ZOOLOGY

- **M. Sc. in ZOOLOGY**:
  FACULTY OF LIFE SCIENCE
- **FIRST SEMESTER** (ODD SEMESTER)

Eligibility Criteria (Qualifying Exams)	Admission Criteria	Course Code	Course Type	Course (Paper/Subjects)	Credits	Contact Hours Per WeeK			EoSE Duration (Hrs.)	
						L	T	P	Thy	P
Chemistry, Botany, Zoology (CBZ-Group) & Chemistry, Geology, Zoology (CGZ-Group)	1) Merit List 2) Entrance Test (written or/and oral) if decided by the University 3) Observance of Reservation Policy.	ZOO 101	CCC	Systematics, Biodiversity and Evolution	5	4	2	0	3	0
		ZOO 111	CCC	Systematics, Biodiversity and Evolution –Laboratory work	2	00	00	3	0	3
		ZOO 102	CCC	Principles of Ecology	5	4	2	0	3	0
		ZOO 112	CCC	Principles of Ecology-Laboratory Work	2	00	00	3	0	3
		ZOO 103	CCC	Computational Biology, Biostatistics and Bioinformatics	5	4	2	0	3	0
		ZOO 113	CCC	Computational Biology, Biostatistics and Bioinformatics--Laboratory Work	2	00	00	3	0	3
		ZOO S01	OSC	RESEARCH METHODOLOGY & COMPUTER APPLICATION: BASICS	6	4	3	00	3	00
		ZOO A01	ECC/CB	CONSTITUTIONALISM & INDIAN POLITICAL SYSTEM	6	4	3	00	3	00
		ZOO A02	ECC/CB	Entomology- Insect Diversity, Society and Evolution Theory						
		ZOO A03	ECC/CB	EMTOMOLOGY- Insect Physiology, Toxicology & Vector Biology						
		ZOO A04	ECC/CB	ENTOMOLOGY- **Pest Ecology & Agricultural Entomology**						
					TOTAL= 33					

M.Sc. (ZOOLOGY)			**IST SEMESTER**
COURSE CODE: ZOO 101			**COURSE TYPE: CCC**
COURSE TITLE: Systematics, Biodiversity and Evolution			
CREDIT:7		**HOURS:135**	
THEORY: 5	**PRACTICAL:2**	**THEORY:90**	**PRACTICAL: 45**
MARKS			
THEORY: 100 (30+70)		**PRACTICAL:33**	

OBJECTIVE: This course is aimed towards generating fundamental knowledge , concepts related to Systematics, Biodiversity and Evolution.

UNIT-1- ***18 Hours***	An overview of evolutionary biology, concept of organic evolution during pre- and post- Darwin era; evolution and molecular biology- a new synthesis; from molecules to life, life originated from RNA, introns as ancient component of genes.
UNIT-2- ***18Hours***	The universal common ancestor and tree of life, three domain concept of living kingdom; molecular phylogeny– history, terms, definition and limitations, construction of phylogenetic trees using molecular data, construction of phylogenetic trees by using 16S rRNA gene sequences and concept of speciation in bacteria.
UNIT-3- ***18 Hours***	Molecular divergence and molecular clocks and molecular drive; complication in inferring phylogenetic trees; origin and diversification of bacteria and archea; diversification of genomes; the nature of bacterial and archeal genomes; origin of genomes by horizontal gene transfer; role of plasmid, transposons, integrons and genomic islands in DNA transfer.
UNIT-4- ***18Hours***	Origin and diversification of eukaryotes- origin of cells and first organisms; early fossilized cells; evolution of eukaryotic cell from prokaryotes- a case of symbiosis; evolution of eukaryotic genomes; gene duplication and divergence.

UNIT-5- ***15Hours***	Mode of speciation- factors responsible for speciation; tempo of evolution; systematics- definition and role in biology, biological classification- theories and objectives, types of taxonomy, taxonomic diversity- definition and types, origination and extinction, rates of change in origination and extinction, causes of extinction, causes of differential rates of diversification, current status and future of biodiversity; human evolution- human evolutionary history; placing humans on tree of life; genomics and humanness; current issues in human evolution.
LABORATORY WORK (ZOO111)	1. Isolation of Genomic DNA from a bacterium and its quantification. 2. Designing primers for 16S rRNA gene sequence. 3. Amplification of 16S rRNA gene sequences by using genomic DNA as well as by colony boiling method. 4. Purification of 16S rRNA gene. 5. Sequence of 16S rRNA gene; editing the sequence, multiple alignments, construction of phylogenetic trees and interpretation of results. 6. Dot blot hybridization of different eubacterial species and interpretation of results.

SUGGESTED READINGS	1. *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 2. *Evolution*, Hall, B. K. and Hallgrimsson, B., Jones and Bartlett Publisher, Sudbury, USA 3. *Evolution*, Futuyma, D. J., Sinauer Associates, Inc., Sunderland, USA 4. *What Evolution Is*, Mayr, E., (2001), Basic Books, New York, USA

M.Sc (ZOOLOGY)			IST SEMESTER
COURSE CODE: ZOO 102			**COURSE TYPE: CCC**
COURSE TITLE: Principles of Ecology			
CREDIT:7		**HOURS:135**	
THEORY: 5	**PRACTICAL:2**	**THEORY:90**	**PRACTICAL:45**
MARKS			
THEORY: 100(30+70)		**PRACTICAL:33**	

OBJECTIVE: The purpose of the course is to make the students to understand various ecological principles and factors that determine the size and number of population that can co-exist within a specific area. This knowledge is crucial for better development and management of natural resources and global environment.

UNIT-1- *18Hours*	Introduction to ecology, evolutionary ecology, environmental concepts – laws and limiting factors, ecological models. Characteristics of population, population size and exponential growth, limits of population growth, population dynamics, life history pattern, fertility rate and age structure. Competition and coexistence, intra-specific and inter-specific interactions, scramble and contest competition model, mutualism and commensalism, prey-predator interactions.
UNIT-2- *-18Hours*	Nature of ecosystem, production, food webs, energy flow through ecosystem, biogeochemical cycles, resilience of ecosystem, ecosystem management. The biosphere, biomes and impact of climate on biomes.
UNIT-3- *18Hours*	Environmental Stresses and their management, global climatic pattern, global warming, atmospheric ozone, acid and nitrogen deposition, coping with climatic variations. Major classes of contaminants. Uptake

UNIT-4- *18Hours*	Biotransformation, detoxification, elimination and accumulation of toxicants. Factors influencing bioaccumulation from food and trophic transfer. Pesticides and other chemical in agriculture , industry and hygiene and their disposal. Impact of chemicals on biodiversity of microbes, animals and plants. Bioindicator and biomarkers of environmental health. Biodegradation and bioremediation of chemicals.
UNIT-5 *18Hours*	Biodiversity – assessment, conservation and management, biodiversity act and related international conventions. Sustainable development, natural resource management in changing environment. Molecular ecology, genetic analysis of single and multiple population, phylogeography, molecular approach to behavioural ecology, conservation genetics.
LABORATORY WORK (ZOO112)	**Habitat studies:** 1. Physical and chemical characteristics of soil. 2. Assessing influence of light, temperature and moisture on plant germination and growth/animal behavior and growth. 3. Assessing influence of soil nutrient status on plant germination and growth. **Community/ecosystem studies:** 1. Assessment of density, frequency and abundance of plants/animal in a community using various techniques i.e. transect, quadrate etc. 2. Comparison of stands/communities and ordination. 3. Profile diagrams. 4. Biomass and reproductive allocation under various environments. 5. Nutrient uptake and budget for various communities/Food chain assessment. 6. Decomposition of various organic matters and nutrient release mechanisms/role of arthropods and other micro-, and macrofauna in decomposition. 7. Understanding ecosystem succession by studying various stages of vegetation/community assemblages development. 8. Molecular techniques in laboratory. 9. Insect diversity in soil. **Landscape studies:** 1. Principles of GIS, GPS and RS technology. 2. Interpretation (visual and automated) of remote sensing information for landscape differentiation.

SUGGESTED READINGS	1. *Field Sampling: Principles and Practices in Environmental Analysis*, Conklin, A.R. Jr., (2004), CRC Press. 2. *Principles and Standards for Measuring Primary Production*, Fahey, T.J. and Knapp, A.K., (2007), Oxford University Press, UK 3. *Ecological Modeling*, Grant, W.E. and Swannack, T.M., (2008), Blackwell. 4. *Fundamental Processes in Ecology: An Earth system Approach*, Wilkinson, D.M., (2007), Oxford University Press, UK. 5. Animal Ecology, Ranga M.M., Agrobios, Jodhpur, India

<table>
<tr><td colspan="2">M.Sc (ZOOLOGY)</td><td colspan="2">IST SEMESTER</td></tr>
<tr><td colspan="2">COURSE CODE: ZOO103</td><td colspan="2">COURSE TYPE: CCC</td></tr>
<tr><td colspan="4">COURSE TITLE: Computational Biology, Biostatistics and Bioinformatics</td></tr>
<tr><td colspan="2">CREDIT:7</td><td colspan="2">HOURS:135</td></tr>
<tr><td>THEORY: 5</td><td>PRACTICAL:2</td><td>THEORY: 90</td><td>PRACTICAL: 45</td></tr>
<tr><td colspan="4">MARKS</td></tr>
<tr><td colspan="2">THEORY: 100 (30+70)</td><td colspan="2">PRACTICAL: 34</td></tr>
<tr><td colspan="4">OBJECTIVE: The Purpose of this course is to make the students to understand computational biology- Bioinformatics & Biostatistics</td></tr>
<tr><td>UNIT-1-
20 Hours</td><td colspan="3">Basic components of computers– hardware (CPU, input, output, storage devices), Software (operating systems), Application software; Introduction to MSEXCEL- use of worksheet to enter data, edit data, copy data, move data; Use of in- built statistical functions for computations of mean, S. D., correlation, regression coefficients etc., Use of bar diagram, histogram, scatter plots, etc., Graphical tools in EXCEL for presentation of data; Introduction to MS- WORD word processor- editing, copying, moving, formatting, table insertion, drawing flow charts etc; Introduction to Power Point, image and data handling.</td></tr>
<tr><td>UNIT-2-
15 Hours</td><td colspan="3">Biostatistics- population, sample, variable, parameter, primary and secondary data, screening and representation of data, frequency distribution, tabulation, bar diagram, histograms, pie diagram, mean, median, mode, quartiles and percentiles, variance, standard deviation, coefficient of variation; Probability and distributions- definition of probability (frequency approach), independent events. Addition and multiplication rules,</td></tr>
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UNIT-3- ***15 Hours***	Conditional probability, examples- bernoulli, binomial, poisson and normal distributions; bivariate data- scatter plot, correlation coefficient (r), properties (without proof), interpretation of r, linear regression: Fitting of lines of regression, regression coefficient, coefficient of determination; hypothesis, critical region, and error probabilities, tests for proportion, equality of proportions, equality of means of normal populations when variances known and when variances are unknown: chi-square test for independence, P- value of the statistic, confidence limits, introduction to one way and two- way analysis of variance.
UNIT-4 ***-20 Hours***	The era of computerized biology information, review of relevant definitions in molecular biology, overview of challenges of molecular biology computing, proteins, secondary structure and folding, RNA secondary structures, introduction to phylogenetic analysis; introduction to bioinformatics; introduction to genomics and proteomics databases- nucleic acid sequence database: Genbank, UCSC, ENSEMBL, EMBL, DDBJ, protein sequence databases: Swiss- prot, PDB, BLAST, PSI- BLAST (steps involved in use and interpretation of results) and HMMER, BLAST vs FASTA, file formats- FASTA, GCG and ClustalW.
UNIT-5- ***20- Hours***	Databank search- data mining, data management and interpretation, multiple sequence alignment, genes, primer designing; Protein modeling, protein structure analysis, docking, ligplot interactions, phylogenetic analysis with the program PHYLIP, DISTANCES, GROWTREE etc.; introduction to computational genomics and proteomics- basics of designing a microarray, image analysis and normalization, annotations, protein prediction tools- protein secondary structure, molecular modeling, identification and characterization of protein mass fingerprint, world- wide biological databases, Introduction to programming languages such as “C”.

LABORATORY WORK (ZOO 113)	1. Use of excel sheet for data processing. 2. Use of search engines like Scopus, Science direct for reference material collection and management. 3. Nucleic acid and protein sequence databases. 4. Data mining for sequence analysis. 5. Web– based tools for sequence searches and homology screening. 6. Primer designing for gene amplification and gene cloning. 7. Annotations: ORF finder, Use of ARTEMIS or any other suitable software. 8. Construction of phylogenetic trees for DNA and proteins. 9. Introduction to microarray technology. 10. Identification of peptide finger print by nano LC- MS/MS and database search using MASCOT and OMSSA.
SUGGESTED READINGS	1. *Principles of Biostatistics*, Pagano M., Gauvreau, K, (2000), Duxbury Press, USA 2. *Bioinformatics for Dummies*, Claverie J. M., Notredame C., (2nd Ed., 2007), Wiley Publishing, Inc., New York, USA 3. *Bioinformatics: Sequence and Genome Analysis*, Mount, D. W. (2nd Ed., 2001), Cold Spring Harbor Laboratory Press, New York, USA. 4. Animal Ecology, Ranga M.M., Agrobios, Jodhpur, India

M.Sc (ZOOLOGY)	**IST SEMESTER**
COURSE CODE:ZOOS 01	**COURSE TYPE: OSC**
COURSE TITLE:RESEARCH METHODOLOGY & COMPUTER APPLICATION: BASICS	
CREDIT: 06 **THEORY: 06**	**HOURS : 90** **THEORY: 90**
MARKS : 100 **THEORY: 70 CCA : 30**	

OBJECTIVE:

- Understands the concept and place of research in concerned subject
- Gets acquainted with various resources for research
- Becomes familiar with various tools of research
- Gets conversant with sampling techniques, methods of research and techniques of analysis of data
- Achieves skills in various research writings
- Gets acquainted with computer Fundamentals and Office Software Package .

UNIT - 1 15 Hrs	**CONCEPT OF RESEARCH :** Meaning and characteristics of research , Steps in research process , Types of research - i) Basic, applied and action research ii) Quantitative and qualitative research , Areas of research in concern discipline **SELECTION OF PROBLEM FOR RESEARCH :** Sources of the selection of the problem , Criteria of the selection of the problem ,Drafting a research proposal , Meaning and types of variables ,Meaning and types of hypotheses.
UNIT - 2 15 Hrs	**TOOLS OF RESEARCH :** Meaning and general information about construction procedure of (i) Questionnaire, (ii) Interview, (iii) Psychological test, (iv) observation (v) Rating scale (vi) Attitute scale and (vii) check list , Advantages and disadvantages of above tools **SAMPLING :** Meaning of population and sample , Importance and characteristics of sample , Sampling techniques - i) Probability sampling : random sampling, stratified random sampling, systematic sampling, cluster sampling ii) Non-probability sampling: incidental sampling, purposive sampling, quata sampling
UNIT - 3 15 H rs	**METHODS OF RESEARCH** Meaning and conducting procedure of following methods of research : Historical method , Survey method , Case study , Causal comparative method , Developmental methods , Experimental methods

UNIT - 4 **15 Hrs**	**TREATMENT OF DATA :** Level of measurements of data , Steps in treatment of data: editing, coding, classification, tabulation, analysis and interpretation of results **WRITING RESEARCH REPORT :** Sections of report : Preliminary section , Content section : various chapters , Supplementary section : appendices, references, abstract , Format and style
UNIT - 5 **15 Hrs**	**Computer Fundamentals** **Computer System :** Features, Basic Applications of Computer, Generations of computers. **Parts of Computer System :** Block Diagram of Computer System ; Central Processing Unit (CPU) ; Concepts and types of Hardware and Software, Input Devices - Mouse, Keyboard, Scanner, Bar Code Reader, track ball ; Output Devices - Monitor, Printer, Plotter, Speaker ; Computer Memory - primary and secondary memory, magnetic and optical storage devices. **Operating Systems - MS Windows :** Basics of Windows OS ; Components of Windows - icons, taskbar, activating windows, using desktop, title bar, running applications, exploring computer, managing files and folders, copying and moving files and folders ; **Control panel :** display properties, adding and removing software and hardware, setting date and time, screensaver and appearance ; **Windows Accessories :** Calculator, Notepad, WordPad, Paint Brush, Command Prompt, Windows Explorer.
UNIT - 6 **15 Hrs**	**Office Software Package** **Word Processing - MS Word :** Creating, Saving, Opening, Editing, Formatting, Page Setup and printing Documents ; Using tables, pictures, and charts in Documents ; Using Mail Merge sending a document to a group of people and creating form, letters and label. **Spreadsheet - MS Excel :** Opening a Blank or New Workbook, entering data/Function/ Formula into worksheet cell, Saving, Editing, Formatting, Page Setup and printing Workbooks. **Presentation Software - MS Power Point :** Creating and enhancing a presentation, modifying a presentation, working with visual elements, adding Animations & Transitions and delivering a presentation.

SUGGESTED READINGS	
	Agrawal, Y. P. (1988). ***Better sampling : Concepts, Techniques and Evaluation.*** *New Delhi : sterling Publishers Private Ltd. Best, J. W. (1993).* ***Research in Education*** *(6th ed.) New Delhi : Prentice-Hall of India Pvt. Ltd. Broota, K. D. (1992)* ***Experimental design in Behavioral Research*** *(2nd ed.) New Delhi : Wiley Eastern Limited. Dasgupta, A. K. (1968).* ***Methodology of Economic Research****. Bombay: Asia Publishing House. Edwards, A. L. (1957).* ***Techniques of Attitude Scale construction.*** *New York : Appleton-Contury Gall, M. D., Gall, J. P. and Borg, W. R. (2007).* ***Educational Research : An introduction*** *(8th ed.) Coston : Allyn and Bacon. Garrett, H. E. & Woodworth, R. S. (1969).* ***Statistics in Psychology and Education****. Bombay : Vakils, Fecffer & Simons Pvt. Ltd. Goode, W. J. & Hatt, Paul K. (1952).* ***Methods in Social Research.*** *New York : McGraw-Hill. Gopal, M. H. (1964).* ***An Introduction to research Procedure in Social Sciences.*** *Bombay : Asia Publishing House. Hillway, T. (1964)* ***Introduction to Research (2nd ed.)*** *Noston : Houghton Miffin. Hyman, H. H., et al. (1975****). Interviewing in Social Research.*** *Chicago : University of Chicago Press. Kerlinger, F. N. (1983)* ***Foundation of Behavioural Research. (2nd Indian Reprint)*** *New York : Holt, Rinehart and Winston. Kothari, C. R. (2007)* ***Research Methodology: Methods & Techniques*** *(3rd ed.) New Delhi : Wishwa Prakashan. Fundamentals Of Computers, Dr. P. Mohan, Himalaya Publishing House. Microsoft First Look Office 2010, K. Murray, Microsoft Press. Fundamental Of Research Methodology And Statistics, Y.K. Singh, New Age International (P) Limited, Publishers.Practical Research Methods, Dr Catherine Dawson, The Essence Of Research Methodology, Jan Jonker & Bartjan Pennink, Springer.*

M.Sc (ZOOLOGY)	IST SEMESTER
COURSE CODE:ZOOA 01	**COURSE TYPE: ECC**
COURSE TITLE: CONSTITUTIONALISM & INDIAN POLITICAL SYSTEM	
CREDIT: 06 **THEORY: 06**	**HOURS : 90** **THEORY: 90**
MARKS : 100 **THEORY: 70 CCA : 30**	

OBJECTIVE:

- Understands the concept of Constitutionalism
- Gets acquainted with various Indian Political System
- Becomes familiar with various Union Executive
- Gets conversant with Legislatures, Legislative Bills
- Achieves skills in various writings

UNIT - 1 12 Hrs	Unit- I: Meaning: Constitution, Constitutional government & constitutionalism; Difference between Constitution & Constitutionalism; Constitutionalism: Basis, Elements, Features & future. Forms of Government: Democracy & Dictatorship, Unitary & Federal, Parliamentary & Presidential form. Ideals of the Indian Constitution incorporated in the Preamble. Special Features of the Indian Constitution.
UNIT - 2 24 Hrs	Unit-II: Concept of State and Citizenship, Judicial Review and Fundamental Rights, Directive Principles of the State Policy, Fundamental Duties, Procedure to Amend the Indian Constitution, Judiciary: Supreme Court and High Court, Judicial Activism and Public Interest Litigation and Provisions relating to Emergency.
UNIT - 3 10 **H rs**	Unit-III: Union Executive- President, Prime Minister, Council of Ministers. State Executive- Governor, Chief Minister and Council of Ministers. Local Bodies & Panchayati Raj
UNIT - 4 24 **Hrs**	Unit-IV: Parliament of India, State Legislatures, Legislative Bills: Ordinary, Money and Financial, Union State Relations, Principles of the 'Separation of Power and the 'Principles of Check & Balance'. Political Parties and Pressure Groups. Challenges before Indian Democracy: Terrorism, Regionalism, Communalism, *Linguistics* and National Integration.
UNIT - 5 20 **Hrs**	Unit-V: Controller & Accountant General of India, Solicitor General, Advocate General, Election Commission, Union and State(s) Public Service Commission, Finance Commission.

SUGGESTED READINGS	
	HOBBES, Thomas, The Leviathan, Chapters XIII & XVII [entry] LOCKE, John, The Second Treatise of Civil Government, Chapter IX [entry] ROUSSEAU, Jean-Jacques, The Social Contract or Principles of Political Right MONTESQUIEU, The spirit of the laws, RAZ, Joseph, "The rule of law and its virtue", in The authority of law, Oxford University Press, 1979 Dicey on British constitution P. Ishwara Bhat Inter-relationship between Fundamental Rights M P Jain Indian Constitutional Law H M Seervai Constitutional Law of India V N Shukla Constitution of India D DBasu Shorter Constitution of India B Sivarao Constitutional Assembly Debates J. V R Krishna Iyer Fundamental Rights and Directive Principles Paras Diwan Human Rights and the Law P K Tripathi Some Insight into Fundamental Rights S P Sathe Fundamental Rights and Amendment to the Constitution P B Gajendragadkar Law, Liberty and Social Justice David Karrys Politics of Law

M.Sc (ZOOLOGY)			IST SEMESTER
COURSE CODE: ZOO A02			**COURSE TYPE: ECC/CB**
COURSE TITLE: **Entomology- Insect Diversity, Society and Evolution Theory**			
CREDIT:6		**HOURS:90**	
THEORY: 6	**PRACTICAL:0**	**THEORY: 90**	**PRACTICAL: 0**
MARKS			
THEORY: 100(30+70)		**PRACTICAL:0**	
OBJECTIVE: This course is aimed towards generating fundamental knowledge of insects diversity society and evolution theory.			
UNIT-1- *18-Hours*	Morphology: external features and their articulation. Comparative study of head-antennae, mouth parts; thorax – legs, wings; abdominal appendages, genitalia		
UNIT-2- *18 Hours*	Taxonomy- historical development of classification of insect, basis of insect classification; classification of insects up to sub orders and up to super families in economical important groups; fossil history, origin and evolution of insects		
UNIT-3- *18 Hours*	Insect Society: group of social insects and their social life; evolution of sociality; social organization and social behaviour in honey bee, ants, termites and wasps		
UNIT-4- *18-Hours*	Insect Plant Interaction - Theory of co-evolution, role of allelochemicals in host plant mediation, tritrophic interaction, host-plant selection by phytophagous insects, establishment of insect population on a plant surface.		
UNIT-5- *18 Hours*	Forensic Entomology: Introduction, forensically important insects, collection of data from cadaver site, interpretation of data for predicting time and cause of death.		

SUGGESTED READINGS	1.*A general text book of entomology,* Imms , A. D., Chapman & Hall, UK 2. *Introduction to the study of insects,* Borror, D. J., Triplehorn, C. A., and Johnson, N. F.,M Saunders College Publication, USA 3. *Principles of Insect Morphology,* Snodgrass, R. E., Cornell Univ. Press, USA 4. *The Insect Societies*, Wilson, E. O., Harward Univ. Press, UK 5. *Host Selection by Phytophagous insects*, Bernays, E. A., and Chapman, R. F., Chapman and Hall, New York, USA 6. *Insect Plant Biology*, Schoonhoven, L. M., van Loop, J. A., & Dicke. M. Pub. Oxford Univ. Press. USA

M.Sc (ZOOLOGY)		IST SEMESTER	
COURSE CODE: ZOO A03		**COURSE TYPE: ECC/CB**	
COURSE TITLE: **EMTOMOLOGY- Insect Physiology, Toxicology & Vector Biology**			
CREDIT:6		**HOURS:90**	
THEORY: 6	**PRACTICAL:0**	**THEORY:90**	**PRACTICAL: 0**
MARKS			
THEORY: 100 (30+70)		**PRACTICAL-0**	
OBJECTIVE: This course is aimed towards generating fundamental knowledge concepts related to insect physiology toxicology and vector biology			

UNIT-1- *20-Hours*	Structure and physiology of integumentary, digestive, excretory, circulatory, respiratory, endocrine, reproductive, and nervous system. Sensory receptors. Growth, metamorphosis and diapause in insect.
UNIT-2- *20-Hours*	Definition of pesticides, brief history, pesticides registration, pesticide industries and markets. Dose-response relationship; mode of action of insecticide, carcinogenic, mutagenic and teratogenic effects, and evaluation of toxicity
UNIT-3- *15- Hours*	Group characteristics of insecticide, structure and function of organochlorine, organophosphorus, carbamate, pyrethrod, other plant origin as well as bio-insecticides, neonicotinoids and nitrogenous insecticides, fumigants, IGRs. Metabolism or degradation of pesticides - phase I and phase II reactions. Insecticide resistance and health hazards.
UNIT-4- *15 Hours*	Introduction to vector biology, economic importance and control of fleas, lice, bugs, mosquitoes, flies and parasitoids.
UNIT-5- *20 Hours*	Vector-parasite interaction; host-pathogen interaction, Insect transmitting bacteria and viruses of medical, veterinary and agricultural importance; control of insect vector.

SUGGESTED READINGS	1. *The Insects: Structure and functio*n, Chapman, R. F., Cambridge University Press, UK 2. *Physiological system in Insects*, Klowden, M. J., Academic Press, USA 3. *The Insects, An outline of Entomology*, Gullan, P. J. , and Cranston, P. S., Wiley Blackwell, UK 4. *Insect Physiology and Biochemistry*, Nation, J. L., CRC Press, USA 5. *Toxicology and Risk Assesssment: A Comprehensive Introduction*, Greim H., and Snyder, R. (ed), John Wiley and Sons, UK 6. *The Complete Book of pesticide management*, Whitford, F., Wiley Interscience, John Wiley and Sons, UK 7. *Safer Insecticides*, Hodgson, E., and Kuhr, R. J., (ed), Marcel Dekker Inc., New York, USA 8. *Pesticide Application Methods*, Matthews, G, A., Blackwell Science, London, UK 9. *Pesticide Biochemistry and Physiology*, Wilkinson, C. F., Plenum Press, New York, UK 10. *Metabolic pathways of agrochemicals Part II*, Roberts, T. R., and Hutson, D. H. The Royal Society of Chemistry, UK 11. *Medical and Veterinary Entomology* Mullen, G. , Durden, L., Academic Press, USA 12. *Medical and Veterinary Entomology*, Kettle, D. S., Cabi Press, USA 13. *Medical Entomology for students, Service,* M. Cambridge University Press, UK

M.Sc (ZOOLOGY)			IST SEMESTER
COURSE CODE: ZOO A04			**COURSE TYPE: ECC/CB**
COURSE TITLE: ENTOMOLOGY- **Pest Ecology & Agricultural Entomology**			
CREDIT:6		**HOURS:90**	
THEORY: 6	**PRACTICAL:0**	**THEORY: 90**	**PRACTICAL: 0**
MARKS			
THEORY: 100 (30+70)		**PRACTICAL:0**	

OBJECTIVE: This course is aimed towards generating fundamental knowledge concepts related to pest ecology and agricultural entomology

UNIT-1- *25-Hours*	Pest - definition and its ecology, pest status, features responsible for evolutionary success of insect species, factors responsible for achieving the status of pest, Economic injury level, economic threshold, action threshold, pest spectrum, pest complex, carrying capacity, secondary pest out break, pest surveillance and sampling.
UNIT-2- *15-Hours*	Population dynamics of pests - agro-ecosystem, phases of population fluctuation, models of population growth, factors for population fluctuation, population size and regulatory mechanisms.
UNIT-3- *20-Hours*	Identification, seasonal history, biology, nature of damage and control measures of pests, of cereals, pulse crops, cotton, vegetables (summer vegetable and winter vegetable), oil seeds, fruit crops, sugarcane and stored grains. Locust- different species and phases, phase transition, periodicity, migration, biology and control measures
UNIT-4- *15 Hours*	Integrated Pest Management: history, different phases of pest control, Quarantine, Physical, Cultural, Chemical, Biological control and, genetic and biotechnological methods of control. Pheromones- production, and their use in pest surveillance and management

UNIT-5- *15 Hours*	Plant resistance to insects: types of resistance, mechanism of resistance-antibiosis, antixenosis, tolerance, factors mediating resistance, JH Mimics & MH-agonist. Transgenic plants: history, *Bacillus thuriengensis* and its mode of action on insect, different sub species of *Bt* , development of *Bt* plant by recombinant DNA technology, resistance management of *Bt* crop, prospective and controversies of *Bt* crop.
SUGGESTED READINGS	1.*Ecology of insects*, Speight, M. R., Hunter, M. D., & Watt, A. D., Wiley-Blackwell, UK 2. *Insect Plant Biology*, Schoonhoven, L. M., van Loon, J.A., & Dicke, M., Publisher Oxford University Press, USA 3. *Interrelationship between insects and Plants*, Jolivet, P., CRC Press, USA 4. *Chemical Ecology of Insects*, Carde, R. T., and Bell, W. J., Chapman & Hall, New York, USA 5. *Entomology & Pest Management*, Pedigo, L. P.,Prentice Hall, New Jersey, USA 6. *Concepts of IPM*, Norris, Caswell-Chen and Kogan, Prentice-Hall, USA 7. *Agricultural insects pests of the tropics and their control*, Hill, D. S., Cambridge University Press, UK

- **M. Sc. in ZOLOGY**
  FACULTY OF LIFE SCIENCE
- **SECOND SEMESTER** (EVEN SEMESTER)

Eligibility Criteria (Qualifying Exams)	Course Code	Course Type	Course (Paper/Subjects)	Credits	Contact Hours Per WeeK			EoSE Duration (Hrs.)	
					L	T	P	Thy	P
After appearing in the First semester examination irrespective of any number of back/ arrear papers	ZOO 201	CCC	Genetics and Cytogenetics	5	4	2	00	3	00
	ZOO 211	CCC	Genetics and Cytogenetics- LABORATORY WORK	2	00	00	3	00	3
	ZOO202	CCC	Principles of Gene Manipulation	5	4	2	00	3	0
	ZOO 212	CCC	Principles of Gene Manipulation - LABORATORY WORK	2	00	00	3	00	3
	ZOO 203	CCC	Structure and Function of Genes	5	4	2	00	3	0
	ZOO213	CCC	Structure and Function of Genes -LABORATORY WORK	2	00	00	3	00	3
	ZOO221	PRJ/FST/EST	SOCIAL OUTREACH AND SKILL DEVELOPMENT	6	00	00	9	00	4
	ZOO B01	ECC/CB	ENVIRONMENTAL AND FOREST LAWS	6	4	3	00	3	00
	ZOO B02	ECC/CB	**Fish Biology** - Evolution and Functional Anatomy of Fish						
	ZOO B03	ECC/CB	**Fish Biology** - Aquatic Resources and Their Conservation-						
	ZOO B04	ECC/CB	**Fish Biology** - Aquaculture						
				TOTAL= 32					

M.Sc(ZOOLOGY)			IIND SEMESTER
COURSE CODE: ZOO 201			**COURSE TYPE: CCC**
COURSE TITLE: Genetics and Cytogenetics			
CREDIT:7		**HOURS:135**	
THEORY: 5	**PRACTICAL:2**	**THEORY: 90**	**PRACTICAL:45**
MARKS			
THEORY: 100 (30+70)		**PRACTICAL:33**	

OBJECTIVE: This course is aimed towards generating fundamental knowledge, concepts related to genetics and cytogenetics.

UNIT-1- 15 *Hours*	Mendel's laws and their chromosomal basis; extension of Mendel's principles: allelic variation and gene function- incomplete dominance and co-dominance, allelic series, testing gene mutations for allelism; gene action- from genotype to phenotype– penetrance and expressivity, gene interaction, epistasis, pleiotropy
UNIT-2- 25 *Hours*	Nature of the gene and its functions: evolution of the concept of the gene, fine structure of gene (rII locus); methods of gene mapping: 3- point test cross in *Drosophila*, gene mapping in humans by linkage analysis in pedigrees.
UNIT-3- *15 Hours*	Gene mutation and DNA repair: types of gene mutations, methods for detection of induced mutations, P- element insertional mutagenesis in *Drosophila*, DNA damage and repair; regulation of gene activity in *lac* and *trp* operons of *E. coli*, general introduction to gene regulation in eukaryotes at transcriptional and posttranscriptional levels, organization of a typical eukaryotic gene, transcription factors, enhancers and silencers, non coding genes.
UNIT-4 *-15 Hours*	Sex determination and dosage compensation: sex determination- in humans, *Drosophila* and other animals; dosage compensation of X-linked genes– hyperactivation of X-linked gene in male *Drosophila*, inactivation of X-linked genes in female mammals; human genetics- karyotype and nomenclature of metaphase chromosome bands; chromosome anomalies and diseases- chromosomal anomalies in malignancy (chronic myeloid leukemia, Burkitt's lymphoma, retinoblastoma and Wilms' tumor); genetic analysis of complex traits - complex pattern of inheritance, quantitative traits, threshold traits; human genome and mapping.

UNIT-5- *20 Hours*	Genetics and cancer: oncogenes- tumor inducing retroviruses and viral oncogenes; chromosome rearrangement and cancer; tumor suppressor genes- cellular roles of tumor suppressor genes, pRB, p53, pAPC, genetic pathways to cancer.
LABORATORY WORK (ZOO-211)	1. Study of mutant phenotypes of *Drosophila.* 2. Demonstration of law of segregation using *Drosophila* mutants. 3. Study of law of independent assortment. 4. Demonstration of sex- linkage by using *white* mutation of *Drosophila.* 5. Demonstration of dosage compensation in *Drosophila* males and females. 6. Demonstration of Green Fluorescence and Red Fluorescence protein for monitoring gene expression. 7. Targeted tissue specific expression of a gene using UAS-Gal4 System in *Drosophila.* 8. Preparation and study of metaphase chromosomes from mouse bone marrow: a. Chromosome banding (C, G, H banding). b. Study the differences in number, shape and size of chromosomes in normal vs. tumor cells, or normal vs. irradiated cells. c. Preparation of human karyotype and study of chromosomal aberrations with respect to number, translocation, deletion etc. from the pictures provided. 9. Study of transcriptional activity in polytene chromosome upon heat shock induction by uridine incorporation. 10. Study of sex chromatin in buccal smear and hair bud cells (Human). 11. Study of Hardy– Weinberg equilibrium in human population by taking the example of blood group system (ABO).

SUGGESTED READINGS	1. *Principles of Genetics*, Snustad and Simmons, (4th Ed. 2005), John Wiley & Sons, USA 2. *Modern Genetic Analysis: Integrating Genes and Genomes*, Griffiths, J.F., Gelbart, M., Lewontin, C. and Miller, W. H. Freeman and Company , New York, USA 3. *Genetics*, J. Russell, Benjamin-Cummings Publishing Company, San Francisco, California, USA

M.Sc(ZOOLOGY)			IIND SEMESTER
COURSE CODE: ZOO 202			COURSE TYPE: CCC
COURSE TITLE: Principles of Gene Manipulation			
CREDIT:7		HOURS:135	
THEORY: 5	PRACTICAL:2	THEORY: 90	PRACTICAL: 45
MARKS			
THEORY: 100 (30+70)		PRACTICAL: 33	

OBJECTIVE: This course is aimed towards generating fundamental knowledge, concepts related to principle of gene manipulation.

UNIT-1 ***-18 Hours***	Basic recombinant DNA techniques, cutting and joining DNA molecules, restriction modification systems, various enzymes used in recombinant DNA technology, restriction maps and mapping techniques;
UNIT-2 ***-18 Hours***	Nucleic acid probes, blotting techniques, DNA fingerprinting, footprinting, methyl interference assay. Polymerase chain reaction– methods and applications.
UNIT-3 ***-18 Hours***	Basic biology of cloning vectors: plasmids, phages, single stranded DNA vectors, high capacity vectors, retroviral vectors, expression vectors and other advanced vectors in use. Gene cloning strategies: methods of transforming *E. coli* and other cells with rDNA; methods of selection and screening of transformed cells; construction of genomic and cDNA libraries; strategies of expressing cloned genes; phage display.
UNIT-4 ***-18 Hours***	Principles of DNA sequencing, automated sequencing methods; synthesis of oligo- nucleotides, primer design; micro-arrays; confocal microscopy; changing genes- directed evolution, protein engineering in microbes **.**
UNIT-5 ***-18 Hours***	Manipulating genes in animals: gene transfer to animal cells, genetic manipulation of animals, transgenic technology, application of recombinant DNA technology; genetically modified organisms: gene knockouts, mouse disease models, gene silencing, gene therapy, somatic and germ- line therapy.

LABORATORY WORK (ZOO-212)	1 Plasmid DNA isolation: minipreps. 2. Agarose gel electrophoresis of isolated plasmid. 3. DNA quantization and purity of DNA. 4. Restriction enzyme digestion of plasmid DNA. 5. Purification of DNA from an agarose gel. 6. Vector and insert ligation. 7. Preparation of competent cells and storage. 8. Transformation of *E. coli* with standard plasmids, calculation of transformation efficiency. 9. Polymerase Chain Reaction, using standard 16S rRNA eubacterial primers.
SUGGESTED READINGS	1. Recombinant DNA: Genes and Genomics – a short course, Watson et al., W. H. Freeman and Company, New York, USA 2. Principles of Gene Manipulation and Genomics, Primrose, S. B. and Twyman, R. M., (7th Ed. 2006), Blackwell Publishing, West Sussex, UK 3. Molecular Biotechnology: Principles and application of recombinant DNA, Bernard R. and Jack, ASM Press, Herndon, USA

M.Sc(ZOOLOGY)			IIND SEMESTER
COURSE CODE: ZOO 203			**COURSE TYPE: CCC**
COURSE TITLE: Structure and Function of Genes			
CREDIT:7		**HOURS:135**	
THEORY: 5	**PRACTICAL:2**	**THEORY: 90**	**PRACTICAL:45**
MARKS			
THEORY: 100(30+70)		**PRACTICAL:34**	
OBJECTIVE: This course is aimed towards generating fundamental knowledge, concepts related to structure and function of genes.			
UNIT-1- *20 Hours*	Structure of nucleic acids- structure of nucleic acids, folding motifs, conformation flexibilities, denaturation, renaturation, kinetics of hybridization, super-coiling of DNA, packaging of DNA in the nucleus, structure of chromatin, chromatin territories. Genetic material and its evolution- structure and function relationships, evolution of genetic material, genes and genomes.		
UNIT-2 *-20 Hours*	DNA replication, recombination and repair- energetics of nucleic acid polymerization, accuracy during flow of genetic information, DNA polymerases, proof- eading activity, errors and damage in the DNA, mechanism of DNA repair; genome instability;		
UNIT-3 *-10 Hours*	Transcriptional control of gene expression- positive and negative regulations, RNA polymerases, promoters and regulatory sequences, activators and repressors of transcription, transcription initiation by RNA polymerases, regulation of transcription-factor activity, elongation and termination of transcription.		
UNIT-4 *-20 Hours*	Post-transcriptional gene control and nuclear transport- ypes of introns and their splicing, evolution of introns, catalytic RNA, alternative splicing and proteome diversity, regulation of Pre-mRNA Processing, micro RNA and other non-coding RNAs, degradation of RNA.		

UNIT-5- *-20 Hours*	Transport across the nuclear envelope and stability of RNA- structure of nuclear membrane and nuclear pore complexes, processes of nuclear import and export and their regulation, degradation of RNA. Translational machinery and translational control -energetics of amino acid polymerization, tRNAs and their modifications, aminoacyl tRNA synthetases, accuracy during aminoacylation of tRNA, regulation of initiation of translation in eukaryotes, elongation and its control, inhibitors of translations.
LABORATORY WORK (ZOO-213)	**1. Studies on structure of Gene** a. Familiarization with sterile-handling techniques for growth of bacteria, such as sterilization, growth media, types of culture etc. b. Isolations of genomic DNA from bacteria and mouse/rat liver. c. Measurement of absorption-spectrum of DNA, RNA, and nucleotides. d. Studies on denaturation of DNA and determination of Tm and calculation of G:C content. e. Studies on stability of DNA and RNA towards alkali. **2 Studies on regulation of gene-expression in bacteria** a. Studies on growth curve of *E.coli* in synthetic medium and calculation of log-phase for metabolic experiments. b. Studies on induction of *lac*-operon. c. Studies on catabolite repression of *lac*-operon and role of cAMP. **3. Generation and selection of mutants for *lac*-operon, calculation of mutation-frequency.**
SUGGESTED READINGS	1. *Molecular Biology of the Gene*, Watson *et al*.,(5th Ed. 2004), Pearson Education, Delhi, INDIA 2. *Genes IX*, Lewin, (9TH Edition 2008), Jones and Bartlett Publishers, Boston, USA

M.Sc(ZOOLOGY)	IIND SEMESTER
COURSE CODE:ZOOB 01	**COURSE TYPE : ECC**
COURSE TITLE: FOREST AND ENVIRONMENTAL LAWS	
CREDIT: 06 **THEORY: 06**	**HOURS : 90** **THEORY: 90**
MARKS : 100 **THEORY: 70 CCA : 30**	

OBJECTIVE:

- Understands the concept and place of research in concerned subject
- Gets acquainted with various resources for research
- Becomes familiar with various tools of research
- Gets conversant with sampling techniques, methods of research and techniques of analysis of data
- Achieves skills in various research writings
- Gets acquainted with computer Fundamentals and Office Software Package .

UNIT - 1 18 Hrs	**EVOLUTION OF FOREST AND WILD LIFE LAWS** a) Importance of Forest and Wildlife b) Evolution of Forest and Wild Life Laws c) Forest Policy during British Regime d) Forest Policies after Independence. e) Methods of Forest and Wildlife Conservation.
UNIT - 2 18 Hrs	**FOREST PROTECTION AND LAW** a) Indian Forest Act, 1927 b) Forest Conservation Act, 1980 & Rules therein c) Rights of Forest Dwellers and Tribal c) The Forest Rights Act, 2006 d) National Forest Policy 1988
UNIT - 3 18 H rs	**WILDLIFE PROTECTION AND LAW** a) Wild Life Protection Act, 1972 b) Wild Life Conservation strategy and Projects c) The National Zoo Policy

UNIT - 4 **18 Hrs**	**CHAPTER – BASIC CONCEPTS** a. Meaning and definition of environment. b. Multidisciplinary nature of environment c. Concept of ecology and ecosystem d. Importance of environment e. Meaning and types of environmental pollution. f Factors responsible for environmental degradation. **CHAPTER– INTRODUCTION TO LEGAL SYSTEM** a. Acts, Rules, Policies, Notification, circulars etc b. Constitutional provisions on Environment Protection c. Judicial review, precedents d. Writ petitions, PIL and Judicial Activism **CHAPTER – LEGISLATIVE FRAMEWORK FOR POLLUTION CONTROL LAWS** a) Air Pollution and Law. b) Water Pollution and Law. c) Noise Pollution and Law.
UNIT - 5 **18 Hrs**	**CHAPTER- LEGISLATIVE FRAMEWORK FOR ENVIRONMENT PROTECTION** a) Environment Protection Act & rules there under b) Hazardous Waste and Law c) Principles of Strict and absolute Liability. d) Public Liability Insurance Act e) Environment Impact Assessment Regulations in India **CHAPTER – ENVIRONMENTAL CONSTITUTIONALISM** a. Fundamental Rights and Environment i) Right to Equality …….Article 14 ii) Right to Information ……Article 19 iii) Right to Life ……..Article 21 iv) Freedom of Trade vis-à-vis Environment Protection b. The Forty-Second Amendment Act c. Directive Principles of State Policy & Fundamental Duties d. Judicial Activism and PIL

SUGGESTED READINGS

Bharucha, Erach. Text Book of Environmental Studies. Hyderabad : University Press (India) Private limited, 2005.

Doabia, T. S. Environmental and Pollution Laws in India. New Delhi: Wadhwa and Company, 2005.

Joseph, Benny. Environmental Studies, New Delhi: Tata McGraw-Hill Publishing Company Limited, 2006.

Khan. I. A, Text Book of Environmental Laws. Allahabad: Central Law Agency, 2002.

Leelakrishnan, P. Environmental Law Case Book. 2nd Edition. New Delhi: LexisNexis Butterworths, 2006.

Shastri, S. C (ed). Human Rights, Development and Environmental Law, An Anthology. Jaipur: Bharat law Publications, 2006.

Environmental Pollution by Asthana and Asthana, S,Chand Publication

Environmental Science by Dr. S.R.Myneni, Asia law House

Gurdip Singh, Environmental Law in India (2005) Macmillan.

Shyam Diwan and Armin Rosencranz, Environmental Law and Policy in India – Cases, Materials and Statutes (2nd ed., 2001) Oxford University Press.

JOURNALS :-

Journal of Indian Law Institute, ILI New Delhi.

Journal of Environmental Law, NLSIU, Bangalore.

MAGAZINES :-

Economical and Political Weekly

Down to Earth.

M.Sc(ZOOLOGY)			IIND SEMESTER
COURSE CODE: ZOO B02			**COURSE TYPE: ECC/CB**
COURSE TITLE: **Evolution and Functional Anatomy of Fish** **Theory**			
CREDIT:6		**HOURS:90**	
THEORY: 6	**PRACTICAL:0**	**THEORY: 90**	**PRACTICAL:0**
MARKS			
THEORY: 100 (30+70)		**PRACTICAL:0**	
OBJECTIVE: The main objective is to furnish the process of evolution, its importance and let the students know the functional anatomy of fish.			
UNIT-1 ***-20 Hours***	Origin, diversity and distribution- origin and evolution of major groups of fishes, evolutionary strategies and morphological innovations, gene and genome duplication, evolutionary genetics, biogeographical distribution, methods employed in phylogenetic studies and fish identification, fish barcoding.		
UNIT-2 ***-15Hours***	Fish as a research model. Body form, swimming mechanisms and buoyancy regulation- propulsive systems, hydrodynamic analyses, swimming modes, fish biomodelling, bioenergetics, strategies for buoyancy regulation. Gas exchange, internal transport and homeostasis- aquatic and aerial respiration, cardiovascular physiology, hematology, fish leucocytes, phagocytes, lymphoid organs, gas transport, osmoionic regulation, acid- base balance, nitrogen excretion and metabolism.		
UNIT-3 ***-20 Hours***	Sensory systems– photoreception, chemoreception, mechanoreception, electroreception. Adaptations to environmental extremes- temperature, pressure, stressors. Growth and metabolism- regulation of food intake by neuropeptides and hormones, environmental factors and feed intake, digestive physiology and nutrient digestibility in fishes, nutritional energetic, growth.		

UNIT-4 *-20 Hours*	Defense mechanism– integument and Immune system, development of immune system, cells and tissues of the fish immune system, modulators of fish immune responses, humoral and cell mediated immune defense, fish antibody molecules and their effector functions. Reproduction- reproductive strategies, environmental and endocrine factors regulating reproductive cycles, hormonal and molecular mechanisms of oogenesis, spermatogenesis, oocyte maturation and spermiation, fertilization, mechanism of sex determination, maternal factors in early development.
UNIT-5- *15Hours*	Endocrines- piscine endocrine glands, hormones and their role in appetite, osmoregulation, calcium metabolism, cardiovascular regulation and behaviour, hormone receptors in fish, endocrine disruption, behaviour and cognition - patterns of migration, orientation and homing, schooling, feeding, background adaptations, parental care.
SUGGESTED READINGS	1. *Biology of Fishes*, Bone, Q. and Moore, R., Talyor and Francis Group, CRC Press, U.K. 2. *The Physiology of Fishes*, Evans, D. H. and Claiborne, J. D., Taylor and Francis Group, CRC Press, UK 3. *The Senses of Fish Adaptations for the Reception of Natural Stimuli*, von der Emde, R., Mogdans, J. and Kapoor, B. G., Narosa Publishing House, New Delhi, INDIA

M.Sc(ZOOLOGY)			IIND SEMESTER
COURSE CODE: ZOO B03			**COURSE TYPE: ECC/CB**
COURSE TITLE: **Aquatic Resources and Their Conservation**			
CREDIT:6		**HOURS:90**	
THEORY: 6	**PRACTICAL:0**	**THEORY: 90**	**PRACTICAL: 0**
MARKS			
THEORY:100(30+70)		**PRACTICAL: 0**	
OBJECTIVE: This course is aimed towards generating fundamental knowledge, concepts related to aquatic resources and their conservation			

UNIT-1- ***18 Hours***	Riverine fisheries- important river systems and their hydrological conditions, flora and fauna with special reference to fisheries, dams and their impact on riverine fisheries, fish ladders, interlinking of rivers and likely impact on fisheries. Cold water fisheries - ecology of hill streams, biology of important cold water fishes of India, recreational fishing. Lacustrine fisheries - origin of lakes and lake morphology, light, temperature and density relationship in the lacustrine ecosystems, heat energy and water movements, oxygen and other dissolved gases in lakes, pH and redox potential, fisheries profile and potential of major Indian lakes.
UNIT-2- ***18Hours***	Estuarine fisheries- major estuarine systems of India, hydrography, flora and fauna with special reference to fisheries. Marine fisheries – coastal and deep sea fisheries, permanent and seasonal stratification, upwelling, the photic zone, control of primary production by light and nutrients availability, chemical properties of sea water, biology of important fishes (sardine, mackerel, tuna), marine protected areas.
UNIT-3- ***18 Hours***	Integrated resources- coastal wet lands, mangroves, coral reefs, sea grasses and their conservation. Fishing techniques-- technologies for localizing catches- remote sensing, sonar, radar; crafts and gears. Stock assessment and management.

UNIT-4- ***18 Hours***	Natural markers- morphological analyses, environmental signals, genetic analyses; Applied markers- marking and tagging, Stock identification data analysis - stock composition analysis, age and growth, fecundity estimation, application of statistical methods in fisheries. Fish conservation- fishing laws and regulation, permitting. Post harvest technology-- Fish spoilage, rigor mortis, rancidity, enzymatic spoilage, microbial spoilage; Fish preservation and processing- handling of fish at harvest/onboard, principles of fish preservations, methods of preservation, problems associated with fish preservations, quality control, fishery by-products.
UNIT-5- ***18 Hours***	Aquatic pollution- types and sources, impact of pollution on aquatic organisms, ecosystem analysis- bio-indicators, biomonitoring, environmental factors and fish health, xenobiotics. Waste management- national and international standards. Extension services - basic principles and emerging issues of extension, role of information and communication technology in fisheries extension.
SUGGESTED READINGS	1. *Computers in Fisheries Research*, Megrey, B. A. and Moksness, E. (2009), Springer, USA 2. *Biological Invasions in Marine Ecosystems Ecological, Management and Geographic Perspectives*. Rilov, G. and Jeffrey, A. C. (2009), Springer-Verlag, GERMANY 3. *Handbook of Fisheries and Aquaculture, Indian Council of Agricultural Research*, ICAR, (2006), DIPA, New Delhi, INDIA

M.Sc(ZOOLOGY)		IIND SEMESTER	
COURSE CODE: ZOO B04		**COURSE TYPE: ECC/CB**	
COURSE TITLE: **Aquaculture**			
CREDIT:6		**HOURS:90**	
THEORY: 6	**PRACTICAL:0**	**THEORY: 90**	**PRACTICAL: 0**
MARKS			
THEORY: 100(30+70)		**PRACTICAL:0**	

OBJECTIVE: The purpose of this course is to make students understand Aquaculture. This knowledge is crucial for better development and management of aquaculture

UNIT-1- *18 Hours*	Culture technology– freshwater (carps, catfishes, murrels, prawns), brackish water (asian sea-bass, milk fish, mullets, crabs, shrimps), mariculture (mussels, oysters, sea weeds), fish food organisms **(**algae; *Artemia*; zooplankton).
UNIT-2- *18 Hours*	Water Quality Requirements for Aquaculture- Role of temperature, pH, salinity, dissolved oxygen, ammonia, nitrite, nitrate, phosphate, Biological oxygen demand, Chemical oxygen demand. Integrated farming - fish-cum-live stock farming, paddy-cum-fish farming, aquaculture engineering- aquahouse, hatchery, ponds, race ways, recirculating system, cage, pen.
UNIT-3- *18 Hours*	Fish seed technology - natural collection, bundh breeding, induced breeding, cryopreservation of gametes. Transport of finfish and shellfish- transport of eggs, fry, fingerlings and adults. Nutrition of aquatic animals - nutritional requirements of commercially important finfish and shellfish, dietary requirements of larvae and brooders, feed types, manufacture and ingredients, anit- nutritional factors in fish feed ingredients and their treatments, use of attractants and growth stimulants in fish feeds, alternative protein sources in aquaculture diets, feeding techniques, role of probiotics in nutrition.

UNIT-4- *18 Hours*	Setting up of display aquarium- freshwater and marine aquaria, selection of compatible species, breeding of aquarium fishes. Role of genetics in aquaculture– gynogenesis, androgenesis, triploidy, tetraploidy, hybridization, sex reversal and breeding, production of transgenic fish, impact of GMOs on aquatic biodiversity.
UNIT-5- *18 Hours*	Fish health- infection and diseases in fish, common fish pathogens, routes of pathogen entry in fish, methods of colonization and spread of pathogens, immune - evasion mechanisms of fish pathogens. Environmental impact of aquaculture- aquacultural wastes and future developments in waste minimization, environmental consequences of hypernutrification. Fish vaccines-strategy and use in aquaculture.
SUGGESTED READINGS	1. *Fishponds in Farming Systems*, Zijpp, V. D., Verreth, J. A. J., Tri, L. Q., van Mensvoort, M. E. F., Bosma, R. H., and Beveridge, M. C. M., Wageningen Academic Publishers, Netherlands. 2. *Aquaculture Principles and Practices*, Pillay, T. V. R., Blackwell Publishing, USA 3. *Aquaculture and Fisheries Biotechnology Genetic Approaches*, Dunham, R. A., CABI Publishing, USA.

- **M. Sc. in ZOOLOGY**
  FACULTY OF LIFE SCIENCE
- **THIRD SEMESTER** (ODD SEMESTER)

Eligibility Criteria (Qualifying Exams)	Course Code	Course Type	Course (Paper/Subjects)	Credits	Contact Hours Per WeeK			EoSE Duration (Hrs.)	
					L	T	P	Thy	P
After appearing in the Second semester examination irrespective of any number of back/ arrear papers	ZOO 301	CCC	Comparative Animal Physiology	5	4	2	00	3	00
	ZOO 311	CCC	Comparative Animal Physiology- LABORATORY WORK	2	00	00	3	00	3
	ZOO302	CCC	Developmental Biology	5	4	2	00	3	00
	ZOO 312	CCC	Developmental Biology – LABORATORY WORK	2	00	00	3	00	3
	ZOO 303	CCC	Immunology	5	4	2	00	3	00
	ZOO 313	CCC	Immunology- – LABORATORY WORK	2	00	00	3	00	3
	ZOO S02	OSC	INTELLECTUAL PROPERTY, HUMAN RIGHTS & ENVIRONMENT: BASICS	6	4	3	00	3	00
	ZOO C 01	ECC/CB	TRIBAL STUDIES	6	4	3	00	3	00
	ZOOC02	ECC/CB	**Molecular Endocrinology and Reproduction-** Neuroendocrinology						
	ZOOC 03	ECC/CB	**Molecular Endocrinology and Reproduction -** Molecular Endocrinology						
	ZOO C 04	ECC/CB	**Molecular Endocrinology and Reproduction -** Biology of Reproduction						
				TOTAL= 33					

M.Sc (ZOOLOGY)			IIIRD SEMESTER
COURSE CODE: ZOO 301			**COURSE TYPE: CCC**
COURSE TITLE: Comparative Animal Physiology			
CREDIT:7		**HOURS:135**	
THEORY: 5	**PRACTICAL:2**	**THEORY: 90**	**PRACTICAL: 45**
MARKS			
THEORY: 100 (30+70)		**PRACTICAL:33**	
OBJECTIVE: This course is aimed towards generating fundamental knowledge of comparative animal physiology. This knowledge is crucial for better development and management of comparative animal physiology.			
UNIT-1- *15 Hours*	Internal Transport and Gas Exchange – Systems of circulation, Peripheral circulation, Regulation of heart beat and blood pressure, Transport and exchange of gases, Neural and chemical regulation of respiration, Gas transfer in air and water, Gas exchangers,		
UNIT-2 *-20 Hours*	Circulatory and respiratory responses to extreme conditions, Acid –base balance, Regulation of body pH.		
UNIT-3- *15 Hours*	Osmoregulation Osmoregulation in aquatic and terrestrial environments, Kidney functions and diversity, Extra-renal osmoregulatory organs, Patterns of nitrogen excretion. Thermoregulation - Heat balance in animals, Adaptations to temperature extremes, torpor, Aestivation and hibernation, Counter current heat exchangers. Adaptations to Stress- basic concept of environmental stress, acclimation, acclimatization, avoidance and tolerance, stress and hormones.		
UNIT-4- *25 Hours*	Sensing the Environment- photoreception, chemoreception, mechanoreception, echolocation, Endogenous and exogenous biological rhythms, Chromatophores and bioluminescence.		

UNIT-5- ***15 Hours***	Feeding mechanisms and their control, effect of starvation. Muscle physiology – striated and smooth muscle, Adaptations of muscles for various activities, Neuronal control of muscle contraction, Electric organs.
LABORATORY WORK (ENV-311)	1. Observe and compare the inherent rhythmicity of the different parts of the heart. 2. Determine the effects of application of parasympathetic or sympathetic agonists/ antagonists. 3. Assessing physical and chemical modifiers of heart rate in frog. 4. Determine the response of the heart to direct electrical stimulation / vagal stimulation. 5. Effects of drugs and hormones on contraction of smooth muscles. 6. Demonstration of tetany, action current and fatigue in muscle. 7. To study the effect of load on muscle contraction. 8. Concentration / dispersal of pigment in isolated scales of dark / light adapted fish. 9. To examine the relative activity of enzymes in the fore, mid, and hindgut of a typical insect and to correlate the enzyme activity with gut regions. 10. To determine the median threshold concentration of sucrose for housefly population.
SUGGESTED READINGS	1. General and Comparative Animal Physiology, Hoar W. S. (ed), Prentice Hall, India 2. Comparative Physiology (Handbook of Physiology): Vol. 1, 2, Dantzler, W.H. (ed.) Oxford University Press, New York, USA 3. Animal Physiology: Adaptation and Environmental, Nelson K. S. (ed) Cambridge University Press, Cambridge, UK

M.Sc (ZOOLOGY)			IIIRD SEMESTER
COURSE CODE: ZOO 302			**COURSE TYPE: CCC**
COURSE TITLE: Developmental Biology			
CREDIT:7		**HOURS:135**	
THEORY: 5	**PRACTICAL:2**	**THEORY: 90**	**PRACTICAL: 45**
MARKS			
THEORY: 100(30+70)		**PRACTICAL: 33**	
OBJECTIVE: The purpose of the course is to make the students to understand developmental biology.			
UNIT-1 ***18Hours***	History and basic concepts: the origin of developmental biology- cell theory, mosaic and regulative development, discovery of induction, genetics and development; basic concepts of developmental biology- cell division, cell differentiation, signaling, patterning; model systems: vertebrates model organism- *Xenopus laevis*, chicken, mammals, zebrafish; invertebrate model organism- *Drosophila melanogaster*, *Caenorhabditis elegans;* identification of developmental genes: spontaneous and induced mutation, mutant screening, developmental mutations in *Drosophila*.		
UNIT-2- ***15 Hours***	Early embryonic development of vertebrates and invertebrates: structure of the gametes– the sperm, the egg; cleavage and gastrulation; axes and germ layers; morphogenesis– cell adhesion, cleavage and formation of blastula, gastrulation, neural tube formation, cell migration; Axis specification in *Drosophila*; origin of anterior- posterior and dorsal- ventral patterning- role of maternal genes, patterning of early embryo by zygotic genes; segmentation genes- the gap genes, the pair– rule genes, the segment polarity genes, the homeotic selector genes- bithorax and antennapedia complex.		

UNIT-3- ***18 Hours***	General concepts of organogenesis: development of chick limb- development and patterning of vertebrate limb, proximal- distal and dorso- ventral axis formation, homeobox genes in patterning, signaling in patterning of the limb; insect imaginal disc– determination of wing and leg imaginal discs, organizing center in patterning of the wing, butterfly wing development, the homeotic selector genes for segmental identity; insect compound eye– morphogenetic furrow, ommatidia, signaling, eyeless gene; kidney development– development of ureteric bud and mesenchymal tubules.
UNIT-4- ***18 Hours***	Postembryonic development: growth- cell proliferation, growth hormones; aging- genes involved in alteration in timing of senescence; regeneration– epimorphic regeneration of reptile (salamander) limb, requirement of nerves for the proliferation of blastema cells;
UNIT-5- ***18 Hours***	Embryonic stem cells and their applications; medical implications of developmental biology: genetic errors of human development- the nature of human syndromes– pleiotropy, genetic heterogeneity, phenotypic variability, mechanism of dominance; gene expression and human disease– inborn errors of nuclear RNA processing, inborn errors of translation; teratogenesis- environmental assaults on human development- teratogenic agents like alcohol, retinoic acid etc.

LABORATORY WORK (ENV-312)	1. Study of life cycle of *Drosophila melanogaster*. 2. Study of embryogenesis in *Drosophila* and pattern of gene expression in embryogenesis by *in situ* hybridization technique. 3. Immunohistochemical staining to study the expression pattern of gap and pair-rule gene proteins. 4. Dissection and study of larval and prepupal wing, leg and eye antennal imaginal discs of *Drosophila.* 5. Patterning of the adult wing and demonstration of the effect of cell death on the patterning of the adult wing. 6. Study of Homeotic gene mutations. 7. Influence of temperature and teratogenes on animal development. 8. Study of regeneration in *Hydra*.
SUGGESTED READINGS	1.*Developmental Biology*, Gilbert, (8th Ed., 2006) Sinauer Associates Inc., Massachusetts, USA. 2. *Principles of Development*, Wolpert, Beddington, Brockes, Jessell, Lawrence, Meyerowitz, (3rd Ed., 2006), Oxford University Press, New Delhi, INDIA. 3. *Analysis of Biological Development*, Kalthoff, (2nd Ed., 2000), McGraw-Hill Science, New Delhi, INDIA.

M.Sc (ZOOLOGY)			IIIRD SEMESTER
COURSE CODE: ZOO 303			**COURSE TYPE: CCC**
COURSE TITLE: Immunology			
CREDIT:7		**HOURS:135**	
THEORY: 5	**PRACTICAL:2**	**THEORY: 90**	**PRACTICAL: 45**
MARKS			
THEORY:100(30+70)		**PRACTICAL : 34**	
OBJECTIVE: This course is aimed towards generating fundamental knowledge concept related to immunology.			
UNIT-1- 30 Hours	Overview of the immune system: components of the immune system, principles of innate and adaptive immunity, the recognition and effector mechanisms of the adaptive immunity- antigen and immunogenicity, clonal selection theory.		
UNIT-2- *10 Hours*	Antigen recognition by immune cells: Adaptive immunity- antibody structure, antigen recognition by B lymphocytes, TCR, antigen recognition by T- cells, co-receptors, structure and function of MHC complex; generation of lymphocyte antigen receptors- generation of diversity in immunoglobulins, T- cell receptor gene rearrangement, structural variations in immunoglobulin constant regions; antigen processing and presentation to T lymphocytes- antigen presenting cells, generation of T- cell receptor ligand, and MHC restriction, role of CD1 in antigen presentation;		
UNIT-3- *15 Hours*	Innate Immunity- pattern recognition in the innate immune system, role of TLRs in innate immune response, complement and innate immunity, induced innate response to infection.		

UNIT-4- ***20 Hours***	Effector mechanisms and regulation of immune responses: Signaling through immune system receptors- antigen receptor structure and signaling pathways, other signaling pathways that contribute to lymphocyte behavior; development and survival of lymphocytes- B lymphocyte development and survival, humoral immune response, T lymphocyte development and survival, production of effector T- cells, cytotoxic T- cell effector mechanisms; NK and NKT cell functions; mucosal immunity; immunological memory; regulation of immune response: cytokines and chemokines, complement system, leukocyte activation and migration, APC regulation of the immune response, T- cell mediated regulation of immune response, Immunological tolerance and allergy.
UNIT-5- ***15 Hours***	Immunity in health and disease: introduction to infectious disease, innate immunity to infection, adaptive immunity to infection, evasion of the immune response by pathogens; immunodeficiency diseases- inherited immunodeficiency diseases, acquired immune deficiency syndrome; allergy and hypersensitivity- IgE and allergic reactions, hypersensitivity diseases; autoimmunity- responses to self antigens, transplant rejection- responses to alloantigens; manipulation of immune responses, vaccines; evolution of immune system- evolution of innate immune system, evolution of adaptive immune system.

LABORATORY WORK (ENV-313)	Dissection of primary and secondary immune organs from mice: a. Preparation of single cell suspension from bone marrow and spleen (spleenocytes) of mice. b. Cell counting and viability testing of the spleenocytes prepared. 2. Preparation and study of phagocytosis by spleenic/peritoneal macrophages. 3. Raising polyclonal antibody in mice, serum collection and estimating antibody titre in serum by following methods: a. Ouchterlony (double diffusion) assay for Antigen -antibody specificity and titre. b. ELISA 4. Antibody purification from the serum collected from immunized mice: affinity purification/chromatography. 5. Immunoelectrophoresis. 6. Demonstration of Western blotting: a. Protein estimation by Lowry's method /Bradford's method b. SDS-PAGE. c. Immunoblot analysis.
SUGGESTED READINGS	1. Kuby Immunology, Richard, Thomas, Barbara, Janis, (5th Ed., 2003), W. H. Freeman and company, New York, USA. 2. Immuno Biology- The immune system in health and disease, Janeway, Travers, Walport and Shlomchik, (6th Ed., 2005), Garland Science Publishing, New York, USA. 3. Immunology, David, Brostoff and Roitt, (7th Ed., 2006), Mosby & Elsevier Publishing, Canada, USA.

M.Sc (ZOOLOGY)	IIIRD SEMESTER
COURSE CODE: ZOOS 02	**COURSE TYPE : OSC**
COURSE TITLE: INTELLECTUAL PROPERTY RIGHTS, HUMAN RIGHTS & ENVIRONMENT: BASICS	
CREDIT: 06 **THEORY: 06**	**HOURS : 90** **THEORY: 90**
MARKS : 100 **THEORY: 70 CCA : 30**	

OBJECTIVE:

- Understands the concept and place of research in concerned subject
- Gets acquainted with various resources for research
- Becomes familiar with various tools of research
- Gets conversant with sampling techniques, methods of research and techniques of analysis of data.

UNIT - 1 **12 Hrs**	• Patents :- Introduction & concepts, Historical Overview. • Subject matter of patent. • Kinds of Patents. • Development of Law of Patents through international treaties and conventions including TRIPS Agreement. • Procedure for grant of patents & term of Patent. • Surrender, revocation and restoration of patent. • Rights and obligations of Patentee • Grant of compulsory licenses • Infringement of Patent and legal remedies • Offences and penalties • Discussion on leading cases.
UNIT - 2 **24 Hrs**	• Meaning of Copyright, Historical Evolution, • Subject matter of copyright. • Literary works • Dramatic Works & Musical Works • Computer Programme • Cinematographic films • Registration of Copyrights • Term of Copyright and Ownership of Copyrights • Neighboring Rights • Rights of Performers & Broadcasters • Assignment of Copyright. • Author's Special Rights (Moral Rights) • Infringement of Copyrights and defenses • Remedies against infringement (Jurisdiction of Courts and penalties) • International Conventions including TRIPS Agreement WIPO, UCC, Paris Union, Berne Convention, UNESCO. • Discussion on leading cases.

UNIT - 3 10 H rs	• Rights: Meaning • Human Rights- Meaning & Essentials • Human Rights Kinds • Rights related to Life, Liberty, Equals & Disable
UNIT - 4 24 Hrs	• National Human Rights Commission • State Human Rights Commission • High Court • Regional Court • Procedure & Functions of High & Regional Court.
UNIT - 5 20 Hrs	• Right to Environment as Human Right • International Humanitarian Law and Environment • Environment and Conflict Management • Nature and Origin of International Environmental Organisations (IEOs) • Introduction to Sustainable Development and Environment • Sustainable Development and Environmental Governance
SUGGESTED READINGS	1. G.B.Reddy, *Intellectual Property Rights and Law*, Gogia Law Agency, Hyderabad. 2. S.R.Myneni, *Intellectual Property Law*, Eastern Law House, Calcutta 3. P Narayanan *Intellectual Property Rights and Law (1999)*, Eastern Law House, Calcutta, India 4. Vikas Vashistha, *Law and Practice of Intellectual Property*,(1999) Bharat Law House, New Delhi. 5. Comish W.R *Intellectual Property*,*3rd ed, (1996),* Sweet and Maxwell 6. P.S. Sangal and Kishor Singh, *Indian Patent System and Paris Convention,* 7. Comish W.R *Intellectual Property, Patents, Copyrights and Allied Rights, (2005)* *8.* Bibeck Debroy, *Intellectual Property Rights, (1998),* Rajiv Gandhi Foundation.

M.Sc (ZOOLOGY)	IIIRD SEMESTER
COURSE CODE: ZOOC 01	**COURSE TYPE : ECC**
COURSE TITLE: TRIBAL STUDIES	
CREDIT: 06 **THEORY: 06**	**HOURS : 90** **THEORY: 90**
MARKS : 100 **THEORY: 70 CCA : 30**	

OBJECTIVE:

- Understands the concept and place of research in concerned subject
- Gets acquainted with various resources for research
- Becomes familiar with various tools of research
- Gets conversant with sampling techniques, methods of research and techniques of analysis of data
- Achieves skills in various research writings
- Gets acquainted with computer Fundamentals and Office Software Package .

UNIT - 1 12 Hrs	**Tribal Studies :** Meaning, Nature, Scope, Need & importance of tribal studies. Meaning, Definition & characteristics of Tribe, Caste & Race.
UNIT - 2 24 Hrs	**Scheduled Tribe in India :** Population Composition of tribal, classification of Indian Tribe – Racial, Lingual, Geographical, Cultural. **Some Major Tribes in India :** Santhal, Khasi, Munda, Bhils. **Some Major Tribes in Central India :** Gond, Baiga, Bharia, Korkus.
UNIT - 3 10 H rs	**Iliteracy :**Poverty, Indebt ness, Unemployment, migration & Exploitation Environmental & Degradation. **Problem of Health and sanitation :** Prostitution, Culture Decay due to assimilation. Replacement & Rehabilitation of Tribal population.
UNIT - 4 24 Hrs	**Welfare-Concept, Characteristics:** Tribal Welfare in post independence period. Constitutional provision & safe guard after independence, Legislation & Reservation Policy.

UNIT - 5 20 Hrs	**Tribal Development Programs for Scheduled Tribes :** Medical, Education, Economy, Employment & Agriculture Evaluation of Programs **Tribal Welfare & Advisory Agencies in India :** Role of NGO's in tribal development, Role of Christian missionaries in tribal welfare & development. Tribal Welfare Administration.
SUGGESTED READINGS	*Tribal Development In India (Orissa)* by Dr. Taradutt *Books on Tribal studies* by PK Bhowmik *Books on 'Tribal Studies'* by W.G. Archer

M.Sc (ZOOLOGY)		IIIRD SEMESTER	
COURSE CODE: ZOO C02		**COURSE TYPE: ECC/CB**	
COURSE TITLE: **Molecular Endocrinology and Reproduction-Neuroendocrinology**			
CREDIT:6		**HOURS:90**	
THEORY: 6	**PRACTICAL:0**	**THEORY: 90**	**PRACTICAL:0**
MARKS			
THEORY:100(30+70)		**PRACTICAL:0**	
OBJECTIVE: The purpose of the course is to make the students to understand molecular endocrinology and reproduction neuroendocrinology.			
UNIT-1- *18 Hours*	General organization of neuroendocrine organs and nervous system. Neuroanatomy: form, varieties and distribution of neurons; Structural characteristics of neurons; Stereotaxic atlas of rat brain and the hypothalamus. Neurophysiology: electrical properties of neurons and propagation of nerve impulses; Synapse: types, structure and function. Neurotransmitter and its release; Neuromodulation:		
UNIT-2 *-18 Hours*	Neurotransmitter vs neuropeptides, Synaptic transmission: role of G-protein coupled, glutamate and on-channel linked receptors; GABA/glutamate neurons in adult preoptic area: sexual dimorphism and function.		
UNIT-3- *18 Hours*	The hypothalamo- hypophyseal axis. Hypothalamo- vascular system. Hormones from hypothalamus: chemistry and physiology of releasing and release inhibiting hormones; Regulation of hypothalamic hormone secretion. Hypothalamo-hypophyseal interactions with the gonads, adrenal and other endocrine organs. Diversity of ovarian steroid signaling in the hypothalamus. Development and cytology of pituitary gland. Regulation of pituitary hormone secretion. Neurohypophysis: synthesis and storage of oxytocin and vasopressin; Regulation of the release of neurohypophyseal hormones. Concepts of feed-back inhibition and feed-forward activation.		

UNIT-4- ***18 Hours***	Regulation of the expression of POMC-related peptides and their differential expression in brain and pituitary. Environment and reproduction. Endocrine disruptors; Embryonic diapauses and other adaptive mechanisms. Biological clock and the pineal: synthesis and regulation of melatonin, phylogeny of pinealocytes, role of pineal in circadian rhythms, regulation of pineal by SCN and vice versa, physiological actions of melatonin, biological clock and clock gene expression, fluoride and pineal.
UNIT-5- ***18 Hours***	Neuroendocrine regulation of immune system; Stress hormones and immune responses; Regulation of systemic homeostasis by nervous and immune system interactions. Melatonin, immune responses and cancer therapy. Neuroendocrine disorders: genetic versus environmental cause. Principles and application of techniques: electrophysiology, immunocytochemistry, *in situ* hybridization, autoradiography, in vitro perifusion
SUGGESTED READINGS	1.An Introduction to Neuroendocrinology, Brown R., (1994), Cambridge University Press, Cambridge, UK 2. Psychoneuroimmunology, , Ader R, Felten D.L. and edited by Nicholas C. (4th Ed., 2007), Academic Press, UK 3. Endocrinology (3 volumes set), *DeGroot* L. J. and Jameson J.L., Editors, (5th Ed., 2006), Saunders Elsevier Press, USA.

M.Sc (ZOOLOGY)			IIIRD SEMESTER
COURSE CODE: ZOO C03			**COURSE TYPE: ECC/CB**
COURSE TITLE: Molecular Endocrinology and Reproduction-Molecular Endocrinology			
CREDIT:6		**HOURS:90**	
THEORY: 6	**PRACTICAL:0**	**THEORY: 90**	**PRACTICAL: 0**
MARKS			
THEORY: 100 (30+70)		**PRACTICAL:0**	

OBJECTIVE: The purpose of the course is to make the students to understand molecular endocrinology and reproduction neuroendocrinology.

UNIT-1- *15 Hours*	Discovery of hormones as chemical signals for control and regulation of physiological processes. Nature of hormonal actions. Major questions in biology of hormones. Techniques for quantitation of hormones. Design and development of hormonal assays.
UNIT-2- *20 Hours*	Structure of peptide and protein hormones. Purification and characterization of hormones. Structure-Function relationships in different hormones. Phylogenic analysis of hormonal structures and functions. Biosynthesis of protein hormones. Storage and secretion of hormones: molecular mechanisms of regulation.
UNIT-3- *20 Hours*	Transcriptional and post-transcriptional mechanisms of hormone biosynthesis and secretion. Regulation of biosynthesis and secretion. Inhibitors of hormone biosynthesis and their use.
UNIT-4- *15 Hours*	Nature of hormonal effects and actions. Discovery of receptors in target tissues. Mechanisms of hormone action and signal attenuation.. Signal discrimination, signal transduction and signal amplification in hormone regulated physiological processes. Structural requirements for successful hormone-receptor interactions. Receptor antagonists and their applications. Metabolism of hormones by target and non-target tissues. Pharmacokinetics of hormones. Hormones and behavior-cellular and molecular actions of semiochemicals.

UNIT-5 *-20 Hours*	Hormones as therapeutic agents. Current developments in design and production of hormonal contraceptives. Recombinant protein hormones-production and application in regulation of fertility in farm animals and humans. Evolution of chemical communication in animal systems. Unsolved problems in hormonal biology.
SUGGESTED READINGS	1.Peer reviewed journal articles, monographs and reviews as and when recommended. 2. Molecular Biology of Steroid and Nuclear Hormone receptors, ed. Freedman L. P., (1998), Birkhauser, Boston, USA 3. Biochemical actions of hormones, ed. Litwack, G. (1985), Academic press, New York, USA

M.Sc (ZOOLOGY)			IIIRD SEMESTER
COURSE CODE: ZOO C04			**COURSE TYPE: ECC/CB**
COURSE TITLE: **Endocrinology and Reproduction -** Biology of Reproduction			
CREDIT:6		**HOURS:90**	
THEORY: 6	**PRACTICAL: 0**	**THEORY: 90**	**PRACTICAL:0**
MARKS			
THEORY: 100 (30+70)		**PRACTICAL:0**	
OBJECTIVE: The purpose of the course is to make the students to understand molecular endocrinology and reproduction neuro-endocrinology.			
UNIT-1- *18 Hours*	Sex determination and differentiation: Mechanism of Sex determination, differentiation of gonad and the genital tract.		
UNIT-2- *18 Hours*	Stem cell renewal in testis, Spermatogenesis: structural and molecular events, experimental approaches to study spermatogenesis; Seminiferous epithelial cycle; Sertoli cell: structure and function; Leydig cell: generation of Leydig cell, steroidogenesis; Leydig and Sertoli cell proliferation during foetal and postnatal development; Regulation of testicular functions.		
UNIT-3- *18 Hours*	Epididymal maturation of spermatozoa; Capacitation, Signal transduction pathway in acrosome reaction; Male sterility: azoospermia, oligozoospermia, asthenozoospermia, varicocele; Genetic basis for male infertility, Mutational analysis in genes for hormones, receptor and gamete development.		
UNIT-4- *18 Hours*	Follicular development and selection; Role of extra-and intra-gonadal factors in folliculogenesis; Oocyte maturation and its regulation; Ovulation: factors involved in follicular rupture; Luteinization and luteolysis; Follicular atresia.; Regulation of reproductive cycle in female: menstrual cycle in human, estrous cycle in rat, estrous behaviour in cycling animals; Female reproductive disorder: amenorrhea, polycystic ovary.		

UNIT-5- ***18 Hours***	Fertilization: A comparative account on pre-fertilization events in oviparous animals (echinoderms-amphibians-mammals), activation of egg, candidate molecules involved in fertilization; Contraception leading to prevention of polyspermy: surgical, hormonal and immunocontraception.
SUGGESTED READINGS	1. *The Physiology of Reproduction*, *Vol 1 and 2*, Ernst Knobil and Jimmy D. Neil, (ed), Raven Press. 2. **Male Reproductive Function**, Christina Wang, (ed), Kluwer Academic Publishers. 3. *The ovary, (ed), Solly Zuckerman Zuckerman*, Barbara J. Weir, T. G. Baker. Academic Press. 4. *The ovary*, *Peter C.K. Leung and Eli Y. Adashi*, (ed), Elsevier (Academic Press), 2004. 5. *Cell and Molecular Biology of Testis, (ed*), Claude Desjardins and Larry L. Ewing. Oxford University Press, USA 6. *Reproductive Endocrinology: Physiology, Pathophysiology, and Clinical Management*, Samuel S. C. Yen, Robert B. Jaffe, Robert L. Barbieri, (ed), Saunders publisher. USA.

- **M. Sc. in ZOOLOGY**
  FACULTY OF LIFE SCIENCE
- **FOURTH SEMESTER** (EVEN SEMESTER)

Eligibility Criteria (Qualifying Exams)	Course Code	Course Type	Course (Paper/Subjects)	Credits	Contact Hours Per WeeK			EoSE Duration (Hrs.)	
					L	T	P	Thy	P
After appearing in the Third semester examination irrespective of any number of back/ arrear papers	ZOO 401	CCC	Animal Behavior	5	4	2	00	3	00
	ZOO 411	CCC	Animal Behavior-laboratory work	2	00	00	3	00	3
	ZOO 402	CCC	Biology of Parasitism	5	4	2	00	3	00
	ZOO 412	CCC	Biology of Parasitism--laboratory work	2	00	00	3	00	3
	ZOO 403	CCC	Comparative Endocrine Physiology	5	4	2	00	3	00
	ZOO 413	CCC	Comparative Endocrine Physiology - laboratory work	2	00	00	3	00	3
	ZOO 421	SSC/PRJ	DISSERTATION	6	00	00	9	00	4
	ZOOD 01	ECC/CB	**Genomics, Metagenomics and Epigenetics- Genomics**	6	4	3	00	3	00
	ZOOD 02	ECC/CB	**Metagenomics - Epigenetics- Chromatin Biology**						
				TOTAL= 32					

M.Sc (ZOOLOGY)			IVTH SEMESTER
COURSE CODE: ZOO 401			**COURSE TYPE: CCC**
COURSE TITLE: Animal Behavior			
CREDIT:7		**HOURS:135**	
THEORY: 5	**PRACTICAL:2**	**THEORY: 90**	**PRACTICAL: 45**
MARKS			
THEORY: 100(30+70)		**PRACTICAL:33**	
OBJECTIVE: The purpose of the course is to make the students to understand about the animal behaviour			
UNIT-1 ***-18 Hours***	Introduction - definition, historical out line, patterns of behaviour, objectives of behaviour, mechanism of behaviour, asking questions. Reflexes- reflex action, types of reflexes, reflex arch, characteristics of reflexes and complex behaviour. Orientation primary and secondary orientation; kinesis – orthokinesis, klinokinesis; taxis – different kinds of taxis; sun-compass orientation, dorsal- light reaction.		
UNIT-2- ***18 Hours***	Eusociality, social organization in honey bee, polyphenism and its neural control, flower recognition, displacement and translocation experiment, various type of communications, production of new queen and hive, swarming, honey bee as super organism**.**		
UNIT-3- ***18 Hours***	Fixed action pattern: mechanism, deprivation experiment, controversies. FAP-characteristics and evolutionary features. Learning and instincts: conditioning, habituation, sensitization, reasoning.		

UNIT-4- *18 Hours*	Innate releasing mechanisms: key stimuli, stimulus filtering, supernormal stimuli, open and closed IRM, mimetic releaser, code breakers. Homeostasis and behaviour: motivational system, physiological basis of motivation, control of hunger drive in blow fly and thirst drive in goat, role of hormone, motivational conflict and decision making, displacement activity, models of motivation, measuring motivation. Hormones and pheromones influencing behaviour of animals.
UNIT-5- *18 Hours*	Altruism – reciprocal altruism, group selection, kin selection and inclusive fitness, cooperation, alarm call. Parental care, parental manipulation, evolutionarily stable strategy, cost benefit analysis of parental care with suitable case studies. Sexual selection: intra sexual selection (male rivalry), inter-sexual selection (female choice), infanticide, sperm competition, mate guarding, sexual selection in human, consequences of mate choice for female fitness, monogamous verses polygamous sexual conflict.
LABORATORY WORK (ENV411)	1. To study the responses of woodlice to hygrostimuli. 2. To study the geotaxis behaviour of earthworm. 3. To study the orientational responses of 1st instar noctuid larvae to photo stimuli. 4. To study the median threshold concentration of sucrose solution in eliciting feeding responses of housefly. 5. To study the orientational responses of larvae to volatile and visual stimuli.
SUGGESTED READINGS	1. *Mechanism of Animal Behaviour*, Peter Marler and J. Hamilton; John Wiley & Sons, USA 2 *Animal Behaviour*, David McFarland, Pitman Publishing Limited, London, UK 3 *Animal Behaviour*, John Alcock, Sinauer Associate Inc., USA 4 *Perspective on Animal Behaviour*, Goodenough, McGuire and Wallace, John Wiley & Sons, USA 5 *Exploring Animal Behaviour*, Paul W. Sherman & John Alcock, Sinauer Associate Inc. ,Massachusetts, USA 6 *An Introduction to Animal Behaviour*, A. Manning and M.S Dawkins, Cambridge University Press, UK 7. Animal Behaviour by Ranga M.M. Agrobios, Jodhpur, India

M.Sc (ZOOLOGY)			IVTH SEMESTER
COURSE CODE: ZOO 402			**COURSE TYPE: CCC**
COURSE TITLE: Biology of Parasitism			
CREDIT:7		**HOURS:135**	
THEORY: 5	**PRACTICAL:2**	**THEORY: 90**	**PRACTICAL:45**
MARKS			
THEORY:100(30+70)		**PRACTICAL:33**	
OBJECTIVE: The purpose of the course is to make the students to understand biology of parasitism			

18 Hours	1 General organization and classification of parasitic protozoa .2 Morphology, Life cycle ,Mode of infection- Endameba. 3 Morphology ,Life cycle mode of infection -Trypanosome . 4 Morphology ,Life cycle in Guardia .6 Life cycle and infection of plasmodium .
18 Hours	1 Gastro intestinal nematodes-Ascaris.2 Morphology life cycle in Wuchereia. 3 Morphology life cycle in Ancylostoma .4 Life cycle of Enterobius vermicularis .5 Trichinella .6 Dracanculus .
18 Hours	1 General organigation and classification parasitic Cestodes .2.Life cycle of Parasitic Fasciola hepatica . Viral disease- 3 AIDS.4 Rabbis .4 Plague 5 Small pox .
18 Hours	Bacterial disease -1 Tuberculosis .2 Leprosy .3 Fungal diseases –Mycosis .4 Reproduction in bacteria (Asexual and Sexual)5 Life cycle and infection –Leismania .
18 Hours	Diseases transmitted by Insects and Ticks- 1 Sleeping sickness .2 Malaria 3 Rickettesiae .4 Plant parasite nematods .5 Gastro intestinal Helminthes – biology and life cycle Systosoma .

LABORATORY WORK (ZOO-412)	1.Study of prepared slides and museum specimens of selected parasites of representative groups of protozoans, helminths and arthropods. 2. Demonstration of *in vitro* culture of *Plasmodium*, infection of mice with *Plasmodium*, chasing the process of infection by histopathology and immune reactions. 3. Culturing insect parasitic nematode, and chasing the lifecycle of the nematode on the insect host. 4. Culturing an insect parasitoid and studying their infection on an insect host. 5. Studying the infection of tomato plant by root knot nematode.
SUGGESTED READINGS	1. Foundations of Parasitology, Roberts L.S. and Janovy J., McGraw-Hill Publishers, New York, USA. 2. Modern Parasitology: A Textbook of Parasitology, FEG Cox., Wiley-Blackwell, U. K.

M.Sc (ZOOLOGY)			**IVTH SEMESTER**
COURSE CODE: ZOO 403			**COURSE TYPE: CCC**
COURSE TITLE: Comparative Endocrine Physiology			
CREDIT:7		**HOURS:135**	
THEORY: 5	**PRACTICAL:2**	**THEORY: 90**	**PRACTICAL:45**
MARKS			
THEORY: 100(30+70)		**PRACTICAL:0**	
OBJECTIVE: The purpose of the course is to make the students to understand Endocrine physiology			

UNIT-1- ***18 Hours***	Concept of endocrinology: introduction to the endocrine system, classes of hormones, modes of hormone secretion. Phylogeny of endocrine system. Endocrine control of various physiological mechanisms in nemerteans, annelids, mollusks, arthropods (Insects and crustaceans) and echinodermates.
UNIT-2- ***18 Hours***	Comparative aspects of endocrine physiology in vertebrates. Evolution of pituitary gland; Physiological actions of pituitary hormones. Urophysis and action of its hormone(s). Evolution of discrete adrenal gland; Synthesis of corticosteroid, structural diversity of glucocorticoids among vertebrates, role of glucocorticoid in gluconeogenesis;
UNIT-3- ***18 Hours***	Evolution of renin-angiotensin system, hormonal control of water and electrolyte balance; Catecholamine biosynthesis, its storage and release mechanism, physiological actions of adrenal medullary hormones; Importance of adrenocortical and adrenomedullary interaction.
UNIT-4- ***18 Hours***	Evolution of thyroid gland. Thyroid hormone synthesis and its regulation, paradigms of thyroid hormone action in poikilotherms and homeotherms. A comparative account of parathyroid gland and ultimobranchial body/C cells, synthesis of parathyroid hormone, calcitonin and of vitamin D3; benthic organisms and source of vitamin D; hormonal regulation of calcium and phosphate homeostasis.
UNIT-5- ***18 Hours***	Hormonal control of feeding behaviour and gastrointestinal tract functioning including acid release, gall bladder contraction and relaxation, pancreatic enzyme secretion, and GI tract motility; Pancreatic hormones and glucose homeostasis; hormones, vitellogenesis and the evolution of viviparity.

SUGGESTED READINGS	1. Comparative Vertebrate Endocrinology, Bentley, P. J., Cambridge University Press, UK 2. Vertebrate Endocrinology, Norris D. O., Elsevier Academic Press, 3. Hand Book of Physiology, American Physiological Society, Oxford University Press, Section 7: Multiple volumes set. 4. The Insects: Structure and Function, Chapman, F.R., The English Language Book Society (ELBS) and The English Universities Press Ltd. 5. The Principles of Insect Physiology Wigglesworth, V. B., ELBS and Chapman and Hall.

M.Sc (ZOOLOGY)			**IVTH SEMESTER**
COURSE CODE: ZOO D01			**COURSE TYPE: ECC/CB**
COURSE TITLE: Genomics, Metagenomics and Epigenetics- Genomics			
CREDIT:6		**HOURS:90**	
THEORY: 6	**PRACTICAL:0**	**THEORY:90**	**PRACTICAL:0**
MARKS:			
THEORY:100(30+70)		**PRACTICAL:0**	

OBJECTIVE: The purpose of the course is to make the students to understand Genomics, Metagenomics and Epigenetics- Genomics	
UNIT-1- *15 Hours*	Organization and structure of genomes - size, complexity, gene-complexity, virus and bacterial genomes, organelle genome, architecture of mitochondrial genome, conserved chloroplast DNA;
UNIT-2- *15 Hours*	organization and nature of nuclear DNA in eukaryotes; transposable elements, retro-teaspoons, SINE, LINE, Alu and other repeat elements, pseudogenes, segmental duplications.
UNIT-3- *20 Hours*	Mapping genomes - physical maps, EST, SNPs as physical markers, radiation hybrids, FISH, optical mapping, gene maps, integration of physical and genetic maps; sequencing genomes: high-throughput sequencing, strategies of sequencing, recognition of coding and non-coding regions and annotation of genes, quality of genome-sequence data, base calling and sequence accuracy.
UNIT-4- *20 Hours*	Bioinformatics - datasets, sequence analysis based on alignment, de novo identification of genes, *in silico* methods. Comparative genomics - orthologs and paralogs, protein evolution by exon shuffling; human genome project, comparative genomics of bacteria, organelles, and eukaryotes

UNIT-5- ***20 Hours***	Large scale mutagenesis and interference - genome wide gene targeting; systematic approach, random mutagenesis, insertional mutagenesis, libraries of knock-down phenocopies created by RNA interference; transcriptome analysis, DNA micro-array profiling, data processing and presentation, expression profiling, proteomics - expression analysis, protein structure analysis, protein-protein interaction.
SUGGESTED READINGS	1.Principle of Genome Analysis and Genomics, Primrose, S. B. and Twyman R. M., (7th Ed., 2006), Blackwell Publishing Company, Malden, USA 2. Genomes 3, Brown, T. A., Garland Science Publishing, London, UK 3. Bioinformatics: Sequence and Genome Analysis, Mount, D. W., Cold Spring Harbor Laboratory Press, New York, USA

M.Sc (ZOOLOGY)		IVTH SEMESTER	
COURSE CODE: ZOO D02		**COURSE TYPE: ECC/CB**	
COURSE TITLE: Metagenomics- Epigenetics and Chromatin Biology			
CREDIT:6		**HOURS:90**	
THEORY: 6	**PRACTICAL:0**	**THEORY: 90**	**PRACTICAL:0**
MARKS:			
THEORY: 100(30+70)		**PRACTICAL:0**	
OBJECTIVE: The purpose of the course is to make the students to understand Genomics, Metagenomics and chromatin biology			
UNIT-1- *20 Hours*	Chromatin structure - basic organization of a eukaryotic genome; histone - structure and function; nucleosome as the fundamental particle; 30 nm chromatin fibers, higher order structure of chromatin, chromatin-territories; intra-nuclear spatial organization of chromatin: MARs and SARs and their importance		
UNIT-2- *20 Hours*	Epigenetics - from phenomenon to field, a brief history of epigenetics - overview and concepts; chromatin modifications and their mechanism of action, concept of 'histone-code' hypothesis, epigenetics in *saccharomyces cerevisiae*, position effect variegation, heterochromatin formation, and gene silencing in *Drosophila*		
UNIT-3- *20Hours*	fungal models for epigenetic research: *Schizosaccharomyces pombe* and *Neurospora crassa*; epigenetics of ciliates; RNAi and heterochromatin assembly, role of noncoding RNAs; epigenetic regulation in plants.		
UNIT-4- *15 Hours*	Chromatin structure and epigenetics marks - transcriptional silencing by polycomb group proteins , transcriptional regulation by trithorax group proteins, histone variants and epigenetics , epigenetic regulation of chromosome inheritance, epigenetic regulation of the X chromosomes in *C.elegans*, dosage compensation in *Drosophila*, dosage compensation in mammals; types mechanism of chromatin remodeling.		
UNIT-5- *15 Hours*	Epigenetics and genome imprinting - DNA methylation in mammals, genomic imprinting in mammals, germ line and pluripotent stemcells , epigenetic control of lymphopoiesis , nuclear transplantation and the reprogramming of the genome. epigenetics and human disease, epigenetic determinants of cancer.		

SUGGESTED READINGS	1. *Epigenetics*, C. David Allis and Thomas Jenuwein, (2007)Cold Spring Harbor Laboratory Press, New York, USA 2. *Molecular Biology of Gene*, Watson et al., (5th Ed. 2004), Pearson Education, Delhi, INDIA