

SHRI GURU RAM RAI UNIVERSITY

(Estd. by Govt. of Uttarakhand, vide Shri Guru Ram Rai University Act no. 03 of 2017)



Syllabus of M.Sc Zoology

Effective from Academic Session

2017-2018

Patel Nagar, Dehradun, Uttarakhand

M.Sc. ZOOLOGY SYLLABUS

Course Code	SEMESTER-I	L-T-P	Credits
MZOC 101	Cell Biology and Genetics	4-0-0	4
MZOC 102	Lower Non- Chordata	4-0-0	4
MZOC 103	Molecular Biology, Evolution and Systematics	4-0-0	4
MZOC 104	Computer application, Biostatistics and Tools & Techniques in Biology	4-0-0	4
MZOL 105	Lab course I based on C101 & C102	0-0-3	3
MZOL 106	Lab course II based on C103 & C104	0-0-3	3
			Total Core Credits=22

Course Code	SEMESTER-II	L-T-P	Credits
MZOC 201	Biotechnology and Microbiology	4-0-0	4
MZOC 202	Higher Non-Chordata	4-0-0	4
MZOC 203	Animal Physiology and Toxicology	4-0-0	4
MZOC 204	Developmental Biology	4-0-0	4
MZOL 205	Lab course I based on C201 & C202	0-0-3	3
MZOL 206	Lab course I based on C203 & C204	0-0-3	3
			Total Core Credits=22

Course Code	SEMESTER-III	L-T-P	Credits
MZOC 301	Endocrinology and Animal Behaviour	4-0-0	4
MZOC 302	Chordata	4-0-0	4
MZOE 303 MZOE 304 MZOE 305	Fish Systematics Entomology I Environmental Biology I	4-0-0	4
MZOE 306 MZOE 307 MZOE 308	Fish Physiology and Biochemistry Entomology II Environmental Biology II	4-0-0	4
MZOL 309	Lab course I based on C 301& C302	0-0-3	3
MZOL 310	Lab course II based on E303/304/305 and E 306/307/308	0-0-3	3
	*Self Study		
MZOS 311	Aquatic Biodiversity	3-0-0	3
MZOS 312	Economic Zoology & Parasitology	3-0-0	3
Total Credits=22 (Core Credits=11 + Elective Credits=11)			

Course Code	SEMESTER-IV	L-T-P	Credits
MZOC 401	Ecology and Wild Life	4-0-0	4
MZOC 402	Immunology & Biochemistry	4-0-0	4
MZOE 403 MZOE 404 MZOE 405	Fisheries Science Applied Entomology Applied Environmental Biology	3-0-0	3
MZOE 406 MZOE 407 MZOE 408	Research Methodology in Fishery Science Research Methodology in Entomology Research Methodology in Environmental Biology	3-0-0	3
MZOL 409	Lab course I based on C401 & C 402	0-0-3	3
MZOL 410	Lab course II based on E403/404/405 and E 406/407/408	0-0-3	3
MZOE 411	Dissertation *	0-0-9	9
Total Credits=20 (Core Credits=11 + Elective Credits=09)			

Grand Total: Core Credit 66 + Elective Credits 20 = 86

Max. Marks for each paper: 100 (40 – Sessional Tests + 60 End Term Test).

Sessionals may be in the form of Mid Term Test, Assignment, Classroom Seminar & Laboratory Work, Internship, Industrial / Institutional visits, Winter / Summer Training based report Writing & Presentation, Report based on field trips, excursion organized by Department etc.

All 2-year Master's Programmes will have the following components, viz.

(i) Core Course (C) Minimum 66 credits (ii) Electives (E) Minimum 20 credits (iii) Self study course (SS) Maximum 09 credits (one minimum 03 credits course shall be mandatory but not to be included while calculating the grades)

* M.Sc. 4th Semester –Dissertation shall be allotted in the beginning of 3rd semester to the students securing more than 70% in the First & Second Semester together.

M. Sc. I Semester**MZOC 101 : CELL BIOLOGY AND GENETICS**

No. of Credits = 4

UNIT-I

Theories in Origin of cell and cell as a unit of life, Structure of Prokaryotic and eukaryotic Cell: Cellular Organelles and their functions : Plasma membrane and its various models, ionic transport, type of transport (symport, antiport, uniport) cell membrane , cell wall and their structural organization , Mitochondria and its function & genetic organization , Chloroplast, Nucleus and ultrastructure of Nucleus, ER, Golgi Complex and microbodies . cytoskeleton and its organization , Ribosomes &its biosynthesis & formation in nucleolus.

UNIT II

Molecular aspects of cell division - Cell Cycle, cell cycle regulation
Molecular basis of signal transduction.

UNIT-III

Cancer and its types, Apoptosis and necrosis, oncogenes and tumour suppressor gene Viral and cellular oncogene,
Plant tissue culture and animal tissue culture, primary culture, cell line cell clones callus culture

UNIT IV

Classical aspect: Mendelian laws (Law of dominance, Law of Independent assortment,)
Exception of Mendelian laws, lethal allele, multiple alleles gene interaction (modification of dihybrid ratios) Sex linked inheritance, linkage and crossing over,

UNIT V

Fine Structure of gene , Giant Chromosome (Polytene and lampbrush chromosome) , Pedigree analysis in man , genetic disorder, cytoplasmic inheritance and extrachromosomal inheritance, operon hypothesis, Hardy-Weinberg law and its application, Mutation and its types.

Recommended Books:

1. Lewin: Genes, Vol. VII Oxford, 1998, Inded.
2. Straehan& Read: Human Molecular Genetics 1999, John Wiley & Sons Pte. Ltd.
3. Snustad et al: Principles of Genetics 1997, John Wiley & Sons,
4. De Robertes&Robertis: Cell & Molecular Biology, 1987, Lee & Fabiger Philadelphia
5. Strickberger: Genetics, 1996, Prentice Hall.
6. Lodish et al.: Molecular Cell Biology (4th ed.)

7. Alberts et al.: Molecular Biology of the cell (3rd ed.)

MZOC 102 : LOWER NON- CHORDATA

No. of Credits = 4

UNIT-I

General Classification, Characters of Non Chordate Phyla, Major and minor Invertebrate Phyla, Origin of Higher and lower Invertebrates, Origin of Metazoa, Organisation of Coelom (Acoelomates, Pseudocoelomates, Coelomates)

Unit II

Protozoa :Nutrition in Protozoa, Locomotion: LocomotoryOrganelles and type of locomotion, Reproduction (Asexual, Sexual Reproduction and parthenogenesis), life cycle of *Trypanosoma* , *Plasmodium*,*Giardiana* etc.

Unit III

Porifera : Comparative morphology of all classes, Skeleton, Canal System , Reproduction and Phylogeny of porifera

Unit IV

Coelentrata :Comparative morphology of all classesPolymorphism, Coral &coral reefs and their formation.

Ctenophora: Brief account and affinities.

UNIT- V

Helminthes: Parasitism in Helminthes with life cycles and pathogenecity of (*Schistosoma*, *Wuchereria*)

Recommended Books :

1. Barnes: Invertebrate Zoology (4th ed.), Holt-Saunders, 1980.
2. Barrington: Invertebrate Structure and function, Nelson, 1987.
3. Iyer: A Manual of Zoology, Part I. Visawanathan, 1973.
4. Hickman, Roberts & Hickman: Integrated principles of Zoology (7th ed) Times-Mirror, Mosby, 1984.
5. Kotpal, Agrawal &Khetrapal: Modern Text-book of Zoology, Invertebrates. Rastogi, 1976.

6. Marshall & William: Text book of Zoology, Vol I (Parker & Haswell, 7th ed.) Macmillan, 1972

MZOC 103: MOLECULAR BIOLOGY, EVOLUTION AND SYSTEMATICS

No. of Credits =4

UNIT –I

DNA replication. Genetic code. Transcription and translation in prokaryotes and eukaryotes. RNA processing. Mutations & DNA repair systems. Theories in support of DNA as a genetic material

UNIT II

The central Dogma of Molecular Biology. DNA: Structure and conformation, supercoiling, packing of DNA into chromosomes. Structural polymorphism of DNA & RNA. Three dimensional structure of t-RNA.

UNIT-III

Concepts of organic evolution and evolutionary theories. Origin of life (including aspects of prebiotic environment and molecular evolution). Micro and macroevolution. Synthetic theory of evolution, Natural selection: Concept; Types of selection and selection coefficient.

UNIT- IV

Role of mutation in evolution. Speciation: Isolating mechanisms; Modes of speciation (allopatric, sympatric, parapatric). Fossils and fossilization. Geological distribution of animal. Evolution of Horse and Man.

UNIT V

Introduction, scope and History of animal taxonomy. Species concepts (Typological, Nominalistic, Biological and Evolutionary). Linnean hierarchy. Zoological Nomenclature: ICZN; Taxon, Rank and Categories. Preparation of Keys, Techniques of museum preparation.

Recommended Books:

1. De Robertes & Robertis: Cell & Molecular Biology, 1987, Lee & Fabiger Philadelphia
2. Friefelder: Molecular Biology (2nd ed.), 1996 Narosa Publ. House,
3. Alberts et al: Molecular biology of the cell (4th ed.) 1994, Garland Publ. New York.
4. Elliott & Elliott: Biochemistry and Molecular Biology, 1996, Oxford

5. Mayr : Animal species and Evolution Belknap Press, 1966.
6. Moody : Introduction to evolution (Indian Edition) Kalyani Publ., 1978.
7. Strickberger : Evolution, (Indian Edition). CBS Publ., 1994. 4. Richard Swann Lull: Organic Evolution
Seema Publications, 1976
8. Simpson G.G.: Principles of Animal Taxonomy, Columbia Univ. Press, 1961.
9. Mayr, E. Systematics and the Origin of Species, Columbia Univ. Press, 1942.
10. Blackwelder RE: Guide to the Taxonomic Literature of Vertebrates, Iowa State Univ. Press, 1972.

**MZOC 104 : COMPUTER APPLICATION, BIOSTATISTICS AND TOOLS
& TECHNIQUES IN BIOLOGY**

No. of Credits = 4

UNIT- I

Introduction to computer: mini, micro, mainframe and super computers, Components of a computer system (CPU,I/O units), Data storage device, memory concepts., Types of softwares, Computer application in biology and information communications.

UNIT- II

Biostatistics: Importance of statistics in biological research. Calculation of mean, median, mode, range, variance, standard deviation. Concepts of co-efficient of variation, skewness & kurtosis. Simple correlation. Elementary idea of random variables. Students-t, chi-square and F- test of significance. Introduction to some distributions of random variables: Binomial, Poisson, normal.

UNIT- III

Microscopy, principle & applications - Light microscope and phase contrast microscope ,Fluorescence microscope, Electron microscope , General Principle and applications of, Colorimeter , Spectrophotometer, Flame photometer

UNIT-IV

Separation techniques- Chromatography, principle type and applications. Electrophoresis, Principles, types and applications PAGE and Agarose gel electrophoresis.Principles of centrifugation , Ultra centrifuge

UNIT –V

Histological techniques: Principles of tissue fixation ,Microtomy, Staining, Mounting

MZOL 105 Lab course I based on C101 & C102

MZOL 106 Lab course II based on C103 & C104

SUGGESTED READING MATERIAL

1. Introduction to instrumental analysis-Robert Braun-McGraw Hill.
2. Clark &Swizer. Experimental Biochemistry. Freeman, 2000.
3. Robert Braun. Introduction to instrumental analysis. McGraw Hill
4. Locquin and Langeron. Handbook of Microscopy. Butterwaths, 1983
5. Sharma, V.K.: Techniques in Microscopy and Cell Biology Tata McGraw Hill, 1991.
6. Hoel, P.G.: Elementary Statistics. John Wiley & Sons, Inc. New York.
7. Mahajan: Methods in Biostatistics, (4th ed.). Jaypee Bros. 1984.
8. Milton &Tsokos: Statistical Methods in Biological and Health Sciences, McGraw Hill, 1983.
9. Zar JH: Biostatistical Analysis. Pearson.
10. Casselman : Histochemical techniques, John Wiley, 1959.

M. Sc. II Semester**MZOC 201: BIOTECHNOLOGY AND MICROBIOLOGY**

No. of Credits = 4

UNIT - I

Biotechnology: History, definition & Scope. Gene cloning- cutting, ligation, transformation and analysis of clones, genomic & c-DNA library. A general idea of cloning vectors based on plasmid & phages, blotting techniques, DNA-sequencing, polymerase chain reaction.

UNIT - II

Gene therapy, DNA finger printing, Transgenic animals and plants. Potential hazards of recombinant DNA technology. Products of recombinant DNA technology, Human genome project and its applications.

UNIT - III

Microbiology: Bacteria - classification, staining techniques, pathological significance. Physiology, genetics & reproduction of viruses of plants and animals, Bacteriophage, lysogenic & lytic cycle, Bacterial genetics.

UNIT - IV

Microbial culture techniques & media enrichment techniques. Microbial fermentation: Microbes in decomposition and recycling processes. Microbes as pathological agents in plants, animals and man.

UNIT - V

Laboratory facilities, culture media for animal cell culture, Primary culture, cell lines and cloning, Tissue and organ culture, Transfection methods & transgenic animals. Molecular markers CRFLPs, RAPDs, minisatellites, microsatellites. Application of animal cell culture.

Recommended Books:

1. Pelczar: Microbiology, Tata McGraw Hill, 1993
2. Davis: Microbiology (3rd ed.) Harper & Row, Publ. Inc., 1980
3. Prescott, Harley & Kliens: Microbiology (7th ed.) McGraw-Hill International Edition, 2008.
4. Michael J. Pelczar, E.C.S. Chan, Noel R. Krieg: Microbiology (5th ed.) Tata McGraw-Hill, 2008.

5. Alcamo's Jeffrey C. Pommerville: Fundamental of Microbiology (8th ed.) Jones & Bartlett Publ. 2007.

6. P.K. Gupta: Elements of Biotechnology, Rastogi and Co. Meerut, 1996

7. H.D. Kumar: Modern Concepts of Biotechnology, Vikas Publ. Pvt. Ltd.

MZOC: 201 HIGHER NON-CHORDATA

No. of Credits =4

UNIT –I

Minor phyla : Organization and affinities of Rotifera, Entoprocta, Brachiopoda, Phoronida

UNIT-II

Annelida: Comparative Morphology of Various classes of Annelids, Coelom, Segmental Organs (Excretory organs), Adaptive radiation in polychaeta

UNIT-III

Arthropoda: Appendages and Mouth part in insects, Larval forms and Parasitism in Crustacea, Affinities of Trilobita and Onychophora, Arachnida

UNIT -IV

Mollusca: Comparative morphology of all classes, feature of respiratory and reproductive system, torsion and pearl formation

UNIT- V

Echinodermata: Larval forms of Echinodermata, water vascular system, Affinities of Echinodermata

Recommended Books :

1. Kotpal R.L: Modern Text Book of zoology: Invertebrates.
2. Nigam : Biology of Non-Chordates, Nagin Chand, 1985.
3. Parker TJ & Haswell WA: A Text book of Zoology Vol I & II, McMillan
4. Hyman L: Invertebrate Series, Academic Press
5. Starr et al: Biology, The Unity and Diversity of Life

MZOC 203 : ANIMAL PHYSIOLOGY AND TOXICOLOGY

No. of Credits = 4

UNIT I

Physiology of digestion & absorption: Functional anatomy of the gastrointestinal tract. Secretions of the gastrointestinal tract. Liver and biliary system.

Mechanism of Digestion and absorption of proteins, fats and carbohydrates.

Physiology of respiration: Exchange of respiratory gases at the pulmonary surface. Transport of respiratory gases by blood. Oxyhaemoglobin dissociation curve. Neural and chemical control of respiration.

UNIT II

Physiology of cardiovascular system: Characteristics of vertebrate cardiac muscle. Initiation, conduction and regulation of heart beat. ECG and myocardial infarction.

Blood pressure and its regulation.

Circulation (open and closed, blood composition and function). Blood groups.

The cascade of biochemical reactions involved in coagulation of blood.

UNIT-III

Physiology of excretion: Formation of urine: Functional anatomy of the kidney. Glomerular filtration and its control. Reabsorptions & secretions in the tubules. Counter current mechanism. Excretion and control of urea, sodium, potassium and other ions.

Functions of aldosterone, antidiuretic hormone and renin-angiotensin system in renal physiology.

UNIT IV

Nervous system: Functional differentiation of brain, Neuron - the basic functional unit.

Ionic basis of resting and action potentials of neurons, Mechanism of synaptic transmission. Reflexes and types of reflexes.

Neuromuscular physiology: Structural proteins of muscle cells, actin myosin complex and source of energy for contraction. Sliding filament theory of muscle contraction. Excitation-contraction coupling.

Photochemistry of vision. Conduction of sound from tympanum to cochlea. Mechanism of thermoregulation in poikilotherms, homeotherms and heterotherms.

UNIT V

Introduction of toxicity, Toxicology and Toxic substance

Classification of toxic substances: Pesticides, Heavy metals, Industrial chemicals & Radioactive substances.

Exposure to Toxicants: Routes & sites of exposure (inhalation, injection & through food or intestinal). **Duration & frequency of exposure:** Acute, subacute, chronic & subchronic.

Dose-response relationship & dose-response-curve.

Mechanism of action of DDT, Lead (Pb) & UV rays.

Bioaccumulation of Xenobiotics and process of elimination of xenobiotics.

Recommended Books.

1. D.E. Hathway: Molecularly aspects of Toxicology: The Royal Society of Chemistry, Burlington House, London.
2. V.V. Metelev, A.I. Kanaev & N.G. Dzasokhova: Water Toxicology Amerind Pub. Co. Pvt. Ltd., New Delhi.
3. Omkar: Concepts of Toxicology, Shoban Lal Nagin Chand & Co. 64. B Bunglow Road, Delhi

MZOC 204 : DEVELOPMENTAL BIOLOGY

No. of Credits = 4

UNIT-I

Basic concepts of development: Potency, commitment, Specification, Cell Fate and Cell lineages, Stem Cells, Programmed cell death, Aging and Senescence.

UNIT-II

Early development :Development and differentiation of sperm and oocytes, capacitation, vitellogenesis. Mechanism of fertilization acrosomal reaction, cortical reaction and fertilization membrane. Blocks to polyspermy, Parthenogenesis.

UNIT- III

Cellular differentiation (transcriptional regulation of gene expression, differential RNA processing and translation). Concept of organiser and embryonic inductions: primary, secondary & tertiary cellular interactions. Eye morphogenesis.

UNIT -IV

Development in Drosophila: Cleavage, gastrulation; Molecular basis of development, maternal-effect genes, segmentation genes and homeotic selector genes.

Sex Determination: Sex determination in vertebrates and flies, Temperature dependent sex determination in vertebrates and flies

UNIT - V

Metaplasia & Transdifferentiation. Lymphocyte differentiation and genomic alterations. Limb morphogenesis, Regeneration, Teratogens.

Metamorphosis: Insect, Amphibian metamorphosis.

Recommended Books

1. Gilbert: Developmental Biology. Sinauers Associates Publ. Massachusetts, 1997.
2. Balinsky: An Introduction to Embryology. W.B. Saunders Company. Philadelphia and London.
3. Berill: Development Biology. Tata McGraw Hill Publishing Co. Ltd

MZOL 205 Lab course I based on C201 & C202

MZOL 206 Lab course II based on C203 & C204

M. Sc. III Semester**MZOC 301 ENDOCRINOLOGY AND ANIMAL BEHAVIOUR**

No. of Credits =4

UNIT-I

Endocrine messengers: hormones, neurohormones, hormone like substances (neuronal peptides, autocoids, pheromones, neurosecretion). Hormones and Physiological actions of the following endocrine glands in vertebrates: Thyroid, Parathyroid, Pancreas, Gastro-intestinal tract, Adrenal cortex and Medulla, Thymus & Pineal.

UNIT-II

Hormone biosynthesis: Protein peptide hormones (gonadotrophins, thyrotrophin, corticotrophin, Steroids and catecholamines). Mechanism of action of Protein hormones and Catecholamines: membrane bound receptors, G-protein and control of adenylyl cyclase, Cyclic nucleotide cascade.

Mechanism of action of Steroid and Thyroid hormones: Cytosolic receptors, effect on transcriptional and translational processes.

UNIT - III

Organisation & physiological actions of the Testis: Androgen binding protein (ABP), Inhibin. Neuroendocrine control of testicular functions (Gn RH regulation, FSH- effects on germinal epithelium, LH-effects on Leydig cells, negative feed back regulation). Organisation & physiological actions of the Ovary: Folliculogenesis, Ovulation, Luteinization, Ovarian cycles; Seasonal reproductive cycles; sexual dysfunctions in man.

UNIT - IV

Learning behaviour: Definition. Spatial learning. Associative learning, classical conditioning, operant conditioning, language learning. Imprinting. Kin recognition. Instinct versus learning behaviour. Timing of behaviour: Biological rhythms. The Biological Clock. Circadian rhythms and their synchronisation seasonal rhythms. Photoperiodism. Evolutionary and ecological aspects of animal behaviour. Territoriality. evolution of migratory behaviour, costs and benefits of migration. Ecology of foraging behaviour: Prey detection. Prey capture. Antipredator behaviour. Cooperation and conflict: Evolution of altruism. Evolution of cooperative breeding in birds and mammals.

UNIT V

Communication: Visual, olfactory, acoustic. Bird songs. Amphibian calls. Communication in bats. (echolocation in bats, electrolocation in fish) Chemoreception: Chemicals (pheromones) as signals in insects, fish and mammals. Role of olfaction in communication behaviour (territorial, sex recognition, feeding etc) in fish and mammals. Neural control of behavior: Components

of brain involved in various behaviours. Neural control of drinking, learning, eating, activity & rest, sleep, aggression, sexual behaviour. Hormonal Control of behaviour. Hormone brain relationships. Sexual behaviour in mammals (eg. rat). Sociobiology: Elements of sociality and social grouping in animals. Grouping versus predation. Grouping vs foraging.

Recommended Books:

1. Alcock : Animal behaviour Sinaur Associates, Inc. 1989.
2. Goodenough et al.: Perspectives on animal behaviour. Wiley & Sons, New Youk. 1993.
3. Grier : Biology of animal behaviour, Mosby 1984.
4. Krebs & Davies : An introduction to behavioural ecology (3rd ed.) Blackwell 1993.
5. Mac E. Hadley: Endocrinology, Prentice-Hall International ed. 1988/1992.
6. G J Goldsworthy et al: Endocrinology, Blackie, 1981.
7. Maurice Goodman: Basic and Medical Endocrinology, Raven Press.

MZOC 302 : CHORDATA

No. of Credits = 4

UNIT-I

Classification of chordates , Development and feature of Urochordata and Cephalochordata Affinities of Hemichordata, cephalochordata, Urochordata

UNIT-II

Character and affinities of Cyclostomes, Sailable Features of different Group of fishes: Comparison between Chondrichthyes and Osteichthyes, Migration in Fishes: Dipnoi and its affinities. Origin of tetrapoda

UNIT-III

Origin of Amphibia and their evolution , Parental care in Amphibia.

Origin of Reptilia and adaptive radiation in Reptilia, Snakes: Poisonous and non poisonous and their characters . Character and affinities of Rhynchocephalia and Chelonia.

UNIT-IV

Origin of Birds, Flightless bird, Origin and mechanism of Flight in Birds, Migration in Birds, Modification of Beaks, feet and Palate in Birds Character and affinities of Ratitae.

UNIT-V

Origin of Mammalia from reptilian order, Mammals general character (Prototheria, Metatheria, Eutheria) affinities of Prototheria and metatheria. Adaptive radiation in mammals, Dentition in Mammals, Aquatic and Flight adaptation in Mammals

Recommended Books:

1. Parker T.J. & Haswell WA: A Text Book of Zoology, Vol II, ed. 7th, Macmillan & Co. Ltd, London, 1962.
2. Young JZ: The Life of Vertebrates, Oxford, 1950.

MZOL 309 Lab course I based on C 301 & C 302

MZOE: 303 FISH BIOLOGY-I (SYSTEMATICS)

No. of Credits =4

UNIT - I

Systematics and Phylogeny Introduction and History of Ichthyology. Zoogeographical distribution Origin, evolution, and phylogeny of fishes. Schemes of classification of fossil and recent fishes. General Characters of Teleost and Elasmobranch fishes.

UNIT - II

Agnatha: Characters, basic biology and affinities of Cyclostomes and Ostracoderms. Placoderms: General characters and affinities. Holocephali: Salient features external and internal morphology and affinities. Dipnoi: Salient features and affinities.

UNIT - III

Comparative Morphology of Teleosts and Elasmobranchs Morphometric and meristic study of fishes. Integuments (Teleosts and Elasmobranchs), colouration and its significance, mechanism of colour change. Exoskeleton: Structure and development of placoid and nonplacoid scales. Fins and their origin. Skeletal system : Vertebrae, Girdles, Opercular bones, Pharyngeal bones

UNIT - IV

Alimentary canal and associated glands. Modifications based on different feeding behaviour. Structure of heart, afferent and efferent branchial arteries. Structure of a Gill and Pseudobranch. Brain and cranial nerves in fishes. Urino-genital system of a teleost and an elasmobranch fish. Techniques for the study of histology, histochemistry and biochemistry.

UNIT -V

Fish Physiology Respiration: Functional organization of Gill lamellae, Blood supply of gill, Mechanism of gas exchange, Counter current mechanism. Physiology of excretion and osmoregulation, Mechanism of water- salt balance in freshwater, marine and estuarine fishes. Reproductive physiology: Spawning patterns and stimulating factors, Follicular atresia. Haemopoiesis: Composition of Blood, haemopoietic tissues, synthesis of Haemoglobin. Physiology of Thermo-regulation in fishes.

Recommended Books

1. C.B.L. Srivastava: Fish Biology, Narendra Publication House, 2008.
2. Dr. J. Ojha: Biology of Hill Stream Fish, Narendra Publication House, 2002.
3. Kyle: The Biology of Fishes, 2007.
4. H.R. Singh: Advances in Fish Biology, Hindustan Publishing Corp., 1994.
5. J.D. Munshi & J.S.D. Muni: Fundamental of Freshwater Biology, Narendra Publ. House, 1995.
6. Carlander: Handbook of Freshwater Fishery Biology, vol. 2, Iowa State Univ. Press, 1977.
7. SS Khanna & H.R. Singh: Fish & Fisheries

MZOE :304 ENTOMOLOGY-I

UNIT - I

Introduction to external morphology: body wall, segmentation. The head: structure of head; appendages, and antennae. The thorax: pro, meso and metathorax; legs. The wings: origin, structure and articulation. The abdomen: structure, appendages; external female and male genitalia.

UNIT - II

Classification of insect with special reference to that of different orders. General characters, habits, habitats, importance of the insect orders-Collembola, Protura, Diplura, Thysanura, Ephemerida, Placoptera, Odonata.

UNIT-III

General characters, habits, habitats, importance of the insect orders-Embioptera, Orthoptera, Phasmida, Dermaptera, Blattaria, Menteodea, Isoptera, Zoraptera.

UNIT - IV

General characters, habits, habitats, importance of the insect orders-Psocoptera, Thysanoptera, Heteroptera, Homoptera, Anoplura, Neuroptera, Megaloptera, Trichoptera.

UNIT - V

General characters, habits, habitats, importance of the insect orders-Coleoptera, Strepsiptera, Hymenoptera, Lepidoptera, Diptera.

Recommended Books:

1. Metcal& Flint: Destruction and useful Insects, Tata McGraw-Hill, 1979.
2. Ayyar, TVR: Hand Book of Economic Entomology for South India, International Book & Periodical Supply Service, 1984.
3. Pruthi HS: Text Book on Agricultural Entomology, ICAR Publication, 1969.
4. Fernald HT, HH Shepard: Applied Entomology, McGraw-Hill, 1955
5. Frost SW: Insect life and insect Natural History, Dover Publication, New Yark, 1959.
6. Ananthkrishnan TR: Applied Entomology
7. Evans JW: Insect Pests and Their Control, Periodical Expert Book Agency, 1984.

MZOE : 305 ENVIRONMENTAL BIOLOGY-I

UNIT - I

Introduction to Environmental biology, its multidisciplinary nature and scope. Components of Environment: atmosphere, lithosphere & hydrosphere. Climate (micro, regional and global); Hydrological cycle; Soil profile. Changing interactions between man and environment (cultural, political, ecological).

UNIT - II

Terrestrial biomes of the world their characteristics and major biota (Grassland, Desert, Forest, Tundra). Aquatic biomes (lotic, lentic, marine, estuaries, coral reef), their status. Wetlands of India. Environmental adaptations: Aquatic, Aerial, Desert, Arboreal, Fossorial, Defensive.

UNIT - III

Island biogeography theory. Habitat fragmentation, Habitat selection, Corridors, Community patterns (gradients and Continuum), Community indices. Ecological niche.

UNIT-IV

Population cycles and fluctuations; Dispersal. Intra & Inter specific relationship. Models of succession; Pioneer & climax concept.

UNIT - V

Concept of biological indicators; biological monitoring; Indicator organisms. Invasive species and its impact. Biological control: Biomagnification, Bioassimilation & Bioaccumulation. Xenobiotics: Carcinogenic (heavy metals, pesticides).

Books Recommended

1. Odum : Fundamentals of Ecology (Saunders, 1971)
2. Odum : Basic Ecology (Saunders, 1985)
3. Turk and Turk : Environmental Science (4th ed. Saunders, 1993)
4. Primark : A Primer of Conservation Biology (2nd ed. Sinauer Associates)
5. Calabrese : Pollutants and High-Risk Groups (John Wiley, 1978)
6. Raven, Berg, Johnson : Environment (Saunders College Publishing, 1993)
7. Sharma : Ecology and Environment (Rastogi Publication, 7th ed. 2000)

MZOE : 306 FISH BIOLOGY –II

No. of Credits = 4

UNIT - I

Specialized Characters Accessory Respiratory organs in fishes.

Swim Bladder and its modifications, Blood supply of Air bladder, Gas secreting complex, Functions.

Weberian ossicles: Structure and arrangement, Working mechanism and functions.

UNIT-II

Electric organs: Structure, Mechanism of electric discharge, Functions. Bioluminescence: Luminiscent organs, Mechanism of light emission, Significance. Sound production in fishes

UNIT - III

Fish Behaviour Fish behavior: Social, ecological, reproductive, migratory, foraging behavior. Parental care in fishes. Receptor organs: Eye, Acoustico-Lateralis system, olfactory organs and Taste buds Migration in fishes: Pattern, Causes and Factors influencing. Parental care and viviparity in fishes. Pheromones and their role in sexual behavior of fish

UNIT - IV

Fish Embryology Fertilization and development of fish egg (Teleost). Cleavage, Blastulation, Gastrulation and fate map. Hatching and post-embryonic development.

UNIT - V

Endocrine and Biochemistry Pituitary gland: Micro-anatomy, Hormones of Pituitary and their physiological actions. Thyroid gland: Structure and function Structure and functions of Pancreatic islets in fishes. Location and functions of Corpuscles of Stannius, Pineal and Urophysis in fishes.

MZOE: 307 ENTOMOLOGY II

UNIT - I

Digestive system: structure, physiology of digestion and absorption of different types of food. Structure of circulatory system: haemolymph its composition and function. Physiology of respiration; the tracheal system, spiracles, respiration in aquatic insects. Nervous system: structural basis, Excretion: structure and physiology of malpighian tubules and its secondary functions. Reproduction: male and female gonads.

UNIT- II

Structure of compound eye, mosaic vision. Production and reception of sound. Light producing organs. Hormones: neurosecretion and co-ordination, Metamorphosis: types, hormonal control of metamorphosis, Pheromones.

UNIT - III

Structure of the insect egg, maturation, cleavage, formation of blastoderm, gastrulation, blastokinesis, germ layers, Various types of larvae and pupae, moulting, diapauses, Oviparity, viviparity, ovo-viviparity in insects.

UNIT- IV

Abiotic factors: effect of temperature, light and humidity on growth of insect population; biotic potential, Malthusian principle and dynamics of population fluctuation, hibernation, aestivation.

UNIT-V

Biotic factors: parasitism, predation and social life in insects, phase theory of locust, parental care.

MZOE : 308 ENVIRONMENTAL BIOLOGY- II

UNIT - I

Natural Resources: Management & conservation; Renewable & non-renewable resources; Concept and currencies of Sustainable development. Biodiversity & its conservation. Environment Protection laws. Earth Summit, Rio+20.

UNIT - II

Concept of Protected areas: Sanctuary, National Parks & Biosphere Reserves. IUCN. Categories Biodiversity hot spots, conventions on biodiversity.

UNIT-III

International efforts in biodiversity conservation (UNFP, IUCN, WWF); CITES; UNESCO's World heritage mission; Convention on Biological Diversity (CBD).

UNIT - IV

Global Environmental Problems: Climate change, Green house effect; Acid rain; Ozone layer depletion; Deforestation; Desertification; Marine pollution; Urbanization.

UNIT -V

Environmental Problems/Hazards in Hills: Earthquake; Land slide; Soil erosion; Sedimentation; Cloud burst; Flash floods; Glacial retreat. Application of Remote sensing & Geographical Information Systems (GIS) in environment management.

MZOE 310 Lab course II based on E303/304/305 & E306/ 307/308

MZOS 311 : AQUATIC BIODIVERSITY

No. of Credits =3

UNIT - I

Biodiversity: Definition, Concept, Scope and measurement of biodiversity. Types of Biodiversity: Species, Genetic, Community, Ecosystem. Factors governing biodiversity: Historical & Proximate Endemic species: Definition, Concept, Scope, Hot spots

UNIT - II

Types of aquatic ecosystem & biomes and their characteristics. Freshwater biodiversity. Marine biodiversity. Biodiversity data bases of CMFRI, CIFRI, NBFGR.

UNIT - III

Threats to habitats and Biological diversity in Freshwater and marine ecosystems. Endangered species: Definition, Concept, Scope. Conservation; Definition, Concept, Scope. Physical and chemical characteristics of freshwater rivers, lakes, reservoirs and wetlands. Over view of freshwater biodiversity in important Rivers, Lakes Reservoirs and Wetlands of India with emphasis on Himalaya.

UNIT - IV

Impact of Hydroelectric Projects (HEP) on aquatic biodiversity. Environmental Impact Assessment (EIA): Case studies. Environmental flows: Importance for the aquatic flora & fauna. Environmental flows assessment methodology: Hydrological, hydraulics rating, habitat simulation & holistic.

Recommended Books: 1. KJ Gaston & JI Spicer: Biodiversity: An Introduction 2. WT Edmondson: Freshwater Biology 3. VG Jhingran: Fish & Fisheries of India 4. EP Odum: Ecology 5. HBN Hynes: Freshwater Ecology 6. WK Dodds: Freshwater Ecology 7. Rivers for Life: Managing water for people and nature, Sandra Postel, Brain D. Richter

MZOS 312: ECONOMIC ZOOLOGY & PARASITOLOGY

No. of Credits = 3

Unit I

Elementary knowledge of sericulture Life Cycle of Silk Worm, Apiculture, Life cycle of Honey bee, Honey bee culture and tool used in honey bee culture lac culture.

Unit II

Fish culture System in India, Major Fresh water Fishes, Poultry keeping. Elementary knowledge of Animal Husbandry. Integrated Pest Management (IPM).

Parasitology

Unit III

Parasitism and evolution of parasitism. Protozoan parasites: Biology, life cycle and diseases caused by selected pathogenic protozoans of man their preventive and control measures

(*Entamoeba histolytica*, Trypanosomes, *Leishmania donovani*, *Trichomonas vaginalis*, *Giardia intestinalis* & *Plasmodium*).

UNIT IV

Parasitic adaptations in Platyhelminthes and Aschelminthes. Common trematode, cestode and nematode parasites. Biology, life history and preventive measures of economically important helminth parasites of man and domesticated animals (*Ascaris*, *Schistosoma*, *Fasciola*, *Wuchereria*) Taenia. Introduction to arthropods and vectors of human diseases (mosquitoes, lice, flies & ticks). Parasitism in Crustacea

Recommended Books:

Shukla, G.S. & Upadhyay, V.B.: Economic Zoology. 4th Ed. 2005-06. Rastogi Publ., Meerut.
Sobti, R.C.: Medical Zoology. Sobhan Lal Nagin Chand & Co. Jallendhar.

Kotpal, Agrawal & Khetrapal: Modern Text-book of Zoology, Invertebrates. Rastogi, 1976.

M. Sc. –IV SEMESTER**MZOC 401: ECOLOGY AND WILD LIFE**

No. of Credits =4

UNIT-I

Definition, Scope, Importance, Application. Limiting Factors: Liebig's law of the minimum, Shelford's law of tolerance. Combined concept of limiting factor, Factor interaction. Homeostasis. Biogeochemical cycle (nitrogen, phosphorus, carbon & water cycle). Ecosystem. Concept; Energy flow; Food chains & Ecological pyramids. Habitat Ecology: Concept of habitats & ecological niche.

UNIT- II

Population: Concept & attributes: Biotic potential, Density, Natality, Mortality; Intrinsic rate of natural increase, survivorship curves. Population growth forms; Carrying capacity; Population regulation (Density dependent and independent). Community: Concept & characteristics: Density, Dominance, Diversity & Stratification. Succession of communities; Key stone species.

UNIT - III

Biodiversity: Endemism, Genetic, Species and ecosystems diversity; Factors influencing biodiversity.

Economic valuation of biodiversity: Concepts & Importance. Environmental pollution (Air, water, solid waste, Radioactive); Environmental Impact Assessment. Cumulative Impact Assessment of hydropower development; Environmental flows: need, methodologies, DRIFT, BBM.

UNIT - IV

Techniques in wildlife: Identification by natural marking, pug marks, calls, behavioural idiosyncrasies etc. Passive marking (collars, tags, branding, rings etc). Dynamic marking (radiotelemetry, satellite telemetry, radioisotopic tracers). Population estimation techniques: Absolute versus relative density, total count versus estimates. Census methods (Drive count, aerial count, point count). Indices (pug marks, droppings, nests, burrows, dens, calls). Biogeography of India: Topography & Climate. Patterns of distribution of biota.

General introduction to Sanctuaries, National Parks and Biosphere Reserves of India, Endangered species, Endangered fauna of Himalaya (distribution, habitat, habits).

UNIT - V

Wildlife Conservation and Management: National Organizations involved in wild life conservation; Wild life Legislation – Wild Protection act - 1972, its amendments and implementation

Important features of protected areas in India; Tiger conservation - Tiger reserves in India; Management challenges in Tiger reserve.

Recommended Books:

1. Kendeigh : Animal ecology, Prentice Hall 1961.
2. Odum: Fundamentals of ecology, Saunders Co. Publ., 1993 Indian ed.
3. Odum : Basic ecology, Saunders Co. Publ., 1993 Indian ed.
4. Krebs: Ecology (4th ed.) Harper Collins College Publisher
5. Negi: An Introduction to Wildlife Management, 1983.
6. Majupuria T C: Wildlife Wealth of India Tecprress Service, Bangkok, 1986.
7. Saharia: Wild life of India Nataraj Publishers, Dehradun.
8. Robert H. Giles: Wildlife Management Techniques (3rd ed.) Natraj Publishers, Dehradun, 1981
9. Negi: Handbook of National Parks, Sanctuaries and Biosphere Reserves in India, 1995.
10. Negi: Himalayan Wildlife: Habitat and Conservation, 1992. Indus Publishing Company, New Delhi.
11. Sharma: High Altitude Wildlife of India Oxford & IBH Publishing Co. Pvt. Ltd.1994.
12. Smith RL: Ecology and Field Biology, Harper Collins Publ. 1996.
13. Dash MC: Fundamental of Ecology, Tata Mc Graw Hill 2001, New Delhi

MZOC 402 : Immunology & Biochemistry

No. of Credits = 4

UNIT-I

Enzymes:Classification, concept of E-S complex, Lock and Key Hypothesis, Induced –Fit Hypothesis, Michaelis- Menten equation and its derivation,

Carbohydrate Metabolism I: Pathway and regulation of Glycolysis, Gluconeogenesis, Glycogenolysis, Glycogenesis.

UNIT-II

Carbohydrate Metabolism II: Citric acid cycle and its regulation and pentose phosphate pathway and its regulation.

Urea cycle (conversion of ammonia into urea), linkage between urea cycle and citric acid cycle) and its regulation. Conversion of nitrogen to ammonia by microorganisms, overview of amino-acid biosynthesis.

UNIT-III

Fatty Acid Metabolism: β Oxidation and its regulation, Fatty Acid Biosynthesis and Regulation. Nucleic Acid Metabolism: Purine biosynthesis and its regulation, pyrimidine biosynthesis and its regulation. Salvage pathway for purine & pyrimidine in nucleotides.

UNIT - IV

Overview of The Immune System. Cells and Organs of The Immune System. Antigens, Antigenicity versus Immunogenicity. Haptens & Epitopes Immunoglobulins: Structure and Function. Major Histocompatibility Complex. Antigen processing and presentation. Structure and functions of BCR & TCR.

UNIT-V

Cytokines. The Complement System. Cell mediated cytotoxicity: Mechanism of T cell & NK cell mediated lysis. Ab-dependent cell mediated cytotoxicity (ADCC) Overview of Hypersensitivity and Autoimmunity. Introduction to Transplantation. Vaccines: Active and Passive Immunization Introduction to Monoclonal Antibodies and Hybridoma technology. Antigen-Antibody Interactions: Precipitation Reaction, Agglutination Reactions, RIA, ELISA, Western Blotting, Immuno precipitation, Immuno-fluorescence.

Recommended Books

1. Lehninger: Principles of Biochemistry, 4th ed., Nelson & Cox, WH Freeman and Company, 2007
2. Voet & Voet: Biochemistry, 2nd ed., Wiley & Sons.
3. Berg, Tymoczko, Stryer: Biochemistry, 5th ed., WH Freeman and Company, 2003.
4. Garrett & Grisham: Biochemistry, 4th ed., Brooks/Cole Cengage learning, 2010.
5. Murray, Granner, Rodwell: Harper's Illustrated Biochemistry, 27th ed. McGraw Hill, 2006
6. Conn & Stumpf: Outlines of Biochemistry, 5th ed., Wiley India, 2007.
7. Kuby : Immunology (4th ed.).
8. Roitt, Male & Brostoff : Immunology (3rd ed).

9. Elgert&Elgert : Immunology.
10. Wilson & Walker: Practical Biochemistry (4th ed.).

MZOL 409 Lab course I based on C401& C402

MZOE 403 : FISHERIES SCIENCE

No. of Credits =4

UNIT - I

Aquaculture: Scope, importance and present status. Concept of different culture systems: Extensive and intensive fish culture, Fish culture in ponds and reservoirs. Culture in rice fields, bheries, Cage culture, Pen culture, Monoculture and polyculture. Preparation and maintenance of fish farm: Fertility and pH maintenance. Role of fertilizers, required water quality and its maintenance. Control of aquatic weeds, insects and predatory fishes. Fish nutrition: Development of natural food and supplementary feeding. Culture techniques Procurement of stocking material from natural sources, Induced breeding and use of new generation drugs, ovaprim, different hatching techniques, Transport of fish seed.

UNIT - II

Culture Practices: Culture of Common carp and Exotic Trouts. Prawn culture. Sewage – fed Fisheries and Integrated fish farming Common fish diseases and their control. Mahseer and Schizothoracid fishery. Current status, problems and perspectives. Culture of Larvicidal fishes. Characters and importance

UNIT - III

Harvesting and Post harvesting Fishing gears used in inland waters and seas. Fish preservation and processing techniques. Fish by-products and their uses. Fish spoilage: Causes of rigor mortis, precautions to control rancidity, microbial spoilage. Nutritive value of fish, biochemistry of fish flesh of Indian major carps. Storage, transportation and marketing.

UNIT -IV

Capture and Ornamental Fishery: Rivers, Lakes, Dams / Reservoir fishery- Problems and perspectives in Capture fisheries. Estuarine fishery. Characteristics and species dynamics. Marine fishery: Coastal, Off shore and deep sea fishery. Exclusive Economic Zone. (Hilsa, Oil sardine, mackerel, Bombay duck, Sole, Ribbon, Shark and Rays).

UNIT- V

Recreational fishery and Cooperative movements. Fish Farmers Development Agencies (FFDA). Climate change and fishery. Major, Marine and freshwater ornamental fishes, their food & breeding needs. Health management of ornamental fishes. Specific diseases and their cure. Setting and maintenance of aquaria.

MZOE 404: APPLIED ENTOMOLOGY

UNIT - I

Insects in relation to man: sericulture, apiculture and lac culture and its parasites, predators and diseases. Insect of veterinary importance; sand fly, horse fly, sucking louse, fleas.

UNIT - II

Brief knowledge of important household, vegetable, store grain and fruit pests with special reference to distribution, habits, habitat, nature of damage, life history and control.

UNIT-III

Cut worm (*Agrotis ipsilon*) Cabbage caterpillar (*Pieris brassicae*) Rice weevil (*Sitophilus oryzae*) Mustard aphid (*Lipaphis erysimi*) Red cotton bug (*Dysdercus ingulatus*) Woolly apply aphid (*Eriosoma lanigerum*) Termite: important termites of Fam. Termitidae (*Odontotermis* sp.)

UNIT IV

Origin of pests, Insect pest control; mechanical, physical, culture, biological. Fenetical control: chemosterilants, radiation.

UNIT V

Integrated Pest Management (IPM), Role of pheromones and hormones in insect pest management. Legislative control of insect pests and quarantine law. Nomenclature and classification of insecticides on the basis of mode of action, chemical nature. Environmental factors influencing effectiveness of insecticides, persistence, biodegradability, hazards of insecticides, precaution and antidotes.

MZOE 405 : APPLIED ENVIRONMENTAL BIOLOGY**UNIT - I**

Air: Air pollutants (chemistry, sources & control); Air Quality standards, carbon credits, carbon footprint, Thermal pollution sources and effect. Water: Biochemical aspects of water pollutants (domestic, industrial & agricultural waste). Waste water treatment (Aerobic & anaerobic treatment processes); Water quality standards. Case study-Ganga Action Plan. Noise Pollution: Effects of noise and its control.

UNIT - II

Radioactive fallouts its effects & safe disposal. Solid waste management: Sources & control methods (composting, Vermi Culture, Biogas). Hazardous waste & their management. Bioremediation (herbicides, pesticides, hydrocarbons, oil spills). Ecological Restoration: wasteland & its reclamation & restoration.

UNIT - III

Environmental Impact Assessment (EIA): Case study of River valley projects & Mining. Bioassay: Dose-response relationships; Frequency; Response & cumulative response; statistical concepts (LD50-potency v/s Toxicity). Concept of hyper & hypo sensitivity factors affecting Toxicity.

UNIT- IV

Ecological experimentation & models: Theories & hypothesis; experimentation; Inductive & deductive methods.

UNIT-V

Models: Analytical & simulation models; Validation & verification. Biological pest control: Use of predators; Parasites, parasitoids & pathogens; Integrated Pest Management.

MZOE 406 : RESEARCH METHODOLOGY IN FISHERY SCIENCE**UNIT - I**

Research and scientific methods, Criteria of good research, Compilation of research paper, Presentation of research paper, Preparation of research proposal, Compiling bibliography, Sampling

UNIT-II

Water Chemistry and substrate conditions: Dissolved Oxygen, Free Carbon di oxide, Total alkalinity, Total hardness, pH, BOD, Chlorides, SO₄- S, PO₄-P and NO₃-N and related in instrumentation (probes, meters) Qualitative and quantitative estimation of plankton &

periphyton. Fish sampling and preservation Morphometric & meristic analysis of important hillstream carps and catfishes. Truss analysis. Use of Keys and Monographs for fish identification

UNIT –III

Importance of statistics in biological research. Calculation of mean, median and mode, range, variance, standard deviation. Students-t test. Chi-square and F-test of significance, Analysis of variance (ANOVA), Introduction to statistical softwares.

UNIT –IV

Calculation and importance of Shannon Wiener Diversity Index, species richness and Margalef diversity index. Regression analysis and coefficient of correlation. Cluster analysis, Factor analysis and Discriminate analysis.

MZOE 407 RESEARCH METHODOLOGY IN ENTOMOLOGY

UNIT I

Introductory Entomology Research methodology in entomology in introduction. Role of entomology in agriculture (Beneficial and Harmful insects). Medical entomology: Disease vectors (Mosquito, Sand fly, tsetse fly, pathogens, lifecycle and diseases). Veterinary entomology: Vector insect (Ticks, Mites, Flies, pathogens, lifecycle and diseases). Forensic Entomology: Principle, Forensic entomological flies, use of human lice in forensic entomology, Importance.

UNIT II

Entomological techniques –I Type of sampling survey, Different Collection Methods, Collection of wild flies and Domestic insects. Collecting Insect in the wild area-Tools and Equipments, Preparing and using baits, Collecting from natural substances, Collection permission from govt. agency like forest department State Biodiversity Board (SBB), National Biodiversity Authority (NAB), Transporting live adults or larvae. Preservation of insects, classification of insects up to the level of families with hands-on experience in identifying the families of insects and Catalogues.

Insect Laboratory and rearing equipment, Experimental designs in field and Laboratory Observation techniques and Molecular techniques in insect taxonomy. Mortality correction, Bioassay: Principles, Importance, Factor affecting, Procedures apparatus used.

UNIT III

Entomological Techniques –II Trophic relationships. Use of ecological data, insect diversity: Indices, richness, rarity. Population estimates. Coexistence and Competition. Distribution patterns. Study of terrestrial/aquatic insect biodiversity, physic-chemical parameters of water (turbidity/transparency, velocity, pH, temperature, estimation of CO₂, O₂ hardness).

UNIT IV

Application of Statistics Descriptive statistics, Chi-Square test, Student t-test. Analysis of variance.

MZOE 408 : RESEARCH METHODOLOGY IN ENVIRONMENTAL BIOLOGY**UNIT - I**

Importance and need of environmental research. Problem identification, objectives, significance, scope and limitations. Literature survey. Importance and designing of the problem to be undertaken. Field survey: Site selection, source selection for data acquisition. Sampling strategies, Sample size, Frequency, Bias, Error. Project Report Preparation.

UNIT - II

Measurement of solar radiation, wind velocity, air quality monitoring, measurement of oxides of nitrogen, carbon, sulphur, lead, tropospheric ozone, methane, aerosol, pesticide. Stack sampling, sample collection for particulate matters (Dustfall collection, High volume sampler), indoor air pollutants (radon) measurement.

UNIT -III

Water quality analysis: Measurement of water temperature, velocity, depth, transparency, dissolved oxygen, free carbon dioxide, pH, turbidity, hardness, alkalinity, BOD, COD, dissolved nutrients (Nitrates, phosphates, sodium, potassium, chloride, etc.), heavy metals. Sampling methods for terrestrial flora and fauna (quadrant method).

UNIT - IV

Sampling methods for aquatic fauna and flora (plankton, periphyton, micro and macroinvertebrates, nekton, etc.). Soil types, measurement of soil pH, water holding capacity, organic matter, soil nutrients (nitrate, nitrite, calcium and magnesium), Sampling of soil fauna. Sampling of soil for microbial diversity. Application of statistical Descriptive and regression analysis in Environmental Science: Parameteric and Nonparameteric Tests, Hypothesis testing, t-test, Z-test, F-test, multivariate test chi square test, Kruskal Wallis test. Statistical Softwares: Excel, Statistica, SPSS, etc.

MZOE 410 Lab course II based on E403/ 404/405 & E 406/ 407 /408