

MAHARAJA GANGA SINGH UNIVERSITY, BIKANER

SCHEME OF EXAMINATION AND SYLLABUS

M. Sc. ZOOLOGY

2023-24

M.Sc. Zoology

Semester I

PAPER I: TAXONOMY & INVERTEBRATE PHYLOGENY

3 hours duration
Internal Assessment

Max Marks 40
Max. Marks : 10

Min. Marks 10
Min. Marks 3

NOTE: The question paper shall be divided into three sections: Section A (10 marks) shall comprise of 10 compulsory questions of 1 marks each and not more than 4 questions from each Section (Answer is not more than 50 words). Section B (12 marks) shall comprise of two questions from each section and candidate has to attempt all questions from each Section, 2 marks for each question (Answer in not more than 200 words) and Section C (18 marks) shall comprise of three questions with not more than one question from each section and candidate has to answer all three, 6 marks for each question (Answer in not more than 500 words).

SECTION A

1. A study of the classification of Invertebrates with distinguishing features and examples of various subdivisions.
2. Introduction to the science of taxonomy, rules of nomenclature.
3. Principles of classification: Theories of biological classification and their history; the species category; the polytypic species; population systematics; intraspecific categories.
4. Methods of classification: taxonomic collection and the processes of identification, taxonomic characters: types of variations (qualitative and quantitative) within a single population, methods of arriving at taxonomic divisions on species level; preparation and use of taxonomic keys.
5. Cytotaxonomy: Importance of cytology and genetics in taxonomy

SECTION B

1. Criteria for phylogenetic interrelationship between Invertebrate phyla
2. Origin of Multicellularity(Protozoa, Parazoa and Metazoan)
- 3 Origin of Radiata (Coelenterata and Ctenophora)
- 4.Origin of Bilateria from Radiata(Importance of Planula larva and Ctenophores)
5. Phylogenetic significance of Rhynchocoela

SECTION C

- 1 Interrelationship of the Pseudocoelomate groups with special reference to Rotifera, Gastrotricha, Kinorhynca, Nematomorpha and Entoprocta.
- 2 Affinities and evolutionary significance of the unsegmented lesser Protostome phyla(Priapulida, Echiuroidea and Sipunculoidea, Echiurida and Sipunculida).
- 3 Phylogenetic relationship between the coelomate phyla(Annelida, Onychophora, Arthropoda and Mollusca).
4. Affinities and evolutionary significance of the Lophophorate Coelomate phyla (Brachiopoda, Phoronida and Ectoprocta).
- 5 Affinities of the invertebrate Deuterostome phyla(Chaetognatha, Echinodermata, Pogonophora and Hemichordata)

PAPER II: BIOLOGICAL CHEMISTRY & IMMUNOLOGY

3 hours duration
Internal Assessment

Max Marks 40
Max. Marks : 10

Min. Marks 10
Min. Marks 3

NOTE: The question paper shall be divided into three sections: Section A (10 marks) shall comprise of 10 compulsory questions of 1 marks each and not more than 4 questions from each Section (Answer is not more than 50 words). Section B (12 marks) shall comprise of two questions from each section and candidate has to attempt all questions from each Section , 2 marks for each question (Answer in not more than 200 words) and Section C (18 marks) shall comprise of three questions with not more than one question from each section and candidate has to answer all three, 6 marks for each question (Answer in not more than 500 words).

SECTION A

1. **Structure of atoms, molecules & Chemical Bonds**
2. **Biophysical Chemistry : Water, Acids & Bases, Buffers, Solution, Colloidal State, Viscosity, Surface Tension, Adsorption, Isotopes**
3. **Chemistry of Carbohydrates:** definition, general properties, classification (Monosaccharides, Disaccharides, Polysaccharides) Sugar derivatives; Metabolism of carbohydrates
4. **Chemistry of Lipids:** definition, general properties and classification, fatty acids: Simple and compound lipid, Steroids, metabolism of lipids, Biomedical importance of lipids.

SECTION B

1. **Chemistry of Proteins and Amino acids:** definition, general properties of amino acids and proteins, Metabolism of proteins, Biomedical importance of proteins; Vitamins : Types and Importance
2. **Chemistry of Nucleic Acids:** Definition, general properties, classification and importance of Nucleic acids.
3. **Enzymes:** Chemistry of enzymes, Nomenclature, specificity and mechanism of enzyme action. Competitive and noncompetitive inhibition, Allosteric inhibition. Kinetics, factors affecting enzyme activity,
4. **Inborn errors of metabolism**

SECTION C

1. Introduction and historical background of immunology, Antigens, Antibody, antibody structure and diversity
2. Antigen Antibody reaction, MHC, mechanism of immune response. HLA class I, II, II molecules, Humeral and cell mediated immunity,
3. Hypersensitivity reaction: type I, II, III and IV. Active and passive immunization, novel approach for various vaccines, process of vaccination,
4. Autoimmunity : Autoimmune diseases & Transplantation.

PAPER III: MOLECULAR BIOLOGY & CYTOGENETICS

3 hours duration
Internal Assessment

Max marks 40
Max. Marks : 10

Min. Marks 10
Min. Marks 3

NOTE: The question paper shall be divided into three sections: Section A (10 marks) shall comprise of 10 compulsory questions of 1 marks each and not more than 4 questions from each Section (Answer is not more than 50 words). Section B (12 marks) shall comprise of two questions from each section and candidate has to attempt all questions from each Section , 2 marks for each question (Answer in not more than 200 words) and Section C (18 marks) shall comprise of three questions with not more than one question from each section and candidate has to answer all three, 6 marks for each question (Answer in not more than 500 words).

SECTION A

1. History and Scope of Molecular Biology

2. Detailed structure of DNA and RNA, B-DNA,Z-DNA, Topological structure of DNA, t-RNA, micro RNA

3. DNA Replication: Process and difference between Prokaryotic and Eukaryotic DNA replication.DNA and RNA polymerase, Structure and function. Accessory proteins involved in DNA replication, regulation of replication.

SECTION B

1. Protein Synthesis:Mechanism of transcription in Prokaryote and Eukaryotes. Role of sigma and Rho factor in transcription, Split gene, processing of Hn-RNA(capping, tailing and splicing)Translation(Initiation complex, elongation and termination) Post and cotranslational modification

2. Gene regulation in prokaryote and Eukaryote- Lac operon, tryo operon of E.Coli, Enhancer and silencer, Non coding gene.

3.Molecular recombination and repair of DNA- Holliday junction, rec A and other recombinase, Mobile genetic element(transposon). Integrons, retroposons, DNA repair (direct repair, nucleotide excision repair NER, base excision repair BER, Mismatch repair MMR).

SECTION C

1. Somatic cell genetics-cell fusion, heterokaryon

2. Imprinting of genes

3. Cell cycle. Cancer and Apoptosis (cell death), mitosis promoting factors MPF, Anaphase promoting factors APF, CDKs and cyclins, p53, onchogenes (SIS and RAS), tumour suppressor gene(TS)

PAPER IV: EVOLUTION

3 hours duration
Internal Assessment

Max marks 40
Max. Marks : 10

Min. Marks 10
Min. Marks 3

NOTE: The question paper shall be divided into three sections: Section A (10 marks) shall comprise of 10 compulsory questions of 1 marks each and not more than 4 questions from each Section (Answer is not more than 50 words). Section B (12 marks) shall comprise of two questions from each section and candidate has to attempt all questions from each Section, 2 marks for each question (Answer in not more than 200 words) and Section C (18 marks) shall comprise of three questions with not more than one question from each section and candidate has to answer all three, 6 marks for each question (Answer in not more than 500 words).

SECTION A

1. Theories of evolutionary thought:

- (a) Greek thought to Lamarck
- (b) Darwin and theory of evolution
- (c) The period after Darwin

2. Genetic basis of Evolution: genetic and quantitative aspects of evolution; population as a unit of evolution; gene frequency; gene pool; evolution, the result of change in gene frequency; genetic equilibrium and Hardy Weinberg Law; Mutation pressure; selection pressure; effects of population size; random and non-random reproduction; genetic drift(Sewall-Wright effect)

SECTION B

1. Variation: Somatic and germinal variations, chromosomal variations; gene mutations, rate, direction and nature of mutations, natural and induced mutations, mutagens.

2. Isolation and its role in species formation

- (i) Speciation; definition of species, sub-species and races; speciation a gradual or a sudden process. Allopatric and sympatric speciation.
- (ii) Isolating mechanisms; geographical, ecological, physiological, biochemical, anatomical, developmental, behavioral, psychological and social.
- (iii) Effects of Isolation: restriction of random dispersal and random mating; character displacement; reduction of fertility
- (iv) Failure of isolating mechanism, gene flow, migration, Heterosis

SECTION C

1. Adaptational diversity and nature of adaptations; adaptive radiations and occupation of new environments and niches; mimicry and coloration. Ecology and evolution

2. Natural selection, critical evaluation of the concepts of struggle for existence and survival of the fittest; the modern concept of natural selection's adaptation and differential reproduction; Nedarwinism and Neolamarckism. Characteristics of evolution: Extinction, replacement, irreversibility of specialization etc.

Semester I

Practical Work Based on Paper I to IV

Max marks 40

Internal Assessment Max. Marks : 10

Min. Marks 16

Min. Marks 4

Day 1

1. Invertebrates: Identification, classification & study distinguishing features of important representatives from various groups' (Protozoa to Aschelminthes).

2. Study of permanent prepared slides (From Protozoa to Aschelminthes).

3. Anatomy: .

General Anatomy, Reproductive and Nervous Systems of Cockroach, Grasshopper, Crab and Prawn.

4. Premanent Preparation and Their Study :

(i) Preparation of cultures of Amoeba, Paramecium and Euglena; Study of these protozoans using vital dyes. - ,

(ii) Collection and study of live Hydra, its fixation and permanent preparation.

(iii) Permanent preparations of different materials to be provided for study (Protozoa to Platyhelminthes)

5. Biological Chemistry: . - .

i. Identification of Protein, carbohydrates and lipid in various tissues.

ii. Identification of different kinds of mono, di and polysaccharides in biological and chemical materials.

iii. Quantitative estimation of the following by spectrophotometer and semi auto analyser methods in various tissues,

(a) Carbohydrates: glycogen and glucose.

(b) Proteins: total proteins.

(c) Lipid: Phospholipids and cholesterol.

(d) Nucleic acids: DNA and RNA. .

(e) Enzymes: acid and alkaline phosphatase.

Note: Use Of animals for dissection and practical work is subject to the conditions that these are not banned under the wildlife protection act.

DAY 2

Max marks 40

Internal Assessment Max. Marks : 10

Min. Marks 16

Min. Marks 4

1 Invertebrates:

Study of various larval stages of invertebrates (Protozoa to Aschelminthes)

2. Anatomy:

Identification of various local Insects up to order with the help of taxonomic keys.

3. Permanent Preparation and Their Study :

- (i) Collection, fixation & permanent preparations of trematodes; cestodes & nematodes found in sheep and pig in the stool of infected persons.
- (ii) Permanent preparation of various parts of dissection carried out of the animals (Protozoa to Aschelminthes)
- (iii) Permanent preparations of different materials to be provided for study,

4. Cell Biology:

- i. Preparation of multi-polar nerve cell from the spinal cord of a mammal.
- ii. Chromosome counts in cells of the testis of an insect or mammal or cells of the bone marrow of a mammal.
- iii. Study of prepared microscopic slides, including those showing various cell types, mitosis, meiosis and giant Chromosomes.
- iv. Preparation and staining of bar bodies.
- v. Squash & smear preparations of testis of cockroach and grasshopper, Acetocarmine & Fuelgen staining of these preparations.
- vi. Study of mitosis in onion root tip and mammalian bone marrow cells.
- vii. Study of giant chromosomes in the salivary gland of Chironomus larva and Drosophila.
- viii. Vital and supra-vital staining (with neutral red and Janus Green B) of cells of the testis of an insect or mammal to study the mitochondria.
- ix. RNA and DNA estimation.

5: Genetics:

- i. Identification of blood groups in man.
- ii. Monohybrid & Dihybrid inheritance in Drosophila.

Note: Use Of animals for dissection and practical work is subject to the conditions that these are not banned under the wildlife protection act

Semester I

Max marks 40

Min. Marks 16

Internal Assessment Max. Marks : 10

Min. Marks 4

PRACTICAL EXAMINATION SCHEME

BOARD FIRST: DAY FIRST

DURATION 4HRS

1. Exercise in Biological Chemistry	08 Marks
2. Dissection	08 Marks
3. Permanent preparation	04 Marks
4 Spots (5)	10 Marks
5. Viva-voce	05 Marks
6. Class record	05 Marks
Total	40 Marks
Internal Assessment	10 marks
Grand Total	50 Marks

BOARD SECOND: DAY SECOND

DURATION 5 HRS

1. Exercise in Cell biology	07 Marks
2 Exercise in Genetics	07 Marks
3. Exercise in Taxonomy	06 Marks
4. Seminar/Field/Tour report	10 Marks
5. Viva Voce	05 Marks
6. Class record	05 Marks
Total	40 Marks
Internal Assessment	10 marks
Grand Total	50 Marks

SEMESTER II

PAPER V STRUCTURE AND FUNCTIONS IN INVERTEBRATE

Max marks 40

Min. Marks 10

Internal Assessment Max. Marks : 10

Min. Marks 3

NOTE: The question paper shall be divided into three sections: Section A (10 marks) shall comprise of 10 compulsory questions of 1 marks each and not more than 4 questions from each Section (Answer is not more than 50 words). Section B (12 marks) shall comprise of two questions from each section and candidate has to attempt all questions from each Section , 2 marks for each question (Answer in not more than 200 words) and Section C (18 marks) shall comprise of three questions with not more than one question from each section and candidate has to answer all three, 6 marks for each question (Answer in not more than 500 words).

SECTION A

1. Locomotion in Invertebrate

(a) Amoeboid movements: Ultrastructure of cilia and flagella: Ciliary and flagellar movements; molecular and physiological mechanisms involved in the three kinds of movements

(b) Myotomes and muscle fibers in invertebrate structure and their involvement in locomotory action.

(c) Locomotion in relation to hydrostatics. Coelome, metamerism, arthropodization

(d) An outline of flight mechanism in insects.

2. Filter feeding in higher invertebrates; Feeding mechanisms in insects and echinoderms.

3. Respiration

(a) Respiration in lower invertebrates(Protozoans to Helminthes)

(b) Respiration In higher invertebrates(Trachea, Gills, Lungs and Lophophores)

(c) Physiology of respiratory pigments in invertebrates

4. Excretion: Study of structural and functional organization of excretory systems in various invertebrate groups and a survey of various excretory products met within them.

SECTION B

1. Structural and functional organization of nervous systems and receptor

(a) Plan of nervous systems in the Coelenterates, Platyhelminthes, Annelida, Arthropoda, Mollusca and Echinodermata. Structural and functional complexities of brain and ganglionic structures.

(b) Receptors: Structural and functional organization of the mechanoreceptors, chemoreceptors and photoreceptors.

2. Endocrine system: A survey of endocrinal structures and their hormones role of neurosecretions and hormones in developmental events of insects and crustaceans.

3. Reproduction : Asexual and sexual reproduction met within different invertebrate groups, Parthenogenesis. Larval forms met within different invertebrate group and their significance

4. Osmoregulation and ionic regulation: Survey of principle mechanisms in fresh water, marine and terrestrial invertebrate forms.

SECTION C

1. Parasitism: general consideration, Types of parasites, type of hosts, symbiosis and commensalism.

2. Protozoan parasites: Distribution, habit and habitat, structure life cycle and disease caused by selected pathogenic protozoan parasites of man. *Entamoeba histolytica*, *Trypanosoma gambiens*, *Leishmania donovani* and *Plasmodium vivax*.

3. Helminthes parasites: General characters, organization and larval forms of Platyhelminthes and nemathelminthes.

4. Distribution, habit and habitat, structure and life cycle of economically important helminth parasites of man and domesticated animals: *Echinococcus granulosus*, *Hymenolapsis nana*, *Schistosoma haematobium*, *Paragonimus westermani* and *Trichinella spiralis*.

PAPER VI : ANIMAL PHYSIOLOGY

Max marks 40

Min. Marks 10

Internal Assessment Max. Marks : 10

Min. Marks 3

NOTE: The question paper shall be divided into three sections: Section A (10 marks) shall comprise of 10 compulsory questions of 1 marks each and not more than 4 questions from each Section (Answer is not more than 50 words). Section B (12 marks) shall comprise of two questions from each section and candidate has to attempt all questions from each Section , 2 marks for each question (Answer in not more than 200 words) and Section C (18 marks) shall comprise of three questions with not more than one question from each section and candidate has to answer all three, 6 marks for each question (Answer in not more than 500 words).

SECTION A

Physiology of Digestion, Respiration and Circulation

1. Mechanism of secretion and action of all types of digestive juices met within the mammalian digestive pathway, Physiological mechanisms involved in the absorption of

the end products of digestion, digestive glands and process of digestion, digestive disorders.

2. Chemistry of respiration with particular reference to mammals, respiratory path, respirator pigments, ventilation, modified forms of respiration, respiratory disorders.
3. Blood, Physiology of blood clotting, heart, transport mechanism, nervous regulation of heart function in man, conductile and contractile mechanism of heart, cardiac cycle in man, ECG, regulatory mechanism of heart, circulatory disorders(hypertension, Hypotension, Anaemia, Myocardial infarction etc.)

SECTION B

Physiology of Excretion, Muscle tissue and Nervous tissue

1. Various nitrogenous waste products, Kidney, Architecture of nephron, role of kidney in osmoregulation, mechanism and regulation of urine formation, disorders of excretion.
2. Morphology and functional architecture of the contractile apparatus in muscle tissue; Study of the biophysical and biochemical events underling contraction and relaxation process. Muscular disorders.
3. Biochemistry and molecular physiology of genesis, conduction of nerve impulse and transmission across synaptic junctions, neurotransmitters, reflex action.

SECTION C

1. **Physiology of the receptor system:** general mechanism involved in stimulus transduction at receptor sites: Functional architecture and stimulus processing in eye, ear and olfactory epithelium.

2. **Endocrine physiology:** Cellular mechanisms of hormone action in target tissues (Hormone receptors, membrane receptors, nuclear receptors, G protein), Hypothalamic control of pituitary activity and phenomenon of neurosecretion; genesis types and general functions of hormones of various endocrine glands (Hypophysis, adrenal, thyroid, parathyroid, testis, and ovary, Islets of Langerhans).

3. **Reproduction:** Endocrinological control of the testicular, ovarian and uterine functions, physiological aspects of implantation and parturition and lactation. Reproductive abnormalities(Gonorrhoea, Syphilis, genital herpes, prostrate problems, vaginitis, Uterine tumors, menstrual complications).

PAPER VII : BIOTECHNIQUES & MOLECULAR EVOLUTION

Max marks 40

Min. Marks 10

Internal Assessment Max. Marks : 10

Min. Marks 3

NOTE: The question paper shall be divided into three sections: Section A (10 marks) shall comprise of 10 compulsory questions of 1 marks each and not more than 4 questions from each Section (Answer is not more than 50 words). Section B (12 marks) shall comprise of two questions from each section and candidate has to attempt all questions from each Section , 2 marks for each question (Answer in not more than 200 words) and Section C (18 marks) shall comprise of three questions with not more than one question from each section and candidate has to answer all three, 6 marks for each question (Answer in not more than 500 words).

SECTION A

1. **Human karyotype-** Banding techniques, Human genome, Human chromosome and genetic map, chromosomal mapping, human pedigree analysis)
2. **Molecular cytogenetics-** FISH, GISH, DNA finger printing, PD-Loop techniques, chromosomal painting, PCR, DNA chip and microarrays.
3. **Genome organization-** C value paradox, prokaryotic genome, viral genome and eukaryotic genome.
4. **Somatic cell genetics-** Cell fusion and hybrids agents and mechanism of fusion; Heterokaryon- selecting hybrids and chromosome segregation.

SECTION B

1. **Biosensors**
2. **Immunological techniques based on Ag-Ab interactions**, ELISA, radioimmunoassay (RIA)
3. **Separation techniques and radioisotope and mass techniques in Biology:** electrophoresis, centrifugation, MRI,
4. Cryo-techniques, for microscopy, Freeze dying

SECTION C

1. **DNA sequencing and genome libraries:** preparation of template DNA, Automated DNA sequencing, DNA sequence storage and analysis.
2. **Animal and Human genomics:** C. elegans, Drosophila genome, Mouse genome, Human genome, genome of other animals.
3. **Molecular evolution:** Concept of neutral evolution, molecular divergence and molecular clock, molecular tools in phylogeny, classification and identification, proteins and nucleotide sequence analysis; origin of genes and proteins, gene duplication and divergence.
4. Genetic evidences for modern human origins-Tracing human history through mitochondrial DNA. The Neanderthal genome , another archaic huminin genome.

PAPER VIII : STATISTICAL METHODS IN BIOLOGY

Max marks 40

Min. Marks 10

Internal Assessment Max. Marks : 10

Min. Marks 3

NOTE: The question paper shall be divided into three sections: Section A (10 marks) shall comprise of 10 compulsory questions of 1 marks each and not more than 4 questions from each Section (Answer is not more than 50 words). Section B (12 marks) shall comprise of two questions from each section and candidate has to attempt all questions from each Section , 2 marks for each question (Answer in not more than 200 words) and Section C (18 marks) shall comprise of three questions with not more than one question from each section and candidate has to answer all three, 6 marks for each question (Answer in not more than 500 words).

SECTION A

1. Objective and significance; important terms (Sample, Population, Variable, Types of Sampling, Data : Types of Data) ; graphs (bar diagrams, histograms, frequency polygon, line diagrams, pie diagram)
2. Frequency distribution
3. Centering constants (Mean, Median and Mode)

SECTION B

1. Significance of difference in proportions:
Correlation : Definition, types, Karl Pearson's Coefficient of Correlation, Rank Correlation
Regression : Equations and Regression Lines
Probability Distribution : Binomial, Poisson and Normal
2. Measures of variation (Standard deviation, variance, standard error of the mean)
3. F-test, t-test

SECTION C

1. Statistical Modelling
(a) Types, Properties, and building of model
2. Chi-square test.
3. Analysis of variance (ANOVA)
4. Computer application in zoological study; software used in biomedical sciences (Image analysis, system automation)

SEMESTER II

Practical Work Based on Paper V to VIII

Day I

Max Marks 40

Min. Marks 16

Internal Assessment Max. Marks : 10

Min. Marks 4

1 Invertebrates:

- (i) Identification, classification & study distinguishing features of important representatives from various groups' (Annelida to Hemichordata).
- (ii) Study of permanent prepared slides (From Annelida to Hemichordata)

(ii) Preparation of culture of poriferans from local water bodies.

(iii) Study of sections of the arm of a starfish; water vascular system of starfish; general anatomy of a holothurian; Aristotle's lantern of a sea-urchin: complete as well as disarticulated arrangement of the parts of Aristotle's lantern.

2. Anatomy: .

(ii) Nervous system and general anatomy of Patella, Lamellidens, Mytilus, Sepia, Loligo, Octopus and Aplysia.

3. Permanent Preparation and Their Study :

(i) Permanent Preparation of different mounting material (Annelida to Hemichordata.)

4. Physiology:

i. Recording of Electrocardiogram, Muscle twitch, heart beat & the study of the effect of electrical stimulation, various ligatures, drugs, etc. through Computer simulation

ii. Estimation of blood pressure (Diastolic and Systolic).

iii. Photometric determination of haemoglobin in blood sample.

iv. Demonstration of the following in blood: clotting time, erythrocyte sedimentation rate, haemolysis and crenation. .

v. Determination of blood urea value.

vi. Enzyme activity of LDH and SDH.

5. Statistical Methods in Biology:

- i Preparation of frequency tables and graphs.
 - ii). Preparation of histogram, bar diagram and Line graph using computer.
 - iii)Calculation of standard deviation, variance and standard error of the mean. .
 - iv). Plotting the slope of a line on a graph, calculations of the slope of a line, regression coefficient.
 - v) Coefficient of Correlation
 - vi) Use of t -test.
 - vii. Use of Chi-square test.
- Students shall have to maintain a complete record of the work done.

Note: Use Of animals for dissection and practical work is subject to the conditions that these are not banned under the wildlife protection act.

SEMESTER II Practical Work Based on Paper V to VIII

DAY 2

Max Marks 40

Min. Marks 16

Internal Assessment Max. Marks : 10

Min. Marks 4

1. Biological Chemistry:

- i). Paper chromatography and thin layer chromatography:- uni-dimensional chromatography, using amino acids from purified samples and biological materials.
- II). Paper electrophoresis and Gel (SDS page and Agarose) electrophoresis; Determination of serum protein through paper and gel (SDS and Agarose electrophoresis)

2. Cell Biology:

- i. Preparation of thick and thin blood film smear.
- ii. Study of PBF (Peripheral blood film).
- iii. Eosinophil count in given/ own blood sample.

3: Genetics:

- i. Simple problems based on Mendelism to be done by the students.
- ii. Demonstration of sex chromatin.
- iii. Problems based on gene interaction to be done by the students.
- iv. Drosophila culture
- v. Culture and identification of male and female Drosophila.
- vi. Identification of wild and mutant forms of Drosophila.
- vii. Human Karyotype

Note: Use Of animals for dissection and practical work is subject to the conditions that these are not banned under the wildlife protection act

Semester II

PRACTICAL EXAMINATION SCHEME

BOARD FIRST: DAY FIRST

DURATION 4 HRS

1. Dissection/ Demonstration	06 Marks
2. Exercise in Physiology	06Marks
3. Exercise in Statistics	04 Marks
4. Permanent preparation (Higher Invertebrates)	04 Marks
5. Spot	10 Marks
6. Viva-voce	05 Marks
7. Class record	05 Marks
Total	40 Marks
Internal Assessment	10 marks
Grand Total	50 Marks

BOARD SECOND: DAY SECOND

DURATION 5 HRS

1. Exercise in Cell biology	08 Marks
2 Exercise in Genetics	08Marks
3. Permanent preparation	06Marks
4. Exercise in Biochemistry	08 Marks
5. Viva Voce	05 Marks
6. Class record	05 Marks
Total	40 Marks
Internal Assessment	10 Marks
Grand Total	50 Marks

M.SC. ZOOLOGY
Semester III

SEMESTER III

PAPER IX: CHORDATA

NOTE: The question paper shall be divided into three sections: Section A (10 marks) shall comprise of 10 compulsory questions of 1 marks each and not more than 4 questions from each Section (Answer is not more than 50 words). Section B (12 marks) shall comprise of two questions from each section and candidate has to attempt all questions from each Section, 2 marks for each question (Answer in not more than 200 words) and Section C (18 marks) shall comprise of three questions with not more than one question from each section and candidate has to answer all three, 6 marks for each question (Answer in not more than 500 words).

Max Marks 40

Min. Marks 10

Internal Assessment Max. Marks : 10

Min. Marks 3

SECTION A

1. Origin and outline classification of the chordates (Pisces to Mammals)
2. Interrelationships of Hemichordata, Urochordata and Cephalochordata and their relations with other Deuterostomes.
3. Life histories of sessile and pelagic tunicates and ascidian, Pyrosoma, Salpa, Doliolum and Oikopleura
4. Origin, evolution and adaptive radiation of vertebrates.
 - (a) Geological time scale and fossils
 - (b) Origin, evolution and general characters of Agnatha (Ostracoderms and Cyclostomes).
 - (c) The early gnathostome (Placodermi)
 - (d) A general account of the elasmobranchi, Holocephali, Dipnoi, Crossopterygi
 - (e) Adaptive radiation in bony fishes.

SECTION B

1. Origin, evolution and adaptive radiation of Amphibia
2. Origin and evolution of reptiles: the concept of land Seymouria and related forms: Cotylosauria, basic skull types and outline classification of reptiles.
3. Dinosaurs, types and evolutionary significance
4. Living reptiles- a brief account of Rynchocephalia. Chelonia, Crocodilia and Squamata

SECTION C

1. Origin and evolution of birds
2. Origin of flight: flight adaptations
3. Origins of mammals: Primitive mammals (Prototheria and Metatheria)
4. A general survey of the main radiations in eutherian mammals (excluding detailed reference to individual order)
5. Evolution of man: relationship of man with other Primates: fossil record of Man's ancestry.

PAPER X : ANIMAL BEHAVIOUR

The question paper shall be divided into three sections: Section A (10 marks) shall comprise of 10 compulsory questions of 1 marks each and not more than 4 questions from each Section (Answer is not more than 50 words). Section B (12 marks) shall comprise of two questions from each section and candidate has to attempt all questions from each Section, 2 marks for each question (Answer in not more than 200 words) and Section C (18 marks) shall comprise of three questions with not more than one question from each section and candidate has to answer all three, 6 marks for each question (Answer in not more than 500 words).

Max Marks 40 Min. Marks 10

Internal Assessment Max. Marks : 10 Min. Marks 3

SECTION A

1. Introduction to animal behavior
2. Behaviour of domestic and zoo animals
3. Orientation : Classification of various types of taxes and kineses.
4. Methods of studying behaviour: Brain lesions; electrical stimulation, drug administration. Effect of toxins, drugs and alcohol on human behaviour and addiction.

SECTION B

4. Types of behaviour and their regulation:
 - (i) Components of feeding behaviour, hunger drive, directional movement, avoidance, eating, carrying and hoarding
 - (ii) Factors influencing choice of food
 - (iii) Nervous regulation of food and energy intake
 - (a) Motivated behaviour, Drive, satiation and neuro-physiological control
 - (b) Feeding behaviour
 - (c) Learning: Habituation conditioned reflex: trial and error, latent learning, learning and discrimination, imprinting, neural mechanism of learning.
 - (d) Instinctive behaviour; concept, phyletic descent and physiology
 - (e) Hormones and behaviour, Mammalian nervous system with special reference to the involvement of hypothalamus in the regulation of behavioural patterns

SECTION C

1. Social behaviour in Primates
 - (a) Primate societies
 - (b) Social signals, olfactory, tactile, visual, vocal
 - (c) Status: Dominance and hierarchy territorial behaviour courtship and mating aggression.
3. Behaviour in birds: Behaviour of Streptopelia (ring dove); homing and migration
4. Reproductive behaviour in fish(Stickle back or any other fish)
5. Social behaviour in insects: Communication; concealment behavior; Role of pheromones (A general account)
6. Behavioural genetics: Single gene effect, multiple gene effect, behavioural variation in an individual, genetics and human behavior

PRACTICAL WORK BASED ON PAPER IX AND X

Max Marks 40
Internal Assessment Max. Marks : 10

Min. Marks 16
Min. Marks 4

1. Chordates

(a) Taxonomy: Study of museum specimens or representative, animals from all chordate groups (protochordates to mammals).

(b) Anatomy (Models, Charts, Computer simulation):

- (i) General anatomy and neural gland of Herdmania.
- (ii) Afferent and efferent arteries, cranial nerves of any commercial fish.
- (iii) Accessory respiratory organs of fishes
- (iv) Limb musculature, cranial nerves and eye muscles and their innervations in frog,
- (v) General anatomy, major blood vessels and cranial nerves of any nonpoisonous snake.
- (vi) Study of differences between poisonous and non-poisonous snakes.
- (vii) Flight muscles, perching mechanism, air sacs and anatomy of the neck region in the pigeon.
- (viii) Reproductive system and anatomy of the neck region in rat.
- (ix) General anatomy, digestive, respiratory and urinogenital systems in chick

(c) Permanent Preparations: Spicules and pharyngeal wall of Herdmania, velum and pharyngeal wall of Amphioxus. Whole mounts of pelagic tunicates, ampulla's of Lorenzini in a skate or ray; Different types of scales, ear ossicles of fish or any other animal.

(d) Histology: A detailed study of the histology of all mammalian tissues and organs through prepared slides to be made available .

2. Ethology:

- (a) Study of the process of learning in rat with the help of animal maze, analysis of the results of simple experiments.
- (b) Study of the shock and avoidance behaviour in rat including extinction and relearning; analysis of the result of these experiments
- (c) Chemical communication in the earthworm
- (d) Study of the food preferences and feeding behaviour of an insect pest.
- (e) Study of the phototactic response in Tribolium/Housefly
- (f) Study of habituation in chicks.

3. Zoological tour

Tour is compulsory for all the candidates to observe and study fauna in natural habitat.

(Note - use of animals for dissection/practical work is subject to the conditions that these are not banned under the Wild Life Protection Act and UGC guidelines.)

PAPER XI(A 1): CELL BIOLOGY

The question paper shall be divided into three sections: Section A (10 marks) shall comprise of 10 compulsory questions of 1 marks each and not more than 4 questions from each Section (Answer is not more than 50 words). Section B (12 marks) shall comprise of two questions from each section and candidate has to attempt all questions from each Section , 2 marks for each question (Answer in not more than 200 words) and Section C (18 marks) shall comprise of three questions with not more than one question from each section and candidate has to answer all three, 6 marks for each question (Answer in not more than 500 words).

Max Marks 40

Min. Marks 10

Internal Assessment Max. Marks : 10

Min. Marks 3

SECTION A

1. Concept of cell theory and historical development in cell biology
2. **Cell types:** detailed structure of the structure of the different types of cells
(i) Nerve cell (ii) Muscle cell (iii)Gland cell (iv) Blood cell

SECTION B

1. **Membrane structure and function:** various models of Plasma Membrane, osmosis, ion channels, active transport, ion pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes
2. **Structural organization and function of intracellular organelles:** Cell wall, nucleus, mitochondria, golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility

SECTION C

1. **Cell division and cell cycle:** Types of cell divisions and their regulation, control of cell cycle Physiological study of mitotic and meiotic divisions with special reference to the mechanism of chromosome movement and organization of the spindle apparatus, mitotic poisons and their actions
2. Gametogenesis : Spermatogenesis , Oogenesis & Fertilization including their mechanism and physiology

PAPER XI(A 2): CELL BIOLOGY

The question paper shall be divided into three sections: Section A (10 marks) shall comprise of 10 compulsory questions of 1 marks each and not more than 4 questions from each Section (Answer is not more than 50 words). Section B (12 marks) shall comprise of two questions from each section and candidate has to attempt all questions from each Section , 2 marks for each question (Answer in not more than 200 words) and Section C (18 marks) shall comprise of three questions with not more than one question from each section and candidate has to answer all three, 6 marks for each question (Answer in not more than 500 words).

Max Marks 40

Min. Marks 10

Internal Assessment Max. Marks : 10

Min. Marks 3

SECTION A

1. **Chromosomes:** Structural, chemical and functional organization of the different types of chromosomes (giant chromosomes, supernumerary chromosomes), Chromosomal aberration
2. **Gene organization:** Operon, interrupted genes, gene families, structure of chromatin and chromosomes, unique and repetitive DNA, heterochromatin, euchromatin, transposons

SECTION B

1. **Cell Signalling :** Hormones & their receptors, Signalling through G-Protein coupled receptors, Signal Transduction Pathways, Second Messengers.
2. **Cell Communication :** General Principles of Cell Communication, Cell adhesion & Role of Different Adhesion Molecules, Gap Junctions, Extra cellular Matrix, Integrins, Neurotransmissions and its Regulations.

SECTION C

1. **Cancer:** Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancer, metastasis, interaction of cancer cells with normal cells, apoptosis, therapeutic interventions of uncontrolled cell growth
2. **Apoptosis :** Extrinsic and Intrinsic pathways, Necrosis, Autophagy, Apoptosis in *C. elegans*.

PRACTICAL WORK BASED ON PAPER XI(A 1)AND XI(A 2) CELL BIOLOGY

The question paper shall be divided into three sections: Section A (10 marks) shall comprise of 10 compulsory questions of 1 marks each and not more than 4 questions from each Section (Answer is not more than 50 words). Section B (12 marks) shall comprise of two questions from each section and candidate has to attempt all questions from each Section , 2 marks for each question (Answer in not more than 200 words) and Section C (18 marks) shall comprise of three questions with not more than one question from each section and candidate has to answer all three, 6 marks for each question (Answer in not more than 500 words).

Max Marks 40

Min. Marks 10

Internal Assessment Max. Marks : 10

Min. Marks 3

1. Handling and operation of following apparatus and equipments:
 - (a) Phase Contrast Microscope
 - (b) Electrophoretic, Chromatographic and electrophysiological equipments
2. Microtomy - Wax, fresh, frozen and fixed frozen sections
3. Study of stained preparations of mitochondria and golgi bodies under the light Microscope
4. Biochemical estimations of the following in various tissues:
 - (a) Lipids: Cholesterol
 - (b) Carbohydrates: Glycogen, Blood Glucose
 - (c) Proteins
 - (d) Amino acids: chromatographic and electrophoretic separation
 - (e) Ascorbic acid

5. Preparation of Karyotype in animal tissue
6. Field visit to Centres of research for knowledge of different instruments, artificial insemination etc. and preparing field report
7. Spotting :
 - (a). Study of Different stages of Mitosis
 - (b). Equipments used in Cell Biology

PAPER XI (B 1): ENVIRONMENTAL BIOLOGY

The question paper shall be divided into three sections: Section A (10 marks) shall comprise of 10 compulsory questions of 1 marks each and not more than 4 questions from each Section (Answer is not more than 50 words). Section B (12 marks) shall comprise of two questions from each section and candidate has to attempt all questions from each Section , 2 marks for each question (Answer in not more than 200 words) and Section C (18 marks) shall comprise of three questions with not more than one question from each section and candidate has to answer all three, 6 marks for each question (Answer in not more than 500 words).

Max Marks 40

Min. Marks 10

Internal Assessment Max. Marks : 10

Min. Marks 3

SECTION A

1. Concepts and Scope Environmental Biology, Earth, man and environment.
2. The earth systems and Biosphere: Conservation of matter in various geospheres- lithosphere, hydrosphere, atmosphere and biosphere. Climates of India.
3. Impact of environment at cellular level: Cellular interaction with environment with special reference to pH, light, temperature and salinity.

SECTION B

1. Environmental Physiology: Ecophysiological adaptations with special reference to desert, high altitudes lotic, marine environment, Hibernation and aestivations. Poikilo-therms and Homeotherms. Response to temperature and pressure. Thermal properties of water and survival limits. Acclimatization.

SECTION C

1. A detailed study of different ecosystems: Study will include Abiotic and biotic components and their interrelationships, productivity and adaptations of animals.
Terrestrial ecosystems: Grasslands, including grazing lands.

PAPER XI (B 2): ENVIRONMENTAL BIOLOGY

The question paper shall be divided into three sections: Section A (10 marks) shall comprise of 10 compulsory questions of 1 marks each and not more than 4 questions from each Section (Answer is not more than 50 words). Section B (12 marks) shall comprise of two questions from each section and candidate has to attempt all questions from each Section , 2 marks for each question (Answer in not more than 200 words) and Section C (18 marks) shall comprise of three questions with not more than one question from each section and candidate has to answer all three, 6 marks for each question (Answer in not more than 500 words).

Max Marks 40
Internal Assessment Max. Marks : 10

Min. Marks 10
Min. Marks 3

SECTION A

A detailed study of different ecosystems: Study will include Abiotic and biotic components and their interrelationships, productivity and adaptations of animals.

- (I) Forests: Characteristics of alpine, temperate and tropical forests. Stratification. High altitude with special reference to Himalayan Ecology.
- (II) Deserts: Types and ecological attributes of desert biota.
- (III) Taiga: Extent and ecological peculiarities.
- (IV) Tundra: Extent and ecological peculiarities.

SECTION B

Aquatic Ecosystems :

- (i) Fresh water: Lakes including salt lakes, ponds streams, springs, rivers and marshes.
- (ii) Marine ecosystem: Zonation, fauna.
- (iii) Estuarine: Ecological peculiarities, adaptations including impact on fauna.

Major biogeographic (zoogeographic and phytogeographic) regions of the world and India, extent, characteristics and species composition.

SECTION C

Development and evolution of ecosystems, causes and kinds of succession. Diversity and productivity in relation to stages of succession and development.

Urban, rural and other man made ecosystems their impact on flora and fauna, socio-ecological impacts of urbanization and industrialization.

PRACTICALS FOR ENVIRONMENTAL BIOLOGY XI B1 & XI B2

Max marks 40
Internal Assessment Max. Marks : 10

Min. Marks 16
Min. Marks 4

1. Water quality analysis (Physico- chemical parameters).
 - (a) Temperature
 - (b) pH
 - (c) Dissolved oxygen
 - (d) Acidity
 - (e) Hardness
 - (f) Alkalinity
 - (g) Chlorides.
 - (h) Sulphates
 - (i) Total dissolved solids
 - (j) BOD
 - (k) COD
2. Microscopic examination of water: Indicators of pollution, Phytoplanktons and littoral fauna and flora and slide preparation of phytoplankton.
3. Bioassays of polluted waters using fish or other aquatic organisms.
4. Spots:- Local Fauna
5. Sampling procedures and report on a case study.
6. Statistical Analysis : Grouping of data and preparation of frequency distribution. Histogram and frequency polygon; Calculating mean, median and mode for grouped and ungrouped data; Calculating standard deviation for grouped and ungrouped data; Fitting simple linear regression.

(Students are Supposed to give complete ecological report of the trip)

PAPER XI (C 1): ENTOMOLOGY

The question paper shall be divided into three sections: Section A (10 marks) shall comprise of 10 compulsory questions of 1 marks each and not more than 4 questions from each Section (Answer is not more than 50 words). Section B (12 marks) shall comprise of two questions from each section and candidate has to attempt all questions from each Section , 2 marks for each question (Answer in not more than 200 words) and Section C (18 marks) shall comprise of three questions with not more than one question from each section and candidate has to answer all three, 6 marks for each question (Answer in not more than 500 words).

Max Marks 40

Internal Assessment Max. Marks : 10

Min. Marks 10

Min. Marks 3

SECTION A

History of Entomology : A general idea of fossil insects, evolution of insects; Insect classification (up to orders and suborders).

SECTION B

Detailed classification of important and selected super families and families of the following orders of economic importance: Orthoptera, Isoptera, Homoptera, Hemiptera

SECTION C

Detailed classification of important and selected super families and families of the following orders of economic importance: Lepidoptera, Diptera, Coleoptera and Hymenoptera

PAPER XI (C 2): ENTOMOLOGY

The question paper shall be divided into three sections: Section A (10 marks) shall comprise of 10 compulsory questions of 1 marks each and not more than 4 questions from each Section (Answer is not more than 50 words). Section B (12 marks) shall comprise of two questions from each section and candidate has to attempt all questions from each Section , 2 marks for each question (Answer in not more than 200 words) and Section C (18 marks) shall comprise of three questions with not more than one question from each section and candidate has to answer all three, 6 marks for each question (Answer in not more than 500 words).

Max Marks 40

Internal Assessment Max. Marks : 10

Min. Marks 10

Min. Marks 3

SECTION A

Insect morphology: Head, thorax, abdomen and their appendages ; Integument

SECTION B

Functional organization of Muscular, digestive, circulatory, respiratory, excretory, reproductive systems

SECTION C

Functional organization of Nervous and endocrine systems; sense organs, sound and light producing organs.

Embryology: Structure of a typical insect egg, types of metamorphosis met within insects, development: embryonic and post embryonic, diapause.

ENTOMOLOGY PRACTICAL BASED ON PAPER XI C 1 & C 2

Max marks 40

Min. Marks 16

Internal Assessment Max. Marks : 10

Min. Marks 4

1. Knowledge and use of equipment for the collection and preservation of insects, insect net, killing bottle, spreading board, insect box device for inflating larva, light trap, etc.
2. Collection and preservation of insects and their different stages.
3. Collection of seasonal insects, nocturnal insects, aquatic insects, crop pests, stored grain pests and insects of medical and veterinary importance.
4. Identification of insects families from various orders prescribed for study in the syllabus. .
5. Permanent preparations: wings, mouth parts, antennae, legs, spiracles, sting etc. of insects.
6. A visit to local farm houses/ gardens for study of various pests of vegetables and crops.

PAPER XI (D 1): FISH BIOLOGY

The question paper shall be divided into three sections: Section A (10 marks) shall comprise of 10 compulsory questions of 1 marks each and not more than 4 questions from each Section (Answer is not more than 50 words). Section B (12 marks) shall comprise of two questions from each section and candidate has to attempt all questions from each Section , 2 marks for each question (Answer in not more than 200 words) and Section C (18 marks) shall comprise of three questions with not more than one question from each section and candidate has to answer all three, 6 marks for each question (Answer in not more than 500 words).

Max Marks 40

Min. Marks 10

Internal Assessment Max. Marks : 10

Min. Marks 3

SECTION A

1. General account and phylogenetic significance of ostracoderms and placoderms.
2. Classification of fishes, with distinguishing characters of the principal subdivisions.

SECTION B

- 1.. Origin and adaptive radiation of various groups.
2. Geographical distribution
3. Body form and locomotion

SECTION C

1. Integument and exoskeleton
2. Structure, modification and functions of fins
3. Theories of origin of median and paired fins

PAPER XI (D 2): FISH BIOLOGY

The question paper shall be divided into three sections: Section A (10 marks) shall comprise of 10 compulsory questions of 1 marks each and not more than 4 questions from each Section (Answer is not more than 50 words). Section B (12 marks) shall comprise of two questions from each section and candidate has to attempt all questions from each Section, 2 marks for each question (Answer in not more than 200 words) and Section C (18 marks) shall comprise of three questions with not more than one question from each section and candidate has to answer all three, 6 marks for each question (Answer in not more than 500 words).

Max Marks 40

Internal Assessment Max. Marks : 10

Min. Marks 10

Min. Marks 3

SECTION A

1. Endoskeleton
2. Musculature
3. Food & alimentary canal, physiology of digestion.
4. Blood vascular system and circulation of blood

SECTION B

1. Respiratory organs, physiology of respiration and regulation of breathing, air-breathing organs.
2. Structure, function and physiology of the swim bladder.
3. Weberian apparatus.

SECTION C

1. Excretory organs and the physiology of excretion, Osmoregulation.
2. Nervous system and sense organs.
3. Endocrine glands, hormones & reproductive behaviour, gonads, reproduction development and hatching, viviparity

FISH BIOLOGY PRACTICAL BASED ON PAPER XI D 1 & D 2

Max marks 40

Internal Assessment Max. Marks : 10

Min. Marks 16

Min. Marks 4

1. Dissection/demonstration:

Complete anatomy of a teleost, represented by *Wallago* or any other locally available fish: external features. General viscera; including the urinogenital organs, jaw and lateral musculature, including the nerve supply, afferent and efferent branchial blood vessels, brain and cranial

nerves; eye muscles and their innervation; membranous labyrinth, Weberian ossicles- swim bladder connection, dry and alizarin preparations of the skeleton and its study

2..Study of breathing organs in a fish of commercial use (*Channa* and *Heteropneustes* or any cat fish).

3. (a). Periodical visits to a local fishing farm of fish centre to gain a first hand knowledge of its pisciculture practices and fisheries activities

(b. A week's tour of an inland fisheries research station of Pisciculture centre. The suggested places for the tour are Udaipur;- Rana Pratap Sager Dam at Kota, Alwar, Bhartapur, Allahabad, Cuttack and Barrackpore

Note: A record of the work done under 3 Items has to be compulsorily submitted by each candidate.

(Note: Use of animals for dissection/practical work is subject to the conditions that these are not banned under the wild life protection act and UGC guidelines.)

4. External features, cranial nerves and membranous labyrinth of any ray.

5. Permanent preparations and study of different scales.

6. Spotting based on Museum Specimens Elasmobranchii, Dipnoi & Holocephali

SEMESTER III

(Duration 4h)

SCHEME OF PRACTICAL EXAMINATION AND DISTRIBUTION OF MARKS

General Chordates and Ethology

(a) Chordate's major dissection/demonstration	05 Marks
(b) Permanent preparation/Microtomy	05 Marks
(c) Exercise in Ethology	06 Marks
(d) Tour Report	04 Marks
(e) Identification and comments of spots (5)	10 Marks
(f) Viva- voce	05 Marks
(g) Class Record	05 Marks
Total	40 Marks
Internal Assessment	10 marks
Grand Total	50 Marks

(Special paper)

(a) Cell Biology

(a) Exercise histo-chemical or cyto-chemical techniques in tissue	07 Marks
(b) Isolation of DNA	05 Marks
(c) Light Microscopic Preparation of spermatozoa/ Meiotic Chromosome Study	05 Marks
(d) Spot	08 Marks
(e) Project /Field report	05 Marks
(f) Viva- voce	05 Marks
(g) Class Record	05Marks
Total	40 Marks
Internal Assessment	10 marks
Grand Total	50 Marks

(b) Entomology

(a) Identification of 3 insects using taxonomic key	09 Marks
(b) Permanent preparation	05 Marks
© Study of Pests	04 Marks
(d) Spots (4)	08 Marks
(e) Project/Field Report	04Marks
(f) Viva- voce	05 Marks
(g) Class Record	05 Marks
Total	40 Marks
Internal Assessment	10 marks
Grand Total	50 Marks

(c) Fish Biology

(a) Major Dissection/ demonstration	7 Marks
(b) Minor dissection/demonstration	04 Marks
(c) Permanent preparation	5 Marks
(d) Identification and comments on Spots (5)	10 Marks
(e) Viva-voce	05 Marks
(f) Class Record	05 Marks
(g)Field Report	04 Marks
Total	40 Marks
Internal Assessment	10 marks
Grand Total	50 Marks

(d)Environmental Biology

(a) Water analysis	07 Marks
(b) Microscopic Examination of water and slide preparation(Phytoplankton)	05 Marks
(c) Bioassay method/Statistical method	05 Marks
(d) Spots (4)	08 Marks
(e) Project report (Case Study)	05 marks
(f) Viva- voce	05 Marks
(g) Class Record	05 marks
Total	40 Marks
Internal Assessment	10 marks
Grand Total	50 Marks

SEMESTER IV**PAPER XII : DEVELOPMENTAL BIOLOGY**

The question paper shall be divided into three sections: Section A (10 marks) shall comprise of 10 compulsory questions of 1 marks each and not more than 4 questions from each Section (Answer is not more than 50 words). Section B (12 marks) shall comprise of two questions from each section and candidate has to attempt all questions from each Section , 2 marks for each question (Answer in not more than 200 words) and Section C (18 marks) shall comprise of three questions with not more than one question from each section and candidate has to answer all three, 6 marks for each question (Answer in not more than 500 words).

SECTION A

1. Theories of Development. Preformation and Epigenesis
2. Oogenesis
 - (a) Growth of oocyte and Vitellogenesis
 - (b) Organization of egg cytoplasm; role of the egg cortex:
 - (c) Morphogenetic determination in egg cytoplasm.
- Spermatogenesis
3. Fertilization; significance of fertilization for development and the essence of activation of the egg.
4. Early embryonic development:
 - (a) Patterns of cleavage, blastulation & gastrulation in chordates (Tunicates to mammals).
 - (b) Fate maps.
 - (c) Morphogenetic movements.
 - (d) Mechanics and significance of gastrulation. .
5. Causal basis of development: Primary embryonic induction:
 - (a) Concepts of potencies; prospective fates; Progressive determination, Totipotency and Nuclear transfer experiment.
 - (b) Induction of the primitive nervous system (Spemann's primary organizer).
 - (c) Nature & regionally specific properties of inductor.
 - (d) Competence.
 - (e) Abnormal (heterogeneous) inductors.
 - (f) Chemistry & mechanism of action inducing substances.

SECTION B

1. Cell differentiation and differential activity
2. Organogenesis:
 - (a) Morphogenetic processes in epithelia and mesenchyme in organ formation.
 - (b) Morphogenesis- of the brain; neural crest cells and their derivatives.
 - (c) Development of the eye, heart & alimentary canal and its accessory organs.
3. Maternal contribution in early embryonic development
4. Genetic regulation of early embryonic development (Drosophila development as a model).

SECTION C

1. Embryonic adaptations:
 - (a) Evolution of the cleidoic egg and its structural and physiological adaptations.
 - (b) Development & physiology of the extra- embryonic membranes in amniotes. .
 - (c) Evolution of viviparity.
 - (d) Development, types and physiology of the mammalian placenta.
 2. Metamorphosis in Amphibia
 - (a) Structural & Physiological changes during metamorphosis.
 - (b) Endocrine control of metamorphosis.
 3. Regeneration:
 - (a) Types of regeneration, physiological, reparative and compensatory hypertrophy regenerative ability in chordates. .
 - (b) Morphological and histological process in amphibian limb regeneration.
- © Wolffian regeneration

(d) Origin of cells of regeneration, de-differentiation, re-differentiation, pattern formation during amphibian limb regeneration, reasons for the absence of limb regenerative ability in mammals. Methods for induction of regenerations.

PAPER XIII : ANIMAL ECOLOGY

The question paper shall be divided into three sections: Section A (10 marks) shall comprise of 10 compulsory questions of 1 marks each and not more than 4 questions from each Section (Answer is not more than 50 words). Section B (12 marks) shall comprise of two questions from each section and candidate has to attempt all questions from each Section, 2 marks for each question (Answer in not more than 200 words) and Section C (18 marks) shall comprise of three questions with not more than one question from each section and candidate has to answer all three, 6 marks for each question (Answer in not more than 500 words).

Max Marks 40

Min. Marks 10

Internal Assessment Max. Marks : 10

Min. Marks 3

SECTION A

1. Concepts of modern ecology.
2. Limiting factors: Liebig's law of minimum, Shelford's law of tolerance; combined concept of limiting factors, conditions of existence as regulatory factors.
3. Analysis of Environment
 - (a) The general environment.
 - (b) Role of Physical factors: temperature, light water; atmospheric gases, the media, substratum, climatology.
 - (c) Brief review of important physical factors as limiting factor.
 - (d) Nutrients and environment.

SECTION B

1. Organization at the population level:
 - (a) General properties of population.
 - (b) Population growth form and forces shaping the population growth.
 - (c) Measurement of Population. Simple numerical problems on measurement of population to be done.
 - (d) Animal aggregation and social life.
2. Organization at the community level:
 - (a) Biotic community concept.
 - (b) Community structure and concept of community dominance.
 - (c) Ecotone and concept of "edge effect".
 - (d) Pattern in communities: Stratification, zonation, activity, food web, reproductive and social structure.
 - (e) Community versus the continuum.
 - (f) Evolution of Communities; Palaecology; Community structures in past ages.
3. Ecological regulations:
 - (a) Succession in community: Basic types of succession, convergence and divergence in succession; modifications in succession; concept of climax, mono-climax versus poly-climax theory; barriers and ecesis in succession; Biome.
 - (b). Fluctuations within Community; irruptive cycle, fluctuation, causes of fluctuation cycles.

SECTION C

1. Environment and animals:
 - a. Nature and constituents of ecosystem.
 - b. Fundamental, operation of ecosystem
 - c. Flow of matter and energy in ecosystem
 - d. Homeostasis in the ecosystem
 - e. Cycling of chemical elements in ecosystem.
 - f. Concept of productivity: Productivity of land and water, measurement of productivity.
2. Organization and dynamics of ecological communities : The habitat approach: A detailed knowledge of extent, Zonation, environment biota, adaptations and communities of fresh water, marine, terrestrial and estuarine ecosystems.
3. The ecological outlook: Space ecology, nuclear radiation, Climate change, Environmental challenges

PRACTICAL WORK BASED ON PAPER XII AND XIII

Max marks 40

Min. Marks 16

Internal Assessment Max. Marks : 10

Min. Marks 4

1. Development Biology:

- (a) Study of development of frog or toad through:
 - (i) Formalin preserved or living material (egg, spawn, embryo, larvae and metamorphic stages).
 - (ii) Permanent microscopic slide of sections through representative regions of successive embryonic and larval stages
- (b) Study of development of chick through
 - (i) Permanent whole mounts of successive embryonic stages and
 - (ii) Permanent microscopic slides of sections through representative regions of successive embryonic stages (Special emphasis should be laid on organogenesis and morphogenesis)
- (c) Removal of chick embryos 18, 21, 24, 33, 72 and 92 hours from the egg and their study and identification in the living state.
- (d) Study of (i) formalin preserved fetuses with placenta and (ii) histology of placenta of any mammal.

2. Ecology:

- (a) Measurement of climatic factors (atmospheric, water, temperature and relative humidity)
- (b) Measurement of water, soil pH, edaphic factors of soil, preparation of soil extract, determination of humidity in microhabitat. pH, Alkalinity of water; pH, dissolve oxygen, free carbon dioxide, chloride, salinity, temporary and permanent hardness of water, velocity of current.
- (c) Measurement of population density, Numerical problems of population determination to be done
- (d) A field study of any one of the following habitat to be assigned to an individual or to a group of students.
- (e) Mode of life and types of beak and feet in birds.

3. Osteology:

Comparative study of the axial and appendicular skeleton from amphibia to mammals, with particular reference to important skull types in reptiles, birds and mammals.

Alizarins and Victoria-blue preparation of the skeleton of any vertebrate, dried and articulated preparation of the skeleton of any vertebrate.

PAPER XIV(A 1): CELL BIOLOGY

The question paper shall be divided into three sections: Section A (10 marks) shall comprise of 10 compulsory questions of 1 marks each and not more than 4 questions from each Section (Answer is not more than 50 words). Section B (12 marks) shall comprise of two questions from each section and candidate has to attempt all questions from each Section, 2 marks for each question (Answer in not more than 200 words) and Section C (18 marks) shall comprise of three questions with not more than one question from each section and candidate has to answer all three, 6 marks for each question (Answer in not more than 500 words).

Max Marks 40

Internal Assessment Max. Marks : 10

Min. Marks 10

Min. Marks 3

SECTION A

1. Cell and tissue culture:

- (a) Behaviour of cells in culture
 - (b) Primary and established cell lines; kinetics of cell growth
 - (c) Natural and defined media for culture
 - (d) Importance of cell and tissue culture
2. Primary tissue explantation technique, organ culture
 3. Basic concept of cloning; methods and utility.

SECTION B

1. Chemical basis of "fixation" and "staining" and a discussion on the following techniques:

- (a) Freeze substitution
- (b) Freeze drying
- (c) Fresh and fixed frozen sections
- (d) PAS, Metachromasia, Feulgen, lipid and protein staining techniques
- (e) Centrifugation and ultra-centrifugation
- (f) Single two dimensional & column chromatography
- (g) Intra-vital and supra-vital staining
- (h) Paper, gel and disc electrophoreses

2. Role and mechanism of action of the following enzymes at the cellular level:

- (a) ATPase
- (b) Succinic dehydrogenase
- (c) Acid and alkaline phosphatases
- (d) Hyaluronidase

SECTION C

1. Elementary concept of the principle & theory of microscopy as exemplified by the following:

- (a) Phase contrast microscopy
- (b) Interference microscopy
- (c) Polarizing microscopy
- (d) Fluorescence microscopy
- (e) Electron microscopy
- (f) Ultra violet microscopy

PAPER XIV(A 2): CELL BIOLOGY

The question paper shall be divided into three sections: Section A (10 marks) shall comprise of 10 compulsory questions of 1 marks each and not more than 4 questions from each Section (Answer is not more than 50 words). Section B (12 marks) shall comprise of two questions from each section and candidate has to attempt all questions from each Section , 2 marks for each question (Answer in not more than 200 words) and Section C (18 marks) shall comprise of three questions with not more than one question from each section and candidate has to answer all three, 6 marks for each question (Answer in not more than 500 words).

Max Marks 40

Min. Marks 10

Internal Assessment Max. Marks : 10

Min. Marks 3

SECTION A

1. **Immune Response: Different types of immunity, Cellular aspects of Innate and Adaptive Immunity** : T and B Cells Structure and Function. Antigens, Antigenecity and molecules involved in innate and adaptive immunity, antigens, antigenecity and immunogenicity. MHC molecules, antigen processing and presentation, activation and differentiation of B and T cells, B and T cell receptors, humoral and cell-mediated immune responses. Primary and secondary immune modulation, the complement system, Toll-like receptors

SECTION B

1. Structure and function of antibody molecules, generation of antibody diversity, monoclonal antibodies, antibody engineering, antigen-antibody interactions. Inflammation, hypersensitivity and autoimmunity. Immune response during bacterial (tuberculosis), parasitic (malaria) and viral (HIV) infections, congenital and acquired immunodeficiencies, vaccines

SECTION C

1. A general account of the effect of ionizing radiation at the cellular level
2. Elementary ideas of the origin of following diseases:
(a) Glycogen storage disease (b) AIDS
3. Cellular aspects of the process of ageing
4. Molecular Maps of Animal Genomes: Molecular markers; Mapping population and Computer softwares, Genetic maps, cytogenetic maps, physical maps, integrated genomic maps, linkage disequilibrium (LD), Maps of the future, Sequencing of Genomes.

PRACTICAL WORK BASED ON PAPER XIV(A 1) AND XIV(A 2) **CELL BIOLOGY**

Max marks 40

Min. Marks 16

Internal Assessment Max. Marks : 10

Min. Marks 4

1. Study of germ cells; smear preparation of spermatozoa from vas deferens (vital staining) and permanent preparation of a single ovum

2. Histo-cytochemistry:
 - (a) Methyl green-pyronin -method
 - (b) Feulgen staining
 - (c) Periodic acid schiff method
 - (d) Alcian blue/ Bromophenol blue method
3. Histo,cytochemical staining of Enzymes in animal tissue:

Staining of alkaline and acid phosphates, total proteins, Glucose 6 Phosphatase
4. Isolation of DNA from Onion tissue extract
5. Meiotic chromosome from Grasshopper/Cockroach testis by Squash Method
6. Spotting :

Different stages of Meiotic Division
Mammalian Histological slides
7. Field visit to Centers of research for knowledge of different instruments, artificial insemination etc. and preparing field report

PAPER XIV(B 1): ENVIRONMENTAL BIOLOGY

The question paper shall be divided into three sections: Section A (10 marks) shall comprise of 10 compulsory questions of 1 marks each and not more than 4 questions from each Section (Answer is not more than 50 words). Section B (12 marks) shall comprise of two questions from each section and candidate has to attempt all questions from each Section , 2 marks for each question (Answer in not more than 200 words) and Section C (18 marks) shall comprise of three questions with not more than one question from each section and candidate has to answer all three, 6 marks for each question (Answer in not more than 500 words).

Max Marks 40

Min. Marks 10

Internal Assessment Max. Marks : 10

Min. Marks 3

SECTION A

1. History of man and his cultural evolution in relation to impact on environment.
2. Management of Environment: Natural resources, their conservation and development:
 - (i) Agriculture and forestry including pest management.
 - (ii) Wild life resources.

SECTION B

1. Mineral resources.
2. Aquaculture (Fresh and Marine)
3. Energy resources
4. River basin

SECTION C

1. Pollution: (Monitoring, sources, effect and control)
 - (a) Water
 - (b) Air
 - (c) Land
 - (d) Thermal
 - (e) Noise
 - (f) Radiation
2. Municipal water supply, sewage and its treatments
3. Environmental health
 - (a) Urban health problem. Impact of urbanization stress, Health status and health problem.
 - (b) Rural health problem
 - (c) Occupational health

PAPER XIV(B2): ENVIRONMENTAL BIOLOGY

The question paper shall be divided into three sections: Section A (10 marks) shall comprise of 10 compulsory questions of 1 marks each and not more than 4 questions from each Section (Answer is not more than 50 words). Section B (12 marks) shall comprise of two questions from each section and candidate has to attempt all questions from each Section, 2 marks for each question (Answer in not more than 200 words) and Section C (18 marks) shall comprise of three questions with not more than one question from each section and candidate has to answer all three, 6 marks for each question (Answer in not more than 500 words).

Max Marks 40

Min. Marks 10

Internal Assessment Max. Marks : 10

Min. Marks 3

SECTION A

1. Environmental legislation in Indian perspective
 - (i) Wildlife Protection Act 1972
 - (ii) Environmental Protection Act 1986
 - (iii) Biological Diversity Act 2002
 - (iv) International Conventions and Treaties

SECTION B

1. Environmental toxicology: Natural and man made toxicants in the environment and their impact on animal life in different ecosystems; Safety measures; Disposal and management of different types of wastes
2. Current Environmental Issues: Green House Effect, Ozone layer depletion, Desertification, Soil erosion, Population explosion, Sustainable development

SECTION C

1. Methodology for environmental analysis:
 - (a) Monitoring
 - (b) Analysis of physical and chemical factors.
 - (c) Statistical analysis
 - (d) Bioassay techniques.
2. Environmental Impact Assessment

PRACTICALS FOR ENVIRONMENTAL BIOLOGY XIV B 1 & XIV B2

Max marks 40

Min. Marks 16

Internal Assessment Max. Marks : 10

Min. Marks 4

1. Air quality monitoring for:
 - (a) Settled matter
 - (b) Suspended particulate matter
2. Soil/ Sediment analysis
 - (a) EC
 - (b) pH
 - (c) Alkalinity
 - (d) Organic matter
 - (e) Texture
 - (f) Salinity
3. Microscopic examination of water: Indicators of pollution, Zooplanktons and benthic fauna. Slide Preparation.
4. Statistical analysis: Plotting scatter diagram and regression line; Computing correlation coefficient and testing its significance for grouped and ungrouped data.

5.Spots

- (i). Micro and Macro Aquatic Flora and Fauna
- (ii). Instruments/Equipment in environmental studies: viz., pH meter, Turbidimeter, Conductivity meter, Spectrophotometer, Flame photometer, Centrifuge, BOD incubator, COD Flux unit, Air, water and mud samplers, Min.-Max. thermometer, Dry-Wet bulb thermometer, Barometer, Wind wane, Rain gauge, GPS, etc.

6. Field trip to any of the following habitats:

- (a) Forest: Wild life sanctuary
- (b) Fresh water habitat
- (c) Marine habitat
- (d) Semi arid habitat

(Students are expected to give complete ecological report of the trip including ecosystem structures; indicators and estimation of environmental degradation, if any)

Note: Use of animal for dissection and practical work is subject to the conditions that these are not banned under the Wildlife Protection Act and UGC guidelines

PAPER XIV(C 1): ENTOMOLOGY

The question paper shall be divided into three sections: Section A (10 marks) shall comprise of 10 compulsory questions of 1 marks each and not more than 4 questions from each Section (Answer is not more than 50 words). Section B (12 marks) shall comprise of two questions from each section and candidate has to attempt all questions from each Section , 2 marks for each question (Answer in not more than 200 words) and Section C (18 marks) shall comprise of three questions with not more than one question from each section and candidate has to answer all three, 6 marks for each question (Answer in not more than 500 words).

Max Marks 40

Min. Marks 10

Internal Assessment Max. Marks : 10

Min. Marks 3

SECTION A

Definition of pest; Types of pest; General idea of damage caused by pests; Principal methods of pest control: Physical, Mechanical, Cultural, Use of Botanicals, Biological and Legal;

SECTION B

The concept of IPM; A general idea of plant protection organization in India

Development of resistance to chemicals

Ecology: effect of physical factors. Intra specific and inter-specific relations; dynamics of population

SECTION C

Chemical control: Insecticides: their chief types, modes of action and methods of application/ formulation; a general idea of appliances used in the application of insecticides and their safe handling.

PAPER XIV (C 2): ENTOMOLOGY

The question paper shall be divided into three sections: Section A (10 marks) shall comprise of 10 compulsory questions of 1 marks each and not more than 4 questions from each Section (Answer is not more than 50 words). Section B (12 marks) shall comprise of two questions from each section and candidate has to attempt all questions from each Section , 2 marks for each question (Answer in not more than 200 words) and Section C (18 marks) shall comprise of three questions with not more than one question from each section and candidate has to answer all three, 6 marks for each question (Answer in not more than 500 words).

Max Marks 40

Internal Assessment Max. Marks : 10

Min. Marks 10

Min. Marks 3

SECTION A

A general knowledge of chemosterilants, attractants, repellants, pheromones, growth regulators and other compounds

Life history, damage caused and control of stored grain pests of cereals and pulses (including general idea of storage)

SECTION B

Life history, damage caused and control of 3 major pests of the main crops: wheat, paddy, maize, jowar, millet, sugarcane, cotton and oil seeds

Social life in Isoptera and Hymenoptera, caste determination in social insects;

Life cycle of aphids, Phase theory of locust

SECTION C

Beneficial insects: Silkworm, honey bee and lac insect and industries related to them; Insects as vectors of diseases and their control– mosquitoes, house flies, sand flies, lice, fleas. Insect borne diseases of man – Typhus, yellow fever, dengue fever, malaria, encephalitis, plague, leishmaniasis ; Forensic Entomology : Subfields, Scope and Applications. Importance of Insects in medico-legal investigations

ENTOMOLOGY PRACTICAL BASED ON PAPER XIV C 1 & C 2

Max marks 40

Internal Assessment Max. Marks : 10

Min. Marks 16

Min. Marks 4

1. Dissections of grasshopper, locust, house cricket, bug, honey bee, wasp, beetle to study important features of the digestive, circulatory, respiratory, excretory, nervous, reproductive and neuroendocrine systems.

2. Familiarity with techniques and appliances of applying insecticides, experiments for testing the insecticides.

3. Knowledge of rearing insects and of maintaining the insectary.

4. Exercise in ecology: Soil pH, water pH, free carbon dioxide; dissolved oxygen, chlorides, total alkalinity and total salinity.

5. Drosophila culture in Laboratory: Collection, Handling and Identification of Male and Female Drosophila

6. A tour to visit important centers of entomological studies.

(Note : Use of animal for dissection and practical work is subject to the conditions that these are not banned under the Wildlife Protection Act and UGC guidelines.)

PAPER XIV (D 1): FISH BIOLOGY

The question paper shall be divided into three sections: Section A (10 marks) shall comprise of 10 compulsory questions of 1 marks each and not more than 4 questions from each Section (Answer is not more than 50 words). Section B (12 marks) shall comprise of two questions from each section and candidate has to attempt all questions from each Section , 2 marks for each question (Answer in not more than 200 words) and Section C (18 marks) shall comprise of three questions with not more than one question from each section and candidate has to answer all three, 6 marks for each question (Answer in not more than 500 words).

Max Marks 40

Internal Assessment Max. Marks : 10

Min. Marks 10

Min. Marks 3

SECTION A

1. A general survey of world fisheries, survey of principal fisheries of India (Fresh water, estuarine and marine).
2. Plankton in relation to fisheries.
3. The biology of Indian major carps, catfishes, Hilsa, sardine, mackerel, sharks, prawns and oysters.

SECTION B

1. Pisciculture and its importance, with special reference to India.
2. A brief outline on the methods of fishing in fresh water of India. Crafts & Gears used in fishing.
3. Biochemical composition of fish; fish as food.
4. Bi-products of fishing industry, with special reference to India.

SECTION C

1. Ecological factors affecting the life of fishes; marine ecosystems.
2. Fish and mankind.
3. Age and growth determination in fishes
4. Population dynamics: Estimation of population number and mortality rates in fresh waters
5. Fecundity: eggs and life history of fish production with special reference to fresh water

PAPER XIV(D 2): FISH BIOLOGY

The question paper shall be divided into three sections: Section A (10 marks) shall comprise of 10 compulsory questions of 1 marks each and not more than 4 questions from each Section (Answer is not more than 50 words). Section B (12 marks) shall comprise of two questions from each section and candidate has to attempt all questions from each Section , 2 marks for each question (Answer in not more than 200 words) and Section C (18 marks) shall comprise of three questions with not more than one question from each section and candidate has to answer all three, 6 marks for each question (Answer in not more than 500 words).

Max Marks 40

Min. Marks 10

Internal Assessment Max. Marks : 10

Min. Marks 3

SECTION A

1. Aquaria and their uses, setting up and maintenance of aquaria
2. Exotic fishes and their role in Indian fresh waters
3. Diseases of fishes (symptoms, etiology and treatment)
 - i. Bacterial Disease
 - ii. Viral Disease
 - iii. Fungal Disease
 - iv. Protozoan Disease
 - v. Crustacean Disease
4. Problems of fresh water pollution in relation to fisheries with special reference to Rajasthan

SECTION B

1. Adaptations in Fishes: Deep Sea and Hill Streams
2. Courtship and parental care, a general study of fish behaviour
3. Sound producing organs
4. Bioluminescence

SECTION C

1. Electric Organs
2. Poisons and Venoms: Poison Glands in Fishes
3. Migration and its causes

FISH BIOLOGY PRACTICAL BASED ON PAPER XIV D 1 & D 2

Max marks 40

Min. Marks 16

Internal Assessment Max. Marks : 10

Min. Marks 4

1. Micro-technical procedures: Preparation and study of serial sections of a larval fish and representative tissues and organs of fish.
2. Collection of local fishes and their identification upto the species level; Study of the available museum specimens of Teleostomi. Identification of fingerlings of Indian Major Carps.
3. Hydro-biological Studies:
 - (a) Analysis of water to determine the pH, free carbon dioxide; dissolved oxygen, chlorides, calcium, total alkalinity and total salinity.
 - (b) Collection: estimation and analysis of plankton.
4. Biochemical and-physiological:
 - (a) Estimation of Glycogen in liver.
 - (b) Induced spawning
5. Field studies
 - (a) Visit at an important marine Biological or fisheries centre in the country. The suggested places for this work are Veraval, Central Institute of Fisheries Education at Bombay and National Institute of Oceanographic Research at Goa.

Note: A record of the work done under 5 Items has to be compulsorily submitted by each candidate.

(Note: Use of animals for dissection/practical work is subject to the conditions that these are not banned under the wild life protection act and UGC guidelines.

SEMESTER IV

(Duration 4 h)

SCHEME OF PRACTICAL EXAMINATION AND DISTRIBUTION OF MARKS

Ecology and Developmental Biology

(a) Exercise in Ecology	06 Marks
(b) Exercise in developmental biology	06 Marks
(c) Permanent preparation	04 Marks
(d) spots (5)	10 Marks
(e) Tour Report and Seminar	04 Marks
(f) Viva- voce	05Marks
(g) Class Record	05 Marks
Total	40 Marks
Internal Assessment	10 marks
Grand Total	50 Marks

Board Second (Special paper)

(a) Cell Biology

- | | |
|---|----------|
| (a) Microtomy (Double Staining) | 07 Marks |
| (b) Biochemical Estimation | 05Marks |
| (c) Karyotype/Slide Preparation/ Techniques | 05 Marks |
| (d) Spots (4) | 08 Marks |
| (e) Project /Field report (Hand written, not more than 100 pages) | 05 Marks |
| (f) Viva- voce | 05 Marks |
| (g) Class Record | 05Marks |

Total **40Marks**

Internal Assessment **10 marks**

Grand Total **50 Marks**

(b) Entomology

- | | |
|-------------------------------|----------|
| (a) Dissection/ Demonstration | |
| 10 Marks | |
| (b) Exercise in Ecology | 08 Marks |
| (c) Spot | 08 Marks |
| (d) Project/ Field Report | 04 Marks |
| (e) Viva- voce | 05 Marks |
| (f) Class Record/ | 05 Marks |

Total **40 Marks**

Internal Assessment **10 marks**

Grand Total **50 Marks**

(c) Fish Biology

- | | |
|---|----------|
| (a) Species identification using taxonomic key (2 fishes) | 6 Marks |
| (b) Hydro-biological Exercise | 6 Marks |
| (c) Biochemical/Physiological exercise/Permanent Preparation | 6 Marks |
| (d) Project/Field report(Hand written, not more than 100 pages) | 4 Marks |
| (e) Identification and comments on Spots (4) | 8 Marks |
| (f) Viva-voce | 05 Marks |
| (g) Class Record | 05 marks |

Total **40 Marks**

Internal Assessment **10 marks**

Grand Total **50 Marks**

(d)Environmental Biology

- | | |
|--|----------|
| (a) Air/Soil analysis | 07 Marks |
| (b) Microscopic Examination of water and slide preparation(Zooplankton/ Benthos) | 05 Marks |
| (c) Statistical method | 05 Marks |
| (d) Spotting (4) | 08 Marks |
| (e) Field trip/ Project report | 05 marks |
| (f) Viva- voce | 05 Marks |
| (g) Class Record | 05 marks |

Total **40 Marks**

Internal Assessment **10 marks**

Grand Total **50 Marks**