DEPARTMENT OF ZOOLOGY
MSC SYLLABUS

Paper No	**Title**	***Total Credits***
ZOO-PG-CT101	Functional biology in non-chordates and parasitology	4
ZOO-PG-CT102	Biochemistry, cell biology and genetics	4
ZOO-PG-CT103	Endocrinology, tools and techniques, biosystematics, biostatistics	4
ZOO-PG-CP104	Practical- Identification of non-chordates, parasitology, biochemistry, genetics, biostatistics	4
Total Credits		**16**
ZOO-PG-OT201	Ecology, biogeography, animal behaviour and biodiversity	4
ZOO-PG-CT202	Functional biology of chordates, Aquaculture, Histology and Histochemistry	4
ZOO-PG-CT203	Immunology, general and comparative animal physiology	4
ZOO-PG-CP204	Practical- Identification of chordates, Ecology, Immunology, Physiology and standard field sampling of fauna.	4
Total Credits		**16**
ZOO-PG-CT301	Environmental physiology, neurobiology, biotechnology and biophysics	4
ZOO-PG-CT302	Developmental biology & gamete biology, evolutionary biology, population genetics and entomology	4
ZOO-PG-CP303	Practical - Developmental biology, Biotechnology, Environmental Physiology	2
ZOO-PG-ET304	Ecology and Climate Change Biology	4
ZOO-PG-ET305	Immune system, Antigen and Antibody, B and T Cells, Hypersensitivity; General Parasitology, Vector biology	4
ZOO-PG-EP306	Practical: Ecology	2
ZOO-PG-EP307	Practical: Immunology & Parasitology	2
Total Credits		**16**
ZOO-PG-ET401	Biodiversity and Conservation Biology	4
ZOO-PG-ET402	MHC and and complement system; Protozoology; Helminthology	4
ZOO-PG-ET403	Wildlife Biology and Animal Behaviour	4
ZOO-PG-ET404	Molecular and Applied immunology; Immunoparasitology and Diagnostics	4
ZOO-PG-EP405	Practical: Biodiversity, Wildlife and Animal Behaviour	4

ZOO-PG-EP406	Practical: Immunology and Parasitology	4
ZOO-PG-DV407	Dissertation and Viva-Voce	4
Total Credits		**16**

Abbreviations:
CT - Core Theory
CP- Core Practical
OT-Open Theory
OP- Open Practical
ET-Elective Theory
EP-Elective Practical
ZT- Zoological Tour
DV- Dissertation and Viva Voce

SEMESTER I

ZOO-PG-CT101: FUNCTIONAL BIOLOGY IN NON-CHORDATES AND PARASITOLOGY

Unit I: Functional biology in non-chordates
Hydrostatic movements in Cnidaria, Annelida and Echinodermata; Significance of segmentation with reference to locomotion.
Respiratory pigments -Types and chemical nature in non-chordates and their role in respiration.
Excretion: Excretory products and mechanism of excretion in non-chordates. Osmoregulation in non-chordates.
Primitive and advance types of nervous system, cephalization and trend of neural evolution in non-chordates. Defence mechanism in Cnidaria, Insect and Mollusca.

Unit II: Insect Biology
Insect classification: major orders with characters and examples.
Trophic adaptations in insects. Reproductive strategies in insects. Insect development and metamorphosis.

Unit III: Protozoan Parasitology
Concept, types of parasites, hosts and parasitism.
Distribution, habit and habitat, structure, life cycle and diseases caused by *Plasmodium* sp. Problems and strategies in development of vaccination for malaria.
Morphology and life cycle of insect vectors involved in Leishmaniasis and Trypanosomiasis

Unit IV: Helminth Parasitology
Distribution, habit and habitat, structure and life cycle of economically important helminth parasites of man – *Echinococcus granulosus, Hymenolepis nana, Schistosoma haematobium, Trichinella spiralis*.
General characters, organization and larval forms of Platyhelminthes and Nemathelminthes
Zoonosis, host-parasite interaction; parasitic adaptations in helminthes.

Suggested Reading

1. Anderson, D.T. (2001) *Invertebrate Zoology*. Oxford University Press.
2. Bogitish, B.J., Carter, C. E. & Oeltman, T, N, (2012) Human Parasitology. Academic Press.
3. Bush, A.O., Fernandez, J.C., Esch, G.W., & Seed, J.R. (2001) Parasitism: The diversity and ecology of Animal parasite. Cambridge University Press.
4. Chapman, R.F. (2012) The Insects: Structure and Function. Cambridge University Press.
5. Chaterjee, K.D. (2009) Parasitology: Protozoology & Helminthology. CBS Publishers & Distributors Private Limited.
6. Cheng, T.C. (1986) General Parasitology. Academic Press.
7. Gullan, P.J & Crasnston, P.S. (2010) The Insects: An Outline of Entomology. Wiley Blackwell Publisher.
8. Hausmann, K. & Hulsmann, N. (1996) Protozoology. George Thieme Verlag.
9. Hyman,L.H (1992) Invertebrates Zoology -Volume I-VII. International Books & Periodicals Supply Services, Delhi.
10. Klowden, M.J. (2013) Physiological system in Insects. Academic Press.
11. Kotpal, R. L. (2012) *Modern Text Book of Zoology: Invertebrates*. Rastogi Publications, India.

ZOO-PG-CT102: BIOCHEMISTRY, CELL BIOLOGY AND GENETICS

Unit I: Biochemistry

Protein structure: Primary and secondary structure (α helix, β pleated sheets and bends); Ramachandran plot; Tertiary structure: Domains and Motifs; Quaternary structure

Enzyme kinetics: Michelis Menten Equation (MM and LB Plots); Mechanism of enzyme action; concept of enzyme activity, Ribozyme, Abzyme. Enzyme inhibition.

Bioenergetics and Metabolism: Principles, glycolysis with emphasis on control points, citric acid cycle with emphasis on regulatory steps, oxidation of fatty acids and amino acids, oxidative phosphorylation, biosynthesis of carbohydrates, fatty acids, amino acids and nucleotides. Biotransformation: cytochrome P450.

Unit II: Cell biology

Chromosomal proteins: Histones and their modifications, Scaffold Matrix protein, nucleosome organization of chromosome. Targeting and sorting of proteins- processing through endomembrane system.

Cell cycle: Phases and Cell Cycle Control, Check points and regulation. Genetic regulation of meiosis.

Cancer: Tumor types, properties of tumor cells, cancer as a genetic disease, oncogenes, stem cells.

Unit III: Transcription and Translation

Replication in Eukaryotes

Transcription in Eukaryotes: General transcription factors, capping, splicing, transcription initiation, elongation and termination.

Translation in Eukaryotes: tRNAs, tRNA synthetase, translational initiation, elongation, termination; telomerase and DNA-end replication.

Unit IV: Genetics

Gene concept: concept of cistron; Benzer's Experiment and modern view.

Recombination with special reference to site specific recombination- ser/tyr recombination and their mechanism of action.
Gene regulation: Lac Operon, Regulon, Trp Operon.
Promoter elements, enhancer/silencer concepts.

Suggested Reading

1. Barberis, A. & Petrascheck, M. (2003) Transcription activity in Eukaryotic cells. Wiley Online Library.
2. Berg, J.M., Tymoczko, J.L. & Stryer, L. (2002) Biochemistry. W.H. Freeman & Company.
3. Cooper, G.M. (2009) The Cell: A Molecular Approach. Sinauer Associates, Inc.
4. De Robertis, E.D.P. (2006) Cell & Molecular Biology. Lippincott Williams and Wilkins.
5. Franks, L.M. & Teich, N.M. (1997) Introduction to the Cellular & Mol Biology of Cancer. Oxford University Press.
6. Gardner, A. & Davies, T. (2009) Human Genetics. Scion Publishing Ltd.
7. Gardner, E.J., Simmons, M.J. & Snustad, D.P. (2000) Principles of Genetics. John Wiley & Sons.
8. Griffths, A.J.F. et al. (2010) Introduction to Genetic Analysis. W. H. Freeman Publisher.
9. Hartwell, L. et al. (2010) Genetics: From Genes to Genomes. McGraw-Hill Science/Engineering/Math.
10. Karp, G. (2009) Cell & Molecular Biology Concepts and Experiment. Willey Blackwell Publisher.
11. Klug, W.S. et al. (2011) Concept of Genetics. Benjamin Cummings Publisher.

ZOO-PG-CT103: ENDOCRINOLOGY, TOOLS AND TECHNIQUES, BIOSYSTEMATICS, BIOSTATISTICS

Unit I: Endocrinology

Vertebrate endocrine system: Concept of Neurosecretion, Neurosecretory centres, Hypothalamus, Pineal and Thymus and their hormones.
Hypophysis: Neurohyphphysis and Adenohypophysis, structure, function and hormones
Hormones: Molecular mechanism of hormone actions in detail.
Biosynthesis: steroid hormones and some protein hormones.

Unit II: Tools and Techniques of Biology

Assay: Definition, criteria of reliability.
Principles and uses of analytical instrument – spectrophotometer
Microscopy: General concept, Electron microscopy.
Separation Technique: Centrifugation, Basic principles of sedimentation, differential and density gradient centrifugation.
Chromatography: Principles of Column Chromatography – Ion Exchange Chromatography, Gas Liquid Chromatography (GLC), High Performance Liquid Chromatography (HPLC), Gel Exclusion Chromatography, Affinity Chromatography.

Unit III: Biosystematics

Biological species concept, species and supra and infra species categories
Speciation, origin of reproductive isolation, biological mechanism of genetic incompatibility
Classical and molecular taxonomy, phenetics and cladistics
Zoological nomenclature (ICZN): Principles, interpretation and application of important rules

Unit IV: Biostatistics

Definition of biostatistics, utilization in biological studies. Terminologies: variables, populations, data, samples, estimates.

Hypothesis testing, Student's "t" test distribution, Mann-Whiteny 'U' Test

Probability distribution: concept, bionomial and Poisson's distribution

Models: Types of models, statistical, empirical, mechanistic, stochastic, simulation.

Suggested Reading

1. Balinsky, B.I. (1970) An introduction to embryology, Saunders, New York.
2. Bargmann, W., Oksche, A., Polenov, A. & Scharrer, B. (1979) Neurosecretion and Neuroendocrine Activity. Springer Link.
3. Cotterill, R. (2002) Biophysics: An Introduction. Wiley & sons.
4. Darwin, C. (1858) On the origin of species by means of natural selection. London John Murray.
5. Das, N.G. (2008) Statistical Method. Vol I. Tata McGraw Hill Education Private Limited.
6. Gilbert, L. (1981). Metamorphosis: A Problem in Developmental Biology. Springer publisher.
7. Gilbert, S.F. (2000) Developmental Biology (6^{th} ed). Sinauer Associates Inc.,U.S.
8. Glaser, R. (2004) Biophysics: An introduction. Springer publisher.
9. Graham, J. (2001) Biological centrifugation. Garland Science (Taylor & Francis).
10. Hadley, M. & Levine, J.E. (2006) Endocrinology. Benjamin Cummings.
11. Hall, B. & Hallgrimsson, B. (2007). Strickberger's Evolution. Jones and Bartlett Publishers.
12. Mayr, E. (1970). Population, species & evolution. Belknap Press of Harvard University Press.

ZOO-PG-CP104: IDENTIFICATION OF NON-CHORDATES, PARASITOLOGY, BIOCHEMISTRY, GENETICS

1. Identification with reasons: *Paramecium*, *Plasmodium* (Gametocyte, Signet ring, trophozoite stage), Spicules of Porifera/*Sycon, Hydra, Obelia* (Gastrozooids), *Planaria, Dugesia, Ascaris, Wuchereria bancrofti, Hirudo, Neris, Chaetopterus, Macrobrachium, Hippa, Eupagurus, Aplysia,, Sepia, Holothuria, Ophiothrix.*

2. Mounting and dissection: Mouth parts of mosquito and housefly.

3. Isolation and study of soil nematodes

4. Estimation of sugars by Somogyi-Nelson Method, Estimation of saponification values of oils and fats, Estimation of DNA Diphyenyl-amine Reaction.

5. Study of Meoitic stages of Grasshopper / Rat testis, Barr body preparation, Study of gene frequency in ABO Blood group

6. Problems based on Biostatistics.

7. Submission of photographs of five locally available insects.

8. Lab Note Book and Viva-voce

SEMESTER II
ZOO-PG-OT201: ECOLOGY, BIOGEOGRAPHY, ANIMAL BEHAVIOUR AND BIODIVERSITY

Unit: Community Ecology and Population Dynamics

Community Ecology: Biotic community concept, ecological dominance, Ecotone and edge effects, Ecological Niche, Ecological Succession and its theories

Population ecology: Growth patterns, natality, mortality, age distribution, population regulation-extrinsic and intrinsic mechanisms, oscillation, dispersal, concept of metapopulations, Competition, Gause Exclusion Principle, r-selection, k-selection, life table and survivorship curve

Inter and intra-specific interaction, Predator-prey relationship, predator dynamics.

Unit: Habitat Ecology and Biogeography

Freshwater Ecology: Characteristics, limiting factors, nutrient status, classifications of fresh water organisms, lentic communities, lotic communities, zonation of fresh water ecosystem.

Terrestrial environment, terrestrial biota, major biomes, soil subsystem.

Biogeographical patterns: Vertical zonation of vegetation with special reference to the Himalayas, Faunal diversity patterns: comparison along altitudinal and latitudinal gradients.

Unit III: Animal Behaviour

Ethology: Definition, Basic concepts and models of classical ethology. Innate and learned behaviour: Definition, classical conditioning, instrumental learning, habituation and imprinting.

Optimal foraging theory (patch choice, diet choice, prey selectivity, foraging time), plant-animal interaction, evolution of plant pollinator relationship.

Unit IV: Biodiversity and wildlife

Definition and indices of biodiversity; Levels of biodiversity: genetic, species and ecosystem; Major threats to biodiversity of the world

Definition of wildlife, importance of wildlife and rationale for their conservation; classification of wildlife according to severity of threats

Models of wildlife management and conservation. *In Situ* and *Ex Situ* conservation: prospects and limitations. Socio-economic perspective of wildlife conservation

Brief idea about Biodiversity Law and Conventions with reference to Indian Context

Suggested Readings

ECOLOGY

1. Odum, E.P. (1971). Fundamentals of Ecology. Saunders, Philadelphia
2. Odum, E.P. (1983). Basic Ecology. Saunders, Philadelphia
3. Clarke, G.L. (1954) Elements of Ecology. John Wiley & Sons, Inc. New York.
4. Giller, P.S. (1984) Community Structure and the Niche. Chapman & Hall.
5. Saunders, D.S. (1977) An Introduction to Biological Rhythms. Blackie, Glasgow & London.
6. Bailey, J.A. (1984) Principles of Wild Life Management. John Wiley & Sons, New York
7. Smith, R.L. and T.M. Smith (2002) Ecology and Field Biology. Addison – Wesley Educational Publishers Inc.
8. Ricklefs, R.E. and G.L. Miller. (1999) Ecology W.H. Freeman & Company
9. Stiling, P. D. (2012). Ecology Companion Site: Global Insights and Investigations. McGraw Hill Education.

ANIMAL BEHAVIOUR

1. Alcock, J. (2005) Animal Behaviour: An evolutionary approach. Sinauer Assoc., Sunderland, Mass.
2. Bradbury, J, W., and S.L. Vehrencamp. (1999) Principles of animal communication. Sinauer Assoc., Sunderland, Mass, USA.
3. Eibl- Eibesfeldt, I. Ethology: (1970) The biology of behavior. Holt, Rinehart & Winston, New York
4. Drickamer, L.C., S.H. Vessey and E.M. Jakob. (2002) Animal Behavior. McGraw Hill.16.
5. Dewsbur, D.A. (1978) Comparative animal behaviour. McGraw Hill Book Company.
6. Hunting ford, F. (1984) The Study of Animal Behavior, Chapman and Hall.
7. Mc Farland, D. (1998) Animal Behavior: Psychobiology, Ethology and Evolution. Benjamin Cummings
8. Krebs, J.R. and N.B. Davies. (1984) Behavioral Ecology: An Evolutionary Approach. Blackwell Scientific Publication

BIODIVERSITY

1. M. Kato. (2000) The Biology of Biodiversity, Springer.
2. E.O. Wilson. (1988) Biodiversity, Academic Press, Washington.
3. E.O. Wilson. (1992) The Diversity of life, Cambridge:Belknap.
4. B.K. Tikadar. (1983) Threatened Animals of India, ZSI Publication, Calcutta.
5. Kothari, A.S. & Chapgar. (2005) Treasure of Indian Wildlife, BNHS, Mumbai.
6. B. B. Hosetti. (2005) Concepts in Wildlife Management. 2nd Revised & Enlarged Edn, 2005. Daya Publishing House, Delhi.
7. Anne E., Magurran. (2004) Measuring Biological Diversity. Blackwell Publishing.

ZOO-PG-CT202: FUNCTIONAL BIOLOGY OF CHORDATES, AQUACULTURE, HISTOLOGY AND HISTOCHEMISTRY

Unit I: Functional Biology of Chordates

Respiration in amphibians. Skull in reptiles, temporal region of reptiles and evolutionary significance, venom and antivenom in ophidian.

Aerodynamics of flight. Aquatic adaptations in birds and mammals. Placenta in Mammals, Stomach in ruminants.

Evolution of cerebrum, functional association of Central Nervous System (CNS), Information processing. Jaw suspension and its evolutionary significance. Auditory system and its evolutionary changes.

Unit II: Aquaculture

Definition, scope and importance of aquaculture. Monoculture, polyculture/composite fish farming and integrated fish farming, Induced breeding in fishes, Hybridisation in fishes, androgenesis, gynogenesis, polyploidy, cold water fishery, fish spoilage.

Fish Diseases Management: Fungal, Viral, bacterial, protozoan, crustacean etc.

Unit III: Histology

Fixation and Fixatives: Types of fixatives, Chemistry of fixation, Choice of Fixatives

Tissue processing: Dehydration, Clearing and Embedding

Microtomy: Types of microtomes, Sectioning of Paraffin blocks

Staining of paraffin sections: Principle and methods of staining.

Histological stains: Haematoxylin and Eosin

Unit IV: Histochemistry

Principles and methods of histochemical localization and identification of the following - Carbohydrate moieties: Glycogen and glycoproteins with oxidizable vicinal diols by Periodic acid Schiff method, Glycoproteins with carboxyl groups and/or O-sulphate esters by Alcian blue methods

Protein end groups: General proteins by Bromophenol blue method, $-NH_2$ groups by Nihydrin-Schiff method, - SS groups by Performic acid –Schiff and performic acid- alcian blue methods

Lipid moieties: General lipids by Sudan black B method

Suggested Reading

CHORDATES

1. Parker & Haswell (revised by A.J. Marshall) (1972) A Test Book of Zoology, Vol - II, 7th Ed. Macmillan, London.
2. J.Z. Young (1982) The Life of Vertebrates, , 3rd End. Oxford Univ. Press, Oxford.
3. M. Hildebrand (1974) Analysis of Vertebrates Structure. John Wiley & Sons., New York.
4. Walter & Sayles (1965) Biology of Vertebrates. Macmillan, New York.
5. C.K. Weather (1951) Anatomy of the Chordates. McGraw-Hill, New York.
6. Pugh, Heifer & McFarland (1999) Vertebrate life. 4th End. Prentice-Hall of India, New Delhi.
7. R.F. Schmidt & Thaws (1989) Human Physiology, (Eds.), 2nd End. Springer-Vela, Berlin.
8. K. Kardong (2011) Vertebrates: Comparative Anatomy, Functions, Evolution (6th Ed.). McGraw-Hill Science.
9. A. Thangamani et al (2013) A text book ofchordates. Saras Publication
10. Wells, K.D. (2007) Ecology and Behaviour of Amphibians. The University of Chicago Press.

AQUACULTURE

1. Bone, Q., N.B. Marshall and J.H.S. Blaxter. Biology of Fishes. Chapman & Hall, London.
2. Das, M.K. and R.K. Das. Fish and Prawn diseases in India – Diagnosis and Control. Inland Fisheries Society of India, Barrackpore, West Bengal.
3. Govindan, T.K. Fish Processing Technology. Oxford & IBH Publishing Co. Pvt. Ltd., Kolkata.
4. Gupta, S.K. & P.C. Gupta. General and Applied Ichthylogy (Fish & Fisheries). S. Chand & Co. Ltd., New Delhi.
5. Jhingran, V.G.: Fish & Fisheries of India. Hindustan Publishing Corporation, Delhi.
6. Pillay, T.V.R. Aquaculture; Principles & Practices. Fishing News Books, Oxford.
7. Santhanam, R., N. Sukumaran, & P. Natarajan. A Manual on Freshwater Aquaculture. Oxford IBH Publishing Co. Ltd, Kolkata.
8. Rath, R.K. Freshwater Aquaculture. Scientific Publishers, Jodhpur.

HISTOLOGY AND HISTOCHEMISTRY

1. John Kiernan (2008) Histological and Histochemical Methods: Theory and Practice, 4th edition, Cold Spring Harbor Laboratory Press.
2. Bancroft, J.D. and Gamble, M (2007) Theory and Practice of Histological Techniques, 6th Edition, Churchill Livingstone.
3. Ross, M.H,, Kaye, G.I. & Pawlina, W. (2002) Histology: A text and atlas (4th ed). Lippincoat Williams & Wilkins.

4. Luiz Carlos (2005) Basic Histology: Text and Atlas (11th Ed). Mc Graw Hill Medical
5. Kerr, J. (2013) Functional Histology, Elsevier
6. Kiernan, J.A. (2008) Histological & Histochemical methods: Theory & Practice (4th Ed). Cold Spring Harbor Laboratory Press.

ZOO-PG-CT203: IMMUNOLOGY, GENERAL AND COMPARATIVE ANIMAL PHYSIOLOGY

Unit I: General Immunology

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

Genetic basis of antibody diversity, Immunoglobulin structure – biological and physical properties of immunoglobulin, Concept of Antigen

Cytotoxicity, Complement, Cytokines, Interferons, Immunization

Unit II: Immuno Histocompatibility and Immune Disorder

Major Histocompatibility Complex: Complex of mouse and human

Antigen processing and presentation. Concept of tolerance and autoimmunity, Hypersensitivity. Immune disorders, HIV

Unit III: Physiology I

Respiratory pigments through different phylogenic groups. Physiological adaptations at high altitude.

Transport of oxygen and carbon dioxide in blood and body fluids, Physiological response to oxygen deficient stress, Physiological response to body exercise, Meditation, yoga and their effects. Diving physiology of birds and mammals.

Circulation: Blood, heart function, haemodynamics.

Unit IV: Physiology II

Patterns of nitrogen excretion in different animal groups

Physiology of digestion in mammals

Concept of homeostasis: Thermoregulation in homeotherms, poikilotherms, hibernation and aestivation.

Physiology of pregnancy, placental hormones, pregnancy diagnostic tests, amniocentesis, parturition and breast and lactation.

Physiology of impulse transmission through nerves and synapses

Autonomic nervous system, neurotransmitters and their physiological functions

Suggested Reading

IMMUNOLOGY

1. Abbas, A.K. (2011). Cellular and Molecular Immunology (7th Ed). Saunders.
2. Chakravarty, A.K. (2003) Immunology. 2nd Ed. National Library.
3. Chakravarty, A.K.Immnology & Immunotechnology. (2006) Oxford University Press.
4. Glodsby, R. A. et al. (2003) Immunology (5th Ed) W.H. Freeman & Company, New York
5. Humphrey J.H. & White R.G. (1963) Immunology for students of medicine. F. A. Davis Company
6. Benjamini, E. et. al. (2000). Immunology: a short course. John Wiley and Sons, Inc
7. Coico, R and Sunshine, G. (2008) Immunology: A short course (6th Ed) Wiley-Blackwell
8. Kindt, T.J et. al. (2006) Kuby: Immunology 6 Th Ed. W.H. Freeman & Company

9. Roitt. I. (2001) Immunology Mosby Publ. London
10. William E.P. (2012) Fundamental Immunology (7th Ed). Lippincott Williams & Wilkins Publisher.

PHYSIOLOGY

1. Hughes, G. M. Comparative Physiology of Vertebrate Respiration (1963) Cambridge, Mass., Harvard University Press.
2. Barrett, K.E. et al (2012). Ganong: Review of Medical Physiology (24th Ed.), McGraw-Hill Medical.
3. Guyton and Hall (2001) Text Book of Medical Physiology (10th Ed.), W.B. Saunders.
4. Keel et al (1989). Samson Wright's Applied Physiology (13th Ed.), Oxford Press.
5. Murray et al (2003) Harper's Illustrated Biochemistry (26th ed), Appleton and Lange.
6. West, J B (Ed) (1985): Best and Taylor's Physiological Basis of Medical Practice (11th Ed), Williams and Wilkins.
7. Webster, R. (2001) Neurotransmitters, Drugs and Brain Function (Ist Ed). Wiley.
8. Hill, R. W., Wyse, G. A. and Anderson, M. (2012). Animal Physiology, 3rd Edition, Sinauer Associates Inc.
9. Schmidt-Nielsen, K. (2002). Animal Physiology: Adaptation and Environment. Cambridge University Press.

ZOO-PG-CP204: PRACTICAL
IDENTIFICATION OF CHORDATES, ECOLOGY, PHYSIOLOGY, IMMUNOLOGY AND STANDARD FIELD SAMPLING OF FAUNA

1. Identification with characters: *Doliolum, Myxine, Anabas, Hetrepneusts, Clarias, Schizothorax, Philautus, Paa, Gecko, Japalura, Trimeresurus, Ptyas, Dicrurus, Megalaima, Cissa, Myophonus, Dremomys, Selenarctos, Ailurus.*

2. Sampling of any two major faunal groups using standard methodology

3. Soil analysis – Estimation of percentage of calcium carbonate by rapid titration method; Estimation of Organic-carbon by wet oxidation method.

OR

Preparation/Identification of histological slides

4. Immunology - Collection of plasma and serum, study of lymphoid organ *in situ*, preparation of lymphocytes suspension from lymphoid tissue, viability test

5. Physiology: RBC count, WBC count (total and differential count) and estimation of haemoglobin in human blood, determination of O2 consumption, CO2 libration and respiratory quotient of cockroach.

6. Ecological Excursion and field reports

7. Lab Note Book and Viva-voce

SEMESTER III

ZOO-PG-CT301: ENVIRONMENTAL PHYSIOLOGY, NEUROBIOLOGY, BIOTECHNOLOGY AND BIOPHYSICS

Unit I: Environmental Physiology

Adaptation: The nature and levels of adaptation, Fundamental mechanisms of adaptation
Stress Physiology: Basic concept of stress and strain, stress avoidance, stress tolerance, etc.
Excretion: Excretory organs, glomerular filtration rate, tubular absorbtion and secretion.
Osmoregulation: Control of osmoregulation via ADH; Osmorgulation in aquatic and terrestrial animals.
Thermoregulation: Concept of Temperature Coefficient (Q_{10}); Adaptations to cold and heat by aquatic & terrestrial animals; Adaptive Hypothermia and Adaptive Hyperthermia; Thermal Neutral Zone; Thermogenesis, Evaporative cooling.

Unit II: Neurobiology

Organization of Nervous System: Origin and Differentiation of neurons.
Electrical potentials of Neurilemma and their molecular basis.
Brain motor mechanism: Sensory motor integration. Nature of somatic motor actions in reference to muscles. Organization and functions of autonomic nervous system.
Hypothalamus.
Neuro-endocrine integration: Components, orders and feedback regulation
Neural basis of learning and memory.

Unit III: Biotechnology

Genomic and cDNA libraries: constructions and screening. Expression of Vectors and expression of fusion proteins. Transgenic Animals: production, prospects, advantages and disadvantages. Site directed mutagenesis: strategies and prospects.
Applications of recombinant DNA technology in human gene therapy, vaccine development, environmental bioremediation and protein engineering.
Microbial synthesis of commercial products: restriction endonucleases, antibiotics and vitamins.

Unit IV: Biophysics

Principles and uses of analytical instruments: Spectrofluorometer, Mass Spectrometry. Electrophoresis: Basic principles, Polyacrylamide gel electrophoresis, Agarose gel electrophoresis, 2-D gel electrophoresis. Crystallography and X-ray diffraction, Basic idea of Nuclear Magnetic Resonance (NMR) Spectroscopy.
Radioisotope techniques: Radioactivity and half life, radioisotopes, units of radioactivity, G-M counter, solid and liquid scintillation counter, Applications of radioisotopes.

Suggested Readings:

Environmental Physiology

1. Eckert, R. Animal Physiology: Mechanisms and Adaptations. W.H. Freeman and Company, New York.
2. G.K. Pal and P. Pal: Test book of Practical Physiology. Publisher: Orient Longman.
3. Schmidt-Nielsen, K. (2002). Animal Physiology: Adaptation and Environment. Cambridge University Press.
4. Prosser, C. L. (1991). Comparative Animal Physiology. W. B. Saunders & Company.
5. Wilmer, P.G. Stone, and I. Johnston. Environmental Physiology. Blackwell Sci. Oxford, UK.
6.

Neurobiology

1. Shepherd, G.M. 1994 Neurobiology, 3rd Edn.,. Oxford Univ. Press.
2. Delcomyn, F.1998 Foundations of Neurobiology, W.H. Freeman & Co., New York.
3. Brown, A.G 1991.Nerve Cells and Nervous Systems:An Introduction to Neuroscience, Springer-Verlag (Narosa Publishing House, New Delhi, 1992 Springer International Student Edn.).

Biotechnology

1. Helen Kreuzer & AdrianneMassey Biology and Biotechnology: Science, Applications and Issues.. ASM Press, Washington DC. 2005
2. Handbook of Molecular and Cellular Methods in Biology and Medicine. Second Edition, 2004. Edited by Leland J. Cseke, Peter B. Kaufman, Gopi K. Podila, Chung-Jui Tsai. CRC Press, Boca Raton, London, New York, Washington DC.
3. Joseph Sambrook & David W. Russell Molecular Cloning : A Laboratory Manual. Third Edition, 2001. Volumes I, II & III.. Cold Spring Harbor Laboratory Press, New York.
4. PCR Protocols : A Guide to Methods and Applications. Edited by Michael A. Innis, David H. Gelfand, John J. Sninsky, Thomas J. White. Academic Press, Inc. 1990.
5. Principles of Gene Manipulation and Genomics. Seventh Edition, 2006. S. B. Primrose & R. M. Twyman. Blackwell Publishing
6. Molecular Biology of the Cell. 4th Edition, 2002. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts & Peter Walter. Garland Science, Taylor Francis Group.
7. Analysis of Genes and Genomics. Richard J. Reece. John Wiley & Sons Ltd. (2004)
8. From Genes to Clones : Introduction to Gene Technology. Ernst-L. Winnacker Panima Publishing Corporation, New Delhi/Bangalore.
9. Molecular Biotechnology. Third Edition, 2002. Glick & Pasternak. ASM Press.
10. Concepts in Biotechnology. Edited by D. Balasubramanian, K. Dharmalingam, C. F. A. Bryce, J. Green & K. Jayaraman. Unversity Press.

Biophysics

1. Wilson & Waker, Practical Biochemistry, 5th ed., Cambridge University Press.
2. P. Narayanan, Essentials of Biophysics, New Age International Publishers
3. R. Boyer, Modern Experimental Biochemistry, 3rd Ed., Pearson Education
4. Plummer, L. Practical Biochemistry, Tata McGraw-Hill.

ZOO-PG-CT302: DEVELOPMENTAL BIOLOGY & GAMETE BIOLOGY, EVOLUTIONARY BIOLOGY, POPULATION GENETICS AND ENTOMOLOGY

Unit I: Developmental biology and gamete biology

Genomic equivalence and differential gene expression: Proto-differentiation, Rutter and Wessel's experiment, Briggs and King's experiment, Gurdon's experiment.

Cell association, concept of morphogenesis. *In vitro* fertilization and embryo transfer technology. Stem cells and their use, Bioethics. Metamorphosis, regeneration and aging.

Cell – cell communication in development.

Unit II: Evolutionary biology

Genome Evolution: Evolution of Multigene Family, Acquisition of new genes- Mechanisms and Exon Theory.

Concerted Evolution and Molecular Drive.

Emergence of Non-Darwinism: Neutral Hypothesis.

Macro evolution: Concept, Phylogenetic gradualism, punctuated equilibrium, Major trends in the origin of higher categories. Origin and Evolution of man.

Unit III: Population genetics

Destabilizing forces influencing allele frequencies: Mutation and Estimation of mutation rates; Natural Selection: Gametic Selection, Selection against recessive and recessive lethal, Selection against dominant, Heterozyote advantage; Migration; Mutation-Selection Balance.
Genetic structure of population: Optimum phenotype, Selection pressure, Fisher's Theorem of Natural Selection, Canalization, Genetic Homeostasis, Genetic load and Genetic death.
Inbreeding: Measure of inbreeding, inbreeding depression, heterosis.
Quantitative traits: Polygenic concept, Genotype- environment interaction, phenotypic variance, Heritability and its estimation, Quantitative trait loci

Unit IV: Entomology

Concept of pest status and classification of Pesticides.
Conventional and Non-conventional methods of pest control, integrated pest management.
Introduction to major vectors, pests of medical and agricultural importance from India.
Insect hormones: Sources, biosynthesis, transport, mode of action and regulation of their titers.
Intra-specific and inter-specific chemical and mechanical communications in insects.
Insect based drugs, dyes, food and aesthetics.

Suggested Readings:

Developmental biology and gamete biology

1. Balinsky: Introduction to Embryology (CBS College Publishers)
2. Berril, NJ: Developmental Biology (Tata-McGraw Hill)
3. Grant: Biology of Developmental System
4. Austin, C.R. and Short, R.V. Reproduction in animals
5. Schatten and Schatten. Molecular Biology of Fertilization
6. R.G. Edwards. Human Reproduction
7. S.F. Gilbert: Developmental Biology
8. L. Harvey, D. Baltimore, B. Arnold, S.L. Zippers, P. Matsudaira and J. Darnell: Mollecular Cell Biology

Evolutionary biology and Population genetics

1. Coyne, J.A. & Orr, H.A., Speciation, Sinauer Associates Inc.,2004
2. Elseth, B.D. and K.M. Baumgartner. Population biology. Van Nostrand Co. Yew York.
3. Futuyama, D.J. Evolutionary Biology, Sinauer Associates INC Publishers, Dunderland.
4. Futuyma, DJ, Evolution, Sinauer Associates,Inc,2005
5. Graur, D. & Li,W-H., Fundamentals of Molecular Evolution, 2nd Ed., Sinauer Associates
6. Hartl, D.L. Principles of Population Genetics. Sinauer Associates, Inc., Massachusetts.
7. Hedrick, P.W., Genetics of Populations, 3rd Ed., Jones & Bartlett Publishers
8. Jha, A.P. Genes and Evolution. John Publication, New Delhi.
9. Lewin, R., Human Eolution, 5th Ed., Blackwell Publishing Ltd.
10. Merrel, D.J. Evolution and Genetics. Holt, Rinehart and Winston, Inc.

Entomology

1. Ananthakrishnan, T.N. 1996 Biotechnological perspectives in Chemical ecology of Insects (Edited Book) Oxford & IBH.

2. Atwal 1976 Agricultural pests of India and South-East Asia Kalyani Publishers.
3. Atwal, A.S. & Singh Balraj 1989 pest population and assessment of crop loss. Publication & Information division, Indian Council of Agricultural Research
4. Gullan, P.J. and Cranston, P.S. 1994 The Insects, An outline of Entomology, Chapman & Hall.
5. G.A. Kerkut & L.I. Gilbert.Comprehensive Insect Physiology, Biochemistry and Pharmacology, Vols. 1-12. Ed. Pergamon Press, Oxford (1985).
6. Gavin C. Essential Entomology – An order by order introduction
7. Howell. V. et al. Introduction to Insect biology and diversity
8. Hill, D.S. 1987 Agricultural Insect pests of the tropics and their control Cambridge University Press, Cambridge (Rept. Edn.)
9. Persley, G.J. 1996 Biotechnology and Integrated pest management, CAB International.
10. R.F. Chapman. The Insects: Structure and Function. 4th Edn. Cambridge Univ. Press (2000).

ZOO-PG-CP303: PRACTICAL
DEVELOPMENTAL BIOLOGY, BIOTECHNOLOGY, ENVIRONMENTAL PHYSIOLOGY

1. Electrophoresis for separation of plasma proteins

2. Developing organs of chick in histological sections.

3. Identification of regeneration stages in histological preparation (hydra/limb of amphibian).

4. Surgical techniques such as adrenalectomy, thyroidectomy, castration, etc. to be done on rats or mice.

5. Study of the changes of blood glucose level in a vertebrate species.

6. Estimation of ascorbic acid in an unknown solution.

7. Estimation of Amino-N by Sorenson's Formol Titration method.

8. Laboratory Note Book and Viva Voce

ZOO-PG-ET304: ECOLOGY AND CLIMATE CHANGE BIOLOGY

Unit I: Ecological Niche; Radiation Ecology

Habitat and microhabitat, Development of Niche concept, Niche width, Niche overlap, Diffuse competition, Niche dynamics, Concept of Ecological Niche Modelling, Ecological equivalents, Character displacement: Sympatry and Allopatry.

Types of ionizing radiations, Radionuclides of ecological importance, Fate of radionuclides in the environment, Fallout problems, Waste disposal. Biodegradation and Bioremediation concept.

Unit II: Systems ecology and tools

Energy in ecological systems; Biogeochemical cycles: Concept, carbon, nitrogen, sulphur, phosphorus and oxygen cycle.
Measuring ecosystem productivity, patterns in primary production, efficiency of primary and secondary production in aquatic system.
Role of Geographical Information System (GIS) and remote sensing in ecology.

Unit III: Climate Change: Causes and Initiatives
Greenhouse gases and green house effect, ozone layer depletion.
Global warming, global patterns of temperature and precipitation, Carbon sequestration, Carbon trading, Carbon foot print, Concept of REDD (reducing emission through destruction and deforestation) and $REDD^{+}$.
Introduction to Intergovernmental Panel on Climate Change (IPCC) and their reports.
Vulnerability assessment, Resilience and Adaptation of species.
El niño, La niña, southern oscillation and their ecological impact.

Unit III: Impact of Climate Change
Impact on the physical environment: glacial melt including glacial retreat in the Himalayas, sea level rise, glacial lake outburst flood (GLOF), landslides, drought, changes in rainfall patterns, snow fall events, coral reef bleaching, etc.
Impact on the faunal characteristics: species range shift, species migration, species extinction, changes in phenology and altered breeding pattern of animals (herpetofauna, birds and mammals), changes in insect emergence pattern and effect on food chain, Infestations of diseases and crop pests.

ZOO-PG-ET-305: IMMUNE SYSTEM, ANTIGEN AND ANTIBODY, B AND T CELLS, HYPERSENSITIVITY, GENERAL PARASITOLOGY, VECTOR BIOLOGY

Unit I: Immune System
History of immunology. Overview of the immune system: components of the immune system. Innate and adaptive immune system. Barriers of immune system. Cells of immune system: Macrophage, Natural Killer Cells, T and B Lymphocytes. Organs of immune system: Bursa fabricius, Thymus, Lymph node, Spleen; hematopoiesis, primary and secondary lymphoid organs.

Unit II: Antigen and antibody, B and T cells, Hypersensitivity and Inflammation
Antigen: Physical and chemical nature, structure, antigenic determinants. Antibody: Three dimensional structure, subclasses, binding forces of antigen and antibody. Isotype, allotype, idiotype. Hypersensitivity reactions: mechanisms, types, prevalence, factors. Inflammation: Chemical mediators of inflammation, Chemotaxis during inflammation.

Unit III: General Parasitology
Basic concept of Parasitism, symbiosis, phoresis, commensalisms, mutualism, parasitoids. Evolution of parasitism. Types of Parasites and hosts. Parasitic transmission. Molecular, cellular and physiological basis of host-parasite interactions. Alteration of host behaviour by parasites. Zoonosis with reference to filariasis and schistosomiasis.

Unit IV: Vector Biology
Vectors and its importance in transmission of parasites. Vector biology: special reference to rats, ticks and mites. Major malaria vectors of India: distribution, bioecology, potentiality and present sustainability status, form and function. Symbiotic association of microbes with vectors. Role of microbes as controlling agents of vectors.

ZOO-PG-EP306: PRACTICAL- ECOLOGY AND BIODIVERSITY

1. Water Analysis: Estimation of total hardness, salinity, chloride, calcium, magnesium, phosphate.
2. Estimation of Primary productivity of water bodies.
3. Soil Analysis: Estimation of phosphorus, zinc and magnesium.
4. Study of the traditional knowledge of biodiversity conservation of any local communities.
5. Study of bacterial succession in Milk.
6. Identification of Limnological Apparatus: Secci Disk, Jacksons Candle Turbidometer, Ekmanns Dredger.
7. Comment on animal association/interaction: Commensalism, parasitism, mutualism, predation, protocooperation.
8. Seminar.
9. Laboratory Note Book and Viva Voce.

ZOO-PG-EP307: PRACTICAL- IMMUNOLOGY AND PARASITOLOGY

1. Cell counting and cell viability-Cytotoxicity Analysis
2. Raising of antibody.
3. Agglutination test for antigen and antibody
4. Immunological diagnosis of pregnancy (ELISA method).
5. Antigen antibody reaction- immunodiffusion –Ouchterlony plate test.
6. Standardization of Microscope; Drawings of protozoan to scale: measurements of protozoan specimen.
7. Fixation, staining and identification (with reasons) of parasite of annelid.
8. Smear preparation and staining and identification (with reasons) of parasites from faecal content of cattles.
9. Smear preparation and staining and identification (with reasons) of gut parasites of fishes/locally available insects.
10. Preparation and staining and identification (with reasons) of blood parasite from pigeon.

11. **Identification**:

a) Identification of lymphoid organs.
b) Identification of histological slides of lymphoid tissue; spleen, thymus, lymph node.
c) *Plasmodium* sp., *Leishmania* sp., *Ascaris* sp., *Fasciola sp., Anopheles sp,.Culex sp., Cimex sp.*, microfilaria.

14. Seminar.
15. Laboratory Note Book and Viva Voce.

SEMESTER IV
ZOO-PG-ET401: BIODIVERSITY AND CONSERVATION BIOLOGY

Unit I: Biodiversity: concepts, components, process and patterns

Conceptual framework of Biodiversity. Patterns and process of local and regional biodiversity: Niche assembly theories, unified Neutral theory, Island biogeography model. Global Hotspots of biodiversity. Values of biodiversity. Biodiversity with reference to

Eastern Himalayas. Restricted range species and endemism, threatened species (IUCN categories), Key stone species, Flagship species, Indicator species, Surrogate Species.

Unit II: Threats to biodiversity
Biodiversity losses: past and present, Natural and Human induced threats and vulnerability of species to extinctions. Mass extinction, zero extinction, Extinction vortex. Problem of Genetic diversity loss over time: Bottlenecks, Genetic drifts, Inbreeding depression.

Unit III: Conservation of Biodiversity
Identification and prioritization of ecologically sensitive area (ESA). Coarse filter and fine filter approaches of biodiversity conservation. Population viability analysis-conceptual foundation, uses of PVA models. Brief idea of Conservation genetics.
Minimum viable populations and recovery strategies for threatened species.
Traditional knowledge and biodiversity conservation. NGO movement in conservation with focus in India and Sikkim state.

Unit IV: Legal framework of biodiversity conservation
Introduction to laws and policies for biodiversity conservation: Convention on Biological Diversity, Kyoto protocol, Nagoya Protocol, Ramsar Convention on conservation of wetlands, Forest Conservation Act of India (1927), Environment Protection Act of India (1986), Indian Biodiversity law and rules, Sikkim State Biodiversity rules.
Organisations involved in biodiversity conservation: World conservation Union, National Biodiversity Authority, State Biodiversity Boards, Biodiversity Management Committees and Peoples Biodiversity Register.

ZOO-PG-ET402: MHC, CYTOKINE AND COMPLEMENT SYSTEM; PROTOZOOLOGY; HELMINTHOLOGY

Unit I: Major Histocompatibility Complex (MHC)
MHC: Genetic organization, classical and non classical MHC genes. Molecular organization of MHC molecule. Polymorphism of MHC. Antigen presentation and MHC restriction. HLA and disease association. HLA (Human Leukocyte Antigen) typing: microlymphocytotoxicity assay, molecular HLA typing. HLA-G and reproductive immunology, Killer Immunoglobulin like Receptors (KIR)

Unit II: Cytokine and complement system
Cytokines - properties of cytokines, cytokine receptors, cytokine secretion by TH1 and TH2 subsets, cytokine-related diseases, therapeutic uses of cytokines and their receptors. Cell mediated cytotoxic responses: effector mechanisms, leukocyte activation and migration. Complement system: classical, alternative and lectin pathways, regulation of complement system, biological consequences of complement activation.

Unit III: Protozoology
Origin and evolution of parasitic protozoa, Plasmodium: life-cycle, mode of infection, molecular biology, immunopathology, treatment (drug targets, mechanism of drug resistance). *Leishmania*: life-cycle, mode of infection, molecular biology, immunopathology, drug targets, drug resistance and vaccine strategies. *Trypanosoma* (African Trypanosomiasis): mode of infection, molecular biology, evasion of host immune system, treatment.

Unit IV: Helminthology
Origin and evolution of parasitic helminthes. Classification of helminthes. Larval form of

Helminthes. Ultra structure of important helminthes cuticle. Structure of scolex in cestodes. Life cycle, mode of transmission, infection, pathogenesis, immunopathology, clinical features, treatment and control of *Wuchereria, Schistosoma, Echinoicoccus.*

ZOO-PG-ET403: WILDLIFE BIOLOGY AND ANIMAL BEHAVIOUR

Unit I: Wildlife and their management

Wildlife wealth of India and threatened wildlife, threats to survival of Red Panda, Musk deer, Great Indian Bustard, Olive Ridley turtle.

Wildlife census technique - objectives, direct and indirect methods with reference to herpetofauna, birds and mammals.

Population management – Project Tiger, Elephant and Snow Leopard.

Values of Wildlife, Principles of wildlife management, cloning and wildlife management.

Unit II: Wildlife conservation, wildlife trade and legislation

Wildlife conservation approaches and limitations. Management of rare and endangered species. Control and management of over abundant wildlife populations.

Ecological monitoring of animal species and restoration programmes. Captive breeding of wild animals: management, prospects and problems; case studies of Red panda and Snow leopard. Human animal conflict.

Assessment, documentation, and Prevention of wildlife trade. Concept of Wildlife forensics.

Wild life laws and ethics: Wildlife Protection Act of India and its schedules. Endangered Fauna of India- Mammals, Birds and reptiles. Introduction to organizations: The world Conservation Union (IUCN), World wildlife fund (WWF), Indian Board for Wildlife (IBWL).

Unit III: Animal Behaviour - Hypothesis, aggression, altruism and behavioral genetics

Principles and mechanisms of animal behaviour: Four propositions of Tinbergen.

Conflict: Male-male competition. Sexual selection: contribution of Darwin, the Healthy Male theory, the Good Gene theory. Elaborate ornaments: Fisher's hypothesis (runaway selection) and Handicap hypothesis of Zahavi.

Aggressive behaviour: Dominance aggression, sexual aggression, parental disciplinary aggression, weaning aggression, antipredatory, aggression.

Survival value of behavior: Experimental studies, Darwinian and inclusive fitness.

Altruism: Kin-selection, reciprocal altruism, parental care, cooperation.

Behavioral genetics: Single gene effect, multiple gene effect, quantitative genetics, genetic techniques.

Unit IV: Animal Behaviour- communications, mating and social systems, and human behaviour

Communications and signaling. Territoriality, home range and courtship display. Scent markings and competition for resources.

Mating systems: Monogamy, polyandry and polygyny.

Social systems of mammals – Primates. Contemporary theories in insect socio-biology.

Human behavior: Adaptionist approach, genetic difference and human behavior, IQ differences.

ZOO-PG-ET404: MOLECULAR AND APPLIED IMMUNOLOGY; IMMUNOPARASITOLOGY AND DIAGNOSTICS

Unit I: Cellular and Molecular Immunology

Toll-like receptors. Tumor immunology. Tolerance. Autoimmunity. Neuro-Immunology: Glial cells, Hypothalamic-Pituitary-Adreno cortical Axis (HPA) immune system interaction. Vaccines: types of vaccines, advantages and disadvantages. Immunodeficiency diseases: combined immunodeficiency, acquired immunodeficiency syndrome (AIDS).

Unit II: Applied Immunology
Techniques and technologies for quantitation of immunologically relevant molecules, substances and the cells and their uses for diagnostic purposes. Agglutination reaction, Precipitation reaction, immunodiffusion, immunoelectrophoresis, Radioimmunoassay, Enzyme linked immunosorbent assay (ELISA), Florocent antibody cell sorter (FACS), Polymerase chain reaction (PCR). Hybridoma technology, monoclonal antibody and usage.

Unit III: Immunoparasitology
Immunity to helminth pattern. General consideration and immunopathology of filarial infections. Evasion of host immune system by *Plasmodium*. Vaccine development against *Plasmodium*, Electron transport in parasitic heliminth. Immune response and self-defense mechanisms, immune evasion and biochemical adaptations of parasites. Immunity in human trypanosomiasis. Physiology, immunopathology of *Plasmodium*, immunity of *Plasmodium*. Immunopathology of helminthic disease with reference to schistosomiasis.

Unit IV: Diagnostic parasitology/Molecular Parasitology
Molecular techniques in parasitology: Isolation of DNA and RNA, Hybridisation, ELISA, Blotting techniques, DNA sequencing, Amplification of DNA by polymerase chain reaction. Molecular probes and diagnosis of parasitic infection. Repetitive DNA sequence and diagnosis of parasites.

ZOO-PG-EP405: PRACTICAL
BIODIVERSITY, WILDLIFE AND ANIMAL BEHAVIOUR

1. Ecological sampling and census techniques of select faunal groups.
2. Data analysis using statistical softwares such as SPSS, EstimateS, Etc.
3. Calculation of species richness, diversity, equitability, similarity and generation of species accumulation curves based on study of any animal community.
4. Preparation of GIS Maps using Q-GIS/Map Info/Arc GIS.
5. Field study of behavior of any one species of mammal/birds.
6. Foraging behaviour in ants - Orientation and cues.
7. General behaviour, Aggressive behaviour and Predatory behaviour in fish.
8. Behavioral comments: a) Imprinting in Greylag Goose, b) Flank marking by golden Hamster, c) Mobbing behaviour of colonial ground squirrel, d) Cooperation among Scrub Jay relatives, e) Alarm call of Belding's Ground Squirrel, f) Sibling aggression in Great Egret, g) Parental care in male stickleback, h) Resource defense polygyny in African Chiclid fish, i) Female defense polygyny in marine amphipod, j) Resource defense polyandry in Spotted Sandpper, k) Polyandry without polygyny in Red Phalarope, l) Egg shell removing behaviour in Black-headed Gull
9. Laboratory Notebook and Viva voce

ZOO-PG-EP406: PRACTICAL
IMMUNOLOGY AND PARASITOLOGY

1. Differentiation of primary and secondary antibody response in haemagglutination test by using mercaptoethanol.

2. Precipitation and quantitation of immunoglobulins from the immunized rabbit/mouse serum by ammonium sulphate preparation.
3. Characterization of purified immunoglobulin preparation by SDS-PAGE.
4. Preparation of cell suspension from lymphoid organs and solid tumours: staining and identification of cell types.
5. Separation of cells in Hypaque Ficoll gradient and count of percentage of blasts.
6. Raising of antiserum (ALS) and test of specificity of the serum in lysis of target; Immunodiffusion and Immunoelectrophoresis.
7. Plaque forming cell (PFC) Assay and Rosette forming cell (RFC) assay
8. Test for cell mediated immune response: Measurement of Arthur's rxn/CML/GVH/MI Response.
9. Peritoneal Lavage / Macrophage Activity
10. FITC conjugation of antibody
11. HLA Typing demonstration
13. Preparation of stains: Haematoxylin, Acetocarmine, Borax caramine and Bouins fluid.
14. Collection, fixation, mounting of different helminth parasites from vertebrate (Nematode, Trematode and Cestode).
15. Studying the infection of tomato plant by root knot nematode.
16. Histochemical demonstration of alkaline phosphatase activity in tissues of parasitic helminthes.
17. Identification: Spot and with reasons of permanent mounts of Trematodes and cestodes viz. *Polystoma, Gyrodactylus,Paramphistomum, Fasciola hepatica, Gastrothylax, Fasciolopsis buski Schistosoma Japonicum, Schistosoma mansoni, Clonorchis sinensis, Paragonimus westermani, Taenia solium* and *Taenia saginata, Moniezia expansa, Railletina, Cotugnia, Echinococcus Granulosus, Diphyllobothrium latum,Dipylidium caninum,Hymenoplepis nana, Dipylidium Caninum, Gyrocotyle*
18. Submission of Prepared Slides.
19. Laboratory Notebook and Viva Voce.

Suggested readings

Ecology, Climate Change Biology, Wildlife Biology, Animal Behaviour and Biodiversity

1. Odum, E.P. Fundamentals of Ecology. W.B. Saunders Co. Philadelphia.
2. Clarke, G.L. Elements of Ecology. John Wiley & Sons, Inc. New York.
3. Giller, P.S. Community Structure and the Niche. Chapman & Hall.
4. Mc Naughton, S.J. & L.L. Wolf. General Ecology. Holt, Rinehartx, Winston New York.
5. Saunders, D.S. An Introduction to Biological Rhythms. Blackie, Glasgow & London.
6. Miller, R.W. & R. L. Donahue. Soils in our environment. Prentice Hall India Pvt. Ltd., New Delhi.
7. Bailey, J.A. Principles of Wild Life Management. John Wiley & Sons, New York.
8. Smith, R.L. Ecology and Field Biology. Addison – Wesley Educational Publishers. Inc.
9. Ricklefs, R.E. and G.L. Miller. Ecology W.H. Freeman & Company
10. Truk and Turk: Environmental Science (W.B. Saunders).
11. Chapman Jr., W.B. Natural Ecosystems. Macmilan Pub. Co. Inc.
12. Alcock, J. Animal Behaviour: An evolutionary approach. Sinauer Assoc., Sunderland, Mass. USA.
13. Bradbury, J, W., and S.L. Vehrencamp. Principles of animal communication. Sinauer Assoc., Sunderland, Mass, USA.

14. Clutton-Brock T.H. The evolution of parental care. Princeton Univ. Press, Princeton, NJ USA.
15. Eibl- Eibesfeldt, I. Ethology; The biology of behavior. Holt, Rinehart & Winston, New York.
16. Drickamer, L.C., S.H. Vessey and E.M. Jakob. Animal Behavior, McGraw Hill.
17. Dewsbur, D.A. Comparative animal behavior McGraw Hill Book Company.
18. Hunting ford, F. The Study of Animal Behavior, Chapman and Hall.
19. Mc Farland, D. Animal Behavior: Psychobiology, Ethology and Evolution.
20. Krebs, J.R. and N.B. Davies. Behavioral Ecology: An Evolutionary Approach.
21. IPCC (2007) Fourth assessment report of the Intergovernmental Panel on Climate Change (IPCC). Cambridge University Press, Cambridge, United Kingdom.
22. Wormworth, J. and Sekercioğlu, Ç.H. (2011) Winged Sentinels: Birds and Climate Change. Cambridge University Press.
23. Ramasamy, B. (2013) General Issues on Environmental Ecology, Bio diversity and Climate change. Pragun Publication.
24. Hussain, M. (2013) Environment and Ecology: Biodiversity, Climate Change and Disaster Management. Access Publishing House.
25. The Little Data Book on Climate Change (2011) World Bank Publications.
26. Negi, S. S. (2010) Hand Book of Climate Change Science. Bishen Singh Mahendra Pal Singh.
27. Henson, R. (2011) The Rough Guide to Climate Change. Rough Guides Publisher.
28. Kaur, R. (2014) General Issues on Environment, Biodiversity and Climate Change. New Vishal Publication.
29. Kondratyev, K.Y. and Krapivin, V. F. (2014) Global Carbon Cycle and Climate Change. Springer publications.
30. Seidel, K. and Martinec, J. (2014) Remote Sensing in Snow Hydrology: Runoff Modelling, Effect of Climate Change. Springer publications.
31. Mastrandrea, M.D. and Schneider, S.H. (2010) Preparing for Climate Change. MIT Press.
32. Novacek, M.J. (2010) The Biodiversity Crisis: Losing What Counts. The New Press.
33. Biodiversity: Convention on Biological Diversity, Abiotic Stress, International Treaty on Plant Genetic Resources for Food and Agriculture Books LLC, Wiki Series (2011).
34. Wilson, E. O. (1988) Biodiversity. National Academy Press
35. Pyers, G. (2010) Biodiversity of Rain Forests. Benchmark Books.
36. Anderson, A.B. (2006) Applying Nature's Design - Corridors as a Strategy for Biodiversity Conservation (Issues, Cases, and Methods in Biodiversity Conservation). Columbia University Press.
37. de Boef et al. ed (2013) Community Biodiversity Management: Promoting resilience and the conservation of plant genetic resources (Issues in Agricultural Biodiversity). Routledge.
38. Lanzerath, D. and Friele, M. (2014) Concepts and Values in Biodiversity (Routledge Studies in Biodiversity Politics and Management). Routledge

Immunology and Parasitology

1. Kuby Immunology, Richard, Thomas, Barbara, Janis, (5th Ed., 2003), W. H. Freeman and company, New York, USA.
2. Immuno Biology- The immune system in health and disease, Janeway, Travers, Walport and Shlomchik, (6th Ed., 2005), Garland Science Publishing, New York, USA.
3. Immunology, David, Brostoff and Roitt, (7th Ed., 2006), Mosby & Elsevier Publishing,
4. Canada,USA.

5. Abbas, A. K., Lichtman, A. H. & Pillai, S. (2006). *Cellular and molecular Immunology.* 6th ed. Saunders.
6. Abbas, A. K. & Lichtman, A. H. (2006). *Basic Immunology.*2nd ed. Elsevier.
7. Coico R, Sunshine, G., Benjamini, E. (2003). *Immunology: A short Course*. 5th ed. Wiley- Liss: New Jersey.
8. English, L. S. (1994). *Technological Applications of Immunochemicals (BIOTOL*).
9. Butterworth- Heinemann, Oxford Freeman & Co.
10. Goldsby, R. A., Kindt, T. J., Kuby, J. & Osborne, B. A. (2003). *Immunology*. 5th ed. W. H. Freeman & Co.
11. Khan F. H. (2009) *The Elements of Immunology*. Pearson.
12. Kindt, T., Goldsby, R. Osborne, B. (2007). *Kuby Immunology*. 6th ed. W.H. Freeman & Co.
13. Male, D., Brostaff, J., Roth, D. & Roitt, I. (2006). *Immunology.* 7th ed. Mosby.
14. Rao, C. V. (2002). *Immunology*. Narosa Publishing House, New Delhi.
15. Roitt, I. M. & Delves, P. J. (2001). *Roitt's Essential Immunology*. 10th ed. Blackwell
16. Science. Ltd.
17. Chandler, A. C. & Read. C. P. (1961). *Introduction to Parasitology*, 10th ed. John Wiley & Sons Inc.
18. Chandra, G. (2000). *Mosquito*. Sree Bhumi Publication Co. Kolkata.
19. Cheng , T. C. & Bogitsch. *Human Parasitology.*
20. Cheng , T. C. (1986). 2nd ed. General Parasitology Academic Press, Inc. Orlando.U.S.A.
21. Cox, F. E. G. (1993). *Modern Parasitology*. 2nd ed. Blackwell Scientific Publications. ed. Lea and Febiger, Philadelphia.
22. Hati, A. K. (2001). *Medical Entomology*. Allied Book Agency, Kolkata.
23. Hati, A. K. (2001). *Medical Parasitology*. Allied Book Agency, Kolkata.
24. Noble, E. R. & Noble G. A. (1982). *Parasitology. The Biology of animal Parasites*. 5th ed.
25. Schmidt, G. D. & Roberts, L. S. (2001). *Foundation of Parasitology*, McGraw Hill Publishers, 3rd ed.
26. Schmidt, G. D. (1989). *Essentials of Parasitology*. Wm. C. Brown Publishers (Indian print; 1990, Universal Book Stall).
27. Smyth, J. D. (1994). *Animal Parasitology*. 3rd ed. Cambridge University Press.
28. Soulsby, E. J. L. (1982). *Helminths, Arthropods and Protozoa of domesticated animals.* ELBS and Bailliere Tindall. London.

ZOO-PG-DV407: DISSERTATION AND VIVA-VOCE

Students have to undertake short term research work in the field of their special paper (elective subject). Topics are to be decided in consultation with the course teacher(s). Dissertation should be prepared following standard format i.e. Introduction, Materials and Methods, Results, Discussion and Conclusions. Every student has to defend their research in the viva-voce in the presence of faculty members of Zoology or any other department of the University and the external examiner appointed by the University.