UNIVERSITY OF CALCUTTA SYLLABUS
STRUCTURE FOR M.Sc. (ZOOLOGY) SEMESTER
COURSE

		Marks	Credit
1st Semester -	ZCT 101 - Structure & Functions of Nonchordates	- 40	3
	ZCT 102 - Ecological theories and applications	- 40	3
	ZCT 103 - Genetics and Genetic Engineering	- 40	3
	ZCT 104 - Tissue structure, Function and Chemistry	- 40	3
	ZCT 105 - Parasites and Immunity	- 40	3
	ZCP 106 - Laboratory course (5 modules)	- 50	3
		250	**18**
2nd Semester -	ZCT 207 - Structure & Functions of Chordates	- 40	3
	ZCT 208 - Comparative Animal Physiology	-40	3
	ZCT 209 - Endocrinology and Neuroscience	-40	3
	ZCT 210 - Cell and Receptor Biology	- 40	3
	ZCT 211 - Biochemistry and Molecular biology	- 40	3
	ZCP 212 - Laboratory course (5 modules)	- 50	3
		250	**18**
3rd Semester -	ZCT 313 - Taxonomy and Biodiversity	- 40	3
	ZCT 314 - Evolution and Animal Behaviour	- 40	3
	ZCT 315 - Development and Differentiation	- 40	3
	ZCP 316 - Laboratory course (3 modules)	- 40	2
	ZET 301 - 309 - Elective I Theory	- 50	4
	ZEP 301 - 309 - Elective I Practical	- 40	3
		250	**18**
4th Semester -	ZCT 417 - Conservation Biology and Wild life	- 40	3
	ZCT 418 - Biostatistics, Bioinformatics and Instrumentation	- 40	3
	ZCT 419 - Biotechnology and Applications	- 40	3
	ZCP 420 - Laboratory course (1 module)	- 20	1
	ZET 401 - 409 - Elective II Theory	- 50	4
	ZEP 401 - 409 - Elective II Practical	- 40	3
	Seminar & Dissertation / Review	- 20	1
		250	**18**

Fields of Specialization for Electives:

1. Ecology
2. Endocrinology
3. Entomology
4. Environmental Biology & Toxicology
5. Fisheries and Aquaculture
6. Genetics and Molecular Biology
7. Immunology
8. Wildlife biology
9. Stem cells and developmental biology

1000 72

The regulations for the Two-year M. Sc. course in Zoology, University of Calcutta

1. The University of Calcutta shall provide instructions leading towards two year (four semesters) M. Sc. degree in Zoology.

2. A candidate who has passed the three-year B.Sc. Examination with **Honours in Zoology** will be eligible for admission to this course.

3. A limited number of seats, at par with the UGC guidelines, will be available to the non-C.U. students. These students, however, will have to satisfy the same eligibility criteria applicable to the students of University of Calcutta.

4. 4. The duration of the course shall be two academic years and the examination for the M. Sc. degree in Zoology shall be held over four semesters over a total of 1000 marks. The duration of the semesters shall be as follows:

1st Semester	**July– December**
2nd Semester	**January– June**
3rd Semester	**July –December**
4th Semester	**January – June**

Course Structure

To be comprised of:
A] **Core Subjects** : Compulsory for all
B] **Elective Subjects** : **Specializations** (Optional) – Each student has to opt for only one elective from the list of the courses offered in each of the 3rd and 4th Semesters.

	MARKS			CREDIT		
	THEORY	PRACTICAL	Total	THEORY	PRACTICAL	Total
1st Semester	**200**	**50**	**250**	**15**	**3**	**18**
2nd Semester	**200**	**50**	**250**	**15**	**3**	**18**
3rd Semester	**170**	**80**	**250**	**13**	**5**	**18**
4th Semester	**170**	**80**	**250**	**13**	**5**	**18**
GRAND TOTAL:			**1000**			**72**

5. The courses shall comprise a total marks of 1000 and credit of **72** evenly distributed over the four semesters. The courses shall be grouped as Core and Elective (Specialization) and will carry credits according to the number of theoretical classes required, study hours and laboratory hours.
6. A candidate shall be eligible for appearing at the examination provided he/she prosecutes a regular course of studies in Zoology maintaining percentage of attendance as specified by the University.
7. Examinations would be held after the completion of curriculum at the end of each semester. However, evaluation of the core practical will be based on continuous assessment as well as the final consolidated practical and viva-voce examination of the students on the laboratory course. The marks allotted through internal assessment, and assessment of the final consolidated practical comprising of external examiners, will be in the ratio of 2:3.
   Evaluation of the elective practical will be based on continuous assessment as well as the final consolidated practical and viva-voce examination of the students on the laboratory course. The marks allotted through internal assessment, and assessment of the final consolidated practical comprising of external examiners, will be in the ratio of 2:3.
8 The credit course may comprise of only theory, or only practical. The candidate should obtain at least 50% in each of the theory and practical courses, to qualify in each semester.
9. If a student gets 'F' in a particular course, he/she shall be deemed to have failed in that course only and shall be required to repeat that course in a supplementary examination, along with the next coming semester when offered. A student can attempt a maximum number of two times to clear a particular course (including the first one) failing which he/she shall be dropped from the rolls of the University on the advice of the concerned authority.
10. If a student is dropped from the University rolls because of the failure to clear a particular course, he/she may apply for readmission in the beginning of the next academic session along with fresh application.
11. A student securing a cumulating grade point of average C or above shall be considered as secured at least 50% of the marks.
12. Paper-setter and examiner for each of the core theory papers will comprise of three internal examiners appointed on the recommendations of the Board of Post Graduate Studies in Zoology.
13. There shall be at least one external paper-setter and examiner for each of the elective theoretical papers in 3rd and 4th Semester, appointed by the authority for this purpose.
14. The external paper-setters may be from the other Universities / faculty members of premier research institutions.
15. Examination time for theory papers with more than 25 and upto 40 marks, will be 1hr 30 mins, courses having full marks more than 40 upto 50, will be 2 hours.
16. Continuous evaluation of laboratory practicals of core and elective papers will be taken into account by the internal examiners throughout the course in all the semesters.
17. The students will be required to give a seminar (marks 20) on their review work related to the elective paper opted during the 3rd and 4th Semester. A panel of examiners comprising of both internal and external examiners shall evaluate the work performed and the presentation.
18. For each of the semester theoretical examinations, there shall be a Board of Moderators for the theoretical papers.

Structure and Function of Nonchordate

ZCT 101

36 Lectures
40 marks
3 credits

1. Non chordate body forms
- 1.1 Non chordate body forms and adaptive significance
- 1.2 Synopsis of diversity of non chordate phyla

2. Feeding and Digestion
- 2.1 Nutrition in protozoa - Types and mode of feeding
- 2.2 Feeding diversity in insects
- 2.3 Filter feeding in Crustacea and Mollusca-Functional mechnism
- 2.4 Feeding & digestion in Bryozoa and Echinodermata

3. Excretion
- 3.1 Organs of Excretion in nonchordate animals
- 3.2 Excretory structures and functions in Helminthes
- 3.3 Excretory structures and functions in Annelids and Insects

4. Sense organs
- 4.1 Chemical senses & animal orientations in nonchordates
- 4.2 Mechanoreception in nonchordates
- 4.3 Chemoreception & chemotaxis in insects
- 4.4 Statocysts as balancing organ in molluscs
- 4.5 Photoreception and photosensitivity in non chordate forms, Functional morphology of compound eye in arthropods

5. Reproduction
- 5.1 Reproductive mechanisms in nonchordates–Asexual, Sexual. Parthenogenesis, Hermaphroditism,
- 5.2 Functional form variations of reproductive organs in nonchrordate examples.
- 5.3. Invertebrate hormones of reproduction in annelids, Molluscs, Echinoderms, crustaceans, and insects.

6. Movements
- 6.1 Micromorphology and mechanism of Contractile motility in nonchordates. Movements of cilia and flagella
- 6.2 Hydrostatic evasive movements in ctenophora and hydrostatic selection in annelids.
- 6.3 Insect flight mechanism.

7. Growth & Development
- 7.1 Metamorphosis & Diapause in insects & hormonal control
- 7.2 Moulting in crustacea

Ecological theories & applications

ZCT-102

36 Lectures
40 marks
3 credits

1. Population growth and control :

1.1 Age structured population growth and empirical projections
1.2 Deterministic and stochastic growth models, Time lags and limit cycles, Oscillations, chaos.
1.3 Population cycles in discreet time logistic population models-Beverbon-Holt and Ricker model.
1.4 Evaluationg controls on population size, key factor analysis, contemporary ideas on popula tion control.

2. Metapopulation

2.1 Metapopulation concept
2.2 Levin's model of metapopulation and development of theories. Comparison of Metapopulation and Logistic population model.
2.3 Metapopulation structure.
2.4 Metapopulation dynamics-empirical examples.

3. Community organization

3.1 Nature of communities, Analysis of community structure. Gradient analysis and ordination.
3.2 Niche preemption and Random Niche model of species association.
3.3 Species diversity in ecological gradient. Experimental and field test of diversity-stability hy pothesis.
3.4 Competition theory, modelling competitive exclusion and coexistence.

4. System concept

4.1 Fixation, generation and cycling of energy across the food web.
4.2 Measuring ecosystem productivity, Limits to primary production, patterns in primary production.
4.3 Efficiency of primary and secondary production in aquatic system, Limits to secondary production.
4.4 Climate change and Ecosystem

5. System structure and Function

5.1 Ecological processes in Mangrove ecosystem
5.2 Ecological processes in Herbivore dominated ecosystem
5.3 Ecological processes in wetland

6. Ecology of biological and industrial invasion

6.1 Eutrophication in freshwater, coastal and marine ecosystem, Faunal interaction and changes. Remediation of eutrophication.
6.2 Acidification in aquatic and terrestrial environment, Consequences and control strategies.

7. Biodegradation and Bioremediation

7.1 Biodegradation and Bioremediation concept
7.2 Environmental limitation for bioremediation
7.3 Bioremediation of ecosystem (Air/water/soil)

8. Wastes in Ecosystem and management

8.1 Agricultural wastes and Management
8.2 Biomedical wastes and Management
8.3 Domestic waste, effects and management for purification and recirculation

Genetics and Genetic Engineering

ZCT 103

36 Lectures
40 Marks
3 Credits

1. Organisation of genes and chromosomes :

1.1 Organization of chromatin - Nucleosome, molecular anatomy of eukaryotic chromosomes, Structure and organization of telomere, centromere and kinetochore, polytene chromosome.

1.2 Unique and repetitive DNA, Euchromatin and Heterochromatin, Constitutive and facultative heterochromatin, chromatin domains and boundary function.

1.3 Basic ideas of Prokaryote genome, Eukaryotic genome

1.4 Sex-determination and dosage compensation in *C.elegans, Drosophila* and Human

1.5 Transposable elements in Prokaryote and eukaryotes

2.Genetic Imprinting

2.1 Imprinting of genes, Epigenetic regulation by DNA methylation

3. Somatic Cell Genetics

3.1 Cell fusion and technology

3.2 Heterokaryon selecting hybrids and chromosome mapping, hybridoma

4. Microbial genetics

4.1acterial conjugation, transformation and transduction

5. Genetics of Cell Cycle

5.1Genetic regulation of cell division in yeast and eukaryotes. Regulation of CDK-cyclin activities

5.2 Molecular basis of cellular check points

5.3 Molecular basis of neoplasia

6. Recombination and repair

6.1 Recombination : Homologous and non-homologous recombination, site-specific and transpositional recombination

6.2 DNA repair mechanism : types in prokaryotes and eukaryotes

7. Recombinant DNA technology

7.1 Cloning vectors for eukaryotes

7.2 DNA-cloning - Mechanism, Genomic/cDNA Library.

8. Genome expression analysis

8.1 Southern and Northern analysis

8.2 Western Blotting

8.3 DNA Microarray and its application.

8.4 In-situ localisation techniques (FISH and GISH)

Tissue Structure, Function and Chemistry

ZCT 104

36 Lectures
40 Marks
3 Credit

Tissues: concept and classification

1. Epithelial tissue:
- 1.1 Characteristics and basics of epithelial tissue
- 1.2 Molecular Organization of epithelial cell surface modifications
- 1.3 Ultrastructure of transport, synthetic-secretory and specialized epithelial cells

2. Muscle tissue
- 2.1 Characteristics, ultrastructure and functions of muscle cells
- 2.2 Molecular aspects of primary and accessory muscle proteins
- 2.3 Muscle contraction

3. Bone tissue
- 3.1 Ultrastructure and functions of bone cells
- 3.2 Bone development – cancellous and compact bones
- 3.3 Hormones and vitamins on bone regulation

4. Connective tissue
- 4.1 Tropocollagen synthesis, glycosylation and post-transcriptional modification and structure
- 4.2 Collagen types, functions and diseases

5. Extra cellular matrix-organization and chemistry
- 5.1 Structure and composition chemistry of glycosaminoglycans, proteoglycans and adhesive proteins
- 5.2 Distribution, staining and physiological significance of extracellular matrix

6. Histochemical localization of tissue substance of biological interest
- 6.1 Principles and methods of histochemical localization of carbohydrates, proteins, nucleoproteins and lipids in tissues
- 6.2 General consideration of enzyme histochemistry-principles and methods
- 6.3 Inorganic constituents of tissue and localization

7. Histochemical applications of functional approach
- 7.1 Morphological and histochemical changes in malignant tissues
- 7.2 Diagnostic histochemistry and histophysiology-Detection and application in biopsy materials.

ZCT 105

Parasites and Immunity

36 Lectures
40 marks
3 credits

1. Vector Biology
- 1.1 Vectors and its importance in transmission of parasites.
- 1.2 Major malaria vectors of India : Distribution, bioecology, potentially and present sustainability status, form & function)

2. Biology (Form & function) of Parasites.
- 2.1 Protozoan parasites - *Trypanosoma,* Chaga Disease, *Trichomonads*
- 2.2 Helminthic parasites - *Taenia*, *Echinococcus, Systosomiasis*
- 2.3 Nematode parasites - *Fasciola*
- 2.4 Arthropod Parasites - Ticks & Mites

3. Immune System
- 3.1 Phylogeny of Immunity, Evolution of Immune system
- 3.2 Concept of immunity and development of the immune system
- 3.3 Primary and Secondary lymphoid organ.
- 3.4 Tissue, cells and molecules of the human immune system.

4. Innate Immunity
- 4.1 Overview, Features, Epithelial barrier. Neutrophil and Macrophage function.
- 4.2 Inflammation.
- 4.3 NK cell.
- 4.4 Cross-talk with Adaptive Immune system

5. Antigen Presentation
- 5.1. APCs
- 5.2 Dendritic cell
- 5.3. MHC

6. Antigen Recognition
- 6.1 T and B cell receptor
- 6.2 Immunoglobulin-Structure and types
- 6.3 Antigen Receptor Diversity
- 6.4 Clonal selection and Expansion

7. **Host parasite interaction**
- 7.1 Recognition and entry processes of different pathogens like bacteria, viruses into animal and plant host cells,
- 7.2 Alteration of host cell behaviour by pathogens, virus-induced cell transformation, pathogen-induced diseases in animals and plants, cell-cell fusion in both normal and abnormal cells.

8. Cell Mediated Immunity
- 8.1 Peptide recognition, adhesion and co-stimulation
- 8.2 Cell mediated immune response (T_H, T_c)
- 8.3 Th1 and Th2 Response (with emphasis on allergy)

9. Humoral Immunity
- 9.1 Immunoglobulin function
- 9.2 Class switching Mechanism
- 9.3 B-cell function, matuaration and development
- 9.4 Complement pathway & Disease
- 9.5 Monoclonal & Polyclonal Antibody and its application
- 9.6 Immunological Memory and Vaccination

Laboratory Course

ZCP - 106

150 Hours
50 Marks
3 Credits

(A) Module 1 - Non-chordate Anatomy

1. Comparative anatomy of Excretion & Nervous systems in Annelid, Insect and Molluscan models.
2. Special structures (i) Stomatogastric nervous system in cockroach (ii) Poison gland of Ant/Spider (iii) Mounting of mouth parts of mosquito-identification of genera & sex, (iv) Haltere in housefly, mouth parts of housefly
3. Distinctive features of non-chrodate body forms from museum study

(B) Module 2 - Ecological methods

1. Qualitative and Quantitative estimation of Zooplankton communities.
2. Qualitative analysis of sampled terrestrial community
3. Spatial variations of dissolved oxygen concentration in water and percentage saturation.
4. Dissolved free carbon dioxide dynamics in relation to pH and alkalinity of water.
5. Estimation of total hardness. total alkalinity and Salinity of water.
6. Estimation of Primary productivity and assessment of nutrient status of water bodies.

(C) Module 3 - Cytogenetics

1. Chromosome preparations from rat bone marrow and polytene chromosomes.
2. Handling of *Drosophila*, *Drosophila* genetic crosses, Induction of mutation in *Drosophila* by P-M mutagenesis.
3. Karyotyping

(D) Module 4 - Tissue structure & functions.

1. Identification of mammalian tissue sections.
2. Tissue fixation, microtomy and double staining of tissue sections.

(E) Module 5 - Immunological method & Parasitic forms.

1. Identification of parasitic forms
2. Antigen-Antibody Interaction (Haemoagglutination assay)
3. Identification of histological slides of lymphoid tissue
4. Immunization Protocol Demonstration of Thioglycolate induced peritonitis (cell infiltration and Inflammatory exudates)

(F) Sessional work (Internal evaluation)

(G) Viva voce

Structure and Function of Chordates

36 Lectures
40 Marks
3 Credits

ZCT - 207

1. Protochordates
- 1.1 Fine structure and role of notochored and endostyle in Amphioxus and Ascidia with evolu tionary significance.

2. Skeletal System
- 2.1 Origin of Jaw and modification of Jaw bones and types. Functional and evolutionery signifi cance
- 2.2 Jaw kinetics in relation to feeding.

3. Respiration
- 3.1 Pre-requisites of respiratory system and functional requirements
- 3.2 Ventilatory mechanisms
- 3.3 Analysis of structures and functions

4. Circulation
- 4.1 Heart and circulation in foetal and neonatal mammal.
- 4.2 Evolution of portal systems

5. Sense organs
- 5.1 Sensory receptors and classification
- 5.2 Organs of olfaction and taste
- 5.3 Special senses : Vomero-nasal organs in reptiles, electroreception in fish.

6. Nervous System
- 6.1 Functional organization of Brain
- 6.2 Evolution of cerebrum
- 6.3 Functional association of CNS and information processing

7. Excretion
- 7.1 Evolution of uro-genital system in vertebrate series.
- 7.2 Ultrastructure of kidney and its role in homeostasis.
- 7.3 Juxtaglomerular apparatus.

8. Structural Adaptations
- 8.1 Structural elements of the body
- 8.2 Energetics and Locomotion
- 8.3 Feeding adaptations
- 8.4 Swimming, flying and gliding mechanics

Comparative Animal Physiology

36 Lectures
Marks - 40
Credit - 3

ZCT - 208

1. Principles of Animal Physiology
- 1.1 Idea of mechanistic and Evolutionary physiology
- 1.2 Homeostasis in different forms.

2. Size and Scale of organisms
- 2.1 Size and Surface area to volume ratio
- 2.2 Metabolic scope (Scaling relationship) between BMR and Bodymass
- 2.3 Metabolic rates as a function of body mass in mammals and arthropods.
- 2.4 Metabolic rate as a function of animal locomotor speed
  - a. In locust and migratory butterfly
  - b. In rainbow trouts c.
  - In speedy cheetah.

3. Thermal Physiology
- 3.1 Heat Transfer between animal and environment
- 3.2 Poikilothermy and Homeothermy
- 3.3 Physiological adjustments in extreme environmental conditions.

4. Sensory Physiology
- 4.1 Lateral Inhibition and enhanced edge effect in invertebrates under different Illumination
- 4.2 Receptor system and sensory perception in phytophagous insects.
- 4.3 Phototransduction in compound and vertebrate eye.

5. Physiology of Excrection
- 5.1 Physiology of ultrafiltration, Reabsorption, tubular secretion.
- 5.2 Counter current theory of urine concentration, Regulation of urine formation.
- 5.3 Method of Urine formation, Nitrogenous wastes
- 5.4 Renal regulation of acid-base balance

6. Physiology of blood and body fluids :
- 6.1 Comparative structure of cells in circulation of invertebrate and vertebrates.
- 6.2 Composition of blood, Plasma and blood Corpuscles, in vertebrates, Functions.
- 6.3 Haemopoiesis.

7. Physiology of Respiration
- 7.1 Respiratory pigments in animals
- 7.2 Physiology of aerial and aquatic respiration in invertebrates and vertebrate examples.
- 7.3 Respiratory adaptations in animals living in O_2 deficient environment.

8. Physiology of behaviour
- 8.1 Pheromones in colonial interactions, foraging and mating
- 8.2 Allelo chemicals in plant-Insect interaction
- 8.3 Chemotaxis

Endocrinlogy and Neuroscience

36 Lectures
Marks 40
Credit 3

ZCT- 209

1. Classification of hormones.
2. General principles of nature of hormone action.
3. Nature of hormone receptors
4. Neuroendocrine feedback and response to varied stimuli
5. Hypothalamic hormones - their structure and functions.
6. Anterior pituitary cell ultrastructures, nature of hormones and their functions.
7. Neurosecretion - structure and functions of oxytocin and vasopressin
8. Structure and functions of hormones:
- 8.1 Thyroid hormone structure and functions.
- 8.2 Pancreatic cell types, hormone structure and their role in glucose, homeostasis.
- 8.3 GI tract hormones: source, composition and functions.
- 8.4 Adrenocorticomedullary hormones – structure and functions
- 8.5 Role of gonadotrophins and steroids in estrous cycle

9. Neurogenesis Neuronal Ageing and death
- 9.1 Sequential development of neurons from stem cells
- 9.2 Development of neuronal functionality
- 9.3 Factors leading to neuronal death

10. Electrical properties of nerve cells
- 10.1 General organization of neuron
- 10.2 Neuronal cytoskeletons
- 10.3 Molecular aspect of development of action potential and conduction

11. Overview of synaptic function
- 11.1 Ionotropic and metabotropic receptors and neurotransmission
- 11.2 Mechanism of neurotransmitter release
- 11.3 Role of calcium in biochemistry of exocytosis and endocytosis

12. Neuromuscular Junction
- 12.1 Organization and properties of neuromuscular junction
- 12.2 Neurotransmitters, neurohormones and neuromodulators

13. Aspects of neuronal disorders
- 13.1 Strokes and exicotoxicity and NMDA receptors
- 13.2 Epilepsy
- 13.3 Parkinson's disease
- 13.4 Alzheimer's disease

Cell and Receptor Biology

ZCT- 210

36 Lectures
40 Marks
3 Credit

1. Cell membrane:
- 1.1. Structure (model cell membrane structure, lipid bilayer, proteins and principles of membrane assembly) and biosynthesis of cellular membranes (incl. specialized areas of plasma membrane and cell junctions);
- 1.2. Roles of adhesion and other cell surface molecules like integrins and other receptors (some important GPCRs) and signaling (clinical correlation);
- 1.3. Membrane transport: Protein diffusion osmosis, ion channels, active transport, ion pumps, mechanisms of sorting and regulation of intrac ellular transport, electrical properties of membranes.

2. Structural organization and function of intracellular organelles:
- 2.1. Sites of organelle and membrane protein synthesis,
- 2.2. Concept of structure-function dynamism of GERL complex,
- 2.3. Protein import into cell nucleus,
- 2.4. Mitochondrial DNA- structure, expression and variability,
- 2.5. Synthesis and localization of mitochondrial protein.

3. Cytoskeleton and cell movements:
- 3.1. Structure and diversity of microtubules,
- 3.2. Heterogeneity of α and β tubulin,
- 3.3. Intracellular transport via microtubules (clinical perspective).

4. Cell to cell communication:
- 4.1. Extracellular matrix, and cell and matrix interactions during development,
- 4.2. Regulation of hematopoiesis,
- 4.3. Cell growth and oncogenic transformation.

5. Receptor Biology and Cell signaling :
- 5.1. Receptor classes-(i) Nuclear receptors, (ii) Membrane receptors (Enzyme linked receptors, Ion channel receptors), (iii) Miscellaneous receptors (Toll like receptors-TLR)
- 5.2. Signal transduction:
  - (i) G-protein mediated signaling pathway
  - (ii) Cytokine receptor-STAT mediated signaling pathway
  - (iii) Receptor tyrosine kinase-subfamilies, signaling (overview)-specific examples with relevance to drug discovery (ERBB1 AND 2, HER/neu, tyrosine kinase activities of EGFR, VEGFR)
  - (iv) Second messenger pathways-iNOS
  - (v) Ras-Raf, MAPK- ERK, MEK pathway
  - (vi) Cell death pathway

Biochemistry and Molecular Biology

ZCT-211

36 Lectures
40 marks
3 credits

1. Protein metabolism :
- 1.1 Amino acid classification and SAR,
- 1.2 Metabolic of Amino acids.
- 1.3 Detoxification of Amino acid

2. Enzymes :
- 2.1 Classification and preferability as drug targets,
- 2.3 Effect of substrate, pH, temperature,
- 2.4 Allosteric modulation.

3. Carbohydrates and Lipids Metabolism :
- 3.1 Digestion, absorption, metabolism
- 3.2 Glycolysis, glycogenolysis, gluconeogenesis, TCA cycle, Digestion and absorption, Interrelationship between different carbohydrate metabolism
- 3.3 Lipid
- 3.4 (Cholesterol biosynthesis and metabolism)
- 3.5 Prostaglandins

4. Bioenergetics :
- 4.1 Energy producing and utilizing systems,
- 4.2 Electron transfer and oxidative phosphorylation,
- 4.3 Concept of CYP enzymes and implications in pharmacology.

5. Vitamins and minerals : Free redicals and anti-oxidants

6. DNA Replication :
- 6.1 Prokaryotic and euraryotic DNA replication. Mechanics of DNA replication

7. Transcription :
- 7.1 Basic concept of prokaryotic and eukaryotic transcription
- 7.2 Transcriptional and post-transcriptional events-splicing, capping, polyadenylation, other RNA processing events (Transplicing, Editing and receptor mRNA Stability)
- 7.3 Post transcriptional gene silencing

8. Translation :
- 8.1 Prokaryotic and eukaryotic translation including mechanism of initiation, elongation and termination
- 8.2 Co-and post translation modification of proteins

9. Antisense and Ribozyme Technologies :
- 9.1 Molecular mechanism of antisense molecules
- 9.2 Biochemistry of Ribozyme
- 9.3 Gene therapy with special reference to antisense and ribozyme technologies.

10. DNA based Molecular Markers :
- 10.1 DNA fingerprinting (AFLP, RFLP and RAPD-PCR)
- 10.2 Expressed sequence tags and their use for developing STSs, SSRs and SNPs.

Laboratory Course

ZCP-212

150 Hours
50 Marks
3 credits

(A) Module - 1 Chordate Anatomy

1. Comparative anatomy of Circulation and Urogenital systems in Fish and Mice model.
2. Special Structures (i) Olfactory apparatus and otolith in Tilapia (ii) Weberian ossicles and swimbladder in carp

(B) Module - 2 Comparative animal Physiology

1. Determination of activity of anylase from ecto and endothermic organisms.
2. Haemocytes in invertebrate models Blood corpuscles in a vertebrate model

(C) Module - 3 Endocrine and Neurobiology.

1. Processing and double staining of different stages of estrous cycle of rats.
2. Identification of endocrine gland sections
3. Estimation of Acetylcholinesterase in animal model.
4. Sympathetic nervous system / Spinal nerves in rat model.

(D) Module - 4 Cell Biology

1. Quantification of cells by Trypan blue exclusion dye.
2. Adhesion and suspension cell culture technique
3. Characterization of haemtaopoietic cells in mice

(E) Biochemistry and Molecular Biology

1. Determination of Km of an enzyme
2. Determination of glucose in different patho physiological condition.
3. Estimation of total protein from tissues of animal model
4. DNA isolation and Agarose gel electrophoresis
5. Thin Layer chromatography

(F) Sessional Work (Internal Evaluation)

(G) Viva-Voce

Taxonomy and Biodiversity

36 Lectures
40 Marks
3 Credits

ZCT 313

1. Characters
- 1.1 Discrete and overt characters
- 1.2 Identifying primitive, advanced character states, character state transitions.
- 1.3 Missing data and polymorphic characters, characters of special consideration, charaters subject to strong selection pressure
- 1.4 Environmental effects
- 1.5 Molecular sequence characters
- 1.6 Microcharacters, cryptic and internal characters
- 1.7 Artifacts
- 1.8 Behavioural characters

2. Texa and species
- 2.1 Phylogenetic groups, Monophyly, Polyphyly and Paraphyly
- 2.2 Problem with parthenogenetic and asexuals

3. Phylogenetic reconstrution, cladistic and related methods
- 3.1 Cladistics and Cladogram
- 3.2 Parsimony

4. Phenetic methods
- 4.1 Similarity and distance measure
- 4.2 Measures using binary characters
- 4.3 Similarity distance measures using continuous data

5. The meanings to Biodiversity
- 5.1 Conceptial framework of Biodiversity
- 5.2 Problems and scales of Biodiversity extinctions in time and space
- 5.3 Levels and Measures of Biodiversity, Interrclationship between Biodiversity measures, applications and integration of diversity measures.
- 5.4 Process and pattern of local and regional biodiversity-Niche assembly theories, unified Neutral theory, Island biogeography model

6. Threats to species diversity
- 6.1 Natural and Human induced threats and vulnerability of species to extinctions
- 6.2 Biodiversity and Rarity, Endemism and Biodiversity
- 6.3 Problem of Genetic diversity loss over time : Bottleneeks, Genetic drifts, Inbreeding depression
- 6.4 Effective and minimum viable population size, measurements and variations
- 6.5 Review of Risks to Biodiversty extinctions. Extinction vortex

7. Uncertainities and biodiversity extinction
- 7.1 Dynamics and spatial uncertainities
- 7.2 Population fragmentation and Metapulation. Level of genetic variation in metapopulation, metapopulation and extinction

8. Global pattern of biodiversity
- 8.1 Diversity in biogeographical region and marine zones
- 8.2 Diversity clines in relation to area, latitude, altitude and deep sea
- 8.3 Theories on biodiversity dispersions

9. Tracking biodiversty towards management
- 9.1 Biodiversity indicators : Surrogate species
- 9.2 Taxon based biodiversity indicators
- 9.3 Structure and Function based biodiversity indicators
- 9.4 Ecological redundancy and Function based indicators.

Evolution and Animal Behaviour

ZCT 314

36 Lectures
40 Marks
3 Credits

1. Arguments of evolutionary ideas and evolutionary theories since Darwin
2. Evolutionary Process
- 2.1 Mechanisms producing genetic diversity
- 2.2 Phenotypic diversity by the regulation of gene expression

3. Natural Selection and Adaptation
- 3.1 The concept of stabilizing selection, Disruptive selection, Frequency dependent selection, Balancing selection
- 3.2 Adaptation program
- 3.3 Neutral theory of evolution and neutralist-selectionist controversy

4. Gene Frequencies in Population
- 4.1 The Hardy-Weinberg principle and analysis of gene frequencies in natural population.
- 4.2 Major factors influencing gene frequencies (migration, inbreeding), effects of selection and mutation on gene frequencies. Gene flow between subpopulations, genetic drift

5. Patterns and trends in evolution
- 5.1 Constructing evolutionary trees, measures of genetic relationship among organisms
- 5.2 Molecular clock of evolution
- 5.3 Molecular phylogeny

6. The Origin and Evolution of Primates
- 6.1 Evolution of Anthropoid Primates
- 6.2 The first hominids and origin of modern man

7. Principles and mechanisms of animal behaviour:
- 7.1 Four propositions of Tinbergen

8. Gene, Environment and Behaviour/Levels of Selection:
- 8.1 Individual vs Group Selection
- 8.3 Fundamental of Behavioral Genetics and molecular tools
- 8.4 Genotype and Environment Interaction, Phenotypic Plasticity

9. Cooperation and conflict:
- 9.1 Male-male competition and sexual selection
- 9.2 Elaborate ornaments: Fisher's hypothesis and Handicap hypothesis
- 9.3 Parent-offspring conflict
- 9.4 Range of cooperative behaviours and Prisoner's dilemma

10. Foraging:
- 10.1 Optimal foraging theory
- 10.2 Foraging and predation risk: defense strategies against predators
- 10.3 Territoriality and Group foraging

11. Aggression:
- 11.1 Aggressive behaviour
- 11.2 Game theory models and strategies

12. Sensory system and Communication:
- 12.1 Signal content and structure
- 12.2 Orientation and cues

Development and Differentiation

ZCT 315

36 Lectures
40 Marks
3 Credits

1. Principles of Developmental Biology
- 1.1 Potency, commitment, specification, induction, competence,
- 1.2 Determination and differentiation; morphogenetic gradients; cell fate and cell lineages

2. Embryonic stem cells
- 2.1 Embryonic stem cells; Stem cell niches.
- 2.2 Genomic equivalence and the cytoplasmic determinants.

3. Gametogenesis, fertilization and early development:
- 3.1 Primordial Germ cells and development of sex organs
- 3.2 Production of gametes, prerequisites of fertilization
- 3.3 Zygote formation, cleavage, blastula formation, embryonic fields,
- 3.4 Gastrulation and formation of germ layers in animals; embryogenesis

4. Metamorphosis and organogenesis in model animal system:
- 4.1 Axes,compartment formation and pattern formation in *Drosophila*. Wnt and cadherin pathways
- 4.2 Sea urchin axis specification and coiling genetics of snail embryos
- 4.3 Organogenesis – vulva formation in *Caenorhabditis elegans*
- 4.4 Organizer formation and Mesoderm specification and metamorphosis in Xenopus and Chick
- 4.5 Maternal effect mutations and Neurulation in zebrafish
- 4.6 Limb development and regeneration in vertebrates

5. Ageing and Senescence
- 5.1 Mitochondrial control of ageing
- 5.2 Insulin pathway control of ageing and possible relation to oxygen radicals
- 5.3 "Ageless" animals and environmental control of ageing
- 5.4 Senesence and cell death

6.Environmental regulation of normal development
- 6.1 Molecular bases for environmental regulation of gene expression
- 6.2 Importance of symbionts in mammalian gut and immune system development
- 6.3 Signaling from fetal mammalian lung to initiate labor
- 6.4 Predator-induced polyphenism and toxicity testing
- 6.5 Genetic assimilation of environmentally induced traits

7. Sex determination
- 7.1 Timing and gene expression in mammalian sex determination
- 7.2 Brain sex determination pathways in vertebrates and flies
- 7.3 Hormone disruptors and sex determination problems
- 7.4 Temperature-dependent sex determination in turtles
- 7.5 Evoloution of sex from invertebrate to vertebrate

Laboratory Course

ZCP - 316

90 Hours
50 Marks
3 credits

(A) Module - 1 : Taxonomy and Biodiversity.

1. Taxonomic Study : Insect spider model, Fish Model.
2. Recognition of fauna from museum study and taxonomic key preparation.
3. Biodiversity assessment, Measuring species diversity of aquatic community, Dominance diversity analysis.
4. Diversity Parameters for comparative study of habitats.
5. Community analysis indices.

(B) Module-2 - Evolution and Animal Behaviour

1. Foraging behaviour in ants - Orientation and cues.
2. Quantifying aggressive behaviour in ants, Predatory behaviour in fish.
3. Focal behavioural sampling - Behavioural repertoire.
4. Time activity budgeting
5. Evolutionery significance of Isozyme analysis
6. Pattern of evolution from museum study

(C) Module - 3 - Development Biology

1. Identification of diagnostic features of the early stages of developing Chick embryo (brain, eye, heart and somites)
2. Preparation of different stages of chick embryo from blastoderm to subsequent changes.
3. Developing stages of fish embryo-characteristics and documentation

(D) Sessional work (Internal evaluation)

(E) Viva voce

Conservation Biology & Wildlife

ZCT - 417

36 Lectures
40 Marks
3 Credits

1. Biodiversity extinction and conservation approaches
- 1.1 Perspectives and Expressions.
- 1.2 Identification and prioritization of Ecologically sensitive area (ESA)
- 1.3 Coarse filter and fine filter approaches.
- 1.4 Regional and National approaches for biodiversity conservation.

2. Theory and analysis of Conservation of populations
- 2.1 Stochastic perturbations - Environmental, Demographic, spatial and genetic stochasticity.
- 2.2 Population viability analysis-conceptual foundation, uses of PVA models.
- 2.3 Management Decisions for small populations using PVA models.
- 2.4 Minimum viable populations & recovery strategies for threatened species

3. National and International efforts for conservation
- 3.1 Information on CITES, IUCN, CBD
- 3.2 International agreements for conserving marine life
- 3.3 Convention on wetlands of International Importance (Ramsar convention)

4. Conservation of Natural Resources
- 4.1 Resourses : Types and Degradations
- 4.2 Human impact on Terrestrial and Aquatic resources
- 4.3 Overview of conservation of Forest &Grassland resources

5. Wildlife in India
- 5.1 Wildlife wealth of India & threatened wildlife
- 5.2 Reasons for wildlife depletion in India
- 5.3 Wildlife conservation approaches and limitations

6. Wild life Habitat
- 6.1 Characteristic, Fauna and Adaptation with special reference to Tropical forest
- 6.2 Protected Area concept : National Parks, Sanctuaries and Biosphere Reserves, cores and Buffers, Nodes and corridors.
- 6.3 Community Reserve and conservation Reserves

7. Management of Wildlife
- 7.1 Distribution, status. Habitat utilization pattern, threats to survival of Slender Loris, Musk deer, Great Indian Bustard, Olive Ridley turtle.

8. Wild life Trade & legislation
- 8.1 Assessment, documentation, Prevention of trade
- 8.2 Wild life laws and ethics

Biostatistics, Bioinformatics and Instrumentation

ZCT - 418

36 Lectures
40 Marks
3 Credits

1. Biostatistical approach
- 1.1 Statistics and biological world
- 1.2 General Principles of biostatisties.

2. Descriptive Statistics
- 2.1 Frequency distribution
- 2.2 Central Tendency
- 2.3 Dispersion
- 2.4 Correlation and Regression

3. Sampling and Analysis
- 3.1 Sampling theory : Statistical inference and estimated hypothesis testing
- 3.2 Analysis of variance and experimental designs
- 3.3 Non Parametric Tests
- 3.4 Analysis of categorical data

4. Biology and Bioinformatics.
- 4.1 Proteins-structure, folding and function (CADD, Docking, Synchrotron)
- 4.2 Nucleic acid structure and function
- 4.3 Genomics and Proteomics

5. Database and search tool
- 5.1 Computational tools and biological databases
- 5.2 National centre for Biotechnology information (NCBI)
- 5.3 European Bioinformatics Institute (EBI)

6. Sequence alignment and database searching
- 6.1 The evolutionary basis of sequence alignment
- 6.2 Database similarity searching
- 6.3 Sequence Similarity search tools : BLAST and FASTA

7. Computational Tools for DNA Sequence Analysis
- 7.1 Database submission
- 7.2 Data retrieval
- 7.3 Relationship between sequence and biological functions.

8. Microscopy Advancements : *(Working Principle methods of application)*
- 8.1 Fluorescence Microscopy
- 8.2 Confocal Microscopy
- 8.3 Scanning and Transmission electron microscopy

9. Tools for biological assays : *(Working principles)*
- 9.1 Colorimetric and spectrophotometric analyses.
- 9.2 Radioactive methods
- 9.3 Flow cytometry and FACS

10. Molecular separation techniques.
- 10.1 TLC (Thin Layer Chromatography)
- 10.2 Ion excahnge
- 10.3 SDS PAGE
- 10.4 HPLC

Biotechnology & Applications

(36 Lectures)
ZCT - 419 **40 Marks**
3 Credits

1. Animal cell and tissue culture technology
- 1.1 Cell culture laboratory design and equipments
- 1.2 Media and reagents
- 1.3 Different types of cell culture, application, scale up

2. Biotechnology in improvement of live stock.
- 2.1 Fish breeding
- 2.2 Androgenesis and Gynogenesis in fish
- 2.3 Polyploidy in fish
- 2.4 Gene manipulation in aquaculture.

3. Reproductive biotechnology
- 3.1 Cryopreservation and Cryoprotection and gamete banking
- 3.2 Assisted reproductive technology
- 3.3 *In vitro* fertilization and embryo transfer, ICSI, Sperm sexing

4. Gene and Somatic cloning techniques
- 4.1 Transgenic technology
- 4.2 Animals as bioreactores
- 4.3 Knockout model systems & their utility.

5. Animal Production technology & Food security
- 5.1 Polyculture of fish for high yield.
- 5.2 Edible oyster and Pearl oyster production.
- 5.3 Vermiculture and Vermi conposting for alternative sustainable agriculture.
- 5.4 Soil fauna in soil formation & fertility
- 5.5 Organic farming
- 5.6 Fish culture in flow through system and recirculation technology.

6. Environmental Bio-technology
- 6.1 Bioprocess technology
- 6.2 Bioassay and Biosensors in ecotoxicological screening
- 6.3 Biomarkers in ecotoxicological screening

7. Medical Biotechnology
- 7.1 Disease diagnostic markers
- 7.2 Gene therapy
- 7.3 Mechanism of gene therapy (antisense, virus mediated, immunotherapy, stem cell therapy)
- 7.4 Drug delivery and targeting
- 7.5 Forensic Biotechnology

Laboratory Course

ZCP - 420

40 Hours
20 Marks
1 Credit

(A) Module - 1 Tools and Techniques

1. Sampling and census technique for wild life study.
2. RAPD - PCR
3. Sex manipulation techniques in fish
4. Freshwater pearl culture technique
5. Demonstration of Instruments - UV - VIS spectrophotometer, ultracentritugation, Microscopy
6. Induced breeding of fish
7. Basic laboratory techniques.
8. Statistical softwares and data analysis
9. Database and search tools for bioinformatics.
10. Demonstration of cell culture facilities.

(B) Sessional work (Internal Evaluation)

(C) Viva voce

Population and Community Ecology

ZET 301

50 Lectures
50 Marks
4 Credits

1. **Evolutionary Ecology**
   - 1.1 Evolution and Adaptation
   - 1.2 Adaptations to heterogeneous environment
   - 1.3 Evolution of life history strategies and social behaviour
   - 1.4 Evolution of sex
2. **Behavioural Ecology**
   - 2.1 Optimal foraging theory
   - 2.2 Mating system, Mate choice and Conflicts
   - 2.3 Dispersal, Navigation and Migration
   - 2.4 Predator Prey Interactions - Functional Strategies
   - 2.5 Living in groups, Cooperation and Helping
   - 2.6 Behavioural strategies - Game theory, Social systems of mammals - Primates, Contemporary theories in insect socio-biology
3. **Ecology of Population and Communities**
   - 3.1 Population dynamics - Model presentation and assumptions, predictions and variations
   - 3.2 Metapopulation structure, theories on Metapopulation, Metapopulation and extinction risks
   - 3.3 Community structure and food web analysis
   - 3.4 Metacommunity concepts, Importance of trade offs
   - 3.5 Resources and Consumers
   - 3.6 Competition theory, Predation, herbivory and parasitism, coevolution and mutualism

ZEP301 **Laboratory Course** **40 Marks, 3 Credits**

1. Ecological sampling and census techniques.
2. Morphometric evidences of niche separations.
3. Experiments on functional response (prey-predator interactions, etc.) of populations.
4. Estimation of biodiversity of terrestrial and aquatic population habitats.
5. Preparation of ethogram *ad libitum* observations on wild fauna.
6. Behavioural quantification of coexisting populations.
7. Evolutionary studies on adaptive characters.
8. Field experiments and analysis.
9. Sessional (Internal Evaluation)
10. Viva-voce.

Elective I : Endocrinology

50 Lectures
50 Marks
4 Credits

ZET 302

Molecular Endocrinology

1. Chemical nature and classification of hormones
2. Nature of hormone action.
2.1 Hormone receptors–identification, quantitation, purification and physico-chemical properties
2.2 Membrane receptors – structure and signal transduction mechanisms
2.3 G-proteins.
2.4 Hormonal regulation through differential gene expression.
3. Production of hormones by DNA technologies.
4. Endocrine hypothalamus.
5. Biosynthesis, characteristics and functions of hormones: Molecular basis
5.1 Characteristics and functions of anterior pituitary hormones and target organs.
5.2 Structure and function of posterior pituitary hormones and neuroendocrine modulation.
5.3 Biosynthesis, functions and diurnal variations of biosynthetic components of pineal gland.
5.4 Parathyroid and thyrocalcitonin hormone structure and function: Control of calcium homeostasis.
5.5 Thyroid hormone synthesis and regulation: Incidence of pathophysiology.
5.6 Thymic hormones and cell immunity.
5.7 Pancreatic hormones: Structure, functions and their impact on carbohydrate metabolism.
5.8 Adrenocortical hormones: Biosynthesis, structure and functions.
5.9 Adrenomedullary hormones: Biosynthesis, structure and functions.

6. Genetic analysis and clinical management of hormonal disorders.

Laboratory Course : Molecular Endocrinology

ZEP 302

40 Marks
3 Credits

1. ELISA of selected hormone (demonstration).
2. Identification of endocrine organs and estrous cycle.
3. Planimetry and oculometry of thyroid, adrenal and pineal.
4. Hemicastration-induced changes in testis
5. Sessional (Internal Evaluation)
6. Viva voce

Elective I : Entomology **50 Lectures**
50 Marks

ZET 303 **Insect Organization and Physiology** **3 Credits**

1. External Morphology
- 1.1 Integuments-epidermis; cuticle-structure, types, formation, functions
- 1.2 Head/ Thorax/ Abdomen
- 1.3 Pre and Post Genital appendages.

2. Anatomy and Physiology
- 2.1 Digestion : Structure, Types and Mechanism
- 2.2 Excretion in insects **: U**ltrastructure of malpighian tubule, Cryptonephridial condition, significance, Physiology of excretion.
- 2.3 Respiration in insects : Terrestrial and aquatic form, Accessory respiratory organs.
- 2.4 Reproduction and Development : Male and female reproductive organs; Spermatogenesis and Oogenesis, Accessory reproduction.

3. Blood and Circulatory system
- 3.1 Structure, Types of Haemocytes, Function, Defence mechanism.

4. Endocrine Organs and Hormones
- 4.1 Endocrine organs, mode of action of hormones, chemical nature and functions, Exocrine glands, pheromones, semiochemicals and defensive secretions.

5. Nervous and sensory system
- 5.1 Learning, eyes and vision-occurrence and structure of compound eyes, light reception, image formation.
- 5.2 Sound production- Structures, mechanisms and significance; Mechanoreception, Chemore ception,
- 5.3 Light production – Structure, mechanisms and significance

Laboratory Course

ZEP 303 **40 Marks**
3 Credits

1. Insect Diversity : Collection, Preservation & Identification
2. Identification of body parts : Mounting
3. Dissections of digestive system
4. Dissection of nervous system
5. Dissection of reproductive system
6. Sessional (Internal Evaluation)
7. Viva voce

50 Marks

Elective I : Environmental Biology and Toxicology **4 Credits**

ZET- 304 **Environment, Adaptation & Toxicokinetics**

1. **Fundamentals of Environmental Biology: Earth's major physical and chemical environment. Micro and macroenvironment. Homeostasis and physiological integration of animals in dif ferent environmental conditions. How and why animals often modify their ambient environ ment?**
2. **Major environmental regimes of Earth.**
3. **Semiochemistry of selected natural compounds:**
   - 3.1. Role of phenolics, flavonoids, steroids, odorants, pigments and related compounds in animal- plant interaction.
   - 3.2. Coevolutionary process.
4. **Environmental impact assessment and environmental management plan.**
5. **Adaptation in extreme environment (case studies).**
6. **Toxicology:**
   - 6.1. Definition and scope
   - 6.2. Relationship with other science
   - 6.3. History.
7. **Toxin:**
   - 7.1 Dose- response relationship. Routes of entry. Sources of toxic compounds:
   - 7.2 Syntheticorganic compounds, natural occurring toxins, inorganic chemicals.
   - 7.3 Environmental movement and fate of toxin. Mode of action: chronic, Natural poisons.
8. **Absorption of toxin**
   - 8.1 Mechanism, Rate of penetration, Routes of absorption
9. **Metabolism of toxin:**
   - 9.1 Phase I and II reactions, Toxicokinetics
10. **Elimination of toxin**
    - 10.1 Renal, Hepatic, Respiration and Others.
11. **Biology of stem cell and environmental implications**

40 Marks

Laboratory Course **3 Credits**

ZEP- 304

1. Isolation and staining of murine peritoneal macrophages.
2. Determination of Phagocytic Index of macrophages exposed to selected environmental particulate *in vivo*.
3. Determination of Phagocytic Index of macrophages exposed to selected environmental particulate *in vitro*.
4. Testing of viability of cells exposed to toxins.
5. Spectrophotometry and digital photomicrography (Demonstration).
6. Determination of $LC_{50.}$
7. Sessional (Internal Evaluation)
8. Viva voce

Elective I: Fisheries and Aquaculture **50 Lectures**
50 Marks

ZET 305 **Limnology and Biological Oceanography** **4 credits**

1. Freshwater Resources
1.1 Rivers, Lakes and Reservoirs -Zonations, Characteristics and Morphometry
1.2 Productivity in Lakes and Reservoirs
2. Stratificationsin lakes and reservoirs
2.1 Thermal stratifications
2.2 Stratification and dynamics of Oxygen and Inorganic carbon
2.3 Stratification and dynamics of Nitrogen and Phosphorous
3. Water quality
3.1 Requirements and Aquaculture generated changes in water quality
3.2 Water quality management
3.3 Environmental fish toxicity problem
4. Marine Fishery Resources
4.1 Exclusive economic zone- Potentialities and Exploitations
4.2 Modern Devices of exploitation
4.3 Major Fisheries of Indian coasts
5. Mariculture
5.1 Coastal culture practices and consequences
5.2 Culture of edible oysters and shrimps
6. Processing and preservation
6.1 Fish spoilage and methods of preservations
6.2 Fish byproducts
6.3 Shrimp processing technology
7. Conservation of Fishery resources
7.1 Sustainability of Fisheries Development
7.2 Open water stocking and ranching programmes

Laboratory Course

40 marks
ZEP 305 **3 credits**

1. Anatomy of Teleosts from dissections of organ systems
2. Estimation of maturity and fecundity of fish specimens
3. Hydrological and soil analysis
4. Estimation of productivity and relationship with biodiversity
5. Study of zooplanktonic interactions in aquatic systems and interpretations
6. Post mortem changes and Microbiology
7. Field study and case analysis
8. Sessional (Internal Evaluation)
9. Viva voce

Elective I: Genetics **50 Lectures**
50 Marks

ZET- 306: Genome organization and regulation of Gene Expression **4 credits**

1. Chromosome structure and molecular organization

1.1 Structure of chromosome, Pro & Eukaryote, Chromosome theory of inheritance, Euchromatin & hetero chromatin; process of gene silencing; centromere and telomere.

1.2 Chromatin organization & structure, Nucleosome organization & positioning, Molecular basis of chromatin activation & inactivation; methylation, Histone modification & epigenetic modification of nucleic acid, repetitive DNA, bound ary element. 1.3 DNA sequencing.

2. DNA Replication:

2.1 Modes of replication- semi-conservative, semi-discontinuous, bi-directional, rolling cycle, origin of repli cation sequence, Telomeric DNA replication. 2.2 Enzymology of replication and Gene amplification.

3. Regulation of Gene Expression:

3.1 Transcription regulation in Prokaryotes: RNA Pol subunit composition and DNA motif, operon

3.2 Transcription in Eukaryotes: RNA Pols subumit composition and DNA motif, transcription factor and chain termi nator. 3.3 Promoters; enhancers, silencers. 3.4 Post transcriptional events: Splicing; capping & polyadenylation; co-ordination of mRNA processing, rRNA & tRNA Processing; RNA editing, Post-transcriptional control of gene regulation.

4. Translation:

4.1 Translation in Prokaryotes: Initiation, elongation& termination.

4.2 Translation in Eukaryotes: Initiation, elongation & termination. 4.3 Protein splicing, Chaperons & protein folding.

5. Genetic regulation during development:

5.1 Gradients in early embryogenesis in *Drosophila*. 5.2 Cell fate & signaling pathways. 5.3 Gap genes; segment po larity genes; axis formation; homeotic genes; homeo-domains; Hox genes & HOM-c genes.

5.4 Sex determination and mode of regulation in *C. elegans*; *Drosophila* and Human.

6. Cell cycle:

6.1 Cell cycle control points; DNA damage check points.

6.2 Cell cycle inducers; M-phase kinase activities, cdks and phosphorylation.

6.3 Spindle orientation & assembly. 6.4 Apoptosis; Genes involved in cell cycle and cancer.

7. Recombination & Repair:

7.1 Recombination in bacteria; transformation, transduction & conjugation. Recombination in eukaryotes; recombination types: Homologous, site specific, transposition.

7.2. Recombination models: Holliday structure & resolution, model involving single strand & double strand breaks, rolling circle model. 7.3. Repair: Types of repair; Enzymes involved in repair.

8. Genetic variability in population:

8.1. Chromosomal polymorphism- Inversion polymorphism in *Drosophila*.

8.2. Polymorphism at protein & DNA level- Isozyme, RAPD, RFLP, SNP etc.

9. Genomics & proteomics:

9.1. Definition & basic concepts. 9.2. DNA microarray; ESTs. 9.3.Organization of Human genome-repeat sequences, transposons, pseudogenes. 9.4. Multigene families & genome conservation. 9.5. Proteomics.

9.6 Bioinformatics.

ZEP: 306 Laboratory Courses **40 marks** **3 credits**

1. Chromosome preparations: Rat bone marrow; *Drosophila* polytene chromosomes (Inversion and translocation).
2. Protein gel electrophoresis: (Native and SDS). 3. Sessional (Internal Evaluation). 4. Genetic crosses, P lacZ, US-Gal-4, FLP and FRT crosses. 5. Some aspects of developmental genetics of *Drosophila*
6. Viva voce. 7. Sessional (Internal Evaluation)

Elective I : Immunology
ZET 307

Immunity and Disease

50 Lectures
50 Marks
4 Credits

I. Infection and Immunity
1.1 Immune response to the bacteria
1.2 Immune response to the Virus
1.3 Immune response to the Parasites

2. Inflammation and Immunity
1.1 Overview of Inflammation
1.2 Inflammatory mediators
1.3 Inflammation and disease
1.4 Therapeutic Aspect

3. Asthma and Hypersensitivity
3.1 Type I
3.2 TypeII
3.3 Type III
3.4 Type IV

4. Tolerance and Autoimmunity
4.1 Peripheral and Central Tolerance of T and B cell
4.2 Malfunction and different autoimmune disease.

5, Tumor Immunology
5.1 Strategies of tumor cell to evade Immune system
5.2 Anti-tumor Immune response
5.3 Modern Immunotherapy of Cancer

ZEP 307

Laboratory Course

40marks
3 credits

1. Cell counting and cell viability-Cytotoxicity Analysis-Titrations/Microscopy/Hemacytometer
2. Animal Handling and - Mouse Handling / Injection of Antigen
3. Mouse lymphoid system dissection. Mononuclear leukocyte separation
4. Prepare serum and Isolation of Spleen, Thymus and Bone marrow cells
5. Cell fractionation and extraction
6. Peritoneal Lavage / Macrophage Activity
7. Histology and Immunohistochemistry-Immunopathology
8. Cell Culture (Demonstration) and Microscopy Techniques (Inverted and Fluorescence)
9. Sessional (Internal evaluation)
10. Viva Voce

Elective I : Wildlife Biology

50 lectures
50 marks
4 credits

ZET 308

Wildlife & Habitats

1. Introduction to Wildlife Conservation

1.1 Conservation strategies - past and present.
1.2 Emerging conservation movements.
1.3 Biogeographic classification of India.

2. Wildlife Habitat

2.1 Forest types in India - characteristics, fauna, adaptation
2.2 Wetland - characters (physical and biological), faunal make-up, adaptations
2.3 National parks, Sanctuaries, Biosphere Reserve, Community Reserves and Conservation Reserves; Case study - Sunderbans Biosphere Reserve.
2.4 Importance of monitoring animal population and their habitats, habitat assessment, mapping habitat components. Cover, forage, habitat and fire.
2.5 Identification, age and sex determination, animal abundance, distribution and density.
2.6 Population assessment techniques.

3. Status of Wildlife Habitats

3.1 Characteristics of fragile habitats - grasslands,, wetlands, , the coastal and rain forests.
3.2 Wildlife corridors, islands and significant issues relating to their management.

4. Wildlife Behaviour

4.1 Migration, communications and signaling.
4.2 Territoriality, home range and courtship display.
4.3 Scent markings and competition for resources.

5. Wildlife Tools, Techniques and Practices

5.1 Wildlife census technique - objectives, direct and indirect methods
5.1.1 Pugmarking and line transect method - technique, merits and limitations.
5.2 Bird census methods - Call count and point count
5.3 Telemetry - types, instrumentations, techniques, limitations.
5.4 GIS - instrumentation, application, merits and limitations

ZEP 308

40 marks
3 credits

Laboratory Course

1. Census Techniques

1.1 Line Transect Method, Point Count, Pug marking, Application of GPS, Field Studies.

2. Wildlife Orientation-Cum-Techniques Field Trip

2.1 Exercises in developing habitat description, mapping and elevation, learning operations for esti mation of wildlife populations, and description of wildlife populations.
2.1.1 Bird / butterfly sampling, Small mammal trapping, Population estimation using Mark-recap ture method, Habitat structure description methods, Reptile and amphibian sampling, GPS use, plant identification, Introduction to radiotelemetry and Large mammal population estimation techniques

3. Sessional (Internal evaluation). 4. Viva Voce

Elective I: Stem Cell and Developmental Biology **50 Lectures**
50 Marks

ZET-309 **Stem cells and regenerative biology** **4 Credits**

1. Genesis of cells
- 1.1 Concept of stem cells : types, self-renewal and pleuripotency, isolation and characterization
- 1.2 Niche and its role on differentiation of stem cells
- 1.3 Stem cells and restorative biology
- 1.4 Reprogramming of genome function through epigenetic inheritence

2. From single to multicellular components
- 2.1 Regulation of cell division and cytoskeleton
- 2.2 Stem cells in regeneration
- 2.3 Cell specification and early signaling events during morphogenesis
- 2.4 Development of cell adhension and motility
- 2.5 Cellular imprinting

3. Factors controlling cell development
- 3.1 Environmental factors like temperature, oxeygen, location, time, cell number
- 3.2 Chemical factors like growth factors, hormones, cytokines, microRNAs
- 3.3 Genetic factors

4. Stem cells and therapeutics
- 3.1 Cancer stem cells
- 3.2 Stem cells treatment to diseases
- 3.3 Ethical issues associated with stem cells

Laboratory Course

ZEP-309 **40 Marks**
3 Credits

1. Bone/cartilage staining of developing fish/chick embryo
2. Ablation and regeneration of fish tail
3. Surgical ablation techniques
4. Review assignment
5. Sessional (Internal evaluation)
6. Viva voce

Ecological Resources and Management

ZET 401

50 Lectures
50 Marks
4 Credits

1. Habitat and Ecosystem Ecology

1.1 Productivity of terrestrial and aquatic systems
1.2 Pathways of elements in ecosystems
1.3 Nutrient regeneration in terrestrial and aquatic systems
1.4 Ecosystem functions in terrestrial and aquatic systems
1.5 Stability of ecosystem
1.6 Restoration of degrading ecosystem

2. Conservation Ecology

2.1 Conservation challenges from climate change. Habitat loss and fragmentation
2.2 Theory and analysis of conservation of population
2.3 Conservation of habitats and landscapes
2.4 Conservation at genetic levels
2.5 Ecological economics

3. Microbial Ecology

3.1 Interactions among microbial populations
3.2 Microbes and biogeochemical cycling
3.3 Microbes and soil processes
3.4 Microbes in mineral and energy recovery, fuel and biomass production

ZET 401 **Laboratory Course** **40 marks**
3 credits

1. Assessment of habitat quality - terrestrial and aquatic systems.
2. Productivity determination of different ecosystems - Lindeman's efficiency.
3. Molecular methods of ecology.
4. Statistical methods / application in ecological analysis.
5. Assignment on ecological literature.
6. Microbial analysis of soil and water.
7. Field methods for wildlife study.
8. GIS and ecological assessment.
9. Sessional (Internal Evaluation)
10. Viva-voce.

Elective II: Endocrinology

50 Lectures
50 Marks
4 Credits

ZET 402

Reproductive Endocrinology

1. Endocrinology of female sex cycle:
- 1.1 Biosynthesis and metabolism of ovarian hormones
- 1.2 Interrelationship between ovarian hormones and ovarian follicles, corpora lutea, uterus and vagina.

2. Cellular and endocrine events of fertilization and implantation.
3. Endocrine physiology of gestation, parturition and lactation.
4. Physiological roles of ovarian steroids.
5. Control of testicular functions:
- 5.1 Biosynthesis and metabolism of androgens.
- 5.2 Spermatogenesis, sertoli-spermatid interaction.
- 5.3 Influence of androgens on sex accessory glands.

6. Modes and methods of male and female fertility control.
7. Endocrine malfunction induced male and female infertility.
8. Photoperiodism and endocrinology of photosexual activity:
- 8.1 Responds to different photoperiods.
- 8.2 Role of Extra-retinal photoreceptors.
- 8.3 Photorefractoriness, scotorefractoriness and relative refractoriness.
- 8.4 Prevention of refractoriness.

9. Pheromones and interactions.
10. Prostaglandins: Structure and functions.
11. Gerantological endocrine profiles.
12. Hormones and manifestations of malignancy.

Laboratory Course

60 Marks
4 Credits

ZEP 402

1. Androgen bioassay (demonstration).
2. Surgical techniques – Unilateral and bilateral ablations of selected endocrine glands.
3. Effects of surgical ablation of testis on seminal vesicle and prostate.
4. Effects of surgical ablation of ovary on uterus.
5. Viva voce
6. Sessional (Internal Evaluation)

Elective II : Entomology
ZET 403

Applied Entomology

50 Lectures
50 Marks
4 Credits

1. Agricultural Entomology :
- 1.1 Soil insects and acarines ; Distribution, Types, Role in soil formation and productivity
- 1.2 Insects & Acarines Pest : Assessment of pest status; EIL & ETL etc. Important pests of Jute, paddy, sugarcane, vegetable, mango, tea, stored products and forest insects- their distribution, nature of damage, biology and control measures.
- 1.3. Pest Management : Cultural, chemical - nature, mode of action of insecticides (organochlorine, organophosphorous, carbamates, botanical insecticides).Biological, pheromones and other attractants, Biotechnology in insect control, Concept IPM.

2. Medical Entomology :
- 2.1 Mosquito vectors, Types, Role in disease transmission. Case studies- Malaria and Filaria
- 2.2 Sandflies - Morphology, Life cycle, Vector status, Disease relationship.
- 2.3 Flies – Types, Role in disease transmission, Case studies – Myasis.
- 2.4 Fleas- Morphology, Life cycle, Role in plague transmission, Control strategy
- 2.5 Bee Venom – Stinging apparatus, Mechanism, Effect , Remedial measures
- 2.6 Acarines of Medical Importance -
  - i) Scabies – Morphology and Life cycle of the causative agent, Habit & habitat, Mode of Transmission, Pathogenesis and Control
  - ii) Trombiculid mites : Morphology, Habit & Habitat, Life cycle and medical importance
  - iii) Ticks : General consideration, Soft and Hard ticks - External morphology, Internal anatomy, Life cycle, Disease relationship and control measures.
  - iv) Allergenic mites-General account, Mechanism, Control measures

Laboratory Course

ZEP 403

40 Marks
3 Credits

1. Pest of crops/ plantations: Identification of pests of different crops/ vegetables/ stored products.
2. Anatomy, physiology and histology: Tissue sections and their identification
3. Medical entomology: study of life stages of medically important arthropods. Diptera, anoplura, siphonaptera and Acarina ; Identification of major vector species.
4. Social Insects : Morphological studies of social insects.
5. Appliances used in insect control – Types and applications.
6. Submission of specimens
7. Sessional (Internal evulution)
8. Viva voce

Elective II : Environmental Biology and Toxicology

ZET- 404 **Environment, Disruption and Analysis**

50 Lectures
50 Marks
4 Credits

1. Historical review of human impact on environment and basis of environmental toxicology.

2. Reproductive and life style adaptations

2.1. Breeding patterns: continuous and discontinuous.

2.2. Factors controlling reproductive pattern: a) proximate and b) ultimate factors.

3. Nutritive adaptations:

3.1. Nutrition in benthic environment.

3.2. Coral-microalgal symbiosis.

4. Endocrine disruptors:

4.1 Endocrine disruption hypothesis, environmental disruptors,

4.2 Mechanism of endocrine disruption, environmental consequences.

5. Management of natural resources with reference to wildlife:

5.1. Resource classification

5.2. Technologies involved in natural resource management

5.3. Contraception and other methods of population control of wildlife.

6. Analytical toxicology:

6.1. Chromatography

6.2. Immunocytochemistry

6.3. FACS analysis

6.4. PCR

7. Environmental toxicology: Diversity and classification of environmental toxins.

7.1. Air pollutants, Water and soil pollutants

7.2. Food additives and contaminants

7.3. Pesticides

7.4. Metals and Solvents

7.5. Radioactive pollution

Laboratory Course

ZCP- 404

40 Marks
3 Credits

1. Staining and identification of microbes.
2. Monitoring of heart rate of aquatic molluscs exposed to toxin and study of recovery response.
3. Dye retention assay as biomarker of environmental pollution.
4. Cell culture technology (Demonstration).
5. Determination of birth rate of *Bellamya bengalensis.*
6. Ssessional (Internal evulution)
7. Viva-voce

Elective II: Fisheries and Aquaculture **50 Lectures**
50 Marks

ZET 405 **Fishery Biology and Aquaculture** **4 Credits**

1. Fish reproduction Development and Growth
- 1.1 Hormonal actions for fish breeding
- 1.2 Developmental traits and pattern of fish eggs and larvae
- 1.3 Ageing and growth of fish

2. Fish pathology and diseases
- 2.1 General principles of diseases in aquaculture
- 2.2 Major diseases in aquaculture, control and management
- 2.3 Immune protection in fish systems and Stress response
- 2.4 Transformation of infection into diseases

3. Selection of site and species for aquaculture
- 3.1 Qualities of culturable indigenous and exotic species
- 3.2 Site selection and construction of farms for carp and prawn culture

4. Aquaculture of carps
- 4.1 Concepts and economic principles of farm management
- 4.2 Culture system, preparation and management of ponds for culture
- 4.3 Spawning and fry production, grow out, Transportation and polyculture

5. Aquaculture of freshwater prawns
- 5.1 Major cultivated species of prawns
- 5.2 Reproduction and larval rearing of prawns, grow out

6. Integration of aquaculture
- 6.1 Rationale of integrated farming of fish and livestock
- 6.2 Rice field aquaculture

7. Techniques of stock improvement
- 7.1 Induced breeding and bundh breeding
- 7.2 Cryopreservation, hybridization, polyploidy and transgenesis
- 7.3 Modern hatcheries and management

8. Non-conventional aquaculture system
- 8.1 Raceways, Cages and Pen enclosures
- 8.2 Waste water recycling through aquaculture

ZEP 405 **Laboratory Course** **40 Marks**
3 Credits

1. Studies on fish diversity- Documentation of endangered fish fauna and morphometric analysis
2. Fish pathology- Study of fish parasites and diseases, pathological experiments
3. Preparation of graft tissue and nucleus implantation for artificial pearl formation
4. Fish physiology experiments- Digestive enzymes, biochemical composition
6. Identification of aquatic weeds, predatory fishes and insects
7. Bioinformatics and statistics of aquaculture data
8. Demonstration of research methods & Field study
9. Sessional (Internal evaluation)
10. Viva voce

Elective II: Genetics

50 Lectures
50 Marks
4 Credits

ZET: 406 **Genetic Engineering, Oncogenes & Cancer**

1. **Fundamental concept of recombinant DNA technology:**
   - 1.1 Gene cloning:
   - 1.2 Restriction enzymes: Properties & usage.
   - 1.3 Kinases, ligases & polymerases.
   - 1.4 Vectors: plasmids, cosmids, phagemids, Ti plasmids, polylinkers, shuttle vectors.
   - 1.5 Basic principles in molecular cloning; cloning & identifying specified clones; positional cloning; somatic cloning.
   - 1.6 Strategies for gene isolation: cDNA libraries & genomic libraries.
   - 1.7 Techniques for identifying specific clones with specific probes & recovery of cloned DNA.
   - 1.8 Handling the DNA sources- cutting for specific ends & techniques for end modifications, joining DNA molecules.
   - 1.9 Techniques for identifying mutations in cloned DNA - DNA fingerprinting (RFLP & RAPD-PCR).
2. **Oncogenes & cancer:**
   - 2.1 Fundamental concepts: dysplasia, neoplasia, metastasis, tumor suppressor genes, tumor cells- immortalized and transformed.
   - 2.2 Oncogenes & proto-oncogenes, retroviral oncogenes, origin of oncogenes, Philadelphia tranlocation.
   - 2.3. Cell cycle & cancer; oncogenes & signal transduction cascades.
   - 2.4 P53 & oncogenes; oncogenes & ageing.
   - 2.5 Cancer & telomere.
3. **Gene therapy:**
   - 3.1 Methods for gene targeting.
   - 3.2 Methods for gene therapy.
   - 3.3 Stem cells: application & therapy. Micro-RNA therapy
4. **Manipulation of genes in eukaryotes:**
   - 4.1 Transposable elements. 4.2 Transfection of cells - principles & methods. 4.3 Germ line transformation in *Drosophila* and other eukaryotes. 4.4 Generation of transgenic animals- strategies & methods. 4.5 Gene knockout and silencing. 4.6 Applications of embryonic stem cells.
5. **Molecular techniques:**
   Chromosome walking, Polymerase chain reaction, Restriction mapping, Pulse filed gel electrophoresis, Site directed mutagenesis, In situ hybridization; Southern, Northern & western Blot analysis, Gel retardation assay, RNase protection assay.

ZEP : 406 **Laboratory Courses**

40 Marks
3 Credits

1. Isolation of genomic DNA and RNA.
2. Agarose gel elctrophoresis.
3. Southern, northern and western blot analysis
4. RAPD-PCR and RT-PCR
5. P-mediated mutagenesis
6. Fusion gene products
7. Sessional (Internal evaluation)
8. Viva voce

Elective II : Immunology

50 Lectures,
50 Marks
4 Credits

ZET 407

Developmental Immunology & therapeutics

1. Transplantation Immunology
- 1.1 Basis of Tranplatation
- 1.2 Acute, Hyperacute and chronic Graft rejection
- 1.3 Modern techniques of transplantation (e.g BMT,liver,cornea etc)

2. Immunodeficiencies
- 2.1 Congenital Immunodeficiencies
- 2.2 Acquired Immunodeficiencies

3. Vaccination
- 3.1 Principles and Significance
- 3.2 Types of Vaccines (subunit, killed, attenuated etc.)
- 3.3 Future trend and target of vaccination

4. Developmental and Regenerative Immunology
- 4.1 Molecular mechanisms of B lymphocyte development and leukemogeneis
- 4.2 Thymic and T cell development - lineage commitment of hematopoietic stem cells
- 4.3 Plasticity of hematopoietic stem cell and application
- 4.4 Evolution of this primary lymphoid organ (model sea Urchin, Drosophila, Xenopus,zebrafish and mice)

5. Specialized Immune System
- 5.1 Mucosal Immunology
- 5.2. Neonatal Immunology
- 5.3. Neuroimmunology
- 5.4. Liver-A lymphoid organ

ZEP 407

Laboratory Course

40 marks
3 credits

1. Immunodiffusion(Radial and/or Ochterlony)
2. ELISA-Direct and Sandwich System
3. Immunoprecipitation-Precipitate mouse IgG from cell lysates with goat/Rabbit anti-mouse IgG-agarose and prepare samples for electrophoresis.
4. SDS PAGE AND Western Blot- Prepare samples, run gels. Perform electrophoretic transfer of proteins from slab gel to nylon membrane.. Add antibodies to nylon membranes. Develop nylon membranes with labeled antibodies and plot MW standard curve.
5. Immunofluorescence and FACS-Sample preparation and staining
6. PCR
7. Confocal Microscopy (Demonstration)
8. Sessional (Internal evaluation)ce
9. Viva voce

Elective II : Wildlife Biology

ZET 408 **Wildlife Management** **50 Lectures**
50 marks
4 credits

1. Wildlife Management
- 1.1 Management of rare and endangered species, control of weed species.
- 1.2 Control and management of overabundant wildlife populations.
- 1.3 Use of barriers, demographic and genetic management of small populations.
- 1.4 Ecological monitoring of animal species and restoration programmes.

2. Captive Breeding of Wild Animals
- 2.1 Management, problems and prospects.
- 2.2 Case studies - Red panda and Snow leopard.

3. Special Management Programme of Wild Animals in India
- 3.1 Project tiger
- 3.2 Operation rhino
- 3.3 Project Elephant

4. Man and Wildlife
- 4.1 Issues of ecodevelopment.
- 4.2 Community participation in wildlife management.
- 4.3 Conservation and development linkage.
- 4.4 Man animal conflict. Case studies - man-elephant conflict

5. Wildlife Health
- 5.1 Importance of wildlife health management.
- 5.2 Major diseases of wild animals in captivity and free ranging situation.
- 5.3 Wildlife health monitoring and surveillance.

6. Wildlife Trade
- 6.1 Assessment and documentation.
- 6.2 Preventive measures and trans-boundary problems.

7. Wildlife Legislation
- 7.1 National Forest Policy, 1988.
- 7.2 National Wildlife Action Plan, 2002.
- 7.3 Wildlife Protection Act, 1972.
- 7.4 National and State Biodiversity Action Plans.
- 7.5 Other Forests and Environmental Acts.

8. Wildlife Forensics

ZEP 408 **Laboratory Course** **40 marks**
3 credits

1. GIS and application of remote sensing
2. Field studies on wildlife management and submission of Field Note Book
3. Modern tools and techniques in wild life analysis
4. Sessional (Internal evuluation)
5. Viva voce

Elective II : Stem Cell and Developmental Biology **50 Marks**
4 Credits

ZET-409 **Cell Interaction and Development** **50 Lectures**

1. Integration of cellular macromolecules
- 1.1 Intracellular trafficking of proteins
- 1.2 Interconversion of carbohydrates, proteins and lipids
- 1.3 Action of transcription factors and their coregulators
- 1.4 Transport of biomolecules through nuclear pore
- 1.5 Neuro-endo-immunological interactions

2. Cell-to-cell communication in development
- 2.1 Early signaling molecule in development
- 2.2 Receptor specificity and signal transduction in developmental processes

3. Comparison of developmental mechanisms
- 3.1 Life cycle and developmetal paterns
- 3.2 Evolutionary changes

4. Biotechnical manipulation of cells
- 4.1 Animal cell culture
- 4.2 SCNT and cloning
- 4.3 Transgenic and Knock-out models
- 4.4 Therapy using nanotechnology

5. Deformities of cellular functioning
- 5.1 Cellular ageing
- 5.2 Metabolic irregularities and teratogenic effects
- 5.3 Unregulated cell growth (cancer)

Laboratory Course

40 Marks
3 Credits

ZEP-409

1. Primary cells and cell line culture techniques
2. Analysis of ploidy differences in cells by FACS
3. Isolation and visualization of celluar proteins
4. Brain regionalization in chick embryo
5. Experimental techniques in developmental biology
3. Sessional (Internal evuluation)
4. Viva-voce