

**NETAJI SUBHAS UNIVERSITY
JAMSHEDPUR**



2024- 2026

**MASTER OF SCIENCE
ZOOLOGY**

SYLLABUS

(2024- 2026)

NETAJI SUBHAS UNIVERSITY, JAMSHEDPUR

MASTER OF SCIENCE

ZOOLOGY

(2021- 2023)

The course for Master of Science (M.Sc.) in Zoology shall comprise of four semesters of six months duration each. Each semester shall include four theory papers and two practical (laboratory) courses. Each theory course will be of 70 marks each and there shall be a related internal assessment for each theory course involving 30 marks. Each practical course will include 100 marks each. The practical examinations may be held before or after theory examinations. The students are required to participate in study excursions of short and/or long-term duration organized by the University as and when possible.

The students have to select four papers of specializations (electives); each of two will be taught in third and fourth semesters:

- A. Aquatic Biology & Aquaculture
- B. Computer Application
- C. Limnology
- D. Eco-Toxicology
- E. Applied Zoology
- F. Ichthyology
- G. Entomology
- H. Immune System

SEMESTER-I

Code	Theory/Practical	Credit	Examination Scheme		
			External	Internal	Total
101	Animal Systematics	4	70	30	100
102	Biology of non-chordates	4	70	30	100
103	Molecular Biology	4	70	30	100
104	Bioinstrumentation	4	70	30	100
Practical -1	Practical (Based on Theory Paper 101 &102)	4	75	25	100
Practical -2	Practical (Based on Theory Paper 103 &104)	4	75	25	100
		24			600

SEMESTER -II

Code	Theory/Practical	Credit	Examination Scheme		
			External	Internal	Total
201	Molecular Genetics	4	70	30	100
202	Human Physiology	4	70	30	100
203	Biology of Chordates	4	70	30	100
204	Developmental Biology	4	70	30	100
Practical -3	Practical (Based on Theory Paper 201 &202)	4	75	25	100
Practical -4	Practical (Based on Theory Paper 203 &204)	4	75	25	100
		24			600

SEMESTER –III

Code	Theory/Practical	Credit	Examination Scheme		
			External	Internal	Total
301	Biomolecules and Structural Biology	4	70	30	100
302	Quantitative Biology, Biodiversity and Wild life	4	70	30	100
Elective -1	Aquatic Biology OR	4	70	30	100
	Computer Application				
Elective -2	Limnology OR	4	70	30	100
	Eco- Toxicology				
Practical -5	Practical (Based on Theory Paper 301 & 302)	4	75	25	100
Practical -6	Practical (Based on Elective -1 & 2)	4	75	25	100
		24			600

SEMESTER –IV

Code	Theory/Practical	Credit	Examination Scheme		
			External	Internal	Total
401	Evolutionary Biology	4	70	30	100
402	Endocrinology	4	70	30	100
Elective -3	Applied Zoology OR	4	70	30	100
	Ichthyology				
Elective -4	Entomology OR	4	70	30	100
	Immune System				
Practical -5	Practical (Based on Theory Paper 401 & 402)	4	75	25	100
Practical -6	Practical (Based on Elective -3 & 4)	4	75	25	100
		24			600

Semester I

101: ANIMAL SYSTEMATICS

Unit -I:

Introduction to science of taxonomy, Principles of taxonomy, History of biological classification.

Unit -II:

Theories of biological classification. Hierarchy of categories and higher taxa.

Unit -III:

(a) Taxonomic procedures: taxonomic collections, preservation, enrating, cataloging and identification.

(b) Taxonomic characters; procedure of classification.

(c) International Code of Zoological Nomenclature (ICZN); Interpretation of Rules of Nomenclature (in Brief).

Unit-IV:

(a) General characters and classification of invertebrate phyla (Protozoa to Echinodermata)

(b) General characters and classification of Minor phyla

Unit-V

(a) General characters and classification of Protochordata

(b) General characters and classification of Chordata

References:

1. Ernest Mayr. 1997. Principles of systematic Zoology. Tata-McGraw-Hill, New Delhi. 428 pp.
2. Simpson, G.G. 1961. Principles of animal Taxonomy. Columbia University Press, New York. 247 pp.
3. Barnes, R.D. 1968. Invertebrate Zoology. II Ed. Saunders, Philadelphia.
4. Barrington, E.J.W. 1967. Invertebrate Structure and Function, Nelson, London.

102 - BIOLOGY OF NON-CHORDATES

Unit-I:

Locomotion: Principles of hydrostatic movements, Amoeboid and flagellar movements and Locomotion in Arthropods

Unit-II:

- a) Nutrition and Digestion: Food and feeding habits of non-chordates, Filter feeding in Mollusca and Echinodermata, Symbiotic nutrition.
- b) Respiration and Excretion: Organs of respiration; Gills, trachea and Lungs, Respiratory pigments, Mechanisms of respiration, Organs of excretion- Coelomoducts, Nephridia, malphigian tubules, Coxal Glands and mechanism of excretion.

Unit-III:

Nervous system: Primitive nervous system: Coelenterate and Echinodermata, Advanced nervous system: Annelida, Arthropod (Crustacea and Insecta)

Unit-IV:

Reproduction: Patterns of reproduction in invertebrates, larval forms of free living, larval forms of parasites

Unit-V:

Minor Phyla: General characters and affinities of Chaetognatha, Ctenophore, Phoronida and Pogonophora.

References:

1. Barrington. E J W. 1967. Invertebrate structure and function, Nelson, London.
2. Barnes, R. D 1968. Invertebrate Zoology, 2nd Ed. Saunders, Philadelphia.
3. Hyman L H. 1940-67. The Invertebrates, Vol. I-VI. McGraw-Hill, New York.
4. Russell-hunter. W D. 1968. Biology of lower invertebrates, Macmillan Company, New York.

5. Marshall, A.J and Williams, W D (Eds). 1995. Text book of Zoology-Invertebrates. VII Ed., Vol. I, A.L.T.B.S. Publishers.

103 - MOLECULAR CELL BIOLOGY

Unit-I :Introduction to molecular cell biology: Levels of organization. Cell as a morphologic and functional unit within organisms.The central dogma of molecular biology.The scope of modern cell biology.

Unit-II:Biochemistry of cell: Chemical components of the cell-

(a) Water, salts, ions and their properties,

(b) Proteins - primary, secondary and tertiary structures.

(c) Carbohydrates - Complex polysaccharides and glycoproteins,

(d) Lipids - triglycerides and compound lipids and

(e) Nucleic acid - A pentose, Phosphate and four Bases. Nucleotides, double helix formation.Structure of RNA, Nucleosome.

Unit –III:Bio-membranes: Molecular organization. Transport across cell membrane. Cell to cell communication and recognition. Modifications of membranes: Gap junctions and tight junctions, Membrane receptors, ion channels, gated channels.

Unit-IV:Molecular organization and functions of membrane organelles: endoplasmic reticulum, golgi complex, lysosomes, peroxisomes, mitochondria and chloroplast. Molecular organization and function of cytoskeletal structures: Microfilaments, microtubules, cilia and flagella.

Unit –V:Structure of Gene. Gene transcription.Post-transcriptional processing of RNA. Reverse transcription. Introns and exons, RNA Interference.Cell cycle: Molecular events during different stages of cell cycle - regulation of cell cycle.

References:

1. Alberts,B., Bray Dennis, Lewis Julian, Raff Martin, Roberts.K and Watson, J.D. Molecular Biology of the Cell. Garland Publishing Inc. New York, 1994.
2. Bruce Alberts, Essential Cell Biology.
3. Cellis, J.E. Cell Biology: a Laboratory Handbook Vol. I and II.Academic Press, 1998.
4. Lodish, H., Berk,A., Zipuosky, L.S., Matsudaira, P., Baltimore,D& Darnell, J. Molecular Cell Biology IV Ed. W.H. Freeman & Co. 2001.

5. Malacinski, G.M &Freifelder, D. Essentials of Molecular Biology III Ed. Jones & Bartlett Publishers, 1998.

104- BIOINSTRUMENTATION

Unit-I:

Microscopy: Light, phase contrast, dark - field fluorescence. Electron microscopy - transmission and scanning. Histological and histochemical staining techniques.

Unit-II:

Separation techniques and instrumentation: Paper Chromatography. Thin layer Chromatography, Ion exchange chromatography, Gel filtration chromatography, HPLC and Gas chromatography.

Unit-III:

Separation techniques and instrumentation: Electrophoresis and electrofocusing, SDS-PAGE, 2-D Gel Electrophoresis; Centrifugation- types and functions.

Unit-IV:

Spectroscopy: UV-Visible spectroscopy, Infrared spectroscopy, NMR spectroscopy, Flow cytometry and FISH.

Unit-V:

Radioisotopes and tracer techniques: Definition, properties of radioisotopes. Units of measurement of radioactivity. Autoradiography and its utility. Radioimmunoassay, radiometric enzyme assays. Liquid scintillation counters.

References:

1. Robert Brown. Introduction to instrumental analysis. McGraw Hill International Editions.
2. Wilson, K &Goulding, K.H. A Biologists Guide to Principles and Techniques of Practical Biochemistry.

Practical of 102 & 103

1. Study of locomotary organs of Amoeba/Paramecium/Ant/Spider
2. Dissect and display the Digestive / Nervous system of Cockroach.
3. Food, feeding habits and mouth parts of Mosquito/ Housefly/Honeybee/Butterfly/Bed bug.
4. Study of life cycle in Harmful and useful insects.Harmful insects (Termite/Housefly/Wasps)
Useful insects (Honeybee/Silk moth/Lac insect)
5. Identification and classification up to orders with reasons of the animal species belonging from Phylum Protozoa to Class Mammalia.
6. Animal species exhibiting phylogenetic inter-relationships: Peripatus: (Annelida-Arthropoda)
Balanoglossus: (Protochordata-chordata) Archeopteryx: (Reptiles-Aves).

Practical of 103 &104

1. Study of Mitosis in onion root tips.
2. Study of Simple, Compound and Binocular Microscope.
3. Preparation of stains and fixatives.
4. Study of prokaryotic cell and its characteristics.
5. Comparison of Light and Electron microscope.
6. Separation of plant pigments using Paper chromatography.
7. Separation of Amino acids using Paper chromatography.
8. Separation of Amino acids using thin layer chromatography.
9. Caring and Handling of Laboratory instruments
10. To check the purity of DNA using UV-Visible spectroscopy
11. To check the purity of Protein using UV-Visible spectroscopy
12. To check the purity of RNA using UV-Visible spectroscopy

201- MOLECULAR GENETICS

Unit-I:

History and scope of molecular genetics. Identification of DNA as genetic material. Properties, storage and transmission of genetic information. Overview of Mendalism and deviations.

Unit-II:

DNA Replication: Semi conservative model of DNA. DNA polymerases and ligases. Events in replication fork. Discontinuous replication. Leading strand. Circular DNA and its replication.

Unit-III:

Transcription: Prokaryotic transcription. RNA polymerases. Transcription signals. Classes of RNA molecules-messenger, ribosomal and transfer. RNA modification: RNA- 5-cap formation, 3-end processing, polyadenylation, splicing, editing.

Unit-IV:

Translation: The genetic code. Structure of t- RNA. Translation in prokaryotes. The Wobble hypothesis. Gene Regulation: Operon model. Lac Operon and Tryptophan Operon. Auto regulation and feedback initiation.

Unit-V:

Mutation: Types of mutations. Biochemical bases of mutations. Mutagenesis-base analogue mutation, ultraviolet irradiation, intercalating substances and transposable elements.

References:

1. Atherly, A.G. Girten, J.R and Mcdonald, J.F. The Science of Genetics. Saunders College, 1999.
2. Gardner, E.J., Simmons, M.J and Snustad, D.P. Genetics III Ed. John Willy & Sons, New York, 1990.
3. Stickberger, N.W. Genetics. MacMillan Publishing Co. New York, 1985.
4. Watson, J.D et al., Recombinant DNA. W.H. Freeman & Co, 1992.
5. Trevor, B.B and Julian Burke. Gene structure and transcription. Oxford Univ Press, 1998.
6. Benjamin Lewin. Genes Vols I-IV. Oxford Univ Press, 1995.

202- HUMAN PHYSIOLOGY

Unit- I:

Introduction to physiology: Cell and general physiology. Functional organization of human body. Internal environment and homeostasis. Cell and its function.

Unit-II:

Blood circulation: Arteries, veins and capillaries. Blood flow and blood pressure. Regulation of blood circulation. Composition of blood, blood groups, blood transfusion and artificial blood.

Unit-III:

Membrane physiology: Molecular organization of membrane; transport across membrane. Anatomy and physiology of cardiac muscles. ECG, myocardial infarction and cardiac arrest. Physiology of digestion and absorption: Nutrition and balanced diet and vitamins. Malnutrition, over-nutrition and obesity.

Unit-IV:

Respiratory organs and physiology of respiration: Transport of gases in high altitude and diving physiology. Regulation of respiration. Respiratory distress and asthma. The kidneys: Physiology of excretion. Urine formation. Micturition and diuretics. Renal failure and dialysis.

Unit-V:

General organization of the nervous system: peripheral and central nervous system. Structure of neuron and conduction of nerve impulse, Sensory and motor systems. Hormone types and their physiological actions.

References:

1. Text book of medical physiology: Guyton AC and Hall JE, Xth edition Saunders , Philadelphia, 2004.
2. Concise medical physiology: Chaudhuri SK, 4th edition, Central Book Agency, 2002, Kolkata.
3. Biological sciences: Taylor DJ, Green, NPO and Stout GW edited by Soper R, Cambridge University Press, 3rd edition 1997, Cambridge UK.

4. Animal physiology: Schmidt-Nielson K, 5th edition, Cambridge University Press, Cambridge UK.

203- BIOLOGY OF CHORDATES

Unit-I:

Origin and systematic position: Origin of chordate in the light of recent theories, Protochordata: Life cycles of Doliolium and Amphioxus, Significance of retrogressive metamorphosis

Unit-II:

Origin and evolution of vertebrate groups: Agnatha, Placoderms and Chondrichthyes. Osteichthyes: Lateral line system, Migration in fishes

Unit-III:

Amphibian: Origin and evolution, Breeding behavior and parental care of living Amphibia, Neoteny, Adaptive radiation

Unit-IV:

Reptilia: Origin and Evolution of temporal arcades and fossae, extinct reptiles, Adaptive radiation in living reptiles, Poisonous and non-poisonous snakes in India.

Unit-V:

Aves: Aerial adaptations and mechanism of flight, behavior, migration and Aquatic Birds. Mammalia: Origin and evolution of mammals. Adaptive radiation in Marsupials. Aquatic mammals.

References:

1. Marshall, A.J and Williams. W.D (Ed). Textbook of Zoology: Vertebrates-VII Ed. Vol. II. AITBS Publishers and distributors, 1995.
2. Young, J.Z. The Life of Vertebrates, III rd Ed Clarendon Press Oxford, 1981.
3. William N McFarland, F and Harvey Pough Tom.J.C and Heiser, J.B. Vertebrate Life. CollierMacmillan Publishers, London, 1979.
4. Romer, W.B. The Vertebrate Body. Saunders, Philadelphia, 1956.

204- DEVELOPMENTAL BIOLOGY

Unit-I:Introduction: Overview of animal development. The issues of Developmental Biology. Anatomical approach to Developmental Biology. Experimental approach to Developmental biology.

Unit-II:Early embryonic development: Fertilization- structure of gametes, cellular and biochemical processes during early fertilization. Acrosome reaction and egg activation. Cleavage and blastulation in Drosophila and chick (till blastocyst). Gastrulation in frog and chick.

Unit-III:Early development in Drosophila: Origin of anterior & posterior polarity, maternal effects of genes. Segmental genes, homeotic selector genes. Generation of dorso-ventral polarity. Early development in sea urchin egg: Experimental analysis of early development, biochemical and physiological gradients.

Unit-IV:Axis formation in Amphibians: The progressive determination of amphibian axis, primary embryonic induction. Regional specificity of induction. Organogenesis: Differentiation of neural tube - anterior posterior axis, dorsoventral axis, Differentiation of vertebrate lens.

Unit-V:Post-embryonic and abnormal development: Regeneration in animals with reference to Hydra, Planarian and Salamander limb. Metamorphosis in Amphibians- morphological, biochemical changes and hormonal control of metamorphosis. Ageing-consequences and causes of ageing. Control of ageing by genes.

References:

1. Gilbert, S.F. Developmental Biology IV ED. Sinauer Associates Inc. Publishers, Massachusetts, 2000.
2. Kalthoff, K. Analysis of Biological Development. McGraw Hill Inc. New York, 1996.
3. Rao, K. V. Developmental Biology: A Modern Synthesis. Oxford & IBH Publishing co. Pvt. Ltd, 1993.
4. Subramanian, T. Developmental Biology, Narosa Publishing House, 2002.
5. Twyman, R .M. Instant Notes. Developmental Biology. Bios Scientific Publishers Ltd, 2001.
6. Wolpert, L., Beddington, R., Brooks, J., Jessel, T., Lawrence, P and Meyerwitz, E. Principles of Development. Oxford University Press, 1998.

Practical of 201 and 202

1. Study of ultra-structure of Animal cell.
2. Study of Compound and binocular Microscope.
3. Overview of organ systems and its accessory parts a) Human digestive system and salivary glands b) Human liver and pancreas c) Human respiratory and excretory system d) Human heart, kidney and brain.
4. Differential staining of blood smear.
5. Biochemical test: Carbohydrates and Proteins.
7. Study of instruments used in human physiology. a) Accu-chek blood glucose meters and the corresponding strips. b) Sphygmomanometer c) ECG-Electro Cardio Gram. d) Stethoscope.

Practical of 203 and 204

- I. TYPES OF Eggs: Eggs of Frog, Fish, Chick and Mammalian egg.
- II. Development of frog
 1. Early and late cleavage in Frog
 2. Blastula and Gastrula in Frog
 3. Tadpole larva of frog
- III. Metamorphosis of frog
- IV. Preparation of whole mount of chick embryo
- V. Observation of permanent slides of chick embryo based on hours of incubation. 1. 18, 24, 33, 48 and 72 hours
- VI. DEVELOPMENT OF INSECT
 1. Life cycle of honey bee and Silk moth
- VII Study of Migration of fishes
- VIII Study of culturable freshwater fishes.
- IX. Study of poisonous and nonpoisonous snakes in India
- X Study of migratory birds.

301- BIOMOLECULE AND STRUCTURAL BIOLOGY

Unit I:

Chemical foundation of Biology: pH, pK, acid and bases, buffers, weak bonds. Structure and classification of Amino acids, Zwitter ion

Unit-II:

Carbohydrates: Structures, classification and functions of carbohydrates. D and L form of carbohydrates, Reducing and None reducing sugars.

Unit-III:

Proteins: Structures, classification and functions of proteins. Sequencing of proteins Properties of Proteins and functions of Proteins.

Unit- IV:

Lipids: Lipids definition, Properties of Lipids, Structure of Lipids, Classification (Types) of Lipids and functions of lipids.

Unit-V:

Enzymes: Terminologies, Classification and basics of enzyme kinetics. Mechanism of enzyme catalysis. Regulation of enzyme action. Derivation of Michaelis- Menton equation and its significance in enzyme action.

References:

1. Lehninger, Nelson and Cox, Principles of Biochemistry, 4th Edition, W.H.Freeman& Company, 2006.(link is external)
2. Voet&Voet, Fundamentals of Biochemistry, 4th Edition, Wiley, 2012.(link is external)
3. Garret and Grisham, Biochemistry - 4th Edition, Mary Finch, 2012

302- QUANTITATIVE BIOLOGY, BIODIVERSITY AND WILD LIFE

Unit-I:

Biostatistics: Mean- Definition and Calculation, Median- Definition and Calculation, Mode- Definition and Calculation, Standard Deviation- Definition and Calculation, Graphs and Histogram including applications and Bar diagram and Pictogram including applications

Unit-II:

Sampling theory, Experimental designing, Variance and its analysis, Co- relation and its types, t- test, Chi-Square test.

Unit-III:

Biodiversity: Concept and principal of biodiversity, Causes for the loss of biodiversity, Biodiversity conservation method, National biodiversity status of India

Unit-IV:

Wild life of India: Values of Wildlife (Positive and Negative values), Wild life protection act, Causes for the extinction of Wild life, Conservation of Wild life in India, Endangered and threatened Indian species.

Unit-V:

Wild life Conservation: National parks and Sanctuaries, Project tiger and project Gir lions, Crocodile- Conservation. Biospheres reserves and Safari park, Wild life crossing.

References:

1. Dasmann F Raymond. Wildlife Biology. Wiley eastern Ltd. India. 1982
2. Burnie, D. (Ed). Animal : The Definitive Visual Guide to the World Wildlife. D.K Publications. 2001
3. . Anderson, S Managing Wildlife Resources. Prentice-Hall ,EnglwoodCliffs, New Jersey. 1991
4. Gee, E. P The Wildlife of India. E.P. Dutton Co. N.Y. 1964. 5. Nair, S.M. Endangered animal of India and their Conservation. National Book Trust, India 1992.
5. Dutta, N. K. (2004). Fundamentals of Biostatistics, Kanishka Publishers.
6. Gurumani N. (2005). An Introduction to Biostatistics, MJP Publishers.

7. Daniel, W. W. (2007). Biostatistics- A Foundation for Analysis in the Health Sciences, Wiley.
8. Rao, K. V. (2007). Biostatistics - A Manual of Statistical Methods for use in Health Nutrition and Anthropology.

301 &302 - PRACTICALS

1. Quantification of Carbohydrates
2. Quantification of Lipids
3. Quantification of Proteins
4. Separation of amino acid using Paper chromatography
5. Separation of amino acid using Thin Layer chromatography
6. Estimation of protein using Folin-Lowry method
7. Estimation of amino acid by Ninhydrin method
8. Estimation of vitamin – C by 2,6- dichlorophenol indophenols method
9. The effect of pH and temperature (α -amylase) activity
10. Study of Threatened, Endangered, Endemic, Extinct animals in India
11. Study of wetland fauna
12. Field technics in wildlife studies: Transect, Camera trapping, pug marks, scat analysis, Census techniques, sampling, GPS coordinates.
13. Visit to wildlife sanctuaries, museums, zoo, and national parks

Elective-1:- AQUATIC BIOLOGY

Unit-I:

Introduction to Aquatic Biology and Concepts: Physical Characteristics of Water: light, temperature, Electrical Conductivity, turbidity, density, pressure.

Unit-II:

Chemical properties of water: Hydrogen-ion-concentration Dissolved oxygen, free carbon dioxide, total alkalinity, total hardness, chloride, sulphate, nitrate-nitrite, phosphate- phosphorus, BOD, COD

Unit-III:

Rivers and Lakes: origins and morphometry, thermal stratification. Biological communities of lakes and rivers: Phytoplankton, periphyton, Zooplankton, benthos, microphytes, insects, mollusca, amphibians, fish and birds.

Unit-IV:

The Dynamics of ecosystem: The components, abiotic substances, producers, consumers, decomposers, transformers, productions rates, energy flow structure and ecological pyramids.

Unit-V:

Aquatic pollution monitoring and control. Lowland rivers, flood plains and wetlands. Conservation and management of aquatic ecosystem.

References:

1. Tonapi, G.T. (1980): Freshwater animals of India. Oxford and IBH Publishing Company, New Delhi, India.

2. Blakey, D.R. and Hrusa, D.C. (1989): Inland Aquaculture development handbook. Fishing News Books Great Britain.
3. Jhingran, V.G. (1985): Fish and Fisheries of Indian Hindustan Publishing Co, New Delhi.
4. Pillay, T.V.R. (1990): Aquaculture Principles and Practices, Fishing News Books, Oxford

PRACTICAL

AQUATIC BIOLOGY

1. Estimation of physical and chemical characteristics of water (pH, Density, DO, BOD, COD)
2. Identification of phytoplankton, zooplankton in the water samples
3. Morphometric features of fishes
4. Study of Molluscs, benthos, microphytes, aquatic insects, mollusca, amphibians, fish and birds
5. Visit to aquatic ecosystems.

Elective -1:- COMPUTER APPLIICATION

Unit 1:

Basics of Computer, Characteristics of Computers, Evolution of computers, computer memory, computer generations, Basic computer organization; System software, Application software, introduction to operating system.

Unit 2:

Data Communication and Networks Data communication concepts, local area network, wide area network, internet, intranet, extranet, website. E-mail, search engines

Unit 3:

Using Internet for Research. The Internet: quick look, what is internet, Use of Internet, major internet services, electronic mail, www, downloading super tools for better computing Internet and the society.

Unit 4:

Data processing and plotting, Excel, presentations and drawings. Power point and word processors.

Unit 5

MS-Office and its application, File handling in window, various versions of MSOffice, Research publishing tool- MS-Word, Adobe acrobat, Graphics.

References:

1. Young, S. S. Computerized data acquisition & Analysis for life Sciences: A Hands-on guide. Cambridge University Press, 2001.
2. Snedecor, G.W and Cochran, W.G. Statistical Methods. Ed VI. Oxford and IBH Publishing co, New Delhi, 1967.
3. Higgins, D & Taylor, W (Eds). Bioinformatics Sequence, Structure. Chapman & Hall, 1995.

PRACTICAL

COMPUTER APPLICATION

1. Study of different parts of Computers and associated devices Computer Hardware: CPU, Mother Board, Hard disc, Floppy disc, Compact disc, USB, Pen drive, Scanner Input devices: Keyboard, Mouse, Joy stick, Touch screen monitor Output devices: Monitor, Printer Microsoft Office: MS word, MS Excel and MS Power Point Access to internet and Computer interfacing with Equipment

Elective-2:-LIMNOLOGY

Unit 1:

Limnology: Definition, historical scope.

Fresh water resources of India and their management

Lotic ecosystem of freshwater and their fishery a) Rivers b) Springs.

Unit II:

Physical characteristics of fresh water fishery resources- Depth, light, temperature and turbidity.

Chemical characteristics of fresh water fishery resources.

Estimation and role of BOD and COD of the river water

Unit III

Phytoplankton--- Definition, types

Zooplankton--- Definition, types

Aquatic insects and their importance.

Unit IV

Aquatic pollution: Its causes effect on fishes and remedy

Pollution status of River Ganga and their remedy

Pollution status of River Yamuna and their remedy

Unit V

Sewage- Definition, composition treatment and use in pisciculture.

Hydrophytes and their role in fish culture.

Uses and Misuses of various inland water resources

References:

1. Anathakrishnan Bioresources Ecology
2. Goldman : Limnology
3. Odum: Ecology
4. Pawlosuske : Physico- chemical methods for water
5. Wetzel:Limnology
6. Trivedi&Goyal : Chemical and biological methods for water pollution studies

7. Welch : Limnology Vols. I-II
8. Perkins: Ecology
9. Arora: Fundamentals of environmental biology.

PRACTICAL
LIMNOLOGY

1. Determination of temperature, pH and salinity in the pond water sample.
2. Estimation of total alkalinity and total hardness of pond sample and water reservoir present in particular area
3. Estimation of dissolved oxygen and free carbondioxide.
4. Estimation of phosphates and nitrites.
5. Estimation of COD and BOD

Elective-2:-ECO- TOXICOLOGY

Unit-1

General principles of Environmental Biology with emphasis on ecosystems.

Abiotic and biotic factors of ecosystems.

Communities of the environment, their structure & significance.

Energy flow in environment: Ecological Energetics.

Unit-2

Productivity, Production and analysis.

Recycling and reuse technologies for solid and liquid wastes and their role in environmental conservation.

Remote sensing-basic concepts and applications of remote sensing techniques in environmental conservation.

Environmental indicators and their role in environmental balance.

Unit-3

Kinds of environmental pollution and their control methods.

Radioactive compounds and their impact on the environment.

Vehicular exhaust pollution causes and remedies.

Noise pollution.

Unit-4.

Toxicology- Basic concepts, Principles and various types of toxicological agents.

Toxicity testing principles, hazards, risks and their control methods.

Food toxicants and their control methods.

Public Health Hazards due to environmental disasters.

Unit-5

Pesticides, types, nature and their effects on environment.

Important heavy metals and their role in environment.

Agrochemical use and misuse, alternatives.

Occupational Health Hazards and their Control

References:

1. Trivedi and Goel: Chemical and biological methods for water Clark: Elements of ecology
2. Odum: Fundamentals of Ecology
3. South Woods: Ecological methods of pollution studies

PRACTICAL**ECO-TOXICOLOGY**

1. Determination of heavy metals (Fe/Cu) by spectrophotometric methods
2. Removal of suspended solids by sand filter method.
3. Detection/estimation of Cr (VI) in presence of Cr (III)
4. Estimation of mixed liquor suspended solids (MLSS) and Sludge Volume Index (SVI) in activated sludge
5. Waste water analysis for pH, conductivity, TDS, DO, COD, BOD, alkalinity, chloride and hardness

IV SEMESTER

401 – EVOLUTIONARY BIOLOGY

Unit I:

Introduction: An overview of landmarks in Evolutionary Biology.

Unit II

Concept of organic evolution: Origin of life. Evolution through ages - Geological time scales. Evidences of organic evolution. Evolution of man through ages.

Unit III

Darwinism: Contributions of Charles Darwin, Alfred Russell Wallace and Thomas Malthus. Postulates of Darwinism - objectives and evidences, limitation of Darwinism, Neodarwinism – Hardyweinberg – genetic equilibrium.

Unit IV

Recent developments on Lamarkian concepts. Postulates of Lamarkism- Objectives and evidences, limitation of Lamarkism. Speciation: Biological and phylogenetic concepts of species. Pattern and mechanisms of reproductive isolation. Models of speciation - Allopatric, Sympatric and Strasipatric.

Unit V

The evolution of life histories: Basic questions in the evolution of life history. Evolutionary age and size at maturation. Evolutionary life span and ageing.

References:

1. Futuyama, D.J. Evolutionary Biology- III Ed. Sinauer Associates Inc. Massachusetts, 1998.
2. Gerhart, J and Kirchner, M. Cell, Embryos & Evolution. Blackwell Science Publishers, 1997.
3. Keynes, R. Charles Darwin's Zoology Notes & Specimen List from H.M.S Beagle. Cambridge University Press, 2000.
4. Price, P.W. Biological Evolution. Saunders College Publishing, 1995.

402- ENDOCRINOLOGY

Unit I

Evolution of endocrine function. Hormones as biological signals. Classification of hormones. The concept of neuroendocrine system. Methods in endocrine research.

Unit II

Nature of hormone action: Hormone receptors- Membrane, cytosolic and nuclear receptors. Mechanism of signal transduction - role of G-proteins. Cyclic AMP and the second messenger concept. Prostaglandins and Calmodulin in hormone action.

Unit III

The pituitary gland: Comparative morphology, chemistry and biological actions of anterior and posterior pituitary hormones, their functions and diseases associated with them

Unit IV

Thyroid and parathyroid glands: Evolution of thyroid function in vertebrates. Biosynthesis and biological actions of thyroid hormones. Parathyroid hormones and calcium homeostasis: parathormone, calcitonin, vitamin D and their interaction. Diseases associated with the dysfunction of these hormones

Unit V

Adrenal glands: Comparative morphology. Biosynthesis and biological actions of corticosteroid hormones. The adrenal catecholamines their biosynthesis, physiological actions and metabolism. Hormones and metabolism: Regulation of carbohydrate, lipid and protein metabolism.

References:

1. Mandal, A. Handbook of Neuroendocrinology. EMKAY Publications, 1994.
2. Nelson, R.J. An introduction to Behavioural Endocrinology. Sinauer Associates Inc, 1995.
3. Turner, C.D and Bagnara, J.T. General and Comparative Endocrinology, 1998.
4. Williams, R.H. Textbook of Endocrinology. W.B. Saunders.
5. Martin.C.R. Endocrine Physiology. Oxford University Press.

ELECTIVE-1:-APPLIED ZOOLOGY

Unit I:

Lac culture: Lac insect (Scientific name), composition of Lac, strains of Lac insect, cultivation of Lac host plants (in brief) processing of Lac and uses of Lac.

Unit II

Apiculture: Importance, history and development of bee keeping. Different species of honeybees and their distribution. Management of bees, product and by product of apiculture and their use.

Unit III

Vermiculture: Introduction and importance of vermiculture, Uses of earthworms for biodegradation of organic waste materials, Earthworms as protein source, Vermiculture technique.

Unit IV

Dairy: History, Importance and scope of Dairy a) Dairy breeds and Management: Cattle breeds: Milk breeds, Draught breeds, Exotic breeds Buffalo breeds: Swamp buffaloes and Riverine Buffaloes b) Principles and methods of breeding: Inbreeding, out breeding and cross breeding. Fertility and breeding efficiency, artificial insemination c) Dairy products: Physico-chemical properties of cow and buffalo milk, Processing, preservation and marketing of milk and milk products.

Unit-V

Poultry: History and Importance and Scope of poultry. a) Poultry Breeds b) Principles and techniques and methods of breeding c) Poultry products: Egg, Meat, feather, excreta, nutritive value of egg and meat. d) Poultry pathology: Viral, Bacterial, fungal and protozoan diseases and their control, vaccines and for infections.

References:

1. Economic Zoology, G.S. Shukla & V.B. Upadhyay, Rastogi publications, Meerut, India
2. Fish and Fishries, Kamaleshwar Pandey & J.P. Shukla., Rastogi publications Meerut, India
3. A handbook on Economic Zoology, Jawid Ahsan & Subhas Prasad Sinha, S. Chand & company Ltd. Ramnagar.

PRACTICAL

APPLIED ZOOLOGY

1. Identification of Different Species of Honeybees-*Apis dorsata*/ *Apis indica*/ *Apis florea*/ *Apis mellifera*.
2. Identification of Honey Comb, Honey, Bee Hive, Drone Bee, Queen Bee, Worker Bee and Honey Bee Wax.
3. Identification of Fresh Water Fish.
4. Food adulteration detection in Dairy and its By-Products: Milk, Cheese, Curd, Ghee.

ELECTIVE-1:-ICTHYOLOGY

Unit-1

Origin and evolution of fishes. Classification of fishes. Fish locomotion

Unit-2

Alimentary canal and digestion of fishes. Accessory respiratory organs. Air bladder and its functions. Weberian ossicles their homologies and functions.

Unit-3

Excretion and osmoregulation. Acoustico-lateral line system. Luminous organs. Colouration in fishes.

Unit-4

Sound producing organs. Deep sea adaptations. Hill stream adaptations. Migration in fishes.

Unit-5

Sexual cycle and fecundity. Parental care in fishes. Early development and hatching. Poisonous and venomous fishes.

References:

1. JR. Norman - The History of fishes.
2. Nagaraja Rao - An introduction to fisheries.
3. Lagler Ichthyology.
4. Herclen Jones: Fish migration.
5. Marshal: The life of fishes.
6. Thomas - Diseases of fish.

PRACTICAL

ICTHYOLOGY

1. Visit to local Fresh water bodies to study their Ecology.
2. Collection, Identification and Screening of fish for Ecto and Endo parasites
3. Estimation of Productivity of local Fresh water bodies.
5. Collection and preservation of Water and Soil from water bodies.
6. Collection, Preservation and Identification of plankton.
7. Estimation of PH, Temperature, Chlorides, Dissolved Oxygen from water samples.
8. Estimation of Organic matter of bottom soil.
9. Visit to local fish seed production

ELECTIVE-2:- ENTOMOLOGY

Unit-1

Insect head types and modification as per their habit and habitat. Modification of mouth parts and feeding behaviour. Structure types and function of antennae. Hypothetical wing venation **Unit-2**

Structure of cuticle and pigment. Sclerotisation and tanning of the cuticle. Structure of alimentary canal and Physiology of digestion. Malpighian tubules – anatomical organization, Transport mechanism

Unit-3

Structure of circulatory system. Cellular elements in the haemolymph. Cell mediated and humoral immunity. Structure of compound eye and Physiology of Vision.

Unit-4

Sound Production in insect. Structure and function of endocrine glands. Pheromones. Embryonic membranous up to the formation of blastoderm.

Unit-5

Metamorphosis. Insecticide effects on CNS. Important pest of Soybean. Modern concept of pest management.

References:

1. Entomophagous Insect by Clausen.
2. Entomology by Gilbert.
3. Principles of Insect Physiology by Wigglesworth.
4. Fundamentals of Entomology by Elzinga
5. Hand book of economic Entomology for South India by Ayyar.

PRACTICAL

ENTOMOLOGY

1. Study of morphology of an insect (local insects to be used).
2. Dissection of digestive, nervous, excretory, reproductive systems of any two insects of different orders.
3. Mounting of different types of mouthparts.
4. a. Field study to collect insect species
b. Identification of at least 10 insects belonging to different orders.
5. a. Field study for various methods of pest management.
b. Field visit to warehouses and Plant protection centres.

ELECTIVE-2:- IMMUNE SYSTEM

Unit-1

Tissues of Immune system- Primary lymphoid organs, structure and functions (Thymus and Bursa of Fabricius). Tissues of Immune system- Secondary lymphoid organs, structure and functions (Spleen, lymph node and Payers patches).

Unit-2

Antigen processing. Antigen presentation. T-cell lineage and receptors. T-cell activation. B-cell lineage and receptors. B-cell activation.

Unit-3

Immunoglobulin structure and physical properties of immunoglobulin. Generation of antibody diversity (Light and heavy chain) 4. Immunization

Unit-4

Immediate type of hypersensitivity reaction of anaphylactic type-1. Antibody dependent cytotoxic type II reaction. Complex mediated type III reaction. Delayed type cell mediated hypersensitivity type IV reaction.

Unit-5

Enzyme linked immunosorbent assay (ELISA) technique and its applications. Immunofluorescence technique (Direct & Indirect and Sandwich antibody labelling techniques). Immunodiffusion techniques. Monoclonal antibody technology (Hybridoma technology).

References:

1. Immunology, Kuby, by Kindt, Goldsby, Osborne, Sixth Edition.
2. Immunobiology, The Immune system in Health and Disease, Seventh Edition by Janeway, Travers et al, Garland Publishing, 2008.
3. Research articles and reviews from scientific publications.

PRACTICALS
IMMUNE SYSTEM

1. Agglutination Reaction: Slide Agglutination Reaction
2. Precipitation Reaction a) Double Diffusion Reaction b) Single Diffusion Reaction
3. Enzyme-Linked Immunosorbent Assay
4. Antigen Antibody interaction
5. Separation of Plasma from Blood
6. Separation of different component of Blood cells
7. Determination of blood grouping

Practical of 401 & 402

1. Study of Fossil evidences – Homology, Analogy and Vestigial structures.
2. Study of Evolution of vertebrate skull.
3. Study of Evolution of vertebrate heart chambers.
4. Study of Phylogeny of horse related to limbs and teeth.
5. Study of Darwin's finches related to beaks of different species.
6. Construction of Cladogram based on morphological characteristics and construction of character table a) Vertebrate Cladogram b) Primate Cladogram
7. Study and verification of Hardy-Weinberg law by chi-square analysis.
8. Study of Phylogenetic trees.
9. Visit to Natural History Museum.
10. Observation of Permanent slides.
 - a) T.S of Fish Pituitary, Testis and Ovary
 - b) T.S of Frog Pituitary, Pancreas, Testis and Ovary
 - c) T.S of Reptilian Testis and Ovary
 - d) T.S of Pituitary of Mammals
 - e) V.L.S of anterior Pituitary gland of Mammals
 - f) V.S of Thyroid gland of Mammals
 - g) T.S of Adrenal gland, Pancreas and Hypothalamus of Mammals
 - h) T.S of Testis and Ovary of Mammals.