

**M.Sc. (Life Science)**  
**(III and IV semester exams 2016-17)**  
**Scheme of Examination and Courses of study**

1. The M.Sc. course in Life Science is a two year full time curriculum offered in the form of Choice-based Credit System organized in four semesters. The number of papers and maximum marks for each theory paper/practical has been shown in the syllabus. It will be necessary for a candidate to pass in the theory part as well as in the practical part (wherever prescribed) separately.
2. The course of study for M.Sc. (Life Science) examination shall be spread over a period of two years with examination at the end of each semester. There shall be **four semesters** in all.
3. Syllabus of every paper of each semester will be divided into 5 units.
4. Scheme of examination

Semester III	MaxMarks	MinMarks	InterAsse.
Paper I	70	25	30
Paper II	70	25	30
Paper III	70	25	30
Paper IV	70	25	30
Practical	200	72	Nil

Note: An aggregate of 50% marks is required to pass a semester.

Semester IV	MaxMarks	MinMarks	InterAsse.
Paper I	70	25	30
Paper II	70	25	30
Paper III	70	25	30
Paper IV	70	25	30
Practical	200	72	Nil

Note: An aggregate of 50% marks is required to pass a semester.

**Present scheme of papers of 2<sup>nd</sup> year of M. Sc. Life Science**

**Semester III**

LS 09 – Genetic Engineering & Bio-Informatics

LS 10 - Biotechnology

LS 11- Biodiversity

LS 12 – Biostatistics & Biophysics

Practical - Day 1- LS09, LS10

Day 2- LS11, LS12

## Semester IV

LS13– Environmental Sustainability

LS14 - Animal Physiology

LS15 - Plant Physiology

LS16 – Immunology

Practical - Day 1- LS13, LS14

Day 2- LS15, LS16

### APPROVED papers in Semester III & IV

## Semester III

LS 09 – Genetic Engineering & Biotechnology

LS 10 - Invertebrates and taxonomy

LS 11 - Developmental Biology

LS 12 – Biostatistics, Bio-Informatics

& Biophysics

Practical - Day 1- LS09, LS10

Day 2- LS11, LS12

## Semester IV

LS13– Vertebrates

LS14 - Animal Physiology

LS15 - Immunology

LS16 – Special paper\*

\* Candidates may choose any special paper out of these two:-

1. Fish Biology, and
2. Molecular Developmental Biology

Contents of syllabus of these additional papers (including practical exercises) will be the same as given in M. Sc. Zoology syllabus running in affiliated colleges of this university and approved by BOS (Zoology), Academic Council and BOM of the University of Kota, Kota.

Practical - Day 1- LS13, LS14

Day 2- LS15, LS16

For each **theory paper**:-

Teaching hrs	Credit pt	Continuous assessment		Semester assessment		Max marks	Min.Pass marks	Paper Duration
		MM	Pass	MM	Pass			
04	04	30	12	70	28	100	40	3 Hrs.

For **Practical**: Teaching Hrs18, Credit pt: 9; Max. Marks 100, Min. pass marks 50 for each day of practical exam.

Total (III and IV each Semester):- 27 Teaching Hrs 34, Credit pt 25, Continuous assessment (MM 120, Min 48) Semester Assessment (MM 380, Min 162) Total marks 500 Min Pass marks 250.

**UNIT WISE DETAILED SYLLABUS**  
**SEMESTER III**

**LS 09– GENETIC ENGINEERING & BIOTECHNOLOGY**

**UNIT I**

1. Definition, Steps, Restriction endonucleases and essential Enzymes used in r-DNA technology
2. Cloning Vectors [Plasmid, Bacteriophage, Cosmid, Phasmid, Artificial chromosomes (BAC, YAC, Shuttle Vector)]
3. Identification and analysis of recombinant DNA clones.
4. Applications of r-DNA technology- Requirement and production of recombinant molecules in pharmaceutical, health, agricultural and industrial sectors and research laboratories.

**UNIT II**

1. DNA Sequencing method: Dideoxy and chemical method, sequence assembly. Gene amplification. Molecular marker. Gene library: genomic library and c-DNA library.
2. Genetic engineering of plants: Gene transfer in plants – Vector mediated gene transfer (Ti plasmid) and direct gene transfer. Genetically transformed plants. T-DNA and transposon mediated gene tagging, chloroplast, transformation.
3. Methods of gene transfer in animals Transgenic animals (Sheep and Goat) Gene Therapy.
4. Genetic Counseling, DNA finger printing. Human Genome Project. Safety of recombinant DNA technology, IPR and patenting. Basic patent rules ethical issues. Bio safety regulations and their utility.

**UNIT III**

1. General introduction: Meaning, brief history, biotechnology in India, Scope and importance.
2. DNA Chip Technology and Microarrays.
3. Plant tissue culture: Introduction, history, Scope, concept of cellular Differentiation totipotency.
4. Organogenesis and somatic embryo-genesis and Somatic hybridization, applications of plant tissue cultures Micro-propagation, Virus free plants, artificial or encapsulated seeds, embryo rescue, Production of androgenic haploids, production of triploids, soma clonal variations, germplasm preservation, Cryopreservation and gene bank.

**UNIT IV**

1. Animal tissue culture: Introduction, Primary culture, cell lines and cloning. Tissue and Organ Culture, IVF, embryo- transfers.
2. Brief discussion on the chemical, Physical and metabolic functions of different constituents of

culture medium. Basic techniques of mammalian cell cultures in – vitro. Microcarrier culture, cell Synchronization and cell culture.

3. Application of animal cell culture. Hybridoma technology and monoclonal antibodies.

## UNIT V

1. Environmental Biotechnology: Water pollution management solid Waste management, bioindicators of biosurfactants, biofilms etc. Biotechnology for pollution abatement: Bio scrubbers and Biofilters, Biotechnology for air and water pollution abatement. Bio-magnifications: Biomagnification of Pesticides and heavy metals. Bioremediation.

2. Industrial Biotechnology: Alcohol and Beverages production, food products - cheese and bread, acid production, vitamin, enzyme production, Antibiotics, Amino acid production, Biotransformation and Bioleaching.

3. Agricultural biotechnology: Biotechnology of Nitrogen fixation, Biofertilizers, Biopesticides, production of Biogas and ethanol. Bio-insecticide: Brief account, application for productivity improvement and crop protection. Microbial pesticides, Neem insecticide. Bio Sensor.

4. Medical Biotechnology: Synthesis of proteins and hormones, production of interferons and other immunoproteins. Production of vaccines, antibodies, Steroids.

## LS 10- INVERTEBRATES AND TAXONOMY

### UNIT - I

1. A study of the classification of invertebrates with distinguishing features & examples of various subdivisions.

**2. Locomotory mechanisms:** a) Amoeboid movements, ultra structure of cilia and flagella: ciliary and flagellar movements; molecular and physiological mechanisms involved in the three kinds of movements. b) Myonemes and muscle fibers in invertebrate structure and their role in locomotion. c) Locomotion in relation to hydrostatics, coelome, metamerism, arthropodization. d) An outline of flight mechanism in insects.

**3. Feeding mechanisms:** a) Amoeboid feeding. b) Ciliary feeding. c) Filter feeding. d) Parasitic mode of feeding. e) Feeding mechanisms in insect and echinoderms.

### UNIT – II

**4. Respiration:** a) Respiration in lower invertebrates (Protozoans to helminthes). b) Gills and Lophophores. c) Gills and lungs in Mollusca. d) Gills, trachea and lung like structures in Arthropods. c) Physiology of respiratory pigments in invertebrates.

**5. Excretion:** a study of structural and functional organization of excretory systems in various invertebrate groups and a survey of various excretory products met with in them.

**6. Osmoregulation and ionic regulation:** a survey of principal mechanisms in fresh water, marine and terrestrial forms.

### UNIT – III

**7. Structural and functional organization of nervous systems and receptors :** a) Plan of nervous systems in the Cocciferates, Platyhelminthes, Annelids, Arthropods. Molluscs and Echinoderms: structural and functional complexities of brain and ganglionic structures. b) Receptors : Structural and functional organization of the mechanoreceptors. chemoreceptors and photoreceptors.

**8. Endocrine system :** a survey of endocrinal structures and their hormones: role of neurosecretions and hormones in developmental events of insects and crustaceans.

**9. Reproduction:** a) Reproduction in Protozoa b) Reproduction in Porifera c) Reproduction in Metazoa : Sexual reproduction; Parthenogenesis. d) Reproduction in Metazoa : Asexual reproduction in Coelenterata and Polychaeta. e) Larval forms and their significance.

### UNIT – IV

**10.** Criteria for phylogenetic interrelationships between Invertebrate phyla.

**11.** Origin of Parazoa, Mesozoa and Metazoa. **12.** Origin of Radiata (Coelenterata and Ctenophora). **13.** Origin of Bilateria from Radiata (Importance of Planula larva and Ctenophores)

**14.** Phylogenetic significance of Rhynchocoela. **15.** Interrelationship of important

**Pseudocoelomate groups**, Rotifera. Gastrotricha, Kinorhynca, Nematomorpha and Entoprocta.

**16.** Affinities and evolutionary significance of the unsegmented lesser **protostome** phyla (Priapulida, Echiuroidea and Sipunculida. **17.** Phylogenetic relationship between **the Coelomate phyla** (Annelida, Onychophora. Arthropoda & Mollusca). **18.** Affinities and evolutionary significance of the Lophophorate coelomate phyla (Brachiopoda, Phoronida & Ectoprocta).

**19. Affinities of the invertebrate deuterostome phyla** (Chaetognatha, Echinodermata, Pogonophora & Hemichordata).

### UNIT – V

**20. Introduction** to the science of taxonomy; rules of nomenclature.

**21. Principles of classification :** theories of biological classification & their history; the species category; the polytypic species; population systematic intraspecific categories. **Methods of classification :** taxonomic collection & the processes of identification, taxonomic characters; types of variations (qualitative and quantitative) within a single population, methods of arriving at taxonomic decisions on species level; preparation and use of taxonomic keys.

**22. Cytotaxonomy :** importance of cytology and genetics in taxonomy. **Sonotaxonomy:** importance of sound, call and sonogram in taxonomy.

## LS 11- DEVELOPMENTAL BIOLOGY

### UNIT – I

**1.** Theories of development : Preformation and epigenesis. **2.** Spermatogenesis: Growth of spermatocyte and acrosome formation; spermeogenesis. **3.** Oogenesis: (a) Growth of oocyte and vitellogenesis. (b) Organization of egg cytoplasm; role of the egg cortex. (c)

Morphogenetic determination in egg cytoplasm. 4. Fertilization : Significance of fertilization in development and the essence of activation of the egg.

## **UNIT – II**

1. Early embryonic development. Patterns of cleavage: morulation and blastulation.
2. Gastrulation in chordates (tunicates to mammals). (a) Fate maps. (b) Mechanics of gastrulation(c) Morphogenetic movements. (d) and significance of gastrulation.
3. Primary embryonic induction: (a) Concepts of potencies; prospective fates; progressive determination, totipotency and pluripotency, 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 and mechanism of action of inducing substances.

## **UNIT – III**

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

## **UNIT – IV**

1. Embryonic adaptations: (a) Evolution of cleidoic egg and its structural and physiological adaptations. (b) Development and physiology of extra-embryonic membranes in amniotes. (c) Evolution of viviparity. (d) Development, types and physiology of mammalian placenta. 2. Metamorphosis in amphibia : (a) Structural and physiological changes during metamorphosis. (b) Endocrine control of metamorphosis.

## **UNIT – V**

1. Types of regeneration, physiological, reparative and compensatory hypertrophy, regenerative ability in chordates. (b) Morphological and histological processes in amphibian limb regeneration. (c) Origin of cells of regeneration, de-differentiation, redifferentiatoin, (d) pattern formation during amphibian limb generation;
2. Reasons for failure of limb generation ability in other chordates and mammals; methods for induction of regenerations. 3. Abnormalities of Embryonic development: teratology.

## LS 12 – BIOSTATISTICS, BIO-INFORMATICS & BIOPHYSICS

### UNIT I

1. Biostatistics Introduction, Statistical Terms and Symbols, Sample and Sampling Techniques.
2. Collection, classification and Tabulation of Data. Frequency distribution, Diagrammatic and Graphical presentation of Data.
3. Measures of Central tendency: Mean, Mode and Median.
4. Measures of Variability or dispersion: range, mean deviation standard deviation.

### UNIT II

1. Probability and its application. Theoretical distribution: Binomial and Normal distribution.
2. Correlation: types, methods, Coefficient of correlation. Regression analysis: Regression Line, regression equations- of X on Y and Y on X. regression in a bivariate grouped frequency distribution. Multiple regressions.
3. Test of Significance, levels of significance, standard errors, chi-square test.
4. Student 't' test, f – test. Analysis of variance (ANOVA).

### UNIT III

1. Bioenergetics: Basic bioenergetics. Law of bioenergetics, whole body bioenergetics. Entropy and evolution relationship. Gibbs free energy. Bioenergetic pathways. Bioenergetics and biocommunication. Control of bioenergetics.
2. Molecular interaction: Intra- molecular and Inter- molecular interaction, Attractive and repulsive forces operating within molecules and their overall effects on molecular interactions.
3. Mechano chemical process of muscles contractions Molecular structure of skeletal muscles - actin, myosin, troponin, tropomyosin, role of myoglobin. Physicochemical process of nerve impulse conduction across Myelinated, non myelinated and synaps.
4. Physicochemical process of vision, colour determination and sound perception by animal, echo location. Biophysics of circulation in animal and water transport and nutrient translocation in plants.

### UNIT IV

1. Bioinformatics: Definition, Introduction, Historical resume, Bioinformatics Career – future prospects and ethical issues.
2. Basic Components of computers and their functions Hardware and Software, Input Output devices. Network: Definition and types (LAN, WAN).
3. Basic Concepts about data and information: Representation of data in Computer in binary, bits and bytes. Conceptual understanding of assemblers and Compilers operating system.
4. Biological Databases: Primary sequence databases (Protein and DNA databases), Secondary databases, Composite databases.

## UNIT V

1. Nucleic acid sequence analysis, alignment, similarity searches including remote similarity searches, secondary structure element, motifs.
2. Protein sequence analysis, alignment, similarity searches including remote similarity searches, secondary structure element, motifs.
3. Genomics and annotation Evolutionary analysis; use of the PHYLIP package, tree construction.
4. Role of bioinformatics in Pharmaceuticals industry Challenges of Commercialization of Bioinformatics and its future prospects.

## PRACTICALS

### First Day

#### 1. Invertebrates :

I Identification, classification & study of distinguishing features of important representatives (Protozoa to Hemichordata).

II. Study of permanent prepared slides (Protozoa to Hemichordata).

III. Anatomy: 1. Reproductive, excretory, nervous & hemocoelomic systems of leech. 2. Nervous system and general anatomy: Patella, lamellidens, Mytilus and Aplysia. 3. General Anatomy, reproductive and nervous system of Cockroach, Grasshopper.

IV. Permanent preparations and their study: 1. Preparation of cultures of Amoeba, Paramecium and Euglena. Study of these protozoans using vital dyes. 2. Permanent preparations of Amoeba, Paramecium and Euglena from cultures, vorticella from the pond water; flagellates from the gut of white ant; Rectal ciliates, Trypanosomes in the blood of house rat; lifecycle stages of Monocystis from the seminal vesicle of earthworm. 3. Collection, fixation & permanent preparations of trematodes, cestodes & nematodes found in sheep and pig and in the stool of infected persons.

#### V. Genetic engineering, Biotechnology

1. Isolation of plant DNA.
2. Estimation of RNA by Orcinol method.
3. Restriction, Digestion of plant DNA, its separation by Agarose gel electrophoresis.
4. Separation of Cell organelle by sucrose gradient.
6. Extraction and estimation of phenol based secondary metabolites.
7. Principle and use of laboratory equipments: pH Metre, Autoclave, Centrifuge Balance, Spectrophotometer.
8. Acquaintance with tissue culture laboratory.
9. Preparatory techniques: Washing of Glassware, Dry and Steam sterilization, sterilization techniques.
10. Preparation of Culture media.
11. Demonstration of the technique of Micropropagation by using different explants eg. Shoot Meristem, axillary bud, callus induction, regeneration.
12. Demonstration of the technique of anther culture.

## Second Day

Developmental 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 slides of sections through successive embryonic and larval stages.

(b) Study of development of chick through : (i) Permanent whole mounts of successive embryonic stages. (ii) Permanent microscopic slides of section through representative regions of successive embryonic stages.

Note : Special emphasis should be laid on organogenesis and morphogenesis.

(c) Removal of chick embryos of 18,21,24,33,72 and 92 hours from the egg and their study and identification in the living state; permanent whole mounts of these embryos using living states.

(d) Study of (i) formalin preserved fetuses with placenta and (ii) histology of the placenta of any mammal.

Biostatistics, Bioinformatics and Bio-Physics

1. Exercise based on presentation of Data, Simple and Complex Table, Graphs, Pie Charts.
2. Exercise based on Classification of Data, Frequency and Frequency distribution.
3. Numerical problems based on measures of central Tendency-Mean, Mode and Median
4. Chi square and Student t-test.
5. Sequence alignment.
6. Homology finding by using BLAST, FASTA.
7. Database sequencing.

## UNIT WISE DETAILED SYLLABUS SEMESTER IV

LS13– VERTEBRATES

### UNIT - I

1. Chordate Characters: primary and other. Origin and outline classification of chordates up to Orders (with salient characteristics and examples). Chordates v/s Vertebrates.
2. Overview of Protochordates. Interrelationships of Hemichordata, Urochordata and Cephalochordata. Their relationship with other deuterostomes.
3. Life histories of sessile and pelagic tunicates (ascidians): *Pyrosoma*, *Salpa*, *Doliolum* and *Oikopleura*.

### UNIT – II

1. Origin, evolution and adaptive radiations of vertebrates: (a) Geological time scale and fossils.
2. Origin, evolution and general characters of Agnatha (Ostracoderms and Cyclostomes) and Gnathostomes (Placoderms). A general account of Elasmobranchi, Holocephali, Dipnoi and Teleostomi. Adaptive radiation in bony fishes.
3. Origin, evolution and adaptive radiation of Amphibians.

### **UNIT – III**

1. Origin and evolution of Reptiles; the conquest of land Seymouria and related forms; Cotylosauria; basic skull types and outline classification of reptiles. Dinosaurs: Types and evolutionary significance. Living Reptiles: a brief account of Rhynchocephalia, Chelonia, Squamata & Crocodilia.
2. . Origin, evolution and adaptive radiations of birds. Origin of flight, flight adaptations.
3. Origin, evolution and adaptive radiations of mammals, primitive mammals (Prototheria & Metatheria). A general survey of evolution and adaptive radiations in eutherian mammals, excluding detailed reference to individual orders. Evolution of man; relationships of man with other primates; fossil record of ancestry of man.

### **UNIT – IV**

Comparative anatomy of the vertebrates:

1. Integument and integumentary derivatives.
2. Alimentary canal and accessory digestive glands.
3. Respiratory organs.
4. Heart, aortic arches and their evolution.

### **UNIT – V**

Comparative anatomy of the vertebrates:

1. Comparative structure and evolution of urinogenital system (pro, meso and metanephric kidney and genital ducts in males and females).
2. Brain and cranial nerves, evolution of brain, spinal cord and ANS.
3. Osteology: Girdles, limb bones, ribs and sternum; jaw suspension in vertebrates
4. Comparative anatomy of sensory organs, especially of eye and ear.

## **LS14 - ANIMAL PHYSIOLOGY**

### **UNIT I**

1. Digestion and Absorption of food in gastrointestinal tract.
2. Regulation of gastrointestinal processes.
3. Obesity and Starvation.
4. Common disorders of digestive tract.

### **UNIT II**

1. Physiology and regulation of respiration.
2. Homeostasis, prevention of blood loss.
3. Cardiac cycle.
4. Blood pressure and common cardiovascular diseases.

### **UNIT III**

1. Structure and mechanism of Kidney function.
2. Ionic and Osmotic balance.
3. Osmoregulation in aquatic and terrestrial environments.
4. Homeostasis.

#### **UNIT IV**

1. Structure and function of muscle fibres in vertebrates.
2. Molecular theory of contraction.
3. Muscle fatigue
4. Skeletal muscle disorder- Tetany, Cramps, Muscular dystrophy.

#### **UNIT V**

1. Electrochemical potential and membrane excitation.
2. Impulse conduction via myelinated , non-myelinated fibres and synaptic junctions.
3. Neurotransmitters and Neuromodulators.
4. Learning and memory.

### **LS15 – IMMUNOLOGY**

#### **UNIT – I**

1. Innate and Acquired Immunity: Active and Passive immunity, Specific and non-specific defence mechanism.
2. Organs and cells of immune system - Hematopoiesis and differentiation, B and T cell lymphocytes, Macrophages, Dendritic cells, Eosinophils, Neutrophils and Mast cells, Natural killer Cells and Cancer Cells
3. Lymphoid Organs: Spleen, Lymph Node, Thymus, MALT, GALT
4. Lymphocytes trafficking and Lymphokine activated killer cells,

#### **UNIT –II**

1. Antigen: Concept of haptens, properties of antigen, Epitopes, Super antigen.
2. Immunoglobulins: Structure, Function and properties of immunoglobulin classes.
3. Antigen-Antibody reaction: Precipitation, agglutination, ELISA, RIA, Western Blotting, Immunofluorescence and immunoelectron microscopy
4. Immune deficiencies and autoimmunity.

#### **UNIT – III**

1. Regulation of Immune response: Antigen processing and presentation, generation of humoral and Cell mediated immune response.
2. Development of B & T cell, Activation of B and T lymphocytes.
3. Cytokines and their role in immunoregulation.
4. Immunological tolerance: Mechanism of development of immunological tolerance.

## **UNIT – IV**

1. Hypersensitivity Antibody – Mediated – type I. Anaphylaxis;
2. Type II.. Antibody dependent cell cytotoxicity; Type III - immune complex mediated Reactions.
3. Type IV Cell mediated hypersensitivity reactions,
4. Monoclonal antibody and Hybridoma Technology

## **UNIT – V**

1. Complement system: Classical, alternate, lectin pathway of complement activation. Regulation of complement activation.
2. Transplantation immunology: MHC Class I and II structure and function, MHC restriction, types of grafts, grafts rejection, GVH reactions.
3. Tumor immunology –Tumor antigens, Immune response to tumors and tumor evasion of the immune system.
4. Vaccines: Types, productions and Applications

## **LS16 – SPECIAL PAPER\* FISH BIOLOGY**

### **UNIT- I**

1. Geographical distribution: Classification of fishes, with distinguishing characters of principal subdivisions.
2. Body form and locomotion.
3. Integument, exoskeleton and colouration of fishes.
4. Structure, modification and functions of median and paired fins. Theories of origin of median and paired fins.
5. Musculature: Lateral musculature, jaw and respiratory musculature, fin musculature and eye muscles.

### **UNIT-II**

1. Endoskeleton: Neurocranium and visceral arches, vertebral column, fin skeleton and girdles, types of jaw suspension in fishes.
2. Food, feeding habits, alimentary canal and physiology of digestion.
3. Blood, heart, vascular system and circulation of blood. Haemoglobin and its adaptation in fishes.
4. Respiratory organs, physiology of respiration and its regulation. Air breathing organs.
5. Excretory organs and physiology of excretion. Osmoregulation in marine, fresh water and estuarine fishes.

### **UNIT-III**

1. Structure, function and physiology of swim-bladder. Weberian apparatus and its significance.
2. Nervous system and sense organs, lateral line system.
3. Endocrine glands and their hormones.
4. Reproduction in fishes: Reproductive organs ( male and female), reproductive behaviour, courtship and parental care, general study of fish behaviour, hormonal control of reproduction.
5. Embryogenesis: Ontogenic development in fishes, categories of fishes with respect to development; viviparity; molecular aspect of yolk formation.

### **UNIT-IV**

1. A general survey of world's fisheries, survey of principal fisheries of India (riverine, reservoir, estuarine and marine fisheries).
2. Biology of Indian major carps, catfishes, Hilsa, sardine mackerel, sharks, mahaseer, prawns and oysters.
3. Pisciculture and its importance with special reference to India. Different types of fish cultures viz. composite fish culture, paddy culture, sea food fish culture, cage culture, air breathing fish culture, carnivorous fish culture and ornamental fish culture.
4. A detailed study of methods of fishing (crafts and gears) in fresh water of India. 8. Fisheries: Management, growth, productivity and expansion.
5. Fish preservation and processing. Bio-chemical composition of fish, fish as food., Fish and mankind, byproducts of fishing industry. Estimation of population number and mortality rates in fresh waters.

### **UNIT-V**

1. Limnology: Definition, types of lakes/ponds, their significance in fishery practice. Ecological factors affecting the life of fishes in various ecosystems. Plankton in relation to fisheries. Water pollution and fisheries with special reference to India. Aquatic weeds and their control.
2. Diseases of fishes: Symptoms, etiology and treatment.
3. Specialized organs: Bioluminescent organs, electric organs, sound producing organs, poisonous and venomous glands.
4. Fish migration, its causes and significance. Adaptations to special conditions of life: Hill stream fishes, deep sea fishes, cave dwelling fishes, arctic and Antarctic fishes.
5. Exotic fishes, larvivorous fishes, predatory and weed - fishes. Prawn culture in lakes and ponds of fresh and brackish water of Rajasthan. Management of fish marketing and impact of fisheries on state economy. Fish culture and cytogenetics. General diversity of fishes of India, transgenic fishes and fish genomics, recombinant DNA technology in fish research. Aquaria and their uses, setting up and maintenance of aquaria.

## PRACTICALS

### 1. First day

#### 1. Chordates :

(a) Taxonomy : Study of museum specimens or representative animals from all chordate groups (Protochordata to Mammalia).

(b) Anatomy : (i) General anatomy and neural gland of *Herdmania* using charts and computer software. (ii) Afferent and efferent arteries, cranial nerves, membranous labyrinth, eye muscles and their innervation, brain of any fish. (iii) Study of fish anatomy through serial section of fry and fingerling stages. (iv) Limb musculature, cranial nerves and eye muscles and their innervation in frog dissection using computer software.

(v) General anatomy, major blood vessels and cranial nerves of any nonpoisonous snake through charts / models / computer software. Study of differences between poisonous and non-poisonous snakes. (vi) Flight muscles, perching mechanism, air sacs and anatomy of the neck region in pigeon through charts / models / computer software. (vii) Reproductive system and anatomy of the neck region in rat.

(c) Osteology : Comparative study of the axial and appendicular skeleton from fish to mammals, with particular reference to important skull types in amphibians, reptiles, birds and mammals.

(d) Permanent preparations : Whole mounts of pelagic tunicates, cycloid scales, pecten and columella in pigeon, ear ossicles of rat or squirrel or any other mammal.

(e) Histology : A detailed study of the histology of all mammalian tissues and organs through prepared slides.

(f) Physiology: Determination of osmotic potential by tissue weight method. Separation of amino acids by TLC/paper chromatography and calculating the R<sub>f</sub> value. To estimate hemoglobin contents of human blood by hemoglobinometer. To conduct serum preparation. To detect clotting time of human blood sample. To detect bleeding time human blood sample. Blood film preparation and identification of cells. To carry out differential leukocyte of human blood sample. Determination of peroxidase activity.

### 2. Second Day

#### 1. Immunology

1. To determine the ABO blood group by slide agglutination.
2. To conduct ELISA.
3. To conduct radio immuno diffusion.
4. Demonstration of Widal, VDRL, pregnancy.

#### 2. Special paper Fish Biology

1. Complete anatomy of a teleost, represented by *Wallago attu* or any other locally available teleost: External features, general viscera (including urino-genital organs), jaw and lateral musculature, including blood supply, afferent and efferent branchial blood vessels, brain and cranial nerves, eye muscles and their innervations, membranous labyrinth, Weberian ossicle-swim bladder connection. 2. Anatomy through model / photograph / chart / CD of the head of any cat fish 3. Breathing organs of *Anabas*, *Clarias*, *Channa* and *Heteropneustis*. 4. Permanent preparations and study of pharyngeal denticles, cycloid scales. 5. Micro-technical pocedures: Preparation and study of serial sections of a larval fish and represetative tissues and organs of

fish. 6. Local fishes and their identification upto the species level, study of the available museum specimens.

7. Hydro-biological exercise: (a) Analysis of water: Determination of pH, free carbon di oxide, dissolved oxygen, chlorides, calcium, total alkalinity, total salinity, BOD, COD. (b) Collection: Qualitative and quantitative analysis of planktons.

8. Biochemical/Physiological/Embryological exercise: (a) Estimation of glycogen in liver. (b) Determination of free amino acids of muscles or blood plasma through chromatography. (c) Induced spawning. (d) Study of development of teleost fish through preserved material (whole embryo or sections): eggs, cleavage, blastula, gastrula, external gill, mature larva, fry and fingerlings.

9. (a) Periodical visits to a local fishing farm to gain a firsthand knowledge of its piscicultural practices and fisheries activities. (b) A week's tour of an inland fisheries research station. (c) A week's tour of an important marine biological or fishery centre in the country.

## LS16 – SPECIAL PAPER\* ENVIRONMENTAL BIOLOGY

### UNIT: I

1. Introduction to environmental Biology. A detailed study of different ecosystems. (Study with inclusions of abiotic and biotic components and their interrelationship, productivity and adaptations of animals).

2. Terrestrial Ecosystems : 1. Grasslands (including grazing lands) 2. Forests : characteristics of alpins, temperate and tropical forests. Stratification, high altitude (with special reference to Himalayan ecology) 3. Deserts : Types and ecological attributes of desert biota. 4. Tundra : Extent and ecological peculiarities 5. Tundra : Extent and ecological peculiarities .

3. System analysis including models.

### UNIT- II

1. Aquatic Ecosystems. (a) Fresh Water : Lakes (including salt lakes) Ponds streams, springs, rivers and marshes. (b) Marine : Zonation fauna (c) Estuarine : Ecological peculiarities and adaptations (including impact on fauna)

2. A general knowledge of Biogeography .

3. Environmental Physiology: Basic Metabolic rate and body size Metabolism and climatic adaptations - Hibernation and aestivation Poikilotherms and Homeotherms Asphyxic responses. Response to temperature and Pressure. Haematological changes Thermal properties of water and survival limits. Acclimatization.

### UNIT-III

1. Air pollution, Water pollution and land pollution , Thermal, noise and radiation pollution

2. Environmental Toxicology: Natural and man-made toxicants occurring in the environment and their impact on animal life in different ecosystems.

3. Methodology for environmental analysis: a. monitoring b. analysis of physical and chemical factors c. statistical analysis d. bioassay techniques.

## UNIT-IV

1. Management of: - 1. Agriculture and forestry including best management 2. Wild life resources 3. Mineral resources 4. Aquaculture (Fresh water and marine) 5. Energy resources 6. River basin. 7. Management of Environment Natural resources: their conservation and development.
2. Environment and Health - Urban health problems, impact of urbanization stress, Health status and health problems. Rural health problems.
3. Climate change, Global warming, natural disasters, water availability, food security in relation to human health.

## UNIT- V

1. Development and evolution of ecosystems: causes and kinds of succession diversity and productivity in relation to succession and development.
2. Urban, rural and other Man-made ecosystems, their impact on animal life. Urbanization and industrialisation.
3. Socio-ecological impacts.

### **2. Practicals of Special paper Environmental Biology**

- (a) Measurement of climatic factors (atmosphere, water, temperature and relative humidity).
- (b) Measurement of water and soil pH, edaphic factors of soil; preparation of soil extract, determination of humidity in microhabitat; pH, alkalinity of water, dissolved oxygen, free carbon dioxide, chloride, salinity, temporary and permanent hardness of water, turbidity.
- (c) Measurement of population density.

Note: Numerical problems of population determination to be done.

- (d) A field trip to study of any one of the following habitats to be assigned to an individual or to a group of students: (i) Pond habitat. (ii) Marine habitat. (iii) Terrestrial habitat.