M.Sc. ZOOLOGY SEMESTER SYLLABUS 2013

Semester I	*Semester II*	*Semester III*	*Semester IV*
Z101 A. Non-chordates B. Chordates	Z201 A. Biosystematics B. Ecology	Z301 A. Entomology B. Animal Physiology	Z401 A. Biodiversity, Pollution & Environmental management B. Biostatistics
Z102 A. Cell Biology B. Histochemistry	Z202 A. Biophysics B. Computer application & Bioinformatics	Z302 A. Evolution B. Biochemistry	Z402 A. Developmental biology B. Techniques and Bioinstrumentation
Z103 A. Wildlife and Adaptation B. Microbiology	Z203 A. Molecular Biology B. Human Genetics	Z303 A. Ecotoxicology B. Endocrinology and Neurobiology	Z403 A. SPECIAL theory Fishery: Aquaculture and Fish Technology Ecology: Systems Ecology Genetics: Recombinant DNA & Molecular Analysis B. Fishery: Inland & Marine Fishery Ecology: Human Ecology Genetics: Applied Genetics
Z104 A. Immunology B. Cytogenetics	Z204 A. Parasitology B. Biotechnology	Z304 A. SPECIAL Theory Fishery: Fish Taxonomy & Biology Ecology: Wildlife & Animal Behaviour Genetics: Genetics B. Fishery: Limnology & Oceanography Ecology: Aquatic Ecology Genetics: Molecular Biology	Z404. Practical based on Z401 & Z402
Z105 Practical based on Z101 & Z102	Z205 Practical based on Z201 & Z202	Z305 Practical based on Z301, Z302& Z303	Z405. Practical (Special)
Z106 Practical based on Z103 & Z104	Z206 Practical based on Z203 & Z204 + Field	Z306. Practical (Special)	Z406. Project + Field (Special)

N.B.: Special papers offered by the department: Fishery, Ecology, Genetics & Molecular Biology.

M.Sc. ZOOLOGY SEMESTER MARKS DISTRIBUTION

SEM	Theory	Prac.
I	200	100
II	200	100
III	200	100
IV	150	150
Total	**750**	**450**

Practical papers	
Z105	**Marks (Total=50)**
Non- Chordate	10
Chordate	10
Cell Biology	10
Histochemistry	10
Internal assessment- (Viva & Lab NB)	10
Z106	**Marks (Total=50)**
Wildlife and Adaptation	05
Microbiology	10
Immunology	10
Cytogenetics	15
Internal assessment- (Viva & Lab NB)	10

Z205	**Marks (Total=50)**
Biosystematics	05
Ecology	10
Biophysics	10
Computer application & Bioinformatics	15
Internal assessment- (Viva & LNB)	10

Z206	**Marks (Total=50)**
Molecular Biology	08
Human Genetics	07
Parasitology	10
Biotechnology	05
Internal assessment- (Viva & LNB)	10
Field report	10

Z305	**Marks (Total=50)**
Entomology	08
Animal Physiology	05
Biochemistry	10
Ecotoxicology	07
Endocrinology and Neurobiology	10
Internal assessment- (Viva & LNB)	10
Z306	**Marks (Total=50)**
Special paper	
Ecology	40
Fishery	40
Genetics	40
Internal assessment- (Viva & LNB)	(10)) in each special paper

Practical papers	
Z4 05	**Marks (Total=50)**
Biodiversity, Pollution & Environmental management	08
Biostatistics	10
Developmental biology	12
Techniques and Bioinstrumentation	10
Internal assessment- (Viva & Lab NB)	10

Z406	Marks (Total=50)
Special paper	
Ecology	40
Fishery	40
Genetics	40
Internal assessment- (Viva & Lab NB)	(10) in each special paper

SEMESTER I

Paper Z101, Group A. Non-chordates

1. Origin & Evolution of Metazoa; Phylogenetic overview of major invertebrate phyla.
2. Comparative account about different larval forms of coelomate non-chordates.
3. Biology of the free living nematods – feeding mechanisms and role of nematodes in ecosystem.
4. Bryozoa – anatomical peculiarities feeding mechanisms and phylogenetic relationship.
5. Rotifera – general organisation, mastax, reproduction and cyclomorphosis.
6. Foraminifera – characteristics, origin, distribution, biology and ecological role of foraminifera.
7. Conservation strategies of invertebrates: invertebrate diversity, importance and threats; alternative approaches to species focussed conservation; conservation status evaluation for invertebrate species.

Paper Z101, Group B. Chordates

1. **Origin of Chordates:**

   Hemichordata, Cephalochordata, Urochordata, Origin of craniates, Evolution of primates with special reference to *Homo sapiens sapiens.*

2. **Protochordates** :

   Endostyle and Iodine binding capacity in Protochordates.

3. **Fishes:**

   Taxonomy of Fishes, Inland and Marine fisheries of India, Problems & Prospects.

4. **Respiratory system & Gas bladder:**

   General functional and requirements; ventilation of Internal gills; Agnathroxs, Cartilaginous fishes, Bony fishes, larval gills; arial respiration in long fishes; swim bladder and the origin of lungs, lung and other ducts, evolution.

5. **Excretory System and Osmoregulation:**

   General nature of kidneys; Evolution of kidneys, Kidney structure in relation to Osmoregulation; Basic pattern and the Archinephros, Pronephros, Mesonephros, Metanephros: External salt excretion, Osmoregulation in freshwater and marine water fishes; Association of Urinary System & General system.

6. **Echolocation:**

   General consideration of organs of hearing balance and Echolocation; Morphological adaptation for echolocation. Bat Echolocation.

Paper 102, Group A. Cell Biology

1) Membrane structure, function & Cell Signaling:

i) Membrane pumps, Membrane channels, Membranes of cell organelles.

ii) Membrane structure & dynamics.

iii) G-protein coupled receptors, signaling through second messengers. Receptor tyrosine kinase signaling, MAP Kinase, TGFβ Signaling

2) Cytoskeleton & Cellular Motility:

i) Microtubular motor proteins: Kinesins & Dyneins.

ii) Microtubular protein: Tubulin, structure & function.

iii) Cellular motility.

3) Cell cycle & its regulation:

i) Cell cycle controlled system depends on cyclically activated cyclin dependent protein kinase (CDKs).

ii) Steps in cell cycle and molecular control of cell cycle.

iii) Tumorogenesis**.**

4) Cellular communication:

i) Principles of cell communication.

ii) Cell adhesion & different adhesion molecules.

iii) Gap junction, extra-cellular matrix & integrins.

Paper 102, Group B. Histochemistry

1. Chemistry of fixation
2. Dye and Staining
3. Histochemical methods for nucleic acids
4. Enzyme histochemistry – acid phosphatase and alkaline phosphatase activity
5. Immunohistochemistry – Fluorescence Markers, ABC and Colloidal Gold methods.

Paper 103, Group A. Wildlife and Adaptation

1. **Wildlife**- Common threatened species in West Bengal. Major laws and acts for wildlife conservation in India; In-situ and Ex-situ strategy for wildlife conservation. Concept of Biosphere Reserve and other Protected areas.
2. Diversity, Biology, Ecology and causes of threats and conservation strategies of major wildlife fauna (amphibians, reptiles, aves and mammals of north and south Bengal)
3. Wildlife crime and molecular techniques for wildlife studies.
4. Major environmental regimes of earth. Environmental **stress** & response of an organism to different conditions. Behaviour as phenotypic traits: Adaptive value of behavior. General Adaptive Syndrome.
5. Oxidative stress. Cellular response. Free radicals and anti-oxidants.
6. Adaptation:
    - Acclimatization
    - Homeostasis, Feedback control systems
    - Conformity and Regulation
7. Water & salt Physiology of animals in relation with their environments
    - Osmoregulation- Adaptive strategy for anadromous and catadromous faunal components.

Paper 103, Group B. Microbiology

1. Outline classification of microorganisms: 5-kingdom, 8-kingdom system, Bergey's manual.
2. Classification & morphology of Bacteria
3. General accounts of Algae, Protists, Fungi & Virus.
4. Microbial Physiology:
    i. Growth in Bacteria: normal growth curve; methods of measuring growth.
    ii. Yield and characteristics, strategies of cell division.
    iii. Bacterial chemotaxis and quorum sensing.
5. Nutrition of microbes
    i. Principles behind formulating culture media
    ii. Culture techniques; pure cultures.
6. Microbes in soil ecology: fertility, petroleum formation.
7. Microbial fermentation: manufacture of industrially important products.

Paper Z104, Group A. Immunology

1. a) Cells and organs involved in Immune System.
   b) Types of Immunity
2. a) Antigenicity and Immunogenicity
   b) Concept of Epitope, Paratope, Agretope
   c) Hapten, Adjuvants
3. a) Origin and maturation of T and B lymphocyte
   b) Humoral and cell mediated Immune Response
   c) T-cell subpopulation
4. a) Antigen processing and presentation
   b) Major Histocompatibility Complex (MHC) Mechanism of immune response and generation of immunological diversity
5. a) Structure and function of Immunoglobulin (Ig) and its Isotypes.
   b) Enzymatic activity on Ig molecule.
6. Applied Immunology:-
   a) ELISA
   b) Southern blotting hybridization
   c) Western blotting hybridization
   d) Immunohistochemistry

Paper Z104, Group B. Cytogenetics

1. **Genetic Fine structure**:
   Classical vs. molecular concept of the gene, the CIS-TRANS or complementation test for functional allelism, Fine structure of the phage T4 rII locus, Complementation mapping.
2. **Conjugation in Bacteria**: F factor, episomes, Hfr, integration of F factor, Interrupted mating Experiment.
3. **The Molecular Basis of Mutation**:
   Chemically induced mutation – Base analogs, Nitrous Acid, Acridines, Alkylating & hydroxylating agents, Radiation induced mutation- Ultraviolet radiation DNA repair mechanisms.
4. **Tumor Inducing Viruses – Viral Oncogenes**.
   Life Cycle of Rous Sarcoma Virus, RV genome organization, mechanism of integration, formation of transducing retroviruses, protein products of protooncogene, Oncoproteins regulate gene expression and signal transduction Cancer induction by Retroviruses.
5. **Genetic structure of Populations** -
   Genotypic frequencies, Allelic Frequencies, the Hardy Weinberg Law, calculation of genotypic and allelic frequencies where multiple alleles are present, derivation the Hardy-Weinberg Law

Practical Paper – Z105

1. **Identification** of common Invertebrate and Vertebrate taxa
2. **Major Dissection** of Invertebrate and Vertebrate specimens
   a) Grasshopper - Reproductive system/ Nervous system
   b) Cockroach – Stomatogastric Nervous system
   c) Achatina – Reproductive system & Nervous system
   d) Bony fish - Vth, VIIth cranial nerves
3. **Minor dissection-** pecten of *Gallus*, head kidney of fish, bursa fabricius, mouth parts of cockroach, otolith of fish.
4. **Cell Biology-** Identification of different stages of cell division and cell organelle.
5. **Histochemistry**
   a) Microanatomy and tissue identification
   b) Measurement of cell diameter by OCM and SM.
   c) Histochemical demonstration of glycogen/ DNA/ RNA in a tissue/ cell
   d) Histochemical demonstration of enzyme in a invertebrate/ vertebrate blood cells/ tissue sections

Practical Paper – Z106

1. **Wildlife & Adaptation**:
    a. Foraging behaviour in ants - Orientation and cues.
    b. Recording of common wildlife fauna In University campus

2. **Microbiology**:
    a. Staining and identification of bacteria, endospores, etc. from a culture media.
    b. Different methods of staining: Gram staining, Negative and differential staining.
    c. Preparation of different culture media with Sterilization techniques.
    d. Inoculation of microbes to respective culture media through proper culture methods.
    e. Enumeration of Coliform bacteria using Multiple tube fermentation method.
3. **Immunology**:
    a. Study of macrophage.
    b. Study of phagocytosis.
    c. Determination of human blood group
4. **Cytogenetics**:
    a. Life cycle of *Drosoplila*.
    b. Analysis and interpretation of genetic crosses with special reference to *Drosophila*
    c. Study of polytene chromosome of *Drosophila*.

Paper Z201, Group A. Biosystematics

1. **Microtaxonomy:**

   Phenon, Taxon,Category, type; stages of taxonomy; Aims and tasks of Taxonomists; Importance of taxonomy in Biology.

2. **Macrotaxonomy:**

   Theory and practice of Biological classification; Basic principles, Rules for the classification of organisms, Identification criteria, Taxonomic characters, Classification and phylogeny, Is classification a Theory? The functions of a classification.

3. **Concept of Species:**

   Typological species concept, Nominalistic species concept, Biological species concept, Evolutionary species concept; other kinds of species; Polytypic species, Subspecies, Infraspecies and Superspecies.

4. **Newer Systematics:**

   Morphological approach, Immature stages and Embryological approach, Ecological approach, Behavioural approach, Ecological approach, Behavioural approach, Cytological approach, Biochemical approach, Numerical systematics, Differential systematics.

5. **Molecular Systematics**

   Immunological aspect, chromatographic aspect, Electrophoresis, Infrared spectrophotometry, Histochemical studies, genetic complement, DNA hybridization, Karyological studies.

6. **Macromolecular & Micromolecular Systematics:** based on DNA, RNA, Protein, amino acids, fatty acids and phenols.

7. **Role of Systematics in applied Biology:**

   Agriculture & Forestry, Biological control, wild life management, National defence, Environmental problems, soil fertility, Mineral prospecting, Quarntine measure, Commercial application.

8. **Systematics and Public Health Management**

Paper Z201, Group B. Ecology

1. System Ecology

Biosphere and Ecosphere; Types of food web : Connectedness, energy and functional webs; Features of food web – nodes, links, linkage density, connectance, chain length; cybernetic nature of ecosystem; stability through feedback control and through redundancy of components; resistance and resilience stability, Gaia hypothesis.

Macroecology: concept and consequences. Causes of higher abundance of species in tropics and small bodied animals. Principles of Thermodynamics, energy flow and ecological energetic; Secondary succession; Evolutionary convergence and ecological equivalence.

2. Population Ecology

Survivorship; Life table, fertility schedule. Reproductive strategies; semelparity, iteroparity, r & k strategies, population interactions- direct and indirect, positive and negative. Lotka-volterra model of competition and predator-prey interaction. Causes of extinction and endangerrment of populations. Anthropogenic impact on species extinction, habitat destruction and fragmentation, introduction of exotic species.

3. Community and Ecosystem

Structure of biotic community. Community patterns: diversity and stability. Community boundary: Ecotone and edge types, Edge effect and edge species, Edge/Area ratio in relation to size, shape and fragmentation of habitat. Organismic and individualistic concepts of community. Leibig's Law of tolerance.

4. Habitat Ecology

Habitat and niche: spatial, trophic and multi-dimensional niche concepts, fundamental and realized niche, niche breadth and niche overlap. Competitive exclusion: experimental and natural evidence. Keystone species. Foundation species. Species abundance hypothesis. Ecological guilds and ecological equivalents.

5. Evolutionary Ecology: Evolution in a variable environment- Bet-Hedging strategies. ESS models for the evolution of parental care. Hamilton's role and limitations of inclusive fitness model. Handicap principle and evolutionary stability of signals. Optimal foraging model.

Paper Z202, Group A. Biophysics

1. Properties of matter
   a. Diffusion – Fick's law, Graham's law, facilitated diffusion, biological application.
   b. Osmosis – Van't Hoff laws
   c. pH. and buffer – pH and its biological significance
   d. Colloids– electro kinetic property
   e. Dialysis – Hollow fibre dialysis and electro dialysis
2. Thermodynamics – Isolated, close and open system, first and second law of thermodynamics, enthalpy and entropy, Biological steady state and its maintenance, Gibb's free energy.
3. Radioactivity – alpha, beta and gamma rays, half life of radio isotopes, kinetics of radioactive decay, artificial radio isotopes, Geiger- Muller counter, Scintillation counter, radioisotopes and their application in biology, Radiation dosimetry, Carbon dating.
4. Model Membrane and dynamics
5. Nanotechnology – Characteristics of nanoparticles and application.

Paper Z202, Group B. Computer application and Bioinformatics

1. **Basics of computers**: hardwares and softwares. Number systems.
2. Networks (LAN, WAN), Information technology.
3. Internet: Webpages, Internet protocols, Search engines, Subject Directories etc.
4. **Biological Database management systems**:
    a. Nucleic acid sequences databases
    b. Genome databases (e.g. Human Genome Project)
    c. Protein sequence and structure databases
    d. Literature databases
5. Importance of Bioinformatics.
6. Introduction to Data archiving systems (FASTA format, Accession number)
7. **Applications of bioinformatics:**
    a. Data retrieval systems: data query and data mining (Pubmed, Entrez), Sequence retrieval system (SRS) and protein identification resource (PIR).
    b. Molecular sequence analysis software packages and tools, Sequence alignments (Pairwise & multiple alignment)
    c. Molecule structure: domains, folds and motif analysis.
    d. Evolutionary study with Phylogenetic trees

Paper Z203, Group A. Molecular Biology

1. **DNA Replication:**

   Role of Topoisomerase, Enzymes involved in DNA synthesis, Molecular model of DNA replication: initiation of replication, Semidiscontinuous DNA replication, structure of oriC, Bidirectional replication.

2. **The Transcription Process –**

   Role of RNA polymerase in prokaryotes initiation of transcription at Promoters, elongation and termination of an RNA Chain.

3. **The Genetic Code:**

   Three nucleotides per codon, Deciphering the Code, Degeneracy and Wobble, Universality of the Code, Initiation and Termination codons.

4. **Protein Synthesis**

   Charging tRNA, initiation of translation; role of initiation factors, Elongation: binding of Aminoacyl tRNA, peptide bond formation and translocation. Termination of translocation.

5. **Regulation of Gene Expression in Prokaryotes:**

   The Operon Model; lac, an inducible Operon, Positive Control of the lac Operon by CAP and Cyclic AMP. Repressible operon, Gene organization of the Tryptophan biosynthesis gene, Regulation of the trp operon.

Paper Z203, Group B. Human Genetics

1. **Basic facts of Human genetics**

   Genetic basis of human disease:

   Genetic counseling based on DNA and other genetic markers, Human genome project – strategies, application and implications.

2. **Genetics of Cancer**

   Cell transformation & tumorigenesis, Oncogenes, Tumor suppressor genes, Genomic instability, Epigenetic modification, Angiogenesis & Metastasis, Current therapies.

3. **Molecular & Biochemical basis of genetic diseases**

   a) **Autosomal Disorders:** Cystic fibrosis, Thalassemia
   b) **X-linked Disorders:** Hemophilia A, Muscular dystrophy
   c) **Metabolic Disorders:** Phenylketonuria, Alkaptonuria
   d) **Dynamic Mutations:** Huntington disease
   e) **Late onset disorders:** Alzheimer disease

4. **Transposable Genetic Element:**

   IS element: its property and transposition, Non-composite and Composite Transposition. Cointegration model for transposition. The AC-DC Controlling elements in Corn, Hybrid dysgenesis and P elements in Drosophila. Sleeping Beauty model of transposon. Retroposons.

Paper Z204, Group A. Parasitology

1. a) Types of Parasites and hosts.

   b) Basic concept of Parasitism, symbiosis, phoresis, commensalisms and mutualism.

2. Molecular, cellular and physiological basis of host-parasite interactions.

3. Life cycle and immunology of plasmodium, African Trypanosomiasis.

4. Epidemiology and transmission of parasitic diseases. Malaria, Kalazar, Filaria.

5. a) Zoonosis and Zoonotic diseases with special reference to Balantidiasis, Giardiasis Filariasis and Paragonimiasis.

   b) Life cycle and biology of *Leishmania, Schistosoma.*

6. Structure and composition of helminthes cuticle.

7. Vector biology special reference to mosquito/Sand fly/ticks.

Paper Z204, Group B. Biotechnology

A. Molecular Biotechnology

1. Recombinant DNA technology

1.1 Restriction Endonuclease

1.2 Production of recombinant DNA molecule

1.3 Cloning Vector

1.4 Amplification by PCR

1.5 DNA finger printing and its application

1.6 Genomics & proteomics

B. Environmental Biotechnology

1. Bioremediation

1.1 *In situ* bioremediation

1.2 *Ex situ* bioremediation

1.3 Bioremediation of Xenobiotic components and hydrocarbons

1.4 Phytoremediation

2. Biosensor

3. Biomarker

4. Livestock management- Artificial insemination and Embryo transfer, Cryopreservation; Integration of different rural biotechnological tools; bee-culture, vermiculture, poultry.

5. Biopesticides and biofertilizer – types, sources and mode of action, composting, solid waste recycling.

Practical Paper Z205

1. **Biosystematics:** Preparation of taxonomic key
2. **Ecology:**
    a. Estimation of primary productivity in aquatic ecosystems
    b. Measurement of intensity of light – using Lux meter.
    c. Estimation of transparency of water
    d. Estimation of textural composition of soil
    e. Determination of the minimum size and number of quadrat – Species area curve method.
    f. Study of density, diversity, frequency and abundance of plant population.

3. **Biophysics**
    a. Role of buffer in living cell
    b. Stress analysis by biophysical method

4. **Computer application and Bioinformatics**
    a. Computation and graphical presentation of data (MS Excel, SPSS)
    b. Familiarization with Internet resources; Use of search engines (Google, Altavista, Dogpile, Meta-crawler)
    c. Demonstration of web-pages related to biological information (NCBI /PubMed, ExPasy)
    d. Data archiving systems: FASTA format, Origin, Accession and GI numbers.
    e. Nucleic acid and Protein sequence databases using pubmed resources
    f. Taxonomic tree preparation, Taxonomy software.
    g. Hands on practice of databases:
        - GenBank, PDB, OMIM, Fly Base, HGDB, Anatomy, SwissProt, etc.
    h. Use of software packages/tools for Pairwise & multiple alignment: BLAST, Clustal-W,
    i. 3D Molecule structure analysis using Cn3D or Rasmol, MMDB.

Practical Paper Z206

1. **Molecular Biology:**
   a. Isolation & purification of DNA from tissue.
   b. Principle & method of Agarose Gel Electrophoresis
2. **Human Genetics:** Karyotype analysis
3. **Parasitology:**
   a. Smear preparation and staining of rectal content of *Bufo* sp.
   b. Preparation and staining of blood parasite from pigeon blood.
   c. Identification:

   Plasmodium sp., Leishmania sp., Ascaris sp., Fasciola sp., Paramphistomum sp., Anopheles sp., Culex sp., Columbicola sp., Pediculus sp., Cimex sp.
4. **Biotechnology:**
   a. Plasmid DNA isolation
   b. Restriction endonuclease digestion of DNA, characterization through Gel Electrophoresis
   c. Identification of suitable earthworm species & isolation of cocoons.
   d. Separation of solid wastes into different categories
5. **Field report & viva**

Paper Z301, Group A. Entomology

1. **The importance, diversity and conservation of insects** – Insect biodiversity, uniqueness and adaptability, insect conservation. Insect for food and silk – prospects and problems of sericulture in drought prone lateritic tracts of South West Bengal, India.
2. **General characters and classification of Insects up to order** - Insect's head, capsule, antennae, legs, wings, digestive system with special emphasis to midgut, filter chamber and peritrophic membrane; integument, Insects' neuro-endocrine system – components, chemical structure of hormones and functions; molting and metamorphosis, insects' egg-type, hatching, growth, development, diapause and aestivation.
3. **Biology, nature of damage and control of Insects' pests** - Jute, cashew, betel vine and stored grains; Integrated approach to pest management.
4. **Aquatic insects** – Diversity of freshwater and marine insects, Adaptation – water balance; Importance for environmental monitoring.
5. **Insect behaviour** - Pheromones – Structure of pheromone glands; types and functions; biochemical synthesis of pheromones. Bioluminescence – Light producing organs, Mechanism of light production, Control and significance of light production.
6. **Insects and Plants –** Insect plant interaction and co-evolutionary interactions between plants and animals; Plant chemicals and their effect on insects; Pollination by insects; Organic compounds and their biosynthesis pathways in insects

Paper Z301, Group B. Animal Physiology

1. Animal Nutrition:
    - BMR
    - Role of vitamins in metabolism
    - Physiological roles of minerals – Na, K, Ca & P.
2. Blood, Circulation and Respiration
    - Haemopoiesis, haemoglobin, blood groups, haemodynamics.
    - Regulation of blood volume and blood pressure, haemostasis.
    - Respiratory response to extreme conditions like hypoxia & diving.
    - Body oxygen stores –blood, muscle and pulmonary.
    - Oxyhaemoglobin and Myoglobin; Oxygen dissociation curve.
3. Cardiovascular System:
    - Cardiac cycle,
    - Electrical and mechanical properties of myogenic and neurogenic hearts;
    - Heart as a pump; regulation of heart pumping;
    - Neural and chemical regulation of excitation & conduction in heart;
    - Frank-Starling mechanism;
    - Principle of ECG.
4. Thermoregulation:
    - Body temperature and determinants of body heat – production and loss.
    - Physiological events for thermoregulation; counter-current system.
    - Thermal biology of ectotherms, heterotherms and endotherms,.

Paper Z302, Group B. Evolution

1. Neo-Darwinism
    a. Hardy-Weinberg law of genetic equilibrium
    b. A detailed account of destabilizing forces: (i) Natural selection (ii) Mutation (iii) Genetic drift (iv) Migration.
2. Molecular phylogenetics
    a. Construction of phylogenetic trees
    b. Phylogenetic inference-Distance methods, parsimony methods, maximum likelihood method
    c. Immunological techniques
    d. Amino acid sequences and phylogeny
    e. Nucleic acid phylogeny, DNA-DNA hybridizations, restriction enzyme sites, nucleotide sequence comparisons and homologies
    f. Molecular clocks
3. Evolution and tinkering

Paper Z302, Group B. Biochemistry

1. **Stablizing** interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction)
2. **Protein Conformation**: Primary, secondary, tertiary and quaternary structures; Ramachandran plot; domains; motif and folds.
3. **Enzymes:** Enzyme kinetics, Michaelis-Menton equation, hyperbolic and Lineweaver-Burke plot; co-enzymes and Cofactor; competitive and non-competitive inhibitor and their effects on enzyme kinetics; Active site of an enzyme; Enzyme regulation, allosteric modification, its kinetics, covalently modulated enzymes.
4. **Biological Oxidation:** Redox potential, mitochondrial electron carriers, the respiratory chain (electron transport chain); Mitchell's chemiosmotic theory of oxidative phosphorylation; FoF, ATPase
5. **Lipid Metabolism**: denovo synthesis of fatty acids, microsomal fatty acid elongase & desaturase systems; oxidation of saturated fatty acids and unsaturated fatty acids.
6. **Protein metabolism**: deamination, transamination, ammonotelism, ureotelism, uricotelesim, formation of urea, formation of specialized products from amino acids: catecholamine, serotonin, melatonin, glutathione, T_3, T_4.
7. **Carbohydrate metabolism**: anabolic role of TCA cycle, integration of carbohydrate, fat and protein metabolism. Regulation of Glucolysis TCA cycle, Gluconeogenesis, Pentose phosphate pathway, Glycogenesis, glycogenolysis with special reference to rate limiting steps.

Paper Z303, Group A. Ecotoxicology

1. **Xenobiotics**

   General idea of Xenobionts and their Physical & Chemical Properties; Corrosive, Metabolic, Neurotoxic, Mutagenic & Carcinogenic toxins; Characteristics of toxin, Route of Entry, Mechanism of Action.

2. **Toxicity test & bioassay**

   LC_{50}, LD_{50}, Dose response curve; Biotransformation, Bioaccumulation & Biomagnification of Xenobionts in food chain; Hazardous heavy metals and their toxicity and probable antidotes; Elementary idea on Chelation therapy.

3. **Aquatic Toxicology**

   A short history of Aquatic toxicology, The aquatic environment, Factors affecting the Environmental Contraction of Chemicals, Toxicological Concept and Principles, Factors influence Toxicity, Toxic agents and their effects, concentration – Response Relationships, toxicity testing, Biomonitoring Toxicity data and Environmental regulation.

4. **Immunotoxicology**

   Immunology – Defensive responses, Immunological methodology; Immunotoxicology – Effects of classes of Toxicants.

5. **Environmental Genotoxicology**

   Basic mechanism of DNA damage, Analytical techniques, In situ Environmental Genotoxicity studies with Aquatic species, potential value of Environmental genotoxicity.

Paper Z303, Group B. Endocrinology and Neurobiology

1. Basic concept of neuroendocrinology
2. Neuroendocrine glands (Insects and fish) – structure and function
3. Neuroendocrine hormones (growth hormones and prolactin) – sources, properties and mode of action.
4. Sensory organs – Classification and Cytological demonstration (Vision/ smell/ taste)
5. Neural disorder – Alzheimer's disease, Parkinson's disease and Auditory processing disorder

Special Paper: Ecology

Paper Z304, Group A. Biodiversity, Wildlife and Animal Behaviour

- Biodiversity - Utility and concept. CBD, Megadiversity countries, biodiversity hotspots, Estimating biodiversity, biodiversity indices. Conservation of biodiversity. IUCN Red List Category Version 3.1; IUCN categories of Protected Areas. Biodiversity convention, criteria for measuring conservation value of areas. Ex-situ conservation of animals; captive breeding; species reintroduction, species translocation; population reinforcement; In-situ conservation- conserving ecosystem function and management.
- Wildlife Ecology – Diversity & Distribution of major Wildlife in India. Wildlife Habitat management for conservation. Size and design of of Natural Reserves. Wildlife crime. Concept of Biome. Social forestry: Joint Forest management- Arabari concept.
- Conservation Status - Critically Endangered Vertebrates of India with special reference to West Bengal. Distribution, endemicity, habitat utilization pattern, threats to survival and conservation strategies of Amphibia, Olive Ridley turtle, Woodpecker, Vulture and Elephant.
- Endemic Wild Avifauna –Categories of birds in respect of different habitats. Distribution, habitat preference, migration, biology, threats to survival, conservation strategy of Woodpeckers, Vulture and Great Indian Bustard. Wetland and forest as complementary habitats for the conservation of Avifauna.
- Tools and techniques for wildlife census and survey: Transects – line and point transects, counting roosts and flocks, counting leks and migrants; Radio telemetry, Capture – recapture, Band recovery, Radio-tagging, pugmark census.
- Remote sensing and GIS: Digital imagery and Image Processing; basic idea of GIS and GPS (Spectral reflectance) and their application in wildlife conservation.
- **Animal behavior**: Types of behavior - Innate and Learned behavior. Role of behavioural study in animal conservation. Motivation-homeostasis and hyperphagia; Biological rhythms- Foraging behavior; Avoiding predation. Reproductive behavior- Mating types, Sex ratio: causes of tilt in operational sex ratio. Sexual selection. Male rivalry, female choice, epigamic qualities, Hypotheses explaining sexual selection. Sexual dimorphism.

Territoriality, home range, communication and signaling (courtship display and calling behavior), man-animal conflict with special reference to elephant.

Paper Z304, Group B. Aquatic Ecology

1. **Water as resource** - types and distribution; past changes and present status; Hydrological cycles – different phases, factors contributing to degradation of water quality and management. **Socio-Ecohydrological balancing**: Sustainable water management- surface & groundwater relationships; Base flow, porosity, permeability, transmissurity and storativity.

2. **Structure and function of aquatic ecosystems and their management : -**

   a) Conservation strategies of river, floodplains, lakes, freshwater wetlands, salt marsh and coastal dunes – in respect of climate change.

   b) **Marine Ecosystem:** Origin, extent and zonation of sea, physical properties and physical processes, chemical composition, behaviour and fate, biological components and their interactions.

   c) **Coastal Ecosystem:** Definition, extent and types, zonation and geomorphological features, significance, human induced problems, global and marine diversity, integrated coastal zone management.

   d) **Estuarine Ecosystem:** Definition, classification, structure – biotic assemblage and their interactions, function.

   e) **Mangrove Ecosystem:** Definition; speciality of this ecosystem; structure and function with special reference to Sundarbans, India; Problems and Management.

   f) **Coral Ecosystem:** Definition, types and distribution, speciality with regard to biodiversity, productivity and ecosystem functioning, problems and management.

   g) **Wetland Ecosystem:** Definition, distribution, causal factors, wetland classification, zonation and succession, significance and values, Ramsar sites in India.

   h) **River Ecosystem:** Fluvial hydrosystem approach; catchment size and drainage basin from selected major rivers, hydrochemical dynamics, biological productivity, human impacts and management perspective.

3. **Wastewater management** – types, source, physical-chemical properties, recycling and bioremediations.

4. **Aquatic biota, types and trophic interactions** – Macrophytes, phytoplankton, zooplankton, periphyton, benthos and nekton.

5. Threats to Marine Biological Diversity – nutrient over-enrichment and consequences of bioinvasions. Global marine diversity and threats to fishes (finfishes and shellfishes), marine mammals, seabirds and sea turtles, invertebrates and plants – conservation biology – the global strategy.

Special Paper: Fishery

Paper Z304, Group A. Fish taxonomy and Fish Biology

1. Classification of fishes
2. Fish nutrition and growth
3. Fish reproduction and development
4. Fish endocrinology
5. Fish migration

Paper Z304, Group B. Limnology and Oceanography

1. Inland water bodies and biotic community of lentic & lotic systems
2. Lakes
3. Geographical, physical, chemical and biological oceanography
4. Marine biodiversity conservation
5. Sources, dispersion mechanisms and Biological impacts of pollutants in the sea.

Special Paper: Genetics & Molecular Biology

Paper Z304, Group A. Genetics

1. **Organisation of the eukaryotic genome**:

   Nucleosome structure, Chromatin remodeling, Histone modification-acetylation, methylation, Centromeric & Telomeric DNA, Epigenetics, Apoptosis.

4. **Mechanism of RNA Splicing & Transcription of rRNA gene**:

   Production of Mature mRNA in Eukaryotes, 5′ and 3′ mRNA, RNA editing, transcription of rRNA genes. Self splicing reaction.

2. **Mechanism of Crossing Over:**

   The holliday model of Crossing over, The Meselson-Radding Model of Recombination, The Double-Strand-Break repair Model of Recombination.

4. **Sex determination and Dosage compensation in Mammals and Drosophila:**

   Primary and Secondary sex determination in mammals. The Y chromosome sex determinant; Sry, Sox 9 gene product, role of DAX 1 gene, hormonal regulation of the sexual phenotype, Mechanism of sex determination in Drosophila; role of sxl gene, transformer gene and double sex protein.

Paper Z304, Group B. Molecular Biology

1. **DNA repair mechanism**

   Mechanism of DNA mutation, Repair mechanism, Base excision repair, Mismatch Repair, Error prone repair. Recombination repair in *E.coli*

2. **Signal Transduction pathway**

   G-protein, Receptor tyrosine kinase, Intracellular receptors, Signal transduction through second messengers, cAMP dependent pathway, IP_3/DAG pathway, MAPK pathway Mechanism of Steroid hormone action.

3. **Gene Therapy**

   Methods of Gene targeting, ex vivo and in- vivo therapy, Stem cell therapy. siRNA and miRNA basics, regulation of transcription and translation of proteins by miRNA. **Transgenesis:** transgenic animal and plants and their application.

4. **Epigenetics and genome imprinting** - DNA methylation in mammals, genomic imprinting in mammals, germ line and pluripotent stem cells , epigenetic control of lymphopoiesis, nuclear transplantation and the reprogramming of the genome. epigenetics and human disease, epigenetic determinants of cancer.

Practical Paper Z305

1. **Entomology**
   a. Method of collection and preservation of insects
   b. Study of the behavioural modification of legs in honey bee.
   c. Entomological comments on common Pests, Aquatic insects, Insects of medical and economical importance. Galls & Seed cocoon
   d. Mounting of sting apparatus & coupling device of Honey bee.
2. **Animal Physiology:** Estimation of pH and its impact on plankton.
3. **Biochemistry:**
   a. Quantitative estimation of protein- Lowry method or by Folin Ciocalteu reagent.
   b. Estimation of Glucose by Dinitrosalicylic (DNS) acid reagent.
   c. Estimation of Fructose by Resorcinol reagent.
   d. Estimation of DNA by Diphenylamine reagent.
   e. Detection of reducing sugars by Benedict's, Barfoed's & Fehling's reagents.
   f. Detection of amino acids by Ninhydrin reaction.
   g. Determination of K_m& V_{max} of enzymes Amylase and/or Alkaline phosphatase. Preparation of Progress Curve of the above mentioned enzymes.
4. **Ecotoxicology:**
   a. Dose response curve
   b. Lethal dose estimation
   c. MATC in a fish species
   d. Lethal dose50 mortality curve
5. **Endocrinology and Neurobiology**
   a. Identification of nerve fibres through silver staining method.
   b. Identification of neural cells by Alcian Blue method.
   c. Demonstration of Electro-olfactometer

Paper Z306. Practical
Ecology Special
Biodiversity, Wildlife and Animal Behaviour & Aquatic Ecology

1. Preparation of Climograph
2. Estimation of transparency, TSS, TDS, conductivity, hardness, salinity and alkalinity of water.
3. Estimation of N, P, K content of water.
4. Basic principle pertaining to acid digestion for the estimation of heavy metals in water sample.
5. Ecological comments on major biotic components in Aquatic system
6. Recording/documentation and submission of terrestrial / aquatic faunal components in and around University campus – (Collection, preservation, identification and analysis of aquatic biota – phytoplankton, zooplankton, benthos, periphyton, aquatic insects, nekton and macrophytes).
7. Applicability of GPS/GIS in recording bioresources and mapping of landscape.
8. Submission of Laboratory notebook.
9. Viva-voce

Paper Z306. Practical

Fishery Special

1. Identification of Indian fish fauna
2. Identification of fish food organism/ artificial fish food
3. Dissection – Urinogenital system of Tilapia, ARO of catfishes, Weberian ossicles of IMCs.
4. Fecundity estimation

Paper Z306. Practical

Practical Special Paper Genetics & Molecular Biology:

1. Probability in Mendelian Inheritance
   a. Chi-square, degree of freedom, test for Independence (contingency Chi square),
   b. Homogeneity Chi-square, Independent Assortment and probability(binomial expansion)
2. Preparation of mitotic metaphase chromosome of rat.
3. Plasmid isolation and restriction digestion.

Paper Z401, Group A. Biodiversity, Pollution & Environmental management

1. **Biodiversity-** concept, International Conventions, Hotspots and Megadiversity countries; IUCN Red List version 3.1. Biodiversity and sustainable resource managementBiomonitoring; types of indicator species; merits and demerits; common indices used in biomonitoring.
2. **Environmental pollution**: Types, natural versus man made; Global scenario.
3. **Air pollution**: Composition of air, zonations of atmosphere; classification, properties/ behaviour and fate of air pollutants; properties and role of oxides of nitrogen, and sulphur as air pollutant, green house effect and global warming; photochemical smog, acid rains, effect of pollutants on human health and plants, Noise pollution.
4. **Water pollution**: Classification and behaviour of water pollutants, point and non-point pollution, pollution of water by agricultural wastes (fertilizers and pesticides); sewage, oil, thermal power plants; and eutrophication.
5. **Soil pollution**: Soil pollution through agricultural and solid wastes; soil erosion – types and causative agents; Bioinvasion and its environmental impact; Biosafety and its significance.
6. **Environmental management:** Ecodegradation and pollution; sustainable environmental management; indicators of quality of life. Objectives of conservation; world conservation strategies. Biomonitoring. Green movements; traditional environmental knowledge and people's participation.

Paper Z401, Group B. Biostatistics

1. **Probability distribution**: Properties and uses of binomial distributions and Poisson's distributions, degrees of freedom.
2. **Testing of Hypothesis**: Null Hypothesis. Level of significance. Error of interference.
3. **Analysis of frequencies**: Chi-square test for goodness of fit.
4. **Correlation and regression**: Properties and types of correlation. Pearson's product-moment correlation coefficient- properties, assumptions, computation from ungrouped data and significance test. Partial and multiple correlations. Regressions- types and models, simple linear regression – assumption, properties and computation. Multiple regression.
5. **Analysis of Variances**: Types and models of analysis of variances. Assumption for ANOVA. One-way ANOVA- computation and interpretation of F ratio, multiple comparison t-test, Scheffe's multiple comparison f-test.

Paper Z402, Group A. Developmental biology

1. **Induction:** Primary and secondary induction of the organizer, organizer concept, diffusible protein of the organizer. The functioning of Niewkoop center
2. **Regeneration:** Regeneration of animals with special emphasis on the process of regeneration in Hydra and Amphibia.
3. **Fertilization:** Molecular mechanism and biochemical changes during the process

Paper Z402 A, Group B. Techniques and Bioinstrumentation

1. Principles and application of gel-filtration, ion-exchange and Affinity Chromatography, Thin layer and Gas Chromatography- MS.
2.
    a. Advanced Microscopy: Light microscopy, Phase Contrast Microscopy, Fluorescence Microscopy, SEM, TEM.
    b. Basics of X-ray diffraction and its function and NMR.
3.
    a. Basic Principles of Electrophoresis, Agarose Gel Electrophoresis, SDS-PAGE, Cell fractionation, Ultracentrifugation, Southern Blotting Hybridization, Western Blotting Hybridization.
    b. Flow Cytometry, 2D Gel Electrophoresis, FISH, FTIR.

Special Paper: Ecology

Paper Z403, Group A. Systems and Molecular Ecology

1. **Community Ecology:** Biotic community: Abundance, Frequency, Relative Abundance, Dominance and Dominance index, Species Diversity and Evenness indices. α, β, γ diversity. Species diversity hypotheses, Species diversity in ecological gradient. Metacommunity concept: Metapopulation structure. Fragmentation of habitat. Metacommunity dynamics: empirical examples.
2. **Restoration Ecology:** Definition, Philosophy and rationale for ecorestoration, Ecological restoration and sustainability, Process of ecorestoration – in the context of landscape to species level.
3. **Ecotourism:** Definition, sustainable development and ecotourism, Foundation of ecotourism, Tourism policy, Economics and management issues, merits and demerits.
4. **Microbial ecology**:

   Microbial communities and ecosystems; Positive and negative interaction between microorganisms and ecological implication; Microbes in nitrogen and carbon cycling; Microbes in fuel and biogas production.
5. **Molecular ecology –**Genetically modified organisms and its impact on environment. DNA fingerprinting and its role in Wildlife conservation. Molecular markers, different types and their role in conservation ecology.
6. **Mathematical Ecology**: Basic concept of ecological modeling; Deterministic and Stochastic models; Theoretical model and analytical solution. - Patterns of Spatial distribution - Random, contagious and regular, coefficient of dispersion. Index of similarity and index of association.
7. **System structure and function:**
   a. Physiography of freshwater ecosystems, stratification, distributions and mixing patterns. Dynamics of light, oxygen and nutrient content.
   b. Ecological processes in Tropical forest ecosystem - Vertical stratification of plants and animals. Production and nutrient cycling. Leaf litter decomposition. Types of humus

Paper Z404, Group B. Human Ecology

1. **Global Environmental Issues:** Nature, Culture and Environmental changes, Agent and processes. Global warming – climate change; Acid rain; Stratospheric ozone layer destruction; Thermal Inversion – Smog, Point and Non-point pollution – fertilizers and pesticides. Global Climate change, Sustainable Development, Biodiversity. Global environmental changes in terrestrial and aquatic systems. Darwin's earthworms, Hypercycles in ecology; Biomass and Gaia. Carbon sequestration and landscape change. The role of life: from geochemical cycles to biogeochmical cycles. The co-evolution of plants and CO_2.
2. **Solid waste recycling:** Agriculture, Municipal, Biomedical Wastes – nature, source, environmental impact and management. Wastes in ecosystems and management-urban waste, industrial waste, agricultural waste, radioactive waste, medical waste- effects and control.
3. **Environmental Management and Acts:** Environmental Impact Assessment: Definition; Types of EIA, EIA process and methodologies – scoping, prediction, evaluation, mitigation and monitoring; Socioeconomic impact assessment; EIA Notification. Environmental Management System, Ecomark; Steps of Management, Environmental Acts of India and their effectiveness.
4. **Urbanization:** Urban environment – criteria and its present global status, major environmental problems of cities. Urban impact on air and water environment, on biodiversity, agriculture; Indoor Pollution – characteristic of indoor environment, common indoor pollutants, their sources and mode of action; Effect of urbanization on biodiversity.
5. **Wasteland and watershed management:** Concept – integrated process and mechanism of wasteland restoration and watershed management; Soil erosion – types and factors.

Special Paper: Fishery

Paper Z403, Group A. Aquaculture and Fish Technology

1. Aquaculture – Problems and prospects in India
2. Integrated fish farming system and fish breeding
3. Fishing methods, harvesting, by-products and export
4. Fish disease
5. Fisheries planning, economics and extension

Paper Z403, Group B. Inland and Marine fisheries

1. Inland and marine resources, problems and potentials
2. Estuarine and coastal fishery
3. Remote sensing and GIS
4. Reservoir fishery
5. Sewage fed fishery

Special Paper: Genetics

Paper 403, Group A.

Recombinant DNA and Molecular Analysis

1. **DNA Markers in Genetic Analysis:**

   Restriction Fragment Length Polymorphism (RFLP), Tandem Nucleotide Repeat Marker, PCR based markers, Random Amplified Polymorphic DNA (RAPD), Amplification of DNAs by the polymerase Chain reaction and variations, Real time PCR.

2. **Protein blotting and Fluorescency:**

   Western Blotting techniques for the analysis of Proteins. Mechanism of Fluorescence and Phosphorescence, Fluorescence spectroscopy. In situ localization by FISH.

3. **DNA and RNA Sequencing:**

   Southern Blotting and Analysis of DNAs, Analysis of RNA by Northern Blot; Sanger Dideoxy Sequencing, Second generation sequencing- pyrosequencing, DNA Sequence information on the Internet.

4. **Recombinant DNA, Plasmid Cloning Vectors:**

   Restriction Endonuclease & Methylases, Recombination of DNA fragments, Plasmid cloning vector and expression vectors; Linker DNA, Homopolymer tailing, Blunt end ligation, Shotgun Cloning, cDNA cloning, cDNA microarray, T-A cloning.

Paper 403, Group B. Applied Genetics

1. **Genes & Immunity:**

   Antibody Genes & diversity, The IGKC (k light Chain) gene, The ICLC 1 (lambda light Chain) gene, The IGHG 1 (heavy Chain) gene,

   Autoimmune disease, Immune deficiencies,

   Antibodies as tools in Genetics Research – Monoclonal Antibody, Immunofluorescence

2. **Metagenomics:**

   Introduction - from genomics to metagenomics, global impact of metagenomics; Approaches to metagenomics analysis, 16S rRNA microarray (phylochip), sequence base analysis, functional based analysis, gene expression system, single cell analysis; data management and bioinformatics challenges of metagenomics, the importance of metadata, databases for metagenomics data, software, analysis of metagenomics sequence data.

3. **The Human Genome Initiative:**

   Human Chromosome mapping, Human Genome Sequencing and data management.

4. **Gene silencing mechanism**, Protein array, Gene chip, Protein Sequencing and peptide characterization (MALDI-TOF)

Paper Z405. Practical

1. **Biodiversity, Pollution & Environmental management**
    a. Qualitative and quantitative estimation of soil and aquatic biodiversity.
    b. Basic principles for the estimation of heavy metals.
    c. BOD and COD estimation.
2. **Biostatistics**
    a. Computation and significance test of product – moment r between two continuous measurement variables.
    b. Computation of simple linear regression.
    c. Computation of variance ratio (F) and multiple comparison of Scheffe's F test for one-way anova and their interpretation.
    d. Chi square test for goodness of fit with a Mendelian frequency distribution.
    e. Significance of observed sex ratios using binomial distribution.
3. **Developmental biology**
    a. Extraction and identification of different stages of chick embryos (24 hours,48 hours and 72 hours)
    b. Histological sectioning and staining of different stages of chick embryo.
4. **Techniques and Bioinstrumentation**
    a. Crystal preparation
    b. Gel Electrophoresis (Agarose, SDS- PAGE)
    c. Visit to RSIC/ SIF

Paper Z406. Practical

Ecology Special

Systems and Molecular & Human Ecology

1. Estimation of the degree of faunal similarity and association between species.
2. Estimation of alpha, beta and gamma diversity.
3. Computation of microdistribution pattern for spatial distribution.
4. Analysis of the structure of biotic community: Abundance, Relative abundance, Frequency, Species diversity and Dominance indices. Shannon-Weiner diversity index.
5. Study of impact of pesticides on soil microbes.
6. Vermitechnology and related matter: Analysis of biota from urban waste materials & identification of suitable specimen for vermicomposting.
7. Air pollution monitoring: demonstration of Air sampler and other ecological monitoring
8. Submission of Laboratory notebook.
9. Viva-voce

Paper Z406. Practical

Fishery Special

Aquaculture and Fish Technology; Inland & Marine Fishery

1. Identification of Shellfish, macrophytes and aquatic insects.
2. Physicochemical characteristics of water – salinity, organic carbon, nitrogen, potassium, phosphorus, turbidity and pH.
3. Calculation of - Length weight relationship, gastrosomatic index and gonadosomatic index in IMC.
4. Estimation of muscle protein and lipid from IMC.

Paper Z406. Practical

Genetics Special

A. Recombinant DNA & Molecular Analysis

4. Probability in Mendelian Inheritance
    a. Chi-square, degree of freedom, test for Independence (contingency Chi square),
    b. Homogeneity Chi-square, Independent Assortment and probability(binomial expansion)
5. Genetic cross
6. Preparation of mitotic metaphase chromosome of rat.

B. Applied Genetics

1. Thin layer chromatography.
2. DNA isolation and Gel electrophoresis (from human blood and goat liver tissue)
3. Family pedigree analysis for autosomal /sex linked, dominant /recessive trait.
4. Isolation & purification of protein & characterization through SDS-PAGE

Practical Z406

Special Paper

1. Dissertation work
2. Field work & viva