

M.Sc. ZOOLOGY SEMESTER SYLLABUS 2007

<i>Semester I</i>	<i>Semester II</i>	<i>Semester III</i>	<i>Semester IV</i>
Z101 A. Non-chordates B. Chordates	Z201 A. Entomology B. Ethology	Z301 A. Computer application & Bioinformatics B. Bioinstrumentation	Z401 A. Animal Physiology B. Env. adaptation & Evolution
Z102 A. Biophysics B. Ecology	Z202 A. Histophysiology & Histochemistry B. Biosystematics	Z302 A. Biotechnology B. Environmental management & Biodiversity	Z402 A. SPECIAL Theo. B. SPECIAL Theo.
Z103 A. Microbiology B. Biostatistics	Z203 A. Molecular biology B. Parasitology	Z303 A. Developmental biology B. Environmental resource & pollution	Z403 A. SPECIAL Theo B. SPECIAL Theo.
Z104 A. Immunology B. Cytogenetics	Z204 Based on Z201 & Z202	Z304 A. Biochemistry B. Ecotoxicology	Z 404 Based on Z402
Z105 Based on Z101 & Z102	Z205 Based on Z203	Z305 Based on Z301 & Z302	Z405 Based on Z403
Z106 Based on Z103 & Z104	Z206 A. Database Development B. Field work	Z306 Based on Z303 & Z304	Z406 A. Dissertation work B. Field Work

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

M.Sc. ZOOLOGY SEMESTER MARKS DISTRIBUTION

SEM	Theory	Prac.
I	200	100
II	150	150
III	200	100
IV	150	150
Total	700	500

Z105 **Marks**

Non- Chordate & Chordate	15
Ecology	10
Biophysics	10
Viva	05
Internal assessment	10

Total	50

Z106

Cytology	13
Immunology	07
Microbiology	08
Biostatistics	07
Viva	05
Internal assessment	10

Total	50

Z204

Entomology	12
Ethology	07
Histology	10
Biosystematics	06
Viva	05
Internal assessment	10

Total	50

Z205

Molecular Biology	13
Parasitology	22
Viva	05
Internal assessment-	10

Total	50

Z206

Field Report	15
Field Viva	10
Database Development	25

Total	50

Z305

Marks

Computer application	15
Bioinstrumentation	10
Env. Management & Biodiversity	10
Biotechnology	
Viva	05
Internal assessment	10

Total	50

Z306

Developmental Biology	9
Biochemistry	9
Environmental Resource & Pollution	9
Ecotoxicology	8
Viva	05
Internal assessment	10

Total	50

Z404	Marks
SPECIAL PAPER	50 Each

Genetics & Mol.Biology

Probability Test	10
Genetic Cross	10
Mitotic Chromosome	15
Viva	05
Internal assessment	10

Fishery:

Identification	15
Dissection Major	10
Dissection Minor	05
Feed formulation	05
Viva	05
Internal assessment	10

Ecology:

Terrestrial Ecology	15
Wildlife	05
Mathematical Ecology	10
Molecular modeling	05
Viva	05
Internal assessment	10

Z405	Marks
SPECIAL PAPER	50 Each

Genetics & Mol.Biology

DNA Isolation & Gel Electrophoresis	15
SDS PAGE	10
Pedigree Analysis	10
Viva	05
Internal assessment	10

Fishery:

Water / Soil parameter	10
Biological estimation	15
Histological preparation	10
Viva	05
Internal assessment	10

Ecology

Aquatic Ecology	25
Human Ecology	10
Viva	05
Internal assessment	10

Z406

Special Paper

Dissertation / Review work	15
Dissertation / Review Viva	10
Field Report	15
Field Viva	10

Total	50

M.Sc. ZOOLOGY DETAILED SYLLABUS

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. Protochordates and the origin of craniates:
Origin of craniates, Evolution of primates with special reference to *Homo sapiens sapiens*. Echinoderms, Hemichordata, Urochordata, Cephalochordata, Endostyle and Iodine binding capacity. The Ammocoete: Vertebrate Larva, Relationship between Amphioxus & Vertebrates.
2. Fishes:
Taxonomy of Fishes, Inland and Marine fisheries of India, Problems & Prospects.
3. Muscles:
Function and gross structure; Fine structure, contraction and physiology; Categories of muscles; Evolution of muscles.
4. Energetics and Locomotion:
Terrestrial locomotion; swimming, flying, scaling of locomotory cost.
5. Migration of Birds:
Memory imprinting, Hormonal control, Homing, etc.
6. Respiratory system & Gas bladder:
General functional and requirements; ventilation of Internal gills; Agnathoxs, Cartilaginous fishes, Bony fishes, larval gills; arial respiration in long fishes; swim bladder and the origin of lungs, lung and other ducts, evolution.
7. 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.
8. Echolocation:
General consideration of organs of hearing balance and Echolocation; Morphological adaptation for echolocation. Bat Echolocation.

Paper Z102, Group A. **Biophysics**

1. Properties of matter:

- a. Diffusion (Fick's Law, Grahams Law, facilitated diffusion, factors affecting diffusion, biological applications)
- b. Viscosity (factors affecting viscosities of liquids, Poiseuille's law, biological application)
- c. Donnan-membrane equilibrium – (concept, factors affecting it, biological exception)
- d. Osmosis (Van't Hoff laws, determination of osmotic pressure, biological application of osmosis and toxicity).
- e. pH and buffers (pH and its biological significance Acid-base buffers of animal body fluids and their role in pH regulation).
- f. Colloids (sols, gels, emulsions, electrokinetic properties, swelling in, salting out, lyophilic and lipophobic sols, Biological significants of colloids adsorption – application).
- g. Dialysis (Hollow fibre dialysis, electro dialysis and biological application)

2. Thermodynamics

- i) Thermodynamic systems – isolated, close and open. First and second laws of thermodynamics, enthalpy and entropy, Biological steady state and its maintenance, Gibbs free energy.
- ii) Atomic absorption and plasma emission spectroscopy

3. Radioactivity

α , β , γ rays, half-life of radioisotopes, kinetics of radioactive decays, Geiger-Muller counter, Scintillation counter, Artificial radio isotopes, and their application in biology, Biological effect of radioactivity, carbon dating. Autoradiography, Cerenkov radiation, Radiation dosimetry.

4. Structure and organization of membranes, Glycoconjugates and proteins in membrane system, Model membranes, Liposomes, Ion-transport, Na^+/K^+ -ATP-ase, Molecular basis of signal transduction in bacteria and animals.

Paper Z102, Group B. Ecology

1. System Ecology

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

2. Community Ecology

Structure of biotic community: Abundance, frequency, relative abundance, dominance and dominance index, species diversity and evenness indices. α , β , γ diversity. Species diversity hypotheses, 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.

3. 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. Species abundance hypothesis: Random niche, niche preemption, lognormal hypothesis. Ecological guilds and ecological equivalents.

4. Population Ecology

Survivorship; Life table, fertility schedule. Reproductive strategies; semelparity, iteroparity, r & k strategies, population interactions- direct and indirect, positive and negative. Competition: interference, exploitation and apparent. Lotka-volterra model of competition and predator-prey interaction. Concept of metapopulation: Levine's model and Hanski's theory.

Paper Z103, Group A. Microbiology

1.
 - i) Microbial diversity in air, water & soil.
 - ii) Classification of microorganisms into major groups.
2. Morphology & Fine structure of Bacteria.
3.
 - i) General accounts of Algae, Protists & Virus.
 - ii) Distinguishing features of Fungi.
4.
 - i) Fundamental characters used in the classification & identification of microbes.
 - ii) Different types of bacteria.
 - iii) Growth, reproduction & metabolism in Bacteria: normal growth curve; methods of measuring growth; enumeration of bacteria in culture.
5.
 - i) Nutrition of microbes
 - ii) Principles behind formulating culture media
 - iii) Culture techniques; Pure cultures.
6. Role of microbes in the living world:
 - i. Microbes in mineral cycling.
 - ii. Microbes & decomposition – Petroleum formation
 - iii. Bacteriological evidence of pollution – Coliforms & BOD
 - iv. Microbes as pathological agents

Paper Z103, 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.

1. a) Cells and organs involved in Immune System.
b) Types of Immunity
2. a) Antigenicity and Immunogenicity
b) Concept of Epitope, Paratope, Agreptope
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) Vaccination
 - b) ELISA
 - c) Southern blotting hybridization
 - d) Western blotting hybridization

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 single 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. **Dissection of Invertebrate and vertebrate specimens**

a) Grasshopper - reproductive system

- b) Cockroach – stomatogastric Nervous system
 - c) Achatina – Reproductive system/Nervous system
 - d) *Sepia* – Digestive/Nervous system
 - e) Shark – V, VII, IX & X Cranial Nerves
 - f) Shark – Internal ear
2. **Preparation / Mounting / Staining**
- a) Sting apparatus of Honey bee.
 - b) Scales of shark/carp/Indian perch
 - c) Hyoid/Pecten of chick
 - d) Setae of Earthworm
 - e) Ink gland of *Sepia*
3. **Biophysics:**
- a) Determination of pH by
 - i. Colorimetric method
 - ii. Spectrophotometric method
 - b) Roll of buffer in living cells.
 - c) Determination of viscosity by viscometer
 - d) Atomic absorption
 - e) Spectroscopy – Demonstrative
4. **Ecology:**
- a. Determination of the minimum size and number of quadrat – Species area curve method.
 - b. Analysis of the structure of community in a grassland and in a community map: Abundance, Relative abundance, Frequency, Species diversity and dominance indices.
 - c. Estimation of alpha, beta and gamma diversity.
 - d. Estimation of primary productivity, conductivity, pH and hardness of water.
 - e. Preparation of Life Table and survivorship curve construction.

Practical Paper – Z106

1. 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.

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. Immunology:

- a. Study of macrophage.
- b. Study of phagocytosis.
- c. Determination of human blood group

4. Cytogenetics:

- a. Life cycle of *Drosophila*.
- b. Study of different mutant of *Drosophila*
- c. Study of polytene chromosome of *Drosophila*.

SEMESTER II

Paper Z201, 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; Insects causing damage to forest trees – Forest entomology, Household pests – termites, cockroaches, crickets, ants, wasps, silverfish; Integrated approach to pest management.
4. **Aquatic insects** – Diversity in freshwater and marine insects, adaptation – water balance and osmoregulation, tracheal system and gas exchange, 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.
7. **Medical Entomology** – Insects as vectors of diseases and their control, Pests of public health, importance and their control – mosquitoes, house flies, sand flies, eye flies, lice, bed bugs, fleas. Insect borne diseases of man – Typhus, yellow fever, dengue fever, encephalitis, plague, leishmaniasis; insects of forensic importance.

Paper Z201, Group B. Ethology

1. Innate and Learned behaviour

Approaches in behavioural studies: observational, experimental and ethological. Types of behaviour: Taxis and kinesis, Fixed Action Pattern, selfish, altruistic, cooperative, spiteful. Neural control of behaviour. Stimulus: motivational, releaser and terminating, Hierarchy of drive. Learning: Habituation, extinction, instrumental learning, operant conditioning, insight, insprinting.

2. Maintenance and defence behaviour

Body care, comfort movement, anting. Habitat selection: types of cover, basis of habitat selection, limiting effect of resource on habitat selection. Primary and secondary defence mechanisms, individual and social strategies, agonistic reactions, conflict in mind, flight and charge distance. Home range and territory, types of territory, territoriality.

3. Social behaviour

Social dominance, hierarchy and peck order, factors associated with social dominance. Evolution of ensocial organization, cooperative social groups. Altruism and Kin selection. Hamilton's rule, coefficient of relationship, reciprocal altruism, Advantages and disadvantages of living in groups. Evolution of social behaviour, optimization theory, game theory, Evolutionarily Stable Strateg.

4. Reproductive behaviour

Mating types, Sex ratio: causes of tilt in operational sex ratio. Sexual selection. Male rivalry, female choice, epigamic qualities, various hypothesis explaining sexual selection. Sexual dimorphism. Domestic bliss situation of Dawkin.

Paper Z202, Group A. Histophysiology and Histochemistry

1. Basics of Histological staining

- (Principles, classification, dyes of different origin, mordant)
2. Histomorphology of the following mammalian tissues (structure and function)
 - a. Skin
 - b. Eye
 - c. Prostate gland
 - d. Uterus
 - e. Gall bladder
 - f. Mammary gland
 3. The chemistry and practice of fixation (Principles, classification, purpose of fixatives, common fixatives).
 4. Enzyme as histochemical reagents.
 5. Quantitative Histochemistry / Immunocytochemistry.

Paper Z202, Group B. 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, Intraspecies 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:** absed 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 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. 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 helminth cuticle.
7. Vector biology special reference to mosquito/Sand fly/ticks.

Practical Paper Z204

A. Ethology:

1. Preparation of behavioural catalogue and Ethogram.
2. Study of behavioural modification of legs in honey bee.
3. Study of castes in a eusocial insect.

4. Study of sex ratio.

B. Histophysiology & Histochemistry:

1. Preparation of mammalian tissues for histological work and tissue identification (from mammalian organ system).
2. Cell diameter measurement using ocular and stage micrometer.
3. Use of camera lucida for morphograph preparation.
4. a) Localization of acid alkaline phosphatase in cell or tissue.
b) PAS
5. Cryotomy/ cryo-sectioning

Practical Paper Z205

A. Molecular Biology:

1. Isolation & purification of DNA from Human blood.
2. Principle & method of Agarose Gel Electrophoresis

B. Parasitology:

1. Smear preparation and staining of rectal content of *Bufo sp.*
2. Preparation and staining of blood parasite from pigeon blood.

3. Identification:

Plasmodium sp., Leishmania sp., Ascaris sp., Fasciola sp., Paramphistomum sp., Anopheles sp., Culex sp., Columbicola sp., Pediculus sp., Cimex sp.

4. Submission of prepared slides

Paper Z206.

A. Database development

B. Field work

SEMESTER III

Paper 301, Group A. Computer application and Bioinformatics

1. Basic concepts about computers:

- a. Definitions of Software and Hardware.
 - b. Brief idea of Windows and their applications.
2. Basics of computer architecture:
 - a. Central processing unit, peripheral and network devices.
 - b. Fundamentals of using a computer and performing operations.
3. Concepts about Number systems:
 - a. Binary, Octal and Hexadecimal data representation.
 - b. Complement system.
4. Basics of computer languages:
 - a. Machine language.
 - b. Assembly language.
 - c. High level language.
5. Basics of programming with C or BASIC.
6. Knowledge of Internet connectivity and access.
7. Computer graphics for solving zoological problems
8. Application of Software packages:
 - a. Microsoft word
 - b. Microsoft excel
 - c. Microsoft PowerPoint
 - d. Any other useful programs
9. Bioinformatics:
 - a. Biological Database - its types and examples
 - b. Bioinformatics Tools
 - c. Applications of Bioinformatics

Paper 301, Group B. Bionstrumentation

1. Basic concept of biomolecules, Principles and applications of gel-filtration, ion-exchange and affinity chromatography, Thin layer and gas chromatography, Electrophoresis, cell fractionation, ultracentrifugation.

2. Principles of biophysical methods used for analysis of biopolymer structure, fluorescence, UV, ORD/CD, Visible, NMR and ESR spectroscopy, hydrodynamic methods.
3. Advanced Microscopy: Light microscopy, Phase contrast microscopy, Fluorescence Microscopy, Scanning electron microscope (SEM), transmission electron microscope (TEM), Electron probe microscopy– Basic principle, physics, application.
4. X-ray structure analysis
 - i. X-ray diffraction
 - ii. Fourier transformation and X-ray crystallography.
 - iii. X-ray scattering
 - a) Small angle X-ray scattering (SAXS)
 - b) X-ray back scattering.

Paper Z302, Group A. 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. Integration of different rural biotechnological tools – Livestock management, Artificial insemination and Embryo transfer, Cryopreservation, beeculture, sericulture, vermiculture, poultry, duckery, Fishery.
- 5. Biopesticides and biofertilizer – types, sources and mode of action, composting, solid waste recycling.
- 6. Microbial fermentation. Role of microbes in manufacture of industrially important products.

Paper Z302, Group B. Environmental Management & Biodiversity

- 1. **Environmental degradation and conservation:** Environmental degradation; resource depletion and sustainable development, Environmental Kuznets curve, indicator of the quality of life. Objective of conservation, World Conservation Strategy.
- 2. **Environmental Management and Acts:** Environmental Impact Assessment: Definition; Types of EIA, EIA process and methodologies – scoping, focusing, prediction, evaluation,

mitigation, evaluation and monitoring; Socioeconomic impact assessment; Landscape impact assessment EIA Notification. Environmental Management, Steps of Management, Environmental Acts of India and their effectiveness.

3. **Biodiversity and Biomonitoring:** Utility and concept of biodiversity. CBD, Megadiversity countries, biodiversity hotspots, Estimating biodiversity, biodiversity indices. Bioindicator of the quality of environment. Types of indicator species, use of biodiversity indices in biomonitoring.
4. **Extinction and Conservation of Biodiversity:** Types of extinction, causes and rates of extinction. Conservation of biodiversity. IUCN categories of Protected Areas.

Paper Z303, Group A. Developmental biology

1. **Induction:** Primary and secondary induction of the organizer, organizer concept, diffusible protein of the organizer. The functioning of Nieukoop 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 Z303, Group B. Environmental resource & Pollution

1. **Resource:** Classification – renewable and non-renewable, conventional and nonconventional; mineral resources and trends of their exploitation; energy resource – fossil fuels, nuclear fuels, geothermal energy, hydroelectric power.
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 climatic change, 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; waste water management.
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.

Paper Z304, Group A. Biochemistry

1. **Protein Structure:** Primary, secondary, tertiary and quaternary structures and the bonds holding them.
2. **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.

3. **Biological Oxidation:** Redox potential, mitochondrial electron carriers, the respiratory chain (electron transport chain); Mitchell's chemiosmotic theory of oxidative phosphorylation; FoF, ATPase
4. **Lipid Metabolism:** denovo synthesis of fatty acids, microsomal fatty acid elongase & desaturase systems; oxidation of saturated fatty acids and unsaturated fatty acids.
5. **Protein metabolism:** deamination, transamination, ammonotelism, ureotelism, uricotelism, formation of urea, formation of specialized products from amino acids: catecholamine, serotonin, melatonin, glutathione, T₃, T₄.
6. **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 Z304, Group B. Ecotoxicology

1. **Xenobiotics**

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

2. **Toxicity test & bioassay**

LC₅₀, LD₅₀, Dose response curve; Biotransformation, Bioaccumulation & Biomagnification of Xenobiotics 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 Contamination 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.

Practical Paper Z305

1. **Computer Application:**

- a. Basic computer operations.
- b. Printing of programs and results.
- c. File management.
- d. Programming with C or BASIC
- e. Computation and presentation of data through computer graphics (MS Excel, etc.)
- f. Use of software packages.
- g. Preparation of a web page.
- h. Biostatistical analysis of data

2. **Bioinstrumentation:**
 - a. Paper chromatography.
 - b. Thin layer chromatography (TLC)
 - c. Crystal preparation
 - d. Sample preparation for SEM (Invertebrate/Vertebrate)
 - e. Photomicrograph analysis
 - f. Visit to: RSIC/SIF (any one) (IIT Kgp, Bose Inst., S/NP, IACS, Kolkata etc.)

3. **Environmental management & Biodiversity**
 - a. Estimation of biodiversity indices.
 - b. Study of bioindicators.
 - c. Preparation of environmental inventory.

Practical Paper Z306

1. **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.

2. **Environmental resource & pollution:**
 - a. Estimation of noise level.
 - b. Estimation of heavy metals.
 - c. BOD and COD estimation.

3. **Biochemistry:**

4. **Ecotoxicology:**

SEMESTER IV

Paper Z401, Group A. Animal Physiology

1.
 - i) General account of Invertebrate & vertebrate hormones
 - ii) Mechanisms of Hormone action
 - iii) Hormonal imbalances
2.
 - i) Genesis of membrane potential & action potential
 - ii) Function of voltage-gated in channels
 - iii) Synaptic transmission
 - iv) Neurotransmitter function
3. Animal Nutrition
 - i) Role of vitamins in metabolism
 - ii) Physiological roles of minerals – Na, K, Ca & P.
4. Homeostasis – neural & hormonal
5. Neuroendocrine integration – hypothalamic connections
6. Cardiac cycle, regulation of heart pumping control of excitation & conduction in heart, Control of cardiac output.

Paper 401, Group B. Adaptation & Evolution

1. Basic concept regarding environmental stress & response of an organism.
2. Thermoregulation in animals.
3. Respiratory environments – O₂ Physiology of diving mammals.
4. Water & salt Physiology of animals in relation with their environments.
5. Neo-Darwinism
 - 5.1 Hardy-Weinberg law of genetic equilibrium
 - 5.2 A detailed account of destabilizing forces; (i) Natural selection (ii) Mutation (iii) Genetic drift (iv) Migration.
6. Molecular phylogenetics
 - 6.1 How to construct phylogenetic trees
 - 6.2 Phylogenetic inference-Distance methods, parsimony methods, maximum likelihood method
 - 6.3 Immunological techniques
 - 6.4 Amino acid sequences and phylogeny
 - 6.5 Nucleic acid phylogeny, DNA-DNA hybridizations, restriction enzyme sites, nucleotide sequence comparisons and homologies
 - 6.6 Molecular clocks
7. Evolution and tinkering

Ecology Special Paper

Paper Z402, Group A. Terrestrial Ecology and Mathematical Ecology

1. **Major terrestrial biomes** - Global Forest Types. Forest profile of India: Forest types in India. Goods & produces of forest threat to forest deforestation & reforestation. Plantation: Joint Forest Management.
2. **Structure and function of tropical forest ecosystem** - Vertical stratification of plants and animals; production and nutrient cycling; types of humus, leaf litter decomposition.
3. **Soil as a habitat** - classification of soil fauna; ecological importance of soil fauna, role of soil fauna in energy flow and nutrient cycling; effect of human activities on soil fauna.
4. **Major soil types**; Physico-chemical properties of soil with special reference to texture, structure, moisture, temperature, organic carbon, pH and NPK. Pedogenesis with special reference to the role played by soil biota.
5. **Mathematical Ecology**: Basic concept of ecological modeling; Deterministic and Stochastic models; Theoretical model and analytical solution. Chaos, local and global stability. Static model – Network analysis / simulation; Elements of network – flows and vectors. Construction of matrix and vector from food web, matrix manipulation. Dynamic and structural dynamic modeling – elements of dynamic models. Difference of dynamic and structural dynamic tool, ecosystem theories and their application in structural dynamic models.

Paper Z402, Group B. Wildlife and Molecular Ecology

- 1. Conservation of wildlife** - IUCN Red List Category Version 3.1; Threat Authority File Version 2.1. Size and design of Natural Reserves. Wildlife crime, Wildlife trade, Threats to wildlife conservation.
- 2. Conservation Status** - Critically Endangered Vertebrates of India with special reference to West Bengal. Population status feeding of breeding, main threats and conservation of Elephant and Tigers.
- 3. Endemic Wild Avifauna** – Different categories of birds in respect to different habitats – aquatic birds – swimming in the sea, long legged wading birds of woodland and garden. Endemism and species turnover with elevation in mountain avifauna – implications for conservation. 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. Conservation and management of endangered birds. Bird's census techniques – point count.
- 4. Different tools and techniques for Wildlife Census and survey:** Mapping, transects – line and point transects, counting roosts and flocks, counting leks and migrants; Radio telemetry, capture – recapture, Band recovery, Radio-tagging, pugmark census, GIS.
- 5. Island Biogeography** - Patterns of Spatial distribution - Random, contagious and regular, coefficient of dispersion. Theory of island biogeography; Relationship between immigration, extinction, size, proximity of island and number of species in an island.
- 6. Molecular ecology** – Genetic diversity in natural population, Heterozygosity, Allozyme electrophoresis., Polymerase chain reaction, DNA sequencing, Coding and Non-coding DNA and DNA sequencing, Genetic manipulation in molecular ecology, Genetically modified organisms and its impact on environment. Metapopulation molecular genetics in Conservation Biology - DNA fingerprinting and its role in Wildlife conservation. Molecular markers, different types and their role in conservation ecology. Fundamental elements of phylogenetic models – Genomes and evolutionary relationships.

Paper Z403, Group A. Human Ecology

- 1. Human Population :** Human population growth, causes, effects and future, Doubling time, Total fertility rate, zero population growth and replacement fertility, Development and population: Demographic transition.
- 2. Global Environmental Issues:** Nature, Culture and Environmental changes, Agent and processes. Environmental change in postglacial period, prehistoric communities as agent as Environmental change, Environmental change in the historic period after 1700 industrialization – Global warming – climate change; Acid rain; Stratospheric ozone layer destruction; Thermal Inversion – Smog, Point and Non-point pollution – fertilizers and pesticides.
- 3. Solid waste recycling:** Agriculture, Municipal, Biomedical Wastes – nature, source, environmental impact and management.
- 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; Ecodevelopment, Sustainable utilization of bioresource and rainwater harvesting.
- 6. Restoration Ecology:** Definition, Philosophy and rationale for ecorestoration, Ecological restoration and sustainability, Process of ecorestoration – in the context of landscape (forest, wetland, rivers) to species level (aquatic plants and invertebrates, fishes, reptiles, amphibians, birds and mammals).
- 7. Ecotourism:** Definition, sustainable development and ecotourism, Foundation of ecotourism, Tourism policy, Economics and management issues, merits and demerits.

Paper Z403, 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.
2. **Structure and function of aquatic ecosystems and their management : -**
 - a) **Marine Ecosystem:** Origin, extent and zonation of sea, physical properties and physical processes, chemical composition, behaviour and fate, biological components and their interactions.
 - b) **Coastal Ecosystem:** Definition, extent and types, zonation and geomorphological features, significance, human induced problems, global and marine diversity, integrated coastal zone management – biodiversity conservation, recovery, restoration and rehabilitation practice.
 - c) **Estuarine Ecosystem:** Definition, classification, structure – biotic assemblage and their interactions, function, estuarine pollution – non point and point pollution (sewage, diffuse source of nutrients; organic enrichment, Industrial contamination) management strategies – human induced changes, their monitoring and control.
 - d) **Mangrove Ecosystem:** Definition; speciality of this ecosystem; structure and function with special reference to Sundarbans, India; Problems and Management.
 - e) **Coral Ecosystem:** Definition, types and distribution, speciality with regard to biodiversity, productivity and ecosystem functioning, problems and management.
 - f) **Wetland Ecosystem:** Definition, distribution, causal factors, wetland classification, zonation and succession, significance and values, Ramsar sites in India; wetland restoration, conservation and management.
 - g) **River Ecosystem:** Fluvial hydrosystem approach; catchment size and drainage basin from selected major rivers, hydrochemical dynamics, biological productivity, human impacts and management perspective.
 - h) **Lakes:** Definition, classification based on trophic status; origin and mixing patterns; thermal stratification; types and its seasonal dynamics.
3. **Aquatic biota, types and trophic interactions** – Macrophytes, phytoplankton, zooplankton, periphyton, benthos and nekton. Threats to Marine Biological Diversity – nutrient over-enrichment and consequences of bioinvasions.
4. **Waste water management** – types, source, physical-chemical properties, recycling and bioremediations.
5. **Biotic interactions** – Global marine diversity and threats to fishes (finfishes and shellfishes), marine mammals, seabirds and sea turtles, invertebrates and plants – conservation biology – the global strategy, Existing Marine Institutions; sustainability indicators and sustainable management of aquatic bioresources.

Practical Z404

1. Estimation of colour, bulk density, particle density and porosity, water holding capacity and pH of soil.
2. Mechanical analysis of soil
3. Estimation of soil temperature
4. Estimation of organic matter of soil
5. Estimation of the moisture content of soil
6. Measurement of intensity of light
7. Preparation of Climograph
8. Study of soil and litter biota
9. Documentation of seasonal occurrence of common insects, birds, reptiles, amphibia and mammals in the University campus- collection and preservation.
10. Construction – structural and non-structural ecological models based on raw data supplied
11. Use of GPS.
12. Estimation of the degree of faunal similarity, association between species and microdistribution pattern.
13. Molecular analysis – Isoenzyme.
14. Submission of Laboratory notebook and internal assessment.

Practical Z405

1. Estimation of transparency, TSS, TDS, salinity and alkalinity of water.
2. Estimation of chlorophyll and N, P, K content of water.
3. Basic principle pertaining to acid digestion for the estimation of heavy metals.
4. Collection, preservation, identification and analysis of aquatic biota – phytoplankton, zooplankton, benthos, periphyton, aquatic insects, nekton, and macrophytes.
5. Analysis of biota from urban waste materials & identification of suitable specimen for vermicomposting.
6. Submission of Laboratory notebook and internal assessment.

Practical Z406

- A. Dissertation work
- B. Field work & viva

Special Paper: Genetics & Molecular Biology

Paper 402, Group A. Molecular Biology

1. Organisation of the eukaryotic genome:

Chromatin remodeling, histone modification-acetylation, methylation, euchromatin & heterochromatin, Centromeric & Telomeric DNA, Unique-Sequence and Repetitive-Sequence DNA, The C-Value paradox, Yeast Artificial Chromosomes (YACS).

2. Genetics of Cancer:

Relationship of the cell cycle to Cancer, The Two-Hit Mutation Model for Cancer, DNA Tumor Viruses, Tumor Suppressor Genes, Genetics of the Human RB Tumor Suppressor gene and p53 Tumor Suppressor gene, Breast Cancer Tumor Suppressor gene.

3. Eukaryotic transcription Complex:

Conserved sequences & transcription factors initiating transcription, Enhancers, Response elements, Transcription factors recognize consensus sequences in Promoter and enhancer, TF has motifs that bind DNA, Zinc finger motif, homeo domain, Leucine Zipper, RNA pol III having downstream promoter.

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.

Paper 402, Group B. Genetics

1. **Genetic fine structure:**

Deletion mapping, Complementation, fine structure mapping, Fine structure of genes and 'Complex loci' in Eukaryotes.

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.

3. **Bacterial Genetics:**

Transduction – generalised transduction & specialised transduction.

4. **Sex determination 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 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. **Gel Electrophoresis and Protein blotting:**

Gel electrophoresis of DNA, Gel electrophoresis of proteins (SDS PAGE & native PAGE), Western Blotting techniques for the analysis of Proteins, Protein Sequencing and peptide characterization (MALDI-TOF)

3. **DNA, RNA and DNA Sequencing:**

Southern Blotting and Analysis of DNAs, Analysis of RNA by Northern Blot;, Sanger Dideoxy Sequencing, 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, siRNA technology, 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 (lamda light Chain) gene, The IGHG 1 (heavy Chain) gene, Autoimmune disease, Immune deficiencies, Antibodies as tools in Genetics Research – Monoclonal Antibody, Immunofluorescence

2. **Genetic diversity:**

Genetic erosion, Conserving Genetic Resources, Measuring genetic variation at the protein level and at the DNA level.

3. **The Human Genome Initiative:**

Human Chromosome mapping, Human Genome Sequencing and data management.

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.

Practical Z404

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. Genetic cross

3. Preparation of mitotic metaphase chromosome of rat.

Practical Z405

1. Thin layer chromatography.

2. DNA isolation and Gel electrophoresis (from human blood)

3. Family pedigree analysis for autosomal /sex linked, dominant /recessive trait.

4. Isolation & purification of protein & characterization through SDS-PAGE

Special Paper: Fisheries

Paper 402, Group A. Fish Taxonomy and Fish Biology

1. **Classification of fishes:** Principles and characters of principal subdivisions up to orders (living & extinct).
2. **Principles of fish growth:** Growth curve, environmental factors (biotic & abiotic) and growth, hormonal enhancement of growth, growth in relation to rations and age.
3. **Nutrition:** Physiological roles of nutrients. Food and feeding habits of freshwater fishes, prawn, mussel and oyster. Nutritional Bioenergetics. Nutrient requirements (Protein, lipids, carbohydrates, minerals and vitamins) for various growth stage of Indian major corps and prawns. Conventional and non-conventional feed resources. Presence of anti-nutritional factors and their removal procedures. Supplementary feed: Kinds of supplementary feeds, Composition and nutrient source, Feeding frequency, Formulation and processing of feeds. Storage and quality control of feeds, Feed dispensing method. Live feed culture, Chemical composition and nutritional value of fish.
4. **Immunodefence:** Electroreception, bioluminance and immunodefence system in fish.
5. **Structure and physiology of endocrine glands:** pituitary, thyroid, gonad, adrenal and others.
6. **Fish migration:** homming, territorial recognition, hormonal control of migration, dams and their effects on fish migration.
7. **Fish reproduction:** types, structure, fecundity, maturity stages and strategies of reproduction, reproductive cycles, breeding habits, and parental care.
8. **Embryonic development:** Fertilization, hatching, metamorphosis.

Paper 402, Group B. Aquaculture and fish technology

1. Aquaculture: Principle, scope & planning; different aquaculture systems (cage culture, pen culture, running water culture etc.); culture of different fishery resource – sea bass, tilapia, hill stream fishes, air breathing fishes, frog, prawn (fresh water and marine water), pearl oyster, mass culture of fish food organism, principles and practices of brackish water aquaculture (bheri, bhasabada fishery) etc.
2. Organic aquaculture: Global scenario, problems and prospects in India
3. Preparation and management of nursery, rearing, stocking ponds; fish pond design criteria, selection of site, and construction of brackish water farm; controls of weeds, pest and predators; fish toxicants, pond manuring, control of aquatic insects and their management.
4. Integrated fish farming system: evolutionary stages in farming system, integrated crop/live stock/fish farming, principles of fish marketing, export and import of fisheries products.
5. Fish breeding: brood fish care, selective breeding, natural breeding, neurohormonal control of breeding, environmental control of spawning; hypophysation, breeding technique, bandh breeding, cryopreservation of eggs and sperms.
6. Transgenic techniques applied in aquaculture, problems and prospects.
7. Fish disease: Important fish diseases, causative agents, symptoms and their control.
8. Fishing methods: onshore facilities for marine fisheries, harbours, landing centres, indigenous crafts, design of fishing crafts, mechanisation of fishing boats; gear, deep sea fishing float, common gear, gear fabrication, net design, gill net, shore seines, purse seines; trawling, regulation for fishing gears. Indian fisheries Act, 1976.
9. Harvesting: port harvesting activities in India, fish processing – freezing, canning, smoking, pickling, processing plants.
10. Fish by product: fish meal, fish oils, fish protein concentrates (FPC), and other by-products.
10. Fisheries extension: objectives and principles, role of extension education in community development, fisheries as a tool in rural development.

Paper 403, Group A. Limnology and Oceanography

1. **Inland water bodies:** Distribution of fresh waters, hydrological cycle – run off flow and global water balance, lentic and lotic systems, their physical and chemical characteristics; wetlands – classification, values and conservation strategies.
2. **Biotic community of lentic systems:** Classification, common planktonic forms and their seasonal dynamics; periphyton, macrovegetation, benthic community and microflora of sediments, adaptive modification of organisms of lotic system.
3. **River and Streams:** Definitions, characteristics, total distribution environmental status and role, factors governing trophic structure, physical-chemical-biological processes and interactions within biological communities.
4. **Lakes:** Origin, classification, zonation and the role of light, thermal stratification, role of eutrophication in changes of lakes' biological productivity.
5. **Geological oceanography:** Horizontal and vertical zonation continental margin, continental shelf and abyssal plain; coastal zones, estuaries, lagoons, delta, upwelling and outwelling, backwater and brackish water, Exclusive Economic Zone (EEZ) and its fishery potentiality.
6. **Physical oceanography:** Physical properties (salinity, density, heat storing capacity and temperature) and physical processes (oceanic circulation, tides and upwelling) of ocean, origin, dimension and depth of oceans.
7. **Chemical oceanography:** Composition of sea water – their distribution, fluctuation and characteristics.
8. **Biological Oceanography:** Biotic community of ocean – their classification, distribution, seasonal dynamics and trophic interrelationships with special reference to zooplankton, benthos and mangrove ecosystem.

Paper 403, Group B. Inland and Marine fisheries

1. Inland and marine fishery resources of India: major culturable and capturable fishes of India, problems and potentials.
2. Reservoir fishery:
Definition, common Indian reservoirs, Eutrophication in reservoir, exploitation of reservoirs, conservation and management, Reservoir system in abroad.
3. Estuarine and backwater fishery:
Ecological classification of Major estuaries of India, Distribution of resident species, case study. Notes: Lagoon, Mangrove environment.
4. Coastal fishery:
General concept, recent development in coastal fishery, Coastal Regulation Zone (CRZ), Coast Guard Act, 1978, EEZ, PFZ.
5. Marine resource:
Important marine resource, Pelagic Fisheries, Demersal Fisheries, Inshore fisheries, Offshore fisheries, Methods of exploitation, Causes of spoilage, Fisheries of important species.
6. Problem and prospects of marine fisheries in India, their exploitation, management and conservation in global perspective.
7. Taxonomy, biology, distribution, seasonal abundance and productivity of some important marine and estuarine fin and shell fishes - Oil sardine, Mackerels, Indian Shad, Crustaceans: (crabs and lobsters), Molluscs: (Bivalves and Cephalopods)
8. Remote sensing:
General idea, Remote sensing system, sensors, Data analysis, Data interpretation, Fisheries applications
9. Sewage feed fisheries
Sewage/Sludge, chemical characteristics, Treatment of Sewage, Ecological engineering in sewage fed Fisheries, Public Health Sewage Fishery, Sewage Water recycling.
10. Fishery planning, economics, export and extension Aquaculture Policy and Planning in India-Basic Idea, Theory of Production, law of diminishing return, risk and profits in fisheries, fishery cooperative, export, extension (brief idea).

Practical Z404

1. Identification of Indian common fish faunal resources from cold water, warm water, brackish water and marine water.
2. Identification of freshwater & brackish water/marine water prawn & shrimps, mussels and oysters.
3. Identification of fresh water/marine water aquatic macrophytes.
4. Fish food organisms (Natural): Phytoplankton and Zooplankton of Midnapore and adjoining areas.
5. Aquatic insects.
6. Formulation and preparation of artificial fish food for Indian major carps & prawns.
7. Gut content of herbivorous fish & carnivorous fish.
8. Urinogenital system of *Ophiocephalus*, *Tilapia*, *Anabas*, *Clarias*, *Heteropneustes*, *Labeo* etc.
9. Accessory respiratory organ of *Ophiocephalus*, *Anabas*, *Clarias*, *Heteropneustes* etc.
10. Egg production (fin fish) in *Ophiocephalus*, *Clarias*, *Tilapia*, *Labeo* etc. (Fecundity estimation).
11. Submission of Laboratory Note Book.. .
12. Viva-Voce

Practical Z405

- 1.. Analysis of physicochemical characteristics of water – salinity, conductivity, chloride, turbidity, nutrients (NPK) and primary productivity.
- 2.. Analysis of physicochemical parameters of soil – pH, organic carbon, nitrogen, potassium and phosphorus.
- 3.. Length weight relationship of at least three fishes.
- 4.. Gastrosomatic index of at least five fishes.
5. Weberian ossicles of Indian major carps.
6. Gonadosomatic index of at least five fishes.
7. Preparation of fish by-products
8. Histological preparation of scales/ovary/testis/kidney/ hepatopancreas etc.
9. Estimation of muscle protein & lipid from Indian major carps.
10. Submission of Laboratory Note Book..
11. Viva-Voce

M.Sc. ZOOLOGY

SEMESTER SYLLABUS

2007-2008

VIDYASAGAR UNIVERSITY