

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 17<sup>th</sup> and 18<sup>th</sup> centuries Chinese, Indian, Mesopotamian.
  - 1.1 Impact of the microscope and staining.
  
- 2.0 Emergence of biological disciplines in 19<sup>th</sup> 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.
  
- 3.1 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), 13<sup>th</sup> edition, International, Asia / Mcgraw Hill Companies Inc. pp.544.
  2. Bloom, W. &Fawcell, D.W. A text book of Histology, 10<sup>th</sup> 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 (8<sup>th</sup> Edition). Lippincott Williams and Wilkins, Philadelphia.
2. Cooper, G. M. and Hausman, R.E The cell: A molecular approach. (5<sup>th</sup> Edition)ASM press and Sunderland, Washington D. C.
3. Lodish H, Berk A, Matsudaira P. Cell and Molecular Biology(2<sup>nd</sup> Edition) John Wiley and Sons,
4. Karp G.(1998) Cell and Molecular Biology (2<sup>nd</sup> 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,  $\beta$ -LPH and  $\beta$ -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 ( $\alpha$ ,  $\beta$ ,  $\gamma$ ,  $\delta$ ), 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 ♂ and ♀. 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, 13<sup>th</sup> Edn., Academic Press, pp.565.
2. Bolaner, F.F. (2004). Molecular Endocrinology, 3<sup>rd</sup> Edn., Academic Press (First printed in India 2000) pp. 637.
3. Goodman, H.M. (2003). Basic Endocrinology, Academic Press, San Diego. Printed by Elsevier India in 2006.
4. Bentley, P.J. (1998). Comparative Vertebrate Endocrinology, Cambridge University Press, 3<sup>rd</sup> Edn.

**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, TGFB, 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
- 6.1 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, costal 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, TH<sub>1</sub> & TH<sub>2</sub> 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.

## Paper ZOO/Th/3s/301: Genetics and Biotechnology

### **1. Basic principles of inheritance**

- i) Mendelian inheritance
- ii) Law of segregation and law of independent assortment: Experimental results and statistical analysis
- iii) Extension to Mendelism
- iv) Linkage and crossing over, Concept of classical gene mapping
- v) Polygenic inheritance, Pleiotropism, Penetrance and Expressivity.

### **2. Organization of genes**

- i) Gene as a unit of function and its location in a cell
  - ii) The mechanism of expression of a character by a gene
  - iii) Polygenes and character
  - iv) Allele concept and human blood group genetics, is o-alleles and pseudo-alleles, complementation test and its importance
3. Molecular architecture of chromosome and nucleosome concept
  4. Sex determination in animals with special reference to *Drosophila*, *Caenorhabditis* and human, Dosage compensation.
  5. Transposable genetic elements

### **1. Variation and the intricate mechanism of origin of variation**

- i) Mutation and molecular mechanism of development of mutation
- ii) Recombination
- iii) Repairing of damaged DNA

### **2. Genetics of bacteria and viruses**

- i) Transformation
- ii) Conjugation
- iii) Transduction
- iv) Gene mapping in prokaryotes

### **3. Human genetics**

- i) Mendelian inheritance in man
- ii) Inborn error of metabolism
- iii) Origin of one gene one polypeptide concept
- iv) Pedigree analysis for identification of the mode of inheritance of a character in human
- v) Chromosomal disorders in human

#### **4. Genetic structure of population and Hardy Weinberg principle**

- i) Species concept and Mendelian population
- ii) Gene pool and allelic frequency of genes in a population
- iii) Method of gene frequency calculation in population
- iv) Meaning of genotypic equilibrium
- v) Hardy Weinberg Principle
- vi) Conditions for H-W equilibrium
- vii) Forces altering gene frequency in a population : mutation, selection, genetic drift, gene flow or migration( elementary idea)

#### **5. Biotechnology**

- i) Traditional and modern biotechnology
- ii) Gene manipulation through cell fusion
- iii) Hybridoma technology and production of monoclonal antibody
- iv) Elementary idea on genetic engineering
- v) Plant breeding and crop improvement

#### **Suggested readings:**

Atherly A. G., Girton, J. R. & McDonald, J. F., 1999. The Science of Genetics, Saunders College Publishing, Harcourt Brace College Publishers.

Brookers R. J., Benjamin / Cummings, 1999. Genetics: Analysis and Principles, Longman Inc.

Lewin, B., 1996. Genes VI, John Wiley and Sons.

Mark H. F. L., 2000. Medical Cytogenetics, Marcel Dekker Inc, N.Y.

Sambamurthy, A.V.S., 1999. Genetics, Narosa Publishing House, New Delhi.

## **Paper:-Zoo/Th/3S/302**

### Animal Physiology and Biochemistry

#### Animal Physiology

1. History of animal Physiology (pioneer scientists, contribution and scope)
2. Principles of physiological homeostasis and adaptation
3. Size and scale of organisms
  - 3.1. Size and surface area versus volume ratio
  - 3.2. Interrelationship between BMR and body mass
  - 3.3. Metabolic rate as a function of locomotor speed (locust/ butter fly/ rainbow trout/cheetah)
4. Physiology of digestion, Metabolism & Excretion
  - 4.1. Feeding & mechanism of digestion, utilization as storage of end products (sugar in vertebrate and/or invertebrate animals)
  - 4.2. Renal regulation of water and electrolyte balance
  - 4.3. Mechanism of urine formation and regulation
  - 4.4. Mechanism of nitrogenous waste formation.
5. Physiology of respiration
  - 5.1. Role of respiratory pigments in animal respiration(in a single animal model)
  - 5.2. Mechanism of respiration in aerial and aquatic animals (model animal for each type)
  - 5.3. Respiratory adaptation in O<sub>2</sub> deficient environment
  - 5.4. Respiratory adaptation during hibernation and estivation.
6. Physiology of body fluid and blood
  - 6.1. Composition and role of body fluid in respiration and transport of nutrients (Invertebrate model)
  - 6.2. Composition and function of blood Plasma and corpuscles (in vertebrate model)
7. Physiology of reproduction (Achatina, Fish/ Silkworm /Honeybee)
  - 7.1. Male & female gonad systems (structure and function)
  - 7.2. Gametogenesis (male & female)
  - 7.3. Hormonal and environmental regulation of gametogenesis

- 7.4. Mating, fertilization and developmental stages
- 8. Thermal physiology
  - 8.1. Heat transfer mechanism between animals and environment (Poikilotherms / homeotherms, examples) (model animal)
- 9. Phycology of behaviour
  - 9.1. Role of Pheromones in colonial integration, foraging and mating (animal model )
- 10. Mechanism of flight
  - 10.1. Neuro- Muscular regulation

## Biochemistry

- 1. Protein Synthesis, function and metabolism
- 2. Amino acid classification
- 3. Protein synthesis, function and metabolism of amino acids
- 4. Detoxification of amino acids.
- 5. Carbohydrate and lipid metabolism
- 6. Digestion, absorption and metabolism (Optional, if included in Animal Physiology)
- 7. Glycolysis, glycol-genolysis, gluco-neogenesis, TCA cycles, digestion and absorption
- 8. Lipids (Cholesterol biosynthesis and metabolism including, their role in prostaglandin and steroid hormone biosynthesis and importance in reproduction)
- 9. Enzymes.
- 10. Classification and role of enzymes in drug targets
- 11. Regulation and kinetics of enzyme activity (effects of substrate PH and temperature on enzyme reaction with role of coenzyme and isoenzyme)
- 12. Bioenergetics
  - 12.1. Energy production and utilization
  - 12.2. Electron Transfer and oxidative phosphorylation.
  - 12.3. Concept of CYP enzymes and implication in pharmacology
  - 12.4. Pharmacological importance of free radicals and antioxidants.

### **Books recommended:**

- 1. Schmiedt- Nelson, K.(1998).Animal Physiology, Application & Environment, Cambridge University press P.607

2. Nelson, D.L. and Cox, M>M. (2004). Lehninger's Principles of Biochemistry, 2<sup>nd</sup> Edn. Macmillar World Publishers.
3. Raundall, D., Burggren, W. and French, K. (2002). Animal physiology Publisher: W. H. Freeman and Co. New York, P.736
4. Sherwood, L. , Klandorf, H. and Yancey, P.H. (2011).Cengage Learning,Australia, Brazil.p.925

# **Pap:Zoo/Th/3S/303: Evolution and Animal Behaviour**

- 1. Argument of evolutionary ideas and evolutionary theories since Darwin**
- 2. Evolutionary Process**
  - 2.1. Mechanisms producing genetic diversity
  - 2.2. Phenotypic diversity by the regulation of gene expression
- 3. Natural Selection and Adaptation**
  - 3.1. The concept of stabilizing selection, Disruptive selection, Frequency dependent selection, Balancing selection
  - 3.2. Adaptation program
  - 3.3. Neutral theory of evolution and neutralist-selectionist controversy
- 4. Gene Frequencies in Population**
  - 4.1. The Hardy- Weinberg principle and analysis of gene frequencies in natural population.
  - 4.2. Major factors influencing frequencies (migration, inbreeding), effects of selection and mutation on frequencies. Gene flow between subpopulations, genetic drift
- 5. Patterns and trends in evolution**
  - 5.1. Constructing evolutionary trees, measure of genetic relationship among organisms
  - 5.2. Molecular clock of evolution
  - 5.3. Molecular phylogeny
- 6. The Origin and Evolution of Primates**
  - 6.1. Evolution of Anthropoid Primates
  - 6.2. The first hominids and origin of modern man
- 7. Principles and mechanisms of animal behaviour:**
  - 7.1. Four propositions of Tinbergen
- 8. Gene, Environment and Behaviour/Levels of Selection:**
  - 8.1. Individual vs Group Selection
  - 8.2. Fundamental of Behaviour Genetics and molecular tools
  - 8.3. Genotype and Environment Interaction, Phenotypic plasticity
- 9. Cooperation and conflict:**
  - 9.1. Male-male competition and sexual selection
  - 9.2. Elaborate ornaments: Fisher's hypothesis and Handicap hypothesis
  - 9.3. Parent-offspring conflict

9.4. Range of cooperative behaviours and prisoner's dilemma

**10. Foraging:**

10.1. 1 Optimal foraging theory

10.2. Foraging and predation risk: defence strategies against predators

10.3. Territoriality and Group Foraging

**11. Aggression:**

11.1. Aggressive behaviour

11.2. Game theory models and strategies

**12. Sensory system and Communication:**

12.1. Signal content and structure

12.2. Orientation and cues

**Recommended Books:**

1. Bowler – Evolution

2. E.Mayr – Evolution and the Diversity of Life

3. Jones et.al. – The Cambridge encyclopaedia of human evolution

4. Max King – Species Evolution

5. J. Futuyma – Evolutionary Biology: Douglas

6. E.H.Colbert – Evolution of the Vertebrates

7. P.A.Moody – Introduction to Evolution

8. Strickberger – Evolution

9. Alcock,J.(2001) - Animal Behaviour

10. Manning,A. and Dawkins,M.S.(1999) – Essentials of Animal Behaviour,  
Cambridge University Press.

## **Paper: ZOO/Th/3S/304**

### **Coastal Resources and Management**

1. Coastal Ecosystem and Resources: Physico- chemical features, Tidal Energy and Nutrient flow; Exploitable and potential biological resources (Fin fish and Shell fish); Seaweeds, Mangroves and Sea grasses.
2. Mangrove Ecosystem: Importance, their role as coastal buffer zone and as breeding habitats for shellfish and finfish; Conservation and Management of Mangrove ecosystem.
3. Coral Reef Ecosystem: Living resources, Exploitation and its impact, Sustainability and Conservation measures.
4. Mariculture: Breeding and larval rearing of shrimps and management; Different shrimp culture system, construction of farm, selection of larvae, water and feeding management, harvesting and disease management; Culture of mud crab; Edible oyster farming
5. Marine fisheries: Exclusive economic zone – potentialities, exploitations and problems ; Modern devices of exploitation (different crafts and gears used in Indian capture fishery); Major fisheries of Indian coasts: Bionomics and production of Hilsa, Sardine, Bombay duck, Pomfret
6. Human Impact on Coastal Fisheries Resources: Threats and sources of pollution; Tools of conservation; Coastal Aquaculture Regulations and CRZ (coastal regulation zone); Integrated coastal zone management; Application of remote sensing and GIS to Coastal fisheries and aquaculture.
7. Apiculture: Bee species in pollination; Biology of honey bees; modern apiculture; honey extraction; diseases and pest of honey bees; role of honey bees in agriculture; problems of pollination with honey bees and other bees in South Bengal.

#### **BOOKS :**

1. Tropical Mariculture - Sena S. De Silva
2. Lake and River Ecosystem – R.G. Wetzel
3. Marine Fisheries – Bal and Rao.
4. Marine Protection Areas and Ocean Conservation – Agardy T. and R.G. Landes
5. Managing Marine Environment – Kenchington, K.A.

## SYLLABUS : PRACTICAL COURSE

**Paper:- Zoo/Pr/3S/305**

1. Study of life cycle of Drosophila melanogaster.
2. Identification of male and female flies.
3. Identifications of Mutations of Drosophila melanogaster.
4. Study of metaphase chromosomes from bone marrow of rat.
5. Study of meiotic cell division of grass hopper male.
6. T.C., D.C.
7. Tests for Sugar (including Starch), Protein and Sudan Black for Lipid.
8. Blood group Test
9. Stress (Cold/Heat) response in Rat/Pigeon.
10. Educational visit to any Coastal Region of India
11. Submission of field report
12. Viva.

# **Paper 401: Biostatistics, Bioinformatics and Instrumentation**

## **1. Basics of statistics:**

- i) Sample and population
- ii) Primary and secondary data Screening and presentation of data : Frequency distribution, bar diagram, pie diagram, cumulative frequency distribution

## **2. Measures of location**

- i) Measures of central tendency- mean, mode and median, percentile and quartile
- ii) Standard deviation and its significance, variance
- iii) Analysis of variance (ANOVA)
- iv) Correlation and regression; Types of correlation, coefficient of correlation, types of regression, regression equation, regression coefficient.

## **3. Probability**

- i) Classical and modern definition of probability
- ii) Sample space and events
- iii) Conditional probability. Addition and multiplication rules of probability
- iv) Probability distributions. Binomial, Poisson and Normal distributions.

## **4. Test of hypothesis**

- i) Formulation of hypothesis
- ii) Null hypothesis, p value and its meaning and level of significance
- iii) Chi-square test and t- test

## **5. Bio-informatics**

- i) Scope of bioinformatics
- ii) Concept of data
- iii) Classification of data

## **6. Data base and search tools**

Computational tools and biological data base  
National Centre for Biotechnology Information (NCBI)  
European Bioinformatics Centre (EBI)

## **7. Sequence alignment**

- i) Types of sequence **alignment**
- ii) Pairwise sequence **alignment**
- iii) Multiple sequence **alignment**
- iv) Methods of sequence analysis : BLAST, FASTA

## **8. Instrumentation**

- i) Microscopy : Principle and operation
- ii) Light, Phase contrast, Fluorescence, and LSM
- iii) Electron Microscopy
- iv) Centrifugation: Principle of sedimentation
- v) Chromatography : Principle and application, Ion exchange, Affinity, HPLC
- vi) Electrophoresis : principles and application of electrophoresis

## **9. Spectrophotometry:**

- i) Principle and application of ultraviolet and visible spectrophotometry
- ii) Spectrofluometry,
- iii) X-ray diffraction crystallography
- iv) Flow cytometry and FACS

### **Suggested readings:**

Zar (2005): Biostatistical Analysis 4/e Pearson Education.

Daniel: (2002): Biostatistics. John Wiley, ISE

Nabendu Pal and Sahadeb Sarkar (2006): Statistics- Concepts and applications. PHI

Attwood, T.K. & D.J.Parry-Smith (1999): Introduction to bioinformatics, Pearson Education Asia, New Delhi

Bergeron(2005): Bioinformatics computing. Pearson Education.

## **PAPER : Zoo/Th/4S/402**

### **BIODIVERSITY, CONSERVATION BIOLOGY AND WILDLIFE**

1. Meaning of biodiversity
2. Conceptual frame work of biodiversity
3. Levels and measures of biodiversity.

3,1 Process and pattern of local and regional biodiversity, Niche assembly theory, Unified neutral theory, Island biogeographic model.

3,2, Threats to species diversity

3.3. Problems and scales of biodiversity extinctions in time and space.

3.4 Natural and human induced threats and vulnerability of species extinction.

3.5 Problem of genetic diversity loss over time: Bottle neck, genetic drift, interbreeding depression.

3.6 Role of invasive alien species and local biodiversity.

3.7 Review of risks to biodiversity extinctions. Extinction Vortex.

4. Uncertainties and biodiversity extinction

4.1 Dynamics and spatial uncertainties

4.2 Population fragmentation and metapopulation; level of genetic variation in metapopulation; metapopulation and extinction.

5 Biodiversity quantification

5.1 Measuring biodiversity

6. Biodiversity Act and Rules: Indian Biodiversity Act and related Rules

1. Biodiversity extinction and conservation approaches: ecologically sensitive area; regional and national approaches for biodiversity conservation

2. Theory and analysis of Conservation of populations: stochastic perturbations; Population viability analysis; minimum viable populations & recovery strategies for threatened species

3. National and International efforts for conservation: CITES, IUCN, CBD; Ramsar Convention on wetlands

4. Conservation of natural Resources: resources types and degradations; human impact on Terrestrial and Aquatic resources; Conservation of Forest & Grassland resources

5. Wildlife and wildlife habitat in India: Wildlife wealth of India, threats, wildlife depletion in India; conservation approaches and limitations; characteristic features of tropical forests; concept of protected Area

6. Management of wildlife: Distribution, status. Habitat utilization pattern, threats to survival of Lion-tailed macaque, Bengal vulture, Great Indian Bustard, Olive Ridley turtle

## 7. Wild life trade and legislation

### Books:

1. A primer of Conservation Biology : R B Primack
2. Biodiversity & Conservation: M J Jeffries
3. Biodiversity: Wilson
4. The Biology of Biodiversity: M Kato
5. Global Biodiversity Assessment: UNEP

### **Practical**

#### Biodiversity and conservation Biology and Wildlife

1. Estimation of species density, diversity and richness
2. Pug-mark analysis
3. Use and application of global positioning system (GPS) and laser range finder in the study of biodiversity
4. Field report, sessional
5. Viva

# **Paper – Zoo/Th/4S/403 - Fishery Special**

## **1. Aquaculture of carps**

- 1.1. Breeding of fish, Hormonal interactions for fish breeding
- 1.2. Modern hatcheries and management
- 1.3. Site selection, culture system, preparation and management of ponds for culture
- 1.4. Transportation of fish seeds
- 1.5 Major diseases in aquaculture, control and management

## **2. Fish Nutrition and Growth**

- 2.1. Nutritional requirements, Digestive energy in fish feed and Energy flow through fish; Feed formulation

## **3. Aquaculture of Freshwater prawns**

- 3.1. Major cultivable species of prawns
- 3.2. Reproduction and larval rearing of prawns, site selection, construction of farms, grow out.

## **4. Fish pathology and diseases**

- 4.1. Major diseases in aquaculture, control and management.
- 4.2. Immune protection in fish systems

## **5. Non conventional aquaculture system**

- 5.1 Raceways, Flow through & recirculation technology in aquaculture, Pens and Cage aquaculture

## **6. Mariculture**

- 6.1. Breeding and larval rearing of shrimps and management
- 6.2. Different shrimp culture system, construction of farm, selection of larvae, water and feeding management, harvesting and disease management
- 6.3. Culture of mud crab

6.4. Edible oyster farming

**7. Marine fisheries**

7.1. Exclusive economic zone – potentialities, exploitations

& problems

7.2. Modern devices of exploitation (different crafts and gears used in Indian capture fishery)

7.3. Major fisheries of Indian coasts: Bionomics and production of Hilsa, Sardine, Bombay duck, Pomfret

# Paper –ZOO/Th/Fis/404-Fishery Special

1. Sex determination in fish
2. Technique of stock improvement
  - 2.1 Cryopreservation , cryoprotection and gamete banking 66
  - 2.2 Production of Monosex and Sterile fish and their significance in aquaculture
  - 2.3 Production of hybrids in captivity – techniques ,inter specific and intergeneric hybrids, application of successful hybrids,limitations
  - 2.4 Polyploidy in fish
  - 2.5 Production of sex reversed fish – different techniques,identification of successful sex reversed fish, process of preparation of steroid hormone treated feed & application, sex reversion in Tilapia.
  - 2.6 Production of transgenic fish – mechanism, example,advantages and limitation
3. Waste water recycling through aquaculture
4. Processin , preservation & curing
  - 4.1. Fish spoilage and methods of preservation Spoilage (causes, changes in protein, amino acid and breakdown products) Preservation (Drying, salting, smoking, freezing and canning,IQF etc.)
  - 4.2. Fish by-products
  - 4.3. Shrimp processing technology- processing, packaging, HACCP,ISI standard, problems &precautions
5. Conservation of fishery resources
  - 5.1. Sustainability of Fisheries development.
  - 5.2. Open water stocking & ranching programme. Referred Books: 67

## **Reference:**

1. Bal, D. V. &Rao, K. V. (1984). Marine Fisheries. Tata McGraw Hill Pub. C Ltd.
2. Bardach, J. E. &Ryther, J. H. (1972). Aquaculture. John Wiley and Sons.
3. Beaumont, A. R. & Hoare, K. (2003). Biotechnology & Genetics in Fisheries and Aquaculture. Blackwell Publishing.
4. Dodson , Introduction to limnology , 2005, Mc Grow Hill
5. Chaudhuri H L (1990) Induced breeding of carps (ICAR)
6. Jhingran, V. G. (1991). Fish and Fisheries of India.3rd ed., Hindusthan Pub. Corp. John Wiley &Sons.

7. Kent, Reservoir limnology:ecological perspectives, 1990, John Wiley Sons
8. Khanna, S. S. & Singh, H. R. (2003). A Text Book of Fish Biology & Fisheries. Narendra Publishing House. New Delhi.
9. Midlen& Redding , Environmental management for aquaculture,1998,Springer
10. Philip Kotler, Marketing management , Printice Hall of India
11. Pillay, T. V. R. (1993). Aquaculture. Fishing News Books.
12. Ruttner et al Fundamentals of limnology, 1974,Univ. of Toronto Press  
Srivastava, C. B. L. (2006).A Text Book of Fishery Science & Indian Fisheries. KitabMahal. Allahabad.Publishing House. New Delhi.
13. Tundisi, Limnology , 2012, Taylor & Francis
14. Wetzel , Limnology 1995 Saunders 68
15. Wetzel , Limnology,lake and river ecosystem ,2001, Academic Press
16. DuttaMunshi and Hughes: Air Breathing Fishes of India

# Paper –ZOO/Pr/Fis/405-Fishery Special

1. Analysis of important water & soil parameters.
2. Histological studies of different fish tissues and their identification.
- 3..Dissection of different organ systems (digestive system, urinogenital system, accessory respiratory organs).
- 4.Techniques of induced breeding (Collection of pituitary gland, preparation of extraction and administration)
5. Estimation of maturity and fecundity of fish specimens.
6. Estimation of relative gut length, hepato-somatic index and interpretations
7. Zooplankton sampling: methods of collection, preservation, identification and interpretations
- 8.Benthos of diverse biotopes
9. Identification of fresh water and brackish water fish fauna.
10. Identification of aquatic weeds, predatory fishes and aquatic insects
- 11..Fish Physiology experiment-Digestive enzymes, biochemical composition of fish.
12. Statistics of aquaculture data
- 13.Field study and submission of field report
14. Internal Assessment (Field study, Laboratory Note Book and class records). 10
- 15.Viva-voce. 5

# **Zoo/Th/Eco/403-Ecology**

## **Concept Ecology**

1.	Energy flow and productivity of ecosystem
1.1	Model study of energy flow mechanism
1.2	Concept of productivity and ecosystem energetic
1.3	Nutrient cycling
2.	Population and community organization
2.1	Population growth form and concept of carrying capacity
2.2	Population interactions-positive and negative
2.3	Metapopulation
2.4	Community analysis and species diversity
2.5	Pattern in communities
3.	Development and evolution of ecosystem
3.1	The strategy of ecosystem development
3.2	Evolution of ecosystem and coevolution
4.	Man-environment interaction
4.1	Global population size, management of energy utilization
4.2	Resource utilization and management strategy of human population
4.3	Public health, human right and animal rights
5.	Society and environmental sociology
5.1	Ethics, economics and politics
5.2	Social environment, modernism and post-modernism

# Zoo/Th/Eco/404- Ecology

## Functional Ecology

1.	Environmental health and ecological economics
1.1	Environmental health hazards and laws, capital and reserves
1.2	Scarcity of natural resources and impact of introduced technologies
1.3	Trade development and jobs, green designs and the environment
2.	Behavioural ecology
2.1	Natural selection and social behavior, territorial behavior and habitat selection, domestication
2.2	Ecology of sex, signals and mating, colonizing ability, distant movement and dispersal
2.3	Altruism and reciprocal altruism, eusociality, colouration and mimicry, photoperiodism and circadian rhythm
3.	Conservation ecology
3.1	Conservation challenges from climate change, habitat loss and habitat fragmentation
3.2	Theory and analysis of conservation of population
3.3	Conservation of habitats, landscapes and gene pool
4.	Microbial ecology
4.1	Interactions among microbial populations
4.2	Microbes and geo-chemical cycling
4.3	Microbes and soil processing
4.4	Microbes in mineral and energy recovery, fuel and biomass production
5.	Applied Human Ecology
5.1	Historical review
5.2	Population ecology of man
5.3	Component for an applied human ecology

## **Zoo/Pr/Eco/405- Ecology(Practical)**

1.	Sampling and measurement of factors (air/water/soil)
	(a) Light, illumination and intensity, transparency (Succhi disc method)
	(b) Primary productivity in an aquatic ecosystem (light and dark bottle method)
	(c) Minerals dissolved in water-temporary and permanent hardness
	(d) Total dissolved solids (TDS), total phosphorus and total silica in freshwaters
	(e) Moisture content of the soil and stored grain samples
2.	Field works and quantitative / numerical studies
	(a) Estimate of population density (direct counts /quadrate method)
	(b) Use of statistical methods (Standard deviation, Pie diagram, Histogram, Bar diagram, Scattergram etc.)
	(c) Life table construction and population projection
	(d) Biodiversity measurement
3.	Ecotypes of terrestrial, freshwater and marine habitats
	(a) Characterization and identification of different ecotypes inhabiting terrestrial, freshwater and marine habitats
	(b) Identification of different tools / instruments used in ecological sampling and analysis
4.	Laboratory Note Book
5.	Field report (Field-work be selected on the survey of ecotypes of the animal species occurring in the Sunderban and adjacent areas)
6.	Viva-voce

# **Paper : ZOO/Th/Gen/403- Genetics**

## **(Gene and Genome organization)**

### **1. Gene concept**

Gene as structural and functional unit of inheritance, Polygene and quantitative inheritance, Organizational variation of genes : split gene, pseudogene, overlapping gene and multigene families, gene-character relationship, one gene one enzyme concept, one gene one polypeptide concept, other views on genic feature , Gene interactions, epigenetics, gene environment interaction

### **2. Chromosome structure and its relation with gene**

Chromosome theory of inheritance, Chromatin variation, Position effect and gene silencing, Molecular basis of its activation and inactivation, Mechanism of X chromosome inactivation in mammalian females and hyperactivation of X chromosome in *Drosophila* male, Molecular organization of eukaryotic chromosomes with relation to DNA compaction and gene activity, Structure of telomere and centromere, Special type of chromosomes: polytene and lamp brush chromosome,

### **3. Gene expression and its regulation**

Operon model in explaining regulation of gene expression in prokaryotes, examples of inducible and repressible operons, polycistronic mRNA, coupled transcription and translation in prokaryotes, structure of operator, promoter and regulator gene of lac, trp and arabinose operon, Regulation of gene expression in eukaryotes, RNA pol. and transcription factors, splicing, capping and polyadenylation of mRNA, RNA editing, post transcriptional control of gene expression.

### **4. Gene action**

DNA as genetic material, Structural variations of DNA, Properties of DNA, C-value paradox, Central dogma, RNA types and properties, DNA markers : VNTR, STR, minisatellites & SNP, RFLP, RAPD, AFLP etc., Genetic code and deciphering of the genetic code, wobble hypothesis, translation of mRNA, protein formation, chaperone and protein folding

### **5. Genes in development with special reference to *Drosophila***

Gradients in early development, cell fate and signaling pathway, gap genes, segment polarity genes, axis formation, Homeotic genes and Hox-c genes, sex determining genes in *Drosophila*, *Caenorhabditis* and human, cytoplasmic determinants for nuclear differentiation.

### **6. Mutation, recombination and repair**

Mechanism of gene mutation, detection of mutation, mutagenesis : X ray as mutagenic agent, chromosomal aberrations: structural and numerical, recombination as source of variation, Recombination in prokaryotes : transformation, conjugation and transduction,

Recombination in eukaryotes : mechanisms, Repairing of damaged DNA : BER and NER.

## **7. Neoplastic growth and carcinogenesis**

Meaning of neoplastic growth, malignancy and metastasis, angiogenesis, carcinogens and tumorigenesis, tumour suppressor genes, oncogenes and proto-oncogene, retroviral oncogene, relation between cell cycle and cancer formation, chromosomal aberrations and malignancy, relation between telomere length and cancer, cancer and heredity.

## **8. Genome organization in some model organisms:**

*E. coli*, *Arabidopsis thaliana*, *C. elegans*, *D. melanogaster* and Human, Human genome mapping, Fluorescent in situ hybridization, long range restriction mapping, linkage analysis, gene identification using positional and functional cloning.

## **9. Genetic structure of a population and evolution**

Gene and genotypic frequency distribution in a population according to Hardy Weinberg principle. Genotypic frequency in population for multiple alleles and sex linked alleles, Random mating vs assortative mating, gene frequency change in population with respect to different evolutionary forces, variation among populations: causal analysis, anagenesis vs cladogenesis, Change of gene frequency and evolution, Neutral theory of mutation and evolution.

### **Suggested reading:**

Griffiths, A.J.G., William M. Gelbart, Richard C. Lewontin & Jeffrey H. Miller, 2003. Modern Genetic Analysis: Integrating Genes and Genomes, 2nd Ed., W. H. Freeman and Company, N.Y.

Robert H. Tamarin, 2002. Principles of Genetics, 7th Ed, Tata McGraw-Hill Edition, New Delhi, India.

Mark H. F. L., 2000. Medical Cytogenetics, Marcel Dekker Inc, N.Y.

## **Paper :ZOO/Th/Gen/404- Genetics**

### **(Genetic engineering and Medical Genetics)**

#### **1. Genetic engineering and its basic Principles**

Aims and objective of genetic engineering or recombinant DNA technology, Major discoveries related to genetic engineering, Basic principles, Organisms mostly used in gene manipulation, overview of the genetic system of prokaryotes and eukaryotes, Basic steps of recombinant DNA technology

#### **2. Ingredients needed for genetic engineering:**

Restriction endonuclease: properties and use, enzymes as Exonucleases, S I nuclease, kinase, ligase and DNA polymerases, reverse transcriptase, terminal transferase, linkers and adaptors, Vectors: plasmids, cosmids, phagemids, Ti plasmid, viral vectors, shuttle vectors and expression vectors, host cells, artificial chromosomes as vectors.

#### **3. Procedures used in recombinant DNA technology**

Isolation of DNA, artificial synthesis of DNA, Identification of desired DNA segment, Formation of recombinant DNA, Insertion of recombinant DNA in the host cell

#### **4. Some molecular techniques used in recombinant DNA**

DNA sequencing : Sanger's method, Maxam and Gilbert's Method, Artificial synthesis of DNA, Chromosome walking, In situ hybridization, site directed mutagenesis, restriction mapping, Gel electrophoresis for separation of DNA, RNA and proteins, Gel retardation assay, RNase protection assay.

#### **5. Some products of genetic engineering**

GMO: Bt Brinjal, Bt cotton, Flavr savr tomato, Golden rice, Vaccine for Hepatitis B, Blood coagulating factor VIII and Human insulin : Nature, method of preparation and benefits.

#### **6. Gene therapy**

Types of gene therapy: Somatic cell gene therapy and germline gene therapy, methods of gene therapy (Viral approach and Non-viral approach), Stem cell application and therapy, Success of gene therapy, Future need of gene therapy in India

#### **7. Manipulation of genes in eukaryotes**

Transfection of cells-principle and methods, Germline transformation in *Drosophila* and other eukaryotes, Production of transgenic plants and animals, Gene knockout and silencing, Nuclear transplantation and animal cloning, Selected traits and animal breeding in live stocks, Animal bioreactors and molecular farming

## **8. Medical genetics**

Identification of single gene disorders-conventional and contemporary approach, pedigree analysis, linkage mapping, positional/structural and functional cloning, bioinformatic analysis, mutation detection, multifactorial disorders, familial forms-linkage analysis, genetic polymorphism and disease susceptibility. Cytogenetics/Molecular cytogenetics/Biochemical methods of screening for mutation, Forensic testing- DNA finger printing for paternity testing and individual identification.

## **9. Genetic counselling**

Eugenics, History of eugenic movement, Types eugenics- positive and negative eugenics, Screening of families for hereditary disease, case studies, Counselling of the parents, counsellor's duty, prenatal diagnosis, risk assessment and advice to the parents, Genetic load for some hereditary diseases in population, prospect of genetic counselling.

### **Suggested reading:**

Tom Strachan & Andrew P. Read, 2004. Human Molecular Genetics 3, 3rd Ed., Garland Science, N.Y.

Watson, J.D., Hopkins, N. H., Roberts, J. W. Steitz & Weiner, A. M., 1987. Molecular Biology of the Genes, The Benjamin/Cummings Publishing Company Inc., Tokyo.

Daniel L. Hartl & Elizabeth W. Jones, 1999. Essential Genetics, 2nd Ed., Jones & Bartlett Publishers

**Paper : ZOO/Pr/Gen/ 405 – Genetics (Practical)**

1. Cloning by PCR
2. Liquid chromatographic separation of protein
3. Del sepaeation if disgested DNA
4. RNA isolation
5. Analysis of Biological Sequences: Basic Blast and Specialized Blast
6. Pedugree analysis for recssive abd dominanr disorders
7. Drosophila genetic cross and chi-square test

## ZOO/Th/Ent/403-Entomology

### General Entomology and Insect Physiology

1. Taxonomic characterization of insects (major insect orders up to family)
2. External morphology
  - 2.1 Integument- structure, types, cuticle formation and functions
  - 2.2 General structure and appendages: Head, Thorax and Abdomen; pre and post genital appendages
3. Feeding and digestion: Modes of feeding and digestion; Strategies of food finding and recognition; Role of microorganisms in digestion; nutritional requirement
4. Circulatory system: Structure and physiology of circulation; Haemolymph - composition, structure and function of haemocytes; Insect Immunity.
5. Nervous and Sensory systems: Components of nervous system; Mechano reception, Chemoreception; Photoreception - Types; Structure of compound eyes and image formation
6. Excretion in insects: Ultrastructure of malpighian tubule, Cryptonephridial condition, significance, Physiology of excretion.
7. Respiration in insects : Terrestrial and aquatic forms, Accessory respiratory organs.
8. Chemical coordination: Endocrine system - Neurosecretory cells and corpora cardiaca; corpora allata, prothoracic glands and other endocrine structures; Neuro-endocrine integration; Insect Allelochemicals and semiochemicals, defensive secretions. pheromones; Exocrine glands
9. Reproduction and development- Structure of male and female reproductive organs; Mechanism of sperm transfer; Special mode of reproduction.
10. Embryogenesis; Special forms of embryonic development; metamorphosis and ecdyson.
- 11..Sound production- Structures, mechanisms and significance.
11. Light production – Examples; Structure of light producing organ, mechanisms and significance of light production.
12. Insect-plant interaction: mechanism of host selection in insects; Insect gall- types of gall inducing insects, mechanism and significance of gall induction.

### **Books recommended:**

1. Principal of Insect morphology - R E Snodgrass
2. Imms General Text Book of Entomology - O W Richards and R G Davies
3. General and Applied Entomology- K K Nayar, T. N. Ananathakrishnan & B. David
4. The science of Entomology- Romser & Stoffolans
5. The Insects: Structure and Function- R F Chapman

6. The Insects- An outline of Entomology- P.J. Gullan & P. S. Cranston
7. Encyclopedia of Entomology- J L Capinera
8. Entomology- C Gillot
9. Modern Entomology- Entomology- D. B. Tembhare

## ZOO/Th/Ent/404-Entomology

### **Agricultural, Medical and Applied Entomology**

1. Insect pests: Status and assessment.
2. Biology, nature of damage and management strategies of major pests of Paddy, Jute, Sugarcane, Vegetables, Mango, Tea, Stored grain and Forest products.
3. Insect pest management: Cultural, mechanical and Chemical management. Classification of insecticides; Nature and mode of action of some common insecticides (Organochlorines, Organophosphates, Carbamates, Neo-nicotinamides and botanical insecticides, organic pesticides); insect resistance to insecticides. Pheromones and other attractants. Biological control (types, agents, implementation, examples, mass production of biocontrol agents). IPM. (Components, appraisal, examples, application). Biotechnology in insect pest management.
4. Vector biology: Morphology, behaviour, life cycle, role in disease transmission and control strategies of Sand fly and Mosquitoes.
5. Fleas: Morphology, behaviour, life cycle, disease relationship and control.
6. Myiasis: Morphology and biology of myiasis causing flies.
7. Ticks and mites of public health importance: Soft ticks and Hard ticks-morphology, behaviour, life cycle, disease relationship and control measures, General account of allergy causing mites.
8. Lac culture: Different strains of Lac insects; lac cultivation; extraction of lac; uses of Lac
9. Forensic Entomology: Types, role of insects in forensic science, PMI determination, succession of insects; role of larvae; case studies.
10. Forest Entomology: Major pests of Sal and Teak plants and their biology and management.

11. Importance of insects as food source, medicine and dye.

Books recommended:

1. Insect Pest Management: D Dent
2. Entomology & Pest management L P Pedigo
3. Agricultural Pest of India and South-East Asia- A.S. Atwal and Dhaliwal
4. Agricultural Insect pests of Tropics and their control- D. Hill
5. Encyclopedia of Entomology- J L Capinera
6. Current Concepts in Forensic Entomology- Jens Amedent & others
7. Medical Entomology-
8. Tropical Forest Insect Pests- KSS Nair

### **ZOO/Pr/Ent/405-Entomology(Practical)**

1. Insect Diversity : Collection, Preservation & Identification
2. Identification of body parts : Mounting
3. Dissections of digestive system, nervous system, reproductive system
4. Identification of insects
5. Pest of crops/ plantations: Identification of pests of different crops/ vegetables/ stored products.
6. Insect vectors and parasites: Identification of insect vectors and parasites of public health importance.
7. Study of life stages of medically important arthropods.
8. Study of appliances used in insect control
9. Toxicology: Estimation of LD50 and LC50; Metabolism of insecticides in insects using TLC/GLC/Paper partition chromatography.
10. Morphological study of social insects.
11. Submission of Field Study Report and collections.
12. Presentation of Project report
13. Sessional and *Viva voce*
14. Viva voce