



Deccan Education Society's

**FERGUSSON COLLEGE (AUTONOMOUS)
PUNE-4**

**SYLLABUS
M.Sc. ZOOLOGY**

**Academic Year 2021-2022
SEMESTER – I & II**

Programme Structure

Sem.	Course Code	Course Title	Course	No.of credits
I	ZOO4101	Comparative Anatomy of Vertebrates	T-Core-1	04
	ZOO4102	Cell Biology	T-Core-2	04
	ZOO4103	Biochemistry	T-Core-3	04
	ZOO4104	Zoology Practical-I	P-Core-1	04
	ZOO4105	Zoology Practical-II	P-Core-2	04
	ZOO4106	Animal Behaviour	Elective-1	04
	ZOO4107	Moocs to be selected by students		04
	ZOO4108	Advanced Endocrinology		04
		Total Credit		(24)
II	ZOO4201	Comparative Physiology of Vertebrates	T-Core-4	04
	ZOO4202	Genetics	T-Core-5	04
	ZOO4203	Developmental Biology	T-Core-6	04
	ZOO4204	Zoology Practical-III	P- Core-3	04
	ZOO4205	Zoology Practical-IV	P-Core -4	04
	ZOO4206	Immunology	Elective-2	04
	ZOO4207	Moocs to be selected by students		04
	ZOO4208	Environmental Biology		04
		Total Credit		(24)
III	ZOO5301	Evolutionary Biology	T-Core-7	04
	ZOO5302	Molecular Biology	T-Core-8	04
	ZOO5303	Biostatistics and Bioinformatics	T-Core-9	04
	ZOO5304	Zoology Practical-V	P-Core-5	04
	ZOO5305	Zoology Practical-VI	P-Core-6	04
	ZOO5306	Skills in Scientific communication and writing	Elective-3	04
	ZOO5307	Moocs to be selected by students		04
	ZOO5308	Histology and Histo-chemistry		04
		Total Credits		(24)
IV	ZOO5401	Project work and Dissertation/ Summer Training / Institutional trainings	P-Special-1	08
		OR		
	ZOO5401	Moocs to be selected by students	M-Special-1	08
		Total Credits		(08)
		Total Credits Of The Course		80

Extra Credits

Semester	Course Code	Title of the Course	Course Credits
I	XHR0001	Human Rights - I	1
	XCS0002	Introduction to Cyber Security - I / Information Security - I	1
	XSD0003	Skill Development - I	1
TOTAL CREDITS			03

Program Outcomes (POs) for M.Sc Programme	
PO1	Disciplinary Knowledge: Demonstrate comprehensive knowledge of the discipline that form a part of an postgraduate programme. Execute strong theoretical and practical understanding generated from the specific programme in the area of work.
PO2	Critical Thinking and Problem solving: Exhibit the skill of critical thinking and understand scientific texts and place scientific statements and themes in contexts and also evaluate them in terms of generic conventions. Identify the problem by observing the situation closely, take actions and apply lateral thinking and analytical skills to design the solutions.
PO3	Social competence: Exhibit thoughts and ideas effectively in writing and orally; communicate with others using appropriate media, build effective interactive and presenting skills to meet global competencies. Elicit views of others, present complex information in a clear and concise and help reach conclusion in group settings.
PO4	Research-related skills and Scientific temper: Infer scientific literature, build sense of enquiry and able to formulate, test, analyse, interpret and establish hypothesis and research questions; and to identify and consult relevant sources to find answers. Plan and write a research paper/project while emphasizing on academics and research ethics, scientific conduct and creating awareness about intellectual property rights and issues of plagiarism.
PO5	Trans-disciplinary knowledge: Create new conceptual, theoretical and methodological understanding that integrates and transcends beyond discipline-specific approaches to address a common problem.
PO6	Personal and professional competence: Perform independently and also collaboratively as a part of team to meet defined objectives and carry out work across interdisciplinary fields. Execute interpersonal relationships, self-motivation and adaptability skills and commit to professional ethics.
PO7	Effective Citizenship and Ethics: Demonstrate empathetic social concern and equity centred national development, and ability to act with an informed awareness of moral and ethical issues and commit to professional ethics and responsibility.
PO8	Environment and Sustainability: Understand the impact of the scientific solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.
PO9	Self-directed and Life-long learning: Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

Programme Specific Outcomes for M.Sc. Zoology	
PSO1	Academic Competence:)Describe fundamental concepts, principles and processes underlying the life science its different disciplines.)Understand the evolutionary, genetical, molecular, histological, and behavioural context of biological thought and research, and the contributions of physiological, anatomical, immunological and cellular studies of animals, to the resolution of medical, social and environmental issues even at molecular level.)Demonstrate a wide range of biochemical techniques, physiological processes, cellular activities, developmental and evolutionary processes, statistical methods and bioinformatics.
PSO2	Personal and Professional competence: (i) Demonstrate the competence in fundamental zoological skills/techniques and experimentation using various methods in animal models and their behaviour, cell and molecular biology, biochemistry, developmental biology and immunology. (ii) Illustrate methods in evolutionary biology, environmental science , biostatistics and bioinformatics and analyse biological data statistically. (iii) Formulation of ideas, scientific writing and authentic reporting, effective presentation and communication skills .
PSO3	Research Competence: (i) Analyse and interpret results obtained in cell biology, molecular biology, biochemistry, genetics, developmental biology, immunology , histology. (ii) Create biological data and skills to explore and authenticate data for experimental and research purpose.
PSO4	Entrepreneurial and Social competence: (i) Evaluate data of the societal relevance of biological systems and the processes and apply the knowledge of zoology in the different fields to address problems related to human kind. (ii) Collaborate in various zoological services with demonstration of true values of leadership, co-operation, hard work, teamwork etc. during the field works, surveys and field visits.

F. Y. M. Sc. Semester I		
Title of the Course and Course Code	Comparative Anatomy of Vertebrates ZOO4101	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 Lectures
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.	1
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.	1

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.	1
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.	1

References:

1. Young, J.Z.: Life of Vertebrates. The Oxford University Press, London.
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.
12. Hildebrand, M. (1995). Analysis of Vertebrate Structure. John Wiley & Sons.

F.Y. M.Sc. Semester I		
Title of the Course and Course Code	Cell Biology ZOO4102	Number of Credits : 04
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 signalling, 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, signalling 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 Lectures
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.	1
II	Structural and functional organization of intracellular organelles: - Nucleus, Mitochondria, Golgi body, Lysosomes, ER and Peroxisomes. 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.	1

III	Cell-Cell Signalling Signalling molecules and their receptors. Function of cell surface receptors. Pathways of intracellular signal transduction, Signalling networks. Regulation of cell cycle Cell Death -Necrosis, programmed cell death (intrinsic and extrinsic pathway)	1
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).	1

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 J. Kleinsmith, Jeff Hardin. Publisher-Benjamin Cummings.
4. Molecular Biology, Weaver R. F., McGraw-Hill Education (5th Ed. 2011).

F.Y. M.Sc. Semester I		
Title of the Course and Course Code	Biochemistry ZOO4103	Number of Credits : 04
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 Credits
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. Methods of Protein sequencing. Fibrous and globular proteins. Structure and functions of haemoglobin and myoglobin Classification of Lipids (Fatty acids, triacylglycerol, glycerol phospholipids, sphingolipids, cholesterol, and prostaglandins). Structure of nucleotide. Structure of DNA and RNA	1
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. Enzyme inhibition, bi-substrate reaction. Immobilized Enzymes- advantages and disadvantages. Enzymes as a diagnostic tool.	1
III	Metabolisms of Carbohydrates Glycolysis pathway and its regulation Pentose Phosphate pathway and glucuronic acid pathway Gluconeogenesis. Tricarboxylic acid cycle. Oxidative phosphorylation. Electron transport chain. Energetics of glucose metabolisms Metabolisms of Proteins- Ornithine cycle. Transamination and deamination.	1
IV	Lipid metabolism: Mobilization of lipid from adipose tissue. Structure and functions of triglycerides, phospholipids, sphingolipids, prostaglandins, and cholesterol. 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.	1

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

F.Y. M.Sc. Semester I		
Title of the Course and Course Code	Zoology Practical –I (Comparative Anatomy of Vertebrates and Cell Biology ZOO4104)	Number of Credits : 04
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. Illustrate preparation of blood smear and differential count.	
CO3	Demonstrate and illustrate the mechanism of phagocytosis, pinocytosis and subcellular fraction.	
CO4	Differentiate the skin and integumentary glands, skull of vertebrate animals.	
CO5	Compare and apprise vertebrates of frog and human, pelvic and pectoral girdles of different groups of vertebrates.	
CO6	Compile the comparative anatomical data of Pisces, Amphibians, Reptiles, Aves and Mammals and prepare a report.	

Sr. No.	Title of Practical	No. of Practicals
1.	Study of skin of Scoliodon, Frog, any one Reptile, Bird and Mammalian skin with the help of slides.	1
2.	Study of any ten integumentary glands of vertebrates with the help of specimen / model / charts / pictogram.	1
3.	Study of any ten integumentary hard derivatives of vertebrates with the help of specimen / model / charts / pictogram.	1
4.	Comparative study of skull of Scoliodon, Frog, Calotes, Gallus and Human.	1

5.	Comparative study of Vertebrae of Frog and Human.	1
6.	Comparative study of pectoral and pelvic girdles of Scoliodon, Frog, Calotes, Gallus and Human.	1
7.	Comparative study of limbs bones of Frog and Human.	1
8.	Comparative study of heart of Scoliodon, Frog, Calotes, Gallus and Rat.	1
9.	Comparative study of urinogenital system of Scoliodon, Frog, Calotes, Gallus and Rat.	1
10.	Comparative study of brain of Scoliodon, Frog, Calotes, Gallus and Human.	1
11.	Comparative study of Genital ducts of Scoliodon, Frog, Calotes, Gallus and Human.	1
12.	Preparation of mitotic chromosomes	1
13.	Preparation of meiotic chromosomes	1
14.	Mitosis : Effect of colchicine on mitosis and polyploidy	1
15.	Subcellular fraction: nuclei, mitochondria, cytosol and assaying functional identification of mitochondria.	2
16.	Study of phagocytosis and pinocytosis.	1
17.	Determination of chiasma frequency and terminalisation coefficient	1
18.	Preparation of blood smears: cell type identification and differential counts.	2
19.	Any other practical set by faculty.	

F.Y. M.Sc. Semester I		
Title of the Course and Course Code	Zoology Practical-II Biochemistry (P core 2) and any one Elective (Animal Behaviour OR Endocrinology) ZOO4105	Number of Credits : 04
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 equipments.	
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	Explain the geotaxis behaviour, orientation responses, feeding responses, orientation responses and observe animal behaviour.	
CO5	Determine blood glucose and liver glycogen levels using suitable model.	
CO6	Perform the calibrations of centrifuge, colorimeter/spectrophotometer, pH meter. Specify the standardization of different acid and bases.	

Elective - Animal Behaviour	
CO1	Describe geotaxis behaviour of earthworm, and outline the orientational responses of 1st instar noctuid larvae to photo stimuli. Identify the soil to which the earthworm are attracted.
CO2	Differentiate changes in earthworm responsiveness. Identify and compare the effect of household and natural solutions on behaviour of ants.
CO3	Demonstrate orientational responses of 1st instar noctuid larvae to photo stimuli
CO4	Categorize and classify animal behaviour, and explain Display Behaviour of Siamese Fighting Fish (Betta splendens) Analyse effect of household and natural solutions on behaviour of ant
CO5	Determine the median threshold concentration of sucrose solution in eliciting feeding responses of housefly
CO6	Design, and perform experiment by using a choice chamber to investigate animal responses to stimuli.
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, colorimeter/spectrophotometer, pH meter.	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.	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
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		
Advanced Endocrinology		
1	Histological slides pertaining to endocrine glands.	1
2	Blood glucose and liver glycogen estimation by using suitable animal model and method by inducing diabetes.	1
3	Study of male and female reproductive system by using suitable animal model/ charts.	1
4	Histology of Ovary and testes.	1
5	Diagnosis of pregnancy by the presence of HCG in Urine by using suitable method.	1
6	Paper chromatographic separation of corticoids.	1
7	Study of models pertaining to ART (Assisted reproductive techniques), Transgenic techniques, STDs and Contraception	1
8	Case study relating to particular clinical conditions of hormone.	1
9	Visit to Veterinary Institutes to learn breeding techniques.	1

F.Y. M.Sc. Semester I		
Title of the Course and Course Code	Animal Behaviour ZOO4106	Number of Credits : 04
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 Lectures
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.	1
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.	1
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	1

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.	1
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References:

1. Aloccock, 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, Rinechart& 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.

F.Y.M. Sc. Semester I		
Title of the Course and Course Code	Advanced Endocrinology ZOO4108	Number of Credits : 04
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 Lectures
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, second messengers, hormone action and termination	1
II	Endocrinology of Pancreas Cell structure and types, Hormones of Endocrine Pancreas, Hormones involved in Carbohydrate Metabolism, Clinical Aspects of Endocrine Pancreas	1
III	Endocrinology of Thyroid Organization in Mammals, Biochemistry and Metabolism of Thyroid Hormones, Physiological Role of Thyroxine and Clinical aspects of Thyroid Functions	1
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	1

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

F. Y. M.Sc. Semester II		
Title of the Course and Course Code	Comparative Physiology of Vertebrates ZOO4201	Number of Credits : 04
Course Outcomes (COs) On completion of the course, the students will be able to:		
CO1	Describe the concepts of comparative physiology, its importance, functions of organs and organ systems of different groups of vertebrates.	
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 aquatic and terrestrial animals.	
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, neurotransmitters and their role.	
CO4	Explain the physiology of reproductive activities in vertebrates and analyse the O ₂ dissociation curve and its physiological and ecological importance.	
CO5	Compare the functioning of different systems of vertebrate animals.	
CO6	Compile the comparative data of physiological aspects related to digestive, respiratory, circulatory, excretory systems, reproductive and neuromuscular systems.	

Unit No.	Title of Unit and Contents	No. of Lectures
I	Physiology of digestion and internal transport & gas exchange. Digestion: Peristalsis, digestion and its regulation, absorption of digestive nutrients, co-relation of digestive enzymes with food, metagenome of gut. Respiration: Respiratory Surfaces: comparison of ventilation associated with gills and pulmonary respiration, tidal and vital capacities, modes of external respiration – gills, and lung, oxygen transport, O ₂ dissociation curves-physiological and ecological significance, CO ₂ transport.	15
II	Circulation, 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. Excretion: Nitrogenous waste products: ammonia, urea and uric acid their formation and excretion, role of gills in excretion, role of kidney in excretion, renal regulation of acid base balance. Osmoregulation: Maintaining water and electrolyte balance in aquatic and terrestrial environments.	15
III	Neuro-muscular Physiology. Nervous co-ordination: Neuron and glia, excitation and	15

	<p>conduction of nerve fibre, resting membrane potential, action potential, electronic potential, alutatory conduction, ionic basis of excitation and conduction, neurotransmitters and their physiological functions, synaptic transmission.</p> <p>Muscle: Types of muscles, ultrastructure of skeletal muscle, biochemistry of contractile proteins, theory of muscle contraction, chemical basis of contraction, neuro-muscular junction.</p>	
IV	<p>Chemical co-ordination and Physiology of reproduction.</p> <p>Chemical Communication: The concept of homeostasis and negative and positive feedback.</p> <p>Reproduction: Physiology of reproductive cycle and their hormonal regulation in vertebrates. Biochemical composition of semen, sperm capacitation and decapacitation – molecular mechanism and significance. Reproductive glands: Testes; Prostate gland and Ovary.</p>	15

References:

1. Comparative Animal Physiology (vol 1 and 2), Prosser CL, Willey Publication, Oxford.
2. Physiology of Sport and Exercise, Kenney WL, Wilmore J and Costill D, Amazon, UK.
3. Comparative Animal Physiology, Withers P, Saunders College Publications
4. General and Comparative physiology, Hoar W. S., Prentice Hall, India, New Delhi.
5. Eckert Animal Physiology, Randall D, Burggren W and French K, WH Freeman and Co, New York.
6. Animal physiology, Harper & Row NW.
7. Animal Physiology, Schmidt-Nielsen, Adaptation and Environment. Cambridge.
8. Comparative Physiology (Handbook of Physiology): Vol. 1, 2, Dantzler, W.H. (ed.) Oxford University Press, New York, USA
9. Animal Physiology: Adaptation and Environmental, Nelson K. S. (ed) Cambridge University Press, Cambridge, UK
10. Principles of Anatomy and Physiology, G.J.Tortora
11. Textbook of Physiology and Biochemistry, Bell and Davidson
12. Textbook of Animal Physiology, Goel and Shastri
13. Animal Physiology, K.S.Nelson
14. Principles of Physiology and Biochemistry, Holurn

F. Y. M. Sc. Semester II		
Title of the Course and Course Code	Genetics ZOO4202	Number of Credits : 04
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 Lectures
I	Classical genetics- Review of Mendel's principles. Allelic variation, Gene function. 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. Quantitative Genetics -Polygenic traits and mode of inheritance. Analysis of variation: genetic and environmental factors	1
II	Cytogenetics -Extra Chromosomal Inheritance, Inheritance of mitochondrial and chloroplast genes maternal inheritance Chromosomal variation -Structure of chromosome, Polytene chromosome, lamp brush, mitotic chromosome, Chromosomal aberration and genetic consequences. Physical mapping of Gene -Chromosomal theory of linkage. Crossing over- Mechanism of meiotic crossing over, kinds of crossing over, factors affecting crossing over, significance crossing over. Linkage in eukaryotes- detection of linkages, Linked genes & linkage groups. Chromosome mapping-Cross over value, two- & three-point test cross (brief account only). Basic steps of construction of gene map.	1
III	Molecular genetics- Brief view of genomes. DNA mutations. Transposable elements Drosophila Genetics- <i>Drosophila</i> as a model organism. <i>Drosophila</i> genome. Molecular basis of dosage compensation. Introduction of genetic tools (GAL4/UAS-system). Developmental genetics of <i>Drosophila</i> .	1
IV	Population Genetics -Basic concepts & terminologies. Hardy-Weinberg principles and applications. Changes in allelic frequencies Exercises for solving population genetics problems. Eugenics and Euphenics	1

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. Michael, 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
8. General Genetics, (1985), Leon A. Snyder, David Freifelder, Daniel L. Hartl Publisher-Jones and Bartlett
9. Genetics, 3rd edition, Monroe W. Strickberger, (1968), Publisher - Macmillan Publishing Co.

F.Y. M.Sc. Semester II		
Title of the Course and Course Code	Developmental biology ZOO4203	Number of Credits : 04
Course Outcomes (COs) On completion of the course, the students will be able to:		
CO1	Define Axis formation. Describe stages of Animal Development, Embryonic Homologies, Malformations and Teratology, the cleavage and Gastrulation in chick. State the outline of developmental Biology.	1
CO2	Discuss the patterns of developments in metazoans and unicellular eukaryotes, the post-embryonic development. Explain the segment formation and anterior-posterior body plan, the role of homeotic selector genes.	2
CO3	Demonstrate the role of environment on animal development. Illustrate the process of fertilization, cleavage, gastrulation in Drosophila.	3
CO4	Explain Hox Genes and Descent with Modification. Distinguish the process of primitive streak formation.	4
CO5	Review the Principles of teratogenesis. Determine the Function of Genes during Development.	5
CO6	Specify the process of teratogenesis. Compile teratogenic agents. Write the homologous Pathways of Development. Compile knowledge of neural tube formation. Design role of genes in axis specification in Drosophila. Write the process and types of Fertilization	6

Unit. No.	Title of Unit and Contents	No. of Lectures
I	Introduction to animal development- Introduction to Developmental Biology. The Stages of Animal Development, Embryonic Homologies, Malformations and Teratology. Developmental Patterns in metazoans and unicellular eukaryotes Determining the Function of Genes during Development. Fertilization.	1
II	Drosophila Development - Early drosophila development: Fertilization, cleavage, gastrulation. The genetics of axis specification in Drosophila. Segmentation and anterior-posterior body plan. Homeotic selector genes. Post-embryonic development	1
III	Chick Development -Early chick development: Cleavage-Gastrulation, Primitive streak formation and its molecular mechanism. Axis formation. Neurulation	1
IV	Ramifications of Developmental Biology - Environmental regulation of animal development. Hox Genes: Descent with Modification. Homologous Pathways of Development., Teratogenesis: Introduction, Principles and Teratogenic agents.	1

References:

1. Gilbert, S.F. Developmental Biology. 10th Edition, Sinauer Associated Inc., Massachusetts
2. Balinsky, B.I. Introduction to Embryology. Saunders, Philadelphia
3. Berril, N.J. and Karp, G. Development Biology. McGraw Hill, New York
4. Hamburger V and Hamilton HL. Handbook of chick developmental stages. Saunders Publications. 1965.
5. Berril, N.J. and Karp, G. Development Biology. McGraw Hill, New York
6. Embryology-An Introduction to Developmental Biology—Stanley Shostak
7. Muthukaruppan and Pitchappan. Animal development – a laboratory guide. CoSIP-ULP Publications, India. First Edition, 1979.

F.Y.M. Sc. Semester II		
Title of the Course and Course Code	Zoology Practical – III (Comparative Physiology of Vertebrates and Genetics) ZOO4204	Number of Credits : 04
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 Drosophila. Identify and detect the blood group.	
CO2	Estimate the gene frequencies in human population and analyse the data.	
CO3	Demonstrate preparation of Drosophila culture and Mendelian laws of inheritance with the help of Drosophila mutants.	
CO4	Explain and demonstrate the reflex action and various cellular changes during the oestrous cycle with the help of vaginal smear.	
CO5	Test the urine for its constituents. Determine the bleeding time and clotting time.	
CO6	Perform the experiments to estimate total plasma proteins, serum uric acid, oxygen consumption, compile the data and write the report.	

Sr. No	Title Of The Practical	No. of practicals
1	Determination of bleeding time and clotting time.	1
2	Effect of salinity on oxygen consumption in aquatic animals.	1
3	Reflex action.	1
4	To study the oestrous cycle by vaginal smear method.	1
5	Estimation serum uric acid.	1
6	Determination of Urine constituents.	1
7	Estimation of total plasma proteins by spectrophotometer or Colorimeter.	1
8	Drosophila culture, its use in genetics, identification virgin, sexing of pupae for virgin isolation for crosses, setting up genetic crosses using Drosophila 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.	1
12	Estimation of gene frequencies in human population and analysis of heterozygote frequencies & Analysis of quantitative traits	1
13	Analysis of quantitative traits & Partitioning of variance in genetic and non-genetic components	1

F. Y. M.Sc. Semester II		
Title of the Course and Course Code	Zoology Practical-IV Subject- Developmental biology and any one elective (Immunology OR Environmental biology) ZOO4205	Number of Credits : 04
Course Outcomes (COs) On completion of the course, the students will be able to:		
Developmental biology		
CO1	Describe larval stages of <i>Drosophila</i> .	
CO2	Illustrate of different stages in Chick embryo (13 -72 hr).	
CO3	Examine a temporary mounting of 72 and 96 hours chick embryo.	
CO4	Explain angiogenesis in chick embryo.	
CO5	Evaluate the effects of teratogen on chick embryo development.	
CO6	Prepare a temporary slide of imaginal disc in <i>Drosophila</i> .	
Elective - Immunology		
CO1	Identify the blood cells of immune system.	
CO2	Explain the basic process in Immunoelectrophoresis.	
CO3	Apply the technique for detection of antigen (ELISA).	
CO4	Analyse the antigen – antibody reaction while cross matching.	
CO5	Compare the histological structure of lymphoid organs.	
CO6	Specify the mechanism of antigen antibody interaction.	

Elective - Environmental biology	
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	No. of Practicals
Developmental biology		
1	Study of larval stages of <i>Drosophila</i> .	2
2	Mounting of 72 and 96 hours chick embryo.	2
3	Mounting of imaginal disc in <i>Drosophila</i>	1
4	Study of angiogenesis in chick embryo.	3
5	Effect of teratogen on chick embryo development.	3
6	Study of different stages in Chick embryo (13 -72 hr).	1
Elective course -Immunology		
1	Study of histology of Lymphoid organ- Skin, Spleen, Thymus, Ileum, Lymph node, Bone marrow.	1
2	Study of various blood cells of immune system.	1
3	Analysis of blood group with reference to cross matching.	1
4	Estimation of antigen concentration using rocket electrophoresis.	2
5	Dot immune binding assay to detect antibodies in the serum.	2
6	Ouchterlony technique of agar gel diffusion.	2
7	Study of Immuno electrophoresis.	2
8	Study of ELISA.	2
Elective course- Environmental biology		
1	Water quality analysis (Physico-chemical parameters) like temperature, pH , dissolved oxygen ,hardness ,total dissolved solids , BOD , COD etc	3
2	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, etc	2
3	Estimating population size & distribution.	1

4	To study communities by quadrat method and to determine percentage frequency, density and abundance.	2
5	Analysis of correlation coefficient and simple linear regression in a set of hypothetical data.	1
6	To determine the biomass of a particular area.	1
7	Report Submission on Landscape ecology	
*Any other practical suggested by the teacher		

F. Y. M.Sc. Semester II		
Title of the Course and Course Code	Immunology ZOO4206	Number of Credits : 04
Course Outcomes (COs) On completion of the course, the students will be able to:		
CO1	Recall the basic concepts of Immunology and describe which cell types and organs are involved in the immune response.	
CO2	Exemplify the adverse effect of immune system. including Allergy, hypersensitivity and autoimmunity	
CO3	Apply basic techniques for identifying antigen-antibody interactions.	
CO4	Explain the importance of phagocytosis and natural killer cells in innate body defence.	
CO5	Compare and contrast innate and adaptive immunity.	
CO6	Write various mechanisms that regulate immune responses and maintain tolerance.	

Unit No.	Title of Unit and Contents	No. of Lectures
I	Introduction to Immune System - Introduction of immunity and immune system.Types of Immune system – Innate and adaptive immunity, humoral mediated immunity and cell- mediated immunity Cells involved in immune system .The organs of the immune system – primary and secondary lymphoid organs.	1
II	Antigen, Antibody and Complement System Types of antigen - epitope, haptens, antigen presenting cells, adjuvants. Immunoglobulins - Types, structure and functions. Monoclonal antibodies and it's applications.Complement system – Components of complement system, classical and alternative pathways .Antigen antibody reactions. Major histocompatibility complex (MHC) structure and functions; genetic control of Immunoresponses; MHC restriction	1
III	Hypersensitivity Reactions and Autoimmune Diseases Hypersensitivity – Types of hypersensitivity reactions; Type-I – Anaphylactic hypersensitivity; Type – II- Antibody mediated cytotoxic hypersensitivity. Type-III – Immunocomplex mediated hyper sensitivity; Type – IV Cell mediated hypersensitivity. Autoimmune diseases – Organ	1

	specific auto immune diseases – Grave’s disease, insulin– dependent diabetes mellitus. Autoimmune diseases – Systemic autoimmune diseases – Systemic Lupus Erythematosus (SLE), Rheumatoid arthritis. Genetic factors, pathogenesis of autoimmune diseases.	
IV	Transplantation and Tumour Immunology- Types of grafts. Graft – versus host reaction. - Rejection of grafts. Barriers to transplantation. Types of tumour. Tumour immunology – Immunity to tumours, tumour specific antigens.	1

References:

1. Kuby’s immunology- Goldsmith et al, 6th Ed, WH Freeman, New York, USA.
2. Basic immunology: functions and disorders of immune system- Abbas, Litchman. Saunders Publications, Philadelphia, USA
3. Janeway’s Immunology- Kenneth Murphy, 8th Ed, Garland Science, Pennsylvania, USA.
4. Roitt’s Immunology- Delves et al, 12th Ed, Willey-Blackwell Science, Oxford, UK.
5. History of Immunology, 2nd Ed- Silverstein [2009], Academic Press, New York, USA.
6. Exploring immunology: Concepts and Evidence- Macpherson and Austyn, WilleyBlackwell Science.

F.Y. M.Sc. Semester II		
Title of the Course and Course Code	Environmental biology ZOO4208	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 grow. 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 Lectures
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.	1
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.	1
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	1
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.	1

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 (2nded. 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, 7thed. 2000)
9. Handbook of Environmental Health, Volume I.Biological, Chemical, and Physical Agents of Environmentally Related Disease,ByHermanKoren, Michael S. Bisesi Edition 4th Edition First Published 2002 eBook Published 29 July 200
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

IMPORTANT NOTE

- ✓ Observations in the practical will be done by using permanent slides/charts/preserved specimens/animal models.
- ✓ The practicals include demonstration/virtual dissections / model 2d or 3d / chart of animal system as per as ugc guidelines.
- ✓ As per ugc guidelines-use of animals (from the list) for any experiment/dissections/mounting is banned. simulations, authorized permanent specimens/slides, charts, models and other innovative methods are encouraged.
- ✓ Animal tissue will be collected from authorized slaughter house and blood will be collected from blood bank