

Two Year, 4 Semester PG Course in Zoology

Grand Total Marks-1000

Course Structure

First Year(First Semester)

Paper	Subject/Topics	Marks in Internal assessment/ continuous evaluation	Marks in Semester Exam.	Total Marks in End Semester	Periods/ Week
Zoo/Th/101	Vision of Zoological Studies and Structural Diversity in Animals	10	40	50	4
Zoo/Th//102	Taxonomy and Economic Zoology	10	40	50	4
Zoo/Th/103	Histology and Neuro Sciences	10	40	50	4
Zoo/Th/104	Cell and Molecular Biology	10	40	50	4
Zoo/Pr/105	Practical	10	40	50	9
Total		50	200	250	25

First Year (Second Semester)

Paper	Subject/Topics	Marks in Internal assessment/ continuous evaluation	Marks in Semester Exam.	Total Marks in End Semester	Periods /Week
Zoo/Th/201	Endocrinology and Reproductive Biology	10	40	50	4
Zoo/Th/202	Stem Cell and Developmental Biology	10	40	50	4
Zoo/Th/203	Applied Ecology	10	40	50	4
Zoo/Th/204	Pests, Parasites and Immunology	10	40	50	4
Zoo/Pr/205	Practical	10	40	50	9
Total		50	200	250	25

Second Year (Third Semester)

Paper	Subject/Topics	Marks in Internal assessment/ continuous evaluation	Marks in Semester Exam.	Total Marks in End Semester	Periods/ Week
Zoo/Th/301	Genetics and Biotechnology	10	40	50	4
Zoo/Th/302	Physiology and Biochemistry	10	40	50	4
Zoo/Th/303	Evolution and Animal Behaviour	10	40	50	4
Zoo/Th/304	Biodiversity, Conservation Biology and Wildlife	10	40	50	4
Zoo/Pr/305	Practical	10	40	50	9
Total		50	200	250	25

Second Year (Fourth Semester)

Paper	Subject/Topics	Marks in Internal assessment/ continuous evaluation	Marks in Semester Exam.	Total Marks in End Semester	Periods/ Week
Zoo/Th/401	Biostatistics, Bioinformatics and Instrumentation	10	40	50	4
Zoo/Th/402	Costal Resource and Management	10	40	50	4
Zoo/Th/403	*Special -I	10	40	50	4
Zoo/Th/404	*Special -II	10	40	50	4
Zoo/Pr/405	Practical(Special)	10	40	50	9
Total		50	200	250	25

*Special Paper:

1. Zoo/Th/Eco/403 1. Zoo/Th/Ent/403 1. Zoo/Th/Fis/403 1. Zoo/Th/Gen/403

2. Zoo/Th/Eco/404 2. Zoo/Th/Ent/404 2. Zoo/Th/Fis/404 2. Zoo/Th/Gen/404

(Ecology)(Entomology)(Fishery)(Genetics.)

From the list of Special Papers as mentioned above, Students are free to choose one before the beginning of the 4th Semester Class. Option once exercised is final and binding. No change shall be permitted. Special paper will be offered as per the existing infrastructure.

Each paper carries 05 credit points

First semester

Paper: Zoo/Th/101

Vision of Zoological Studies and Structural Diversity in Animals

- 1.0 Emerging ideas on Zoology, Egyptian, Ancient Greek Roman traditions and Islamic ideas including idea of 17th and 18th centuries Chinese, Indian, Mesopotamian.
 - 1.1 Impact of the microscope and staining.

- 2.0 Emergence of biological disciplines in 19th Century.
 - 2.1 Natural history and natural philosophy.
 - Geological and paleontological.
 - Evolution and biogeography.
 - 2.1 Physiology.
 - Cell Theory, embryology and germ Theory.
 - Experimental Physiology.

- 3.0 Twentieth Century Biological Sciences, Ecology and environmental Sciences, Classical genetics, the modern synthesis and evolutionary theory, Biotechnology, genetic engineering.

- 4.0 Skeleton system in animals.
 - 4.1 Exoskeleton in vertebrates.
 - 4.2 Endoskeleton: Pectoral and pelvic girdle.

- 5.0 Digestive glands in animals.
 - 5.1 Structure, function and evolution of digestive glands in Arthropoda and mollusca.
 - 5.2 Structure, function and evolution of liver and pancreas in chordates.

- 6.0 Circulatory organs.
 - 6.1 Structure and evolution of heart in vertebrates.

- 7.0 Excretory organs and Structural diversity.
 - 7.1 Evolution of excretory organs in non-chordates.
 - 7.2 Types, Structure and functions of kidney in vertebrates.

Paper: Zoo/Th/102
Taxonomy and Economic Zoology

1. Taxonomic Procedure.
 - 1.1 .Collection, Preservation and methods of identification.
 - 1.2 .Taxonomic keys.
 - 1.3 .Types of classification.
 - 1.4 .Typification and taxonomic types.
2. Taxa and species: Phylogenetic group(Monophyly, Paraphyly and Polyphyly)
 - 2.1 .Biological and Evolutionary Species concept
 - 2.2 .Problems in parthenogenetic and asexual individuals.
3. Taxonomic Characters
 - 3.1. Different types of Characters.
 - 3.2. Discrete and overt Characters.
 - 3.3. Identifying Plesiomorphic and Apomorphic Character Status (Outgroup method).
 - 3.4. Character- State transitions-different types with dendograms.
 4. Concepts and Methodology in Systematics
 - 4.1.MicrotaxonomyandMacrotaxonomy.
 - 4.2.Differentmethods:Morphotaxonomy,Numericaltaxonomy,Cytotaxonomy,Chemotaxonomy and Moleculartaxonomy.
5. Phenetic Method
 - 5.1 Similarity and distance measures using binary and continuous data.
 - 5.2. Different Procedures - UPGMA and Euclidean methods.
 - 5.3. Clustering Method.
6. Cladistics and phylogenetic Reconstruction.
 - 6.1. Cladistics and Cladograms.
 - 6.2. Methods for cladistic analysis.
 - 6.3. Procedure: Parsimony.
7. Vermiculture
 - 7.1 Types of earthworms used in vermiculture
 - 7.2. Vermiculture techniques
 - 7.3. Utility and prospects of vermiculture
8. Soil arthropods and soil fertility
 - 8.1. Diversity of soil arthropods fauna
 - 8.2. Role of soil arthropods in soil fertility and decomposition
9. Sericulture
 - 9.1 Types of silk moth.
 - 9.2 Disease and pests of mulberry silkworm
 - 9.3 Biotechnology in sericulture and future of sericulture in India.
10. Apiculture
 - 10.1. Types of honey bees
 - 10.2. Modern methods of apiary management
 - 10.3 Diseases and pest of honey bees
 - 10.4 Problems and prospects of apiculture particular in Sundarban area.

Books:

1. Principles of Systematic Zoology : E. Mayer
2. Taxonomy: Quicke
3. Principle of systematic zoology: E.Mayr&Ashlock

Paper: Zoo/Th/103
Histology & Neuroscience

1. Overview Histology: (embryological origin –adrenal, pancreas and immune cells (kappa, liver, thymus, spleen, GI and genital tracts), histochemical localization of enzymes (phosphatase), hormones (E/NE), fat, carbohydrate, protein, DNA, RNA, biopsy for cancer detection, etc.)
2. Classification of tissues with characteristic features, structure and functions.
 - 2.1 Epithelial tissue (molecular organization of surface and ultrastructure of specialized cells related to synthesis, transport, secretion and release of hormones.
 - 2.2 Muscle tissue (types: voluntary, involuntary and specialized type heart).
 - 2.3 Ultra structure and molecular mechanism of muscle contraction.
3. Connective tissue
 - 3.1 Components (fibres with types, fibroblast cells & ground substance, cell renewal)
 - 3.2 Tropocollagen biosynthesis with glycosylation, post-transcriptional modification)
 - 3.3 Collagen (structure and functions).
 - 3.4 Bone tissue (composition, cell types and functions)
 - 3.5 Extra-cellular matrix: organization and chemistry (proteoglycans, Glycoseamino -glycans / GAG))
 - 3.6 Haematopoetic tissue (composition, RBC, WBC types with characteristics and functions)
4. Nerve tissue (see Neuroscience)
5. Histology of endocrine glands, Graafian follicles with theca and granulosa, tissues, uterus, testis, spleen, duodenum / stomach etc.)
6. Nerve tissue
 - 6.1 Composition (Neurons, types, characteristics, distribution, function)
 - 6.2 Synapse (composition and function)
 - 6.3 Development of neurons, glial cells etc. from stem cells (neurogenesis)
 - 6.4 Electrical properties of nerve cells
 - 6.5 Transmission of message through synapse
 - 6.6 Neuromuscular junction, organization and properties of neuromuscular junction
7. Neurotransmitters, neurohormones and neuromodulators: origin and neuroendocrine functions.
8. Neural ageing and neural death (by necrosis / apoptosis)
9. Neural disorder
Epilepsy, Parkinson's / Alzheimer's disease / and schizophrenia, Strokes and NMDA receptors.

Recommended Books:

1. Junqueira's Basic Histology, text & Atlas (2013), 13th edition, International, Asia / Mcgraw Hill Companies Inc. pp.544.
 2. Bloom, W. &Fawcell, D.W. A text book of Histology, 10th Edition, W.B., Saunders C

Paper :Zoo/Th/104
Cell and Molecular Biology

1. Cell Membrane

- 1.1 Molecular Organization and functions
- 1.2 Cell-cell interaction including adhesion, integrin, etc.
- 1.3 Membrane transport : Protein diffusion, active transport, ion channels & electrical Properties of membrane
- 1.4 Cell Surface receptors : Second Messengers, (NOS), G-Protein Coupled receptors and signal transduction pathways.(MAPK-ERK, MEK)

2. Cell Organelles: their Organization and function

- 2.1 GERL and role of GERL system on Cellular dynamics
- 2.2 Mitochondria: Molecular Organization and importance in cell metabolism
- 2.3 Ribosomes: their types, molecular Organization and biosynthesis
- 2.4 Structure and functions of Cytoskeleton and its role in mobility

3. Nucleus: Organization and function

- 3.1 Nuclear membrane- organization and function
- 3.2 Nucleolus: Molecular organization and function
- 3.3 Chromatin: organization in eukaryotic chromosomes: structure karyotype and ideogram

4. Cancer cell:

- 4.1 Characteristic features and properties
- 4.2 Oncogenesis: Tumour growth and transformation
- 4.3 Apoptosis: mechanism of factors inducing apoptosis.

5. Cell division and cell cycle (steps and regulation)

- 5.1 Mitosis
- 5.2 Meiosis

6. Biological macromolecules

- 6.1 Carbohydrates: classification and characteristics
- 6.2 Proteins & enzymes: structure, classification and function
- 6.3 Fat structure and function
- 6.4 Nucleic acids: DNA and RNA structural organization and important
7. **Central Dogma:** DNA replication and transcription, genetic codons and protein synthesis

Suggested readings:

1. De Robertis, E.D.P. and De Robertis, E.M.F. Cell and Molecular Biology (8th Edition). Lippincott Williams and Wilkins, Philadelphia.
2. Cooper, G. M. and Hausman, R.E The cell: A molecular approach. (5th Edition)ASM press and Sunderland, Washington D. C.
3. Lodish H, Berk A, Matsudaira P. Cell and Molecular Biology(2nd Edition) John Wiley and Sons,
4. Karp G.(1998) Cell and Molecular Biology (2nd Edition) John Wiley and Sons, Inc. Practical Course

Practical
Paper: Zoo/Pr/105

1.

- Scale (fish), cilia (Paramecium), Flagella (Euglena), feather (bird), corpora cardiaca/allata (cockroach), Olfactory lobe (Tilapia), Weberian Ossicles (fish).
- Identification of endocrine organs/cells (rat thyroid/adrenal / pancreatic islets, ovarian Graafian / atretic follicles, testis spermatid, sperm Leydig/ Sertoli cells).
- Demonstration: Bioassay of androgen (Chick comb assay, in vitro technique of oocyte culture, radio-immunoassay of androgen/ oestrogen/ corticosterone).

2.

- Identify and economic States (name of animals) Silk Worms/ Honey bee/ Termite/ Crab/oyster/ silk cocoon varieties and silk content estimation..

3.

- Identification: Tissue slides (spleen, thymus, liver, kidney, stomach, duodenum), (Nerve/muscle/epithelial/lymphocyte).

4.

- Trypan blue exclusion test for identification of live from dead cells.
- Ultrastructure (mitochondria/rough) smooth endoplasmic reticulum endoplasmic reticulum.
- DNA isolation (liver).

5.

- Study of Polytene chromosomes from chironomous.
- Meiosis stages from grasshopper testis.

Second Semester
Paper: Zoo/Th/201
Endocrinology and Reproductive Biology

1. Overview of Hormones (Definition, Insulin discovery : origin, transport, target organs, functions, immunity, disorder).
2. Classification of hormones based on.
 - 2.1. Chemical nature with examples & targets.
 - 2.2. Receptors with examples & targets.
3. Hypothalamic hormones (origin, chemical nature, transport ,major actions at cellular level and targets).
4. Hypophysiotropic (pituitary) hormones.
 - 4.1. Adrenohypophysis (synthesis, transport, chemical nature and function).
 - 4.2. Somatotropin (prolactin /LTH), Glycoprotein hormones (FSH, LH and TSH), Pro-opiomelanocortin (POMC) (ACTH, MSH, β -LPH and β -endorphin).
 - 4.3. Neurohypophysis (oxytocin and vasopressin/ ADH, site of synthesis, chemical nature transport and physiology).
5. Pineal gland (location in the brain, size, etc).
 - 5.1. Biosynthesis, chemical nature, and regulation of melatonin synthesis, function of melatonin including its role in biological clock, zeit-lag and reproduction including birds.
6. Endocrine pancreas.
 - 6.1. Cell types (α , β , γ , δ), origin, biosynthesis, function of insulin, glucagon, and somatostatin and regulation of secretion.
7. Thyroid and parathyroid glands.
 - 7.1. Biosynthesis (cellular and extra-cellular), sites, function and control of secretion.
 - 7.2. Synthesis , function and control of parathyroid hormones (PTH) parathormone, calcitonin, and role in calcium homeostasis.
8. Adrenal glands (site of synthesis, transport, target organs, functions of glucocorticoid and mineralocorticoid hormones and control of secretion).
9. Gastro-intestinal (GI) hormones, Cellular site of synthesis of gastrin and cholecystokinin and control of secretion.
10. Mechanism of hormone actions.
 - 10.1. Peptide, glyco-peptide hormones (Receptor structure and regulation of hormones including membrane receptor of some steroid hormones).
 - 10.2. Steroid hormones (Nuclear receptors and extra nuclear receptor, types, structure and function)
 - 10.3. Mechanism of hormone actions (genomic and non-genomic pathways) and metabolism.
11. Embryological origin of gonads, genital tract and accessory glands.
 - 11.1. Hormonal control of differentiation of genital tract of σ and ϕ .
12. Testis.
 - 12.1. Endocrine (Leydig and Sertoli cells) and non-endocrine components (seminiferous tubules).

- 12.2. Biosynthesis and feed back control of testosterone secretion.
- 12.3. Hormonal control of spermatogenesis, sex accessories & non-reproductive organs.
- 13. Ovary.
 - 13.1. Endocrine components (Theca interna, granulosa) Biosynthesis : (two cell-2 gonadotropin theory of estrogen synthesis) and regulation of secretion.
 - 13.2. Hormonal and paracrine control of ovarian follicular development and ovulation.
 - 13.3. Hormonal control of estrous (rat) and menstrual (human) cycles.
 - 13.4. Hormonal influence of pregnancy and parturition, hormonal control of milk synthesis, release and milk let-down
- 14. Contraception & IVF.
- 15. Hormonal disorders: Adrenal, thyroid, pancreas, gonads, Hermaphroditism, infertility, abortion.

Books

- 1. Norris, D.P. and Carr, J.A. (2013). Vertebrate Endocrinology, 13thEdn., Academic Press, pp.565.
- 2. Bolaner, F.F. (2004). Molecular Endocrinology, 3rdEdn., Academic Press (First printed in India 2000) pp. 637.
- 3. Goodman, H.M. (2003). Basic Endocrinology, Academic Press, San Diego. Printed by Elsiever India in 2006.
- 4. Bentley, P.J. (1998). Comparative Vertebrate Endocrinology, Cambridge University Press, 3rdEdn.

Paper: Zoo/Th/202

Stem Cell and Developmental Biology

1. Overview of Developmental Biology (Aristotle-epigenesis and preformation, mitotic cycle, Induction, developmental genes, spontaneous mutation in Xenopus levis)
2. Basic principles of developmental biology (Differentiation, potency and genetic disorder in teratogenicity)
3. Gametogenesis, fertilization and early development
 - 3.1. Primordial germ cells and development of sex organs
 - 3.2. Production of gametes and fertilization
 - 3.3. Zygote, cleavage and blastula formation
 - 3.4. Sex determination by Y in ♂ sexual phenotype determined by gonadal hormones
 - 3.5. Brain sex determination pathway in vertebrates.
 - 3.6. Temperature dependent sex determination(turtles)
 - 3.7. Hormonal disorder of sex differentiation
4. Gastrulation and formation of 3 germinal layers and morphogenesis
 - 4.1. Axes and germ cell layers (Animal pole, Vegetal pole, Maternal control in Xenopus and Zebrafish)
 - 4.2. Setting up the body axes (antero-posterior and dorso-ventral axes) in Drosophila/Xenopus
 - 4.3. Induction and Morphogenesis (change in the form of earlier embryo, Neural tube formation and cell migration)
5. Regulation of embryonic development
 - 5.1. Regulation of polarity the development of 3 embryonic germinal layers Environmental (temperature, oxygen, location, cell number). Genetic and other factors including growth factor, hormone, cytokine, micro RNA, etc.
 - 5.2. Role of ocar, steel and c-kit gene in early development
 - 5.3. Role of FGF, EGF, TGF β , wingless genes (wnt) and Notch membrane signal in protein
6. Patterning the early nervous system and the somites
 - 6.1. Role of organizer and neural induction (FGF signalling from mesoderm patterning the nervous system)
 - 6.2. Somite formation and antero-posterior patterning by Hox genes
7. Stem cell, Differentiation and renewal
 - 7.1. Stem cell (embryonic, adult, and occurrence in the organs)
 - 7.2. Self renewal, pluripotency, characterization
 - 7.3. Blood cell from multipotent stem cells
 - 7.4. Niche and its role in differentiation of stem cells
 - 7.5. Stem cell and new organ development
8. Organogenesis
 - 8.1. Limb: vertebrate limb development (limb bud, later from ectodermal ridge)
 - 8.2. Hox gene and codes for limb patterning
 - 8.3. Transcription factors determining digit (fingers)

- 8.4. Initial development of cartilage, muscles and tendons (autonomous)
- 8.5. Foetal lung signalling for initiating labor.
- 9. Organ development
 - 9.1. Eye (origin and neural tube & ectoderm of the head), lungs (epithelial tube), kidney (ureteric bud & mesenchyme), vascular system (angiogenesis), heart (mesodermal tube)
 - 9.2. Nervous system (proliferative zone of neural tube and migration including death of motor neurons during normal development)
- 10. Molting and metamorphosis.
 - 10.1. Molting (Arthropods) for growth
 - 10.2. Environmental and hormonal control of metamorphosis
- 11. Regeneration
 - 11.1. Amphibian limb regeneration (cell differentiation and new growth) Heart regeneration (resumption of cell division by cardiomyocytes in zebrafish)
- 12. Ageing and senescence
 - 12.1. Mitochondrial control of ageing
 - 12.2. Ageless animals and environmental control of ageing
 - 12.3. Senescence and cell death

Books

- 1. Knoepfler, P. (2013) Stem cells. World Scientific-e-book (ISBN- 978-981-4508-81-0)

Paper: Zoo/Th/203
Applied Ecology

- 1.0 Agro-ecosystem management
- 1.1 Crop patterns and productivity
- 1.2 Modernised agricultural system and monitoring of the ecosystem.
- 2.0 Physical aspects of the environment
- 2.1 Lotic and lentic environment, marine biota and zonation, estuarine biota and productivity, terrestrial biota, soil sub-systems, vegetational sub-system.
- 3.0 Ecotourism:
Definition, sustainable development and ecotourism, foundation of ecotourism policy, Economics and management issues, merits and demerits.
- 4.0 Molecular Ecology:
- 4.1 Genetically modified organisms and its impact on environment.
- 4.2 DNA finger printing and its role in wildlife conservation. Molecular marker, different types and their role in conservation ecology.
- 4.3 Host plant- Pest/Parasite interaction in relation to host selection and pest management.
- 5.0 Restoration ecology
Strategy and implementation procedure
 - In Coastal Environment
 - In Island Environment
 - In mainland Environment
- 6.0 System analysis and modeling in ecology
 - Concept of ecological modeling
 - Deterministic and Stochastic models
 - Theoretical model and analytical solution
 - Pattern of Spatial distribution-random, contagious and regulars, coefficient of dispersion
 - Index of similarity and index of association
- 7.0 Society and ecosystem
 - Politics, economics, ethics
 - Natural calamities, modernism, ethnic composition
- 8.0 Productivity of Ecosystem
Ecological factors and faunal abundance of Sunderban biosphere
 - Marine ecosystem
 - Estuarine ecosystem
 - Terrestrial ecosystem
 - Ecological backlash due to farming of
 - Prawns, Crabs, Fishes and Crocodiles
- 9.0 Ecology of biological and industrial invasion

- Eutrophication in fresh water, coastal and marine ecosystem, zonal interaction and changes, remediation.
- Acidification in aquatic and terrestrial environment, effects and remedies.

Paper: Zoo/Th/204
Pests, Parasites and Immunology

1. Economic decision levels for pest population
 - 1.1 Concepts
 - 1.2 Dynamics of economic injury levels
 - 1.3 Calculation of economic decision levels using economic levels
2. Pest management theory and practice
 - 2.1 Concept,
 - 2.2 Biological and Integrated pest management
 - 2.3 Sugarcane pests and Mango pests : Different types, biology, bionomics and management strategies.
3. Vector Biology
 - 3.1 Vectors and its importance in transmission of parasites.
 - 3.2 Major malaria vectors in India: Distribution, bioecology, potentiality and present sustainability status, forms and function.
4. Biology (Forms and functions) of parasites
 - 4.1 Protozoan parasites: Trypanosoma evansi, Leishmania spp.
 - 4.2 Helminth parasites: Taenia, Echinococcus, Schistosoma ,Ancylostoma, Dracunculus.
 - 4.3 Cestode/Trematode Parasites: Taenia, Echinococcus.
 - 4.4 Nematode Parasite: Toxocara
 - 4.5 Arthropod Parasites: Soft ticks, Hard ticks, Argulus, Scabies, Mites- Morphology, Life Cycle and Disease Relationship.
5. Immune System:
 - 5.1 Concept of Immunity and development of the immune system.
 - 5.2 Tissue, cells and molecules of immune system.
 - 5.3 Cell mediated immunity: peptide recognition, adhesion & co-stimulation, APCs , MHC, TH & TC, TH₁ & TH₂ response,
 - 5.4 Humoral immunity: immuno globulins & functions; B-cell Development, maturation and functions. Complement pathways, monoclonal & polyclonal antibodies.
 - 5.5 Immunological memory & Vaccination.

Practical Course
Paper: Zoo/Pr/205

1.

- Demonstration: location of endocrine glands (median eminence, pituitary, thymus , thyroid, adrenal, pancreas, gonads and genital tracts(male, female)
- Slides (Adrenal, Pancreas, Graafian follicles:theca , Granulosa, oocyte, Prostate, uterus)
- Chick comb assay of androgen (chick)

2.

- Identification of stem cells (embryonic, adult)
- Demonstration: germinal layers(chick)
- Developmental stage (gastrulation/ fingerling)
- Demonstrations of 3 germinal layers(chick)

3.

- Microtomy, staining (H&E)
- Demonstrations (Adrenal, fish ovarian follicles and oocytes, rat uterus, Leydig&Sertoli cells and Prostate histology)
- Demonstrations of lipids (rat adrenal cortex) (paraffin section)
- Identification: Pancreas, adrenal/ thyroid/ uterus/ prostate Graafian or atretic follicles, Leydig cells.
- Biopsy specimens of prostate/uterine malignancies.

4.

- Slide (insect pest, mosquito, helminth, arthropoda, protozoa)
- Calculation of ETL/EEL.