- **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, p_{RB}, p_{53}, p_{APC}, 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.