**Jan Nayak Chandrashekhar Vishwavidyalaya, Ballia**

**M. Sc. Zoology Syllabus**

**M. Sc. Previous (w.e.f. 2018-19)**

| **I – Semester** | **Marks** |
|---|---|
| I – Paper – Comparative study of Lower non-chordates | 100 |
| II – Paper – Biostatistics, Biosystematics and Bioinstrumentation | 100 |
| III – Paper – Environmental Biology | 100 |
| IV – Paper – Biochemistry | 100 |
| Practical | 100 |
| **Total** | **500** |
| **II – Semester** | |
| I – Paper – Comparative study of Higher non -chordates | 100 |
| II – Paper – Animal Physiology | 100 |
| III – Paper – Cytology and Genetics | 100 |
| IV – Paper – Molecular Biology | 100 |
| Practical | 100 |
| **Total** | **500** |

**M. Sc. Final (w.e.f.2019-2020)**

**III – Semester**

| | |
|---|---|
| I – Paper –Comparative study Proto-chordates and Lower -vertebrates | 100 |
| II – Paper – Development Biology | 100 |
| III – Paper – Endocrinology | 100 |
| IV – Paper – Special | |
| Fish – Taxonomy and Morphology | 10 |
| Practical Examination – Part – A. (General) | 50 |
| Part – B. (Special) | 50 |
| **Total** | **500** |

**IV – Semester**

| | |
|---|---|
| I – Paper – Comparative study of Higher- Vertebrates | 100 |
| II – Paper – Animal Behavior | 100 |
| III – Paper – Special | 100 |
| A. Fish – Applied Icthyology and Development | |
| IV – Paper – Special | 100 |
| A. Fish – Physiology and Ecology | |
| Practical – Part –A . (General) | 50 |
| Part – B. (Special) | 50 |
| **Total** | **500** |

**M. Sc. (Zoology) Ist Semester**

**Paper I – Comparative study of Lower non-chordates**

**Unit 1**

**Protozoa:**

(i) Osmoregulation- contractile vacuoles and mechanism of osmoregulation,

(ii) Locomotion- locomotor organelles and methods of locomotion

(iii)Nutrition- Holozoic, Holophytic, Saprozoic and Myxotrophic nutrition

(iv)Reproduction- Asexual and sexual

(v)Protozoa and Diseases

**Unit 2**

**Porifera:**

(i)Cellular Organization- Pinacoderm, Choanoderm, Mesenchyme

(ii)Skeleton- Spicules and spongin

(iii) Reproduction- Asexual and Sexual

(iv)Canal System- Types and functions of canal system

**Unit 3**

**Coelenterata And Ctenophora**

(i)Origin of Metazoa

(ii)Polymorphism- Basic forms and patterns, Importance of polymorphism

(iii) Colony formation-

(iv)Corals- coral polyp, coral skeleton, types of corals

(v) General Organization and affinities of Ctenophora

**Unit 4**

**Platyhelminthes and Aschelminthes**

(i)Parasitism in Platyhelminthes and Aschelminthes,

(ii)Parasitic adaptations in Trematodes and Cestodes- Morphological and physiological adaptations

(iii)Larval stages of Trematodes and Cestodes

(iv)General organization and affinities of Rotifers

**Suggested Books :** Invertebrates, Parker Haswell, Invertebrates series- Protozoa – Echinodermata, R L Kotpal; Modern Textbook of Zoology- Invertebrates, R L Kotpal.; Invertebrate Zoology, N C Nair; A textbook of Invertebrates, H S Bhamrah; Non-chordates- E L Jordon

**M. Sc. (Zoology) I Semester**

**Paper II - Biostatistics, Biosystematics and Bioinstrumentation**

**Unit 1- Biostatistics** (i) Major Tendencies (Mean, Median, Mode),

(ii) Standard deviation,

(iii)Analysis of Variance

**Unit 2- Biosystematics**

(i) Speciation- Dimensions and mechanism of speciation

(ii) Species Concept- Species category and different species concept,

(iii) Theories of Biological Classification.

**Unit 3- Biological Techniques**

(i) Principles of Colorimetry and Spectrophotometry- Lambert Beer Law,

(ii) Centrifugation- Principles and technique,

(iii) Chromatography- Principles, types and applications

(iv) Electrophoresis- Principles and applications

**Unit 4- Microscopy**

Principles and construction of -

(i) Compound microscope

(ii) Phase contrast microscope

(iii) Electron microscope

**Suggested Books:** Biostatistics, P Ramakrishnan; Biostatistics, B K Mahajan; Animal Taxonomy, V C Kapoor; Principles of Animal Taxonomy, G G Simpson; Tools and Techniques in Biomolecular Science, Aysha Divan; Microscopy, Terence Allen

**M. Sc. (Zoology) I Semester**

**Paper III - Environmental Biology**

**Unit 1- Population Ecology**

(i) Characteristics of Population

(ii) Population size and exponential growth

(iii) Population dynamics, Competition

(iv) Intra-specific and Inter-specific competition

(v) Mutualism and Commensalism

**Unit 2- Ecosystem**

(i) Nature of Ecosystem

(ii) Production, Food webs and Energy flow through ecosystems

(iii) Biogeochemical cycles

(iv) Biomes

**Unit 3- Environment**

(i) Environmental stresses

(ii) Global warming

(iii)Environmental contaminants- their uptake and biotransformation

(iv) Bio-indicators and Biomarkers

**Unit 4- Biodiversity-** Assessment, conservation and management of biodiversity

**Suggested Books:** Fundamentals o**f** Ecology, E P Odum**;** Ecology and Environment, P D Sharma **;** Environment and Ecology, R Rajgopalan**;** Ecolgy and environmental biology- K A Siddiqui

**M. Sc. (Zoology)**

**I Semester Paper IV - Biochemistry**

**Unit1- Bioenergetics**

(i) Elementary thermodynamics- First law and second law of thermodynamics

(ii) Cell as an open thermodynamic system

(iii)Calculation of free energy change during biological oxidation-reduction reactions

**Unit2- Enzymes**

(i) Mechanism of enzyme action, Activation energy

(ii) Kinetics of enzyme action,

(iii) Enzyme inhibition- Competitive and non-competitive inhibitors, Use of

Lineweaver- Burk curve to predict the type of inhibition,

(iv) Allosteric enzymes

**Unit 3- Biomolecules & Metabolic Pathways**

(i) Carbohydrates- Classification, structure, general properties and biological significance

(ii) Lipids- Classification, structure, general properties and biological significance

(iii)Metabolic pathways- Glycogenesis and Glycogenolysis, Gluconeogenesis, HMP shunt, Oxidative phosphorylation, Beta oxidation of fatty acids

**Unit 4-**

(i) Classification and significance of Vitamins,

(ii) Biology of Cancer- Neoplasia, Metastasis, Phases of cancer, Oncogenes and carcinogens

(iii)Biology of Ageing

**Suggested Books:** Biochemistry, Stryer**;** Biochemistry, Lehninger; Biochemistry, J L Jain;

**M. Sc. (Zoology) I Semester**

**Paper V – Practical Examination**

| **Particulars** | **Marks** |
|---|---|
| Major Dissection- | 20 |
| Preparation- | 10 |
| Spotting (10) - | 20 |
| Environmental Biology exercise- | 10 |
| Biochemistry exercise- | 20 |
| Biostatistics exercise- | 10 |
| Class record, collection and viva | 10 |
| **TOTAL** | **100** |

**Major Dissections**: Dissection of circulatory system and reproductive system of earthworm, Digestive system and Reproductive system of leech and other available lower non-chordates.

**Preparations**: Slide preparation of Euglena and Paramecium, sponge gemmules, Obelia colony and other available materials from lower non-chordates.

**Museum study**: General survey and classification of lower non-chordates

**Protozoa**- Prepared slides of Paramecium (conjugation and binary fission), Euglena, Vorticella, Ceratium, Noctiluca.

**Porifera**- Museums of Euplectella, Spongilla, Euspongia Prepared slides of T.S. Sycon, L.S. Sycon, Spicules of sponges.

**Coelenterata**- Museums of Physalia, Corralium, Madrepora, Fungia, Pennatula, Metridium, Vellela, Porpita, Tubipora, Gorgonia, Prepared slides of Hydra, Obelia,

**Helminths**- Museums of Taenia solium, Cysticercus larva of Taenia solium, Schistosoma, Ascaris male, Ascaris female, Ancyclostoma,

**Prepared slides** – Miracidium larva, Redia larva, Cercaria larva, Scolex of Taenia solium, Mature proglottid and gravid proglottid of T. solium, T.S of Mature proglottid and gravid proglottid of T. solium, T.S. through body of male Ascaris, T.S. through body of female Ascaris

**Environmental Biology exercise**-

Study of different structural adaptations to ecological conditions

Study of micro and macro fauna of soil by froth-floatation method

Comparative study of physico-chemical eco-factors in different localities- temperature, pH,

Estimation of CO2, O2, carbonate in freshwater,

Study of plankton in a water body

Study of biological effects of certain pollutants.

**Biochemistry exercise**-

Chromatographic separation of amino acids

Isolation and colorimetric determination of glycogen in animal tissues.

Kinetic assay of salivary amylase and study of the effects of time and temperature on urease activity

**Biostatistics exercise**- Experiments on probability

Sampling of data for frequency diagram and calculation of mean, median and mode and standard deviation

## M. Sc. (Zoology) II Semester

### Paper I- Comparative study of Higher Non-chordates

**Unit 1- Annelida** Segmental organs, Filter feeding, Adaptive radiation in Polychaetes, Coelom and Metamerism.

**Unit 2- Arthropoda** Larval forms of crustacean, Parasitism in crustacean, Respiration in Arthropods, General organization of Onychophora.

**Unit 3- Mollusca** Respiration, Nervous system and Torsion in Gastropods.

**Unit 4- Echinodermata** Water vascular system, Larval forms and Affinities.

**Suggested Books :** Invertebrates, Parker Haswell, Invertebrates series- Protozoa – Echinodermata, R K Kotpal; Modern Textbook of Zoology- Invertebrates, R L Kotpal.; Invertebrate Zoology, N C Nair; A textbook of Invertebrates, H S Bhamrah

### Paper II - Animal Physiology

**Unit1- Physiology of Digestion**. Digestion and Absorption of Proteins, Carbohydrates and lipids .

**Physiology of Respiration**. Gaseous exchange in terrestrial and aquatic animals, Respiratory pigments.

**Unit 2- Physiology of Circulation** Patterns of Circulation among different animals, Physiological categories of Heart, Haemodynamics.

**Physiology of Excretion** Excretory products, Biosynthesis of Urea, Structure and functional mechanism of nephron.

**Unit 3- Physiology of Nerve Conduction** Ionic basis of resting and Action potential, Synaptic transmission

**Physiology of Muscle Contraction** Structure and Mechanism of Contraction of skeletal muscles

**Unit 4- Concept of Homeostasis**

**Physiology of Defense Mechanism** Immunity, Types of Immune response, Immune cells, Antigen and antibody reaction, Antibody diversity

**Suggested Books:** Medical physiology, Guyton; Human phusiology, C C Chatterjee; Animal physiology, Nagabhushanam, Physiology and Biochemistry, Srivastava and Agrawal

## M. Sc. (Zoology) II Semester

### Paper III - Cytology and Genetics

**Unit 1-** A Brief introduction of Bacteriophages, Animal viruses, and Retroviruses, Structure of E. coli; Plasmids

**Unit 2-** Fluid mosaic model and functions of Plasma membrane, Membrane transport of small molecules, Energy transduction in mitochondria, Cell cycle and its control mechanism.

**Unit 3-** Mendel's laws and their chromosomal basis, Linkage and Crossing over, Genetic interaction, Sex-determination, Sex-linked inheritance,

**Unit 4-** Numerical and Structural chromosomal aberrations, Mutation, Genetic Drift, Hardy-Weinberg Law

**Suggested Books:** ; Genetics, P K Gupta; Genetics, B D Singh; Genetics, P S Verma

### Paper IV - Molecular Biology

**Unit 1- Gene Action**

Chromosomal organization of genes, DNA Replication, Transcription, Genetic code

**Unit 2- Intracellular Protein Trafficking**

Protein Architecture, Protein synthesis on free/bound polysomes, Uptake into ER, Trafficking mechanism of proteins

**Unit 3- Regulation of Gene Action**

Regulation of Gene action in prokaryotes and eukaryotes, Operon model- lac operon and Trp operon

**Unit 4- Cell Signalling**

Types of Cell Signaling, Second messenger system, Cell surface receptors.

**Suggested Books:** Molecular biology of the gene, J D Watson; Molecular Biology, N Arumugam; Genes, Lewin

**M. Sc. (Zoology) II Semester**

**Paper V – Practical Examination**

| **Particulars** | **Marks** |
|---|---|
| Major Dissection- | 20 |
| Minor Dissection- | 10 |
| Preparation- | 05 |
| Spotting (10) - | 20 |
| Physiology exercise- | 10 |
| Molecular Biology exercise- | 10 |
| Cytology and Genetics exercise- | 10 |
| Class record and collection- | 08 |
| Comprehensive viva - | 07 |
| **TOTAL** | **100** |

**Major Dissection**- Nervous system of Pila, Unio, Sepia, and other available materials of higher non-chordates

**Minor Dissection**- Nervous system of Prawn, Other minor dissections of available higher non-chordates
**Preparation**- Hastate plate of prawn, parapodia of Neries, Mouth parts and salivary glands of cockroach, Mouth parts of other insects, and of other available materials.

**Museum and prepared slides study**- General survey and classification of higher nonchordates

**Annelida**- Nereies, Heteroneries, Aphrodite, Chaetopterus, Arenicola, Terebella, Pheretima, Eutyphoeus, Dero, Branchellion, Bonellia, Sipunculus and other available museums T.S. Nereies through body segments, Parapodium of Nereies, etc.

**Arthropoda**- Museums and slides of major representatives of different classes of phylum Arthropoda

**Mollusca**- Museums and slides of major representatives of Mollusca

**Echinodermata**- Museums and slides of major representatives of Echinodermata.

**Physiology exercise**-

Total counts of erythrocytes, total leucocyte counts and differential leucocyte counts of fish, frog, bird and rat.

Estimation of hemoglobin content in fish, frog, bird and rat

Rate of Oxygen consumption of aquatic animals and effects of different stresses upon it.

Determination of respiratory quotient of an air breathing animal

Study of functional properties of the cardiac muscles of frog using acetylcholine and adrenalin
Recordings of Electro cardiogram of frog.

**Molecular Biology exercise-**

Isolation and colorimetric determination of protein from fat bodies of cockroach and liver

Isolation and colorimetric determination of DNA from fat bodies of cockroach and liver. .

**Cytology and Genetics exercise-**

Demonstration of mitochondria in human buccal epithelium by supra vital staining

Study of mitosis in onion root tip and meiosis in testis of grasshopper with acetocarmine squash method
Study of salivary gland chromosomes of Drosophila and Chironomos

Study of the pattern of different hereditary traits in human beings.

**M.Sc. FINAL YEAR**

**M. Sc. (Zoology) III Semester**

**Paper I - Comparative study of Proto-chordates and Lower vertebrates**

**(Protochordates, Fish, Amphibia)**

**Unit I**

(i) General organization and affinities of Protochordates

(ii) Origin of Chordates

(iii)Origin of Tetrapods

**Unit II**

(i) Genaral plan of Digestive system in fish and amphibia
(ii) General plan of circulation in fish and amphibia

**Unit III**

(i) Respiratory system in fish and amphibia
(ii) (ii) Skeletal system in fish and amphibia

**Unit IV**

(i) Evolution and organization of Urinogenital system in fish and amphibia
(ii) (ii) Lateral line system in fish

**Suggested Books:** Vertebrate Zoology, G R Beer, Comparative anatomy of vertebrates, R K Saxena, Vertebrates, R L Kotpal, Vertebrates, P S Verma; Chordates- E L Jordon

**Paper II - Developmental Biology**

**Unit 1. Gonads and Gametogenesis**

(i) Sex differentiation in vertebrates
(ii) Comparative account of differentiation of gonads in mammals,
(iii) Spermatogenesis in vertebrates
(iv) Endocrinology of ovary, oogenesis and vitellogenesis in vertebrates, superovulation.

**Unit2. Fertilization and Embryogenesis**

(i) Mechanism of Fertilization: in vivo and in vitro,
(ii) Patterns of Cleavage
(iii) Patterns of Gastrulation in frog and chick.

**Unit3. Organogenesis**

(i) Development of Brain in vertebrates
(ii) Development of Eye in vertebrates.

**Unit 4**

(i) Hormones and Reproduction- Seasonal and continuous breeders
(ii) Differentiation of cells during embryonic development
(iii) Mechanism of Induction during Organogenesis, Primary organizer

**Suggested Books :** Chordate embryology, P S Verma**;** Developmental Biology, S Gilbert, Developmental Biology, Subramaniam

## M. Sc. (Zoology) III Semester

## Paper III: Endocrinology

**Unit 1**

(i) Hormones as messengers and their types
(ii) Structure and functioning of Pituitary, Pancreas, Adrenal Glands

**Unit 2**

(i) Phylogeny of Thyroid gland
(ii) Structure and functioning of Thyroid, Parathyroid, and Gonads

**Unit 3**

(i) Nature of action of peptide and steroid hormones
(ii) Biosynthesis and secretion of Hormones

**Unit 4**

(i) Neuroendocrine system and neurosecretion
(ii) Hormones and Behaviour

**Suggested Books:** Endocrinology, Turner and Bugnara; Endocrinology, Hadley; Endocrinology, K V Shastry

## Paper IV: Special Paper Fishery Biology

### IV-A: Taxonomy & Morphology

**Unit 1.Taxonomy**

(i) Classification of fish up to orders as proposed by L. S. Berg(1940)
(ii) Systematic/Taxonomic study of freshwater and marine fish of following orders

1- Order- Clupeiformes. Families- Clupeidae (including oil sardine), Notopteroidae.
2- Order- Beloniformes. Families – Belonidae Hemiramphidae
3- Order – Masacembeliformes .Family - Mastacembelidae.
4- Order – Mugiliformes. Family - Mugilidae
5- Order -Perciformes , Family Scombridae (Mackerel)
**6-** Order Actinopterygii, Family Synodontidae (Herpodon)

**Unit 2**. **Identification of Fish**

Study and preparation of identification key of the fish of following order with suitable diagrams, fin formula, local and biological names,

1- Ophiocephaliformes 2- Cypriniformes 3- Perciformes

**Unit 3**

Study of differentiating characters of pair of fish from the orders of Fresh water fish given in to (Ophiocephaliformes, Cypriniformes Perciformes) with special reference to fin formula, suitable diagrams, local and biological names.

**Unit 4 Morphology**

(i) Specialized organs (electric organs, poison glands ,sound producing organs , light producing organs and sense organs, weberian ossicles)
(ii) Scales and tails in fish
(iii) Endocrine glands (Pineal, hypophysis, thyroid, adrenal, ultimobranchial body, corpuscles of stannous and urophysis).

**Suggested Books:** Fishes of UP and Bihar, Gopal ji Srivastava; An Introduction to Fishes, S S Khanna, Ichthyology, Lagler; Inland Fishes, P K Talwar

**M. Sc. (Zoology) III Semester**

**Paper V – PRACTICAL EXAMINATION**

**PART A: GENERAL**

| | |
|---|---|
| Major Dissection- | 10 |
| Minor Dissection- | 05 |
| Microtomy- | 05 |
| Developmental biology- | 05 |
| Endocrinology- | 05 |
| Spotting (05)- | 10 |
| Class record, collection and viva | 10 |
| **Total-** | **50** |

**Major Dissection**- Dissection of cranial nerves of major representative types of fish and amphibian. Neck nerves of a mammal Afferent and efferent branchial arteries of scoliodon

**Minor Dissection**- Eye muscles of scoliodon, internal ear, urinogenital system of scoliodon,

**Preparation**- Placoid scale of scoliodon, Ampulla of Lorenzini; T.S. through liver, intestine, skin etc of frog, Microtomy of tissues

**Museum study-** Study of museums and slides of representative types of Protochordates, Cyclostomata, fishes and amphibia

**Developmental Biology**- Study of life stages of frog, mounting of eggs and embryo of frog, incubation and mounting of chick embryo, study of prepared slides of embryo of frog, chick and mammal, window formation.

**Endocrinology-** Study of prepared slides of different endocrine glands of fish and frog, dissection of vertebrate types to demonstrate different endocrine organs,

**PART B- SPECIAL**

**(A) Fishery Biology**

| | |
|---|---|
| Major Dissection- | 10 |
| Preparation- | 05 |
| Identification of two fish- | 10 |
| Spotting (05)- | 10 |
| Seminar- | 05 |
| Class record, collection and Viva- | 10 |
| **Total -** | **50** |

**Major Dissection**- Cranial nerves of Wallago, Labeo and Scoliodon; Afferent and efferent branchial vessels of Scoliodon, Wallago, Eye muscles of Scoliodon and Wallago,

**Preparation-** Preparation of Placoid scales, Cycloid scales and Ctenoid scales

**Identification-** Identification of freshwater fishes of U.P and Bihar with the help of Identification key.

**Study of specimens, slides and bones of fishes-** Specimens of both freshwater and marine water fishes

**Seminar-** Seminar presentation for 15 minutes compulsory for each student

**Fish collection**- Collection of at least ten different types of fish available in local habitats

## M.Sc. FINAL YEAR

## M. Sc. (Zoology) IV Semester

## Paper I - Comparative Study of Higher vertebrates

## (Reptiles, Birds and Mammals)

### Unit 1. Reptiles and Birds

(i) Origin and evolution of Reptiles,
(ii) Extinct reptiles,
(iii) Origin of Birds,
(iv) Flightless birds

### Unit 2. Mammals

(i) Origin of Mammals,
(ii) Structural peculiarities and phylogenetic relations of Prototheria and Metatheria,
(iii) Dentition in mammals,
(iv) Aquatic mammals

### Unit 3. Circulation and Respiration

(i) General plan of circulation in reptiles, birds and mammals
(ii) General plan of respiration in reptiles, birds and mammals

### Unit 4. Urinogenital system

(i) General plan of urinogenital system in reptiles and birds

**Suggested Books:** Vertebrate Zoology, G R Beer, Comparative anatomy of vertebrates, R K Saxena, Vertebrates, R L Kotpal, Vertebrates, P S Verma, Birds, R L Kotpal; Chordates- E L Jordon

## Paper II - Animal Behaviour

### Unit 1.Learning and Communication

(i) Innate and Learning behavior
(ii) Communication (chemical, visual, audio) among animals

### Unit 2. Reproductive Behaviour

(i) Courtship and mating behaviour,
(ii) Parental care in fish and amphibians

### Unit 3. Migratory Behaviour

(i) Migration in fish
(ii) Migration in birds

**Unit 4. Orientation and Social Behaviour**

(i) Orientation in animals,
(ii) Social behavior in insects

**Suggested Books:** Animal Behaviour, V K Agrawal **;** Text book of Animal behavior, F B Mandal **;** Animal behavior, H S Gundevia; Animal Behaviour, S Prasad

**M. Sc. (Zoology) IV Semester**

**Special Papers - Fishery Biology**

**Paper III-:Applied Ichthyology and development**

**Unit 1**

(i) Fisheries of India; Brief study of Marine, fresh water, estuarine and cold water fishery.

(ii) Fish Farming- Type of fish farming, fish ponds, construction of fish ponds, physico chemical and biological characteristics of ponds, Fishing methods

(iii) Fertilization and management of fishery pond (spawning, hatcheries, reusing, stocking), transport, mortality of fish fry
(iv) Composite culture and cage culture

**Unit 2**

(i) Principle and importance of fish preservation, traditional and advanced methods of fish preservation : sun–drying, salting, pickling,smoking,chilling,frying and canning etc.
(ii) Fish products like oil, fishsauce, fish glue etc.

**Unit 3**

(i) Aplication of genetics in aquaculture – sex manipulation,chromosomal manipulation, gene engineering.
(ii) Transgenic fish
(iii) Production of monosex and sterile fish and their Significance in aquaculture.
(iv) Induced breeding

**Unit 4 Development** :

(i) Gastrulation.
(ii) Neurulation .
(iii) Organ formation.
(iv) Larval development.
(v) Metamorphosis.

Suggested Books: General and Applied Ichthyology, S K Gupta; Applied Ichthyology, G S Sandhu,

## Paper IV

## Physiology and Ecology

**Unit 1**

1. Nutrition - Alimentary canal, associated glands Food and feeding habits, digestion

2. Excretion - Kidney structure and modifications, nitrogenous and excretory products, urine formation.
3.Osmoregulation - Definition, osmoregulation in freshwater, marine and migratory fishes.

**Unit 2**

4. Respiration - Structure and function of gills. Fish blood, process of respiration in a typical fish, accessory respiratory organs.

5. Circulatory System - Heart structure and function, Blood vessels, Arterial and venous system.

**Unit 3**

6. Fish Nervous system

7. Reproduction - Gonads structure, spermatogenesis, Oogenesis, gonadal steroids, endocrine control of reproduction.

8.. Common enemies and symptoms, etiology and treatment of disease of food fishes.

**Unit 4 Ecology** :

(i) Abiotic factors : Density; Pressure; Temperature; salt content in water; Light; Sound; Electric currents; Bottom deposits; Particles suspended in water.

(iii) Biotic factors : interspecific interrelationship among fishes and with other organisms; Intraspecific into relationship among fishes.

(iv) Pollutants affecting fishery water with special reference to oil spills, domestic pollutants, industrial water, radioactive wastes and sewage fed fisheries. Effects of pesticides and heavy metals on fishes, Biomagnification, Dose response relationship and toxicity curve, LC 50

(v) Plankton in relation to fish production.

**Suggested Books:** Physiology of Fishes, David Evans; Anatomy and physiology of fishes, S Kumar; Freshwater fishes and their ecology, Stephen Forbes; Fish and fisheries- Pandey and Sukla

**M. Sc. (Zoology) IVSemester**

**Paper V – PRACTICAL EXAMINATION**

**GENERAL**

| | |
|---|---|
| Dissection major | 10 |
| Dissection minor | 05 |
| Preparation | 05 |
| Animal Behaviour Exercise | 05 |
| Spotting (5) | 10 |
| Class record and collection- | 08 |
| Viva-voce - | 07 |
| **Total-** | **50** |

**SPECIAL Fishery Biology**

| | |
|---|---|
| Dissection major- | 10 |
| Dissection minor- | 05 |
| Preparation- | 05 |
| Ecology exercise- | 05 |
| Seminar | 05 |
| Spotting-(5) | 10 |
| Class record, collection and viva-voce- | 10 |
| **Total-** | **50** |

**Major Dissection :** Digestive system, Urinogenital system, Cranial nerves of *Wallago, and Scoliodon*

**Minor Dissection:** Scroll valve of Wallago and Scoliodon, Accessory respiratory organs of *Heteropneustes fossilis*, Weberian ossicles,

**Preparation:** Scales of fish, internal ear

**Ecology Exercise-**

Ecological adaptation in fishes

Study of pond ecology – measurement of pH, hardness, transparency, dissolved oxygen, dissolved CO2, Qualitative study of plankton

**Seminar** Seminar presentation for 15 minutes by every student.

**Study of Specimans, slides and bones of fishes belonging to different orders**

**Collection-** Collection of fishes available in local habitats; Collection of skull bones of Labeo and Wallago.