DEPARTMENT OF ZOOLOGY
UNIVERSITY OF LUCKNOW
Lucknow

Syllabus

on

Choice basis Credit System

M.Sc. Zoology

Core Course (3 + 2)
&
Minor Electives

Faculty of Science

Submitted on 06.06.2017

Department of Zoology, University of Lucknow Lucknow
(CBCS system from 2017-2018 onwards)

The course for Master of Science (M.Sc.) in Zoology shall comprise of **four semesters**, *each of six months duration.* Each semester will have Three Theory papers (**100 marks each**) and Two Practicals (A and B each of **100 marks**). Each Theory & Practical will be of 04 credits. The students admitted to this course are expected to have the knowledge of subjects included in different papers at the undergraduate level. In addition, four electives (each of 03 credits) – one per semester will also be offered to inter departmental students. Each student will be required to complete 80 + 12 credit courses to obtain M.Sc. Zoology.

There will be four specializations viz: Entomology, Fish and Fisheries, Parasitology and Endocrinology & Reproductive Biology. All these specializations will be taught to students of all the centers. Specialization to students will be given on the basis of merit and options. The First paper (410) in Semester-IV will be compulsory to all.

	M.Sc. Zoology	Credits
Semester-I		
401	**Non-Chordata**	**4**
402	**Animal Physiology**	**4**
403	**Cell and Molecular Biology**	**4**
Semester-Il		
404	**Chordata**	**4**
405	**Animal Behaviour and Chronobiology**	**4**
406	**Environmental Biology and Toxicology**	**4**
Semester-III		
407	**Quantitative Biology, Biosystematics and Evolutionary Biology**	**4**
408	**Biochemistry, Inheritance Biology and Biotechnology**	**4**
409	**Developmental Biology and Immunology**	**4**
Semester-IV		
410	**Bioinstrumentation, Biotechniques, and Bioinformatics**	**4**
Specialization in Entomology		
411	**Insect Ecology, Morphology and Physiology**	**4**
412	**Applied Entomology and Pest Management**	**4**
Specialization in Fish and Fisheries		
413	**Fish Biology and Genetic Resources**	**4**
414	**Fish Ecology, Aquaculture and Capture Fisheries**	**4**
Specialization in Parasitology		
415	**Helminth Parasites**	**4**
416	**General Parasitology, Protozoan and Other Parasites**	**4**
Specialization in Endocrinology and Reproductive Physiology		
417	**Comparative Endocrinology**	**4**
418	**Reproductive Physiology**	**4**
Minor Elective Paper -01: Insects in Human Life		**3**
Minor Elective Paper -02: Parasitic diseases of human and domesticated animals		**3**
Minor Elective Paper -03: Biological clocks and human health		**3**
Minor Elective Paper -04: Aquaculture Management and Entrepreneurship		**3**

M.Sc ZOOLOGY SYLLABUS

SEMESTER-I

401 Non-Chordata

Unit-I

Protozoa

Ultrastructure	**01**
Osmoregulation	**01**
Locomotion	**01**
Nutrition	**01**
Reproduction in Protozoa	**01**

Porifera

Cell types Skeleton Reproduction in sponges	**03**

Cnidaria

Origin of Metazoa	**01**
Polymorphism	**01**
Metagenesis	**01**
Corals	**01**
pigments	**01**

Unit-II

Platyhelminthes

Origin and Evolution of bilateria	**01**
Parasitic adaptations	**01**
General organization of Trematodes and Cestodes	**04**
Larval stages of Trematodes and Cestodes	**02**

Aschelminthes

General organization	**02**
economic importance of Nematodes in animals and plants	**02**

Unit III

Annelida

Coelom & Metamerism	**01**
Adaptive radiation in Polychaeta	**02**
Segmental organs	**01**
Filter feeding	**01**

Arthropoda

Organisation and affinities of Onychophora	**02**
Larval forms in Crustacea	**01**
Parasitism in Crustracea	**01**
Respiratory organs in Arthropods	**01**
General organization of Tardigrada	**01**
General organization of Pycnogonida	**01**
General organization of Trilobitomorpha	**01**

Unit-IV

Mollusca

Foot	**0 1**
Respiration	**0 1**
Nervous system	**0 1**
Torsion in gastropods	**0 1**
Shell types	**0 1**

Echinodermata

Water vascular system	**0 1**
Larval forms & affinities	**0 2**

Minor phyla

Organization and affinities of Rotifera	**0 1**
Organization and affinities of Phoronida	**0 1**
Organization and affinities of Ectoprocta	**0 1**
Organization and affinities of Endoprocta	**0 1**
Organization and affinities of Ctenophora	**0 1**

402 Animal Physiology

Unit-I

Physiology of Digestion

Chemical digestion	**03**
Absorption of proteins, Carbohydrates, lipids and nucleic acids.	**03**

Physiology of Excretion

Homeostasis and ion regulation	**0 2**
Osmoregulation	**0 2**

Physiology of Thermoregulation

Thermal biology based animal categories, mechanism of thermoregulation.	**0 2**

Unit-II

Physiology of Respiration

Gaseous exchange in terrestrial and aquatic animals	**0 3**
Role of respiratory pigments	**0 2**
Mechanism and regulation of respiration	**0 2**

Physiology of Circulation

Pattern of circulation among different animal groups	**0 2**
Haemodynamics, Regulation of circulation, Cardiac cycle.	**0 3**

Physiology of Stress

Mechanism of stress, stress disorders, secondary effects.	**0 2**

Unit-III

Physiology of Muscular System

Theories of muscular contraction molecular mechanism and regulation of muscular contraction	**0 4**

Neurophysiology

Structural and functional organization of the nervous system Physical basis of neuronal function Communication along and between neurons	**0 5**

Physiology of Sense Organs

Touch, Vision, Hearing, Gustatory, Smell	**0 3**

Unit-IV

Physiology of Endocrine System

Endocrine glands, their secretion and physiological role	**0 5**
Mechanism of action of hormones	**0 1**
Neuroendocrine feedback	**0 1**
Neurotransmitters and neuropeptides.	**0 1**
Physiology and hormonal control of mammalian reproduction	**0 2**

Physiology of Aging

Theories and mechanism of aging	**0 2**

403 Cell and Molecular Biology

Unit-I

Biological Membrane System

Molecular organization & specialization	**0 2**
Biosynthesis and turn over	**0 2**
Transport across membrane	**0 3**
Cytoskeleton and cell motility	

Endomembrane system and intracellular trafficking

Endoplasmic reticulum	**0 2**
Golgi bodies	**0 1**
Mitochondria	**0 1**
Nucleus	
Lysosomes	**0 1**
Endosomes	**0 1**
Cytoskeleton and cell motility	**0 1**

Unit-II

Cell division and cell cycle

Mitosis and Meiosis and their regulation	**0 2**

Cell signaling

Communication between cells and their environment (Signalling through cell surface and intracellular receptors; bacterial two component signalling)	**0 5**
Steps in cell cycle and control of cell cycle and cancer	**0 3**

Unit-III

DNA Structure and Processing

DNA Structure: supercoiling and polymorphism	**0 1**
DNA Replication	**0 2**
DNA Damage and Repair	**0 2**
DNA recombination	**0 2**
RNA synthesis and Processing	**0 2**
Protein Synthesis and Processing (including Genetic code and wobble hypothesis)	**0 2**

Unit- IV

Gene Regulation

Fine structure of gene	**0 3**
Regulation of gene expression in prokaryotes and eukaryotes (including Operon Concept)	**0 4**
Intracellular protein degradation	**0 2**
Gene silencing, RNAi	**0 1**

Semester II

404-Chordata

Unit-I

General organization and affinities of Urochordata and Cephalochordata	**0 5**
General organization of fishes	**0 1**
Classification	**0 2**
General organization and affinities of *Ostracoderms*	**0 1**
General organization and affinities of *Dipnoi. Holocephali.*	**0 1**
General organization and affinities of *Coelacanthiformes*	**0 1**

Unit-II

Amphibia

General organization of Amphibia	**0 2**
Origin of tetrapods	**0 2**
Adaptive radiation	**0 1**
Peculiarities and affinities of Apoda	**0 1**
Extinct Amphibians	**0 1**

Reptilia

Origin and evolution	**0 2**
Adaptive radiation	**0 2**
Dinosaurs	**0 1**

Unit-III

Reptilia

General organization and affinities of *Chelonia*	**0 1**
Crocodilia	**0 1**
Squamata	**0 2**
Rhynchocephalia.	**0 1**

Aves

Origin and evolution	**0 2**
Flightless birds	**0 1**
Adaptations for flight	**0 2**
Adaptive radiation	**0 1**

Unit-IV

Mammalia

Origin of mammals	**0 3**
Adaptive Radiation of Mammalia	**0 2**
Structural peculiarities and phylogenetic relations of *Prototheria* and *Metathe ria.*	**0 2**
Dentition	**0 1**
Stomach	**0 1**
Uterus modifications	**0 1**
Aquatic mammals	**0 2**

Semester II

405 Animal Behaviour and Chronobiology

Unit-I

Types of Behaviour	**02**
Learning and Memory	
Nonassociative and associative learning	**0 1**
Mechanisms of learning and memory	**0 1**
Molecular basis of long term memory	**0 2**
Motivation	
The hypothalamus and motivated behaviour	**0 1**
Regulation of feeding and drinking behaviour	**0 1**
Pheromones and behaviour	
Pheromones and behaviour	**0 1**
Hormones and behaviour	
Hormones and behaviour	**01**
Reproductive behaviour and mating systems	
Types, Evolution, Neuroendocrine control	**0 2**
Genes and Behaviour	**0 1**

Unit-II :

Communication in animals	**0 2**
Social structure and behaviour	**0 2**
Parental Care with reference to fish, amphibians and birds.	**0 3**
Territorial behaviour	**0 2**
Sexual selection and kin selection	**0 3**

Unit-III:

Introduction, milestones and Scope of Chronobiology	**0 3**
Types and properties of biological rhythms	**0 2**
Geophysical environment Seasons; proximate and ultimate factors	**0 1**
Anatomy and physiology of the time keeping system	**0 3**
Peripheral clocks	**0 1**
Photoreception, Phototransduction, Photoperiodic time measurement	**0 2**
Regulation of Seasonal Migration	**0 1**

Unit-IV:

Molecular mechanisms underlying clock function in organisms (Cyanobacteria to mammals)	**0 3**
Masking and entrainment	**0 1**
Entrainment of biological rhythms with reference to photic and non-photic cues	**0 2**
Phase shift, Phase response curves (PRC) and phase transition curves (PTC)	**0 2**
Biological rhythms and human health	**0 1**
Rhythms of the Brain	**0 1**
Recording brain waves, EEG rhythms	**0 1**
Mechanical and meaning of brain rhythms	**0 1**
Sleep, Neural mechanisms of sleep	**0 1**

Semester II

406 : Environmental Biology and Toxicology

Unit-I

Ecosystem:

Concept, Production and decomposition	**0 1**
Homeostasis and dynamics.	**0 1**
Biosphere and Biogeochemical cycles	**0 3**
Population ecology.	**0 2**
Community ecology and Ecological succession	**0 3**
Concept of Habitat Ecology and Ecological niche	**0 1**
Island Ecology	**0 1**

Unit-II

Environmental pollution	**0 2**
Waste management	**0 2**
Environmental monitoring	**0 2**

Global environmental problems:

Acid rain, Global warming, Green house effect and Depletion of ozone layer.	**0 1**

Wildlife:

Causes of wildlife depletion and conservation	**01**
Wildlife Health and Population management	**02**
Advanced quantitative methods for wildlife management	**02**
Conservation genetics	**02**

Unit-III

Exposure of toxicants

Different routes/methods of exposure, Frequency & duration of exposure Human exposure	**0 1**
Dose-response relationship	**0 1**

Selective toxicity:

Concept, Significance	**0 1**
Basic mechanisms of selective toxicity	**0 1**

Toxicity Tests:

Bioassay	**0 1**
Acute toxicity tests for terrestrial and aquatic animals	**0 2**
Chronic toxicity tests	**0 1**
Concept of Maximum Acceptable Toxicant Concentration (MATC) and safe concentration.	**0 2**

Factors affecting toxicity:

Factors related to the chemical exposure surrounding medium and the organisms	**0 1**

Unit-IV

Toxic effects of Xenobiotics

Local and systemic effects	**0 1**

Immediate and delayed effects	
Reversible and irreversible effects	
Biochemical and physiological effects of xenobiotics	**0 1**
Nanotoxicology	**0 1**
Toxicogenomics	**0 1**

Bioaccumulation of Xenobiotics

Concept of bioconcentration & Bioaccumulation and biomagnifications; Bioconcentration factor	**0 1**
Process of bioaccumulation in the biological system	**0 1**

Biotransformation of Xenobiotics

Concept of biotransformation and metabolism	**0 1**
Sites of biotransformation	**0 1**
Biotransformation enzymes and general biotransformation reactions	**0 1**
Factors affecting biotransformation	
Safety evaluation of xenobiotics	**0 1**

Antidotal therapy **01**

Semester-III

407 Quantitative Biology, Biosystematics and Evolutionary biology

Unit-I

Summarizing data

Types of statistics: inferential and descriptive	**01**
Parametric and non-parametric tests concepts & applications	**02**
Types of biological data	**02**

Measures of Central tendency

Mean, Median and Mode in grouped and ungrouped data and their properties	**0 1**

Measures of dispersion

Range mean deviation, Variance, Standard deviation, Coefficient of variation	**0 1**
Concept of Skewness and Kurtosis	**0 1**

Correlation and regression

Coefficient of correlation	**0 1**
Linear regression	**0 1**
Regression lines	**0 2**

Unit-II

Tests of significance and their application

one and two sample tests,	**0 1**
t-test,	**0 2**
Chi-square test	**0 2**

Analysis of variance

One-way and two-way ANOVA with or without repeated measures	**0 3**
ANCOVA	**0 2**
Statistical Softwares	**0 1**

Unit III

Taxonomy, and Biosystematics

Principles of classification	**0 2**
Concept and type of species	**0 2**
Modern and Molecular taxonomy (Cytotaxonomy Chemotasonomy taxonomy)	**0 2**

Unit-IV

Evolutionary Biology

Origin of life	**0 1**
Evolutionary theories	**0 2**
Natural selection	**0 2**
Mechanisms of speciation	**0 2**
Molecular evolution,	**0 2**
Adaptation (Evolutionary analysis of form and function)	**0 2**
Phylogenetics: concept, phylogenetic gradualism and Punctutated equilibrium	**0 2**

408 Biochemistry, Inheritance Biology and Biotechnology

Unit-I

Structure of macromolecules

Proteins

Structure, conformations and functions of proteins	**02**
Ramachandran plot	**01**
Protein stability	**01**

Carbohydrates

Types of Carbohydrates	**01**

Lipids

Types of Lipids	**01**

Bioenergetics:

Thermodynamic principles	**0 1**
Energy rich bonds Weak interactions, Coupled reactions, Group transfers	**0 2**
Biological energy transducers	**0 1**
Application of free energy function	**0 2**

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Unit-II

Enzymes:

Mechanism of action	**0 1**
Enzyme kinetics	**0 2**
Regulation of enzyme action	**0 2**

Metabolism of Macromolecules:

Carbohydrates:

Metabolism and regulation of pathways	**0 2**

Lipid:

Biosynthesis of saturated and unsaturated fatty acids	**0 2**
Catabolism of fatty acids and ketone bodies	**0 2**

Unit-III

Basic Genetics

Mendelian principles and its extensions	**0 2**
Linkage and Crossing Over; linkage maps	01

Population genetics:

Gene and genotype frequencies, the Hardy Weinberg Law	**0 2**
Genetic factors affecting gene population & Probability and goodness of fit	**0 1**

Classification of mutations **0 1**
Mutagenesis and Phenotypic effects of mutation **0 1**
Mutagenicity and Carcinogenicity **0 1**

Quantitative genetics:

Polygenic inheritance and its measurements **0 2**

Human genetics:

Pedigree analysis **0 1**
Karyotypes and genetic disorders. **0 1**

Unit-IV

Gene technology:

Recombinant DNA Technology **05**
Restriction Enzymes, DNA modifying enzymes, Cloning Vectors, Ligation
Gene transfer techniques, Gene therapy
Selection and Identification of Recombinant cells (HRT, HART, Hybridoma)
Deletion Analysis
Nucleic acid hybridization and DNA sequencing and fingerprinting **0 2**

Genetic engineering and human welfare:

Single cell proteins **0 1**
Biosensors **01**
Biochips **01**

Enzyme technology:

Methods of enzyme production 01
Immobilization of enzymes, Applications 01

409 Developmental Biology and Immunology

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Unit-I

Gamete Biology:

Gametogenesis, Fertilization **0 2**
Cleavage pattern **0 1**
Gastrulation, fate maps **0 3**
Developmental mechanics of cell specification **0 1**
Morphogenesis and Cell adhesion **0 1**
Genes and development **0 1**
Differential gene expression **0 2**
Cell-cell communication **0 3**

Unit-II

Early development of vertebrates (fish, birds & mammals) **0 5**
Metamorphosis, regeneration and stem cells **0 3**
Environmental regulation of development **0 1**
Organogenesis (Vulva, Eye and Limb) **0 3**

Unit-III

Introduction to Immune system, Immunity and its types	**0 1**
Antigens, Antigenicity	**0 2**
Major Histocompatbility complex (MHC) molecules	**0 2**
Structure and function of Antibody molecules	**0 2**
Generation and Regulation of Antibody diversity	**0 2**
Monoclonal antibodies	**0 1**

Unit-IV

Antigen-Antibody interactions	**0 2**
Antigen Processing and Presentation	**0 2**
Activation and differentiation of B and T cells	**0 1**
Humoral and Cell-Mediated immune responses	**0 2**
Cytokines, Complement system	**0 2**
Hypersensitivity and Autoimmunity	**0 1**
Immunodeficiencies, Vaccines	**0 1**

Semester IV

410 Bioinstrumentation Biotechniques and Bioinformatics

Unit-I

Basic principles of microcsopy	**0 1**
Phase contrast microscope	**0 1**
Electron microscope	**0 2**
Fluorescence microscope	**0 2**
Confocal microscopes	**0 2**
Centrifuges	**0 4**
UV and IR Spectrophotometer	**01**

Unit-II

Chromatography: Paper and this layer chromatography	
Chromatography :	**0 2**
Column-ion-exchange	
Gel filtration	**0 1**
HPLC, FPLC and GCMS	**0 4**
2D Gel electrophoresis	**0 2**
Autoradiography	**0 1**

Unit-III

Histochemical and immunotechniques

ELISA, RIA, Western blot	**0 3**
ChIP,	**0 1**
Flow cytometry, FISH and GISH	**0 2**
Cell and tissue culture	**0 2**
Gene transfer techniques	**0 3**
PCR (RT and Q)	**0 2**

Unit-IV

Basics of computers: (CPU, I/O units), Operating systems, Computer networking.	**0 2**
Concept of homepages and websites, World Wide Web, URLs, using search engines	**0 2**
Databases: nucleic acids, genomes, protein sequences and structures, SNP db, Finding scientific articles.	**0 2**
Information retrieval from biological databases, Entrez system, SRS	**0 2**
Sequence analysis (homology): pairwise and multiple sequence alignments-BLAST, CLUSTALW, Phylogenetic analysis	**0 3**
Protein structure prediction---visualizing 3D-structures of proteins	**0 1**

Specialization: Entomology

411 : Insect Ecology, Morphology and Physiology

Unit-I

Survey and Sampling Methods	**0 1**
Population Dynamics	**0 2**
Reproductive Potential	**0 1**
Predation Ecology	**0 2**
Reproductive ecology	**0 2**
Collection and Preservation of insects	**0 1**
Classification and Characteristic features of Economically Important Insect orders	**0 3**

Unit-II

Structure and function of Integument	**0 2**
Digestive system and its physiology	**0 3**
Circulatory system	**0 3**
Nervous system and sense organs	**0 4**

Unit-III

Respiratory system and its physiology	**0 3**
Excretion, salt and water regulation	**0 1**
Reproductive System	**0 3**
Various modes of Reproduction	**0 2**
Development up to three genn layers, moulting and metamorphosis, various types of larvae and pupae	**0 2**

Unit-IV

Endocrine glands	**0 3**

Communication:

Organs involved and mechanism pertaining to various means of communication [Visual, Mechanical, Acoustic, Chemical (Pheromones)]	**0 5**
Bioluminiscence and Photoperiodism	**0 2**
Diapause and its regulation in insects	**0 2**

412 Applied Entomology and Pest Management

Unit-I

Characteristic features, biology, nature of damage and management measures of:

Important insect pests of cotton	**0 2**
Important insect pests of sugarcane	**0 3**
Important insect pests of vegetables,	**0 2**
Important insect pests of oil seeds,	**0 2**
Important insect pests of fruit crops, especially mango.	**0 3**

Unit-II

Characteristic features, biology, nature of damage and management measures of:

Important insect pests of cereals and pulses	**0 3**
Important insect pests of stored grains	**0 2**
Polyphagous insects	**0 3**
Insects of Medical and Veterinary Importance	**0 4**

Unit-III

Industrial Entomology

Apiculture	**0 4**
Sericulture	**0 4**
Lac-culture	**0 4**

Unit-IV

Pest Management

Components of Insect Pest Management including Mechanical, Physical, Cultural, Chemical, Legal, Ecological, Biological, Microbial, Recent trends.	**0 6**
Concept and Procedure of Integrated Pest Management	**0 2**
Mode of action of organochlorine, organophosphorous and carbamate pesticides	**0 2**
Pyrethroids and neem products	**0 2**

Specialization: Fish and Fisheries

413 Fish Biology, and Genetic Resources

Unit-I : **Fish Morphology and Anatomy:**

1.1. Skin barbels	01
1.2. Scales and Tails	01
1.3. Fins and Locomotion	01
1.4. Pigments, Colour Changes and its Significance	02
1.5. Gills	01
1.6. Physiology of Respiration	01
1.7. Air Breathing Organs and Swim Bladder: (Structural Modifications)	02
1.8. Weberian Ossicles and Sound Producing Organs	02
1.9. Electric and Luminescence Organs	01

Unit-II

Fish Biology

1.10.	Food, Feeding Habits and Digestion	03
1.11.	Age and Growth	01
1.12.	Length-Weight and Length-Length Relationships	02
1.13.	Excretion	01
1.14.	Osmoregulation	01
1.15.	Circulatory System	01
1.16.	Nervous System	01
1.17.	Sense Organs: Eye, Olfactory and Gustatory	02

Unit-III

Endocrinology Reproduction and Behaviour

1.18.	Endocrine Glands	02
1.19.	Gonads Reproductive Cycle and Maturation	03
1.20.	Fecundity (Absolute and Relative) Spawning	01
1.21.	Development and Parental Care	02
1.22.	Selective Breeding and Hybridization	02
1.23.	Fish Behaviour (Conditioned Response and Ethological Analogies)	01
1.24.	Fish Migration	01

Unit-IV

Fish Genetic Resource

1.25.	Fish Biodiversity	01
1.26.	Stock (Concept and Structuring)	01
1.27.	Phenotypic Plasticity and Genetic Differentiation in Traits	01
1.28.	Fish Chromosome and Karyotyping	01
1.29.	Chromosome Banding (C, G and NOR)	02
1.30.	Chromosome Manipulation (Gynogenesis, Androgenesis and Polyploidy)	02
1.31.	Genetic Analysis Techniques (RAPD, RFLP, AFLP, mDNA)	02
1.32.	DNA Polymorphism in Fishes	01
1.33.	MNT and CAT	01

414: Fish Ecology, Aquaculture and Capture Fisheries

Unit-I

Fish Pond and Ecology of Teleostean Fishes

1.1.	Construction and Lay-out of different types of Ponds (Nursery, Rearing and stocking)	02
1.2.	Formulation and Operation of different types of Hatcheries	02
1.3.	Water Quality Requirements and Toxic Substances	02
1.4.	Temperature, salinity, osmotic pressure, pH, dissolves oxygen, carbon dioxide, nitrogen, alkalinity and turbidity	02
1.5.	Toxic substances and their effects	01
1.6.	Productivity of the Pond (Planktons and Live food organism)	02
1.7.	International water code for Responsible Fisheries	01

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Unit-II

Capture Fisheries

1.8.	Freshwater Fisheries (River, Lakes, and Reservoir)	03
1.9.	Cold water Fisheries and Hill Stream Adaptation	01
1.10.	Brackish water Fisheries	01
1.11.	Marine Fish resources of India, Exclusive Economic Zone	01

1.12. Problems and Prospects of Mariculture 01
1.13. Capture Fisheries of India with reference to Elasmobranchs, Bombay Duck, Catfishes, Eels, Thread Fish, Theropon, Mackerel and Pomfrets, 05
1.14 Crustacean and Molluscan Fisheries

Unit-III

Aquaculture and Pond Management

1.15 Problems and Prospects of Aquaculture 01
1.16 Breeding Habits of Carps: Induced Spawning and Bundh Breeding of Carps (Indigenous and Exotic) 02
1.17 Pond Management and Stocking Materials: Manuring, Liming, Predatory and Weed Fishes and their Eradication, Predatory Aquatic Insects and their Control, Fish Poison. Stocking Materials (Spawn, Fry and Fingerlings) and their Culture 05
1.18 Polyculture, Monoculture and Integrated Fish Farming and their Management 02
1.19 Aquatic Weeds and their Control 01
1.20 Nets, Gears and Boats used for Fishing 02

Unit-IV

Fish Products and Fish Diseases

1.21 Fish Preservation and Processing (Traditional and Advanced Methods) 02
1.22 Fish By-Products 02
1.23 Fish Marketing and Trade 01
1.24 Aquarium Fish and their Maintenance 01
1.25 Fish Pathology: Prevention, Prophylaxis and Treatment of Fungal, Bacterial, Viral and Protozoan Diseases 03
1.26 Fisheries Cooperative Societies of India 01
1.27 Fish in relation to Man and Human Welfare 01

Specialization: Parasitology

415-Helminth Parasites

Unit-I : General organization of *Monogenoidea*

With special reference to their morphology, adhesive organs, life cycle, larval *forms (onchomiracidium, miracidium, cercaria, metacercaria),* pathogenicity, diseases and control

Polystoma **0 2**
Diplozoon **0 2**
Gyrodactylus **0 2**

General organization of *Digenea*

With special reference to their morphology, adhesive organs, life cycle, larval *forms (onchomiracidium, miracidium, cercaria, metacercaria),* pathogenicity, diseases and control

Fasciola buski **0 2**
Schistosoma spp **0 1**

Clonorchis sinensis	**0 1**
Paragonimus westermani	**0 2**

Unit-II : General organization of cestodes

with special reference to their morphology, adhesive organs, par uterine organ, life cycle, larval forms (metacestodes), pathogenicity and control	
Echinococcus spp	**0 2**
Hymenolepis spp	**0 2**
Diphylobothrium spp	**0 2**
Dipylidium spp	**0 2**
Acanthocephala (*Macroacanthorhynchus hirudinaceus*)	**0 4**

Unit-III : General organization of Nematodes

with special reference to structures associated with the cuticle, Digestive system, life cycle, pathogencity and control, Patterns of life cycle in nematodes	
Dracunculus mediensis	**0 2**
Wucheraria bancrofti,	**0 2**
Strongyloides stercoralis	**0 2**
Trichinella spiralis	**0 2**
Behaviour of nematodes	**0 1**
General organization of soil and plant nematodes with special reference to *Meloidogyne*. Nematoda and diseases	**0 3**

Unit-IV

Egg shell formation	**0 1**
Ultrastructure of tegument	**0 1**
Physiology of digestion	**0 1**
excretion and respiration	**0 1**
Metabolism of protein and carbohydrate	**0 1**
Methods of collection, preservation and preparation of helminth parasites and their identification	**0 3**
Taxonomy	**0 2**
Diagnosis of parasites, blood and stool examination for parasitic infections	**0 2**

416 General Parasitology, Protozoan and Other Parasites

Unit-I

Parasitism	**0 1**
Evolution of Parasitism	**0 1**
Parasitic Association	**0 1**
Effect of parasites on host	**0 1**
Toxic and poisonous-secretion	**0 1**
Utilization of host	**0 1**
Nutrition,	**0 1**
Parasitic induced alterations	**0 1**
Host specificity	**0 1**
Popul'ation dynamics	**0 1**
Crowding effect	**0 1**
In vitro cultivation of parasites	**0 1**

Unit-ll

Protozoa:

Morphology, life cycle, physiology, pathogenecity, epidemiology, treatment of Sarcodine amoeba *(Entamoeba* spp, *Naegleria* spp, *Acanthamoeba* spp)	**0 3**
Sporozoan *(Toxoplasma* spp, *Eimeria* spp, *Gregarina* spp),	**0 3**
Ciliates *(Balantidium* spp, *Nyctotherus* spp and *Ichthyopthirius* spp)	**0 3**
Haemotlagellates *(Trypanosoma* spp and *Leismania* spp),	**0 3**
Intestinal Flagellates *(Giardia* and *Trichomonas* spp)	**0 2**
Opalinids *(Opalina* spp).	**0 1**

Unit-III

Arachnida:

Parasitic adaptation, characters, morphology, biology, life cycle, pathogenecity, disease caused, control of ticks	**0 3**
Parasitic adaptation, characters, morphology, biology, life cycle, pathogenecity, disease caused, control of mites (03)	**0 3**

Insecta:

Characters, morphology, biology, life cycle, pathogenecity,	**0 1**
disease caused by lice,	**0 1**
Bugs	**0 1**
Flies	**0 1**
Fleas	**0 1**
Myiasis and their control	**0 1**

Unit-IV

Other zooparasites:

Mesozoa, Porifera,	**0 1**
Coelentrata, Ctenophora,	**0 1**
Nematomorpha, Rotifer,	**0 1**
Rhyncocoela, Annelida,	**0 1**
Mollusca,	**0 1**
Crustacea, Pycogonida,	**0 1**
Tardygrada,	**0 1**
Pantastomatida,	**0 1**
Echinoderms, Vertebrates	**0 1**
Laboratory techniques for collection preservation and examination of protozoan, helminth, arthropod parasites	**0 4**

Specialization: Endocrinology and Reproductive Physiology

417: Comparative Endocrinology

UNIT I : Concept of endocrinology

Introduction to the endocrine system	01
Classes of hormones and mechanism of hormone secretion	02
Hormone receptors and mechanism of hormone action	03
Neurotransmitters and neuropeptides	03
Neuroendocrine integration of hormones	03

UNIT II:The neuroendocrine axis

Endocrine hypothalamus `	02
Hormones of adenohypophysis	03
Pars intermedia and melanocortins	03
Hormones of pars nervosa, their synthesis and release	03
Hypothalamic regulation of pituitary hormones	02

UNIT III: Hormones regulating physiology and metabolism

Evolution of thyroid gland	02
Thyroid hormone synthesis and its regulation	02
Thyroid hormone functions	02
Parathyroid gland, its synthesis and action	01
Hormonal regulation of calcium and phosphate homeostasis	02
Regulators of gastrointestinal tract	03

UNIT IV: Hormonal regulation of homeostasis and seasonality

Adrenal gland in mammals and non-mammals	02
Hormones of adrenal gland and their biological action	03
Pineal gland and its structure	01
Melatonin and its biosynthesis	02
Role of melatonin in circadian and seasonal functions	03

418: Reproductive physiology

UNIT I: Neuroendocrine regulation of reproduction

Gonadotropes and lactotropes	02
Dynamics of hormone release	02
Gonadotropin distribution and mechanism of action	03
GnRH: biosynthesis, physiological roles	03
Role of photoperiod in seasonal regulation of reproduction	02

UNIT II: Sex differentiation and reproduction

Mechanism of sex differentiation	02
Gonadal differentiation	03
Differentiation and development of genital tract	02
Epididymus function and sperm maturation	02
Cellular details of testis and ovary	03

UNIT III: Regulation of reproductive processes

Menstrual cycle/ estrous cycle	01
Regulation of ovarian and testicular functions	02
Endocrine regulation of implantation	03
Parturition and hormonal regulation	02
Lactation and its hormonal regulation	02
Placenta in mammals	02

UNIT IV: Reproductive health and endocrine methodologies

Infertility- causes, diagnostics and management	02
Assisted reproductive technologies: in-vitro fertilization, GIFT, ZIFT ICSI	02
Measurement of hormones RIA, ELISA	03
Methods of studying endocrine function-Ablation, transplantation, immunization	03
Manipulation of endocrine function	02

Modified syllabus of Minor Elective Paper-I: Insects in Human Life (03 credits)

Each unit 0.75 credits

Unit-I: General Insect Biodiversity

What are Insects?	02
General Insect Morphology & Anatomy	02
How to Identify Insects?	02
General life cycle of Insects	02

Unit-II: Beneficial Insects-I

Apiculture	02
Sericulture	02
Lac Culture	02
Biological Control Agents	02

Unit-III: Beneficial Insects-II

Ecological Services of Insects	02
Edible Insects	02
Entomotherapy	02
Insects & Cultural Associations	02

Unit-IV: Harmful Insects

Household pests	02
Stored grain pests	02
Common outdoor pests	02
IPM & other Management Practices	02

Minor Elective Paper - II:Parasitic diseases of human & domesticated Animals (03 Credit)

Unit- I Parasitic Protozoan

Dysentery	**0 1**
Diarrhoea	**0 1**
Amoebic Encephalitis and Keratitis	**0 2**
Kala-azar	**0 1**
Sleeping sickness	**0 1**
Malaria	**0 2**
Eimeriasis	**0 1**

Unit- II Common Monogenea, Trematodes, Cestodes

Diplozoon	**0 1**
Polystoma	**0 1**
Gyrodactylus	**0 1**
Fasciola	**0 1**
Schistosoma	**0 1**
Opisthorchis	**0 1**
Hymenolepis nana	**0 1**
Teania solium	**0 1**
Echinococcus	**0 1**

Unit- III Common Nematodes & Acanthocephalan

Ascaris	**0 1**
Enterobius	**0 1**
Ancylostoma	**0 2**
Dracunculus	**0 1**
Wuchereria bancrofti	**0 2**
Meloidogyne	**0 1**
Macroacanthorhyncus	**0 1**

Unit- IV Common Parasitic Arthropods

Anopheles	**0 1**
Culex	**0 1**
Aedes	**0 1**
Ticks & Mites,	**0 3**
Pediculus	**0 1**
Cimex	**0 1**
Haematopinus	**0 1**

Minor Elective Paper – III
Biological clocks and human health (03 Credits)

Unit I: Biological rhythms: General concepts

Milestones in clock research, Chronobiology in 21st century 02
Adaptive functional significance of biological clocks 01
Types of biological Rhythms: ultradian, tidal/ lunar, circadian and circannual 03
Rhythm properties: phase shift and phase response curves 02
Methods of studying biological rhythms 02

Unit II: The clock systems

Circadian photoreception 02
Suprachiasmatic nucleus, the master pacemaker in mammals 02
Organization of clock system in non-mammalian vertebrates 02
The generation of time: molecular clocks 02
Rhythm in melatonin: daily and calendar times 02

Unit III: Photoperiodism and seasonal Biology

Seasonal and annual rhythms. 01
The proximate and Ultimate factors 01
Light as proximate factor in the regulation of seasonal biology 01
Photoperiodic regulations of seasonal events: Mechanisms 03
Role of food and temperature in regulation of seasonal functions 02
Circadian rhythm involvement in seasonal biology 02

Unit IV: Circadian rhythm disruptions and human diseases

Circadian rhythm disruption and sleep-wake cycles 01
Health consequences of circadian rhythm disruptions 02
Jetlag and shiftwork 02
Clock rhythms, diabetes and obesity 02
Clock dysfunction and cancer development 01
Chronopharmacology, Chronomedicine and chronotherapy 02

Minor Elective Paper - IV: AQUACULTURE MANAGEMENT ENTERPRENEURSHIP (03Credit)

Unit-I : Aquaculture and Fish Farming Management Entrepreneurship

Introduction to Aquaculture as an Economic Enterprise	02
Fish Farms and their Economics	02
Fish Farm Management	02
Polyculture as an Enterprise	02

Unit-II : Fish Trading

Aquarium Fish and their Management	03
Women in Aquaculture	02
Fish Seed Production and their Trade	03
Happa Breeding	
Hatchery Breeding	

Unit-III : Fish, Human Health & Cultures Techniques

Fish and Human Health	04
Fish as a Food	
Role of PUFA in Cancer	
Culture Techniques	06
Prawn	
Edible Oysters	

Unit-IV : Post Harvest Technology

	04
Fish By-products	
Fish Oils	
Fish Proteins	
Isinglass	
Fish Preservation and Processing	06
Rigor-mortis and Purification	
Traditional Methods	
Drying	
Salting	
Smoking	
Modern Methods	
Deep Freezing	
Canning	