

**CHOICE BASED CREDIT SYSTEM (CBCS) IN ZOOLOGY****Total credit = 74****Credit (Core 48 + Elective 18 (Department) + Foundation 4+ Elective 4 (Other Departments)**

Foundation Credit 4 = 4 Compulsory (Computer Application)

**Core Courses**

<i>Semester - I</i>		
Course Code	Course Name	Credit
ZL701C	Animal Diversity (Non Chordates and Chordates)	4
ZL702C	Developmental Biology and Endocrinology	4
ZL704C	Laboratory Exercise	4
ZL705C	Biochemistry and Molecular Biology	4
<i>Semester - II</i>		
ZL802C	Cell Biology and Genetics	4
ZL804C	Laboratory Exercise	4
ZL806C	Histology & Histochemistry	2
ZL807C	Environmental Biology and Animal Behaviour	4
<i>Semester - III</i>		
ZL902C	Parasitology and Immunology	2
ZL903C	Project	4
ZL906C	Animal Physiology	4
<i>Semester - IV</i>		
ZL1001C	Biosystematics & Evolution	2
ZL1003C	Project	4
ZL1008C	Economic Zoology	2
<b>Total Credit</b>		<b>48</b>

**Elective Courses**

<i>Semester II</i>		
ZL805E	Tools and Techniques in Biology	2
<i>Semester III</i>		
ZL904E	Aquatic Environmental Science	2
ZL905E1/ ZL905E2/ ZL905E3/ ZL905E5	Advanced Animal Ecology Fisheries Comparative Endocrinology Advanced Biochemistry	4
<i>Semester IV</i>		
ZL1004E	Aquaculture	2
ZL1005E	Insect Taxonomy	2
ZL1006E	Soil Zoology	2
ZL1007E1/ ZL1007E2/ ZL1007E4/ ZL1007E5	Biodiversity Fish Technology Mammalian Reproductive Physiology Advanced Cell Biology	4
<b>Total Credit</b>		<b>18</b>
<b>Compulsory Foundation (Computer Application)</b>		<b>4</b>
ST704E	Elective Other Department (Statistics)	4
<b>Total Course Credit</b>		<b>74</b>

# First Semester

Core Course – 16 Credit

(C = Core Course; E = Elective Course)

Paper: ZL701C      Animal Diversity (Non Chordates and Chordates)      (Credit – 4)

**First Half      Non Chordates      Credit 2**

Sl. No.	Topics	Classes (hrs)
1.	Diversity in forms: unicellular, colonial and multicellular; opportunities and consequences of multicellularity	3
2.	Diversity in body axis: oral – aboral axis, anterior – posterior axis, dorsal – ventral surfaces, body cavity, pattern of cleavage	4
3.	Diversity of characters in major and minor phyla	5
4.	Structural specialities of acoelomates (sponges, coelenterates, flat worms), pseudocoelomates (round worms, rotifers), coelomates (annelids, echinoderms), haemocoelomates (arthropods, mollusks)	6
5.	Functional anatomy of body wall, muscles, locomotion, secretory organs, nervous system and reproduction in major phyla with examples	6
6.	Larval forms in some aquatic and terrestrial animals	4
	Class Tests	2
	Class Discussion	2
	Total	32

**Second Half      Chordates      Credit 2**

Sl. No.	Topics	Classes (hrs)
1.	Outline classification of chordates; an evolutionary approach	2
	Origin of vertebrates	2
2.	Exoskeletal and endoskeletal structures in birds and mammals	3
3.	Evolution of body wall and muscles in vertebrates; integumentary derivatives in mammals	6
4.	Structural evolution of alimentary canal in chordates (Amphioxus, fishes, birds and mammals) in relation to their food habit	4
5.	Structural modification of lungs in birds and mammals in relation to their energy demand	4
6.	Structural modification of nephrons in vertebrates in relation to different habitats	2
7	Adaptive radiation with reference to locomotary appendages in vertebrates	3
8	Buoyancy in pelagic fishes – role of swim bladder	3
	Class Tests	2
	Class Discussion	2
	Total	33

**Paper: ZL702C Developmental Biology and Endocrinology (Credits – 4)****First Half Developmental Biology Credit 2**

Sl. No.	Topics	Classes (hrs)
1.	Gametogenesis and fertilization: production of gametes, acrosomal reaction and gamete interaction (sea urchin and mammals), prevention of polyspermy and egg activation	3
2.	Basic concept of development: potency, specification, determination and differentiation, morphogens and morphogenetic gradients	2
3.	Early development: cleavage, blastula, formation, fate maps, gastrulation, formation of germ layers (frog and chick)	4
4.	Morphogenesis: cell aggregation and differentiation in Dictyostelium, axes and pattern formation in <i>Drosophila</i> (involvement of maternal, segmentation and homeotic genes), Hox genes and patterning in vertebrates, Axis formation in frog and chick	6
5.	Organogenesis: vulva formation in <i>C. elegans</i> , eye-lens induction, limb development and formation of neural tube in vertebrates	5
6.	Sex determination mechanisms in <i>Drosophila</i> and mammals	4
7.	Regeneration	2
8.	Stem cells and application	2
	Class Tests	2
	Class Discussion	2
	Total	32

**Second Half Endocrinology Credit 2**

Sl. No.	Topics	Classes (hrs)
1.	Hormones: endocrine, paracrine and autocrine hormones, neuroendocrine system in vertebrates, nature of hormone receptors	3
2.	Hormones and Homeostasis: glucose homeostasis, calcium homeostasis and sodium homeostasis	1
3.	Hypothalamic hormones: nature and function, regulation of secretion	3
4.	Adenohypophyseal hormones: nature, function regulation of secretion	3
5.	Neurohypophyseal hormones: structure and function, regulation of secretion	3
6.	Thyroid hormones: biosynthesis, regulation and functions	3
7.	Pancreatic hormones: structure and their role in glucose homeostasis	2
8.	Adrenocortical hormones: biosynthesis, regulation and function	2
9.	Adrenomedullary hormones: biosynthesis, regulation and function	3
10.	Sex steroids: structure, biosynthesis, regulation and their roles in spermatogenesis, estrous cycle, ovulation and pregnancy	3
11.	Mechanism of action of steroid and peptide hormones	2
	Class Tests	2
	Class Discussion	2
	Total	32

**Paper: ZL704C Laboratory Exercises****(Credit – 4)**

Sl. No.	Topics	Classes
1.	Slide preparation of mouth parts of different insects	2
2.	Drawing of development of schizocoelic and enterocoelic body cavities	2
3.	Drawing of cleavage pattern in protostomes and deuterostomes	2
4.	Identification of bones in birds (Pigeon) and mammals (Cavia/Ratus)	2
5.	Mounting, drawing & labeling of different types of scales, feathers in birds	2
6.	Slide identification: T.S. of skin (amphibian and mammalian), T.S. of lung (bird and mammal), T.S. of kidney (fish, bird, mammal), T.S. of intestine (amphibian and mammal)	4
7	Development of Chick embryo at different incubation period – studies with permanent slides	2
8	Development of neural fold, notochord and somites in Chick embryo	2
9	Development of fore brain, mid brain and hind brain in chick embryo	2
10	Stages of development of heart in chick embryo	2
11	Study of endocrine gland with permanent slides	2
12	Double stain (H-E) preparation of permanent slides of endocrine glands	3
13	Estimation of protein by Folin's reagent	3
14	Estimation of glucose by Anthrone reagent	3
15	Enzyme assay: effect of time and temperature, effect of substrate	3
16	Protein isolation and polyacrylamide gel electrophoresis	3
17	DNA isolation and agarose gel electrophoresis	3
18	Determination of casein content in milk	2
19	Determination of ascorbic acid in lemon and tomato	2
20	Determination of glucose absorption by intestine of chick	2
	Class Tests	6
	Total (Each class of 3 hours)	54 54x3=162

**Paper: ZL705C Biochemistry and Molecular Biology****Credits – 4****First Half Biochemistry****(Credit 2)**

Sl. No.	Topics	Classes (hrs)
1.	Bioenergetics: Law of thermodynamics, free energy, entropy, high energy bonds and its relevance to biological systems	3
2.	Proteins: Amino acids, peptides and polypeptides, Primary and higher orders of protein structure, protein folding	5
3.	Enzymes: Introduction to enzyme, enzyme properties, enzyme classification, cofactors and coenzymes, effects of physicochemical factors on enzyme activity; Enzyme kinetics – Michaelis –Menten equation and its derivation, Lineweaver-Burk plot, significance of Km, calculation of enzyme kinetics; Inhibitors of enzyme activity, allosteric enzyme, isozyme, ribozyme	7
4.	Carbohydrates: classification of carbohydrates, glycolysis and Krebs' cycle: pathway and regulation, mitochondrial electron transport chain complexes, oxidative phosphorylation; gluconeogenesis, HMP shunt pathway	6
5.	Lipids: Lipids of physiological significance, membrane lipids, cholesterol synthesis, oxidation of fatty acids, ketogenesis	4
6.	General Topics: Purine and pyrimidine bases, structure and properties of DNA and RNA	3
	Class Tests	2
	Class Discussion	2
	Total	32

**Second Half Molecular Biology****(Credit 2)**

Sl. No.	Topics	Classes (hrs)
1.	Basics of Molecular Biology	1
2.	DNA replication: semiconservative, structure and properties of DNA polymerases (pro- and eukaryotic), initiation and elongation of replication in prokaryotes and eukaryotes, enzyme and factors involve in DNA replication, DNA damage and repair mechanism	6
3.	RNA synthesis: mechanism of transcription – initiation, elongation and termination, sense and antisense strand, structure and properties of RNA polymerases in prokaryotes and eukaryotes	9
4.	RNA processing in eukaryotes: capping, poly-adenylation, splicing and RNA editing	5
5.	Protein synthesis: activation, initiation, elongation and termination of protein synthesis in prokaryotes and eukaryotes, post translational modification	7
	Class Tests	2
	Class Discussion	2
	Total	<b>32</b>

## Second Semester

(Core Course (C) – 14 Credit & Elective Course (E) – 2 Credit)

**Paper: ZL802C      Cell Biology and Genetics      (Credit 4)**

**First Half      Cell Biology      Credit 02**

Sl. No.	Topics	Classes (hrs)
1.	Cells: chemical complexity and organization, distinctive structure and molecular features of prokaryotic and eukaryotic cells	2
2.	Cell cycle and its regulation; cell division – mitosis and meiosis	3
3.	Plasma membrane: chemical constituents and function	3
4.	Cytoskeleton: general features, microtubules, microfilaments and intermediate filaments- structural and functional dynamics	3
5.	Endomembrane system: organization and function of endoplasmic reticulum, Golgi and lysosomes	3
6.	Mitochondria, oxidative phosphorylation, peroxisomes	2
7.	Chromosome Structure: organization of chromatin, nucleosome, structure and organization of telomere, centromere and kinetochore, unique and repetitive DNA, euchromatin and heterochromatin, constitutive and facultative heterochromatin, chromatin domains and boundary elements	4
8.	Signal transduction: Intracellular and cell surface receptors, signal transduction pathways	4
9.	Cell transformation and cell death, genes involved (viral oncogenes, cellular oncogenes and tumor suppressors), angiogenesis and metastasis, cell death pathways and their significance	4
	Class Tests	2
	Class Discussion	2
	Total	32

**Second Half      Genetics      Credit 02**

Sl. No.	Topics	Classes (hrs)
1.	Mendel's laws and their chromosomal basis: extension of Mendelism: dominance relationship, epistasis, pleiotropy, expressivity, penetrance, alleles, multiple alleles, isoallele	4
2.	Microbial genetics: methods of genetic transfers: transformation, conjugation, transduction and sex-duction; genetics of bacteriophage: lytic and lysogenic cycle and regulatory mechanisms, genetic fine structure: rII locus	5
3.	Human genetics: karyotype and nomenclature of metaphase chromosome bands: concept of G- banding, R-banding and Q-banding; chromosome anomalies and disease: common syndromes caused by aneuploidy, mosaicism, deletion and duplication, chromosomal anomalies in malignancy (chronic myeloid leukemia, Burkitt's lymphoma, retinoblastoma and Wilm's tumor) fragile site and X-linked mental retardation	6

4.	Linkage and recombination, Gene mapping techniques: three point test cross in <i>Drosophila</i> ; gene mapping in human by linkage analysis in pedigrees; concept of LOD score; somatic cell fusion and gene mapping on chromosomes	5
5.	Mutation: types, causes and deletion: autosomal and sex-linked, loss of function, gain of function; Molecular basis of mutation, germinal versus somatic mutants; Insertional mutagenesis	4
6.	Regulation of gene expression: lac operon; trp operon; typical eukaryotic genes	4
	Class Tests	2
	Class Discussion	2
	Total	32

**Paper: ZL804C      Laboratory Exercises****Credit 4**

<b>Sl. No.</b>	<b>Topics</b>	<b>Classes</b>
1.	Processing of mammalian glandular tissues and their double staining (Eosin & Hematoxylin)	02
2.	Preparation and staining of skeletal muscle of mammals	02
3.	Staining and identification of blood cells	02
4.	Identification of histological slides based on syllabus	02
5.	Metaphase chromosome preparation from rat bone marrow cells	04
6.	Polytene chromosome preparation from <i>Drosophila/Chironomus</i> salivary glands	03
7.	Staining of mitochondria	02
8.	Nucleocytoplasmic index	02
9.	Fluorescence staining	02
10.	Study of meiosis from grasshopper testis	04
11.	Immunofluorescent staining of actin fibres	02
12.	Analysis of Human Pedigree and construction of Pedigree Chart	02
13.	Determination of dissolve oxygen in water	02
14.	Determination of free carbon dioxide in water	02
15.	Analysis of Turbidity and Transparency of supplied sample	02
16.	Analysis of Carbonates and Bicarbonates of supplied sample	04
17.	Chromatographic separation of amino acids	04
18.	Tissue preparation for analysis of proteins, enzymes, nucleic acids using tools like centrifuge and spectrophotometer	05
	Class Tests	06
	<b>Total</b> <b>(Each class of 3 hours)</b>	54 (55x3=165)



Paper: ZL805E

Tools and Techniques in Biology

Credit 2

Sl. No.	Topics	Classes (hrs)
1.	Microscopy: Basics of bright field, dark field, phase contrast, fluorescence, confocal microscopy; transmission and scanning electron microscopy	3
2.	Centrifugation: Principle and uses of centrifuges (tissue processing and separation of various sub-cellular organelles)	3
3.	Spectrophotometry: Types and function of spectrophotometers; Beer-Lambert Law, molar extinction coefficient, absorption spectrum	3
4.	Electrophoresis: Principles, agarose and polyacrylamide gels, isoelectric focusing, two dimensional electrophoresis	3
5.	Chromatography: Principle and types, absorption, partition, gel filtration, ion-exchange, affinity, elementary concepts of HPLC	5
6.	Blotting techniques: Southern, Northern and Western blotting, microarray, DNA foot printing, EMSA	4
7.	Recombinant DNA techniques: Restriction endonucleases, cloning vectors, gene cloning, polymerase chain reaction, DNA sequencing	5
8.	Production of transgenic animals and application	2
	Class Tests	2
	Class Discussion	2
	Total	<b>32</b>

Paper: ZL806C

Histology and Histochemistry

Credit 2

Sl. No.	Topics	Classes (hrs)
1.	Methods of tissues preparation: fixation, dehydration, embedding & sectioning, staining; acid stains & basic stains; auxochrome & chromophore groups in stain	2
2.	Classification of tissues- their origin, structure and functions	4
3.	Histology of lymphoid organ (spleen & its function)	2
4.	Origin, gross anatomy, blood supply, histology & functions of exocrine glands of mammals, viz., liver and pancreas	4
5.	Origin, histology and functions of skin in the mammalian	2
6.	Origin, gross anatomy, blood supply, histology and functions of endocrine glands in mammals, viz., pituitary, thyroid, adrenal, islets of Langerhans, testis & ovary	6
7.	Principle and methods of hisrochemical localization of Carbohydrates, proteins, lipids and nucleic acids	6
8.	Principle and methods of histochemical analysis of enzyme activity	2
	Class Tests	2
	Class Discussion	2
	Total	<b>32</b>

**Paper: ZL807C      Environmental Biology and Animal Behaviour      (Credit 4)**

**First Half      Environmental Biology      Credit 2**

Sl. No.	Topics	Classes (hrs)
1.	Environmental zoology: scope, principle and definition	2
2.	Physico-chemical and biological factors affecting terrestrial and aquatic environment; comparison of stressed and non-stressed environment	4
3.	Spheres of earth: atmosphere, hydrosphere, lithosphere and biosphere; mass and energy transfer across different interfaces. Climate change and global warming- GHG, causes and effects; adaptations; management	4
4.	Natural resources, conservation and sustainable development	2
5.	Environmental pollution and their control methods- case studies (sugarcane, leather and paper mill)	5
6.	Input and effects of organic loading on sedimentation-DO, BOD, COD and NOD	2
7.	Soil: inputs of heavy metals on ecosystem (arsenic, lead, cadmium) and their management	4
8.	Bioindicator: concept and their uses in environment	5
	Class Tests	2
	Class Discussion	2
	Total	<b>32</b>

**Second Half      Animal Behaviour      Credit 2**

Sl. No.	Topics	Classes (hrs)
1.	Basic component of animal behaviour: proximate cause, ultimate cause, adaptive values; innate behaviour – mechanism with examples; learning behaviour – mechanism with examples	4
2.	Behavioural genetics: genetics basis of behaviour – examples; selection of behaviour with life history fitness attributes - examples	4
3.	Cognitive behaviour: problem solving solution in non-human animals - examples	3
4.	Migratory behaviour: orientation – taxis and kinesis; long range migration in birds and fishes	3
5.	Animal communication: kinds of communication signals – levels of specificity; importance of communication in reproduction and group living; dance language of honeybees	5
6.	Behavioural ecology: foraging behaviour – optimization theory; territorial behaviour	5
7.	Altruism and group Living: kin selection – Hamilton's Rule, genetic relationship; evolution of social system – honey bees, leaf cutter ants, some vertebrates	4
	Class Tests	2
	Class Discussion	2
	Total	<b>32</b>

## Third Semester

(Core Course (C) – 10 Credit & Elective Course (E) – 8 Credit)

**Paper: ZL902C**

**Parasitology and Immunology**

**(Credit – 2)**

Sl. No.	Topics	Classes (hrs)
1.	Parasitism as a part of animal association and its features, niches of parasites, concept of vectors	2
2.	Important parasitic protozoa belonging to sporozoa ( <i>Plasmodium</i> ) flagellata ( <i>Leishmania</i> , <i>Trypanosoma</i> ) with reference to their life cycle, disease caused, immunopathology, control and treatment	4
3.	Helminth parasites belonging to Digenea and blood parasites ( <i>Fasciola</i> , <i>Schistosoma</i> )	3
4.	General account of parasitic cestode and nematoda ( <i>Echinococcus</i> , <i>Wuchereria</i> ) including general characters, life history, physiology, pathology, control and treatment	2
5.	Immuno-parasitology: general host response, specific host parasite response, vaccination	2
6.	General principles of <i>in vitro</i> culture of parasitic protozoa and endoparasitic helminths	1
7.	Basics of Immunity: introduction; Cells and organs involved in innate and acquired immunity; antigens, antigenicity and immunogenicity,; B and T cells	3
8.	Antibodies: structure and function of immunoglobulin molecules; generation of antibodies diversity; monoclonal antibodies, antigen-antibody interactions	3
9.	Generation of immune responses: MHC molecules; antigen processing and presentation; activation and differentiation of B cells and T cells; B and T cells receptors; humoral and cell mediated immune responses; primary and secondary immune responses	5
10.	Immune effector mechanism: cytokines; complement system; cell mediated effector functions, inflammations; hypersensitivity and autoimmunity	3
	Class Tests	2
	Class Discussion	2
	Total	32

**Paper: ZL903C**

**Project**

**Credit – 4**

**1. Course work**

<b>Sl. No.</b>	<b>Topics</b>	<b>Credit</b>
1.	Course work	1
2.	Literature review and formulation of objectives	1
3.	Laboratory/ Field work	1
4.	Dissertation submission and power point presentation	1

Paper: ZL904E

Aquatic Environmental Science

Credit – 2

Sl. No.	Topics	Classes (hrs)
1.	Definition and scope of aquatic environmental biology, structure and function of aquatic ecosystem, wetland, pond, lake, river etc.	2
2.	Water and Light : scatter and diffusion, effects of UV radiation on aquatic fauna	2
3.	Thermal stratification and thermocline formation in lake, , flow of heat	2
4.	Contribution of atmospheric gases to aquatic ecosystem; Importance of wetlands as carbon sequester	1
5.	Gaseous biogeochemical cycle: Carbon and Oxygen cycle - diurnal and seasonal changes; Nitrogen cycle - forms of nitrogen, nitrogen fixation, dissolved organic nitrogen, eutrophication and control	3
6.	Sedimentary biogeochemical cycle: Phosphorus cycle, recycling of phosphorus, eutrophication and control	2
7.	Concept of meteorological data, climate change, causes and effects on biota, algae as carbon sequester, management	2
8.	Lentic and lotic resources- their conservation and sustainable development, basic characteristics of lentic and lotic environment, role of inorganic carbon and organic carbon (CO <sub>2</sub> , CO <sub>3</sub> , HCO <sub>3</sub> , H <sub>2</sub> CO <sub>3</sub> ) and organic carbon	2
9.	Pesticides in freshwater: Origin, fate and effects on biota	3
10.	Marine ecosystem, its chemical characters and faunal distribution	2
11.	Estuarine ecosystem, its chemical characters and impact on faunal distribution	2
12.	Principles of analytical methods, Titrimetry, Gravimetry, Colorimetry and Spectrophotometry	2
13.	Hydrologic cycle, global water balance, ice sheets and fluctuations of sea levels, origin and composition of seawater, factors influencing the surface water, resources of oceans, ocean pollution, human use of surface and ground waters, groundwater pollution and control measures	3
	Class Tests	2
	Class Discussion	2
	Total	<b>32</b>

Paper: ZL905E1

Advance Animal Ecology

(Credit – 4)

First Half		Credit -2
Sl. No.	Topics	Classes (hrs)
1.	<b>Life History Strategies</b> <ul style="list-style-type: none"> <li>• Reproductive Strategies, Foraging strategies, Models</li> <li>• Age Structure</li> <li>• Mating System – Polygyny and Polyandry</li> </ul>	8
2.	<b>Population Growth Models</b> <ul style="list-style-type: none"> <li>• Deterministic Models – Geometric growth</li> <li>• Stochastic Models</li> <li>• Life Table Construction and Calculating Life Expectancy</li> </ul>	8
3.	<b>Competition and Coexistence</b> <ul style="list-style-type: none"> <li>• Species Interactions</li> <li>• Intraspecific Competition</li> <li>• Intraspecific Competition</li> <li>• Coexistence of species</li> <li>• Effects of Exotic Competitors on Native Fauna</li> </ul>	8
	Class Tests	2
	Class Discussion	2
Second Half		Credit 2
1.	<b>Herbivore Ecology</b> <ul style="list-style-type: none"> <li>• Plant defenses – physical and chemicals</li> <li>• Effects of Herbivores on Plants - examples</li> <li>• Effects of Plants on Herbivores - examples</li> <li>• Secondary Chemicals</li> </ul>	8
2.	<b>Metapopulations</b> <ul style="list-style-type: none"> <li>• Concepts of Models</li> <li>• Bottom –Up Factors</li> <li>• Top-Down Factors</li> <li>• Environmental Stress</li> </ul>	8
3.	<b>Trophic Structure</b> <ul style="list-style-type: none"> <li>• Food Web Patterns</li> <li>• Thermodynamics of Energy Flow</li> <li>• Guild Ecology</li> <li>• Ecology of Interactions in coexisting species</li> <li>• Keystone species</li> </ul>	8
4.	<b>Conservation Ecology</b> <ul style="list-style-type: none"> <li>• Methods of assessment of population status</li> <li>• Conservation criteria and methods</li> <li>• Genetic basis of conservation</li> <li>• Examples from northeast India</li> </ul>	6
	Class Tests	2
	Class Discussion	2
	Total	<b>62</b>

Paper: ZL905E2

Fisheries

(Credits – 4)

First Half		Credit -2
Sl. No.	Topics	Classes (hrs)
1.	Fisheries-definition, types, fishes, classification	1
2.	Diversity of freshwater and marine water fish fauna	3
3.	Riverine environment, characters of stream, physico-chemical and biological characters	4
4.	River pollution, Chemical characters of polluted river, biological indicators of India	3
5.	Dams and their effects on fish migration	3
6.	Fisheries of important reservoirs and lakes	4
7.	Estuarine and coastal fisheries	3
8.	Management of stocking ponds – Indian major carps (IMC), definition, characterization, wild resources, control of weeds, insects and predatory fishes, pond, fertilization, stocking, supplementary feeding, disease control	3
9.	Responsible fisheries - laws and regulations for conservation	1
10.	Endangered, near threatened, vulnerable and rare fish species and conservation strategies	3
	Class Tests	2
	Class Discussion	2
Second Half		Credit 2
1.	Hatcheries- types, characteristics, water quality	1
2.	Nursery, rearing, pre-stocking and post-stocking systems management	4
3.	Lay-out criteria of different nature of fish pond ecosystem	3
4.	Monoculture, principles, basic steps of field studies - merit and demerit	3
5.	Polyculture, principles, practices, merit of polyculture	3
6.	Integrated fish farming- concept, types, Paddy cum fish culture, Duck cum fish culture, sewage fed fisheries, scope and limitations	4
7.	Culture of herbivore fishes – role of <i>Ctenopharyngodon</i> , <i>Hypophthalmichthys</i> for biological control of weeds and microalgae, low carbon foot print fish	4
8.	Sustainable fish culture	2
9.	Monosex culture of Tilapia	2
10.	Shrimp farming	2
	Class Tests	2
	Class Discussion	2
Total		<b>64</b>



Paper: ZL905E3

Comparative Endocrinology

(Credit – 4)

<b>First Half</b>		<b>Credit -2</b>
<b>Sl. No.</b>	<b>Topics</b>	<b>Classes (hrs)</b>
1.	An overview of endocrine system in vertebrates	1
2.	Basic concept of neurosecretion: neurosecretory system in invertebrates with special reference to insects; anatomy and functions of hypothalamic neurosecretory centers in vertebrates; anatomy of neurohypophysis and its hormones in vertebrates; median eminence: structure and functions in vertebrates	8
3.	Structure and functions of adenohypophysis: general organization in vertebrates; cell types and functions in teleosts and mammals	7
4.	Structure and functions of pars intermedia in non-mammalian vertebrates.	5
5.	Synthesis of steroid, peptides and glycoprotein hormones in vertebrates	3
6.	Pineal organ: cellular organization and functions in vertebrates	4
	Class Tests	2
	Class Discussion	2
<b>Second Half</b>		<b>Credit 2</b>
1.	Morphology and histology of pituitary gland	3
2.	Morphology and histology of thyroid gland in vertebrates; the role of thyroid hormones in amphibian metamorphosis	6
3.	Cellular organization and functions of parathyroid hormones	3
4.	Cellular organization and functions of endocrine pancreas	3
5.	Anatomy, histology and functions of adrenal gland (inter-renal/cortex and chromaffin tissue/medulla)	6
6.	Gonad as endocrine organs: anatomical and histological organization of testis and ovary; functions of testicular and ovarian hormones; effect of castration on male reproductive system	7
	Class Tests	2
	Class Discussion	2
Total		64

Paper: ZL905E5

Advanced Biochemistry

(Credit – 4)

First Half		Credit -2
Sl. No.	Topics	Classes (hrs)
1.	<b>Molecules:</b> <ul style="list-style-type: none"> <li>• Binding of atoms and different forces acting on the molecule (main emphasis on Vander Waals, Electrostatic, Hydrogen bonding, hydrophobic interaction)</li> <li>• Basic structure of carbohydrate, lipid, protein {special emphasis on protein structure(Secondary, Tertiary, Quaternary), Basic idea about Ramachandran Plot} and DNA {conformation of nucleic acid, helix(A, B, Z), t-RNA, micro-RNA}</li> <li>• Supramolecular complexes – ribosomes and their multi-enzyme complexes.</li> </ul>	12
2.	<b>Enzymes and their Properties:</b> <ul style="list-style-type: none"> <li>• Nomenclature and classification, enzyme kinetics, factors influencing enzyme activity, enzyme inhibition and regulatory enzyme, substrate interaction in relation to isomerism, its importance.</li> <li>• Enzyme purification.</li> </ul>	10
3.	<b>Synthesis and Metabolism:</b> <ul style="list-style-type: none"> <li>• Biosynthesis and degradation of Glucose, Palmitic acid, Purine and Pyrimidine bases.</li> <li>• Concept of metabolism with examples.</li> </ul>	6
	Class Tests	2
	Class Discussion	2
Second Half		Credit 2
1.	<b>Biophysical Chemistry:</b> <ul style="list-style-type: none"> <li>• Solutions, Buffers, pH and its effects on biological reactions.</li> <li>• Biological oxidation and reduction</li> <li>• Thermodynamics</li> </ul>	8
2.	Principles and applications of <ul style="list-style-type: none"> <li>• Spectroscopy: UV-Vis spectrophotometry, Atomic absorption and NMR spectroscopy</li> <li>• Transmission and scanning electron microscopy and confocal microscopy</li> <li>• X-ray diffraction</li> <li>• Centrifugation, Chromatography and electrophoresis</li> </ul>	14
3.	Importance of immunological techniques in biochemistry Western blot, Immunocytochemistry, ELISA and RIA	6
	Class Tests	2
	Class Discussion	2
	Total	64

Paper: ZL906C

Animal Physiology

Credit 4

<b>First Half</b>		<b>Credit 2</b>
<b>Sl. No.</b>	<b>Topics</b>	<b>Classes (hrs)</b>
1.	Circulation: circulatory systems in invertebrates and vertebrates, physiological types of hearts, cardiac cycle and its regulation in mammals, composition of blood and function of blood, haemopoiesis, blood pressure, blood groups, blood coagulation	10
2.	Neurons: Ultrastructure, types and function, resting and action potential, nerve impulse conduction through an axon, neurotransmitters and synaptic transmission	9
3.	Musculature in vertebrates: smooth, skeletal and cardiac muscles, ultrastructure and chemical composition of skeletal muscle, mechanism of skeletal muscle contraction, muscle fatigue, tetanus and rigor mortis	9
	Class tests	2
	Class discussion	2
<b>Second Half</b>		<b>Credit 2</b>
4.	Respiration: respiratory organs in vertebrates, mechanism of respiration through gills in fishes, mechanism of breathing and its regulation in mammals, respiratory pigments – brief chemistry and functions, transport of O <sub>2</sub> and CO <sub>2</sub> , oxygen dissociation curve, Bohr effect and Root effect	10
5.	Excretion & Osmoregulation: nitrogen excretion in animals, structure of vertebrate kidney and nephron, formation of urine, counter-current mechanism in higher vertebrates, homeostasis, osmoregulation in aquatic and terrestrial animals – mechanism and regulation	10
6.	Digestion: digestive enzymes in vertebrates, secretion and regulation in mammals, mechanism of digestion of food materials in mammals	8
	Class Tests	2
	Class Discussion	2
Total		64

Paper: ZL907E

Invertebrate Endocrinology

Credit – 2

Sl. No.	Topics	Classes (hrs)
1.	Concept of Neurosecretion: i. Neurosecretory cells, ultrastructural features and types. ii. Differences between neurosecretory cell and ordinary neuron; hormone, neurohormone and neurohumor. iii. Chemical nature of hormone, neurohormone and neurohumor. iv. Staining characteristics of neurosecretory cells. v. Secretory dynamics in neurosecretory cells.	6
2.	Distribution of neurosecretory cells, neurosecretory system and non-neural endocrine glands in invertebrates (Cnidaria to Echinodermata).	2
3.	Detailed structure and functions of neurosecretory system, non-neural endocrine glands and neurohaemal organs in invertebrates (Annelida, Insecta, Crustacea and Gastropoda).	8
4.	Mechanism of synthesis, transport and release of neurohormone.	2
5.	Neuroendocrine control of – i. Growth and regeneration in Annelids ii. Growth and metamorphosis in Insects iii. Gonad maturation in Cephalopod molluscs	6
6.	Neuroendocrine integration in invertebrates.	2
	Class Tests	2
	Class Discussion	2
	Total	<b>30</b>

## Fourth Semester

(Core Course (C) – 8 Credit & Elective Course (E) – 12 Credit)

**Paper: ZL1001C**

**Biosystematics and Evolution**

**Credit- 2**

Sl. No.	Topics	Classes (hrs)
1.	Biosystematics: special concerns, biological species concept, genetic basis of species and population	3
2.	Taxonomy concept: taxonomic procedure – alpha, beta and gamma taxonomy; micro- and macrotaxonomy	3
3.	Taxonomic methods: taxonomic categories; principle of assigning animal grouping into categories	2
4.	Taxonomic characters: selection and kinds of characters – morphological, biochemical, behavioral, cytological and ultra-structural	3
5.	Variation in characters: meaning, methods of measuring variations, infra-species taxonomy – biotypes, ecotypes, races, demes; phenotypic plasticity – genetic basis	2
6.	Principles of zoological nomenclature and brief digest of rules	2
7.	Molecular taxonomy: principle and methods	2
8.	Origin and history of life, evolutionary time scale	2
9.	Organic evolution: concept and evidences, theories (Lamarckism, Darwinism and modern theories), types of selection	2
10.	Population as unit of evolution, Hardy-Weinberg equilibrium, major evolutionary forces, modes of speciation	5
11.	Evolution at molecular level: genomic and proteomic changes, molecular clock, molecular phylogeny	2
	Class Tests	2
	Class Discussion	2
	Total	<b>32</b>

**Paper: ZL1003C**

**Project work**

**Credit 4**

<b>Sl. No.</b>	<b>Topics</b>	<b>Credits</b>
1.	Course work	1
2.	Literature review and formulation of objectives	1
3.	Laboratory/ Field work	1
4.	Dissertation submission and power point presentation	1

Paper: ZL1004E

Aquaculture

Credit 2

Sl. No.	Topics	Classes (hrs)
1.	Aquaculture definition, principle and scope, types, aquatic adaptation of fish, advantages of aquafarming, cultural diversity, biological pathway, socioeconomic importance	3
2.	Selection of sites for aquaculture, land based farm, open water farm etc, water quality and quantity management	2
3.	Biological characteristics of aquaculture species, common species and their importance	2
4.	Design and construction of aqua farms, fundamental concept, economic criteria	2
5.	Nutrition and feeds, food and feeding habits of cultivable species, HUFA, PUFA, nutritional importance and human health	2
6.	Economic viability, data requirements, cost-benefit analysis of aquaculture	2
7.	Aquaculture practices, husbandry procedures, carp	2
8.	Ornamental fish, diversity, culture and importance	2
9.	Management of stocking pond - optimal conditions of water quality criteria, management	2
10.	Culture of air breathing fishes-concept, principles and practices	2
11.	Culture of endangered species- <i>Ompok</i>	2
12.	Fin fish and shell fish- major cultivable species of shrimps, reproduction and larval rearing	2
13.	Fish health and disease treatment, husbandry procedures-cleaning, feeding, effluent treatment and management	2
	Class Tests	2
	Class Discussion	2
	Total	31

**Paper: ZL1005E****Insect Taxonomy****Credit 2**

<b>Sl. No.</b>	<b>Topics</b>	<b>Classes (hrs)</b>
1.	Principles of taxonomy: definitions and concept of species and higher taxa; classification; phylogeny and cladistics; brief digest of rules of nomenclature	5
2.	Insect structure and diversity: insect body plan; important structures and their modifications; insect diversity and their adaptive features	5
3.	Taxonomic characters: mouth parts; head and antennae; wings: thorax and legs; abdomen and genitalia; special characters	6
4.	Classification: super orders and orders; methods of taxonomic key preparation; use of identification guides through www; illustrations – drawings and image of body parts; use of softwares in image acquisition and biometry	6
5.	Molecular taxonomy: principles and methods; enzyme variations – isozymes and allozymes; barcoding – mtDNA and nuclear DNA; monophyly, paraphyly and polyphyly	6
	Class Tests	2
	Class Discussion	2
	Total	<b>32</b>



Paper: ZL1006E

Soil Zoology

Credit 2

Sl. No.	Topics	Classes (hrs)
1	Soil components and types; soil profile; physical and chemical properties of soil; macro and micro nutrients in soil and their importance to the soil organisms; physico-chemical changes in soil following application of organic manure/ vermicompost	3
2	Soil micro, meso- and macro- fauna - their spatial and vertical distribution and importance in soil ecosystem	3
3	Soil inhabiting nematodes, their general characters; life cycle of a plant parasitic nematode ( <i>Meloidogyne incognita</i> ); beneficial and harmful role of soil inhabiting nematodes	8
4	Earthworm and termites as soil-ecosystem engineers; their ecological categories, soil turnover, formation of biogenic structures (casts, galleries)	4
5	Reproductive biology of Earthworms; hermaphroditism, conjugation, cocoon production and biology of cocoon	4
6	Termite colonies; feeding habits and digestive processes in termites	2
7	Adaptive strategies in soil invertebrates	3
8	Class tests	2
9	Class discussion	2
	<b>Total</b>	<b>31</b>

Paper: ZL1007E1

Biodiversity

Credit 4

<b>First Half</b>		<b>Credit -2</b>
<b>Sl. No.</b>	<b>Topics</b>	<b>Classes (hrs)</b>
1.	Global patterns in species richness: species richness gradients along latitude and longitude; global species richness; species richness and community function	8
2.	Species diversity: local and regional components of diversity; diversity in islands; niche concepts and diversity	8
3.	Methods of measuring diversity: diversity indices – dominance indices, information statistic indices, Shannon index, Brillouin index; rank abundance diagrams; community similarity – Jaccard coefficient, Sorenson coefficient; cluster analysis	10
	Class Test	2
	Class Discussion	2
<b>Second Half</b>		<b>Credit 2</b>
1.	Link between diversity and stability: community stability; theory of regulation of species diversity; diversity – stability hypothesis	8
2.	Field study of richness and diversity: butterflies; moths; rapid diversity assessment methods	8
3.	Conservation of biodiversity: the pressure on wildlife; maintaining biodiversity; biodiversity act of India; methods of conservation	10
	Class Tests	2
	Class Discussion	2
	Total	<b>60</b>

Paper: ZL1007E2

Fish Technology

Credit 4

First Half		Credit -2
Sl. No.	Topics	Classes (hrs)
1.	Brood stock management, selection criteria, feeding	2
2.	Reproduction and genetic selection	3
3.	Basic water quality characters of nursery and rearing ponds	3
4.	Acclimatization, concept, basic importance, pathway for acclimatization technology	3
5.	Concept of captive breeding, steps for captive breeding technology, factors stimulating and suppressing, gonadotropin, <i>ex-situ</i> conservation of endangered fish	4
6.	Cryopreservation of gametes, significance, cryo-protectants, steps for cryopreservation, merit and limitations	3
7.	Sex control, sex reversal, sterilization, Hybridization, interspecific, intergeneric, significance	3
8.	Triploid fish, characterization of the species, artificial technology for development of triploid fish	4
9.	Transgenic fishes, gynogenesis, androgenesis, scope and limitations	3
	Class Tests	2
	Class Discussion	2
Second Half		Credit 2
1.	Fish pathology, fungus infection, bacterial diseases, protozoan diseases, control measure	4
2.	Harvesting and post harvesting technologies, by products of fish industry and their economic importance	3
3.	Transportation of live fish and seed, merits and limitations	3
4.	Freshwater prawn culture technology, breeding characteristics, juvenile prawn migration, culture practices	3
5.	Scope for Hilsa breeding and development	3
6.	Low carbon foot print fish culture- silver carp, grass carp, common carp etc.	3
7.	Induced spawning, brood stock, management, environmental control of spawning	3
8.	Trout, Salmon, stripping, fertilization and hatching,	2
9.	Raceway culture technology, water quality characteristics, significance	2
10.	Cage culture and Pen culture technology, species specification, steps of culture, scope	2
	Class Tests	2
	Class Discussion	2
Total		<b>64</b>

**Paper: ZL1007E4 Mammalian Reproductive Physiology****Credit 4****First Half Male Reproductive Physiology****Credit – 2**

Sl. No.	Topics	Classes (hrs)
1.	Male reproductive system: scrotum, testis, cryptorchidism, disorder of testicular functions, ducts of testis, accessory sex glands, sperm transport in male genital duct, motility of sperm in male genital ducts	8
2.	Spermatogenesis: spermatozoa – ultrastructure, hormone control of spermatogenesis, maturation of sperm	5
3.	Semen: constituents of semen, coagulation of semen, physiological significance of seminal plasma	2
4.	Prostaglandins: eicosanoids, prostaglandins, mechanism of actions of prostaglandins and other eicosanoids, functions of prostaglandins	4
5.	Male hormones: characteristics, receptors and target cells, mechanism of hormone action	5
6.	Sexual differentiation and behaviour: gonadal differentiation, brain differentiation, hormones in sexual behaviour	4
	Class Tests	2
	Class Discussion	2

**Second Half Female Reproductive Physiology****Credit 2**

1.	Female reproductive system: structure of ovary; female duct system, external genitalia, mammary gland	2
2.	Oogenesis: process and hormonal control	3
3.	Reproductive cycles: types and duration of reproductive cycles, estrous cycle and menstrual cycle	6
4.	Ovulation and fertilization: process of ovulation, endocrine regulation of ovulation, fertilization – detailed process, prevention of polyspermy	8
5.	Implantation and pregnancy: pre-implantation, implantation, placenta, physiology of pregnancy, pseudopregnancy	4
6.	Parturition and lactation: onset of parturition, the stage of labor, Ferguson's reflex, hormonal control of parturition, process of lactation and hormonal control	6
	Class Tests	2
	Class Discussion	2
	Total	64

Paper: ZL1007E5 Advanced Cell Biology

Credit 4

First Half

Credit– 2

Sl. No.	Topics	Classes (hrs)
1.	<b>Organization of the Cell:</b> <ul style="list-style-type: none"> <li>• Eukaryotic and prokaryotic cellular compartmentalization, their basic functions, and dynamics.</li> <li>• Plasma membrane and its function in relation to communication, channeling and transport.</li> <li>• Structure of nucleus and protein transportation across it. Structure of chromosomes, chromatin, idea of euchromatin, heterochromatin and transposon.</li> <li>• Evolution of mitochondria and basic idea about mitochondrial genome, mitochondrial fission and fusion.</li> <li>• Golgi body, Endoplasmic reticulum and their involvement in protein trafficking.</li> <li>• Actin and movement, importance of microtubules.</li> <li>• Basic understanding of endosomes, peroxisomes and lysosomes.</li> </ul>	18
2.	<b>Maintenance of the Cell:</b> <ul style="list-style-type: none"> <li>• Cellular energy demands-Oxidative phosphorylation.</li> <li>• Replication of DNA, mutation and its repair, importance of recombination.</li> <li>• Transcription, RNA processing, splicing and transport, regulation of gene expression –Operon concept</li> <li>• Genetic code and translation, practical implications of translational inhibitors and post translational modifications.</li> </ul>	10
	Class Tests	2
	Class Discussion	2

Second Half

Credit 2

1.	<b>Cell Communication:</b> <ul style="list-style-type: none"> <li>• Cell Signaling- types of receptors, fundamentals of signal transduction, role of second messengers and regulation.</li> <li>• Cell adhesion – different cell adhesion molecules, tight and gap junctions.</li> </ul>	12
2.	<b>Cell Cycle and Cell Death</b> <ul style="list-style-type: none"> <li>• An overview of stages of mitosis and meiosis.</li> <li>• Cell cycle and check points, involvement of cyclins and cdk.</li> <li>• Chromatin segregation, microtubule and spindle formation, centrosome.</li> <li>• Cancer, proto-oncogenes and tumor suppressor genes, their mechanism of action.</li> <li>• Aging: antioxidant defense system and mitochondrial status.</li> <li>• Apoptosis – intrinsic and extrinsic pathways, importance of apoptosis.</li> </ul>	16
	Class Tests	2
	Class Discussion	2
	Total	64

Paper: ZL1008C

Economic Zoology

Credit 2

Sl. No.	Topics	Classes (hrs)
1.	Concept of pest, Pest management, Integrated pest management. Insect pests of paddy and vegetables, pesticides and their modes of actions.	6
2.	Sericulture: types of silkworm and silk, composition of silk, rearing of silk moth, extraction of silk, diseases of silk worm, scope of sericulture industry and recent approaches to improvement in quality of silk.	6
3.	Fish culture: Economic importance, edible fresh water fishes, indigenous and exotic fishes, culture practices, conservation, by products of fish industry, management	4
4.	Prawn fishery: Characterization of prawn and shrimp; fresh water prawn culture and its prospects in India	5
5.	Vermiculture and vermicomposting: selection of earthworm, principle, method and applications	5
	Class Tests	2
	Class Discussion	2
	Total	<b>30</b>

Paper: ZL1009E

Hormone Receptors and Signaling

Credit 2

Sl. N.	Topics	Classes (hrs)
1.	Classification of hormones on the basis of chemical nature and mechanism of actions at cellular level.	1
2.	<b>Nuclear Receptors:</b> Structure of nuclear receptors; Classification of nuclear receptors; Mechanism of actions of steroid hormones (genomic and nongenomic pathways) and Metabolism	7
3.	<b>Membrane receptors:</b> Enzyme linked receptors, Cytokine receptors, G-protein coupled receptors, ligand-gated ion channels, Receptor metabolism, Receptor regulation	7
4.	<b>Hormone Signaling:</b> cAMP pathway, RTKs pathway, Cytokine receptor pathway, PKC pathway, NO signaling pathway, MAPK pathway	13
	Class Test	2
	Class Discussion	2

On 28/3/16 in the 1st meeting of the 2nd B.F.S.

# CHOICE BASED CREDIT SYSTEM (CBCS) IN ZOOLOGY

Total credit = 72

Credit (Core 48 + Elective 20 + 4 Compulsory)

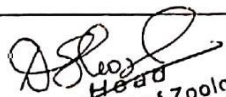
Compulsory Elective (2 + 2 Credits)

## Core Courses

Semester - I		
Course Code	Course Name	Credit
ZOOL701C	Animal Diversity (Non Chordates and Chordates)	4
ZOOL702C	Developmental Biology & Endocrinology	4
ZOOL703C	Biochemistry and Animal Physiology	4
ZOOL704C	Laboratory Exercise	4
Semester - II		
ZOOL801C	Histology	2
ZOOL802C	Cell Biology and Genetics	4
ZOOL803C	Ecology & Environmental Zoology	4
ZOOL-804C	Laboratory Exercise	4
Semester - III		
ZOOL901C	Ethology	2
ZOOL902C	Parasitology and Immunology	4
ZOOL-903C	Project	4
Semester - IV		
ZOOL1001C	Biosystematics & Evolution	2
ZOOL1002C	Molecular Biology	2
ZOOL1003C	Project	4
<b>Total Credit</b>		<b>48</b>

## Elective Courses offered by the Department

Semester II		
Course Code	Course Name	Credit
ZOOL805E	Tools and Methods in Biology	2
Semester III		
ZOOL904E	Aquatic Environmental Science	2
ZOOL905E1/ ZOOL905E2/ ZOOL905E3	Advanced Animal Ecology Fisheries Comparative Endocrinology	4
Semester IV		
ZOOL1004E	Aquaculture	2
ZOOL1005E	Insect Taxonomy	2
ZOOL1006E	Soil Zoology	2
ZOOL1007E1/ ZOOL1007E2/ ZOOL1007E3	Biodiversity Fish Technology Mammalian Endocrinology	4
<b>Total Credit</b>		<b>18</b>
Compulsory Foundation (Computer Application and Soft Skill)		(2+2) 4
Elective Foundation (Statistics)		2
<b>Total Course Credit</b>		<b>72</b>

  
 Head  
 Department of Zoology  
 Tripura University  
 Suryamaninagar





 19/3/15



Paper No. ZL 801C

**Histology**

**Credit: 2**

**Marks 50**

Topic No.	Topics	No. of Classes
<b>HISTOLOGY</b>		
01	Preparation of tissues for study: Fixation, Embedding & sectioning, Staining; Acid stains & Basic stains; Auxochrome & Chromophore groups in stain	02
02	Classification of tissues, their origin, structure and function.	06
03	Histology of Lymphoid organ (Spleen & its function)	02
04	Origin, gross anatomy, blood supply, histology & functions of exocrine glands viz. Liver and Pancreas	04
05	Origin, histology and functions of skin – the largest organ in the body	02
06	Origin, gross anatomy, blood supply, histology and functions of endocrine glands viz. Pituitary, Thyroid, Adrenal, islets of Langerhans, Testis & Ovary	12
	Class Tests	02
	Class discussion	02
	<b>Total</b>	32

Paper No. ZL 802C

## Cell Biology & Genetics

Credit: 4

Marks 100

Topic No.	Topics	No. of Classes
<b>Cell Biology</b>		<b>Credit: 2</b>
01	Membrane structure and function, membrane proteins and channels, electrical properties of membranes	05
02	Cell and cycle and its regulation	05
03	Hormones and their receptors, cell surface receptor, signalling through G-protein coupled receptors, signal transduction pathways, regulation of signalling pathways	06
04	Cytoskeleton, components structure, dynamics and function	02
05	General principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins, neurotransmission and its regulation	06
06	Cellular oncogenes, tumor suppressor genes, virus-induced cancer, metastasis, interaction of cancer cells with normal cells, apoptosis	06
	Class Tests	02
	<b>Total</b>	32
<b>Genetics</b>		<b>Credit: 2</b>
01	<b>Mendel's law and their chromosomal basis:</b> Concept of gene: allele, multiple alleles, pseudo-allele, iso-allele; Extensions of Mendelism: dominance relationship, epistasis, pleiotropy, expressivity, penetrance	03
02	<b>Organization of genes and chromosomes</b> Organization of chromatin: Nucleosome, molecular anatomy of eukaryotic chromosomes, structure and organization of telomere, centromere and kinetochore, polytene chromosome; Unique and repetitive DNA, euchromatin and heterochromatin, constitutive and facultative heterochromatin, chromatin domains and boundary function	03

03	<b>Somatic cell genetics</b> Cell fusion and technology; Heterokaryon selecting hybrids and chromosome mapping, hybridoma	02
04	<b>Microbial genetics</b> Methods of genetic transfer: Transormaiton, conjugation, Transduction and Sex-duction\; Genetics of Bacteriophage: Lytic and Lysogenic cycle and regulatory mechanisms	03
05	<b>Human genetics</b> Karyotype and nomenclature of metaphase chromosome bands: Concept of G Banding, R banding, Q banding; Chromosome anomalies and disease: Common syndromes caused by aneuploidy, mosaicism, deletion and duplication, chromosomal anomalies in malignancy (chronic myeloid leukemia, Burkitt's lymphoma, retionoblastoma and Wilm's tumor), Fragile site and X – linked mental retardation; Pedigree analysis and concept of LOD score	04
06	<b>Gene mapping techniques</b> Three point test cross in Drosophila; Gene mapping in human by linkage analysis in pedigrees; Tetrad analysis in Neurospora	07
07	<b>Sex determination and Dosage compensation in c. Elegance, Drosophila and human</b>	02
08	<b>Transposable elements in prokaryotes and eukaryotes</b>	01
09	<b>Quantitative genetics</b> Polygenic inheritance; Heritability and its measurements	02
10	<b>Mutation</b> Types, causes and detection: autosomal and sex-linked, loss of function, gain of function Molecular basis of mutation, germinal versus somatic mutants Insertional mutagenesis	03
11	<b>Regulation of gene expression</b> Lac operon; Trap operon	03
	Class Tests	02
	<b>Total</b>	33

Paper No. ZL 803C

**Ecology & Environmental Zoology**

Credit: 4

Marks: 100

Topic No.	Topics	No. of Classes
<b>ECOLOGY Credit: 2</b>		
01	<b>Life and Physical Environment:</b> Interdependence of biological and physical worlds; Role of organisms in the formation of the Earth's atmosphere; How humans affect the natural world; Body size and environment relationship	05
02	<b>Energy and Heat relationship:</b> Chemical equations of photosynthesis and respiration; Kinds of adaptations required for living at extremely high and extremely low temperatures; Four avenues of heat transfer between organisms and their environment	05
03	<b>Population Structure:</b> Various components of population structure; How do environmental factors affect geographic distribution at different scales; Why are conservation biologists interested in genetic structure of small populations; How are isozyme analysis and DNA fingerprinting used to examine genetic variation; How are life tables used to characterize population structure?	05
04	<b>Regulation of Ecosystem functions:</b> Phosphorus limitations in fresh water; Nitrogen limitations in marine water; Ecosystem regulations by top-down or bottom-up controls (nutrient flux)	04
05	<b>Resources and Consumers:</b> Four general types of species interactions; difference between renewable and non-renewable resources; three types of renewable resources; What is a limiting resource? Five types of consumers	05
06	<b>Applied Ecology:</b> Environmental pollution; global environmental changes; biodiversity management approaches; biodiversity hot spots of world, biodiversity status of northeast India	05
	Class tests	02
	Class discussion	01
	<b>Total</b>	32

<b>Environmental Zoology      Credit: 2</b>		
01	Scope, principle and definition- environmental Zoology:	02
02	Factors affecting terrestrial and aquatic environment; definition: Interactions between Physico-chemical and biological parameters in an ecosystem; Stressed and non-stressed freshwater environment	04
03	Aspects in the atmosphere, hydrosphere, lithosphere and biosphere. Mass and Energy transfer across different interfaces. Thermodynamics; Aspects and prospects of meteorology, climate change	04
04	Natural resources, conservation and sustainable development.	03
05	Effects of pollution in freshwater, brackish water and marine water ecosystem; definition of DO, BOD, and COD, sedimentation etc. thermo chemical and photochemical reactions in the atmosphere. Oxygen and ozone,	05
06	Effects of acid industrial pollution on air and biota	03
07	Sugarcane and effects of its waste on the distribution of fauna. Biological and Chemical aspects of sewage, effects on diversity of aquatic fauna Leather waste and its impact on terrestrial and aquatic fauna	04
08	Paper mill waste, chemical character & effects on the distribution of fauna. Inorganic and organic components of soil, Nitrogen pathways, NPK of terrestrial and aquatic soil. Agricultural pesticides in water; Biochemical aspects of arsenic, cadmium, carbon monoxide etc	05
	Class Test	02
	<b>Total</b>	<b>32</b>

**Paper No. ZL 804C**  
**Laboratory Exercises**  
**Credit: 4**  
**Marks: 100**

Topic No.	Topics	No. of Classes
01	Processing of mammalian glandular tissues and their double staining (Eosin & Hamatoxylin)	02
02	Preparation and staining of skeletal muscles of mammal	02
03	Staining and identification of blood cells	02
04	Identification of histological slides based on syllabus	02
05	Bactrial Culture in LB Broth	03
06	Animal cell culture	03
07	Staining of Mitochondria	02
08	Nucleocytoplasmic index	02
09	Fluorescence staining	02
10	Study of meiosis from grasshopper testis	04
11	Immunoflouroscent Staining of actin fibre	02
12	Determination of dissolved Oxygen in water	02
13	Determination of free Carbon dioxide in water	02
14	Determination of species diversity of a community by Shannon-Weiner Index	02
15	Chromatographic Separation of Amino acids	02
16	Tissue preparation for analysis of Proteins, Enzymes, Nucleic acids using tools like Centrifuge, Spectrophotometer	06
17	Demonstration of Auto radiographic slide	02
18	Analysis of Turbidity and Transparency of supplied sample	03
19	Analysis of Carbonates and Bicarbonates of supplied sample	03
20	Haematology of some fauna from Pesticide contaminated Environment	02
21	Analysis of Human Pedigree and Construction of Pedigree Chart	01
22	Preparation of Polytene Chromosomes of Drosophila Larvae	01
	<b>Total ( Each class of 3 hours )</b>	55 x 3 hrs = 165 hrs

Paper No. ZL 805C

**Tools and Methods in Biological Sciences**

Credit: 2

Marks: 50

Topic No.	Topics	No. of Classes
01	Principles and uses of different kinds of Microscopes	04
02	Basic principles and uses of different staining techniques used of late.	04
03	Methods of separation and purification of macromolecules including chromatographic and electrophoretic methods	05
04	Different spectrophotometric methods and their uses	04
05	Radio isotopic methods and their utilities in different kinds of studies related to metabolic studies	04
06	Ideas of PCR, X Ray crystallography, NMR, Patch Clamp, FACS and optogenetic methods	05
07	Centrifugation, and its different uses including determination of 'S' value	04
	Class Test	02
	<b>Total</b>	32

# CHOICE BASED CREDIT SYSTEM (CBCS) IN ZOOLOGY

Total credit = 64

Credit (Core 48 + Elective 16)

Compulsory Credit 4 = Foundation Course (Computer Application)

## Semester I

Core Course		Credit	Elective Course		Credit	Total Credit
ZOOL701C	Animal Diversity (Non Chordates and Chordates)	4				4
ZOOL702C	Developmental Biology & Endocrinology	4				4
ZOOL703C	Biochemistry and Animal Physiology	4				4
ZOOL704C	Laboratory Exercise	4				4

## Semester II

Core Course		Credit	Elective Course		Credit	Total Credit
ZOOL801C	Tools and Techniques and Histology	2	ZOOL801E/ Quantitative Zoology/ Aquatic Environmental Science		2	4
ZOOL802C	Cell Biology and Genetics	4				4
ZOOL803C	Ecology & Environmental Zoology	4				4
ZOOL-804C	Laboratory Exercise	4				4

## Semester III

Core Course		Credit	Elective Course		Credit	Total Credit
ZOOL901C	Applied limnology & Ethology	4				4
ZOOL902C	Parasitology and Immunology	4				4
			ZOOL903E1/ ZOOL903E2/ ZOOL903E3/		4	4
ZOOL-904C	Laboratory Exercise	2	ZOOL904E	Laboratory Exercise	2	4

## Semester IV

Core Course		Credit	Elective Course		Credit	Total Credit
ZOOL1001C	Biosystematics and Evolution	4				4
ZOOL1002C	Molecular Biology	2	ZOOL1002E	Insect Taxonomy/ Soil Zoology	2	4
			ZOOL1003E1/ ZOOL1003E2/ ZOOL1003E3/		4	4
ZOOL1004C	Laboratory Exercise	2	ZOOL1004E	Laboratory Exercise	2	4
Total Core Credit		48	Total Elective Credit		16	64

*Basu*  
20/2/15

*Pritya-kanchandam*  
20/2/15

*Pritya-kanchandam*  
20/2/15

*Head*  
64  
20.2.15  
Department of Zool.  
Tripura University  
Suryamaningpur

*Handwritten mark*



Paper No.

ZOOL903E1 – Ecology & Biodiversity

ZOOL903E2 – Fisheries and Fish Technology

ZOOL903E3 – Reproductive Biology and Mol. Endocrinology

ZOOL1003E1 – Ecology & Biodiversity

ZOOL1003E2 – Fisheries and Fish Technology

ZOOL1003E3 – Reproductive Biology and Mol. Endocrinology

*Prof. Anwar*  
20/2/15

*Prayankumar Chatterjee*  
20/2/15

*S. Ghosh*  
20/2/15

*ASR*  
20.2.15  
Head  
Department of Zoology  
Tripura University  
Suryamaninagar

*ASR*  
20/2/15



## Proceeding of the First Meeting of the Board of Post Graduate Studies in Zoology

Date: 2<sup>nd</sup> & 3<sup>rd</sup> August 2016

Time: 12.30 PM – 4.30 PM

Venue: Seminar Hall, Zoology Department

Sl. No.	Name and Address of Members Present	Signature
1.	Prof. B.B. Jana, University of Kalyani, West Bengal	<i>B. Jana</i>
2.	Prof. Jagat K. Roy, Banaras Hindu University, Varanasi	<i>J. K. Roy</i>
3.	Prof. N. Saha, North – Eastern Hill University, Shillong	<i>N. Saha</i>
4.	Prof. M.K. Singh, Dean, Faculty of Science, Tripura University	
5.	Prof. D. Ghosh, Department of Zoology, Tripura University	<i>D. Ghosh</i> 3.8.16
6.	Prof. S. Banik, Department of Zoology, Tripura University	<i>S. Banik</i> 3/8/16
7.	Prof. P.S. Chaudhuri, Department of Zoology, Tripura University	<i>P. S. Chaudhuri</i> 3/8/16
8.	Dr. S. S. Singh, Department of Zoology, Tripura University	<i>S. S. Singh</i> 3/8/16
9.	Prof. A.K. Saha, Department of Botany, Tripura University	
10.	Dr. Dipayan Chaudhuri, Department of Human Physiology, Tripura University	<i>D. Chaudhuri</i> 03.08
11.	Prof. B. K. Agarwala, Head & ex-officio Chairperson	<i>B. K. Agarwala</i>

### 1. To welcome new members of the Board

The Chairperson welcomed all the members to the first meeting of the BPGS. He expressed his gratitude to the external members, in particular, who took the trouble to travel to Agartala and for sparing their valuable time with us.

### 2. To discuss and approve the revised syllabus of second, third and fourth semesters in zoology under the CBC System

Soft copies of the draft of syllabi were sent to all the members in advance and hard copies of the same were distributed in the meeting. All the members actively took part in finalizing the draft of the first, second, third and fourth semester syllabi and, after necessary improvements, approved the modified CBCS course lay out and syllabi of all four semesters in Zoology for implementation beginning from the first semester 2016 as per the rules of Tripura University. It was also resolved that the unmodified CBCS plan of course lay out in Zoology as approved by BOF (Science) will remain unchanged for the students of the 3<sup>rd</sup> semester 2016 and their further progress in to 4<sup>th</sup> semester 2017.

### 3. To approve the Research Advisory Committees (RAC) of the following candidates enrolled for Ph.D.

- (I) Smt. Shilpa Dhar  
 (II) Smt. Sushmita Debnath  
 (III) Smt. Ruma Datta  
 (IV) Smt. Anandita Deb  
 (V) Smt. Sangita Sutradhar

As per the Ph.D. Regulation no. 5. 01. and 05. 02 of Tripura University, RACs of the following candidates are approved:

Sl. No.	Name of Student	RESEARCH ADVISORY COMMITTEE		
		External Member	Supervisor	Internal Member
1.	Smt. Shilpa Dhar	Prof. G. S. Solanki Department of Zoology, Mizoram University, Aizwal- 796004	Prof.P.S. Chaudhuri	1. Prof. B. K. Agarwala 2. Prof. D. Ghosh 3. Prof. S. Banik
2.	Smt. Sushmita Debnath	Prof. G. S. Solanki Department of Zoology, Mizoram University, Aizwal- 796004	Prof.P.S. Chaudhuri	1.Prof. B. K. Agarwala 2. Prof. D. Ghosh 3. Prof. S. Banik
3.	Smt. Ruma Datta	Prof. Sumit Home Chaudhuri Deptt. of Zoology, University of Calcutta	Prof. P. S. Chaudhuri	1. Prof. B.K. Agarwala 2. Prof. D. Ghosh 3. Prof. S. Banik
4.	Smt. Anandita Deb	Prof. S. K. Maitra Deptt. of Zoology Viswa Bharati Santineketan – 731235, W.B	Prof. S.S. Singh ( Supervisor) Prof. D. Ghosh ( Co- Supervisor)	1.Prof. B. K. Agarwala 2. Prof. S. Banik 3. Prof. P.S. Chaudhuri
5.	Smt. Sangita Sutradhar	Prof. S. K. Maitra Deptt. of Zoology Viswa Bharati Santineketan – 731235, W.B	Prof. S.S. Singh ( Supervisor) Prof. D. Ghosh ( Co- Supervisor)	1.Prof. B. K. Agarwala 2. Prof. D. Ghosh 3. Prof. S. Banik
6.	Sri Partha Sarathi Nath	Proposal withdrawn by the Supervisor.		

4. To approve the changes in Ph. D. Thesis titles of the following candidates based on the recommendations of the RACs as under:

- (i) Smt. Santa Ghosh  
 (ii) Smt. Aprajita Singh

As per the Ph.D. regulation no. 6.07, changes in the Ph. D. Thesis titles as proposed by the respective RACs of the candidates are approved:

S.L. No.	Name of student	Existing thesis title	Proposed change in thesis title
1.	Smt. Santa Ghosh	" Genital Morphology, Karyotyping and DNA Barcoding of some species of Coceinellini ( Coleoptera: Coccinellidae) of Tripura, India"	" Genital Morphology, Biometry and DNA Barcoding of some species of Coceinellini ( Coleoptera: Coccinellidae) of Tripura, India"
2.	Smt. Aprajita Singh	"Biology and Aquaculture of Aar, <i>Aorichthys aor</i> (Hamilton, 1822) with reference to its conservation"	" Biology and Aquaculture of Aar, <i>Sperata aor</i> (Hamilton, 1822) with reference to its conservation"

5. To approve the panel of Examiners and moderators for needful use in different examinations to be held during the Academic year:

The list containing 35 names of proposed examiners and moderators from different University/ Institutes in India is approved for needful use by the Controller of Examinations for the M. Sc. end - Semester examinations in Zoology to be held during the year 2016 and 2017.

6. To approve the Ph. D. Work plans of the following Candidates:

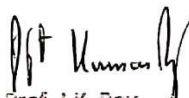
- (i) Smt. Shilpa Dhar
- (ii) Smt. Sushmita Debnath


Ph.D. work plans of Smt. Shilpa Dhar and Smt. Sushmita Debnath, as recommended by the RACs, under the supervision of Prof. P.S. Chaudhuri are approved with necessary modifications.


7. Any other items with the permission of the Chair

(a) It was decided that the meeting of the full Board should be held at least once in an academic year to review and discuss the academic and research performances of the Department. However, infrequent meetings of the Board with quorum may be held as per the need.

The meeting ended with a vote of thanks to the Chair.

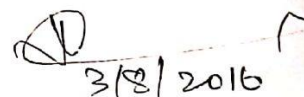
  
Prof. J.K. Roy  
Banaras Hindu University

  
Prof. B.B. Jana  
University of Kalyani

  
Prof. B.K. Agarwala  
Head of the Department

  
Prof. S. Banik  
Tripura University

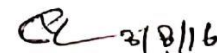
  
Prof. D. Ghosh  
Tripura University

  
Prof. N. Saha  
North Eastern Hill University

  
Dr. Dipayan Choudhuri  
Tripura University

Prof. A.K. Saha  
Tripura University

  
Prof. P.S. Choudhuri  
Tripura University

  
Dr. S.S. Singh  
TU

# NOTICE BOARD

Paul Paul  
8/3/17

## Ph.D. Course Work Syllabus for Course Work -I

- Credit-4

### RESEARCH METHODOLOGY-I

The whole paper is divided into four units as follows:

Unit-1: Basic Computer Applications

Unit-2: Quantitative methods, Statistics and application of Computer in statistics

Unit-3: Research Ethics and IPR

Unit-4: Documentation and scientific writing

#### DETAILED SYLLABUS FOR EACH UNIT:

##### Unit-1: Basic Computer Applications

Basic computer knowledge, Features and applications related to presentation of text in suitable format and saving the data for future applications. Use of word processing, Practical knowledge of MS Word to type the script, insert tables, figures and graphs, plotting of graphs in excel, Preparation of power point presentations based on the topic of research. Insertion of figures, graphs, charts in presentation. Use of spreadsheet and database software, Preparation of scientific posters for presentations, Internet and its application: Email, WWW, Web browsing, acquiring technical skills, drawing inferences from data, Cloud computing.

##### Unit-2: Quantitative methods, Statistics and application of Computer in statistics

Measures of Central tendency and Dispersion. Probability distribution- Normal, Binomial and Poisson distribution. Parametric and Non-parametric statistics. Confidence interval, Errors. Quantitative Techniques: Levels of significance, Regression and Correlation coefficient. Statistical analysis and fitting of data; Chi-Square Test, Association of Attributes t-Test Anova, Standard deviation, Co-efficient of variations. Open source software for quantitative and statistical analysis.

##### Unit-3: Research Ethics and IPR

Environmental impacts - Ethical issues - ethical committees - Commercialization - Copy right - royalty - Intellectual property rights and patent law - Trade Related aspects of Intellectual Property Rights - Reproduction of published material - Plagiarism - Citation and acknowledgement - Reproducibility and accountability.

##### Unit-4: Documentation and scientific writing:

Results and Conclusions, Preparation of manuscript for Publication of Research paper, Presenting a paper in scientific seminar, Thesis writing. Structure and Components of Research Report, Types of Report: research papers, thesis, Research proposal, Research Project Reports, Pictures and Graphs, citation styles, writing a review of paper, Bibliography.

Approved

# Syllabus Ph.D. Coursework in Zoology - 2017

## Paper II: Research Methodology – II

(4 Credits: 100 Marks)

### I. Review and Critics of Published Research in relevant field 2 Credits: 50 Marks

Review of published research work from among the following areas:

- (i) Systematics and biodiversity
- (ii) Ecology and biology
- (iii) Invertebrate neuroendocrinology
- (iv) Molecular endocrinology
- (v) Proteins, enzymes and their genes in invertebrates
- (vi) Fisheries and Aquaculture
- (vii) Fisheries and Fish technology
- (viii) Macroinvertebrate biology including insects and molluscs
- (ix) Environmental pollutants and remediation techniques
- (x) Tropical diseases

Each review will cover at least five original research articles published in last five years and are to be cited in the references.

AN OUTLINE PROFORMA OF THE REVIEW SHOULD BE GIVEN TO THE STUDENTS

40+10

### II. Methodology of Research

2 Credits: 50 Marks

- (i) Sampling methods of terrestrial and aquatic animals statistical methods
- (ii) Use of Phase Contrast and Fluorescent Microscopes
- (iii) Use of Electrophoresis system ✓
- (iv) Blotting Techniques ✓
- (v) DNA Barcoding and Phylogenetic analysis
- (vi) Research design and sampling methods
- (vii) Statistical methods in biology ✓

(ii) through (v) can be clubbed as molecular techniques in biology.

For the points vi and vii above, the following books should be considered strictly

1] Zar JH. 1999. Biostatistical Analysis. IV edition. New Delhi, India: Pearson Education (Singapore) Pte. Ltd., Indian Branch, 663p + appendix

2] Holmes D, Moody P, Dine D. 2006. Research Methods for the Biosciences. , New York, USA: Oxford University Press 377p

Head & Chairperson  
Board of Post Graduate Studies  
Tirupur University  
Department of Zoology  
11/3/17  
Head & Chairperson

**Paper – III: Advances in Zoology**

(4 Credits: 100 Marks)

**1. Biodiversity**

- Importance, levels of biological diversity; Geographical scale of species diversity; Methods of measuring biodiversity in space and time, worked examples.

**2. Proteins and Enzymes**

- Structural organizations in proteins.
- Enzymes and mechanism of action. Purification of enzymes.
- Characterization of Proteins and enzymes.

**3. Fish physiology, Biochemistry and Biotechnology**

- Triploid fish- definition, factors stimulating and suppressing, technology for development of triploid fish; Trans-genesis in aquaculture;
- Cryopreservation of fish gametes, ex-situ methods of conservation of germplasm, applications in aquaculture, sperm cryopreservation, cryopreserved milt and fertilization of eggs, ultra-structural studies on damages in cryopreserved spermatozoa, cryopreservation of fish embryos and embryonic stem cells.
- Captive breeding- Genetic basis for Selection of fish for breeding, inbreeding effects, cross breeding and hybridization, selection and mating designs for select traits, selection for disease resistance, mono-sex, endocrine control of reproduction in fish, synchronization of spawning, brood-stock development and management, technology for preparation of aquaculture hapa, care of fertilized eggs, assessing stripping, induced normality and mortality; Carp fertilization and embryonic development- cleavage, blastula formation, gastrulation; Live feed development for larvae, larval feeding and maintenance, packaging and transport of carp post larvae, fry and fingerlings, nursery, rearing, pre-stocking technologies for carps.

**4. Earthworm Biology and Ecology**

- Biology of reproduction in earthworms with reference to conjugation, cocoon formation and fecundity.

✓  Neurobiology of tropical earthworms with reference to neurosecretion.

✓  Earthworm as ecosystem engineers; Role of earthworms in soil fertility; edaphic factors controlling distribution of earthworms in soil; Vermiculture & Vermicomposting; Principle, method and significance of vermicomposting; Effect of vermicomposting on soil fertility.)

**5. Molecular Endocrinology**

- Hormone modern concept; types of receptors; cAMP and MAPK signalling pathway; hormonal control of gene expression; molecular basis of hormone synergism and antagonism.

**Paper IV: Seminar/ Practical / Project and Assessment**

(4 Credits: 100 Marks)

**1. Project in the following areas of Zoology**

2 Credits: 50 Marks

- (i) Taxonomy and biodiversity
- (ii) Ecology and biology
- (iii) Invertebrate neuroendocrinology
- (iv) Molecular endocrinology
- (v) Proteins, enzymes and gene expression
- (vi) Fisheries and Fish Technology
- (vii) Aquaculture

Project on <sup>other topic</sup> ~~any topic~~ of Zoology and related field can <sup>also</sup> be allowed so that the student enjoys the freedom to select a topic of choice. For future the same topic may be used by the candidate for the Ph.D. programme.

**2. Submission of Project Report, PPT presentation and viva-voce**

2 Credits: 50 Marks

*B. S. Paul*  
11/3/17  
**Head & Chairperson**  
Board of Post Graduate Studies  
Department of Zoology  
Tripura University