

SYLLABUS CBCS 2022

MASTER OF SCIENCE

ZOOLOGY



DEPARTMENT OF ZOOLOGY

THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA

INDEX & COURSE OUTLINE MSc Zoology CBCS 2022

CODE	COURSE DETAILS	CREDIT	PAGE NO.
SEMESTER-I		25 Cr	
THEORY:			
ZOL2101C01	Evolutionary Biology and Animal Phylogeny	4 Cr	1
ZOL2102C02	Physiological Chemistry	4 Cr	2
ZOL2103C03	Quantitative Biology, Instrumentation and Techniques in Biology	4 Cr	3
ZOL2104C04	Cell and Molecular Biology - I	4 Cr	4
PRACTICAL:			
ZOL2105C05	Practical – I: Evolutionary Biology and Animal Phylogeny	2 Cr	5
ZOL2106C06	Practical – II: Physiological Chemistry	2 Cr	6
ZOL2107C07	Practical – III: Quantitative Biology, Instrumentation and Techniques in Biology	2 Cr	7
ZOL2108C08	Practical – IV: Cell and Molecular Biology - I	2 Cr	8
ZOL2109C09	Seminar - I	1 Cr	9
SEMESTER – II		25 Cr	
THEORY:			
ZOL2201C01	Cell and Molecular Biology-II	4 Cr	10
ZOL2202C02	Genetics	4 Cr	12
ZOL2203C03	Environmental and Conservation Biology	4 Cr	13
ZOL2204C04	Biophysical Principles and Ethology	4 Cr	14
PRACTICAL:			
ZOL2205C05	Practical – V: Cell and Molecular Biology-II	2 Cr	16
ZOL2206C06	Practical – VI: Genetics	2 Cr	17
ZOL2207C07	Practical – VII: Environmental and Conservation Biology	2 Cr	18
ZOL2208C08	Practical – VIII: Biophysical Principles and Ethology	2 Cr	19
ZOL2109C09	Seminar - II	1 Cr	20

CODE	COURSE DETAILS	CREDIT	PAGE NO.
SEMESTER-III		25 Cr	
COMPULSORY COURSES: (Theory, Seminar & Practical)			
ZOL2301C01	Endocrinology, Chronobiology and Human Physiology	3 Cr	21
ZOL2302C02	Developmental Biology and Neurobiology	3 Cr	22
ZOL2303C03	Animal Biotechnology and Immunology	3 Cr	23
ZOL2304C04	Seminar – III	2 Cr	24
ZOL2305C05	Practical – IX: Endocrinology, Chronobiology and Human Physiology	2 Cr	25
ZOL2306C06	Practical – X: Developmental Biology and Neurobiology	2 Cr	26
ZOL2307C07	Practical – XI: Animal Biotechnology and Immunology	2 Cr	27
ELECTIVE COURSE: (Theory & Practical) Choose either option A or option B			
Option A			
ZOL2308C08	General and Applied Toxicology - I	3 Cr	28
ZOL2309C09	General and Applied Toxicology - II	3 Cr	29
ZOL2310C10	Practical – XIII: General and Applied Toxicology	2 Cr	30
Option B			
ZOL2311C11	Avian Biology and Wildlife Biology - I	3 Cr	31
ZOL2312C12	Avian Biology and Wildlife Biology - II	3 Cr	32
ZOL2313C13	Practical – XII: Avian Biology and Wildlife Biology	2 Cr	33

Note:

Students have to opt for either of the two elective courses and they are as follows.

1. General and Applied Toxicology 8 Cr

2. Avian Biology and Wildlife Biology 8 Cr

(Each of the above elective courses comprises of two Theory papers, each of 3 credits, and one Practical course of 2 Credits).

SEMESTER - IV		25 Cr	
COMPULSORY COURSES: (Theory, Dissertation, Seminar & Viva)			
ZOL2401C01	Biomimetics, Zoonotic Diseases and Control	4 Cr	34
ZOL2402C02	Dissertation	12 Cr	35
ZOL2403C03	Seminar-IV	2 Cr	36
ZOL2404C04	Comprehensive Viva Voce	3 Cr	37
ELECTIVE COURSE: (Practical)			
Choose either option A or option B			
Option A			
ZOL2405C05	Practical –XIV Research Methodology	2 Cr	38
ZOL2406C06	Practical –XV Regulatory Compliances/Affairs	2Cr	39
Option B			
ZOL2407C07	Practical –XVI Experimental Models in Biomedical Research	2 Cr	40
ZOL2408C08	Practical –XVII Computational Biology	2 Cr	41



The Maharaja Sayajirao University of Baroda
Faculty of Science, Department of Zoology
Sayajigunj, Vadodara 390002, 2795329, Ext: 357
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ACADEMIC YEAR
2022-23

Master of Science: Regular

Year	I	ZOL2101C01: Evolutionary Biology and Animal Phylogeny	Credit	4
Semester	I		Hours	60

OBJECTIVES:

This course aims to provide students with knowledge on the functions and evolution of the behaviours of animals under natural conditions, with special reference to the species-specific evolutionary history and the role played by the interaction between genes and environment on the development of behavioural traits. Thus, understanding of animals and evolution will aid further research outcomes with better knowledge about the animal kingdom. The students would identify key features scientists use to classify animals and interpret the metazoan phylogenetic tree. They will successfully list some of the relationships within the modern phylogenetic tree that have been discovered as a result of modern molecular data.

COURSE CONTENT / SYLLABUS

UNIT-I	1. Concepts in evolutionary biology, Developments and concept of synthetic theory 2. Geological time scale, Emergence, existence and extinction, Mass extinction events and evolution of new taxa, adaptive radiations 3. Elemental forces of evolution, Mutation, Selection (types of selection, selection coefficient, selection in natural population) 4. Genetic drift: Changes in gene frequency in small population; Migration 5. Speciation, Anagenesis and cladogenesis, modes of speciation, polytypic species, subspecies and infra-species categories, 6. The nature of reproductive isolation, genetic basis of isolating mechanisms 7. Evolution of hominids: recent concepts	2
UNIT-II	1. Concepts of animal systematics and phylogeny, phylogeography 2. Early animal diversification: Protista group, Choanoflagellates, Placozoa, Mesozoa and Bilateria relationships 3. Basal metazoan model system 4. Prostomia: Lophotrochozoa and Ecdysozoa groups and Deuterostomia 5. The genealogy and genetics lineages, genomic phylogeny, immune-phylogeny, developmental mechanisms and phylogeny 6. Molecular clock, evolution and phylogenetic tree. 7. Reconstruction of animal phylogeny based on fossilization and molecular data	2

REFERENCES

1.	Approaches to animal phylogeny, Pat Willmer, Cambridge University Press
2.	Evolution, Barton, N. H., Briggs, D. E.G., Eisen, J. A., Goldstein, A. E., Patel, N. H., Cold Spring Harbor Laboratory Press, New York, USA
3.	Evolution, Futuyma, D. J., Sinauer Associates, Inc., Sunderland, USA
4.	Evolution, Hall, B. K. and Hallgrimsson, B., Jones and Bartlett Publisher, Sudbury, USA
5.	Introduction to Mathematics for Life Scientists, Bastchelet, F., Springer Verlag, Berlin
6.	Perspectives in Animal Phylogeny and Evolution, Lessandro Minelli. Oxford University Press
7.	Principle of Animal Taxonomy, Simpson, G.G., Oxford IBH Publication Company

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Master of Science: Regular					
Year	I	ZOL2102C02: Physiological Chemistry		Credit	4
Semester	I			Hours	60
OBJECTIVES:		The students will be able to relate the function and interaction of life processes related to chemical structure and reactions. The students would demonstrate a working knowledge of basic chemical concepts and methods deployed in the biological samples to describe the basic process of life through knowledge of physiological chemistry.			
COURSE CONTENT / SYLLABUS					
UNIT-I		1. Water: Biological importance, pH and acid-base balance. Buffers: Biological importance. Unique solvent properties: electrolytic dissociation into cations and anions, Henderson-Hasselbalch equation 2. Carbohydrates: Classification and nomenclature and biological importance 3. Amino acids and Proteins: Structure, classification and properties 4. Lipids: Classification and biological importance of lipids			1
UNIT-II		1. Carbohydrate metabolism and regulation: Glycolysis, gluconeogenesis, glycogenolysis and glycogenesis 2. Lipid metabolism and regulation: Beta oxidation, ketosis and ketoacidosis, De novo synthesis of fatty acids. 3. Protein metabolism and regulation: Deamination, transamination and urea cycle. 4. TCA cycle, ETC and Oxidative phosphorylation			1
UNIT-III		1. Enzymes: Introduction and classification 2. Enzyme kinetics and enzyme inhibition 3. Catalytic mechanisms and regulation of enzyme activity 4. Enzyme engineering and its applications			1
UNIT-IV		1. Bioenergetics: Laws of thermodynamics; Concepts of entropy, free energy and standard free energy change; Equilibrium constant; Biological oxidation-reduction reactions; standard reduction potential 2. Clinical biochemistry 3. Nutritional biochemistry 4. Experimental approaches to study metabolic pathways and metabolic reprogramming			1
REFERENCES					
1.		Biochemistry, Ed Lubert Stryer. W.H. Freeman & Co.			
2.		Biochemistry. Voet, D. and J.G. Voet. John Wiley & Sons.			
3.		Harper's Biochemistry, Ed. Murray, R.K., Granner, D.K., Mayes P.A., and Rodwell, V.W.			
4.		Introduction to Mathematics for Life Scientists, Batschelet, E.			
5.		Nutrition Science and Application, Lori A. Smolin, Mary A. Grosvenor.			
6.		Principles of Biochemistry, E.D. Lehninger, Nelson and Cox			
7.		Textbook of Biochemistry with Clinical Correlations, Ed. Thomas M. Devlin.			
8.		Tietz Textbook of Clinical Chemistry, Carl A. Burtis and Edward R. Ashwood.			

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Master of Science: Regular						
Year	I	ZOL2103C03: Quantitative Biology, Instrumentation and Techniques in Biology			Credit	4
Semester	I				Hours	60
OBJECTIVES:	Upon completing the course, the students will be able to choose an appropriate sampling scheme and/or experimental design for a given biological question and select and apply the appropriate analytical methods to biological data. The students will demonstrate the necessary computer skills for biological data management, analysis and graphical presentation. In the second half of the course, the students will understand the working principle of various Instruments used for Bio-potential measurement and application of these instruments in diagnosis and in molecular biology, therapeutic treatment and imaging fields.					
COURSE CONTENT / SYLLABUS						
UNIT-I	1. Concepts of Samples and Populations, Measures of Central Tendency and Dispersion 2. Sampling and Probability distributions (Binomial, Poisson and Normal) 3. Parametric and Non-parametric statistics 4. Levels of significance, Null hypothesis, Alternative hypothesis 5. Student's T-test, χ^2 test. 6. Regression and Correlation; Analysis of variance				1	
UNIT-II	1. Research Designing 2. Basics of Data collection and analysis 3. Interpretation and Report writing 4. Scientific Presentation 5. IPR and Patent writing 6. Skills in Scientific communications				1	
UNIT-III	1. Principles of Microscopy, TEM, SEM, STEM, FCS, TIRF, Widefield microscopy 2. FISH and chromosome painting 3. Immunoassays and Immuno-cytological techniques. 4. PCR Technique 5. Molecular marker techniques				1	
UNIT-IV	1. Separation and Chromatographic techniques 2. Centrifugation techniques 3. Spectrophotometry and Spectral characterization of macromolecules 4. GIS, GPS and Remote Sensing technology 5. Ecological census techniques				1	
REFERENCES						
1.	Biometry, Sokal, R.R. and Rolf, F.J.					
2.	Ecological Simulation Primer, Gordon, S. and Kaluzny, S.					
3.	Fundamentals of Ecological Modeling, Jorgensen, S.E.					
4.	Mathematical biology, Murray, J.D.					
5.	Principles and Techniques of Practical Biochemistry, Ed Keith Wilson and Walker, J., Biochemistry, Ed Voet D., and Voet, J. G.					
6.	Sampling design biologists, Green, R.H.					
7.	Statistical methods, Snedecor, G.W. and Cochran, W.G.					
8.	The Interpretation of Ecological Data. A primer on classification and ordination, Pielou, E.C.					

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Master of Science: Regular					
Year	I	ZOL2104C04: Cell and Molecular Biology - I		Credit	4
Semester	I			Hours	60
OBJECTIVES:		This course will provide knowledge about the complex organization in the cell and the molecular mechanisms of the cellular processes that exist in all cell types. To effectively complete this paper, students should have a deeper understanding of molecular cell biology. The course is designed to impart knowledge of this rapidly changing field of modern biology, with its fast-evolving high throughput tools and thought-provoking platform, to deduce functional relationships at all macromolecular levels across the animal kingdom. Translation of the knowledge shall be in understanding (a) Diversity in animal kingdom at the molecular level (b) Consequences of altered gene function in scenario of experimentally induced diseases.			
COURSE CONTENT / SYLLABUS					
UNIT-I		1. Principles of membrane transport: Carrier proteins/Transporters and Active membrane transport 2. Ion channels and the electrical properties of the membrane 3. Cell Junctions 4. Cell-Cell adhesion molecules 5. The Extracellular matrix of animals			1
UNIT-II		1. Dynamic structure and regulation of cytoskeleton filaments 2. Types and functions of molecular motors 3. General principles of cell communication. 4. Signalling through G-protein-coupled cell-surface receptors (GPCSR) and small intracellular mediators. 5. Signalling through enzyme-coupled cell-surface receptors. 6. Signalling pathways dependent on regulated proteolysis of latent gene regulatory proteins.			1
UNIT-III		1. Molecular biology an overview and DNA structure 2. Genome structure, chromatin and nucleosome 3. Regulation of chromatin structure			1
UNIT-IV		1. Replication of DNA 2. Mutability and DNA Repair 3. Recombination and DNA transposons			1
REFERENCES					
1.	Approaches to Animal Phylogeny, Willmer, P., Cambridge University Press				
2.	Evolution, Barton, N. H., Briggs, D. E. G., Eisen, J. A., Goldstein, A. E., & Patel, N. H., Cold Spring Harbor Laboratory Press				
3.	Evolution, Futuyma, D. J., Sinauer Associates Inc.				
4.	Evolution, Hall, B. K., & Hallgrimsson, B., Jones and Bartlett Publisher				
5.	Introduction to Mathematics for Life Scientists, Batschelet, E., Springer Science & Business Media				
6.	Molecular Cell Biology, Lodish, et al., W.H. Freeman and Company				
7.	Molecular Cell Biology: David Baltimore.				
8.	Perspectives in Animal Phylogeny and Evolution, Minelli, L., Oxford University Press				
9.	Principle of Animal Taxonomy, Simpson, G.G., Oxford IBH Publication Co.				

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Master of Science: Regular					
Year	I	ZOL2105C05 PRACTICAL – I: Evolutionary Biology and Animal Phylogeny		Credit	2
Semester	I			Hours	60
OBJECTIVES:		The practical aims to illustrate phylogenetic characters of animals in correlation with evolution. They will associate the modern phylogenetic tree that has been discovered as a result of modern molecular data, with both, conventional and contemporary specimens.			
COURSE CONTENT / SYLLABUS					
1. Make a phylogenetic tree based on the characters provided. 2. Adaptive radiation of mouth parts in various orders of insects. 3. Study of fossils and methods of fossilization. 4. Visit to a local Geology Museum and study various types of fossils. 5. Visit to Dinosaur Fossil Park and Museum at Balasinor/Indroda 6. Study of adaptive evolution using beaks and feet of birds as a model. 7. Adaptation of dentition in relation to the feeding habits: a morphometric analysis of mammalian skull.				2	
REFERENCES					
1.	Approaches to Animal Phylogeny, Pat Willmer, Cambridge University Press				
2.	Evolution, Barton, N. H., Briggs, D. E.G., Eisen, J. A., Goldstein, A. E., and Patel, N. H., Cold Spring Harbor Laboratory Press, New York, USA				
3.	Evolution, Futuyma, D. J., Sinauer Associates, Inc., Sunderland, USA				
4.	Evolution, Hall, B. K. and Hallgrimsson, B., Jones and Bartlett Publisher, Sudbury, USA				
5.	Introduction to Mathematics for Life Scientists, Bastchelet, F., Springer Verlag, Berling				
6.	Perspectives in Animal Phylogeny and Evolution, Lessandro Minelli. Oxford University Press				
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Master of Science: Regular					
Year	I	ZOL2106C06 PRACTICAL - II: Physiological Chemistry		Credit	2
Semester	I			Hours	60
OBJECTIVES:		Students will experience hands-on training on various analytical and separation techniques and will be introduced to various methods of studying biological molecules by performing estimation methods. Students will understand the procedures involved in experiments on enzymes, methods of preparation of buffer, pH & pK determination, and methods for the isolation of enzymes, measuring their activity, kinetics, assays, immobilization, and studies on denaturation. Students will be explained the principle, theory and instrumentation of the technique to be used before starting the practical exercise.			
COURSE CONTENT / SYLLABUS					
1. Quantitative (spectrophotometric) analysis of carbohydrates, proteins, lipids and nucleic acids 2. Chromatographic separation of amino acids by paper and thin-layer chromatography 3. Determination of pK values of amino acids 4. Sub-cellular fractionation of rat liver and marker enzyme assays, isolation of nuclei and mitochondria from the tissue 5. Isolation, purification and characterization of proteins and experiments on protein denaturation 6. Preparation of buffers and determination of pH. 7. Isolation and assay of an enzyme and determination of its kinetic properties. 8. Effect of pH, temperature, time, substrate concentration, enzyme concentration on enzyme activity 9. Immobilization of enzyme and determining its activity 10. Zymography - In-gel staining of enzyme activity (Demonstration only)					2
REFERENCES					
1.	An Introduction to Practical Biochemistry, David T Plummer, McGraw Hill Education (India)				
2.	Biochemical Calculations: How to Solve Mathematical Problems in General Biochemistry, Segel, I H., John Wiley & Sons.				
3.	Comprehensive Enzyme Kinetics, Leskovic, V. Kluwer Academic Publisher				
4.	Principles and Techniques of Biochemistry and Molecular Biology, Wilson K. and Walker, J. Cambridge University Press.				
5.	Principles of Biochemistry, Nelson D.L. and Cox, M.M., W.H. Freeman & Co.				

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Master of Science: Regular					
Year	I	ZOL2107C07 PRACTICAL - III: Quantitative Biology, Instrumentation and Techniques in Biology		Credit	2
Semester	I			Hours	60
OBJECTIVES:		This course will enable students to learn various data analysis methods using biostatistics software. This course will also make students perform calculations of various measures of species diversity and richness. The second part of the practical will help students in learning specific techniques and will provide hands-on training on working of necessary laboratory instruments and their principles.			
COURSE CONTENT / SYLLABUS					
1. Estimation of insect population density of varied habitats 2. Line transects estimation of bird population density 3. Calculation of species diversity of varied habitats 4. Tools for the analysis of quantitative data for descriptive statistics 5. Tools for the analysis of quantitative data for inferential statistics 6. Usage and maintenance of standard laboratory apparatus, handling of instruments and controls. 7. Demonstration of microscopy – Light and Fluorescence 8. DNA fragmentation assay 9. Restriction enzyme digestion					2
REFERENCES					
1.	Biology, Jones, M., and Jones, G., Cambridge University Press				
2.	Biophysical Chemistry, Allen, J. P., Wiley Blackwell				
3.	Fundamentals of Biostatistics, Rosner B., Brooks/Cole, Cengage Learning				
4.	Introduction to Ecological Sampling, Manly, B. F. J., and Navarro Alberto, J., A., Chapman & Hall/CRC Taylor and Francis Group				
5.	Methods in Biostatistics, Mahajan B. K., Jaypee Brothers Medical Publishers				
6.	Principles and Techniques of Biochemistry and Molecular Biology, Wilson, K. and Walker, J., Cambridge University Press				
7.	Principles of Anatomy and Physiology, Grabowski, S. R., and Tortora, G. J., Wiley				

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Master of Science: Regular					
Year	I	ZOL2108C08 PRACTICAL - IV: Cell and Molecular Biology I		Credit	2
Semester	I			Hours	60
OBJECTIVES:		Students will learn various staining methods for cells and specific biomolecules of the cells. The basics of selected physiological responses in isolated cells from animals will be explained to the students.			
COURSE CONTENT / SYLLABUS					
1. Handling of lab probes and maintenance practice, Preparation of Fixatives and stains 2. Histology: Microtomy and paraffin section preparation 3. Histochemical localization of protein e.g., succinate dehydrogenase 4. Periodic Acid-Schiff reaction for Mucopolysaccharides 5. Micrometry: Ocular and Stage Micrometers 6. Isolation of nucleic acids and quantitative analysis 7. Primer designing 8. Quantitative and semi-quantitative PCR					2
REFERENCES					
1.	A Practical Manual of Medical and Biological Staining Techniques, Gurr, E., Andesite Press				
2.	Genetic Engineering, Rastogi S. C., and Pathak, N., Oxford University Press				
3.	Immunohistochemistry and Immunocytochemistry: Essential Methods, Renshaw S., Wiley Blackwell				
4.	Molecular Cloning: A Laboratory Manual, Green M. R., and Sambrook J., Cold Spring Harbour Laboratory Press				
5.	Principles of Gene Manipulation: An Introduction to Genetic Engineering, Old R. W., and Primrose S. B., Blackwell Science				

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Master of Science: Regular					
Year	I	ZOL2109C09: SEMINAR-I		Credit	1
Semester	I			Hours	30
OBJECTIVES:		Students will be able to understand and comprehend a scientific review article through which they will develop a deeper understanding of the subject. This course will also help the student build their presentation skills.			
COURSE CONTENT / SYLLABUS					
1. Introduction to predatory Vs Legitimate journals 2. Types of articles: Letter, Short communication, short notes, research article, review article, preprint etc. 3. Select a recent review article (should not be older than two years) based on relevance and competence. 4. Introduction to PowerPoint: Selection of font, font size, background graphics, animation etc. 5. Organizing the reference in the presentation: Bibliography, webliography, citation styles (APA, MLA, Chicago, Turabian, IEEE)					1
REFERENCES					
1.	Cite Right: A Quick Guide to Citation Styles--MLA, APA, Chicago, the Sciences, Professions, and More, Lipson, C., University of Chicago Press				
2.	Microsoft Office for Beginners, Humphrey M. L., (published by M. L. Humphrey)				
3.	Predatory Journals: What They Are and How to Avoid Them, Elmore, S. A., and Weston, E. H., Toxicologic Pathology, Sage Journals (https://doi.org/10.1177/0192623320920209)				
4.	Presentation Skills for Scientist, Zanders, E., and Macleod, L., Cambridge University Press				

Semester II

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Master of Science: Regular					
Year	I	ZOL2201C01: Cell and Molecular Biology - II		Credit	4
Semester	II			Hours	60
OBJECTIVES:		This course will provide knowledge about the complex organization in the mechanisms of the cellular processes that exist in all cell types. To effectively complete this paper, students should have a deeper understanding of molecular cell biology. The course is designed to impart knowledge and understanding of this rapidly changing field of modern biology and fast-evolving tools for high throughput and thought-provoking platforms to deduce functional relationships at all macromolecular levels across the animal kingdom. Translation of the knowledge shall be in understanding (a) Diversity in the animal kingdom at the molecular level (b) Consequences of altered gene function in scenario of experimentally induced diseases.			
COURSE CONTENT / SYLLABUS					
UNIT-I		1. Overview of cell cycle and its phases; Cell cycle control system; regulation of cell cycle and checkpoint kinases 2. Cell Death: apoptosis and regulatory processes. Differences between apoptosis and necrosis and significance. Cell senescence, caspases, telomerases. 3. Biology of cancer; cancer stem cells; control of cell death, cell differentiation or both; tumour microenvironment 4. Molecular basis of cancer-cell behavior; critical cancer genes; preventable causes of cancer; cancer genomics and cancer treatment			1
UNIT-II		1. Compartmentalization of cells; Evolutionary origins; signal sequences of proteins and their significance 2. Transport of proteins into nucleus, mitochondria, peroxisomes, endoplasmic reticulum 3. Golgi (cis and trans): secretory and lysosomal proteins. Glycosylation of proteins. 4. Intracellular vesicular traffic: Types of coated vesicles and their function; transport of proteins from ER through Golgi apparatus; Golgi network to lysosomes and cell exterior; transport of proteins into the cell from the plasma membrane			1
UNIT-III		1. Mechanism of transcription in Eukaryotes 2. Transcriptional regulation 3. Mechanism of Translation and post-translation regulation			1
UNIT-IV		1. RNA structure, processing and splicing 2. Regulatory RNAs, RNAi and Gene silencing 3. Introduction to Systems Biology			1
REFERENCES					
1.	Anatomy of Gene Regulation: A Three-dimensional Structural Analysis, Tsonis, P., Cambridge University Press				
2.	Cell and Molecular Biology, De Robertis, E. D. P., and De Robertis, E. M. F., B.I. Publications, Pvt. Ltd.				
3.	Cell Physiology Source Book: A Molecular Approach, Sperelakis, N., Academic Press				
4.	Karp's Cell and Molecular Biology, Karp, G., Iwasa J., and Marshall, W., Wiley				
5.	Lewin's Genes X, Lewin, B., Krebs, J., Kilpatrick, S. T., and Goldstein, E. S., Jones & Bartlett Learning				

6.	Molecular Biology of the Cell, Alberts et al., W.W. Norton and Co.
7.	Molecular Biology of the Gene, Watson, J. D., Pearson Education
8.	Molecular Cell Biology, Lodish et al., W. H. Freeman & Co. Ltd.
9.	RNAi: A Guide to Gene Silencing, Hannon, G., Cold Spring Harbor Laboratory Press
10.	The Cell: A Molecular Approach, Cooper G.M., Oxford University Press

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Master of Science: Regular					
Year	I	ZOL2202C02: Genetics		Credit	4
Semester	II			Hours	60
OBJECTIVES:		A study of genetics will aid students in understanding the underlying mechanisms governing the expression of various genetically determined traits. It will also provide examples of how continuous traits are quantitative traits, and that phenotype variation may be due to genetic variation within a population and/or environmental variation experienced by individuals within a population. Explain the polygenic theory of genetic variance, the nature of additive alleles, and the accompanying experiments.			
COURSE CONTENT / SYLLABUS					
UNIT-I		1. Gregor Mendel and Basic principles of heredity 2. Extensions to basic principles: Co-dominance, lethal alleles, multiple alleles, epistasis, interaction between sex and heredity, interaction between genes and environment 3. Extranuclear (cytoplasmic) inheritance			1
UNIT-II		1. Linkage and Recombination 2. Nature of the genetic code and gene regulation 3. Genetic control of proteins			1
UNIT-III		1. Biochemical genetics and pioneering studies using Neurospora 2. Human biochemical genetics 3. Genetic analysis of complex traits 4. Molecular genetic markers			1
UNIT-IV		1. Physical organization of Bacterium 2. Microbial growth curves 3. Plasmids 4. Bacterial Transformation, conjugation and transduction 5. Genetics of phage T4 (Lytic and lysogenic cycle of phage λ)			1
REFERENCES					
1.	Genetics – Analysis of Genes and genomes, Hartl, D. L., and Jones, W., Jones and Bartlett Publishers				
2.	Genetics of Microbes, Bainbridge, B. W., Chapman and Hall				
3.	Genetics, Strickberger, M. W., Pearson Education Inc.				
4.	Genetics: A Conceptual Approach, Pierce, B. A., W. H. Freeman & Co.				
5.	Genetics: from Genes to Genomes, Hartwell et al., Mc-Graw-Hill Education				
6.	Microbial Genetics, Maloy, S. R., Cronan J. E., and Freifelder, D., Narosa				
7.	Molecular Genetics, Bharadwaj, D. N., Kalyani Publishers				
8.	Principles of Genetics Gardner, E. J., Simmons, M. J. and Snustad, D.P., John Wiley & Sons, Ltd.				

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Master of Science: Regular					
Year	I	ZOL2203C03: Environmental and Conservation Biology		Credit	4
Semester	II			Hours	60
OBJECTIVES:		Environmental Studies as an academic field is expected to help in understanding and respond to the variety of changes humans have brought to the world. The course will focus on the following topics: patterns and processes creating biological diversity; consequences of diversity losses; approaches to conserving diversity, including large-scale conservation planning			
COURSE CONTENT / SYLLABUS					
UNIT I		1. Environmental resources, resource exploitation, Sustainability and resources modeling 2. Renewable and non-renewable energy resources: carbon, nitrogen, water, energy and ecological footprints 3. Environmental impact assessment: Notification, guidelines, NABET 4. Environmental auditing: Procedure and guidelines, concept of water, energy and green audit 5. Biological impact assessment and role of an ecologist in environmental management system 6. Causes of climate change and its impacts 7. WTO, Environmental legislation, institutions and policies with special reference to India.			2
UNIT-II		1. Patterns and processes of biodiversity 2. Economic and ecological values of biodiversity: Use and non-use values, Access-Benefit sharing 3. Principles of conservation and conservation priorities 4. Connectivity conservation approaches: Connectivity and meta-population dynamics in highly fragmented habitats, Corridors and buffer zones as connectivity components. 5. Protected Area Networks and Management of PA with Indian wildlife conservation examples 6. Restoration and Translocation as conservation approaches 7. Use of Remote Sensing and GIS in Biodiversity assessment and conservation. 8. Biotechnological approaches in conservation			2
REFERENCES					
1.	Ecology and Tropical Biology, Deshmukh, I., Blackwell Scientific Publications				
2.	Ecology, Miller, G., & Ricklefs, R. E., W. H. Freeman & Co Ltd.				
3.	Ecology-A Bridge Between Science and Society, Odum, E. P., Oxford University Press				
4.	Elements of Ecology, Smith, R. L., and Smith T. M., Benjamin-Cummings Pub. Co.				
5.	Environmental Biotechnology: A Biosystems Approach, Vallero, D. A., Academic Press				
6.	Man and the Ecosystem, Lloyd, J. R., Macmillan Education Ltd.				
7.	Marine Biodiversity, Ormond et al., Cambridge University Press				
8.	Remote Sensing for Ecology and Conservation: A Handbook of Techniques (Techniques in Ecology & Conservation). Horning et al., Oxford University Press.				

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Master of Science: Regular					
Year	I	ZOL2204C04: Biophysical Principles and Ethology		Credit	4
Semester	II			Hours	60
OBJECTIVES:		The course aims to provide students with interdisciplinary knowledge on the physical and physicochemical mechanisms of interactions that structure biological processes. The second part of the course elaborates on functions and evolution of the main behaviors of animals under natural conditions, with special reference to the species-specific evolutionary history and the role played by the interaction between genes and environment on the development of behavioral traits.			
COURSE CONTENT / SYLLABUS					
UNIT-I		1. Introduction to Biophysics, history and scope, concepts and divisions 2. Biophysical principles for animal body 3. Physical basis of arthrology, vision and hearing 4. Bio-magnetism and Magneto-biology 5. Quantum biology: Classical mechanics			1
UNIT-II		1. Physiochemical Interactions within Biological Systems 2. Biophysics of membrane – structure and energy transformations 3. Radiation Biology and Nuclear medicine 4. Chronobiology- Biological Clocks, location and regulation; Regulation in Invertebrates, Reptiles, Birds and Mammals; Molecular mechanisms of internal clocks. 5. Biocybernetics – Biological signals, information transmission and control.			1
UNIT-III		1. Introduction and significance of the study of animal behavior 2. Introduction to the works of Konrad Lorenz, Niko Tinbergen, Karl Von Frisch, Harry Harlow, Desmond Morris, Jane Goodall, Dian Fossey, E.O. Wilson. 3. Behavior: Sign Stimulus, Learning and Memory, Instinctive behavior, Habituation Imprinting, Conditioning (Pavlov’s experiments) Skinner’s experiments. 4. Role of hormones in drive; the role of pheromones in alarm spreading; crypsis, predator detection, predator tactics 5. Brain and behaviour			1
UNIT-IV		1. Concepts of Ethology, sensory filtering, responsiveness, fixed action pattern, sign Stimulus (Code credit sakers, Supernormal stimulus, Stimulus filtering, flush toilet model) 2. Method of studying animal behaviour including Sexual conflict, Selfishness, Kinship and Altruism 3. Definition of social group, advantage of being social, social group of Bees, Deer and Primates 4. Communication among animals- acoustic, visual, tactile. Echolocation, Language of honey bees 5. Reproductive Behavior in Animal: Courtship and Mating			1
REFERENCES					

1.	A Text Book of Biophysics, Roy, R. N., New Central Book Agency.
2.	An Introduction to Animal Behaviour, Manning, A., and Dawkins, M. S., Cambridge University Press
3.	Animal Behaviour, Alcock, J., Sinauer Associate Inc.
4.	Animal Behaviour, McFarland, D., John Wiley & Sons.
5.	Biophysics: A Physiological Approach, Dillon, P. F., Cambridge University Press.
6.	Membrane Structural Biology: With Biochemical and Biophysical Foundations, Luckey, M., Cambridge University Press.
7.	Perspective on Animal Behaviour, Goodenough, J., McGuire, B., and Jacob, E., Wiley.

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Master of Science: Regular					
Year	I	ZOL2205C05 PRACTICAL V - Cell and Molecular Biology II	Credit	2	
Semester	II		Hours	60	
OBJECTIVES:		This subject will aid the students in understanding the structures and purposes of basic components of prokaryotic and eukaryotic cells, with details of macromolecules, membranes, and organelles. It will provide insights into how the cellular components are used to orchestrate intricate mechanisms of body functioning. This will aid students in linking the rapid advances in these active fields of research to understand diseases better. Recent years have seen explosive advances in the study of DNA, RNA and molecular genetics, including gene cloning, gene editing, sequencing and mapping. Advancement in molecular biology has opened new areas of study and provided powerful techniques revolutionizing the pharmaceutical, health, and agricultural industries. They have spawned new industries in biotechnology, and opened avenues for answering basic and applied questions in all of the life sciences.			
COURSE CONTENT / SYLLABUS					
1. Cell Division – Mitosis and Meiosis 2. Janus green staining for Mitochondria 3. Feulgen reaction for DNA and Methyl Green Pyronin staining for DNA and RNA 4. Subcellular fractionation of cell organelles 5. Mammalian cell culture 6. Assessment of proliferation in cultured cells by MTT assay 7. Immunocytochemistry- Localization of Tubulin/microtubules 8. Primer designing for miRNA and methylation study 9. cDNA synthesis and Gene expression study through qRT-PCR 10. Software to study system biology				2	
REFERENCES					
1.	Anatomy of Gene Regulation: A Three-dimensional Structural Analysis, Tsonis, P. A., Cambridge University Press.				
2.	Cell and Molecular Biology: Concepts and Experiments, Karp, G., John Wiley & Sons				
3.	Essential Cell Biology, Alberts et al., Garland Science.				
4.	Lewin's Genes XI, Lewin, B., Krebs, J. E., Goldstein, E. S., and Kilpatrick, S. T., Jones & Bartlett Publishers				
5.	Molecular Biology of the Cell, Alberts, B., Garland Science				
6.	Molecular Cell Biology, Lodish et al., W. H. Freeman & Co. Ltd.				
7.	Molecular Cloning- A Laboratory Manual, Sambrook, J., Fritsch, E. F., and Maniatis, T., Cold Spring Harbor Laboratory Manual				
8.	Trypan blue exclusion test of cell viability, Strober, W., Current Protocols in Immunology				

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Master of Science: Regular					
Year	I	ZOL2206C06 PRACTICAL VI - Genetics		Credit	2
Semester	II			Hours	60
OBJECTIVES:		This course will enable students to perform experiments on animals and isolated cells to understand the principles of genetics. The students will be equipped to solve theoretical problems of classical and microbial genetics. The syllabus will also help students understand the cause and inheritance pattern of the genetic disorders.			
COURSE CONTENT / SYLLABUS					
1. G-banding of chromosomes 2. Karyotyping and human chromosome analysis 3. Metaphase plate preparation from mouse bone marrow and human blood lymphocytes 4. Transformation in bacteria 5. Bacterial conjugation and interrupted mating 6. Transduction using bacterial culture and Phage 7. Pedigree analysis 8. Problem-solving for Genetic cross in Neurospora 9. Chi-square Test 10. Chromosomal abnormalities					2
REFERENCES					
1.	A Practical Manual on Principles of Animal Genetics, Tolénkhombá, T., Lambert Academic Publishers				
2.	A Practical Manual on Principles of Animal Genetics, Tolénkhombá, T., Lambert Academic Publishers				
3.	Genetics: Analysis of Genes and Genomes, Hartl, D. L., and Jones, E. W., Jones and Bartlett Publishers				
4.	Genetics: From Genes to Genomes, Goldberg, M. L., Hartwell, L. H., Fischer, J. A., and Hood, L. E., McGraw Hill Education.				
5.	Microbial Genetics, Maloy, S. R., Cronan J. E., and Freifelder, D., Narosa				
6.	Molecular Genetics, Bharadwaj, D.N., Kalyani Publishers.				
7.	Practical Genetics, Jones R.N., and Rickards, G. K., Open University Press				
8.	Principles of Genetics, Gardner, E.J., Simmons, M.J., and Snustad, D.P., John Wiley & Sons.				

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Master of Science: Regular					
Year	I	ZOL2207C07 PRACTICAL VII - Environmental and Conservation Biology		Credit	2
Semester	II			Hours	60
OBJECTIVES:		Environmental Studies aim to instill the concern for the welfare of the many human and non-human communities that shape this planet. This study will help incorporate social sciences for understanding human relationships, perceptions, and policies towards conserving the environment. The subject focuses on maintaining the scientific temperament needed to upkeep biological diversity and essential ecological diversity and preserve the continuity of food chains. It aims to ensure the sustainable utilisation of life support systems on earth and provide a vast knowledge of potential use to the scientific community. Biological diversity provides immediate benefits to society such as recreation and tourism thus biodiversity conservation serves as an insurance policy for the future. Thus, this subject deals with studying multiple aspects of Biodiversity and its conservation.			
COURSE CONTENT / SYLLABUS					
1. Field ecology techniques, Various assessment methods, biodiversity quantification and use of various indices 2. Population demography, determine community structure and establish the abiotic and biotic correlations, Niche measurement 3. Remote Sensing and GIS in habitat characterization, biodiversity distribution mapping, resource mapping, land use and land cover changes 4. Threat assessment: Dependability for natural resources, Food resources exploitation, Anthropogenic pressure on terrestrial and aquatic habitats, Grazing pressure, Impacts of land use and land cover modifications, Impact of other stressors. 5. Field Visit 6. Carry out economic and ecological valuation of biodiversity of Faculty of Science, Residential colonies of the University and Bhukhi Stream passing through University, Different areas of Vadodara and surroundings. 7. Visit Sir Sayajibaug Zoological Garden to study ex-situ conservation practices, Captive breeding as a successful ex-situ conservation approach. 8. Behaviour of animals in natural habitat and in captivity 9. Wildlife census: Visual encounter, Camera trapping, Drone surveys. Indirect evidences like; pug marks, scat sampling, wildlife movement information, etc. Bird census, Mammal census.					2
REFERENCES					
1.	Ecology and Tropical biology, Deshmukh, I., Blackwell Scientific Publications				
2.	Ecology, Ricklefs, R. E., Miller, G., and Miller, G. L., Macmillan Publications				
3.	Ecology: Principles and Applications, Chapman, J. L., and Reiss, M. J., Cambridge University Press.				
4.	Elements of Ecology, Smith, R. L., Smith, T. M., Hickman, G. C., and Hickman, S. M., Pearson Education				
5.	Man and the Ecosystem, Lloyd, J.R., Lloyd, J. R., Macmillan International Higher Education.				
6.	Marine Biodiversity: Patterns and Processes, Ormond, R. F., Gagean, J. D., and Angel, M. V., Cambridge University Press				
7.	Modeling in Behavioral Ecology, Landren, D., Princeton University Press.				

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Master of Science: Regular					
Year	I	ZOL2208C08 PRACTICAL VIII - Biophysical Principles and Ethology		Credit	2
Semester	II			Hours	60
OBJECTIVES:		The students will be able to understand the concepts and applications of biophysical principles with hands-on training. This course will enable students to learn various data analysis methods using biostatistics software. The second part of the practical aims to provide students with knowledge on the behaviors of animals under natural conditions, with special reference to the role played by the interaction between genes and environment on the development of behavioral traits. This course will enable the students to understand the functionality and importance of interdisciplinary studies.			
COURSE CONTENT / SYLLABUS					
1. Spectral characterization of macromolecules: Determination of absorption spectra and extinction-coefficient 2. Basic body examination: Blood pressure, BMI, and heart rate. 3. Electrocardiography 4. Optometry- Biophysics of visual perception: Defects of vision and their corrections 5. Biophysical foundations of human movement: Movement of synovial joints 6. Study the response of earthworm: 1) to the light 2) to the moisture 3) to the chemical stimuli 7. Study the phototactic and chemotactic behavior in paramecium. 8. Endurance running in rats and voluntary wheel running in mice. 9. Behavioral test to measure exploratory behavior in animals: T-maze test using rodents. 10. Study of aggressive behavior in male Siamese fighting fish (<i>Betta splendens</i>) - Fighter fish.					2
REFERENCES					
1.	A Robust Line Transect Method – Biometrics, Buckland, S. T., and Turnock, B. J., International Biometric Society (https://doi.org/10.2307/2532356)				
2.	An Introduction to Animal Behavior, U.K. Manning, A., and Dawkins, M. S., Cambridge University Press.				
3.	Animal Behavior, Mathur, R., Rastogi Publications.				
4.	Animal Behavior: An Evolutionary Approach, Koprowski, J. L., Alcock, J., Sinauer Associates.				
5.	Animal Behavior – Psychobiology, Ethology and Evolution, McFarland, D., Pitman Publications				
6.	Fundamentals of Biostatistics, Rosner, B., Nelson Education				
7.	Methods In Biostatistics, Mahajan, B. K., Jaypee Brothers Publishers				
8.	Principles of Anatomy and Physiology, Grabowski, S. R., and Tortora, G. J., John Wiley & Sons				

 THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA सत्यं शिवं सुन्दरम्	The Maharaja Sayajirao University of Baroda Faculty of Science, Department of Zoology Sayajigunj, Vadodara 390002, 2795329, Ext: 357 <u>head-zoo@msubaroda.ac.in</u>			ACADEMIC YEAR 2022-23	
Master of Science: Regular					
Year	I	ZOL2209C09: SEMINAR II		Credit	1
Semester	II			Hours	30
OBJECTIVES:		Students will understand and comprehend a scientific research paper through which they will develop a deeper understanding of the subject. This course will also help student better their presentation skills. Students will understand the research and technological advancements happening globally and apply them to their future research using all comprehension skills they earn here.			
COURSE CONTENT / SYLLABUS					
1. Select a recent research article (should not be older than two years) published in WoS, SCI, Clarivate or any other UGC approved journal based on the interest of the student 2. Alternate to Microsoft PowerPoint: Google Slides, Canva, Ludus, Beautiful.ai, Prezi, Powtoon, Genially etc. 3. Use of infographics for presentation. 4. Introduction to (Mendley, End Note, Zotero etc) for organizing the references.					1
REFERENCES					
1.	Best Presentation Software. https://slidebean.com/blog/best-presentation-software-tools				
2.	Predatory Journals: What They Are and How to Avoid Them, Elmore, S. A., and Weston, E. H. Toxicologic Pathology, 48(4), 607–610. (https://doi.org/10.1177/0192623320920209)				
3.	Presentation Skills for Scientist, Zanders, E., and Macleod, L., Cambridge University Press				

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Master of Science: Regular					
Year	II	ZOL2301C01: Endocrinology, Chronobiology and Human Physiology	Credit	3	
Semester	III		Hours	45	
OBJECTIVES:		1. Study the advanced-level concepts of Endocrinology, chronobiology and Human Physiology. 2. Decipher the interplay of key organ systems governed by the endocrine system. 3. To provide an understanding of onset and progression of diseases related to circadian biology, endocrinology or other factors.			
COURSE CONTENT / SYLLABUS					
UNIT-I		1. Hypothalamus, Pituitary, Thyroid, Adrenal 2. Reproductive and Pregnancy 3. Calcium and bone 4. Gut and metabolic endocrinology 5. Clinical Endocrinology, Endocrine Oncology			1
UNIT-II		1. Introduction to chronobiology and biological clocks 2. Chronostasis: The timekeeping of physiological systems 3. Circadian rhythm and diet consumption/assimilation 4. Biological timekeeping in birds 5. Circadian rhythms in subterranean animals			1
UNIT-III		1. Partition of body fluids: Osmotic equilibria, fluid shifts, osmolarities. 2. Smooth muscle physiology: Neuromuscular junction, smooth muscle contraction, Myasthenia Gravis 3. Respiratory physiology: Respiratory centre, chemoreceptor control, anomalies 4. Brain and limbic system: Vegetative and behavioural functions, other functions. 5. Neonatal physiology: Onset of breathing, nutrition, special problems.			1
REFERENCES					
1.	Nussey, S.S.; and Whitehead, S.A. (2001) Endocrinology: An Integrated Approach, Oxford: BIOS Scientific Publishers.				
2.	Hadley, M.E. and Levine J.E. (2007) Endocrinology (6th edition) Pearson Prentice-Hall, New Jersey.				
3.	Kumar, V. Biological Rhythms. Delhi: Narosa Publishing House, 2002 Dunlap J.C. et al. Chronobiology: Biological Timekeeping. Sunderland, MA, USA: Sinauer Associates, Inc. Publishers, 2004 Saunders, D.S. Insect Clocks. New York, USA: Barends and Noble Inc. 2002				
4.	Principles of anatomy and physiology, Grabowski, S. R., & Tortora, G. J. (2000). New York, NY: Wiley. Textbook of Medical Physiology Guyton & Hall. XI Edition. Hercourt Asia PTE Ltd. Principles of Animal Physiology. Moyes, CD and Schulte, PM. Benjamin Cummings, New York				

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Master of Science: Regular					
Year	II	ZOL2302C02: Developmental Biology and Neurobiology		Credit	3
Semester	III			Hours	60
OBJECTIVES :		1. To provide a comprehensive understanding of the concepts of early animal development using the most well-studied animal models. 2. To make the students familiar with different approaches that have been used to study the concepts of development among the organisms across the animal kingdom. 3. To develop an overall understanding of post-embryonic development, influences of environment and medical implications. 4. The topics in neurobiology will provide insights into the structure of brain, its associated functions, associated neurodegenerative disorders.			
COURSE CONTENT / SYLLABUS					
UNIT-I		1. Symmetry-breaking, Polarity, Cell Fate, Signalling, positional information 2. Gene regulation in development, Genome inheritance (Germ cells, mitochondria) 3. The mechanics of morphogenesis 4. Strategies of Nervous System Development 5. Evolution & Development			1
UNIT-II		1. Pattern formation in invertebrate wing and leg. 2. Positional signalling during vertebrate limb development 3. The hormonal reactivation of development: Metamorphosis in amphibians and in insects. 4. Postembryonic development: Regeneration - Epimorphosis and morphallaxis; Aging. 5. Environmental regulation and medical implications of developmental biology			1
UNIT-III		1. Neuron, glial cell types, electrical, chemical properties of neurons 2. Vision, hearing, olfaction, taste, somatosensation and pain 3. The motor system and sensorimotor integration 4. Motivation, emotion, learning, memory, language 5. Connectome, synaptic activity, plasticity, neurodegenerative disorders			1
REFERENCES					
1. Analysis of Biological Development, Kalthoff, McGraw-Hill Science, New Delhi, INDIA. 2. Development Biology, Berril N.J. and Karp. G. McGraw Hill New York. 3. Developmental Biology, Gilbert, Sinauer Associates Inc., Massachusetts, USA. 4. Gene Activity During Early Development, Davidson, E.H. Academic Press, New York. 5. Principles of Development, Wolpert, Beddington, Brockes, Jessell, Lawrence, Meyerowitz, Oxford University Press, New Delhi, INDIA 6. Eric Kandel, James Schwartz, Thomas Jessell, Steven Siegelbaum, A.J. Hudspeth. 2012. Principles of Neural Science; McGraw Hill Education; 5th edition; ISBN-13 : 978-0071390118 7. Squire, L. et al. (2003) Fundamental Neuroscience, Academic Press. 8. Bear, Mark F., Barry W. Connors, and Michael A. Paradiso. <i>Neuroscience: Exploring the Brain</i>, 3rd ed. Baltimore, MD: Lippincott Williams & Wilkins, 2006. ISBN: 9780781760034.					

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Master of Science: Regular					
Year	II	ZOL2303C03: Animal Biotechnology and Immunology		Credit	3
Semester	III			Hours	60
OBJECTIVES:		1. Study of different tools and techniques used in genetic engineering and Recombinant 2. DNA technology and to create interest in advanced studies. 3. Understating of the application of biotechnology in animal sciences and human health 4. To understand the aspects of human immunology such as antigens, antibodies, major histocompatibility complex, complement system, cytokines, lymphoid organs, B- and T- lymphocytes and different cells. Study about concept of tolerance and autoimmunity and hypersensitivity			
COURSE CONTENT / SYLLABUS					
UNIT-I		1. Recombinant DNA technology 2. Basic biology of vector and cloning strategies 3. Transgenic animal techniques and screening methods 4. DNA markers-RAPD, STR, SSCP, RFLP, DNA fingerprinting, SNP, EST 5. Application of biotechnology			1
UNIT-II		1. Over view of Immune system 2. Antibodies: structure and function 3. Organization and expression of immunoglobulin genes 4. Hypersensitivity 5. Tolerance and Autoimmunity			1
UNIT-III		1. Cell mediated Immunity 2. Complement Systems: Classical and alternate pathways 3. Cytokines and cytokine receptors 4. Inflammatory Responses 5. Immunodeficiency, Immunotherapy, Vaccines			1
REFERENCES					
1.	Principles of Gene Manipulation and Genomics, Primrose, S. B. and Twyman, R. M., Blackwell Publishing, West Sussex, UK				
2.	Principles and application of recombinant DNA, Bernard R. and Jack, ASM Press, Herndon, USA				
3.	Immunology, David, Brostoff and Roitt, Mosby & Elsevier Publishing, Canada, USA				
4.	Immuno Biology- The immune system in health and disease, Janeway, Travers, Walport and Shlomchik, Garland Science Publishing, New York, USA.				
5.	Immunology, Richard, Thomas, Barbara, Janis Kuby, W. H. Freeman and company, New York, USA.				

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Master of Science: Regular					
Year	II	ZOL2304C04: Seminar-III		Credit	2
Semester	III			Hours	60
OBJECTIVES:		1. Students will understand and comprehend a scientific research paper through which they will develop a deeper understanding of the subject.			
		2. This course will also help student better their presentation skills.			
		3. Students will understand the research and technological advancements happening globally and apply them to their future research.			
		4. Seminars will also be used to facilitate class discussions to inculcate the spirit of participative learning.			
COURSE CONTENT / SYLLABUS					
Research Technique/Research Paper presentation as per Elective paper selection					

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Master of Science: Regular					
Year	II	ZOL2305C05 Practical – XI: Endocrinology, Chronobiology and Human Physiology	Credit	2	
Semester	III		Hours	60	
OBJECTIVES:		1. To study the anatomy and physiology of vertebrate experimental models. 2. To study surgical techniques and endocrine manipulations in experimental models. 3. To study behavioural patterns and its alterations of suitable models.			
COURSE CONTENT / SYLLABUS					
Endocrinology, Chronobiology and Human Physiology		1. Study of endocrine glands of rat/mice through anatomical studies and permanent slides 2. Surgical techniques: (Any 3 will be demonstrated/performed) a. Hypophysectomy in Fish (Tilapia/catfish). b. Thyroidectomy in a suitable animal (rat/mice). c. Adrenalectomy in a suitable animal (rat/mice). d. Gonadectomy in a suitable animal (rat/mice). 3. Clinical Endocrinology: Thyroid hormones viz. T3, T4 and TSH 4. Behaviour studies: Locomotor activity, depression, anxiety and social interaction - Circadian rhythm related neurobehavioural changes. 5. Feeding behaviour in fishes - Circadian rhythm related changes. 6. Measuring osmosis and haemolysis assay 7. Smooth muscle contraction: Peristalsis	2		
REFERENCES					
1) Hadley, M.E. and Levine J.E. (2007) Endocrinology (6th edition) Pearson Prentice-Hall, New Jersey. 2) David, O.N. (2013) Vertebrate Endocrinology. Kumar, V. Biological Rhythms. Delhi: Narosa Publishing House, 2002 3) Dunlap J.C. et al. Chronobiology: Biological Timekeeping. Sunderland, MA, USA: Sinauer Associates, Inc. Publishers, 2004 4) Saunders, D.S. Insect Clocks. New York, USA: Barenz and Noble Inc. 2002 5) Nessar Ahmed, Maureen Dawson, Chris Smith, Ed Wood. 2006. Biology of Disease; Taylor & Francis; 1st edition					

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Master of Science: Regular					
Year	II	ZOL2306C06 Practical – X: Developmental Biology and Neurobiology		Credit	2
Semester	III			Hours	30
OBJECTIVES : 1. This course is designed to provide comprehensive understanding of the concepts of early animal development. 2. The practical are designed to develop necessary skillsets required for better understanding of principles underlying animal development. 3. To understand the structure and function of brain and have an exposure to improved methods to study it. 4. To introduce the basics of the nervous system of invertebrates and then towards a more complex vertebrate nervous system. 5. The students will get exposure on laboratory analysis of sensory and cognitive performances.					
COURSE CONTENT / SYLLABUS					
Developmental Biology and Neurobiology		1. Drosophila culture, study development, cuticle preparation of Drosophila larva, sexual dimorphism 2. Temporary mounting of chick embryo using filter paper ring method, identify stages of development 3. Embryonic development in <i>Danio rerio</i> 4. To study various stages of epimorphic regeneration in sailfin molly (<i>Poecilia latipinna</i>) 5. To study epimorphic regeneration in house Gecko (<i>Hemidactylus flaviviridis</i>) 6. Study of cockroach sensory nerves 7. Neural development in zebrafish 8. Brain anatomy and histology (comparative account) 9. Computer simulation of neural activity 10. Psychophysical measurements of human sensory and cognitive performance			2
REFERENCES					
1.	Michael J.F. Barresi and Scott F. Gilbert (2019). Developmental Biology (12th edition). Sinauer				
2.	Wolpert, L. (2007) Principles of Developmental Biology (3rd edition). Oxford University Press				
3.	Gerhart, J. et al. (1997) Cells, Embryos and Evolution. Blackwell Science				
3.	Byrne, J.H.; Heidelberg, R. and Waxham, M.N. (2014) From Molecules to Networks: An Introduction to Cellular and Molecular Neuroscience.				
4.	Baer, M.F. and Connors B.W. (2015) Neuroscience: Exploring the brain.				
5.	Simmons, J. and Young, D. (2003) Nerve Cells and Animal Behaviour (2 nd edition) Peter. CUP.				

Semester II

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Master of Science: Regular					
Year	II	ZOL2307C07 Practical – XI: Animal Biotechnology and Immunology		Credit	2
Semester	III			Hours	60
OBJECTIVES:					
1. Understand the function of restriction enzymes and explain how they are used in recombinant DNA technology 2. Learn PCR-based method which can be employed to detect the known SNPs 3. Practicals covered under Immunology will provide the students with the fundamental knowledge of the immune system, immunoassays, potential pathogen detection assays, and role of cytokines in disease biology.					
COURSE CONTENT / SYLLABUS					
Animal Biotechnology and Immunology		1. Restriction Mapping 2. Restriction digestion and analysis 3. Plasmid isolation and Cloning 4. DNA fingerprinting 5. Allele specific PCR 6. Anatomy and Histology of immune organ (primary and secondary) 7. PCR based detection of potential pathogens 8. Detection of cytokines/chemokines through ELISA 9. Demonstration of Western blotting immunoassay 10. Bacterial clearance assay			2
REFERENCES					
1.	Molecular Cloning: A laboratory Manual by Green and Sambrook, Cold Spring Harbor Laboratory Press				
2.	Immunology - An Introduction, 4th edition – Tizzard.				
3.	Basic and Clinical Immunology 5th edition- Stites, Stobo, H. H. Fudenberg				

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Master of Science: Regular					
Year	II	ZOL2308C08: General and Applied Toxicology-I	Credit	3	
Semester	III		Hours	60	
OBJECTIVES:		1. Understand the effect of toxicant that affects the entire body or many organs 2. Study different metabolic process that takes place to facilitate the excretion of both exogenous and endogenous substances			
COURSE CONTENT / SYLLABUS					
UNIT-I	1. History, scope, principles of toxicology 2. Toxicokinetics 3. Biotransformation			1	
UNIT-II	1. Toxic responses of liver 2. Toxic responses of lung 3. Toxic responses of kidney			1	
UNIT-III	1. Neurotoxicology 2. Reproductive toxicology 3. Developmental toxicology			1	
REFERENCES					
1.	Casarett & Doull's Essentials of Toxicology by Curtis D. Klaassen, John B. Watkins				
2.	Principles of Toxicology by Karen Stine, Thomas M. Brown				
3.	Text Book of Pathology by Harsh Mohan				
4.	Regulatory Toxicology by Shayne C. Gad Taylor & Francis				

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Master of Science: Regular					
Year	II	ZOL2309C09: General and Applied Toxicology-II	Credit	3	
Semester	III		Hours	60	
OBJECTIVES:		1. Understand the effects of environmental agents, e.g. chemicals, metals, dye etc. 2. Effect of xenobiotics as a genotoxicant or carcinogen on animal and public health 3. Incorporate knowledge of collection, processing and evaluation of epidemiological & experimental toxicology data to permit toxicologically based decisions directed towards the protection of health against harmful effects of xenobiotics 4. Study the occupational and industrial xenobiotics on human health			
COURSE CONTENT / SYLLABUS					
UNIT-I		1. Chemical and environmental carcinogen 2. Molecular and immunotoxicology 3. Genotoxicity	1		
UNIT-II		1. Toxicology of Heavy Metals 2. Toxicology of Pesticides and Insecticides 3. Toxicology of Organic Solvents and Dyes	1		
UNIT-III		1. Regulatory Toxicology 2. Analytical Toxicology 3. Occupational and Industrial Toxicology	1		
REFERENCES					
1.	Casarett & Doull's Essentials of Toxicology by Curtis D. Klaassen, John B. Watkins				
2.	Principles of Toxicology by Karen Stine, Thomas M. Brown				
3.	Text Book of Pathology by Harsh Mohan				
4.	Regulatory Toxicology by Shayne C. Gad Taylor & Francis				

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Master of Science: Regular					
Year	II	ZOL2310C10: Practical – XII: General and Applied Toxicology	Credit	2	
Semester	III		Hours	60	
OBJECTIVES :		1. Understand the toxic effect on living organism, dose designing, handling of animal			
		2. Evaluate the toxic effect of xenobiotics on liver and kidney through experiment			
		3. Incorporate experiment-based knowledge to understand altered behavioral response neurotransmitter on exposure of toxicant.			
		4. Integrate knowledge to understand mutagenicity			
COURSE CONTENT / SYLLABUS					
1. Methods of animal housing, handling, dosing, tissue collection and preservation for analysis.				2	
2. Probit analysis, calculation of LC50 and LD50					
3. Liver function tests					
4. Kidney Function tests					
5. Neurobehaviour assays					
6. Neurotransmitter estimation					
7. AMES test to assess the mutagenicity potential of a chemical					
REFERENCES					
1.	Practical Toxicology Evaluation, Prediction, and Risk, Third Edition By David Woolley and Adam Woolley, CRC Press				
2	Toxicology laboratory manual by Govind Pandey & Yash Pal Sahni				
3	Drug Discovery and Evaluation: Pharmacological Assays by Vogel & Vogel				

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Master of Science: Regular					
Year	II	ZOL2311C11: Avian Biology and Wildlife Biology - I		Credit	3
Semester	III			Hours	60
OBJECTIVES:		1. To provide a detailed study of body structure and unique physiology of birds.			
		2. In depth study of Physiography, biogeography and climate of India subcontinent			
		3. Basic idea about wildlife laws, policies for conservation, etc.			
COURSE CONTENT / SYLLABUS					
UNIT-I		1. Avian characteristics, Evolution and flight 2. Avian integuments and thermoregulation 3. Physiology of Digestion and Respiration			1
UNIT-II		1. Physiography, climate and vegetation types of India 2. Biogeographic provinces of India 3. Protected area network in India and wildlife laws			1
UNIT-III		1. Quantitative population ecology 2. Mammals, reptiles and amphibians of India 3. GIS, Remote Sensing and LULC assessments in Wildlife			1
REFERENCES					
1) Avian Biology, Vol. 1-8. Franer, King and Prakes.					
2) Avian Integument, Stetenheim.					
3) Avian Physiology, Sturkie, P. D.					
4) Biology of Reptiles, Vol. 1-13., Lowell Ackerman (Editor)					
5) Birds of Indian Subcontinent, Grimmitte, R., Inskipp, C. and Inskipp, T.					
6) Field Guide to the Indian Mammals, Menon, V.					
7) Forest Ecology, Barnes, B. V. et. al.					
8) Life of Birds (Saunders Series in Organismic Biology), Joel Carl Welty, Luis Felipe Baptista .					
9) Physiology and Biochemistry of Domestic Fowl, Freeman, B. M.					
10) The Book of Indian Reptiles and Amphibians, Daniel, J. C.					

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Master of Science: Regular					
Year	II	ZOL2312C12: Avian Biology and Wildlife Biology - II		Credit	3
Semester	III			Hours	60
OBJECTIVE S:		1. To provide detailed study on physiology and adaptations in birds. 2. To acquaint with basic and applied aspects of ornithology 3. To study wildlife management techniques			
COURSE CONTENT / SYLLABUS					
UNIT-I		1. Physiology of Excretion and Osmoregulation 2. Avian Heart and Physiology of circulation 3. Breeding biology and Reproduction in Birds		1	
UNIT-II		1. Avian brain and sense organs 2. Bird Migration and navigation 3. Economic ornithology and wildlife diseases		1	
UNIT-III		1. Wildlife forensics and conservation genetics 2. Captive breeding and reintroduction 3. Forest Management: Silviculture, mensuration and forest fire		1	
REFERENCES					
1) Avian Biology, Vol. 1-8. Franer, King and Prakes. 2) Avian Integument, Stetenheim. 3) Avian Physiology, Sturkie, P. D. 4) Biology of Reptiles, Vol. 1-13., Lowell Ackerman (Editor) 5) Birds of Indian Subcontinent, Grimmitte, R., Inskipp, C. and Inskipp, T. 6) Field Guide to the Indian Mammals, Menon, V. 7) Forest Ecology, Barnes, B. V. et. al. 8) Life of Birds (Saunders Series in Organismic Biology), Joel Carl Welty, Luis Felipe Baptista . 9) Physiology and Biochemistry of Domestic Fowl, Freeman, B. M. 10) The Book of Indian Reptiles and Amphibians, Daniel, J. C.					

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Master of Science: Regular						
Year	II	ZOL 2313C13: Practical – XIII: Avian Biology and			Credit	2
Semester	III				Wildlife Biology	
OBJECTIVES:		1. Training in field based studies related to avian and wildlife biology 2. Acquainting with handling, dosing and avian anatomy 3. Acquainting with handling, dosing and avian egg				
COURSE CONTENT / SYLLABUS						
Avian Biology and Wildlife biology		1. Bird identification- Topography, Cabinet specimens and field study, types of nests 2. Instrumentation – Range finder, Binoculars, data logger, bat detector, camera trap, audio recorders 3. Techniques- habitat analysis, Census techniques (quadrates, transects, point count) Sampling techniques (software and field based) 4. Avian Anatomy- Bird handling, dosing, blood collection, general anatomy and 5. endocrine glands 6. Avian physiology – Blood (RBC), DNA isolation 7. Avian Egg- Structure, handling and dosing 8. Field studies/institutional visit.				2
REFERENCES						
1) Integrated principals of Zoology, C. P. Hickman, L. S. Roberts, and A. Larson, McGraw Hill Company, New York. 2) Avian Physiology, Sturkie, P. D. 3) Biology of Reptiles, Vol. 1-13., Lowell Ackerman (Editor) 4) Birds of Indian Subcontinent, Grimmitte, R., Inskipp, C. and Inskipp, T. 5) Field Guide to the Indian Mammals, Menon, V. 6) Forest Ecology, Barnes, B. V. et. al. 7) Life of Birds (Saunders Series in Organismic Biology), Joel Carl Welty, Luis Felipe Baptista . 8) Physiology and Biochemistry of Domestic Fowl, Freeman, B. M.						

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Master of Science:Regular					
Year	II	ZOL2401C01: Biomimetics, Zoonotic diseases and Control		Credit	4
Semester	IV			Hours	60
OBJECTIVES:		1. This course will bring attention to some of the processes and methods of establishing principles through observations, experimentation, and constructing models of living organisms. 2. To introduce about zoonotic diseases (zoonoses) and the role that animals play as reservoirs, hosts, and vectors – both locally and globally.			
COURSE CONTENT / SYLLABUS					
UNIT-I		1. Methods of Biomimetics, Biomimetic materials 2. Biomimetic Microengineering, Human Organs-on-Chips 3. Biomimetic Disease model: Intestine 4. Biomimetic Disease model: Lung 1. Biomimetic Disease model: Kidney			1
UNIT-II		1. Biomimetic Disease model: Inflammation 2. Biomimetic Disease model: Cancer 3. Biomimetic Model: Host-Microbiome Ecosystem 4. Potential of microfluidics in regenerative medicine 5. Bioinspired imaging; 3D patterning, nano-devices and sensors			1
UNIT-III		1. Introduction to Zoonotic Disease (Zoonoses) 2. Foodborne zoonoses, Animal Feed and Food Safety 3. Integrated Pest Management 4. Mosquito biology, control and Mosquito-borne diseases 5. Tick Biology, control and Tick-borne diseases			1
UNIT-IV		1. Rodent biology, control and Rodent-borne diseases 2. Bats as reservoirs for disease 3. Vectors and disease surveillance in India 1. Zoonotic disease outbreak, human pandemic, illness investigations			1
REFERENCES					
1.		Biomimicry: A tool for innovation. (2009). Retrieved September 4, 2010, from The Biomimicry Institute website: http://www.biomimicryinstitute.org/about-us/biomimicry-a- tool-for-innovation.html			
2.		Vogel, Steven. Cats’ Paws and Catapults: Mechanical Worlds of Nature and People (2000). W. W. Norton & Company. ISBN: 9780393319903.			
3.		Spillover: Animal infections and the next human pandemic. Quammen, D. (2012). New York: W. W. Norton & Company.			

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Master of Science: Regular						
Year	II	ZOL2402C02: DISSERTATION			Credit	12
Semester	IV				Hours	360
OBJECTIVES:		1. Students will get an exposure to the laboratory environment for gaining hands-on skills on various techniques. 2. They will develop scientific acumen to be carrying out research. 3. It aims to equip the students to develop a hypothesis and enable them to comprehend the results generated so as to achieve meaningful conclusion.				
COURSE CONTENT / SYLLABUS						
1. Pre-dissertation seminar 2. Dissertation thesis work and submission 3. Final Presentation & Defence						12

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Master of Science: Regular					
Year	II	ZOL2403C03: SEMINAR IV		Credit	2
Semester	IV			Hours	30
OBJECTIVES:		1. Students will understand and comprehend a scientific research paper relevant to their chosen dissertation thesis topic and through which they will develop a deeper understanding of the current updates in conceptual and technological advancements in the field.			
		2. This course will also help student better their presentation skills.			
COURSE CONTENT / SYLLABUS					
Research Technique/Research Paper presentation on topics in that is directly related to the Dissertation thesis work opted.					2
REFERENCES					
1.	Best Presentation Software. https://slidebean.com/blog/best-presentation-software-tools				
3.	Presentation Skills for Scientist, Zanders, E., and Macleod, L., Cambridge University Press				

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Master of Science: Regular					
Year	II	ZOL2404C04: Comprehensive Viva Voce		Credit	3
Semester	IV			Hours	45
OBJECTIVES:		1. To assess the student for the understanding and knowledge through the subjects covered in the programme.			
		2. The viva-voce exercise will also help students to develop the effective scientific communication skills required for their future endeavors.			
COURSE CONTENT / SYLLABUS					
Comprehensive understanding of the Theory and Practical course of subjects studied throughout all the semesters.					

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Master of Science: Regular					
Year	II	ZOL2405C05 PRACTICAL-XIV: Research Methodology	Credit	2	
Semester	IV		Hours	60	
OBJECTIVES:		1. To help students in learning the different types of research methods and analysis. 2. To enhance their scientific writing. Abilities. 3. To bring an awareness about all the funding agencies and their funding schemes for science and technology division. 4. This course also aims to develop scientific approach and a research question which will be evaluated through presentation.			
COURSE CONTENT / SYLLABUS					
1. Qualitative Research - Methods and Analysis 2. Quantitative Research - Methods and Analysis 3. Research Writing- Scientific communication 4. Research Writing- Project Proposals				2	
REFERENCES					
1.	The craft of scientific writing by Michael Alley				
2.	Writing Science by Joshua Schimel				
3.	The Scientist’s guide to writing by Stephen B. Heard				

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Master of Science: Regular					
Year	II	ZOL2406C06 PRACTICAL-XV: Regulatory compliances/affairs	Credit	2	
Semester	IV		Hours	60	
OBJECTIVES:		1. The course is designed to acquire the foundation to work within or in variety of areas including medical products development, pharmaceutical formulations, sales, strategic marketing and clinical investigations. 2. It will also give industry level education in field of legal and regulatory issues. 3. The course also focuses on regulatory affairs concept which the Pharma companies must comply to sell their drugs/other entities both domestically and in the international market.			
COURSE CONTENT / SYLLABUS					
1. Regulatory affairs, biologics, Data management, Contract research 2. Pharmaceuticals, pharmacovigilance 3. Quality assurance and quality control, Clinical Trials 4. Professional designation in clinical trials and ethics					2
REFERENCES					
1.		Regulatory Affairs in the Pharmaceutical Industry (2021). Editors: Javed Ali, Sanjula Baboot Paperback ISBN: 9780128222119; eBook ISBN: 9780128222232 (1 st edition).			
2.		Clinical Trials & Human Research - A Practical Guide to Regulatory Compliance Hardcover (2003), by FA Rozovsky (Author)			

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Master of Science: Regular					
Year	II	ZOL2407C07 PRACTICAL-XVI: Experimental models in biomedical research	Credit	2	
Semester	IV		Hours	60	
OBJECTIVES:		1. This course will enable students to perform experiments on animals and isolated cells to understand the principles of genetics. 2. The students will be equipped to solve theoretical problems of classical and microbial genetics. 3. The syllabus will also help students understand the cause and inheritance pattern of the genetic disorders.			
COURSE CONTENT / SYLLABUS					
1. <i>Drosophila/C.elegans</i> culture, maintenance, etc 2. Fish breeding, embryo collection, etc 3. Bird handling, upkeep and dosing 4. Rodent handling, upkeep and dosing				2	
REFERENCES					
1.	Animal Models in Toxicology, 3rd Edition Edited By Shayne C. Gad, Shayne C. Gad, Copyright Year 2016 ISBN: 9781466554283 Published August 25, 2015 by CRC Press				
2.	The Laboratory Rat, 2nd Edition, By Patrick Sharp, Jason S. Villano, Copyright Year 2012, ISBN: 9781439829868, Published February 6, 2013 by CRC Press.				
3.	The Clinical Chemistry of Laboratory Animals, 3rd Edition, Edited By David M. Kurtz, Gregory S. Travlos, Copyright Year 2018. ISBN: 9780367570354 Published June 30, 2020				
4.	Sourcebook of Models for Biomedical Research, 2008, by P. Michael Conn, 9781597452854, 1597452858, Humana Press				
5.	Animal Experimentation: Working Towards a Paradigm Change, 2019; by Kathrin Herrmann, Kimberley Jayne, ISBN:9789004356184, 9004356185, Publisher: Brill				
6.	<i>Drosophila</i> Protocols, 2000; Editors:M. Ashburner, R. Scott Hawley, William Sullivan, ISBN:9780879695866, 0879695862, Cold Spring Harbor Laboratory Press				
7.	<i>C. Elegans</i> : A Practical Approach, Editor: Ian A. Hope, Publisher: ISBN:9780191591983, 019159198X, OUP Oxford				

M.Sc (Final) Zoology REVISED syllabus

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Master of Science: Regular					
Year	II	ZOL2408C08 PRACTICAL-XVII: Computational Biology		Credit	2
Semester	IV			Hours	60
OBJECTIVES:		1. Learn virtual screening on large libraries of compounds, rank the results, and propose structural hypotheses of how the ligands interact the target 2. To increase the understanding of biological processes through computational tools 3. Understand and identify patterns in biological data and allows students to organize large amounts of data			
COURSE CONTENT / SYLLABUS					
1. Computer aided drug design-basic principles, docking, QSAR 2. Phylogenetic analysis in bioinformatics 3. FASTA in bioinformatics 4. Biological databases in Bioinformatics					2
REFERENCES					
1.	Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins by Andreas D. Baxevanis and B. F. Francis Ouellette, Wiley				
2.	Molecular computer-Aided Drug Design Docking for Fundamentals, Techniques, Resources and Applications by Mohane Coumar, Academic Press				
3.	Practical Bioinformatics by Janusz Bujnicki, Springer				