

**DEPARTMENT OF ZOOLOGY  
UNIVERSITY OF ALLAHABAD**

**Choice Based Credit System Syllabus (Zoology)**

**SEMESTER I**

**ZOO 501: Non-Chordata**

UNIT I

Protozoa: Nutrition, Reproduction, Locomotory organs and locomotion

UNIT II

Porifera: Canal System, Skeletal system

UNIT III

Cnidaria: Metagenesis in Obelia, Polymorphism: Polypoid and medusoid form

UNIT IV

Platyhelminthes: Evolution of Parasitism, Tegument and tegumental organs

UNIT V

Annelida: Metameric segmentation, Trochophore larva- Structure and significance

**ZOO 502: Non-Chordata**

UNIT I

Arthropoda: Mouth parts and mode of feeding, Crustacean larvae-Structure and significance.

UNIT II

Insect Metamorphosis and its hormonal control,

UNIT III

Mollusca: Archimollusca (Ancestral Mollusca), Segmentation and Molluscan ancestry,

UNIT IV

Cephalopoda - Nervous system and sense organs

UNIT V

Echinodermata: Symmetry, Larval form and its significance

**ZOO 503: Chordata**

UNIT I

Chordata: Origin of Chordates, Origin of Gnathostomes

Pisces: Ostracoderms and Devonian fishes

UNIT II

Lung fishes (Dipnoi) and their peculiar features:

Amphibia: Origin of Tetrapoda

UNIT III

Reptilia: Origin of Reptiles, Mesozoic Reptiles, Skull of reptiles and its significance in classification of Reptilia

UNIT IV

Aves: Origin of Birds, Palate of Birds

#### UNIT V

Mammalia: Origin and evolution of Mammalia, Characteristic features-Montremes, Marsupials and Placentals

#### **Suggested Readings:**

1. Orr, R.T. Morphology and biology of Reptiles.
2. De Beer, G.R. Vertebrate Zoology.
3. Romer, A.S. Vertebrate Body.
4. Majumuria, T.S. Introduction to Chordates.

#### **ZOO 504: Evolution**

##### UNIT I

Concept of organic evolution: Evolution of Protein and Nucleic Acid

Facts and theories of evolution: during pre- and Darwin era.

##### UNIT II

Evolution: a new synthesis: Developments and concept of synthetic theory,

Elemental forces of evolution, Mutation, Selection (types of selection, selection coefficient, selection in natural population), Genetic drift: Changes in gene frequency in small population;

Migration

##### UNIT III

Population genetics: Gene frequencies in Mendelian population, Hardy-Weinberg equilibrium, Conditions for the maintenance of genetic equilibrium

##### UNIT IV

The nature of reproductive isolation, genetic basis of isolating mechanisms

Concepts of species and models of speciation: allopatric and sympatric speciation

##### UNIT V

The polytypic species, subspecies and infraspecies categories

The role of hybridization in evolution: Definition and immediate effect of hybridization.

#### **Suggested Readings:**

1. Organic Evolution: R.S. Lull
2. Dobzhansky Th.: Genetics and the Origin of Species. Columbia.
3. Freeman S. and Jon C. Herron (1998): Evolutionary Analysis. Prentice Hall
4. Futuyma D. J. (1998): Evolutionary Biology. Sinauer
5. Hartl D. L. and A. G. Clark (1989 & 1997): Principles of Population Genetics. Sinauer
6. Ridley M. (1993): Evolution. Blackwell.
7. Strickberger M. W. (2000): Evolution. White M. J. D. (1978): Modes of Speciation. Freeman

#### **ZOO 505: Biostatistics**

##### UNIT I

Population sample, random sample, tabular and graphical representation of data

##### UNIT II

Mean and standard deviation of grouped and ungrouped data

Probability, relative frequency, probability distribution

##### UNIT III

Binomial, Poisson and Normal distribution

#### UNIT IV

Tests of significance- t, F, Chi- square test, test for goodness of fit

Analysis of Variance

#### UNIT V

Correlation

Linear regression

#### **Suggested Readings:**

1. George W. Snedecor, William G. Cochran. 1992. Statistical Methods. Wiley-Blackwell. 503pp.
2. Frederick Emory Croxton, Dudley J. Cowden. 1939. Applied General Statistics. Prentice-Hall, 944pp.
3. Karmel, P.H. & Polasek, M. 1970. Applied statistics for economists. Publisher, Pitman. 519pp.
4. Spiegel, M.R.: Theory & Problems of Statistics, Schaum's outline series, McGraw Hill Pub. Co., New York : Schaum's Outline Series (McGrawHill), 1961
5. Spiegel, M.R.: Probability and Statistics. 1982. Paperback. Wiley's Summer Savings Event. Amazon.com.
6. Marylees Miller, Irwin Miller, 2012. Freund, John, E's Mathematical Statistics with Applications. 624pp. Paperback. Pearson.

#### **ZOO 531: Lab course/Practical**

### **SEMESTER II**

#### **ZOO 506: Ecology**

##### UNIT I

Population growth: Exponential and logistic patterns of population growth, Intrinsic rate of natural increase [r], its determination and importance in population ecology.

##### UNIT II

Lotka- Volterra Model of interspecific competition. Modern concepts of Niche. Niche parameters. Niche overlap.

Biodiversity: Measures of species diversity. Global diversity patterns and mechanisms.

##### UNIT III

Law of thermodynamics as they relate to ecological energetic.

Food webs

##### UNIT IV

Biogeochemical cycles: Nitrogen, Phosphorous and Sulphur cycles in terrestrial and aquatic ecosystems.

Community organization and its dynamics. Energy flow models.

##### UNIT V

Ecological succession, its types and concept of climax.

Ecology of various habitats.

Remote sensing, Practical applications of ecology.

#### **Suggested Readings:**

1. Calver, M., Lymbery, A., McComb, J. and Bamford, M. Environmental Biology.
2. Clarke. Elements of Ecology.
3. Odum. E.P. 1965. Ecology. Amerind Publishing, New Delhi.

4. Kendeigh. S.C. Ecology with Special reference to Animal and Man
5. Allee, Emerton, Park and Schmidt. Principles of Animal Ecology.
6. Krebs, C.J. Ecology
7. Joseph. M. 1984. Ecology 2000. (Eds. Edmond Hillary. London).

### **ZOO 507: Methodology & Instrumentation**

#### UNIT I

Fluorescence and Electron Microscopy (SEM & TEM) with principles and working.

#### UNIT II

General laboratory methods, Autoradiography, radioactive labeling and counting i.e. liquid scintillation

#### UNIT III

Principles of chromatography and electrophoresis, centrifugation and ultracentrifugation

#### UNIT IV

UV- VIS Absorption Spectrophotometry, Spectroflurometry

#### UNIT V

Hydrobiological techniques for determination of inorganic ions in water ( $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Ca}^{++}$ ,  $\text{Li}^+$ ,  $\text{SO}_4^-$ ,  $\text{PO}_4^-$ , and  $\text{Cl}^-$ )

Instruments: Flame Photometer, Nephelometer.

### **ZOO 508: Animal Physiology**

#### UNIT I

Ultrastructure of Muscle and its contraction

Nerve conduction and neurotransmitters

#### UNIT II

Major sense organs and receptors, electric organs

Excretion and osmoregulation

#### UNIT III

Homeostasis- neural and hormonal

Reproduction- Male and female reproductive physiology

#### UNIT IV

Bioluminescence

Active transport across membranes

#### UNIT V

Endocrinology: Glands, hormonal secretions and functions

Stress Physiology: High altitude and deep sea physiology

Signal transduction

### **ZOO 509: Biochemistry**

#### UNIT I

Thermodynamics: Elementary knowledge, oxidation-reduction,

Electrolytes: Concepts of buffer, Handerson-Hasselbach equation

#### UNIT II

Carbohydrates: Chemistry, Glycolysis, Krebs's cycle, oxidative phosphorylation, gluconeogenesis,

Hexose monophosphate pathway, glycogen metabolism, peptidoglycan,

### UNIT III

Amino acid: Chemistry, properties and metabolism

Proteins; Structure-Primary, secondary, tertiary and quaternary structure, Ramchandran plot, protein isolation, Solubilities and protein targeting

### UNIT IV

Lipids: chemistry, metabolism of fatty acid and cholesterols

Nucleic acids: Chemical nature, biosynthesis of nucleotides

### UNIT V

Enzymes: Kinetics, inhibition, mechanism of action, Michaelis and Menton equation, isoenzymes allosteric enzymes, ribozymes, Abzymes

Vitamins (fat and water soluble) and coenzymes: Structure and functions

**Elective (Any one of the following may be opted)**

#### **A. For Biology Student**

Biodiversity and Wild Life

Nematology

Skill-development

Communication Biology

#### **B. For Non Biology Students**

Hormones and Health

Basic Genetics

Elementary Biochemistry

### **ZOO 551: Biodiversity and Wild Life**

#### UNIT I

Animal Taxonomy and Diversity

Ecology and Evolutionary Biology

Conservation Biology

Quantitative Biology

#### UNIT II

Genomics and Biodiversity

Molecular Tools for diversity studies-Significance of Molecular Tools in Diversity and Conservation Studies- Barcoding, RT-PCR.

#### UNIT III

Wildlife habitat and species populations

Threat of species extinction

Wildlife Health and Population Management; Wildlife Health; Population Management- Capture and Handling of Wild Animals

#### UNIT IV

Principles of forest management, forest and wildlife as natural resources. Conservation and sustainable development.

Over-exploitation of wildlife natural resources

#### UNIT V

Concept of conservation with special reference to forest and wildlife management

- a) Conservation verses preservation
- b) Conservation Genetics-Genetic management of threatened species
- c) National Park tour, Wetland tour, High Altitude Techniques tour, and
- d) Management and Conservation Practice
- e) Values of biodiversity and conservation ethics
- f) Significance of ecological restoration in conservation
- g) Role of zoos, aquariums and botanic gardens in conservation, Concept of stakeholders. International conservation bodies; IUCN, UNDP, FAO, WWF

#### **Suggested Readings:**

1. Edward O. Wilson, 1996, Biodiversity, 521pp., National Academy Press.
2. Alison J. Stattersfield, Michael J. Crosby, Adrian J. Long, and David C. Wege. 1998. Endemic Bird Areas of the World: Priorities for Biodiversity Conservation. 846pp.
3. Bibby, J., Collar, N.J., Crosby, M.J., Heath, M.F., Imboden, Ch., Johnson, T.H., Long, A.J., Stattersfield, A.J., and Thirgood, S.J. 1992. Putting biodiversity on the map: priority areas for global conservation.

### **ZOO 552: Communication Biology**

#### UNIT I

Key concepts and their logic

Trends in Natural Sciences (Biology)

- i. Transition from Natural History to Enquiry based study in biology
- ii. General introduction to Philosophy of Biology
- iii. The differences in discipline specific philosophies (e.g. how philosophy of biology might differ from that of the physics etc.)

#### UNIT II

iv. Phases of Scientific Enquiry in Biology

- a) Problem identification/be of scientific approach.
- b) Choosing an appropriate system/s (Species, Ecosystem, Forest Type etc.)
- c) Design of a study
- d) Data Collection (Questionnaires, Surveys and Literature review)
- e) Data Analysis
- f) Ethics in Communication Biology.
- g) Social implications of Biological Communication
- h) Animal experimentation ethics, wild-life ethics and human experimentation ethics
- i) Data fudging and plagiarism

#### UNIT III

v. Importance of scientific communication

- a) Types of scientific communications- traditional and modern

- vii. Different modes of scientific communication
  - a. Proposal writing in Biology
    - i. Statement of Purpose (SOP) and Concept note
    - ii. Proposal for funding
    - iii. Report Writing

#### UNIT IV

- b. Research paper writing in Biology
  - i. Different types of research articles-Reviews, articles etc.
  - ii. Concept of peer reviewing
  - iii. Standard components of research communication

#### UNIT V

- c. Thesis writing in Biology
- d. Oral forms of scientific communication in Biology
  - i. Transformation of written content to oral form
  - ii. Poster presentation
  - iii. Oral presentations
- e. Scientific journalism (Print/media) in Biology
  - i. Science issues in public domain (explanation with case studies)
- f. Legal forms of communication of science IPR, patents submissions etc.

#### **Suggested Readings:**

1. Martha Davis 2005. Scientific Papers and Presentations
2. Strunk, Jr. W., white, E.B., 1979. The Elements of Style, 3<sup>rd</sup> Ed.
3. Grafen, A. and Ridley, M., 2006. Richard Dawkins: How a scientist changed the way we think. Oxford University Press.
4. Dawkins, R. 1998. Unweaving the Rainbow, Penguin Publication, London
5. Medawar, P.B. and Medawar, J.S. 1977. The Life Science: Current Ideas of Biology, Wildwood House, London
6. Barrow and Tipler 1988. The Anthropic Principle, Oxford University Press
7. Bowles, K.L. 1977. Problem Solving using Pascal, Berlin: Springer-Verlag.
8. Maynard Smith, J. 1986. The Problems of Biology, Oxford: Oxford University Press

### **ZOO 553: Nematology**

#### UNIT I

General characters of plant parasitic nematodes: Distribution, morphology (Structural details of oesophagi, excretory, nervous and reproductive systems), life history, feeding habit, symptoms of plant nematode infection, Life history of root-knot nematode. Root knot disease of brinjal.

Diagnostic features and classification of Tylenchoidea, Heteroderoidea, Criconematoidea, Aphelenchoidea, Dorylaimoidea and Trichoderoidea.

#### UNIT II

Techniques in Nematology: Methods of sampling (soil & plant samples), Methods of extracting nematodes from soil & plant samples, Methods of processing nematodes for observation.

Identification of Anguina, Hoplolaimus, Helicotylenchus, Rotylenchulus, Tylenchulus, Meloidogyne. Heterodera and Xiphinema

### UNIT III

Concept of plant disease, Host parasites relationship in nematode infection. Effect of abiotic factors in nematode multiplication. Mechanism involved in injury & histopathology of infected tissue.

### UNIT IV

Interaction of Plant parasitic nematodes with fungi, bacteria and viruses. Nematode-Nematode interactions.

### UNIT V

Broad principles of plant disease management: Disease forecasting, Integrated pest management (IPM), Regulatory and physical measures of disease management, Management of diseases by cultural practices, cropping sequences, organic amendments. Bio-control of nematode diseases. Epidemiology, Pathogenecity and Control of Root knot & Cyst Nematodes. Chemical measures of diseases management of nematicides.

#### **Suggested Readings:**

1. Perry, R.N., Perry, R. and Moens, M. 2013. Plant Nematology.
2. Stirling, G. 2014. Biological Control of Plant-parasitic Nematodes.
3. Kennedy, M. and Harnett, W. 2013. Parasitic Nematodes.

### **ZOO 554: Sericulture**

#### UNIT I

Sericulture: Definition, history and present status. Silkworms: Types of silkworms, their food plants and distribution. Silk production: Mulberry and non-mulberry cocoon and yarn.

#### UNIT II

Prospects of Sericulture in India. Sericulture industry in different states, employment, potential in mulberry and non-mulberry sericulture.

#### UNIT III

Sericulture Centres. Research Training and extension. Seed production, reeling, re-reeling, twisting, doubling, weaving, processing and trading centres. Central Silk Board (CSB): Role in Extension and development. Directorate of Sericulture: Extension and development in sericulture on state level.

#### UNIT IV

Mulberry plant morphology: Mulberry species: Classification, distribution and common varieties used in Sericulture in India.

#### UNIT V

Mulberry cultivation, harvesting & management. Economics: irrigated, non-irrigated & temperate region cultivation. Cost-benefit ratio.

#### **Suggested Readings:**

1. Ganga, G. and Sulochana Chett, J. 1997. Introduction to Sericulture. 302pp.
2. Anonymous. 1987. Manuals on Sericulture, CSB, Bangalore
3. Koshy, T.D. 1990 Silk Export and development, Ashish Publ. House, New Delhi
4. Yokoyama, T. 1959. Silkworm Genetics illustrated, Japanese Society for Promotion of Science, Japan.
5. Anonymous. 1993. Principles and techniques of silkworm Breeding, United Nations, USA (Oxford IBH, Calcutta)
6. Anonymous. 1997. Silkworm Egg production (Translated from Japanese) Oxford IBH, New Delhi



7. Anonymous. 1997. Silkworm rearing. (Translated from Japanese) Oxford IBH, New Delhi
8. Anonymous. 1972. Handbook of Silkworm rearing, Fuji Publ. Co., Tokyo, Japan
9. Jolly et al. 1974. Tasar Culture, CSTRI, Ranchi
10. Sathe, T.V. 1998. Sericultural crop Protection, Asawari Publ, Osmanabad.
11. Aruga, H. 1994 Principle of Sericulture, (Translated from Japanese) Oxford and IBH Publ., New Delhi
12. Sarkar, Dilip de 1998. The silkworm Biology, Genetic and breeding, UBS Publ. New Delhi
13. Jolly et al. 1987. Appropriate sericulture techniques, CSR & TI, Mysore

### **ZOO 555: Hormones and Health**

#### UNIT I

Endocrine system: Brief description of the organization and function of endocrine glands

Endocrine disorders: Types, causes and treatment

Pituitary disorder

Panhypopituitarism, acromegaly and gigantism

#### UNIT II

Thyroid disorder

Hypo/Hyper Thyroidism

Goitre, Hashimoto's Thyroiditis

#### UNIT III

Adrenal Disorder

Addison's disease; Cushing's syndrome; Grave's disease

#### UNIT IV

Hormones and metabolic disorders:

Diabetes (Type I and Type II)

Obesity

#### UNIT V

Reproductive/sexual disorders:

Polycystic ovarian disease;

Osteoporosis

Endocrine disruptors and disease susceptibility

#### **Suggested Readings:**

1. William's Text Book of Endocrinology: Shlomo Melmed, Kenneth S. Polonsky, P.Reed Larsen
2. Guyton's text book of Medical Physiology

### **ZOO 556: Basic Genetics**

#### UNIT I

Basic concept of chromosome, gene, allele and genome

Structure and function of chromosomes

Chromosome packaging, Nucleosome model

#### UNIT II

Euchromatin and Heterochromatin

Autosomes and sex chromosomes;  
Barr body and Dosage compensation

UNIT III

Mitosis and Meiosis  
Principles of Inheritance

UNIT IV

Mendel's Laws: Back cross and Test cross  
Sex-linked inheritance

UNIT V

Genetic disease: Down syndrome; Klinefelter syndrome and Turner's syndrome  
Mutation, Chromosomal aberration

**ZOO 557: Elementary Biochemistry**

UNIT I

Biomolecules: Organizational principle, scope and importance, Carbohydrate; Classification, Structure and conformation, Proteins; Amino acids. Structural organization and functions, Lipids

UNIT II

Biological significance and classification, Nucleic Acids; Bases, nucleosides and nucleotides, structure of DNA

UNIT III

Enzymes: General properties, major classes of enzymes, Elementary knowledge of mechanism of action  
Vitamins: Introduction, classification and significance

UNIT IV

DNA as genetic material; Elementary knowledge of Replication, transcription and translational processes.

UNIT V

Introduction of Glycolysis, Krebs's cycle, Oxidative phosphorylation, Oxidation of fatty acids.

**ZOO 532-533: Lab course/Practical**

**SEMESTER III**

**ZOO 510: Formal and Experimental Embryology**

UNIT I

Descriptive embryology with particular reference to frog and chick  
Egg types; Cleavage Patterns; Fate maps; Morphogenetic movement and formation of germ layers;  
Gastrulation in amphibian and birds

UNIT II

Organizer concept: Properties and physiology of organizer; Primary Organizer and Primary Induction, neurulation. Secondary Induction: Development and patterning of vertebrate limb, proximal- distal and dorso- ventral axis formation, Involvement of pattern forming genes

UNIT III

Metamorphosis in frogs, hormonal regulation

Regeneration (Epimorphic/Morphalactic)

Regeneration of the amphibian limb

Regeneration in Hydra

#### UNIT IV

Foetal membranes ; Placentation in animals: Types and functions

Teratogenesis: environmental assaults on development; teratogenic agents; teratological abnormalities

#### UNIT V

Experimental Embryology: Basic Concepts

Standard techniques and methods of experimental embryology:

Experiments on the analysis of early development and differentiation (Experiments of Spemann and Mangold)

vital dyeing, extirpation, isolation, transplantation

Role of nucleus, cytoplasm and yolk

#### RECOMMENDED BOOKS

1. Balinsky, B.I. : An Introduction to *Embryology*, . Holt-Saunders, Philadelphia.
2. S. F. Gilbert. Developmental Biology

#### ZOO 511: Animal Behaviour

##### UNIT I

Definition and general mechanism of animal behaviour

Major contribution of scientists: In classical ethology and modern behavioural biology

##### UNIT II

Modern concepts of animal behaviour: Ethological, Psychological and Evolutionary

Methods of study of animal behaviour: In wild and laboratory environment, Neuroanatomical, Neurophysiological and Neurochemical approach

##### UNIT III

Development of behaviour: Innate and Learned; Comparative account on characteristics of instinct and learning; Types of fixed action patterns (FAPs); Neuro-genetic mechanism of instinct

##### UNIT IV

Learning and Memory: Classification or forms of learning and memory, Neural mechanisms of learning and memory

##### UNIT V

Evolution of behaviour, Hormones and behaviour, Motivation and behaviour

#### Suggested Readings:

1. Manning, A. An Introduction of Animal Behaviour.
2. Russell, E.S. The behaviour of Animals.
3. Mc Farland, D. Animal Behaviour: Psychology, Ethology & Evolution.
4. Alcock, J. Animal Behaviour: An evolutionary approach.
5. Dugatkin, L.A. Principles of Animal Behaviour.
6. Silverman, P. Animal Behaviour in the laboratory.

## **ZOO 512: Biotechnology**

### UNIT I

Recombinant DNA technology: Introduction, Restriction endonucleases and applications, other useful enzymes for molecular cloning, steps in gene cloning, identification and isolation of desired gene.

### UNIT II

Cloning vectors, screening and selection of recombinant DNA clones, gene probes as diagnostic tools, biosynthesis of insulin, somatostatin and growth hormone

### UNIT III

Tissue culture, hybridoma technology and monoclonal antibodies: Cell culture, organ, cultures, culture media, embryonic stem cell transfer, targeted gene transfer, in vitro fertilization in humans, embryo transfer in cattle, applications of embryo transfer technology, animal cloning

### UNIT IV

Environmental biotechnology: Bioconversions, pollution control, microbial enhancement of oil recovery, microbial mining and metal recovery, sewage treatment

### UNIT V

Health care biotechnology: gene replacement therapy

Miscellaneous: An introductory knowledge of biosensors, biochips, DNA fingerprinting, Immobilized enzymes, bioenergy, genomic DNA libraries

## **ZOO 513: Molecular Biology**

### UNIT I

Molecular analysis of eukaryotic DNA- overall composition, reassociation kinetics, kinetic analysis of eukaryotic DNA,

Nucleotide polymerases, DNA replication, repair and mispair mechanisms

### UNIT II

The basic transcription apparatus, promoters, enhancers, termination and antitermination

Organisation of eukaryotic genes-globin gene, IgG, r DNA, histone gene

### UNIT III

Genetic code, protein synthesis, translation, m-RNA processing and organization of interrupted genes, Ribonucleoproteins, organelle genomes.

### UNIT IV

Structure and life cycles of bacteriophage T2 or T4 virulent and temperate phages, phage mutants and their importance

RNA phages, tumour viruses and their life cycles, retroviruses,

Topoisomerases, gyrases, methylases, nucleases

### UNIT V

Molecular biology of cancer: Oncogenes, chemical carcinogenesis

Genetic and metabolic disorders, Principles and methods of gene targeting, gene silencing

## **Elective (Any one of following may be opted)**

**Entomology**

**Parasitology**

**Fish & Fisheries**  
**Environmental Biology**  
**Cell Biology**

**ZOO 558: Entomology: Morphology and Embryology**

UNIT I

General structure of Head, Thorax and abdomen

UNIT II

Structure and functions of insect cuticle.

Structure and functions of the fat body.

UNIT III

Structure of insect egg. Blastoderm formation, germ band, blastokinesis and three germ layers.

UNIT IV

Various types of larvae and pupae, significance of pupal instar in insects.

UNIT V

Metamorphosis.

Pheromones

**ZOO 559: Parasitology**

UNIT I

Bionomics: Habitat; variety in host parasite relationship

Micro- and Macro- environment of parasites: Autecology and synecology of parasitic helminthes

UNIT II

Host specificity (definition and kinds of host specificity)

Pathophysiology and Immunoparasitology

UNIT III

Physiology of host-parasite interactions.

Immunological control of vector borne and non-vector borne diseases

UNIT IV

Immunodiagnosis and immunoprophylaxis

Immunodiffusion: Fluorescent antibody technique: Serological diagnosis, diagnostic techniques (coprological urine and blood)

UNIT V

Population dynamics of helminthes

Bioinvasion & helminthes

**Suggested Readings:**

1. Schimdt, G.D. and Roberts, L.S. Foundations of Parasitology
2. Maule, A.G. and Dr. N.J. Marks Parasitic Flatworms, Molecular Biology, Biochemistry, Immunology, Physiology
3. Hempel, P.S. Evolutionary Parasitology
4. Gunn, A. and Pitt, S.J. Parasitology: An Integrated Approach
5. Khalil, L.F. Jones, A. and Bray, R.A. Keys to the Cestode Parasites of Vertebrates
6. Rohde, K. Marine Parasitology

7. Duijn, V. 1973. Diseases of Fish
8. Dogiel, Perrushevski and Polyanski. 1958. Parasitology of fish.
9. Cheng 1964. The biology of animal parasites.
10. Smyth J.D. 1976 Introduction to Animal Parasitology.
11. Schell. 1970. How to know the trematodes.
12. Erasmus. 1972. The biology of trematodes.

### **ZOO 560: Fish & Fisheries**

#### UNIT I

Classification; Elasmobranchs, Holocephalians, Dipnoans and Actinopterygians (including the ancestral groups of Acanthodians. Placoderms and Crossopterygians)

#### UNIT II

Origin and evolution of major groups of fish

#### UNIT III

Adaptation of fishes; Hill-stream and deep sea

#### UNIT IV

General features of the skin, scales and fins of teleosts

#### UNIT V

Fish migration with particular reference to Salmon and Eel. Hormonal regulation of fish migration

#### **Suggested Readings:**

1. Datta Munshi, J.S. and M.P. Srivastava. Natural History of Fishes and Systematic of Fresh water Fishes of India. 2006 Narendra Publ. House, New delhi
2. Gupta S.K. and Gupta P.C. General and Applied Ichthyology.
3. Srivastava, C.B.L. A. textbook of Fishery Science and Indian Fisheries.
4. Lagler et. al. Ichthyology
5. Norman, J.R. A History of Fishes.
6. Kyle, H.M.A. Biology of Fishes
7. Khanna, S.S. An Introduction to Fishes.

### **ZOO 561: Environmental Biology**

#### UNIT I

Meaning and Scope of Environmental Biology.

Practical application of Environmental Biology.

#### UNIT II

Environmental Problems: Local, regional and global.

#### UNIT III

Environmental problems associated with resource exploitation and energy utilization in developing and developed countries.

#### UNIT IV

Environmental Biochemistry.

Environmental Toxicology.

#### UNIT V

Sources of toxic substances in the environment.

Factors affecting toxicity.

**Suggested Readings:**

1. Elements of Ecology. Clarke
2. Ecology, Eugene P. Odum. 1965. Amerind Publishing, New delhi
3. Ecology with Special reference to Animal and Man. S. Charles Kendeigh
4. Principles of Animal Ecology : Allee, Emeroon, Park and Schmidt.
5. Ecology. C.J.Krebs.
6. Ecology 2000. Eds. Edmond Hillary. London Michael Joseph. 1984.

**ZOO 562: Cell Biology**

UNIT I

Plasma membrane:

Fine structural details with reference to various models, functions of plasma membrane;

Transport across cell membranes: active transport, phagocytosis, pinocytosis.

UNIT II

Endoplasmic reticulum: Structure and function (protein uptake and modification).

Golgi apparatus: Origin, development, fine structural details and functions; protein sorting in Golgi apparatus.

UNIT III

Ribosomes; prokaryotic and Eukaryotic ribosomes, mechanism of protein synthesis.

Lysosomes: Structure, types (primary and secondary), formation and function, peroxisomes

UNIT IV

Mitochondria: Morphology, conformational states, fine structural detail and functions (Electron Transport Chain and Oxidative phosphorylation)

UNIT V

Nucleus: ultra structure, nuclear envelope, structure and function of nuclear pore complex, internal organization

**Suggested Readings:**

1. Lodish, Molecular Biology of the Cell.
2. Karp, G. (7<sup>th</sup> Edition), Cell and Molecular Biology: Concepts and Experiments.
3. Alberts ET AL., Essentials of Cell Biology

**ZOO 534-535: Lab course/Practical**

**SEMESTER IV**

**ZOO 514: Bioinformatics**

UNIT I

Biology & IT, Computers in Biology and medicine, Introduction to Genomics and Proteomics etc.

Definition and terminology: Cladogram, Dendrogram, Phylogram and Phenogram; Operational taxonomic unit (OTU), Informative sites.

UNIT II

Biological sequence data banks (GENBANK, EMBL, SWISSPORT, PDB)

Sequence alignment (Global & Local), Algorithms used (Dynamic & Heuristic) - Needleman Wunsch, Smith Waterman BLAST, FASTA

#### UNIT III

Trees: Rooted and unrooted trees

Species Tree and Gene Tree: Homology, Homoplasy, Orthology, Paralogy and Xenology

Trees Construction Methods: Maximum Parsimony, Maximum Likelihood, Branch and Bound

#### UNIT IV

Fitch- Margoliash method and distance based methods.

Distance based methods: Least squares, Neighbor joining, UPGMA

#### UNIT V

Bootstrapping and split decomposition; Concepts and its application in tree construction

Application of Phylogeny; Evolutionary study, Pedigree analysis.

#### **Suggested Readings:**

1. Bioinformatics-Sequence and Genome Analysis-David W. Mount, CSHL Press
2. Molecular Systematics, 2<sup>nd</sup> ed. D.M. Hillis, C. Moritz and B.K. Mable, Sinauer Associates, Sunderland. Massachusetts.
3. Fundamental Concepts of Bioinformatics, Krane, D.E. and Raymer M.L. Pearson Education

### **Elective Entomology**

#### **ZOO 563: Insect Physiology**

##### UNIT I

Alimentary canal and digestion in insects.

##### UNIT II

Structure and function of Malpighian tubules.

##### UNIT III

Structure and function of insect spiracle. Respiration in aquatic and endoparasitic insects.

##### UNIT IV

Composition and function of haemocytes.

Diapause.

##### UNIT V

Endocrine glands and insect hormones.

#### **ZOO 564: Taxonomy and Economic Entomology**

##### UNIT I

Modern classification of insects with special reference to that of different economically important orders (Lepidoptera, Diptera, Coleoptera).

##### UNIT II

Biology, nature and extent of damage and control of pests of paddy, sugarcane and cotton

##### UNIT III

Pests of stored products.



UNIT IV

Beneficial insects- honeybee

UNIT V

Beneficial insects- silkworm.

**ZOO 565: Toxicology**

UNIT I

Study of different types of insecticides- Organophosphates, carbamates, botanical insecticides.

Methods of application of insecticides

UNIT II

Hazards of insecticides, precautions and antidotes, fumigants.

UNIT III

Principles of biological control-parasites, predators and pathogens affecting insect pests and the efficacy in controlling the insect pests.

UNIT IV

Principles and components of integrated pest management (IPM), Chemosterilants.

UNIT V

Autocides including 3<sup>rd</sup> and 4<sup>th</sup> generation pesticides.

**Parasitology**

**ZOO 566: Parasitology**

UNIT I

Protozoology, Medical and veterinary entomology.

UNIT II

Epidemiology and zoonotic significance of Ichthyophthiriasis, Trypanosomiasis Giardiasis, Theileriasis and Coccidiosis

UNIT III

General organization, morphology systematic and life cycles of aforementioned protozoans

UNIT IV

Epidemiology and zoonotic significance of parasitic arthropods, Ticks: Argas, Ixodes

Mites: Sarcoptes, Demodex

UNIT V

Fleas: Hypoderma, Tabanus, Lice: Pulex, Cimex

Parasite toxicosis in arthropods.

**ZOO 567: Parasitology**

UNIT I

Epidemiology, life cycle, pathogenicity and control of parasitic helminthes: *Clonorchis sinensis*, *Polystoma integrimum*

General systematics of Platyhelminthes and Aschelminthes

UNIT II

Epidemiology, life cycle, pathogenicity and control of parasitic helminthes:

*Schistocephalus solidus*, *Duthlersia*, *Moneizia expansa*, *Hymenolepis*

UNIT III

Epidemiology, life cycle, pathogenicity and control of parasitic helminthes:

*Ancylostoma duodenale*, *Trichinella spiralis*

UNIT IV

Biology of eggs of parasitic helminthes

Penetration and growth in definitive hosts

UNIT V

Metabolism in parasitic helminthes

Biology of hydatid organisms

## **ZOO 568: Parasitology**

UNIT I

Adhesive organs in parasitic helminthes with reference to *Clonorchis sinensis*, *Polystoma integrimum* and their importance in systematics

UNIT II

Adhesive organs in parasitic helminthes with reference to *Schistocephalus solidus*, *Duthlersia*, *Moneizia expansa*, *Hymenolepis*, and their importance in systematics

UNIT III

Adhesive organs in parasitic helminthes with reference to *Ancylostoma duodenale*, *Trichinella spiralis*

Significance of excretory organs in classification of parasitic helminthes with reference to trematoda.

UNIT IV

Larval stages of parasitic helminthes

Biology and kinds of larvae in trematoda, cestoda and nematoda

Anthelmintics

UNIT V

Hyperparasitism and Hypersensitivity

Helminth zoonoses and its causative agents.

### **Suggested Readings:**

1. Schimdt, G.D. and Roberts, L.S. Foundations of Parasitology
2. Maule, A.G. and Marks, N.J. Parasitic Flatworms, Molecular Biology, Biochemistry, Immunology, Physiology
3. Hempel, P.S. Evolutionary Parasitology
4. Gunn, A. and Pitt, S.J. Parasitology: An Integrated Approach
5. Khalil, L.F. Jones, A. and Bray, R.A. Keys to the Cestode Parasites of Vertebrates
6. Rohde, K. Marine Parasitology
7. Duijn, V. 1973. Diseases of Fish

8. Dogiel, Perrushevski and Polyanski. 1958. Parasitology of fish.
9. Cheng 1964. The biology of animal parasites.
10. Smyth J.D. 1976 Introduction to Animal Parasitology.
11. Schell. 1970. How to know the trematodes.
12. Erasmus. 1972. The biology of trematodes.
13. Von Brand, T. 1973. Biochemistry of Parasites.

## **Fish & Fisheries**

### **ZOO 569: Fish & Fisheries**

#### UNIT I

General features of the anatomy, physiology and function of internal organs of teleosts;  
Aortic arches.

Alimentary canal & Digestion

#### UNIT II

Respiration, Swim bladder, Accessory respiratory organs

#### UNIT III

Excretion and Osmoregulation

Reproduction and Reproductive organs

#### UNIT IV

Endocrine glands and Caudal neurosecretory system

#### UNIT V

Sense Organs, Lateral line organs.

Electric organs and Electroreception in Fishes

### **Suggested Readings:**

1. Datta Munshi, J.S. and M.P. Srivastava Natural History of Fishes and Systematic of Fresh water Fishes of India. 2006 Narendra Publ. House, New Delhi
2. Gupta S.K. and Gupta P.C. General Applied Ichthyology.
3. Srivastava, C.B.L. A. textbook of Fishery Science and Indian Fisheries.
4. Lagler et. Al. Ichthyology
5. Norman, J.R. A History of Fishes.
6. Kyle, H.M.A. Biology of Fishes
7. Khanna, S.S. An Introduction to Fishes.

### **ZOO 570: Fish & Fisheries**

#### UNIT I

**Marine fishery:** Important coastal fishery resources and fish landing in relation to different maritime states of India. Productivity of west coast and east coast, Problems of inshore fishery, off shore and deep sea fishery  
UNIT II

Ecology of sea, Oceanography in relation to fishery, Exclusive Economic Zone (EEZ)

Fishery of Sardine, Mackerel

Past, present and future prospects of marine fishery in India

UNIT III

**Inland Fishery:** Inland capture fishery resources of India, Important riverine systems and their fishery, Riverine pollution and fish landing

Present and future prospects of cold water fishery of India

UNIT IV

**Estuarine Fishery:** Ecology of estuary, Present and future prospects of estuarine fishery of India

UNIT V

**Crafts and Gears :** Important traditional and modern crafts used for fish catch in inland and marine water, Conventional and unconventional fishing methods used in inland and marine sector

Age and growth determination

Methods and principles of fish preservations, development of fish bye - products

**Suggested Readings:**

1. Jhingran, V.G. Fish and Fisheries of India.
2. Bardach. Aquaculture.
3. Aggarwal, S.C. Fishery Management.
4. Govindan, T.K. Fish Processing Technology.
5. Beavan, C.R. Handbook of Freshwater fishes of India.
6. Bal and Rao, Marine Fisheries.

## **ZOO 571: Fish & Fisheries**

UNIT I

**Aquaculture:** Definition, types, resources and cultivable fish and non-fish organisms, including sea-weeds

Current and future prospects of aquaculture in India

Basic principles of aquaculture

**Mariculture:** Important cultivable organisms

UNIT II

**Inland culture:** Principal methods used in fish culture: composite fish culture, air-breathing fish culture, Integrated fish farming, cage, pen, raceways and tank culture.

Trout prawn and pearl culture.

UNIT III

**Pond preparation:** Brooder, nursery, rearing and stocking ponds

**Management of pond :** Pond preparation, use of fertilizers, aquatic vegetation and their control, eradication of weed and predatory fishes as well as aquatic insects, supplementary feeding, physico-chemical and biological factors, control of algal blooms and swarms

UNIT IV

**Carp seed raising:** Natural spawning and seed collection of fish seeds, technique of induced breeding, natural and synthetic drugs for fish breeding

#### UNIT V

**Freshness of fish:** Features of raw fish, decomposition of fish, state of rigor mortis, Fish diseases and their control.

#### **Suggested Readings:**

1. Jhingran, V.G. Fish and Fisheries of India.
2. Bardach. Aquaculture.
3. Aggarwal, S.C. Fishery Management.
4. Govindan, T.K. Fish Processing Technology.
5. Beavan, C.R. Handbook of Freshwater fishes of India.
6. Bal and Rao, Marine Fisheries.

### **Environmental Biology**

#### **ZOO 572: Environmental Biology**

##### UNIT I

Air pollution, effect and control

Pollution indicators, Saprobian Index

##### UNIT II

Water pollution sources, effect and control,

Water quality criteria standards.

Physico-chemical and biological monitoring of water quality

##### UNIT III

Waste water treatment and associated problems

Marine pollution; sources, effect and control

Soil pollution source, effect and control

##### UNIT IV

Biodegradation of pesticides, Bio-geochemical cycle of pesticides

Hazards of pesticide pollution

Heavy metal and pesticide pollution

##### UNIT V

Noise pollution sources, effect and control

Radioactive pollution: Sources, effect and control

Bio-concentration & Bio-magnification

Indian legislation for pollution control.

#### **Suggested Readings:**

1. Elements of Ecology, Clarke.
2. Ecology, Eugene P. Odum, 1965. Amerind Publishin, New Delhi
3. Ecology with Special reference to Animal and Man. S. Charles Kendeigh.
4. Principles of Animal Ecology: Allee, Emeroon, Park and Schmidt
5. Ecology. C.J. Krebs.

6. Ecology 2000. Eds. Edmond Hillary. London Michael Joseph. 1984

### **ZOO 573: Environmental Biology**

#### UNIT I

Diversity of environmental habitats

Animal resource management

#### UNIT II

Vermiculture

Forest management (policies and problems)

Wetland and Wasteland management

#### UNIT III

Integrated pest management

Biological control with the help of natural enemies

Management and Treatment of municipal and industrial wastes

#### UNIT IV

Soil monitoring and management

Management of soil erosion

#### UNIT V

Recycling of non- degradable substances

Role of NGO's in Environmental Management and Conservation

Basic knowledge of use of computer in Environmental Management.

#### **Suggested Readings:**

1. Clarke, Elements of Ecology.
2. Odum, E.P. 1965 Ecology, Amerind Publishing, New Delhi
3. Kendeigh, S.C. Ecology with Special reference to Animal and Man
4. Allee, Emeroon, Park and Schmidt, Principles of Animal Ecology.
5. Krebs. C.J. Ecology
6. Joseph, M. 1984. Ecology 2000 (Edmond Hillary. London)

### **ZOO 574: Environmental Biology**

#### UNIT I

Environmental management of agricultural land, urban land, rural land and forest land

#### UNIT II

Land use classification and practices

Land use planning and management

#### UNIT III

Environmental impact assessment

Purposes of environmental assessment methods

#### UNIT IV

Environmental monitoring: purpose of monitoring, trend monitoring, ambient source-linked monitoring,

Monitoring activities and directions, design and applications

## UNIT V

Sensors and methods

Role of remote sensing in environmental management.

### **Suggested Readings:**

1. Elements of Ecology, Clarke.
2. Ecology, Eugene P. Odum, 1965. Amerind Publishin, New Delhi
3. Ecology with Special reference to Animal and Man. S. Charles Kendeigh.
4. Principles of Animal Ecology: Allee, Emeroon, Park and Schmidt
5. Ecology. C.J. Krebs.
6. Ecology 2000. Eds. Edmond Hillary. London Michael Joseph. 1984

## **ZOO 575: Cell Biology**

### UNIT I

Molecular organization of eukaryotic chromosomes; Chromosome compaction (Nucleosome, solenoid); Organisation and significance of heterochromatin; Specialized chromosomes: Structural organization and functional significance of polytene chromosomes in cells of dipterans, lampbrush chromosomes of vertebrate oocytes .

### UNIT II

Cell signaling:

Signaling through membranes receptors (G protein coupled receptors, Receptor Tyrosine kinase) ; intracellular receptors (signaling of steroid molecules)

### UNIT III

Communication between cells and their environment: Interaction of cells with extracellular matrix and other cells; Integrin, selectins and cadherins

### UNIT IV

Cytoskeleton: structure and dynamics of microfilaments, intermediate filaments and microtubules

### UNIT V

Cell cycle and its regulation;

Cell aging

### RECOMMENDED BOOKS

1. Molecular Biology of the Cell: By Lodish
2. Cell and Molecular Biology: Concepts and Experiments : Gerald Karp (7<sup>th</sup> Edition)
3. Essentials of Cell Biology: Alberts et al
4. Lehninger Principles of Biochemistry: Nelson and Cox

## **ZOO 576: Cell Biology**

### UNIT I

Bioenergetics: Laws of energy changes (concept of entropy, free energy), Redox couples, coupled reactions.

#### UNIT II

Special cell function:

Immunocompetent cells; Differentiation of B lymphocytes and humoral immune response, Differentiation of T lymphocytes and cellular immune response; Antigen Processing and Presentation, Antigen presenting cells, Major Histocompatibility Complex (MHC), MHC Restriction of Lymphocytes.

#### UNIT III

Polyclonal antibody, Types, structure and function; antibody diversity

#### UNIT IV

Monoclonal antibody, hybridomas; Function of monoclonal antibody (

#### UNIT V

Cancer: Cytological characteristics of transformed cells, cancer causing agents. Molecular Biology of cancer: tumor suppressor genes and oncogenes

### RECOMMENDED BOOKS

1. Kuby Immunology: JA Owen, SA, Stranford, PP Uones.
2. Cell and Molecular Biology: Concepts and Experiments : Gerald Karp (7<sup>th</sup> Edition)
3. Essentials of Cell Biology: Alberts et al
4. Lehninger Principles of Biochemistry: Nelson and Cox

### **ZOO 577: Cell Biology**

#### UNIT I

Tools and Techniques of cell Biology

Microscopy

Principles of light and electron microscopy

Tissue preparation:

Fixation of tissue for paraffin and cryocut sectioning and electron microscopy:

Tissue embedding (Paraffin and epoxy resin)

Tissue sectioning (Rotary and ultra microtome)

#### UNIT II

Histochemical techniques for detection of carbohydrates, lipids, proteins,

Techniques for detection of special cells: Neuronal staining: Cresyl violet and Silver Impregnation staining (Golgi Cox)

#### UNIT III

Autoradiography: Uses of radioisotopes as tracers in cell

Immunocytochemistry/ Immunohistochemistry

Light microscopic immunocytochemistry

#### UNIT IV

Immunolectron microscopy: Nano-gold immunoprobe and Protein A-gold immunocytochemistry

Applications of Immunocytochemistry/Immunohistochemistry: Detection of histopathology of diseases. Study of histogenesis and cytogenesis.



## UNIT V

Cell culture: Detection of apoptotic and necrotic cells (AO/EB staining)

Direct and Indirect Method

Fluorescence and Enzymatic Method

Antigen Retrieval

### **Suggested Readings:**

1. Owen, J.A. Stranford, S.A. and Uones, P.P. Kuby Immunology
2. Cell and Molecular Biology:
3. Karp, G. (7th Ed.) Concepts and Experiments
4. Alberts et al. Essentials of cell Biology
5. Lehninger Principles of Biochemistry: Nelson and Cox

**ZOO 578: Project// Seminar Presentation**

**ZOO 536-542: Lab course/Practical**



