

VIDYASAGAR UNIVERSITY
DIRECTORATE OF DISTANCE EDUCATION

Midnapore - 721102



SYLLABUS
for the
MASTER OF SCIENCE
Course of Study
in
ZOOLOGY

M. Sc. Fart - I : ZOOLOGY

Theoretical (300 marks)

Paper- I : Gr.- A. Unit- I : 25 marks : Non-Chordates

Paper- I : Gr.- A. Unit- II : 25 marks : Chordates

Paper- I : Gr.- B. Unit- I : 25 marks : Applied Zoology

Paper- I : Gr.- B. Unit- II : 25 marks : Biosystematics

Paper- II : Gr.- A. Unit- I : 25 marks : Cytogenetics,

Paper- II : Gr.- A. Unit- II : 25 marks : Molecular Biology &
Biotechnology

Paper- II : Gr.- B. Unit- I : 25 marks : Histology & Physiology

Paper- II : Gr.- B. Unit- II : 25 marks : Biophysics & Biochemistry

Paper- III : Gr.- A. Unit- I : 25 marks : Ecology

Paper- III : Gr.- A. Unit- II : 25 marks : Ethology

Paper- III : Gr.- B. Unit- I : 25 marks : Immunology

Paper- III : Gr.- B. Unit- II : 25 marks : Biostatistics

Practical (200 marks)

Paper- IV : Based on paper- I : 70 Marks including excursion report

Paper- V : Based on paper- II : 65 marks

Paper- VI : Based on paper- III : 65 marks

M. Sc. Part - I: ZOOLOGY

Paper - I : Group - A : Unit - I : 25 Marks

(Non-chordate)

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 life cycle ; role of nematodes in ecosystem.
4. Bryozoa - anatomical peculiarities, feeding mechanisms and phylogenetic relationship.
5. Rotifera - general organisation, mastax, reproduction and cyclomorphosis.
6. Conservation of invertebrates : approaches and setting priorities - invertebrate diversity, importance and threats.

Paper - I : Group - A : Unit - II : 25 Marks

(Chordate)

1. Classification of fishes : principle of classification, extinct fish group, detailed study of major fish orders with examples.
2. General structure of endostyle and iodine binding in lower chordates.
3. Origin, evolution and distribution of Primates with special reference to India.
4. Migration of fishes and birds.

5. Functional anatomy of organs of excretion and osmoregulation.
6. Evolution of urinogenital system with special reference to the separation of the two systems.
7. Anatomy of respiratory organs.
8. General considerations of organs of hearing, balance and echolocation.
9. Structure and modification of jaw suspension.
10. Integument, epidermal glands in tetrapods, hair, horn, claw, nail and hoof.

Paper - I : Group - B : Unit - I : 25 Marks

(Applied Zoology)

1. General characters and classifications of Insects up to order ; insects' digestive system with special emphasis to midgut, filter chamber and peritrophic membrane ; insects' neuro-endocrine system, integument, moulting and metamorphosis.
2. Biology, nature of damage and control of insects' pests (jute, cashew, betelvine and stored grains) ; integrated approaches to pest management.
3. Social organization of termites ; prospects and problems of sericulture in drought prone lateritic tracts ; modern technologies - in apiculture.
4. Biofertilisers with special emphasis to vermitechnology.
5. Concept of capture and culture fisheries ; inland and marine fisheries of fin fishes and shell fishes - present status and prospect.

Paper - I : Group - B : Unit - II : 25 Marks.

(Biosystematics)

1. Principle of taxonomy as applied to the systematics and classification of animal kingdom.
2. Basic rules of nomenclature (as per ICZN).
3. Type concept : holotype, paratype, syntype etc.
4. Species concept : biological species, sibling species, allopatric species, sympatric species.
5. α , β , γ taxonomy and key to the identification.
6. Trends in modern biosystematics : morphological approach, immature stages and embryological approach, ecological approach, behavioural approach, cytological approach, biochemical approach, numerical approach, differential systematics.
7. Importance of taxonomy in applied biology : agricultural and forestry, biological control, public health, wild life management, national defence, environmental problems, soil fertility, mineral prospecting, quarantine, commercial application.

Paper - II : Group - A : Unit - I : 25 Marks

(Cytogenetics)

1. Recombination in bacteria : Sexual conjugation, the F factor, conjugation mapping, recombination mapping, the F factor and sexduction, specialized transduction, episomes and plasmids.
2. Genetic fine structure : The rII locus, complex loci,

complementation mapping, deletion detection and deletion mapping, rII fine structure.

3. **Gene frequencies and equilibrium** : Gene frequencies, gene pool, attainment of equilibrium at two loci, codominance in natural population, dominance in natural population, sex linkage in natural population.
4. **Mutation and DNA repair mechanism** : Ionizing radiation, Chemical mutagen, ultraviolet irradiation, DNA repair, target hypothesis.
5. **Genetic code** : The triplet code, overlapping genes & reading frame, universal code, degeneracy of code, Wobble hypothesis.
6. **Transposable elements** : Mobile elements in bacteria and eukaryotes : insertion sequence, simple and composite transposon, structure of TN3 and TN 10, cointegrate structure, several types of transposable elements in *Drosophila melanogaster*, AC-DS element, RNA dependent transposition.
7. **Cancer** : Oncogene, protooncogene, tumorigenic virus, provirus and distinguish between V-src and C-src. structure and function of various sarcoma virus, structure and function of SV40 and polyoma virus, philadelphia chromosome.
8. **Cell cycle** : Anaphase movement is diphasic, mitotic apparatus.
9. **Polytene chromosome** : Structure and function.

Paper - II : Group - A : Unit - II : 25 Marks

(Molecular Biology)

1. Nucleosome particle and the structure of chromatin.

2. **DNA replication** : Semidiscontinuous DNA synthesis, single replicon & multiple replicon, oriC, enzymatic apparatus for DNA replication, topology of DNA.
3. **Constitution of eukaryotic genome** : C - value paradox, non repetitive and repetitive DNA sequences, satellite DNA, the Alu family.
4. **Production of template** : The basic transcription apparatus; sigma factor and core enzyme. structure of promoter, inhibition of transcription, elongation and termination.
5. **RNA processing** - mechanism of RNA splicing, basic differences between hnRNA and mRNA.
6. **Protein synthesis** : A special inhibitor tRNA, inhibition complex, activation of amino acid, factor involved in initiation, elongation and termination.
7. **Control of prokaryotic gene expression** : The lactose operon ; lactose & allolactose, promoter under positive control, operon under negative control, genetics of lac operon.
8. **Genetic engineering** : Plasmid, engineering the plasmid, getting plasmid into the bacteria, screening the bacterial colonies hybridization, making a probe, cloning and gene libraries.

Paper - II : Group - B : Unit - I : 25 Marks

(Histology and Physiology)

Histology

1. **Fixation** : General principles and purpose : classification and properties of fixatives ; composition and mechanism of actions of common fixatives.

2. **Biological Staining** : General principles and purpose ; chromogens and auxochroms ; dye diversity ; special shift ; physical & chemical classification of dyes, vital dyes, nomenclature of dyes, dyes of different origin and their subsequent extraction & processing ; general principle of mordanting.

Physiology

3. **Membrane structure**. active and passive transport, transmembrane transport of sodium ions. ionophores.
4. **Mechanisms of action of peptide and steroid hormones**.
5. **Origin and propagation of nerve impulse**, neurotransmitter and neuromodulator.
6. **Homeostasis**.
7. **Regulation of blood volume, heart rate and blood pressure**.
8. **Role of vitamins in metabolism**.
9. **Physiological role of Na, K, Ca, and P**

Paper - II : Group - B : Unit - II : 25 Marks

(Biophysics and Biochemistry)

Biophysics

1. **Properties of matter** : Law of partial pressure of gases and its biological applications. Diffusion - Fick's law, Grahams law, facilitated diffusion, factors affecting diffusion, biological applications, Viscosity - factors effecting viscosities of liquids and gases, Poisseuille's law, Ostwald viscometer, biological applications of viscosity. Centrifugation - moving boundary

ultracentrifugation and density gradient ultracentrifugation. Surface tension - factors, capillary action, stalagmometer, biological applications, Donan-membrane equilibrium - concept, factors affecting it, biological examples.

2. **Properties of solutions : Osmosis** - Van't Hoff laws, isotonic coefficient, tonicity, isotonic, hypotonic and hypertonic solutions, determination of osmotic pressure, biological applications of osmosis and tonicity.
3. **pH and buffers** : pH and its biological significances. determination of pH using hydrogen electrode, silver-silver chloride electrode and glass electrode. Acid - base buffers of animal body fluids and their roles in pH regulation.
4. **Colloids** : Sols, gels, emulsions. proteins of colloids- Tyndall effect; solvation, gelation, electric double layer. electrokinetic properties, salting in and out, electroviscous effects, difference between lypophilic and lipophobic sols. Biological significance of colloids, adsorption - its characteristics and biological applications. Dialysis, hollow fibre dialysis, electrodialysis and biological applications.
5. **Radioactivity** : alpha, beta and gamma rays, half-life of radioisotopes. kinetics of radioactive decays. Geiger-Muller counter. Scintillation counter, artificial radioisotopes and their application in biology, biological effects of radioactivity, carbon dating.
6. **Photometry and polarimetry** : Principles of colorimetry and photometry, application of photometry in biological experimentation. optical activity of organic substances,

dextrorotatory and levorotatory isomers, polarimeter, polarization microscopy-principle. principle of spectrophotometry.

7. **Thermodynamics** : Thermodynamic systems - isolated, closed and open. first and second laws of thermodynamics, enthalpy and entropy. biological steady state and its maintenance. Gibbs free energy.

Biochemistry

8. **Protein structure** : Primary, secondary, tertiary and quaternary structures and bonds holding them.
9. **Enzymes** : hyperbolic and sigmoid kinetics. competitive and noncompetitive inhibitions and their effects on enzyme kinetics. allosteric modification, its kinetics and models.
10. **Biological oxidation** : redox potential, mitochondrial electron shuttles, mitochondrial respiratory chain, redox loop model & mechanistic model. oxidative phosphorylation.
11. **Lipid Metabolism**: de novo synthesis of fatty acids, microsomal fatty acid elongase & desaturase systems. oxidation of saturated fatty acids.
12. **Protein metabolism** : deamination, transamination, ammonotelism, ureotelism, uricotelism, formation of specialised products from amino acids.
13. **Carbohydrate metabolism** : anabolic roles of TCA cycle, integration of carbohydrate, fat and protein metabolism.

Paper - III : Group - A : Unit - I : 25 Marks

(Ecology)

1. **Concept of Ecosystem** : Biosphere & ecosphere : components of ecosystem, cybernetic nature of ecosystem : stability through feedback control and through redundancy of components, resistance and resilience stability. Gaia hypothesis.
2. **Biotic community** : Species abundance, dominance and dominance index. species diversity, α , β , γ diversity, diversity indices. Species diversity hypotheses. dominance diversity curve. Ecotone. edge and edge effect. Organismic and individualistic concept of community.
3. **Population Ecology**: Life table, survivorship, fertility schedule, reproductive strategies : semelparity and iteroparity, r and k strategies. Types of population interactions. Competition. Predator-prey interaction.
4. **Ecological niche** : Spatial, trophic and multidimensional niche concept. fundamental and realized niche. niche width and niche overlap. Competitive exclusion. Ecological guilds and ecological equivalents.
5. **Limiting factors and toleration** : Laws of limiting factors and toleration. limits of tolerance. factor compensation and ecotypes. temperature as an ecological factor.

Paper - III : Group - A : Unit - II : 25 Marks

(Ethology)

1. **Basic consideration** : Approaches in the behavioural studies : observational, experimental & ethological. Types of behaviour:

taxis and kinesis. Innate and learned and learned. Egocentric and altruistic. Motivation, stimuli & drive. Sign stimulus, motivational, releasing and terminating stimuli. hierarchy of drives.

2. **Learned behaviour** : Habituation, acquisition, extinction, instrumental learning, operant conditioning, insight, imprinting.
3. **Egocentric behaviour** : Maintenance : body care, comfort movement, basking and anting. Habitat selection and shelter seeking : types of cover, basis of habitat selection, habitat shift, limiting effect of resource on habitat selection.
4. **Escape and defence behaviour** : Enemy recognition, reaction towards enemy : escape, freezing, deception, social strategies, agonistic reaction, appeasement, conflict in mind, flight distance & charge distance. evolutionarily stable strategy, game theory.
5. **Social behaviour** : Territoriality : Home range and territory, social dominance, hierarchy and peck order. Cooperative social groups, eusocial organisation. Altruism
6. **Reproductive behaviour** : Sex ratio, mating types. Sexual selection : male rivalry & female choice. Sexual dimorphism, Domestic bliss situation of Dawkins.

Paper - III : Group - B : Unit - I : 25 Marks

Immunology

1. **Antigen and antibody interaction**
2. **Structural properties of antibodies and antigens** :
a) Structure of IgG, IgA, IgD, IgM and IgE.

- b) Constant, variable & hypervariable immunoglobulines.
- c) Concept of epitope
- 3. a) Antibodies to hapten.
- b) Precipitation and agglutination reaction.
- c) Activity of antiserum for antigen.
- 4. a) Origin and maturation of T and B- lymphocyte, subsets of T-cells.
- b) Humoral immune response.
- c) Cell mediated immune response.
- 5. **Complement system :**
 - a) Component of complements.
 - b) General principle of initiation of complement.
 - c) Classical pathway.
 - d) Alternative pathway.
 - e) MAC
- 6. **Immunoassays :**
 - a) ELISA
 - b) RIA
 - c) Western Blotting.
 - d) Immuno electrophoresis.
 - e) Southern Blotting.
 - f) Immunohistochemistry.

Paper - III : Group - B : Unit - II : 25 Marks
Biostatistics

1. **Variable and statistics :** Classification of variables - continuous and discrete measurement variables, ordinal variables, attributes. simple random sampling. frequency distribution. properties and computation of statistics of location - mean, median, mode and percentiles. absolute and relative measures of dispersion - variance, standard deviation, quartile deviation, coefficient of variation. sampling error - standard error of means, standard error of difference between mean.
2. **Probability distribution :** Properties and uses of normal probability distributions, t-distributions, binomial distributions and poisson distributions. degrees of freedom. skewness and kurtosis.
3. **Testing of hypothesis :** Null hypothesis. Level of significance. Error of inference. One-tail and two-tail tests. Critical scores. assumptions for using Z scores and significance of difference between means of large groups using Z scores. assumptions for t-tests. t-tests for significance of difference between means of small and large independent groups and small single groups. assumption and use of binomial distribution for significance of occurrence of observed combinations of events of a dichotomous variable in a sample.
4. **Analysis of frequencies :** Chi-square test for goodness of fit. Chi-square test of independence.
6. **Correlation and regression:** Properties and types of correlation. Pearson's product-moment correlation coefficient-properties,

assumptions, computation from ungrouped data and significance test. Kendall's rank correlation coefficient. Partial and multiple correlations, regressions - types and models, simple linear regression - assumption, properties and computation, multiple regression.

- 6. 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, Gabriel's SS-STP, Kruskal-Wallis nonparametric ANOVA and multiple comparison U test.

Practical

M. Sc. Part - I

Full Marks - 200

Paper - IV

Full marks - 70

Based on paper I (Non-chordates, Chordates, applied Zoology and Biosystematics)

1. Identification of non-chordate and chordates with reasons; preparation of taxonomic key, analysis of Phenax.
15 marks
2. Dissection of the following specimens.
 - (i) Digestive system, ink gland and nervous system of Sepia.
 - (ii) Reproductive system and nervous system of Achatina.
 - (iii) Digestive system and nervous system of scorpion.

- (iv) Reproductive system of *Chrysocoris* (insect).
- (v) Internal ears, IXth and Xth cranial nerves of Scolodon.
- (vi) Vagus sympathetic Nervous system of Bufo.
- (vii) Vth, VIIth, IXth and Xth cranial nerves of Calotes.

3. Preparation / Mounting / Staining 10 marks

- (i) Whole mount preparation of Pediculus
- (ii) Sting apparatus of Honey bee.
- (iii) Mouth parts - Mosquito and House fly.
- (iv) Septal nephridia - Earthworm.
- (v) Cycloid scales

4. Collection, preservation and submission of different stages of life cycle of Insects Pest. 5 marks

5. Submission of excursion report. 10 marks

6. Submission of Laboratory Note Book. 5 marks

7. Viva-Voce. 10 marks

Practical

M. Sc. Part - I

Paper - V

Full marks - 65

Based on paper - II (Cytogenetics, Molecular Biology & Biotechnology, Histology & Physiology and Biochemistry & Biophysics)

1. **Cytology, Genetics & Molecular Biology :** 15 marks
 - (i) Genetic crosses (genotype explanation).
 - (ii) Salivary gland chromosome preparation from 3rd instar larva of *D. melanogaster*.
 - (iii) Preparation of chromosome from grasshopper and identification of different meiotic stages.

(iv) Identification of different mutant strains of *Drosophila* - curly, yellow, white, bent, forked, vermillion.

(v) DNA isolation from vertebrate liver.

2. Histology :

10 marks

(i) Identification of histological slides

(ii) PAS technique

(iii) Principle of microtechnique

(iv) Relationship between ocular and stage micrometer

(v) Estimation cell diameter by micrometry

3. Biochemistry :

15 marks

(i) Estimation of protein by Lowry method.

(ii) Comparative protein estimation from liver, albumen gland and haemolymph of *Achatina*.

(iii) Estimation of blood sugar, blood urea, serum cholesterol.

(iv) Titrimetric estimation of ascorbic acid.

(v) Estimation of aminonitrogen by formol titration method.

(vi) Estimation of DNA & RNA.

(vii) Paper or cellulose acetic paper chromatography. TLC.

(viii) Paper electrophoresis.

(ix) Protein extraction from a mollusc by dialysis and its lyophilisation.

(x) Estimation of serum amylase and serum alkaline phosphatase.

(xi) Effect of pH and temperature on the rate of enzyme action.

(xii) Instrumentation (Demonstration) : Gel electrophoresis

GLC, HPLC. Spectrophotometry. ELISA

4. Submission of prepared slides

15 marks

5. Submission : of Practical exercise book

5 marks

6. Viva-Voce

10 marks

Practical

M. Sc. Part - I

Paper - VI

65 Marks

Based on Paper - III (Ecology, Ethology, Immunology and Biostatistics)

1. Ecology & Ethology :

30 marks

(i) Determination of the minimum size and number of quadrat - Species area curve method.

(ii) Analysis of the structure of community in a grassland ecosystem.

(iii) Analysis of the community structure using a community map.

(iv) Estimation of Alkalinity of water & soil.

(v) Estimation of hardness of water.

(vi) Determination of the moisture content of soil.

(vii) Estimation of plant biomass.

(viii) Estimation of primary production - harvest method, light & dark bottle method.

(ix) Preparation of behavioural catalogue & ethogram.

(x) Study of the behavioural modifications in the legs of

honeybee.

- (xi) Study of sex ratio.

2. Immunology: 10 marks

- (i) Study of macrophase.
- (ii) Study of phagocytosis.
- (iii) Determination of blood group and blood coagulation time.
- (iv) Counting of R.B.C. and W.B.C.

3. Statistical treatment of Zoological data : 15 marks

- (i) Computation of mean, median, mode, quartile deviation, variance, standard deviation, coefficient of variation, skewness and kurtosis, using the frequency distribution of grouped data.
- (ii) Significance of difference between group means using Z scores.
- (iii) Student's, t tests for significance of difference between means of small and large independent groups and small single groups.
- (iv) Computation and significance test of product-moment r between two continuous measurements variables.
- (v) Computation of Kendall's tau between two variables and testing its significance.
- (vi) Computation of simple linear regression.
- (vii) Computation of variance ratio (F) and multiple comparison of Scheffe's F test for one-way anova and their interpretation.

- (viii) Computation of Kruskal-Wallis's H and multiple comparison U for one-way nonparametric anova, and their interpretation.

- (ix) Chi square test for goodness of fit with a Mendelian frequency distribution.
- (x) Chi square test of independence of gene cross-overs and some other biological variable.
- (xi) Significance of observed sex ratios, using binomial distribution.

4. Viva - Voce

10 marks

M. Sc. Part - II : ZOOLOGY

Theoretical (200 marks)

- Paper- VII: Gr.- A. Unit- I : 25 marks : Principle of Instrumentation
& Computer application to
Biology
- Paper- VII: Gr.- A. Unit- II : 25 marks : Parasitology
- Paper- VII: Gr.- B. Unit- I : 25 marks : Microbiology
- Paper- VII: Gr.- B. Unit- II : 25 marks : Environmental Physiology
& Evolution
- Paper- VIII : Gr.- A. Unit- I: 25 marks : Environmental resources
& Pollution
- Paper- VIII: Gr.- A. Unit- II : 25 marks : Ecotoxicology
- Paper- VIII : Gr.- B. Unit- I: 25 marks : Environmental
Management
- Paper- VIII : Gr.- B. Unit- II : 25 marks : Development Biology

Special paper - Fisheries - Paper - IX (100 marks)

- Gr- A. Unit- I : 25 marks : Fish Taxonomy and Biology
- Gr- A. Unit- II: 25 marks : Limnology and Oceanography
- Gr- B. Unit- I : 25 marks : Inland and Marine Fisheries
- Gr- B. Unit- II: 25 marks : Aquaculture and Fish Technology

Special paper - Ecology - Paper - IX (100 marks)

- Gr- A. Unit- I : 25 marks : Soil Ecology
- Gr- A. Unit- II: 25 marks : Biodiversity and Wildlife Ecology 20

Gr- B. Unit- I : 25 marks : Aquatic Ecology

Gr- B. Unit- II: 25 marks : Human Ecology

Practical (200 marks)

- Paper- X : Based on paper - VII (50 marks)
- Paper- XI : Based on paper - VIII (50 marks)

Special paper

- Paper- XII: Based on paper - IX (50 marks)
- Paper- XII: Project report and field report (50 marks)

M. Sc. Part - II: ZOOLOGY

(Theoretical)

Paper - VII : Group - A 100 Marks

**Principles of Instrumentation and
Computer application to Biology**

Unit - I 25 Marks

Principles of Instrumentation :

1. Basic concept of biomolecules and biochemical methods ;
chromatography, gel filtration, electrophoresis, cell
fractionation, purity criteria.

Different types of absorption and partition chromatography

- a) Paper chromatography - principle, technique R_f value,
staining, quantitation, reverse phase partition & two
dimensional.

- b) Thin layer chromatography - principle ATLC & PTLC, technique and quantification.
- c) Ion exchange chromatography - general principle, different types of cation and anion exchanging columns.
- d) Affinity chromatography - general principle, characteristics, different matrices & ligands, biological significance.
- e) Gel filtration chromatography - general principle & biological significance.
- f) Electrophoresis - general principle, basic criteria, basic criteria, SDS-PAGE, isoelectric focusing.
- g) Cell fractionation -
 - (i) Blender method, homogenising, pressure cell method, ultrasounding & chemical method.
 - (ii) Principle of centrifugation ; differential density gradient, CsCl gradient, sucrose gradient, rate zonal, isopycnic and zonal centrifugation. Computer application to Biology :

1. Basic concept about computers : definitions of software and hardware. brief idea of windows and their applications.
2. Basics of computer architecture : central processing unit. peripheral devices, fundamentals of using a computer.
3. Concepts about number systems - binary, octal, hexadecimal. data representation.
4. Basics of computer languages : machine language. assembly language. high level language.
5. Basics of programming: programming with BASIC/FORTAN

6. Basics of simulation and modelling ; computer graphics for solving zoological problems.
7. Software packages : biological database, LOTUS, Microsoft word, harvard graphics, Microsoft excel.
8. Bioinformatics.

Paper - VII

Group -A: Parasitology

Unit - II

25 Marks

1. Animal association & parasitism - different kinds of association and their evolutionary relationship.
2. Host parasite relationship : morphological, biochemical and ecological.
3. a) Life cycle & immunology of Plasmodium, Trypanosoma, Leishmania, Schistosoma, Taenia.
b) Zoonosis & zoonotic protozoans.
4. Epidemiology & disease transmission of parasitic diseases.
5. a) Structure and composition of helminth cuticle.
b) Biology of *Brugia malayi*.
6. a) Life cycle of digenetic trematode.
b) Monoclonal gammopathies.

Paper - VII

Group - B : Microbiology

Unit - I

25 Marks

1. Microbial diversity in soil, air & water, classification and role in the living world - diseases, fossil fuel formation, mineral deposition, soil fertility enhancement and water bodies fertilisation.
2. Morphology and fine structure of bacteria ; distinguishing features of fungi - morphology, reproduction, growth and classification of other microbes, algae and protists.
3. Nutrition of microbes, principles behind formulating culture media and culture techniques.
4. Principal characters used in the classification and identification of microbes.
5. Normal growth cycle of bacteria (growth curve), factors controlling growth ; methods of measuring growth, and enumeration of bacteria in culture.
6. Aquatic microbiology; distribution of microorganisms in aquatic environment and their role in aquatic ecosystem, bacteriological evidence of pollution-the coliform group and BOD ; bioremedial measures for aquatic pollution abatement through microbes.
7. Host - microbes interaction, the process of infection, basis of immune response ; antibiotics and their mode of action.

Paper - VII

Group - B : Environmental Physiology and Evolution

Unit - II

25 Marks

1. Hardy-Weinberg law and natural selection with reference to mutation, gene migration and genetic drift.
2. Genetic Polymorphism.
3. Cambrian explosion.
4. Basic concept regarding environmental stress and organismal response.
5. Adaptation to hypoxia in diving vertebrates.
6. Thermoregulation in animals.
7. Adaptation to moisture and ionic stress.

Paper- VIII

Group -A: Environmental resource & pollution

Unit - I

25 Marks

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, sulphur and

hydrocarbon 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, waste water management ; eutrophication, pollution of water by agricultural waste (fertilizers and pesticides) ; oil, sewage ; industrial effluents, thermal power plants.
5. **Soil pollution** : Soil pollution through agricultural and solid wastes ; Recycling of solid wastes.
6. **Biosafety** - its significance.

Paper - VIII

Group - A : Ecotoxicology

Unit - II

25 Marks

1. General idea of xenobiotics ; their physical and chemical properties.
2. Corrosive, metabolic, neurotoxic, mutagenic and carcinogenic toxins with example and mechanism of action.
3. Characteristics of toxins and rate of entry.
4. Toxicity test and bioassay.
5. Biotransformation, bioaccumulation and biomagnification of xenobiotics.
6. Hazardous heavy metals, their toxicity and probable antidotes.
7. Elementary ideas of chelation therapy.

Paper - VIII

Group - B : Environmental management

Unit - I

25 Marks

1. **Environmental management** : Steps of management, survey, surveillance, research, policy formulation and monitoring, environmental impact; types of impact, impact assessment.
2. **Biocriteria of the assessment of environmental impact**: Advantage of the use of biocriteria, 'Types of biocriteria: Bioindicators, biomonitors, biosensors, biomarkers, indicator species.
3. Common biotic indices used in determining the quality of environment.
4. Environmental laws and policies of India, their effectiveness.
5. Conservation principles : objectives of conservation & global conservation strategy.
6. Abatement of water and air pollution, waste water treatment & recycling. Precombustion & postcombustion measures of the cleaning of air, disposal & bioconversion of solid wastes.
7. Vermitechnology : vermiculture, vermicasting & vermicomposting.
8. Use of biofertilizer for soil fertility.

Paper - VIII
Group - B : Developmental Biology
Unit - II **25 Marks**

1. **Induction in development :-** Nature, characteristics and mechanism of induction, competence.
2. **Regeneration in animals :** Special emphasis on the process of regeneration, Hydroids, Planarians and amphibians (limb-regeneration)
3. **Fertilization:** Mechanism and biochemical changes during the process.
 - (i) Activation of gamete.
 - (ii) Binding of gamete.
 - (iii) Union of gamete.
 - (iv) Capacitation.
 - (v) Polyspermy.
4. **Organogenesis :**
 - (i) Development of heart in vertebrate (Chick)
 - (ii) Development of eyes in vertebrate (Chick)

Ecology Special Paper
Paper - IX

Group - A : Soil Ecology & Forest & Wildlife Ecology 50 Marks

Unit - I : Soil Ecology **25 Marks**

1. Soil as a habitat : major soil types, physicochemical properties of soil with special reference to texture, temperature, moisture, nitrogen, carbon & pH.
2. Pedogenesis with particular reference to the role played by soil biota.
3. Soil fauna; classification of soil fauna, sampling, extraction and preservation of soil fauna with particular reference to microarthropods & nematodes. Ecological importance of major groups of soil fauna.
4. Functioning of soil community : role of soil fauna in the energy flow and nutrient cycle, soil fauna and soil fertility. Types of humus, leaf litter decomposition.
5. Effect of human interference on soil fauna: agricultural practice, afforestation & deforestation, industrialization.

Unit - II : Soil Ecology **25 Marks**

1. Forest profile of India: forest types, deforestation and plantation.
2. Structure and function of tropical forest ecosystem: stratification of animal life, production and nutrient cycling.
3. Biodiversity concept; Megadiversity countries & hot spots. Rate and cause of species extinction. Pattern of spatial distribution.

4. Conservation of biodiversity : Protected areas, sanctuary, national park and biosphere reserve.
5. Endangered wild animals of India with particular reference to the wild animals of West Bengal.
6. Population status, distribution, feeding & breeding habits, and main threats to survival of Tiger & Black Buck.

Paper - IX

Group - B : Aquatic Ecology & Human Ecology: 50 Marks

Unit - I : Aquatic Ecology 25 Marks

1. Types of aquatic bodies : Freshwater - lotic, lentic & wetlands (marshes and swamps); estuary & mangrove; marine & coastal.
2. Classification of lakes : Oligotrophic, eutrophic, special types.
3. Stratification of lakes : epilimnion, thermocline, hypolimnion, thermal stratification dimictic, monomictic, polymictic, oligomictic & meromictic.
4. Ecological classification of aquatic biota: benthos, periphyton, nekton, plankton, neuston, littoral, limnetic, profundal, rapid zone & pool zone. ecological importance of aquatic biota.
5. Eutrophication and its ecological impact.

Unit - II : Human Ecology 25 Marks

1. Human population explosion : causes, effects & future.
2. Global warming and green house effect: causes, impact of these on environment.

3. Smog formation & thermal inversion: types of smogs, formation of smog, effect of smog, causes of thermal inversion & its impact.
4. Acid rain and its ecological impact in environment.
5. Impact of urbanisation on biodiversity.

Special Paper: Fisheries

Paper - IX : Group - A : Unit - I : 25 Marks

Fish taxonomy and Biology

1. **Classification of fishes** : Principles and characters of principal subdivisions up to orders (living & extinct).
2. **Principles of fish growth** : growth curve, environmental factor (biotic & abiotic) and growth, hormonal enhancement of growth, growth in relation to ratios and age.
3. **Fish nutrition** : food, feeding habits, natural food, chemical composition of feed stuff, nutrient and energy requirements, biochemical composition of fish flesh.
4. Electoreception, bioluminance and immunodefence system in fish.
5. Structure and physiology of endocrine glands: pituitary, thyroid, gonad and 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 - IX

Group - A : Unit -II : 25 Marks

Limnology and Oceanography

1. **Island water bodies** : lentic and lotic systems, their physical and chemical characteristics.
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. **Lakes** : Origin, classification, community structure and inter relationship, zonation and the role of light, thermal stratification, role of eutrophication in geomorphological changes of lakes.
4. **Geological oceanography** : horizontal and vertical zonation, continental margin, continental shelf and abyssal plain; coastal zones-estuaries, lagoons, delta etc.
5. **Physical oceanography** : physical properties (salinity, density, heat storing capacity, temperature etc.) and physical processes (oceanic circulation, tides and upwelling) of ocean. Origin, dimension and depth of oceans.
6. **Chemical oceanography** : composition of sea water-their distribution, fluctuation and characteristics.
7. **Biological oceanography** : biotic community of ocean - their classification, distribution, seasonal dynamics and trophic interrelationship with special reference to zooplankton, benthos and mangrove ecosystem.

Paper -IX

Group - B : Unit - I : 25 Marks

Inland and Marine fisheries

1. Inland fisheries resources of India : major culturable and capturable fishes of India, problems and potentials.
2. Commercial exploitation of reservoir, fisheries of India. steps for the conservation of diversified fisheries resources.
3. Estuarine and back water fisheries : potential, problems and prospects in Indian context.
4. Remote sensing : the concept, remote sensing and geographic information system for fisheries with special emphasis on marine faunal and floral resource assessment and exploitation.
5. Problem and prospects of marine fisheries in India : their exploitation, management and conservation in global perspective.
6. Taxonomy, biology, distribution, seasonal abundance and productivity of some important marine and estuarine fin and shell fishes.
 - (i) Oil sardine.
 - (ii) Mackerels.
 - (iii) Indian shad (*Hilsa*, presently *Timualosa*)
 - (iv) Crustaceans (crabs and lobster).
 - (v) Molluscs (bivalves & cephalopods).
7. Sewage in relation to fisheries: cause and effect of pollution in fisheries, fish in relation to public health.
8. Fisheries economics : definition and application of economic principles to fisheries. Theory of production, law of diminishing return, risk and profits in fisheries.

Paper - IX

Group - B : Unit - II : 25 Marks

Aquaculture and fish technology

- I. 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. 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.
3. 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.
4. 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.
5. Transgenic techniques applied in aquaculture, problems and prospects.
6. Fish disease : important fish diseases, causative agents, symptoms and their control.

7. 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.
8. Harvesting : port harvesting activities in India, fish processing - freezing, canning, smoking, pickling, processing plants.
9. Fish by products : fish meal, fish oils, fish protein concentrates (FCP), and other by-products.
10. Fisheries extension: objectives and principles. role of extension education in community development. fisheries as a tool in rural development.

Practical

Paper - X

Based on paper - VII (Instrumentation & computer application; Parasitology, microbiology and evolution) 50 Marks

- I. Computer application to zoological problems : 18 marks
 - a) Basic computer operations.
 - b) Methods of data entry through Keyboard.
 - c) Printing of programmes and results.
 - d) File management.
 - e) Programming with BASIC on zoological problems,
 - f) Computation and presentation of data through computer graphics - frequency distribution, histogram, bar diagram

and pie diagram.

g) Use of computer packages.

2. Computer applications to biostatistical treatment of data:

12 Marks

- a) Computation of mean, median, standard deviation and standard error of mean for zoological data.
- b) Computation of t scores for significance of difference between means.
- c) Computation of product moment r between two variables.
- d) Computation of simple linear regression.

3. Parasitology :

- 2. Preparation and staining of trematode from rumen of goat.
- 3. Preparation and staining of Cestodes from intestine of *Gallus* sp.
- 4. Preparation and staining of Rectal content of *Bufo* sp.
- 5. Preparation and staining of blood parasite from Pigeon blood.
- 6. A) Slide preparation of some ectoparasites.

B) Identification with systematic position.

- i) *Trypanosoma* sp.
- ii) *Plasmodium* sp.
- iii) *Leishmania* sp.
- iv) *Haemoproteus* sp.
- v) *Myxobolous* sp.
- vi) *Ascaris* sp.
- vii) *Ceylonocotyle* sp.

viii) *Fasciola* sp.

ix) *Anopheles* sp.

x) *Culex* sp.

xi) *Columbicola* sp.

xii) *Pediculus* sp.

xiii) *Cimex* sp.

xiv) *Phlebotomus* sp.

4. Microbiology :

8 marks

- a) Preparation of different culture media of bacteria and fungi.
- b) Inoculation of microbes to respective culture media and preparation of pure culture.
- c) Staining and identification of bacteria from culture media.
- d) Enumeration coliform and faecal coliform bacteria.

5. Submission of prepared slides

4 marks

6. Submission of laboratory note book

6 marks

7. Viva-Voce

10 marks

Practical

Paper -XI

Based on paper - VIII (Environmental resources & pollution ; Ecotoxicology, Environmental management and Developmental biology)

50 Marks

1. Environmental pollution, ecotoxicology and environmental management :

20 marks

- i) Measurement of BOD and COD of water.
- ii) Estimation of LC 50 & LD50

- iii) Study of the impact of anthropogenic activities on biodiversity.
- iv) Basic principles for heavy metal estimation.
- v) Identification of the common species of earthworms and their utility in vermicomposting & waste recycling.
- vi) Study of the bioindicators.

1. Development biology: 15 marks

- i) Extraction and identification of different stages of chick embryos (24 hrs, 48 hrs and 72 hrs)
- ii) Histological sectioning and staining of different stages of chick embryo.

2. Submission of laboratory note book : 5 marks

3. Viva-Voce : 10 marks

Practical

Paper -XII

Special paper Ecology 50 Marks

1. Estimation of colour, bulk density, particle density & porosity, water holding capacity & pH of soil.
2. Mechanical analysis of soil.
3. Estimation of soil temperature.
4. Estimation on NPK of soil.
5. Study of soil fertility by estimation of the evolution of CO₂.
6. Measurement of the intensity of light.
7. Preparation of climograph.
8. Study of aquatic biota.

9. Estimation of transparency & conductivity of water.
10. Study of soil and litter biota.
11. Estimation of α , β and γ diversity & microdistribution.
12. Submission of laboratory note book.
13. Viva-Voce

Practical

Paper -XIII

Special paper Ecology 50 Marks

1. Dissertation/Review Work 20 marks
2. Excursion Report 10 marks
3. Seminar and Viva-Voce 20 marks

Practical

Paper -XII

Special paper Fisheries 50 Marks

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 prawns, mussels and oysters.
3. Identification of fresh water/marine aquatic macrophytes
4. Analysis of physicochemical characteristics of water - salinity, conductivity, chloride, turbidity, nutrients and primary productivity.
5. Analysis of physicochemical parameters of soil - pH, organic, carbon, nitrogen, potassium and phosphorus.
6. Fish food organisms (Natural): phytoplankton and zooplankton

of Midnapore and adjoining areas.

7. Formulation and preparation of artificial fish food for Indian major carps & Prawns.
8. Preparation of fish by-products.
9. Gut content of herbivorous fish & carnivorous fish.
10. Length weight relationship of at least three fishes.
11. Gastrosomatic index of at least five fishes.
12. Accessory respiratory organ of *Channa (Ophiocephalus)*, *Anabas*, *Clarias*, *Heteropneustes* etc.
13. Urinogenital system of *Channa (Ophiocephalus)*, *Tilapia*, *Anabus*, *Clarias*, *Heteropmustes*, *Labio* etc.
14. Egg production (per fish) in *Channa*, *Clarias*, *Tilapia*, *Lebio* etc. (Fecundity estimation).
15. Histological preparation of scales/ovary/testis/kidney/hepatopancreas etc.
16. Estimation of muscle protein & lipid from Indian major carps.
17. Submission of laboratory note book.
18. Viva-Voce.

Practical

Paper -XIII

Special paper Fisheries

50 Marks

- | | |
|-----------------------------|----------|
| 4. Dissertation/Review Work | 20 marks |
| 5. Excursion Report | 10 marks |
| 6. Seminar and Viva-Voce | 20 marks |

*Published by : Director,
Directorate of Distance Education
Vidyasagar University, Midnapore - 721102*

**Printed by : J.K. Printers
W/A-5, Arabinda Nagar, Judges Court
Midnapore - 721101, Paschim Medinipur
Ph. (03222) 263897*