaling networks. Regulation of cell cycle and checkpoints, Cell Death -Necrosis, programmed cell death (intrinsic and extrinsic pathway)	15
IV	Cell Renewal - Stem cell and applications. Biology of Cancer - The development and causes of cancer. Oncogenes, Tumour suppressor genes, Molecular approaches to cancer treatment. Biology of Ageing -Theory of ageing (somatic mutation theory; error theory; codon restriction theory; gene regulation theory; free radical theory; telomerase theory).	15

References:

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. The World of the Cell, 7th edition (2005), Wayne M. Becker, Lewis Kleinsmith, Jeff Hardin.
Publisher-Benjamin Cummings.
4. Molecular Biology, Weaver R. F., McGraw-Hill Education (5th Ed. 2011).

M.Sc. Semester I Major		
ZOO-502	Biochemistry	Credits: 4 Hours: 60
Course Outcomes (COs) On completion of the course, the students will be able to:		
CO1	Outline concept of Biomolecules, its importance and explain types of biomolecules in biological system. Describe structure and properties of proteins, DNA and RNA.	
CO2	Classify types of enzymes and explain effect of various factors on enzymatic reaction.	
CO3	Illustrate the metabolism of carbohydrates and proteins.	
CO4	Explain Lipid metabolism and its importance. Compare mitochondrial and peroxisomal systems of fatty acid oxidation.	
CO5	Compare α , β and ω oxidation of fatty acids. Review energetics of carbohydrates and lipid metabolism.	
CO6	Write about the role of enzymes with respect to metabolic reactions.	

Unit. No.	Title of Unit and Contents	No. of hours
I	Introduction to Biomolecules: Classification and Structure of Carbohydrates and conformation of Glucose molecule, importance of carbohydrates. Structures of Protein (Primary, Secondary, Tertiary, and Quaternary). Protein folding and Stability, Ramachandran Plot. Classification of Lipids (Fatty acids, triacylglycerol, glycerol phospholipids, sphingolipids, cholesterol, and prostaglandins). Dark reactions of Photosynthesis- CO ₂ fixation: C ₃ , C ₄ and CAM Pathways.	15
II	Enzyme- Definition & Classification of enzymes. Enzyme catalysis, specificity of enzyme action. Enzyme kinetics and order of reactions, V _{max} , K _m , Michaelis-Menten equation. Factors affecting enzymes activities. Study of Coenzymes, Cofactors, and Iso-enzymes. Regulatory and allosteric enzymes. Immobilized enzymes. Enzyme inhibition- reversible and irreversible inhibitors.	15
III	Metabolisms of Carbohydrates Glycolysis pathway and its regulation Pentose Phosphate pathway. Gluconeogenesis, glycogenolysis, Tricarboxylic acid cycle. Oxidative phosphorylation. Electron transport chain. Energetics of glucose metabolisms Metabolisms of Proteins- Ornithine cycle. Transamination and deamination.	15

IV	Lipid metabolism and nucleic acid metabolism Production of AMP, GMP, CMP, UMP and TMP. Structure of nucleotide. Structure of DNA and RNA. Mitochondrial and peroxisomal systems of fatty acid oxidation Introduction to α , β and ω oxidation of fatty acids. Energetics of fatty acid oxidation Role of carnitine shuttle Ketone bodies – Structure and functions.	15
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References:

1. Biochemistry – Lehninger.
2. Metabolic Pathways - Greenberg.
3. Biochemistry – G. Zubay, Addison Wesley Publ. (1983).
4. Biochemistry – Stryer (1988) 3rd Edition W.H. Freeman and Co.
5. Advanced PRACTICAL ZOOLOGY by J Sinha, A.K. Chatterjee, P Chattopadhyay. (books and Allied publication).
6. Biochemistry by Voet
7. Campbell, MK (2012) Biochemistry, 7th ed., Published by Cengage Learning
8. Campbell, PN and Smith AD (2011) Biochemistry Illustrated, 4th ed., Published by Churchill Livingstone
9. Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H. Freeman
10. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H. Freeman and Company

M. Sc. Semester I Elective		
ZOO-503	Advanced Endocrinology	Credits: 4 Hours: 60
Course Outcomes (COs) On completion of the course, the students will be able to:		
CO1	Describe endocrine glands, their structural features, hormones secreted by endocrine glands /organs and hormone- Cell receptor mechanism.	
CO2	Explain role of pancreas as endocrine organ, hormones of pancreas and carbohydrate metabolism and related clinical aspects.	
CO3	Illustrate role of pancreas and thyroid gland, its physiological role and clinical implications.	
CO4	Classify different classes of hormones and their mechanism of action with special reference to receptor mechanisms and its processing through signal transduction.	
CO5	Review reproductive endocrine system and hormone disruptors Human Exposure to environmental factors, and its Clinical Implications	
CO6	Write a report on hormonal disruptors and associated disorders.	

Unit. No.	Title of Unit and Contents	No. of hours
I	General Endocrinology Overview of endocrine glands and their structural features Classification of hormones, effects and regulation- basic concepts and methods Receptors and Types- Membrane receptors, nuclear receptors, receptor regulation and signal transduction, secondary messengers, hormone action and termination	15
II	Endocrinology of Pancreas Cell structure and types, Hormones of Endocrine Pancreas, Hormones involved in Carbohydrate Metabolism, Clinical Aspects of Endocrine Pancreas. Chemically induced Diabetes	15
III	Endocrinology of Thyroid Organization in Mammals, Biochemistry and Metabolism of Thyroid Hormones, Physiological Role of Thyroxine and Clinical aspects of Thyroid Functions	15
IV	The Hormones and Reproduction Embryology of Gonadal Development, Male and Female Reproductive Hormones, Female Reproductive Cycle, Clinical Aspects of Reproductive Systems. Environmental Endocrinology Introduction, Endocrine Disruptors, Human Exposure, Hormone Disruptors, Clinical Implications Parahormones, IVF, Test tube babies	15

References:

1. Haris, C. W. and B. T. Donovan, 1968. The Pituitary Gland. S. Chand and Co.,
2. Bentley, P. J. 1985. Comparative vertebrate endocrinology, Second Edition, Cambridge University Press. Cambridge.
3. Mac Hadley. 1992. Endocrinology, 3rd Edition, Prentice - Hall Inc. A Simon & Schuster Company, Englewood Cliffs, New Jersey, U. S. A.
4. Ingleton, P. M. and J. T. Bangara, 1986. Fundamentals of comparative vertebrate endocrinology, Kluwer Academic Publishers.
5. Turner, C. D. and J. T. Bangara, 1986. General endocrinology. Saunders International Student edition, Toppan Company Limited. Tokyo.
6. Barrington, E. J. W. 1985. An introduction to general and comparative endocrinology, Clarendon Press Oxford.
7. Bolander FF, Molecular Endocrinology, Elsevier, UK.
8. Hadley ME and Levine JE, Endocrinology, Adeson - Wesley Publication, USA.
9. Melmed S. Polonsky KS, Reed P et al., William's text book of Endocrinology, Willey Blackwell Publication, UK.
10. Franklyn F. Bolander. Molecular Endocrinology Elsevier - Academic Press.
11. J. Darnell, H. Lodish and D. Baltimore, Molecular Cell Biology: Scientific American Book, Inc. USA.
12. Norris, D. O., Vertebrate Endocrinology: Academic Press, New York.
13. Chandra Negi. 2015. Introduction to Endocrinology.

M.Sc. Semester I Elective		
ZOO-504	Animal Behaviour	Credits: 4 Hours: 60
Course Outcomes (COs) On completion of the course, the students will be able to:		
CO1	Describe the behavioural Genetics and social behaviour of animals	
CO2	Explain and discuss how language evolved in primates and different modes of communication.	
CO3	Illustrate the role of nerves and hormones in controlling behaviour.	
CO4	Classify different behavioural patterns of animals to study and analyse animal psychology.	
CO5	Review reproductive behaviour and biological Rhythms.	
CO6	Write a report on application of Animal behaviour and outline different approaches and methods in study of behaviour.	

Unit. No.	Title of Unit and Contents	No. of hours
I	Animal Psychology: Classification of behavioural patterns. Analysis of behaviour (ethogram). Innate behaviour Behavioural Genetics: Genes and behaviour. Evaluation of behaviour. Co evolution. Control of behaviour: Neural and hormonal.	15
II	Communication: Chemical, Visual, Audio Evolution of language (primates) Social Behaviour: Aggregation, Schooling in fishes, Flocking in birds Group selection, kin selection, altruism, Social organization in insects and primates.	15
III	Reproductive Behaviour: Mating systems. Courtship. Sperm competition. Parental Care Biological Rhythms: Circadian and circannual rhythms. Orientation and navigation Migration of fishes & birds Learning and memory: Insight learning. Association learning. Reasoning. Cognitive skills	15
IV	Applications: - Application of Animal behavior, Approaches and methods in study of behavior. Molecular applications – proximate and ultimate causation; Altruism and evolution– group selection, kin selection, reciprocal altruism; Neural basis of learning, memory, cognition, sleep and arousal; Biological clocks. Molecular basis of memory	15

References:

1. Alcock, J. Animal behavior: An evolutionary approach, Sinauer Assoc., Sunderland, Mass. USA.
2. Bradbury, J.W., and S.L. Verhrencamp. Principles of Animal Communication, Sinauer Assoc., Sunderland, Mass. USA.
3. Clutton-Brock, T.H. The evolution of Parental care, Princeton Univ. Press, Princeton, NJ, USA.
4. Eibl-Eibesfeldt, I. Ethology. The biology of behaviour, Holt, Rinehart & Winston, New York.
5. Gould, J.L. The mechanisms and evolution of behaviour.
6. Hauser, M. The evolution of communication, MIT Press, Cambridge, Mass. USA.
7. Hinde, R.A. Animal behaviour: A synthesis of Ethology and comparative psychology. McGraw-Hill, New York.
8. Krebs, J.R. and N.B. Davies, Behavioural ecology, Blackwell, Oxford, U.K.

M.Sc. Semester I RM		
ZOO-510	Research Methodology	Credits: 4 Hours: 60
<u>Course Outcomes (COs)</u> On completion of the course, the students will be able to:		
CO1	Describe the research foundation, problem solving methods and designing the research problem.	
CO2	Discuss the data collection and sampling methods along with qualitative and quantitative research	
CO3	Compile and analyse the data with scientific interpretation and writing a research paper using online and offline tools for literature search.	
CO4	Explain the process of reporting and thesis writing with proper reasoning.	
CO5	Discuss the application of research and research ethics.	
CO6	Compile the data of various research methodologies required for project completion and dissertation.	

Unit No.	Title of Unit and Contents	No. of hours
I	History of research, Indian, Egyptian, Greek ideas methodologies and research in agriculture, chemistry, metallurgy, medical. Ancient Indian research methodology applications.	15
II	Statistical analyses and its significance, Exploratory and confirmatory research, Planned and ad-hoc methods of data collection, Non-response and methods of recovering the missing response, Various software for statistical analysis. The module will consist of case studies of the research performed in various subjects using statistical methods, Error and noise analysis, curve fitting. Data Analysis: Data preparation and presentation (frequency tables, bar charts, pie charts, histograms, etc.) –Univariate analysis, Bivariate analysis – Cross tabulations and testing hypothesis of association including Chi-square test, correlation and regression analysis.	15
III	Literature search, selection of research topic (case study based), maintaining laboratory records (case study based). Safety in Laboratories, Ethical considerations, effective verbal and non-verbal communication, field data collection, safety in field. Writing research paper and/or thesis, making a presentation, writing a research proposal, and patents in Science, technology Use of Tools / Techniques for Research: Methods to search required information effectively, reference management software like Zotero/Mendeley/Endnote, Software for paper formatting like LaTeX /MS Office, software for detection of plagiarism.	15

IV	Data Collection & Sampling for zoological study: execution of the research - observation and collection of data - methods of data collection- planned and ad-hoc methods, concepts of statistical population, sample, sampling frame, sampling error, sample size, non-response and methods of recovering the missing response. Characteristics of a good sample. Probability sample – simple random sampling, systematic sampling, convenience sampling, stratified random sampling & multi-stage sampling. Determining size of the sample – practical considerations in sampling and sample size. Qualitative and Quantitative Research: Qualitative research, Quantitative research, causality, generalization, replication. Merging the two approaches. Concept of measurement -what is measured? Problems in measurement in research – Validity and Reliability. Levels of measurement –Nominal, Ordinal, Interval, Ratio.	15
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References:

1. Research Methodology-C R Kothari
2. Research Methodology: An Introduction-Stuart Melville and Wayne
3. Practical Research Methodology-Catherine Dawson
4. Research Methods for Science Michael P Marder
5. Research Methodology: Principle, Methods and Practices-Joshua O.Miluwi and Hina Rashid
6. Research Methodology: A Step by Step Guide for beginners- Ranjeet Kumar
7. How to Write and publish a Research Paper- Seventh Edition-Robert Day and Barbara Gastle
8. Introduction to Biostatistics and Research Methods- P S S Sunder Rao
9. Research Methodology and Scientific Writings- C George Thomas
10. An Introduction to Research Methodology, RBSA Publishers Garg, B. L.Karadia R. Agrawal, F. and Agrawal U. K., 2002.
11. Research Methodology Ess Publications Sinha S. C. and Dhiman A. K., 2002.
12. Research Methods: The Concise Knowledge Base, Trochim W. M. K., 2005. Atomic Dog Publishing. 270P
13. Law Relating to Patents, Trade Marks, Copyright Design and Geographical Indications, Universal Law Publishing. Wadehra B. L., 2000.
14. History of the Scientific Methods by Martin Shuttleworth, <https://explorable.com/history-of-the-scientific-method>.
15. The Statistical Analysis of Experimental Data' by, John Mandel, ISBN: 0486646661, ISBN13: 9780486646664

M.Sc. Semester I Practical paper I		
ZOO-520	Zoology Practical –I	Number of Credits : 02
Course Outcomes (COs) On completion of the course, the students will be able to:		
CO1	Describe and demonstrate the experiment for preparation of mitotic and meiotic stages of chromosome and the effect of colchicine on mitosis.	
CO2	Clarify the method of determination of chiasma frequency and terminalization coefficient.	
CO3	Demonstrate and illustrate the mechanism of phagocytosis, pinocytosis and subcellular fraction.	
CO4	Demonstrate Cyclosis in Paramecium	
CO5	Determination of Absorption spectrum of hemoglobin and lipid solubility of membrane	
CO6	Illustrate preparation of blood smear and differential count.	

Sr. No.	Title of Practical	No. of Practicals
1.	Preparation of mitotic chromosomes	1
2.	Preparation of meiotic chromosomes	1
3.	Mitosis : Effect of colchicine on mitosis and polyploidy	1
4.	Subcellular fraction: nuclei, mitochondria, cytosol and assaying functional identification of mitochondria.	1
5.	Study of phagocytosis and pinocytosis.	1
6.	Determination of chiasma frequency and terminalisationcoefficient	1
7.	Preparation of blood smears: cell type identification and differential count.	1
8.	EM – interpretation of cellular ultra-structure	1
9.	To study lipid solubility of membrane	1
10.	Determination of Absorption spectrum of hemoglobin (Hb) in Fe ²⁺ and Fe ³⁺ state.	1
11.	Study of Cyclosis in Paramecium	1
12.	Study of meiosis in grasshopper testis/ onion flower buds with emphasis on all stages of prophase.	1
13.	Diagnosis of pregnancy by the presence of HCG in Urine by using suitable method.	1
14.	Study of male and female reproductive system by using suitable animal model/ charts	1
15.	Case study relating to particular clinical conditions of hormone	1
16.	Visit to Veterinary Institutes to learn breeding techniques.	1
17.	Histology of Ovary and testes.	1
18.	Histological slides pertaining to endocrine glands.	1
19.	Any other practical set by faculty.	

M.Sc. Semester I Practical Paper II		
ZOO-521	Zoology Practical-II	Number of Credits : 02
Course Outcomes (COs) On completion of the course, the students will be able to:		
CO1	Describe concept of standard Laboratory Practices and techniques of Sterilization and of equipment's.	
CO2	Estimate different biomolecules by qualitative and quantitative methods.	
CO3	Carry out and examine enzyme reaction and compare the effect of temperature and pH on enzyme activity.	
CO4	Preparation of Buffers of given pH and molarity and measurement of pH of various samples	
CO5	Study of effect of temperature, pH on enzymatic activity.	
CO6	Perform the calibrations of centrifuge, colorimeter/spectrophotometer, pH meter. Specify the standardization of different acid and bases.	
Elective -Advanced Endocrinology		
CO1	Recall the basic concepts of endocrinology and histological aspects of endocrine organs.	
CO2	Explain the basic theory of endocrinological processes with special reference to hormonal regulation	
CO3	Apply the principle and protocols for estimation and determination of endocrine components	
CO4	Analyse anatomical/histological features and interpret clinical conditions of hormones.	
CO5	Determine the hormonal levels of selected endocrine organs and estimate their hormonal levels	
CO6	Perform experiments based on endocrine parameters and prepare a report of observations	

Sr. No	Title of The Practical	No. of Practicals
Biochemistry		
1	Standard Laboratory Practices and techniques- Sterilization, Calibrations of measuring glass wares and equipment, centrifuge, micropipettes, hot air oven, incubators, BOD,etc.	1
2	Preparations and standardization of different acid and bases.	1
3	Qualitative analysis of Carbohydrates.	1
4	Quantitative analysis of Proteins.	1
5	Quantitative analysis of Lipids.	1
6	Estimation of Glucose.	1
7	Estimation of Proteins.	1
8	Estimation of acid and alkaline phosphatase.	1
9	Isolations of genomic DNA from Goat liver tissues./Onion.	1

10	Estimation of cholesterol.	1
11	Demonstration of catalase in Goat liver tissues.	1
12	Study of effect of temperature, pH on enzymatic activity.	1
13	Preparation of Buffers of given pH and molarity and measurement of pH of various samples	1
14	Estimation of Vitamin C	1
15	Effect of substrate concentration on enzyme activity	1
16	Estimation of amino acids by paper chromatography	1
17	Estimation of amino acids by TLC.	1
18	To find absorption spectrum of hemoglobin, BSA, Tyrosine	1
19	Blood glucose and liver glycogen estimation by using suitable animal model and method by inducing diabetes.	1
20	Study of models pertaining to ART (Assisted reproductive techniques), Transgenic techniques, STDs and Contraception	1
21	Any other practical set by faculty.	1
Animal Behaviour		
1	To study the geotaxis behaviour of earthworm	1
2	To study the orientation responses of larvae/adult animal to photo stimuli.	1
3	To study the median threshold concentration of sucrose solution in eliciting feeding responses of housefly.	2
4	To study the orientation responses of larvae/adult animal to volatile and visual stimuli.	2
5	To study the behaviour of Siamese Fighting Fish.	2
6	To observe animal behaviour with the help of charts and/or videos.	1
7	To study the earthworm response to various environmental stimuli.	2
8	Using a choice chamber to investigate animal responses to stimuli.	2
9	To test effect of household and natural solutions on behaviour of ants.	1
10	To determine to which type of soil earthworms are attracted.	1
11	To test the effect of enrichment toy to determine behaviour of pet.	2
	*Any other practical suggested by the teacher	

M. Sc. Semester II Major		
ZOO-551	Genetics	Credits: 4 Hours: 60
Course Outcomes (COs) On completion of the course, the students will be able to:		
CO1	Describe the different concepts and methods available to study classical genetics.	
CO2	Explain Non Mendelian Inheritance, chromosomal inheritance and variations.	
CO3	Apply the concepts and genetical processes for physical mapping of genes.	
CO4	Analyse variations in genetic and environmental factors in quantitative genetics.	
CO5	Determine probability and exercises for solving basic and population genetics problems.	
CO6	Write a report on Chromosomal Aberrations and genetic consequences.	

Unit. No.	Title of Unit and Contents	No. of hours
I	Classical genetics - Review of Mendel's principles. Non-Mendelian Inheritance Incomplete dominance and co- dominance. Gene interaction. Probability and exercises for solving genetics problems. Sex linkage inheritance in <i>Drosophila</i> . Sex linked genes in human and its effect. Sex limited and sex influenced characters. Quantitative Genetics -Polygenic traits and mode of inheritance. Analysis of variation: genetic and environmental factors. Study of stick of phenotypic variance. Introduction to BSH and NSH	15
II	Cytogenetics -Extra Chromosomal Inheritance, Inheritance of mitochondrial and chloroplast genes maternal inheritance, Kappa particles, mu particle. Chromosomal variation -Chromosomal aberration- Deletion, Duplication, Inversion and Translocation and genetic consequences. Physical mapping of Gene -Chromosomal theory of linkage. Crossing over- Mechanism of meiotic crossing over, kinds of crossing over. Chromosome mapping: two- & three-point test cross (brief account only). Basic steps of construction of gene map. Problems based on three-point cross. Determination of interference.	15
III	Molecular genetics - Brief view of genomes. DNA mutations. Transposable elements. Population Genetics -Basic concepts & terminologies. Hardy-Weinberg principles and applications. Changes in allelic frequencies. Exercises for solving population genetics problems. Eugenics and Euphenics	15

IV	Bacterial and Phage Genetics/ Genetic Recombination in bacteria - Bacterial chromosome Mechanisms of gene transfer in bacteria Chromosomal mapping by transformation, conjugation and transduction. Interrupted mating technique. Types of mutations in bacterial cells- auxotrophs, conditional mutants, suppressor mutations, polar mutants. Introduction to Epigenetics.	15
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References:

1. Concepts of Genetics, 9th ed (2008), William S. Klug, Michael R. Cummings, Charlotte
 2. Spencer, and Michael A. Palladino, Publisher-Benjamin Cummings
 3. Genes IX, 9th ed. (2008), Benjamin Lewin, Publisher-Jones and Bartlett Publishers Inc.
 4. Principles of Genetics, 4th edition, (2006), Snustad D. Peter and Simmons J. Micheal, Publisher -John Wiley and Sons. Inc.
 5. Genetics, (1999), Daniel J. Fairbanks, W. Ralph Andersen Publisher-Brooks/Cole Pub Co.
 6. Principles of Genetics, 8th edition (1991), Eldon J. Gardner, D.P. Snustad, M.J. Simmons, and D. Peter Snustad Publisher-John Wiley and Sons. Inc.
 7. Microbial Genetics, (1987), David Freifelder, Publisher-Jones & Bartlett
- 9) General Genetics, (1985), Leon A. Snyder, David Freifelder, Daniel L. Hartl Publisher-Jones and Bartlett**
- Genetics, 3rd edition, Monroe W. Strickberger, (1968), Publisher - Macmillan Publishing Co.**

M.Sc. Semester II Major		
ZOO-552	Animal Physiology	Credits: 4 Hours: 60
Course Outcomes (COs) On completion of the course, the students will be able to:		
CO1	Describe the concepts of human physiology, its importance, functions of organs and organ systems.	
CO2	Discuss the structure of skeletal muscles and mechanism of muscular contraction. Articulate the conduction of impulses through the neurons and ultra- mechanism of osmoregulation in human body.	
CO3	Apply the knowledge of physiology to interpret effect of exercise on cardiovascular activities. Generalize the role of kidney in regulation of acid base balance along with other functions.	
CO4	Explain the physiology of human reproductive system and analyse the O ₂ dissociation curve and its physiological and ecological importance.	
CO5	Explain the role of digestive enzymes along with metagenome of gut and regulation of homeostasis through various mechanisms.	
CO6	Compile the data of physiological aspects related to digestive, respiratory, circulatory, excretory systems, reproductive and neuromuscular systems.	

Unit. No.	Title of Unit and Contents	No. of hours
I	Physiology of digestion and internal transport & gas exchange. Digestion: Peristalsis, digestion and its regulation, nutrient absorption, co- relation of digestive enzymes with food, metagenome of gut, BMR. Respiration: Respiratory Surfaces: ventilation associated with pulmonary respiration, tidal and vital capacities, oxygen transport, O ₂ dissociation curves-physiological and ecological significance, CO ₂ transport, neural and chemical regulation of respiration.	15
II	Circulation, cardiovascular system, Excretion and Osmoregulation. Circulation: Systems of circulation, myogenic and neurogenic heart, Pumping activity of heart, action potential – pace maker, cardiac cycle, electrical changes, neural and chemical regulation of heart beat, cardiac output, effects of exercise on cardiac vascular physiology. Blood corpuscles, haemopoiesis and formed elements, plasma function. ECG – its principle and significance, Excretion: Nitrogenous waste products: ammonia, urea and uric acid their formation and excretion, role of kidney in excretion, renal regulation of acid base balance, micturition, Osmoregulation: Maintaining water and electrolyte balance.	15

III	Neuro-muscular Physiology. Nervous co-ordination: Neuron and glia. Gross neuroanatomy of the brain and spinal cord, central and peripheral nervous system, neural endocrine control of muscle tone and posture. Excitation and conduction of nerve fibre, action potential, saltatory conduction, ionic basis of excitation and conduction, neurotransmitters and their physiological functions, synaptic transmission Muscle: Types of muscles, ultrastructure of skeletal muscle fibres, biochemistry of contractile proteins, theory of muscle contraction, chemical basis of contraction, neuro-muscular junction, Fatigue	15
IV	Chemical co-ordination and Physiology of reproduction. Chemical Communication: The concept of homeostasis and negative and positive feedback. Reproduction: Physiology of reproductive cycle and its hormonal regulation. Biochemical composition of semen, sperm capacitation and decapacitation – molecular mechanism and significance. Reproductive glands: Testes; Prostate gland and Ovary.	15

References:

1. General and Comparative physiology, Hoar W. S., Prentice Hall, India, New Delhi
2. Physiology of Sport and Exercise, Kenney WL, Wilmore J and Costill D, Amazon, UK.
3. Animal Physiology, Schmidt-Nielsen, Adaptation and Environment. Cambridge.
4. Principles of Anatomy and Physiology, G.J. Tortora
5. Textbook of Physiology and Biochemistry, Bell and Davidson
6. Principles of Physiology and Biochemistry, Holurn
7. Textbook of Animal Physiology, Goel and Shastri

M. Sc. Semester II Elective		
ZOO-553	Comparative Anatomy of Vertebrates	Number of Credits : 04
Course Outcomes (COs) On completion of the course, the students will be able to:		
CO1	Describe development of kidney and the evolution of kidneys in vertebrate. Define meninges and write development and differentiations of various parts of brain of vertebrates. Define the hemopoiesis.	
CO2	Explain origin and types of cartilage, development of bones and types of joint. Compare skull bones of vertebrates. Discuss various types of vertebrae of vertebrates. Differentiate the girdles and appendicular bones of frog, Calotes, pigeon and human.	
CO3	Illustrate the origin and development of Alimentary canal.	
CO4	Compare the structure of integuments of vertebrate and list out the epidermal derivatives. Explain various types of epidermal glands and derivatives of vertebrates and explain the functions of epidermal gland and integument. Compare anatomical details of brain of shark, frog, Calotes, bird and rat. Explain the development of heart and compare heart of shark, frog, Calotes, pigeon and rat.	
CO5	Determine the development of gonads and explain the modification of genital ducts in vertebrates.	
CO6	Compile the knowledge of Evolution of Aortic arches of vertebrates, modification of oral cavity and sound producing organs of vertebrates.	

Unit No.	Title of Unit and Contents	No. of hours
I	Comparative study of Integumentary system and derivatives. Comparative study of structure of integuments of Petromyzon, Amphioxus, Scoliodon, Frog, Calotes , Pigeon and Rat. Epidermal derivatives of Vertebrates. Epidermal glands –various types of glands of vertebrates and their functions (e.g. mucous, serous, ceruminous, poison, uropygial, sweat, sebaceous, mammary glands, etc.). Epidermal derivatives -types of scales, feathers, beaks, hair, hoof, horns and antlers, claws, teeth, nails, hooves, and baleen. Functions of integument.	15
II	Notochord, Cartilage - types and origin of cartilage, Bones; - development of bones and types of joints. Comparative study of skull of Shark, frog, Calotes, pigeon and human. Study of Vertebrae of shark, frog, Calotes, pigeon and human. Sternum- origin and comparative study of Tetrapoda Girdles and appendicular bones of frog, Calotes, pigeon and human.	15

III	Comparative anatomy of digestion, respiration and circulation of vertebrates Digestive system -Origin and development of Alimentary canal. Parts and modification of oral cavity of vertebrates. Respiratory system -Types of various respiratory organs and sound production in vertebrates. Circulatory system - Hemopoiesis and Development of heart. Comparative study of heart of shark, frog, Calotes, pigeon and rat. Evolution of Aortic arches.	15
IV	Comparative anatomy of Excretory, Nervous and Reproductive systems -Excretory System-Development of kidney. Evolution of kidneys in vertebrates. Nervous system : Meninges, Development and differentiations of various parts of brain. Comparative anatomy of brain of shark, frog, calotes, bird and rat. Reproductive systems -Development of gonads. Genital ducts in vertebrates.	15

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2. Parker and Haswell: Text book of Zoology vol. II
3. Goodrich. Structure and Development of Vertebrates Vol.I and II.
4. Watermann, A.J.: Chordate Structure and Function, Mac Millan Co. New York.
5. Weichert C.K.: Anatomy of Chordates 4th edn. MC Graw Hill Books Co. New York.
6. Comparative Anatomy of Vertebrates- R.K. Saxena and Sumitra Saxena, Viva Books.
7. Comparative Anatomy and Developmental Biology R.L. Kotpal, Sastry & Shukla-Rastogi publication
8. Kardong K, Vertebrates: Comparative Anatomy, Function and Evolution, McGraw-Hill Companies, USA.
9. Kent CG and Carr R, Comparative Anatomy of Vertebrates, McGraw-Hill Companies, USA.
10. Liem KF and Franklin W, Functional Anatomy of the Vertebrates: an Evolutionary Perspective, Harcourt College Publishers, California.
11. Wolff RG, Functional Chordate Anatomy, Amazon Publication, UK.
- Hildebrand, M. (1995). Analysis of Vertebrate Structure. John Wiley & Sons

M.Sc. Semester II Elective		
ZOO-554	Ecology	Number of Credits : 04
Course Outcomes (COs) On completion of the course, the students will be able to:		
CO1	Describe basic concepts of ecology, different types of ecosystems, outline community organization and its structure.	
CO2	Interpret and explain interaction between environment and biota.	
CO3	Illustrate and demonstrate the characteristics/patterns of population and its dynamics with the help of case studies.	
CO4	Differentiate between Geometric and Exponential population growth. Analyze the limits of population growth and its case studies.	
CO5	Compare, evaluate and then evolve strategies of population study related to dispersal and growth, compile the data of case studies.	
CO6	Develop an in-depth knowledge of the large-scale ecology. Write a report on global and landscape ecology and human influence on atmospheric composition.	

Unit. No.	Title of Unit and Contents	No. of hours
I	Introduction to Ecology: Laws of limiting factor, Laws of minimum, Laws of Tolerance and macronutrients. Types of ecosystem. Community Organization and Structure: Community analysis, species diversity, ecotone concept and edge effect; interaction between environment and biota, Habitat and ecological niche and niche overlap; concept of biome Concepts of productivity; eutrophication of lakes; biological indicator and water quality.	15
II	Population Distribution and Abundance: Concepts. Case Study: Distribution Limits, Distribution Patterns, Organism Size and population density, Rarity and Extinction. Population Dynamics: Concepts. Case Study: Patterns of survival, Age distribution, Rate of population Change, Dispersal Applications and Tools: Using population dynamics to assess the impact of pollutants.	15
III	Population Growth Concepts. Case Study: Geometric and Exponential population growth, Logistic population growth, Limits to population growth, The intrinsic rate of increase. Applications and Tools: The human population	15
IV	Large scale ecology Landscape Ecology -Concepts. Case Study: Landscape Structure, Landscape processes, Origin of Landscape structure and changes. Global Ecology -Concepts. Case Study: A global system, Anthropogenic activity and the Nitrogen cycle, Changes in land cover, Anthropogenic influence on atmospheric composition. Applications and Tools: Cooperative Research Networks for Global ecology.	15

References:

1. Fundamentals of Ecology: Odum (Saunders, 1971)
2. Basic Ecology : Odum (Saunders, 1985)
3. Ecology-Concepts and Applications : Manuel C. Molles Jr (Mc Graw Hill)
4. Environmental Science : Turk and Turk (4th ed. Saunders, 1993)
5. A Primer of Conservation Biology: Primark (2nd ed. Sinauer Associates)
6. Pollutants and High-Risk : Calabrese Groups (John Wiley, 1978)
7. Environment : Raven, Berg, Johnson (Saunders College Publishing, 1993)
8. Ecology and Environment : Sharma (Rastogi Publication, 7th ed. 2000)
9. Handbook of Environmental Health, Volume I. Biological, Chemical, and Physical Agents of Environmentally Related Disease, By Herman Koren, Michael S. Bisesi Edition 4th Edition First Published 2002 eBook Published 29 July 2000
10. Microbes, Man and Animals: The Natural History of Microbial Interactions: Linton, A. H. and Burns, R.G. (1982) John Wiley and Sons.
11. Microbial Methods for Environmental Biotechnology: Grainer, J.M. and Lynch, J.M. 1984. Academic Press.
12. Microbiological Methods for Environmental Scientists and Engineers: Gaudy, A.F. and Gaudy, E.T. 1980, McGraw Hill.
13. Introduction to Weather and Climate: Trewartha
14. Introduction to Climatology for Tropics: Ayoade J. O.
15. General Climatology: Critchfield H. J.
16. Climatology: Fundamentals and Applications: Mater J. R.
17. Climatology, Selected applications: Oiver J. E.
18. Fundamentals of Soil Sciences : Henry D. Forth
19. A Text-Book of Soil Sciences : T. D. Biswas and S. K. Mukherjee
20. Environmental Science : E. D. Enger and B. F. Smith
21. Groundwater Hydrology : D. K. Tosdd
22. Elementary Seismology : Charles F. Richter
23. Earthquakes : Bruce A. Bolt
24. Engineering and General Geology : Parbin Singh
25. Manual on water supply & sewerage.
26. Manual on sewerage & sewage treatment, Ministry of works & housing, New Delhi.
27. Waste water engineering, Met Calf & Eddy; INC, Tata mc Graw Hill.
28. Physico-chemical; Process of water quality control, W. J. Webber, Wileyinter- science.
29. Waste water treatment for pollution control, Dr. Arceivala, Tata Mc Graw Hill.
30. Indian standard for drinking water, BSI, New Delhi.
31. Disposal of municipal waste, House report no. 2012, Report by subcommittee on Govt. Operation, House of representative, March, 24 1965, UK.
32. Water supply & sanitary engineering, Birdie G. S., Dhanpat Rai & Sons, New Delhi.
33. House waste management in Europe, A Bridgestone H Lidgren, Van Nostard Reinhold Co. London.
34. Principal of water quality control, T H Y Tebbut, Pergamon press.
35. Waste water treatment plant design, 1977, A manual of practice, Water pollution control federation.

M. Sc. Semester II Practical Paper I		
ZOO-570	Zoology Practical – III	Credits: 2 Hours: 60
Course Outcomes (COs) On completion of the course, the students will be able to:		
CO1	Describe the pattern of sex linked inheritance with the help of mutants of <i>Drosophila</i> . Identify and detect the blood group.	
CO2	Estimate the gene frequencies in human population and analyse the data.	
CO3	Demonstrate preparation of <i>Drosophila</i> culture and Mendelian laws of inheritance with the help of <i>Drosophila</i> mutants.	
CO4	Determination of order of genes, calculate map distance between three genes	
CO5	Pedigree Analysis: Sex-Linked, Autosomal dominant and recessive	
CO6	Describe different instruments/equipment which are used in environmental studies.	

Sr. No	Title Of The Practical	No. of practicals
1	Study and characterization of normal and abnormal karyotypes from human subjects.	1
2	Cytogenetic studies and preparation of metaphase chromosome spreads using mouse bone marrow	1
3	UV survival curve of bacteria	1
4	Gram's staining	1
5	Study of basic microbiology techniques and bacterial growth curve	2
6	Pedigree Analysis: Sex-Linked, Autosomal dominant and recessive	1
7	Temporary Mounting of Polytene chromosomes of <i>Drosophila</i> or <i>Chironomous</i> larvae -study of puff and bands	1
8	<i>Drosophila</i> culture, its use in genetics, identification virgin, sexing of pupae for virgin isolation for crosses, setting up genetic crosses using <i>Drosophila</i> mutants and wild type.	1
9	Study of law of independent assortment	1
10	(a) Study of sex-linked gene inheritance (F1 and F2 generations) using white or yellow mutant flies & (b) Setting up reciprocal crosses.	1
11	Identification of blood groups A, B, ABO and Rh./ Detection of Human Blood groups	1
12	Estimation of gene frequencies in human population and analysis of heterozygote frequencies.	1

13	Analysis of quantitative traits& Partitioning of variance in genetic and non-genetic components	1
14	Partitioning of variance in genetic and non-genetic components.	1
15	Study of autosomal gene inheritance (monohybrid crosses and dihybrid crosses using vestigial and sepia mutants along with wild-type flies for F1 and F2 generations) and Chi-square analysis of data of progeny	1
16	Study of instruments/equipment in environmental studies.:viz., pH meter, Turbidimeter, Conductivity meter, Spectrophotometer, Flame photometer, Centrifuge, BOD incubator, COD Flux unit, Air, water and mud samplers,Min.-Max. thermometer, Dry-Wet bulb thermometer, Barometer, Wind wane, Raingauge, GPS, Incubator etc.	1
17	Water quality analysis (Physio -chemical parameters) like temperature, pH , dissolved oxygen ,hardness ,total dissolved solids , BOD , COD etc.	2
18	Analysis of correlation coefficient and simple linear regression in a set of hypothetical data.	2
	Any other practical suggested by the teacher	

M.Sc. Semester II Practical paper II		
ZOO-571	Zoology Practical-IV	Credits: 2 Hours: 60
Course Outcomes (COs) On completion of the course, the students will be able to:		
Human Physiology		
CO1	Explain and demonstrate the reflex action	
CO2	Test the urine for its constituents.	
CO3	Determine the bleeding time and clotting time.	
CO4	Perform the experiments to estimate total plasma proteins	
CO5	Perform the experiments to estimate serum uric acid.	
CO6	Study reproductive glands using histological slides.	
Elective - Ecology		
CO1	Describe different instruments/equipment which are used in environmental studies.	
CO2	Estimate population size & distribution.	
CO3	Calculate correlation coefficient and simple linear regression in a set of data.	
CO4	Analyze water quality to assess different physical and chemical parameters. Explain, identify communities and determine percentage frequency, density and abundance.	
CO5	Determine the biomass of a particular area.,	
CO6	Write a report on landscape ecology.	

Sr. No	Title of The Practical	
1	Determination of bleeding time and clotting time.	1p
2	Study of Reflex action- knee jerk, bicep jerk, jaw jerk	1p
3	Estimation of serum uric acid.	1p
4	Determination of normal and abnormal Urine constituents.	1p
5	Estimation of total plasma proteins by spectrophotometer.	1p
6	Quantitative estimation of amylase activity	1p
7	Quantitative estimation of urea.	1p
8	Study reproductive glands using histological slides.	1p
9	Calculation of tidal volume using incentive flow spirometer.	1p
10	Effect of exercise on heart rate and lactic acid in human blood.	1p
11	Determination of glomerular filtration rate by creatinine clearance.	1p
12	Lipid profile in vertebrates	1p
13	Study of nitrogenous waste products of animals from different habitats	1p
14	Body size and oxygen consumption in aquatic animals (crab/fish).	1p
15	RBCs in different vertebrates and in different physiological conditions	1p
16	Estimating population size & distribution	1p
17	To determine the biomass of a particular area.	1p
18	To study communities by quadrat method and to determine percentage frequency, density and abundance.	1p