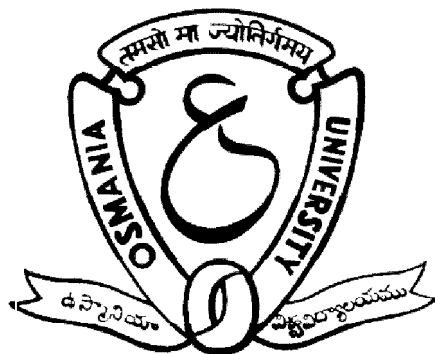


M.Sc. Zoology

**CBCS SYLLABUS FOR 2016–18
ACADEMIC YEAR
FOR ZOOLOGY**

**in
POST GRADUATE DEGREE COURSE
(Master of Science)
I to IV Semester
OF OSMANIA UNIVERSITY**



**Head
Dept. of Zoology
Osmania University**

**Chairperson
BoS in Zoology
Dept. of Zoology
Osmania University**

M.Sc. Zoology

DEPARTMENT OF ZOOLOGY, UCS, OU

PAPER TITLES

SEMESTER – I

Paper I – Structural Biology [SB]

Paper II – Environmental and Conservation Biology [ECB]

Paper III – Immunology [IMM]

Paper IV – Taxonomy, Systematics and Functional Anatomy of Invertebrates [TSFAI]

SEMESTER – II

Paper I – Tools, Techniques and Biostatistics [TTB]

Paper II – Animal Physiology [AP]

Paper III – Molecular Genetics and Developmental Biology [MGDB]

Paper IV – Evolution and Functional Anatomy of Vertebrates [EFAV]

M.Sc. Zoology

SEMESTER – III

Paper I - Systems Biology[SB]

Paper II - Research Methodology [RM]

Elective I

Paper III - Neuroscience - I
Medical Entomology - I
Parasitology - I
Comparative Animal Physiology - I
Fisheries - I

Elective II

Paper IV - Applied Toxicology
Bioinformatics
Endocrinology
Phytonematology
Sericulture
Wildlife Biology

M.Sc. SEMESTER – IV

Paper I- Animal Biotechnology[AB]

Paper II- Fish Biology [FB]

Elective II

Paper III- Neuroscience - II
Medical Entomology - II
Parasitology - II
Comparative Animal Physiology - II
Fisheries - II

Paper IV - Project

M.Sc. Zoology
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Scheme of Examination

Semester – I

S.N.	Subj Code	Subject (Title)	Instruction Hrs/week	Duration of (hrs) Exam.	Max. Marks		Total Marks	Credits
	THEORY				Internal Assessment	Semester Exam.		
1.	Zoo_101T	Structural Biology	4	3	20	80	100	4
2.	Zoo_102T	Environmental and Conservation Biology	4	3	20	80	100	4
3.	Zoo_103T	Immunology	4	3	20	80	100	4
4.	Zoo_104T	Taxonomy, Systematics and Functional Anatomy of Invertebrates	4	3	20	80	100	4
	PRACTICALS							
7.	Zoo_101P	Structural Biology	4	3	-	50	50	2
8.	Zoo_102P	Environmental and Conservation Biology	4	3	-	50	50	2
9.	Zoo_103P	Immunology	4	3	-	50	50	2
10.	Zoo_104P	Taxonomy, Systematics and Functional Anatomy of Invertebrates	4	3	-	50	50	2
Total:			32		80	520	600	24

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Scheme of Examination

Semester – II

S.N.	Subj Code	Subject (Title)	Instruction Hrs/week	Duration of (hrs) Exam.	Max. Marks		Total Marks	Credits
	THEORY				Internal Assessment	Semester Exam.		
1.	Zoo_201T	Tools, Techniques and Biostatistics	4	3	20	80	100	4
2.	Zoo_202T	Animal Physiology	4	3	20	80	100	4
3.	Zoo_203T	Molecular Genetics and Developmental Biology	4	3	20	80	100	4
4.	Zoo_204T	Evolution and Functional Anatomy of Vertebrates	4	3	20	80	100	4
	PRACTICALS							
7.	Zoo_201P	Tools, Techniques and Biostatistics	4	3	-	50	50	2
8.	Zoo_202P	Animal Physiology	4	3	-	50	50	2
9.	Zoo_203P	Molecular Genetics and Developmental Biology	4	3	-	50	50	2
10.	Zoo_204P	Evolution and Functional Anatomy of Vertebrates	4	3	-	50	50	2
Total:			32		80	520	600	24

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Scheme of Examination

Semester – III

S.N.	Subj Code	Subject (Title)	Instruction Hrs/week	Duration of (hrs) Exam.	Max. Marks		Total Marks	Credits
	THEORY				Internal Assessment	Semester Exam.		
1.	Zoo_301T	Systems Biology	4	3	20	80	100	4
2.	Zoo_302T	Research Methodology	4	3	20	80	100	4
3.	Zoo_303T	Elective I	4	3	20	80	100	4
4.	Zoo_304T	Elective II	4	3	20	80	100	4
	PRACTICALS							
7.	Zoo_301P	Systems Biology	4	3	-	50	50	2
8.	Zoo_302P	Research Methodology	4	3	-	50	50	2
9.	Zoo_303P	Elective I	4	3	-	50	50	2
10.	Zoo_304P	Elective II	4	3	-	50	50	2
Total:			32		80	520	600	24

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Scheme of Examination

Semester – IV

S.N.	Subj Code	Subject (Title)	Instruction Hrs/week	Duration of (hrs) Exam.	Max. Marks		Total Marks	Credits
	THEORY				Internal Assessment	Semester Exam.		
1.	Zoo_401T	Animal Biotechnology	4	3	20	80	100	4
2.	Zoo_402T	Fish Biology	4	3	20	80	100	4
3.	Zoo_403T	Elective I	4	3	20	80	100	4
4.	Zoo_406T	Project	4	3	20	80	100	4
	PRACTICALS							
7.	Zoo_401P	Animal Biotechnology	4	3	-	50	50	2
8.	Zoo_402P	Fish Biology	4	3	-	50	50	2
9.	Zoo_403P	Elective I	4	3	-	50	50	2
10.	Zoo_454P	Project	4	3	-	50	50	2
Total:			32		80	520	600	24

Semester - I
CORE PAPER

Paper I: Structural Biology [SB]

UNIT I–Basic concepts of Biomolecules and Structural Biology	15 Hrs
1.1 Biomolecules and their significance – carbohydrates, proteins, amino acids, nucleic acids and lipids.	
1.2 Chemistry and structure of mono, oligo and polysaccharides. Deoxysugars, aminosugars and glycosides	
1.3 Classification and structures of proteins – primary, secondary, tertiary and quaternary.	
1.4 Classification, structure and function of lipids, fatty acids, triglycerides; phospholipids, cerebrosides, steroids	
1.5 Nucleic acids – Structure of DNA and RNA , DNA polymorphism, RNA types.	
UNIT II–Enzymes and Metabolism	15 Hrs
2.1 Classification, nomenclature and properties of enzymes – catalysis and energy of activation; Enzyme kinetics, Michaelis–Menten Constant; (K_m values) and LB plot; mechanism of enzyme action and regulation of enzyme activity	
2.2 Metabolism of carbohydrates – Glycolysis; TCA cycle; Gluconeogenesis; biological oxidation; role of respiratory chain in energy capture; ATP synthesis	
2.3 Catabolism of amino acids – Transamination, deamination and decarboxylation	
2.4 Oxidation and biosynthesis of fatty acids	
2.5 Metabolic disorders of different biomolecules (carbohydrates, proteins, lipids)	
UNIT III–Cellular Organization	15 Hrs
3.1 Molecular organization and functions of cell membranes	
3.2 Cell permeability – Transport across the cell membrane; transport of small molecules; Carrier proteins; Ion pumps; membrane bound enzymes	
3.3 Cell communications – Inter cellular communication and gap junctions; chemical signaling between the cells; strategies of chemical signaling	
3.4 Signaling mediated by intracellular receptors; signaling mediated cell surface receptors – second and third messengers; C–AMP, G–proteins, Ca^{++} , Inositol Triphosphate (IP_3) and prostaglandins	
3.5 Cell cycle; molecular events in cell cycle; mitotic spindle	
UNIT IV - Functional Biology of Nucleic Acids	15 Hrs
4.1 DNA replication – semi conservative, enzymology of DNA replication, replication of circular DNA, initiation, elongation and termination of replication process. Proof reading function of DNA polymerases.	
4.2 Enzymatic synthesis of RNA.	
4.3 Protein synthesis – Events of protein synthesis; transcription in prokaryotes and eukaryotes; post transcriptional processing.	
4.4 Regulation of genetic code – Wobble’s concept, translation in prokaryotes and eukaryotes.	

- 4.5 DNA repair mechanism – High fidelity of DNA sequence – Repair of damage caused by UV light, Eukaryotes repair systems.

PRACTICALS

- 1 Determination of proteins by Biuret method/ Folin Phenol method
- 2 Determination of glucose by Somogi / Anthrone method
- 3 Determination of lipids by Vanlin method
- 4 Determination of glycogen by Kemp's method
- 5 Estimation of cholesterol
- 6 Determination of enzyme activities of SDH and LDH
- 7 Effect of substrate concentration and pH on SDH activity
- 8 Protein fractionation using sodium sulphate
- 9 Estimation of DNA and RNA
- 10 Electrophoretic analysis of proteins/DNA
- 11 Feulgen reaction method for DNA localization.
- 12 Submission of assignment on structure of Biomolecules, mechanism of enzyme action , Metabolic cycles, DNA, RNA, protein synthesis. [To be submitted at the time of Examination – 10 Marks]

Suggested Books

- 1 Textbook of Biochemistry by Harper
- 2 Textbook of Biochemistry by Lehninger
- 3 Textbook of Biochemistry by Stryer and Stryer
- 4 Textbook of Biochemistry by Conn and Stumpf
- 5 Textbook of Biochemistry by A.B.V. Rama Rao
- 6 Cell and molecular biology by De Robertis and De Robertis, 8th ed.
- 7 Molecular Biology by Friefielder
- 8 Molecular cell biology by Darnell, Lodish and Baltimore (Scientific American Books)
- 9 Molecular biology by H. D. Kumar
- 10 Biochemistry and molecular biology by W. H. Elliot and D. C.Elliot(OU Press)
- 11 Molecular Biology of Cell by Bruce Alberts et al.
- 12 Cell by Karp

Syllabus Committee

- 1 Prof. P. Nagaraja Rao
- 2 Dr. Rafath Yasmeeen
- 3 Dr. B. Jyothi
- 4 Dr. S. Padmaja

UNIT I – Basic concepts of Ecology	15 Hrs
1.1	Laws of limiting factor, Laws of minimum, Laws of Tolerance and Tragedy of commons
1.2	Micronutrients and macronutrients
1.3	Types of ecosystem – freshwater, marine and terrestrial
1.4	Population characteristics and dynamics – conceptual approach
1.5	Growth curves and pyramids; sigmoid curve, J curve and hyperbola; logistic equation and concepts relating to growth
UNIT II – Community Organization and Structure	15 Hrs
2.1	Community analysis, species diversity, ecotone concept and edge effect; interaction between environment and biota Habitat and ecological niche and niche overlap; concept of biome
2.2	Concepts of productivity; eutrophication of lakes; biological indicator and water quality
2.3	Ecosystem dynamics and management; stability and complexity of ecosystem
2.4	Biogeochemical cycles; inorganic pollutants and their impact SO ₂ , NO ₂ , CO, Phosphates, heavy metals (Arsenic, Lead and Mercury); radioactive nucleotides and their impact on biological system
2.5	Acid rain sources and its impact on biological system; green house effect and ozone depletion
UNIT III - Biogeography of India, Habitats and Resources	15 Hrs
3.1	Classical concepts of biogeography – continental drift, endemism, refugia
3.2	Biogeographical regions of India and their salient features
3.3	Classification, function and values of habitats – Freshwater wetlands, deserts, grasslands and forests
3.4	Concepts of natural resources – renewable and non-renewable resources
3.5	Overexploitation of resources – deforestation, water table depletion and land degradation
UNIT IV - Natural Resource Management	15 Hrs
4.1	Environmental Impact Assessment – principle, scope and purpose
4.2	Role of ecological restoration in conservation; displacement and settlement of local communities
4.3	Major conservation movements in India; NGOs in conservation efforts
4.4	Community diversity resources use and management; conflict management and resolution
4.5	National legislations for protecting biological resources – Biodiversity Act, 2002 and Biodiversity Rules, 2004

PRACTICALS

- 1 Estimation of phosphates from the water sample
- 2 Estimation of nitrates and nitrites
- 3 Estimation of magnesium
- 4 Estimation of calcium
- 5 Biological indicators of water quality and their population dynamics – collection of water sample
- 6 Identification, enumeration of zooplankton, and their ecological significance
- 7 Estimation of total alkalinity of water and soil
- 8 Estimation of particulate matter in air
- 9 Draw the biogeographical regions of India and provide in brief the salient features of each biogeographical zone
- 10 Enumerate the biological diversity (zooplanktons and birds) using the habitat of freshwater lake in your place
- 11 Enumerate the diversity (plants and animals) use and their management in a community/village near your place

Suggested Books

- 1 Caughley, G., and A. Gunn. 1996. Conservation Biology in Theory and Practice. Blackwell Science, Cambridge, Massachusetts, U.S.A.
- 2 Cox, G. W. 2005. Conservation Biology: Concepts and Applications. McGraw-Hill, Dubuque, Iowa, U.S.A.
- 3 Dasmann, R., 1981. Wildlife Biology, 2nd ed. John Wiley and Sons, NY
- 4 Dobson, A. P. 1996. Conservation and Biodiversity. Scientific American Library, New York, New York, U.S.A.
- 5 Jeffries, M. J. 1997. Biodiversity and Conservation. Routledge, New York, New York, U.S.A.
- 6 Mills, L. Scott 2006. Conservation of Wildlife Populations. Blackwell Science, Oxford, U. K.
- 7 Milner-Gulland, E. J., and R. Mace. 1998. Conservation of Biological Resources. Blackwell Science, Oxford, U.K.
- 8 Morris, W. F., and D. F. Doak 2002. Quantitative Conservation Biology: Theory and Practice of Population Viability Analysis. Sinauer Associates, Sunderland, Massachusetts, U.S.A.
- 9 Sinclair, A. R. E., J. M. Fryxell, and G. Caughley 2006. Wildlife Ecology, Conservation and Management, Blackwell Publishing
- 10 Soulé ME (ed) 1986. Conservation biology: the science of scarcity and diversity- Sinauer, Sunderland
- 11 Bram F. Noble 2005. Introduction to Environmental Impact Assessment: A Guide to Principles and Practice. Oxford University Press, London
- 12 John A. Wiens and Michael R. Moss 2005. Issues and Perspectives in Landscape Ecology. Cambridge University Press, London
- 13 Aparna Sawhney 2004. The New Face of Environmental Management in India. Ashgate Publishing Ltd., Sheffield

Syllabus Committee

- 1 Prof. S. Jithender Kumar Naik
- 2 Dr. C. Srinivasulu
- 3 Dr. Apka Nageshwar Rao

UNIT I – Introduction to Immune System	15 Hrs
1.1 Phylogeny of Immune system –invertebrates and vertebrates	
1.2 Immune system – Innate and adaptive immunity , humoral mediated immunity and cell-mediated immunity	
1.3 Cells involved in immune system; role of macrophages in immunity	
1.4 The Lymphoid tissues – primary and secondary lymphoid organs, lymphatic traffic	
1.5 Activation of B– and T– Cells; production of effectors – antibodies and cytokines	
UNIT II – Antigen-Antibody Nature and Complement System	15 Hrs
2.1 Antigens nature, epitope, haptens, antigen presenting cells, adjuvants, antigenicity	
2.2 Immunoglobulins structure, function and classification of antibodies.	
2.3 Monoclonal antibodies and its application. Antigen antibody reactions. Immunological techniques -Principles and applications of ELISA, RIA, Immunoprecipitation, FISH and GISH	
2.4 Complement system – Components of complement system, pathways - classical and alternative, biological consequences of complement activation and complement significance	
2.5 Major histocompatibility complex (MHC) structure and function; genetic control of Immunoresponses; MHC restriction	
UNIT III – Hypersensitivity Reactions and Autoimmune Diseases	15 Hrs
3.1 Hypersensitivity – Classification of hypersensitivity reactions; Type-I – Anaphylactic hypersensitivity; Type – II Antibody – mediated cytotoxic hypersensitivity.	
3.2 Type-III – Immunocomplex mediated hyper sensitivity; Type – IV Cell mediated (Delayed) hypersensitivity.	
3.3 Autoimmune diseases – Organ specific auto immune diseases – Grave’s disease, insulin–dependent diabetes mellitus (type–I diabetes).	
3.4 Autoimmune diseases – Systemic autoimmune diseases – Systemic Lupus Erythematosus (SLE), Rheumatoid arthritis.	
3.5 Genetic factors, pathogenesis and treatment of autoimmune diseases.	
UNIT IV – Transplantation and Tumour Immunology	15 Hrs
4.1 Transplantation – Barriers to transplantation.	
4.2 Genetic predisposition for graft rejection, prevention of rejection.	
4.3 Immunity to infection – viruses, bacteria, fungi, parasites, nature of interaction; immunopathological considerations.	
4.4 Tumor immunology – Immunity to tumors, tumor specific antigens.	
4.5 Immunosurveillance.	

PRACTICAL

- 1 Slide agglutination test – A,B,O blood groups
- 2 Latex agglutination slide test by kit method
- 3 RPR Test for Sphilis
- 4 HIV test(Tridot method)
- 5 Widal test for diagnosis of enteric fever
- 6 Blood smear preparation and identification of lymphocysts
- 7 Identification of histological slides of lymphoid tissue - Spleen, thymus, lymphnode and bone marrow
- 8 Single Radial immune diffusion for estimation concentration of antibodies and antigens
- 9 Separation and identification of immunoglobulins by electrophoresis
- 10 Immunization schedules and rising of antibodies
- 11 Demonstration of Immunoectrophoresis
- 12 Submission of assignment on structure of immune cells, antibodies, antigen-antibody reactions, MHC, Hypersensitivity types. Mechanisms in transplantation and tumor immunology. [To be submitted at the time of Examination – 10 Marks]

Suggested Books

- 1 Immunology, Kuby, W.F.Freeman, U.S.A
- 2 Fundamentals of Immunology, W.Paul
- 3 Essentials of Immunology, I.M.Roitt
- 4 Immunology A Foundation Test by Basiro Davey
- 5 An introduction to immunology, by Ian R. Tizard

Syllabus Committee

- 1 Prof. K. Pratap Reddy
- 2 Dr. G. Sunitha Devi
- 3 Dr. Rafath Yasmeen

Paper IV: Taxonomy, Systematics and Functional Anatomy of Invertebrates [TSFAI]

UNIT I - Biosystematics and Taxonomy	15 Hrs
1.1 Basic concepts of biosystematics, taxonomy and classification	
1.2 Recent trends in biosystematics — molecular taxonomy	
1.3 Taxonomic hierarchies, species concepts.	
1.4 International Code for Zoological Nomenclature (ICZN) – operative principles, interpretation and application of important rules; basis of scientific names	
1.5 Concepts of Prokarya, Eukarya, Protostomia and Deuterostomia; Significance of symmetry, coelom and metamerism	
UNIT II– Protozoa to Platyhelminthes	15 Hrs
2.1 Structure and functions of Locomotory organs in protozoans, reproduction in protozoa, conjugation in verticella	
2.2 Porifera :-sycoin canal system, life cycle	
2.3 Platyhelminthes:- Polyembryons	
2.4 Life cycles and modes of transmission, Paragonimus westermani, Diphyllbothrium latum.	
2.5 Overview of reproduction and development in Protozoa, Proifera, Cnidaria, Ctenophora and Platyhelminthes	
UNIT III - Annelida to Echinodermata	15 Hrs
3.1 Filter feeding in polychaetes and respiration in Annelida.	
3.2 Shell in mollusca; respiration in mollusca foot in molluscs	
3.3 Arthropoda; social life in insects; respiration and excretion in arthropods	
3.4 Echinodermata; Autotomy and regeneration in echinodumata	
3.5 Overview of reproduction, development and phylogenetic significance of the larval forms of Arthropoda and Echinodermata	
UNIT IV - Minor and Other Phyla	15 Hrs
4.1 Systematic position, general organization and affinities of Ctenophora and Nemertea (Rhynchoceola)	
4.2 Systematic position, general organization and affinities of Rotifera	
4.3 Systematic position, general organization and affinities of Bryozoa (Ectoprocta).	
4.4 Systematic position, general organization and affinities of Onychophora and Chaetognatha	
4.5 Systematic position, general organization and affinities of Hemichordata	
PRACTICAL	
1 Salient characteristics, identification and classification of representative types of invertebrate groups from Protozoa, Porifera, Cnidaria, Ctenophora, Annelida, Mollusca, Arthropoda, Echinodermata and Hemichordata	

M.Sc. Zoology

- 2 Preparation of permanent slides of mouth parts of house fly, mosquitoes and silk moth
- 3 Collection and identification of invertebrates in pond water
- 4 Collection and identification of parasites from cockroach
- 5 Dissections –
 1. Minor – a) Reproductive system of cockroach, b) Mouth parts of cockroach
 2. Major – a) Nervous system of prawn

Suggested Books

- 1 Principles of systematic Zoology (2 nd Edition) by E. Mayr and P.D. Ashlock
- 2 A Textbook of Zoology Vol. I by Parker and Haswell (Revised)
- 3 The Invertebrates Vol. I to Vol. VI by L. H. Hyman
- 4 Invertebrate structure and function by E. J. W. Barrington
- 5 Invertebrate Zoology by P. A. Meglitsch (Oxford Press)
6. Life of Invertebrates by Russel Hunter
7. Invertebrate Zoology by Ruppert and Barnes (Saunders College Publishing Co.)
8. Life of Invertebrates by S. N. Prasad
9. Evolutionary Biology by Eric C. Mitkoff
10. Worms and Man by D. W. T. Crompton
11. Parasitology by Noble and Noble
12. Regeneration by S. M. Rose–Appleton (Century Crofts)

Syllabus Committee

- 1 Prof. Geeta Rajalingam
- 2 Dr. C. Srinivasulu
- 3 Dr. A. V. Rajashekar

UNIT I - Tools and Separation Techniques	15 Hrs
1.1 Principles of microscopy – light, UV, confocal, phase contrast, fluorescent, electron microscopy (SEM & TEM)	
1.2 Principles of histology – microtomy – tissue fixation, staining, mounting, histochemistry	
1.3 Homogenization; cell fractionation; centrifugation – principles and applications of Preparative, analytical and ultra centrifugation	
1.4 Chromatographic techniques – principle and applications of adsorption, affinity, partition, permeation, ion-exchange, column, TLC, GLC, HPLC	
1.5 Electrophoresis techniques – principles and applications of continuous, disc, isoelectrofocussing, isotachopheresis.	
UNIT II - Separation and Diagnostic Techniques	15 Hrs
2.1 Spectroscopic techniques – principles and applications of visible, UV, fluorescence, IR, ESR, NMR and mass spectroscopy	
2.2 Radioisotope techniques – principles and application of Geiger-Muller counter, scintillation counter, tracer studies, autoradiography	
2.3 Electrophysiological techniques – principles and applications of single neuron recording, patch clamp recording.	
2.4 Imaging techniques - ECG, PET, MRI, fMRI and CAT	
2.5 Microarray techniques – principles and applications of DNA, RNA and Protein microarray Techniques	
UNIT III - Biostatistics I – Introduction, Measures and Theories of Probability	15 Hrs
3.1 Statistical data, organization, classification and tabulation of data; Frequency distribution and graphical representation of data	
3.2 Measures of central tendency – Mathematical average (Mean – Arithmetic, Geometric & Harmonic Mean) and Positional Averages (Median and Mode)	
3.3 Measures of dispersion (or variability) – types, range, quartile deviation, mean deviation, variance, standard deviation, coefficient of variance	
3.4 Basics of Probability – Concept of probability, addition and multiplication laws of probability and application to the problems of biology	
3.5 Probability distribution – Definition, Types, properties and applications – Normal, Binomial and Poisson distributions	
UNIT IV - Biostatistics II – Hypothesis testing and Inferential Statistics	15 Hrs
4.1 Sampling – concept, sampling distribution of mean, standard error; Random variable – concept, expectation and variance of random variable	
4.2 Statistical estimation – types, methods and applications; Statistical hypothesis – types, testing (hypothesis, null hypothesis, alternate hypothesis), decision making (Type I & Type II errors), determination (fixation of level of significance)	

- 4.3 Nonparametric tests – Assumptions, applications of Sign Test, Wilcoxon Signed Rank Test, Man-Whitney Test
- 4.4 Parametric tests – Student’s t-Test; Analysis of Variance (ANOVA or F-Ratio: One way and Two-way analysis); Chi-square test (Test of Independence and Test of Goodness of Fit)
- 4.5 Correlation and regression analysis concepts and their application

PRACTICALS

- 1 To fix a tissue with Bouin’s fixative and stain using haemotoxylin – eosin stain for histochemical studies
- 2 To prepare a paraffin block of tissue for microtomy for making sections of tissue for histochemical studies
- 3 Quantitative detection of total carbohydrates using Anthrone technique
- 4 Quantitative detection of total lipids using sulpho-phosphovanillin technique
- 5 Quantitative detection of total proteins using Lowry et al’s Biuret technique
- 6 Graphic presentation of data – bar diagram, histogram, frequency polygon and pie chart
- 7 Calculation of measures of central tendencies – mean, median and mode
- 8 Calculation of measures of dispersions – range, mean deviation, standard deviation, variance and coefficient of variance
- 9 Computation of test of significance – comparison of sample mean with population mean and two sample means
- 10 Calculate the coefficient of correlation between two variables
- 11 Computation of linear regression
- 12 Computation of One Way Analysis of Variance (ANOVA)
- 13 Using Chi Square Test, test the independence of two variables

Suggested Books

- 1 Principles and techniques of Practical Biochemistry Ed. B.L. Williams & K. Wilson, Arnold Publishers
- 2 Practical Biochemistry By Plummer
- 3 Immunology – Roit
- 4 Cell and Molecular Biology – DeRoberties
- 5 Cell and Molecular Biology – Ladish et al.
- 6 Statistical methods, Snedecor, G.W. and W.G. Cochran, Iowa State Univ. Press
- 7 Biometry by W. H. Freeman and Francisco
- 8 Fundamentals of Biometry by L.N. Balaram (1980)
- 9 Biostatistics by N. Gurumani
- 10 Techniques in life sciences – by Tembhare

Syllabus Committee

- 1 Prof. B. Reddya Naik
- 2 Dr. C. Srinivasulu

UNIT I – Digestion-Respiration- Circulation	15 Hrs
1.1 Cellulose digestion –Ruminant and non-ruminant digestion; absorpition in mammals; events of absorptive and post absorptive states and their regulation (endocrine and neural).	
1.2 Respiration – Cascade of oxygen transport to tissues at high altitude; adaptation to diving.	
1.3 Responses to CO ₂ and O ₂ rich environment; oxygen toxicity; hypercapnea, control of respiration.	
1.4 Buffering mechanisms by body fluids.	
1.5 Circulation - Cardiac cycle and principles of hemodynamics; blood coagulation,haematome formation; Anti-coagulants.	
UNIT II– Osmoregulation, Excretion and thermoregulation	15 Hrs
2.1 Osmoregulation – Osmoregulatory problems in brackish water, fresh water and marine organisms; osmotic problems in terrestrial animals; hormonal control of osmoregulation.	
2.2 Excretion – Urine formation, counter current mechanism; juxtaglomerular apparatus, rennin-angiotensin system; hormonal regulation – ADH and aldosterone.	
2.3 Detoxification of nitrogen products; purine cycle and miscellaneous detoxification pathways.	
2.4 Thermal physiology – temperature regulation in poikilotherms,homeotherms and heterotherms, and their mechanisms of survival; central control of homeothermy.	
2.5 Cold death, cold resistance, heat death; Torpor, hibernation and aestivation.	
UNIT III– Muscle Physiology, Neurophysiology & Receptors	15 Hrs
3.1 Comparative molecular structure and function of skeletal, smooth and cardiac muscles; energy metabolism in skeletal muscle, muscle fatigue.	
3.2 Types of neurons and glial cells.	
3.3 Basis and significance of membrane potentials, equilibrium potentials, their change during stimulus, Na, K currents in action potential.	
3.4 Types of synapses, synaptic transmission - electrical and chemical; synaptic inhibition and neurotransmitters.	
3.5 Receptors – Receptor mechanisms, sensory coding; Mechanoreceptors, photochemical aspects of vision and phonoreception in mammals.	
UNIT IV – Endocrinology, Bioluminiscence & Stress Physiology	15 Hrs
4.1 Structure and function of endocrine glands of invertebrate.	
4.2 Structure and function of endocrine glands of vertebrate.	
4.3 Mechanism of hormone action (peptide and steroid hormones).	

- 4.4 Bioluminescence-luminiscent organisms-neural control. Biochemistry and significance of luminescence.
- 4.5 Stress – resistance to stress, functions of hormones and sympathetic nervous system in stress

PRACTICAL

- 1 Estimation of blood chlorides under hetero osmotic media.
- 2 Cold and heat stress on metabolic rate in tilapia fish/crab.
- 3 Effect of heat stress on glycogen levels in tilapia fish/crab.
- 4 Estimation of Acetylcholinesterase activity.
- 5 Estimation of phosphorylase activity.
- 6 Adrenalin and insulin induced changes in blood glucose levels in rat/mice.
- 7 Kymographic recordings of twitch, tetanus and fatigue.
- 8 Estimation of Hb, ESR and blood clotting time.
- 9 Cell fragility.

Suggested Books

- 1 Principles of Animal Physiology by D.W. Wood.
- 2 Principles of Animal Physiology by Gordon.
- 3 Animal Physiology-Adaptations and environment by Schmidt-Nielson.
- 4 Principles of Animal Physiology by Wilson.
- 5 Text Book of Medical Physiology by Guyton.
- 6 General & Comparative Animal Physiology By William Hoar.
- 7 Comparative Animal Physiology by Florey.
- 8 Comparative Animal Physiology by L.C.Prosser.
- 9 Human Physiology by vander .

Syllabus Committee

- 1 Prof. Sugita Mathur
- 2 Dr. Rafath Yasmeen
- 3 Dr. S. Padmaja
- 4 Dr. Jyothi

UNIT I - Introduction to Genetics	15 Hrs
1.1 Mendelism, mendelian inheritance; modification of mendelian inheritance.	
1.2 Linkage studies, crossing over and extra chromosomal inheritance, multiple alleles, blood group antigens.	
1.3 Chromosome structure (Prokaryote and Eukaryote); identification, karyotype.	
1.4 Genetic disorders – chromosomal disorders, inborn errors of metabolism and polygenic and environmental disorders.	
1.5 Bacterial genetics – transformation, transduction, conjugation, viral lytic and lysogenic cycle.	
UNIT II – Molecular Genetics	15 Hrs
2.1 Introduction of DNA technology – Restriction endonucleases, methods of ligation – DNA ligases, ligation of fragment with cohesive and blunt ends.	
2.2 Features of vectors – cosmids, plasmids and shuttle vector with one example representing each class construction and characterization of new cloning vectors	
2.3 Applied molecular biology – DNA sequences – Maxam and Gilbert methods, Sanger’s method. Application of recombinant DNA technology with reference to the example of insulin, somatostatin, and interferon. DNA fingerprinting and its application	
2.4 Cloning strategies – Shotgun cloning, construction of gene libraries, genomic library and DNA library	
2.5 Hybridization techniques – Southern blot, Northern blot, R-loop mapping methods, In-situ hybridization	
UNIT III – Overview of Developmental Biology	15 Hrs
3.1 Scope and importance of developmental biology	
3.2 Gametogenesis; spermatogenesis, oogenesis, vitellogenesis and chemodifferentiation	
3.3 Fertilization, parthenogenesis and its significance	
3.4 Types of cleavage, mechanism of cleavage, chemical changes during cleavage	
3.5 Role of cytoplasm and nucleus during early development; morphogenetic movements, presumptive areas and fate maps	
UNIT IV – Organogenesis	15 Hrs
4.1 Gastrulation, metabolic events during gastrulation and rudimentary organs formation	
4.2 Concept of organisers and induction – Neural tubule formation	
4.3 Organogenesis: limb, central nervous system, heart, kidney and eye	
4.4 Role of hormones in metamorphosis of insects and frog; regeneration in Cnidaria, Echinodermata, Amphibia (limb and tail regeneration), and Reptiles (tail regeneration)	
4.5 Teratogenesis– genetic and environmental; developmental mechanisms of teratogenesis	

PRACTICAL

- 1 Identification of ABO Blood groups
- 2 Extraction of DNA from tissues
- 3 Extraction and isolation of RNA from tissues
- 4 Estimation of RNA, DNA in tissues
- 5 Estimation of structural proteins
- 6 Estimation of soluble proteins
- 7 Estimation of SDH activity in chick embryo
- 8 Estimation of LDH activity in chick embryo
- 9 Estimation of calcium in egg shell by EDTA method
- 10 Identification of chick embryo developmental stages – 24hrs, 48hrs, 72hrs, &96hrs

Suggested Books

- 1 General genetics by Winchester
- 2 Molecular Biology of gene by Watson et al. Vol I & II
- 3 Genetics by Strickberger
- 4 Molecular Biology by Friefielder
- 5 Genetics by P.K. Gupta
- 6 Genes by Lewis
- 7 General genetics by S. R. B. Owen
- 8 Cell and molecular biology by De Robertis and De Robertis, 8th ed.
- 11 Molecular cell biology by Darnell, Lodish and Baltimore (Scientific American books)
- 12 Molecular biology by H. D. Kumar
- 13 Biochemistry and molecular biology by W. H. Elliot and D. C. Elliot (OUPress)
- 14 Text book of molecular biology by K. S. Sastry et al. (MacMillan Ind. Pvt. Ltd.)
- 15 Developmental Biology - patterns, problems and principles by W. Saunders Jr.
- 16 Principles of Animal Developmental Biology by S.C. Goel
- 17 Introduction to embryology by Balinsky
- 18 Developmental Biology S. Gilbert
- 19 Evolution by Savage
- 20 Process of organic evolution by Stebbings
- 21 Evolution of vertebrates by Colbert
- 22 Developmental Biology by Beryll

Syllabus Committee

- 1 Prof. V. Vanitha Das
- 2 Dr. G. Sunitha Devi
- 3 Dr. A.V. Rajashekar

Paper IV: Evolution and Functional Anatomy of Vertebrates [EFAV]

UNIT I – Evolution	15 Hrs
1.1	Concept of evolution and theories of evolution
1.2	Variation, gene mutation and chromosomal aberrations in evolution; genetic drift
1.3	Speciation – species concepts, categories; Modes of speciation – Allopatric, parapatric and sympatric speciation
1.4	Natural selection; patterns of evolution – sequential, divergent, convergent, gradual, punctuated, monophyletic, polyphyletic and paraphyletic
1.5	Origin and evolution of primates and human
UNIT II – Evolution of Vertebrates	15 Hrs
2.1	Origin and salient features of Ostracoderm, Placoderm, Acanthodii, Sarcopterygii and Actinopterygii
2.2	Origin, salient features and adaptive radiation in amphibians – Lepospondyli and Lissamphibia
2.3	Origin, salient features and adaptive radiation in early and Mesozoic reptiles
2.4	Origin, salient features and adaptive radiation in birds – Palaeognathae and Neognathae
2.5	Origin, salient features and adaptive radiation in mammals – Prototheria and Theriiformes
UNIT III – Functional Anatomy of Vertebrates – from fishes to mammals	15 Hrs
3.1	Integumentary system – Integument and its derivatives
3.2	Skeletal system – Cranial and Post-Cranial (axial and appendicular) skeletal system
3.3	Nervous system – brain, spinal cord and peripheral nerves; sense organs
3.4	Respiratory and circulatory system; Digestive and excretory system
3.5	Reproductive system – comparison of male and female reproductive systems from fishes to mammals
UNIT IV – Functional Anatomy of Vertebrates – Evolutionary significance	15 Hrs
4.1	Evolutionary significance of internal fertilization, neoteny and paedogenesis
4.2	Amniotic egg – structure and its evolutionary significance
4.3	Basic plan of skull; Temporal fossae and their evolutionary significance; Vertebrate Jaw suspension
4.4	Types and evolutionary significance of axial and appendicular joints
4.5	Types and evolutionary significance of placenta; evolutionary significance of opposable thumb and bipedalism in primates (both non-human and human)
PRACTICAL	
1	Salient characteristics, identification and classification of representative types of vertebrate groups from Pisces, Amphibia, Reptilia, Aves and Mammalia

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- 2 Collection and preparation of slides of ticks, mites, bed bug, human lice, fleas, mosquitoes and house flies
- 3 Structure, bionomics and biology of earthworms. Commercially important prawns, mussels and pearl oysters, harmful and useful insects and moths, cultivable fishes and frogs
- 4 Dissections --
 1. Minor – a) Weberian ossicles of Labeo, and b) Respiratory trees of Clarius
 2. Major – a) a) Cranial nerves of Labeo (V, VII, IX & X cranial nerves, b) Cornea and pecten of chick

Suggested Books

- 1 Life of vertebrates by J.Z. Young
- 2 A textbook of zoology Vol. II by Parker and Haswell (revised by Marshall)
- 3 Vertebrate body by A.S. Romer.
- 4 Chordates by Alexander.
- 5 Comparative vertebrate anatomy by Hyman.
- 6 Vertebrate structure and function by Waterman.
- 7 Evolution of vertebrates by E.H. Colbert.
- 8 Evolutionary biology by Mitkoff.
- 9 Comparative Anatomy by Kent.
- 10 Vertebrates – R. L. Kotpal
- 11 Chordate Zoology E. L. Jordan & P. S. Verma
- 12 Vertebrate Zoology & Evolution – Yadav B. N. & D. Kumar

Syllabus Committee

- 1 Prof. V. Vanitha Das
- 2 Dr. C. Srinivasulu
- 3 Dr. B. Neeraja

Semester – III
Core Paper
Paper I - Systems Biology

UNIT I – Introduction to Systems Biology 15 Hrs

- 1.1 History, concept, prospects and applications of systems biology.
- 1.2 Molecules to Organisms – Biomolecules, cell, tissue, organ and organisms.
- 1.3 Basic concepts of systems approach to biology.
- 1.4 Basic concepts of models and modeling, model behavior, classification.
- 1.5 Basic concepts of networks; types of networks.

UNIT II – Systems approach 15 Hrs

- 2.1 Mammalian biological clocks, neuronal and humeral network mechanism.
- 2.2 Biochemical networks and metabolic cycles – Kreb's cycle, Electron Transport System.
- 2.3 Sustainable pest and disease management – quantitative and qualitative models.
- 2.4 Apoptosis - molecular modeling.
- 2.5 Bioremediation - hydrocarbon bioremediation, radionuclide biotransformation, metals bioimmobilization.

UNIT III – Predictive modeling 15 Hrs

- 3.1 Continuous population models for single species.
- 3.2 Insect out break model: Mosquito model.
- 3.3 Predictive ecology, game theory population models, predator-prey model.
- 3.4 Kinetic models of biochemical system – metabolic control analysis.
- 3.5 Data formats, simulation techniques, modeling tools.

UNIT IV – Systems biology applications 15 Hrs

- 4.1 Networks in nervous system: Integrative synaptic mechanism of the neural networks.
- 4.2 Caenorhabditis elegans model system for neurotoxicity.
- 4.3 Endobiogeny: An approach to systems biology, host-parasite interaction.
- 4.4 Evolutionary systems biology; approach to molecular phylogeny.
- 4.5 Nanoparticles in biological systems – application, characterization and interactions.

PRACTICALS

1. Live cell imaging.
2. Estimation of predator-prey relationship using larvivorous fish.
3. Temperature dependent enzymatic activity in metabolites.
4. In silico phylogenetic analysis.

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5. Neurotransmitters – defined systems.
6. Estimation of parasitic load in infected fish/ chicken.
7. Bioassay of neurotoxicity.
8. Estimation of population growth under different environmental conditions.
9. Protein expression profiling using 2D electrophoresis.

Suggested Books

1. An Introduction to Systems Biology: Design Principles of Biological Circuits By Uri Alon.
2. Systems biology: A Text Book by Edda Klipp.
3. Mathematical Biology: An Introduction by Murray J.
4. An Introduction to Mathematical Biology by Linda J.S. Allen.
5. Introduction to Systems Biology by Sangdun Choi.
6. Life: An Introduction to Complex Systems Biology, by Kaneko Kunihiro.
7. Systems biology, by Robert A. Meyer.
8. Systems biology: Principles methods and concepts by A. K. Konopka.
9. Systems biology: The challenges of complexity by Shigetada Nakashini.

UNIT – I: Research, experimental and sampling design 15 Hrs

- 1.1. Research – basic and applied research, essential steps in research.
- 1.2. Research – definition, importance and application.
- 1.3. General methods in biological research – natural observation, field study, and experimentations.
- 1.4. Experimental design – basic principles, hypothesis, one & two group experimental design. matched pair data analysis, factorial design, randomized block design.
- 1.5. Sampling method - Concept of population, random sampling and non random sampling, variables – random, independent and intervening variables.

UNIT – II: Collection, analysis and interpretation of data. 15 Hrs

- 2.1 Data collections: methods for primary data- observation, interview, questionnaire methods, and experiments.
- 2.2 Methods for secondary data – scientific journals, books, reports, databases.
- 2.3 Representation of data – tabular representations of quantitative data, frequency table – one way and two way.
- 2.4 Graphical representation of quantitative data – line graph, histogram, frequency polygon, frequency curve, Ogive, bar diagrams and pie diagrams.
- 2.5 Analysis of data – Tools of statistics and software applications.

UNIT – III: Use of inferential statistical tools in research 15 Hrs

- 3.1 Use of different statistical estimations depending on the type of data, hypothesis testing, and test of significance.
- 3.2 Student's 't' test – applications and importance in research data.
- 3.3 Application of Chi-square test for the experimental data.
- 3.4 Use of ANOVA – (one-way and two-way ANOVA) for the research data analysis.
- 3.5 Application of correlation and regression analysis for the data.

UNIT – IV: Reporting research 15 Hrs

- 4.1 Literature collection – Need, review process, consulting source material, literature citation; Components of research report – Text, tables, figures, bibliography.
- 4.2 Writing of dissertations, project proposals, project reports, research papers.
- 4.3 Intellectual Property Rights – Biopiracy, copyrights, patent and traditional knowledge and plagiarism.
- 4.4 Laboratory safety – Biohazardous agents, biosafety levels, lab acquired infections, other hazards; Laboratory good practices.
- 4.5 Animal model systems; animal ethics- animal welfare guidelines for care and use of animals.

PRACTICALS

1. Preparation of charts (histograms, frequency graphs, scatter plots, pie charts).
2. Calculation of Mean and Standard Deviation and preparation of the graph depicting mean and standard deviation.
3. Calculation of descriptive statistics of data.
4. Calculation of t-test for paired two samples for means.
5. Calculation of correlation for bivariate data.
6. Calculation of regression for bivariate data.
7. Calculation of one-factor ANOVA.
8. Calculation of two-factor ANOVA .
9. Literature review using online resources.
10. Preparation and documentation of research publication/dissertation.

Wherever possible, use the computer for the analysis of data by using MS-Excel.

Suggested Books

1. Biostatistics by N. Gurumani
2. Research Methodology by N. Gurumani
3. Research methodology by R C Kothari
4. Research methodology by Ranjith kumar
5. Research methodology by Khan
6. Practical statistics using Microsoft excel by Dibyojyoti Bhattacharjee
7. Next generation excel by I D Gottlieb

Semester - III
Elective I

Paper III - Neuroscience - I [NS-I]

UNIT I – Cellular Neurobiology 15 Hrs

- 1.1 Ultra structure of neuron, axonal transport and its mechanism.
- 1.2 Types of neuronal and glial cells, organization of neurons in brain.
- 1.3 Organization of CNS and PNS.
- 1.4 Over view of functional anatomy of brain and spinal cord.
- 1.5 Neuroanatomical and neuroimaging technique.

UNIT II – Neurophysiology 15 Hrs

- 2.1 Principles and methods of electrophysiological techniques – voltage and patch clamp.
- 2.2 Ion channels and ion pumps.
- 2.3 Types of biopotentials and mechanism; Action potential and propagation cable conduction.
- 2.4 Synaptic transmission, molecular and physiological mechanisms, EPSP and IPSP.
- 2.5 Synaptic receptor – nicotinic and muscuranic Ach receptor.

UNIT III – Molecular Neurobiology 15 Hrs

- 3.1 Neurotransmitters and neuromodulators.
- 3.2 Metabolism and functional significance of neurotransmitters, specific transmitter defined system.
- 3.3 G-protein coupled receptor mechanisms.
- 3.4 Neuroendocrine circuits.
- 3.5 Neuroimmune circuits.

UNIT IV – Cognitive and Behavior Neurobiology 15 Hrs

- 4.1 Biorthym – Sleep and awake; neuronal – humoral mechanisms.
- 4.2 Types of learning and memory; cellular and molecular basis of learning and memory; role of hippocampus and LTP in memory.
- 4.3 Neuronal basis of feeding.
- 4.4 Neuronal basis of emotion.
- 4.5 Cerebral cortex; organization and behavior.

PRACTICALS: (All experiments involving live animals are for demonstration only)

- 1 Demonstration of gross anatomical regions of brain.
- 2 Isolation of hippocampus, preparation of AchE, staining, protocol of hippocampal cell culture.
- 3 Identification of different types of neural and glial cells.
- 4 Estimation of acetylcholine in different regions of brain.
- 5 Estimation of acetyl cholinesterase sodium and potassium ATPase activity.

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- 6 Electrophysiological demonstration of biopotentials and conduction velocity.
- 7 Determination of maze learning and estimation of proteins in hippocampus.
- 8 Biochemical differentiation of fast and slow muscles – SDH, LDH activities.
- 9 Induction of stress and estimation of glycogen, lactate, AChE and Na-K ATPase activities.

Suggested Books

- 1 Physiology and biophysics – Ruch and Patten.
- 2 A text book of muscle physiology – D. A. Jones and J. M. Round.
- 3 Neurobiology – Gordon M Sheperd.
- 4 Principles of neural science – E. Kandel and others.
- 5 Essentials of neural science and behaviour – E. Kandel and others.
- 6 Behavioral neuroscience – Cottman.
- 7 From Neuron to Brain – Nichollas, J. G. others.
- 8 Neuroscience – A. Longstaff .
- 9 Elements of molecular Neurobiology – C U M Smith.
- 10 Physiology of excitable cells – D. J. Aidley.
- 11 Text book of medical physiology – Guyton.

UNIT I: Overview of Entomology. 15 Hrs

- 1.1. Significance of Insects to human importance: Reasons why insects are so successful.
- 1.2. Classification of Class Insecta and Arachnida with special emphasis medically important Arthropods.
- 1.3. Insect Morphology: Exoskeleton, Head, thorax, and abdomen.
- 1.4. Insects Physiology: Digestive system, Excretory system, Circulatory system, Reproductive system, Nervous system, and Endocrine system.
- 1.5. Insect Development: Growth & development, Metamorphosis.

UNIT II: Biology of medically important Insects 15 Hrs

- 2.1. Diptera: Mosquitoes (Anopheles, Aedes, Culex), Housefly, Horsefly, Tsetse fly and Sand fly.
- 2.2. Hemiptera: Bed bugs.
- 2.3. Siphonaptera: Flea.
- 2.4. Siphunculata: Head louse, Body louse and pubic louse.
- 2.5. Dictyoptera: Cockroaches.

UNIT III: Insect Ecology & Behaviour 15 Hrs

- 3.1. Insects and climate: Temperature, Light, Rainfall, Wind and Influence of Climate change.
- 3.2. Insect population dynamics: Population functions and factors affecting population size.
- 3.3. Climate change and its influence on Malaria in India.
- 3.4. Community ecology: Classes of interaction, factors affecting interaction and consequences of interaction.
- 3.5. Insect behavior: mating, feeding and defensive strategies.

UNIT IV: Arthropod-borne diseases and 15hrs

- 4.1. Bacterial diseases - Plague, Rickettsiasis, Bartonellosis.
- 4.2. Viral disease – Dengue, Japanese Encephalitis, Chikungunya, Zika.
- 4.3. Protozoan diseases – Leishmaniasis, Malaria, Trypanosomiasis.
- 4.4. Helminthic diseases – Filariasis (Wuchereria, Brugia, Loa).
- 4.5. Direct injury, Annoyance, Allergies, toxins, myiasis and venomous arthropods.

PRACTICALS:

1. Insect Collection and Preservation methods.
2. Collection of medically important Insects and identification up to genus level.
3. Maintenance and study the stages life cycle of Cockroach / house fly / mosquito.
4. Preparation of permanent mounts of mosquito respiratory siphon and trumpet.
5. Preparation of permanent mounts of Insect leg and antennae.
6. Preparation of permanent mounts of wings of Cockroach / house fly / mosquito.
7. Dissection, mounting and preparation of permanent slides of Insect mouth parts.

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8. Dissection of salivary glands of Cockroach / house fly / mosquito.
9. Dissection of Digestive system, nervous system and reproductive system of Cockroach / house fly / mosquito.
10. Dissecting and mounting of male and female genitalia of Cockroach / house fly / mosquito.
11. Collection of venomous Arthropods and identification.
12. **Maintenance of Insect / venomous arthropod collection box. (**Submission of Insect / venomous arthropod collection box is must during the practical examination)

References:

1. Biology of Disease Vectors, 2nd Ed., William C. Marquardt, 2004, Elsevier Academic Press.
2. Medical and Veterinary Entomology, 2nd Ed., Gary Mullen & Lance Durden.
3. Medical Entomology: A Textbook on Public Health and Veterinary Problems Caused by Arthropods, Revised Edition. by Bruce Eldridge & John Edman.
4. Medical Toxicology by Richard C. Dart. Pub: Lippincott Williams & Wilkin.
5. Manual of Medical Entomology by Deane P. Furman & Paul Catts.
6. Infectious Diseases of Arthropods by Goddard.
7. Medical Entomology for Students 5th edition by Mike Service.
8. General and Applied Entomology by David and Ananthkrishnan.
9. Destructive and Useful Insects by R. L. Metcalf.
10. Ecology of Insects by Martin R. Speight Pub: Wiley-Blackwell.
11. Insect ecology by Timothy D. Schowalter 3rd Edition. Pub: Elsevier, 2011.

Semester - III
Elective I
Paper III - PARASITOLOGY - I

- UNIT-I: Morphology, Anatomy and Classification 15 Hrs
- 1.1 An overview and classification of Monogenea, Aspidogastrea, Digenea and Cestoda.
 - 1.2 Ultra structure and function of tegument.
 - 1.3 Digestive system, feeding and mechanism of digestion.
 - 1.4 Excretory system, paranephridial system and lymphatic system.
 - 1.5 Nervous system and its mechanism; sense organs and its functions.
- UNIT-II: Reproduction, Ecology and Evolution 15 Hrs
- 2.1 Reproductive system, egg shell formation, types of eggs, and morphology of larval forms.
 - 2.2 Population concept, factors regulating population, dispersion concept.
 - 2.3 Origin and evolution of Monogenea, Aspidogastrea, Digenea & Cestoda.
 - 2.4 Helminthes' host specificity and its breakdown.
 - 2.5 Host – parasite interactions and their significance; the role of helminthes as vectors of microbial infection.
- UNIT-III: Trematode and Cestode Diseases 15 Hrs
- 3.1 Trematode and Cestode parasites of humans; Morphology, life cycle, pathogenicity, diagnosis, treatment, and control measures of *Clonorchis sinensis*, *Fasciolopsis buski*, *Hymenolepis nana* and *Echinococcus granulosus*.
 - 3.2 Helminthes of livestock with emphasis on *Fasciola hepatica* and *Moniezia* spp.
 - 3.3 Life cycle and pathogenicity of Trematode parasites - *Dactylogyrus* spp. and *Gyrodactylus* spp.
 - 3.4 Life cycle and pathogenicity of Cestode parasites - *Diplostomum* spp. *Sanguinicola inermis*.
 - 3.5 General account of Trematode and Cestode parasites of wild animals with emphasis on *Dicrocoelium dendriticum* and *Echinococcus multilocularis*.
- UNIT -IV: Adult metabolism, Anthelmintics and Immunology 15 Hrs
- 4.1 Carbohydrate metabolism - Glycolysis (EMP-pathway), CO₂ fixation, PK/PEPCK branch point, malate dismutation; role of TCA cycle, Electron Transport chain - oxidation.
 - 4.2 Protein composition and metabolism-Amino acid catabolism, transamination.
 - 4.3 Lipid composition and metabolism-fatty acid metabolism and role of β oxidation.
 - 4.4 Immunity to schistosomiasis and fascioliasis; evasion of immunity and molecular mimicry.
 - 4.5 Role of arthropods and molluscs in spreading of helminth diseases.

PRACTICALS:

1. Collection, fixation, and staining techniques of permanent whole mount preparations and identification of Monogeneans, Digeneans, Aspidogastrea and Cestode (Host Fishes, water snakes, birds, sheep, goat and cattle viscera).
2. *Fasciola* smear preparation, staining and study for eggs & concentration.

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3. Collection and examination of infective larvae from intermediate hosts, snails, microcrustaceans (Cyclops, Gammarus etc., fishes).
4. Effect of light, and temperature on the emergence of cercaria.
5. Estimation of total proteins, carbohydrates and lipids in helminthes.
6. Measurement of infection: Prevalence, density, intensity and index of helminth parasites.

Reference books:

1. Animal parasitology – J. D. Smyth (Cambridge Univ. Press., 1976).
2. Foundations of parasitology 6 ed. – L. S. Roberts & J. Janovy Jr (McGraw Hill Publ., 2000).
3. Parasitism – A. O. Bush, J.C. Fernandez & J. R. Seed (Cambridge Univ. Press, 2000).
4. Helminthology – Eds. N. Chaudhury & I. Tada (Narosa Publ. House, 1994).
5. Helminthes, Arthropods, & Protozoa of domesticated animals 6 ed. – E.J.L Soulsby (ELBS, 1976).
6. Introduction to parasitology – B.E. Matthews (Cambridge Univ. Press. 1998).
7. The physiology of Trematodes – J.D. Smyth & D. W. Halton (Cambridge Univ. Press, 1983).
8. The physiology and Biochemistry of Cestodes – J.D. Smyth & D.P. MEmanus, (Cambridge Univ. Press, 1989).
9. T.B.Fish Diseases – (Tr.) – D.A. Convoy & R.L. Herman (narendra Publ. House, 1997).
10. Hand book of Medical Parasitology – V. Zaman & L. H. Keong (K.C. Ang publishing Pvt. Ltd., 1989).
11. T.B. Medical parasitology – P. Chakraborty (New Central Book Agency, 2004).
12. Ecological Animal Parasitology – C. R. Kennedy (Black well Scientific Publ., 1975).
13. Infectious Diseases of fish – S. Egusa (Oxonian Pvt. Ltd., New Delhi, 1978).
14. A.T.B. of Parasitology 2 ed. – S. S. Kekar & R.S. Kelkar (Bomby popular Prakshan, 1993) .

UNIT I – Comparative Aspects of Digestion and Nutrition 15 Hrs

- 1.1 Scope, principles and validity of comparative approach to physiology.
- 1.2 Origin of nutritive types - special dietary requirements of some animals, amino acid requirements, and essential vitamins.
- 1.3 Mechanisms of food intake and feeding mechanisms, comparative physiology of digestive enzymes and regulatory mechanism of digestion.
- 1.4 Coordination of digestive activities - visceral autonomic system and gastro intestinal hormones.
- 1.5 Comparative aspects of carbohydrate pathways - Glycolysis and gluconeogenesis pathways and regulation.

UNIT II – Comparative Aspects of Respiration 15 Hrs

- 2.1 Availability of oxygen, uptake of oxygen and factors that it influence uptake.
- 2.2 Oxygen consumption by intact animal, modifying agents.
- 2.3 Adaptations to diving and high altitudes.
- 2.4 Comparative aspects of transport of oxygen and carbon dioxide; regulation of respiration.
- 2.5 Respiratory pigments in different phylogenetic groups, genes with reference to hemoglobin.

UNIT III – Osmoregulation, Excretion and Thermoregulation 15 Hrs

- 3.1 Problem of osmoregulation and biological responses in different environments.
- 3.2 Comparative aspect of osmoregulation in different animal groups.
- 3.3 Excretory organs and general mechanisms of excretion in various animal groups.
- 3.4 Freezing, winter hardening, lethal limits and resistance adaptation; behavioral and locomotory adaptations; heat regulation - physical and chemical.
- 3.5 Temperature regulation in homeotherms; neural mechanism of thermoregulation.

UNIT IV – Deranged metabolism and disorders 15 Hrs

- 4.1 Effects of colonic bacterial flora (beneficial and harmful effect); lactose intolerance, GERD.
- 4.2 Liver cirrhosis and its causative agents; fatty liver.
- 4.3 Chronic obstructive pulmonary disease – Asthma, sleep apnea, and snoring.
- 4.4 Electrolyte imbalance - Acidosis, alkalosis; Dialysis.
- 4.5 Heat stroke; thirst and its physiological mechanism.

PRACTICALS

- 1 Estimation of levels of lactic acid and free amino acids levels.
- 2 Effect of Heterosmotic media on blood chlorides in any one animal- crustacean/fish.

- 3 Effect of acclimatization to hetero osmotic media on SDH, LDH in gills and muscle tissue of crustacean/fish.
- 4 Effect of starvation on glycogen levels in fish/crab.
- 5 Effect of starvation on free amino acids in liver and muscles of fish/crab.
- 6 Starvation induced changes in aminotransferases in fish/crab.
- 7 Starvation induced changes in excretory products in fish.
- 8 Acclimatization to cold and high temp in fish/crab and its effect on oxygen consumption.
- 9 Effect of thyroid and anti thyroid agents on oxygen consumption in fish.

Suggested Books

1. Comp. Animal Physiology by Ladd Prosser (Publ. W. B. Saunders, Philadelphia).
2. Comp. Animal Physiology by William Hoar. (Pub. E.E.E. IBH).
3. Animal Physiology – Adaption and function By F. Reed Hainswoth (Publ. by Addison – Wesley Publ. Company, Calofornia).
4. Animal Physiology by Kent Schmidt Nielson (Publ. E.E.E. IBH).
5. Animal Physiology and adaptation by David Gordon.
6. Animal Physiology by Wilson.
7. Concise Medicalphysiology by Sujit K. Chaudari.
8. Text book of medical physiology by Arthur Guyton.

UNIT I – Introduction to Fisheries 15 Hrs

- 1.1 History of fisheries, perspectives and prospects of Indian fisheries.
- 1.2 General account of systematic classification of fishes.
- 1.3 Classification of fisheries.
- 1.4 Fisheries resources and management.
- 1.5 Fishery economics.

UNIT II – Ecology of Water Bodies 15 Hrs

- 2.1 Ecology of lentic and lotic ecosystems.
- 2.2 Ecosystem energetic, trophodynamics and ecological productivity.
- 2.3 Physico-chemical characteristics of freshwater, brackishwater and Marine water.
- 2.4 Dynamics of fish population- fecundity, recruitment and harvesting.
- 2.5 Aquatic pollution and its impact on fisheries, eutrophication.

UNIT III – Biology of Cultivable Organisms and Culture Systems 15 Hrs

- 3.1 Criteria for selection of fish species for culture.
- 3.2 Biology of Indian and exotic major carps.
- 3.3 Biology of cultivable prawns and crabs.
- 3.4 Biology of cultivable mollusks, oysters and echinoderms.
- 3.5 Culture systems of fishes, prawns and crabs: open, closed, semi intensive and intensive.

UNIT IV – Fishing Crafts, Gears and Fish Biotechnology 15 Hrs

- 4.1 Fishing Crafts – Non-mechanized and mechanized vessels and maintenance of boats.
- 4.2 Fishing Gears – Gear material, gear making, accessories; types of gear and their preservation.
- 4.3 Cryopreservation; transgenic fish; fish genomics – chromosomal mapping, inbreeding genetic markers.
- 4.4 Sex reversal; monosex culture; hybridization.
- 4.5 Fish processing and preservation; fish by-products and value added products.

PRACTICALS

- 1 Water analysis- pH, dissolved oxygen, total alkalinity, salinity, calcium, magnesium, nitrates, nitrites, phosphates, total dissolved solids, suspended solids, turbidity.
- 2 Soil analysis – pH, total alkalinity, electric conductivity, C/N ratio.
- 3 Identification of fishing crafts and gear models.
- 4 Fabrication of nets.

Suggested Books

- 1 Water quality criteria for fresh water fish. Albastor, J. S. and Lloyd, R. Butterworth Scientific.
- 2 Fish and Fisheries of India – Jhingran, V. G. Hindustan Publishing Corporation New Delhi.
- 3 The fishes of India – Francis. Day. Vol. I &II, New Delhi – CSIR.
- 4 The freshwater fishes of Indian Region – Jayaram, KC. Narendra Publishing house, New Delhi.
- 5 Prawns and prawn fisheries – Kurian, C.V. and Sebastian, V. O. Hindustan Publishing Corporation, New Delhi.
- 6 A manual of freshwater aquaculture – Santhanam, R. Sukllnaran. N. Natarajan Oxford and IBH Publishing Company, New Delhi.
- 7 Freshwater aquaculture – Rath, R. K. Scientific Publishers, Jodhpur.
- 8 Text book of fish culture, breeding and cultivation of fish – MareelHuet, Fishing News Books.
- 9 Aquaculture development, processes and prospects – TVR Pillaay Fishing news books.
- 10 Aquaculture – John, E. Bardach, John H. Ryther, W.O. Mclamey, John Willey and Sons, New York.
- 11 Fish Ecology – RJ. Wotton, Dalckie, Chapman and Hall, New York.
- 12 Environmental stress and fish diseases – Wedemeye, G. A. Narendra. Publishing House.
- 13 Diseases of fishes – C. Vandujn, Narendra Publishing House, New Delhi.
- 14 Aquaculture Principles and Practices by T. V. R. Pillay.

M.Sc. Zoology Semester - III
Elective II
Paper IV - Applied Toxicology

- UNIT I – Principles of Toxicology 15 Hrs
- 1.1 Definition, scope and importance of toxicology; classification of toxic agents - natural toxins, animal toxins, plant toxins, food toxins, genetic poisons and chemical toxins.
 - 1.2 Dose, dose effect and dose response relationship – Acute toxicity, chronic toxicity; toxic kinetics.
 - 1.3 Factors affecting toxicity - species and strains, age, sex, nutritional status, hormone, environmental factors.
 - 1.4 Absorption and distribution of toxicants, portals of entry – Skin, gastrointestinal tract and respiratory system.
 - 1.5 Bio-accumulation, bio-magnification, bio-transformation and elimination of xenobiotics.
- UNIT II – Biochemical toxicology 15 Hrs
- 2.1 Mechanism and reactions of toxicants - Covalent bonding, non-covalent bonding and enzymatic reactions.
 - 2.2 Lipid peroxidation – Reactive Oxygen Species (ROS) and Reactive Nitrogen Species (RNS); Mechanism of Reactive Oxygen Species production; Superoxide, hydrogen peroxide and hydroxyl radicals in toxicity of xenobiotics.
 - 2.3 Oxidative Stress – Consequences of oxidative stress; protein and DNA damage.
 - 2.4 Antioxidant defense mechanism – Role of glutathione, superoxide dismutase, metallothionein.
 - 2.5 Xenobiotic induced intracellular and cellular alterations.
- UNIT III - Systemic toxicology 15 Hrs
- 3.1 Basics of organ toxicity - Target organs, organ selectivity and specificity.
 - 3.2 Hepatotoxicity - susceptibility of the liver; Types of liver injury and biochemical mechanism.
 - 3.3 Pulmonary toxicity – Lung injury, systematic lung toxins, lung pathology.
 - 3.4 Renal toxicity – susceptibility of the kidney to toxicants; Chemical induced renal injury.
 - 3.5 Neuro toxicity – Effect of toxic agents on neurons, ion channel neurotoxins; Lesions of neural tissue.
- UNIT IV - Environmental and Occupational Toxicology 15 Hrs
- 4.1 Eco-toxicology of heavy metals – Mechanism of heavy metal toxicity; Case studies of Arsenic, Mercury and Cadmium.
 - 4.2 Environmental problems by organochlorine and organophosphate pesticides; case studies of DDT, endosulphan, parathion and malathion.
 - 4.3 Occupational hazards - physical, chemical, biological and mechanical hazards. Occupational diseases: Pneumoconiosis, silicosis, asbestosis; Prevention of occupational diseases.

- 4.4 Carcinogenesis – Carcinogen types, mechanisms of carcinogenesis; Skin cancer, lung cancer and leukemia.
- 4.5 Legislation and Regulation – Federal government, State government; Legislation and regulation in other countries.

PRACTICALS: (All experiments involving live animals are for demonstration only)

- 1 Determination of LC50/LD50 of selected toxicant (bioassay method).
- 2 Determination of LPO activity by TBRAS method.
- 3 Effect of toxicant on glycogen, glucose and amino acids.
- 4 Hepato-toxicant effect on Total Bilirubin Content (direct and indirect method).
- 5 Estimation of SGOT and SGPT as a marker enzyme for hepatotoxicity.
- 6 Estimation of serum creatinine activity as a marker enzyme for Renal toxicity.
- 7 Micronuclei test.
- 8 Estimation of Hemoglobin and RBC in Lead exposed experimental animals.
- 9 Estimation of AchE activity as a marker of pesticide poisoning.

UNIT I - Introduction to Bioinformatics & Sequencing Alignment Concepts 15Hrs

- 1.1. Need of computers in biology research.
- 1.2. Bioinformatics - Introduction, scope and applications.
- 1.3. File Transfer Protocol (FTP), TELNET, HTTP, Internet.
- 1.4. Pair wise Alignments; Local, Global alignment; Gap- Gap penalty.
- 1.5. Comparison of pair-wise and multiple alignments.

UNIT II - Biological Databases and Datamining 15Hrs

- 2.1. Biological information on the web; Introduction to databases.
- 2.2. Classification of biological databases; Information retrieval from databases.
- 2.3. Sequence database searches FASTA, BLAST programs.
- 2.4. Amino acid substitution matrices - PAM and BLOSUM.
- 2.5. Data Mining and Visualization Tools - RASMOL and PDB viewer.

UNIT III - Phylogenetic Analysis & Genome Mapping and Prediction 15Hrs

- 3.1. Understanding evolutionary process; Origins of molecular phylogenetics.
- 3.2. Phylogenetic analysis algorithms - Maximum Parsimony, UPGMA, Neighbor-Joining.
- 3.3. Probabilistic models of evolution - Maximum Likelihood algorithm; Bootstrapping method; use of tools such as PHYLIP, MEGA and PAUP.
- 3.4. Genome sequencing; Genome mapping; Human genome mapping project.
- 3.5. Gene prediction methods and tools; Gene annotation in prokaryotes and eukaryotes.

UNIT IV - Protein Structure Prediction Methods 15Hrs

- 4.1. Basics of protein biology (Classification, structural organization, domains & motifs).
- 4.2. Protein structure prediction concepts: Secondary and tertiary structure predictions; Chou-Fasman method, GOR methods, neural network methods.
- 4.3. Homology modelling; abintio method, threading methods.
- 4.4. 3-D structure visualization and simulation - Visualization of structures using SPDBV.
- 4.5. Structure-based drug discovery; binding sites detection; docking.

PRACTICALS:

1. Bioinformatics databases - NCBI
2. Pairwise sequence alignment using BLAST
3. Sequence similarity searching for DNA
4. Multiple sequence alignment and editing - CLUSTALW
5. Phylogenetic analysis using distance based methods & character based methods using PHYLIP

6. Gene prediction tools – ORF Finder.
7. Prediction of secondary structure of proteins – Homology modeling using GCG.
8. Sequence based prediction and validation of 3d Protein structure – 3D check or Procheck.
9. Docking studies using GOLD or AMBER.

Text books:

1. Bioinformatics. Genome and sequence analysis by David Mount, CSH Publications
2. Essential Bioinformatics by Jin Xiong, Cambridge University Press, 2011.

References

1. Cynthia Gibas, Per Jambeck, "Developing Bioinformatics Computer Skills", O'Reilly Media, Inc., 2001.
2. David Edwards, Jason Eric Stajich, David Hansen, "Bioinformatics: Tools and Applications", Springer, 2009.
2. David W Mount, "Bioinformatics: Sequence and genome analysis", Cold spring harbor laboratory press, 2nd edition, 2004.
3. Stan Tsai C., "Biomacromolecules: Introduction to Structure, Function and Informatics", John Wiley & Sons, 2007.
4. Attwood T K, D J Parry-Smith, "Introduction to Bioinformatics", Pearson Education, 2005.
5. Parag Rastogi, "Bioinformatics Methods And Applications: Genomics Proteomics And Drug Discovery", PHI Learning Pvt. Ltd., 3rd edition, 2008.
6. Computational Molecular Biology – An Introduction by Peter Clote, Rolf Backofen, John Wiley & Sons.
7. Bioinformatics: Methods and Applications- SC Rastogi, N Mendiratta & P Rastogi.
8. Bioinformatics Principles & Applications by Zhumur Ghosh, Oxford University Press

UNIT I – Chemical and Neural Integration 15 Hrs

- 1.1 Scope and position of endocrinology.
- 1.2 Concept of neurohumors and neurotransmitters.
- 1.3 Characteristics of neural and hormonal integration, neuro-endocrine mechanism.
- 1.4 Hormones as chemical messengers; Regulation of hormone secretions.
- 1.5 Concept of internal environment and homeostasis.

UNIT II - Endocrine Glands and their Hormones 15 Hrs

- 2.1 Invertebrate endocrine system – Hormones and their functions (Coelenterata and Annelida).
- 2.2 Invertebrate endocrine system – Hormones and their functions (Arthropoda and Echinodermata).
- 2.3 Hypothalamus and its secretions.
- 2.4 Vertebrate endocrine glands – Structure, hormones and functions of pituitary, thyroid, parathyroid and thymus.
- 2.5 Vertebrate endocrine glands – Structure, hormones and functions of adrenal, pancreas, pineal, gastro-intestinal tract and gonads.

UNIT III - Chemistry of Hormones and Mechanism of Hormone Action 15 Hrs

- 3.1 Classification of hormones.
- 3.2 Biosynthesis of release and transport of amino acid derivatives.
- 3.3 Biosynthesis and transport of peptide and steroid hormones.
- 3.4 Membrane bound and intra cellular receptors.
- 3.5 Mechanism of action of amino acid derivatives, peptide and steroid hormones.

UNIT IV - Clinical and Applied Endocrinology 15Hrs

- 4.1 Obesity – Role of hormones and its metabolic complications – The role of Adipokines Insulin Resistance and Dyslipidemia.
- 4.2 Hormones in IVF, pregnancy testing, and Amniocentesis.
- 4.3 Clinical disorders of male and female gonads.
- 4.4 Pheromones in applied endocrinology; Induced breeding in fish.
- 4.5 Hormones in Sericulture and Apiculture.

PRACTICALS:

- 1 In situ demonstration of endocrine glands of rat.
- 2 Histology slides of Endocrine glands - Pituitary, Thyroid, Parathyroid, Thymus, Adrenal, Pancreas, Ovary & Testis, and Uterus.
- 3 Effect of Eye Stalk ablation on Blood Glucose levels in Crabs.
- 4 Identification of Gonadotrophin in Human urine samples.
- 5 Effect of thyroxin and thiourea (antithyroid agent) on oxygen consumption in fish.

- 6 Effect of parathormone on serum calcium levels in Rat.
- 7 Effect of insulin and adrenalin on blood glucose levels in Rat.

Suggested Books

- 1 Comparative Endocrinology of Invertebrates by Highman and Hill.
- 2 Comparative Vertebrate Endocrinology by P.J.Bentley, Cambridge Univ. Press.
- 3 General and Comparative Endocrinology by E.J.W. Barrington, Oxford Clarendon Press
- 4 Endocrinology Vol.1-3 by DeGroot L.J.et.al.
- 5 Text Book of Endocrine Physiology by C.R.Martin, Oxford Univ.Press, New York.
- 6 Text Book of Endocrinology by Turner and Bangnara (W.B.Sanders).
- 7 Vertebrate Endocrinology by Mc.Hadley.
- 8 Text Book of Comparative Endocrinology by Gorbman A, and Bern H.A., John Harley and Sous, New York.
- 9 Essential Endocrinology by JoenLaycock and Peter Loise Oxford Univ. Press.
- 10 A Text Book of Medical Physiology by ArthrumaC.Gnyton.
- 11 Text Book of Endocrinology by R.H.Williams (W.B.Saunders).

UNIT I - Introduction, Taxonomy and Collection Methods 15 Hrs

- 1.1 Introduction to plant parasitic nematodes, historical perspective and their significance.
- 1.2 Scope, significant and development of phytonematology in India.
- 1.3 General characters, taxonomy upto family level with representative examples.
- 1.4 Techniques of nematode collection from different habitats (soil, root, shoot, leaf, seed and galls).
- 1.5 Collection of nematodes, counting, fixing, staining, mounting, micrometry and deMan's ratio.

UNIT II - Morphology and life cycles 15 Hrs

- 2.1 General account of nematodes, morphology and pattern of life cycles.
- 2.2 Structure of cuticle, cuticular modifications, structure of body wall and musculature.
- 2.3 Habit, habitat, life history and pathology of Rice nematode (*Hirschmaniella*) and Lance nematode (*Hoplolaimus*).
- 2.4 Habit, habitat, life history and pathology of Cyst nematode (Heterodera) and Root-knot nematode (*Meloidogyne*).
- 2.5 Predatory nematodes and control measures.

UNIT III - Feeding, pathology and symptoms 15 Hrs

- 3.1 Digestive system –Types of oesophageal modifications and associated digestive glands.
- 3.2 Types of stylet and feeding mechanisms.
- 3.3 Host and nematode parasite relationship; Nematode injury – histopathology.
- 3.4 Field symptoms - General and specific (above ground and below ground).
- 3.5 Nematode associations and formation of disease complexes.

UNIT IV - Nematode control 15 Hrs

- 4.1 Physical methods – Tilling, fallowing, sun drying, hot water treatment, fumigation.
- 4.2 Cultural practices - Crop rotation, trap crops.
- 4.3 Chemical control of nematodes and its consequences in the ecosystem.
- 4.4 Biological control of nematodes and its field application.
- 4.5 Integrated Nematode Management (INM).

PHYTONEMATOTOLOGY – PRACTICALS

1. Collection of soil and plant parasitic nematodes by various techniques.
2. Nematode counting and calculations (frequency).
3. Nematode fixing, staining and mounting methods.
4. Identification of phytonematodes by deMan's ratio.
5. Identification of predominant plant parasitic nematodes of the following crops:
 1. Rice
 2. Ground nut
 3. Vegetables

6. Field trip – Observation Book.

List of Books

1. Principals of Nematology – Thorne.
2. Nematology - Saucer and Jenkins.
3. Plant parasitic nematodes – Zuckerman, Mei and Rhode.
4. Nematology ecology –and plant diseases – H.R.Wallace.
5. Plant nematodes and their control – Heinz Decker.
6. Plant nemotology – Siddiqui and Jairajpuri.
7. A treatise on Phytoneematology – P.Parvata Reddy.
8. An introduction to plant nematology – J.C.Edwards and S.L.Mishra.
9. Soil and fresh water nematodes – T.Goodey.
10. A manual of Agricultural Helminthology-Filipjev I.N.and Schurmann Steckovan J. H.
11. Introduction to Nematology – Chitwood B.G. and Chitwood M.B.
12. The biology of plant parasitic nemotodes –Wallace H.R.
13. Plant nematology – Edited by Southy J.F.
14. Biological Control – Shamim Jairajpuri et al.
15. Plant Phathogens – Nematodes – R.S.Singh and J.Sita ramaiah.
16. Phytoneematology – Mrinal K.and Dasgupta.
17. Nematode vectors of plant viruses – C.E.Taylor and B.J.F.Brown.
18. Root Parasitic nematodes – Hoplolaimidae.
19. Plant pathology – George N Agrios.

UNIT I - Introduction 15 Hrs

- 1.1 Introduction - Sericulture as an agro industry
- 1.2 Mulberry cultivation - Varieties of Mulberry, Agroclimatic conditions for Moriculture, Agricultural practices - Tilling & systems of Planting, intercultivation. Mulching, Pruning, Manuring, Harvesting and Preservation of leaves.
- 1.3 Diseases of Mulberry and their management - Bacterial diseases, Viral diseases, Fungal diseases
- 1.4 Mineral deficiency diseases and their management
- 1.5 Insect Pests of Mulberry and their management

UNIT II - Biology of silk worms and food plants 15 Hrs

- 2.1. Biology, food plants and culture of mulberry (Bombyx) and non mulberry Silkworms (tasar, eri & muga)
- 2.2. External morphology of silkworm - egg, larva, pupa & adult
- 2.3. Internal morphology of silkworm - Digestive, respiratory, nervous, excretory and reproductive systems
- 2.4. Morphology and anatomy of silk glands.
- 2.5. Properties and composition of silk.

UNIT III - Silkworm rearing 15 Hrs

- 3.1 Rearing House and rearing appliances.
- 3.2 Environmental conditions for silkworm rearing.
- 3.3 Rearing of early stages (Chawki rearing) and late stages of silk worms.
- 3.4 Mounting and harvesting of silkworm cocoons.
- 3.5 Silkworm diseases and pests.

UNIT IV - Harvesting technology 15 Hrs

- 4.1 Transport of cocoons to the cocoon markets.
- 4.2 Commercial characters of cocoons, defective cocoons and price fixation
- 4.3 Reeling technology – mulberry and vanya silk rearing.
- 4.4 Seed technology – Grainage, DFLs.
- 4.5 By-products- types and uses.

PRACTICALS:

1. Rearing appliances
2. Study of life history of silkworm by rearing.
3. Identification of different types of silk worms - Mulberry, Tasar, Eri and Muga
4. Identification of defective cocoons
5. Sex differentiation of larva, pupa and adult silkworms
6. Preparation of permanent slides of month parts, spiracles and appendages of larva

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7. Dissection of silk glands of the silk worm larva
8. Dissection of digestive and nervous systems in the larva
9. Dissection of reproductive organs in the adults moths
10. Calculation of Shell Ratio.
11. Visit to the Cocoon market.
12. Visit to the Reeling Centre and Grainage Units

Books recommended:

1. FAO Manuals
2. Ullal and Narasimhanna: Hand Book of Practical Sericulture
3. Manjeet Singh Jolly: Appropriate Sericulture Techniques
4. CSB Bulletins of Sericulture
5. Ganga and Sulochana Shetty: An Introduction to Sericulture
6. NCERT Manuals of Sericulture

UNIT I - Wildlife in India and its conservation 15 Hrs

- 1.1 Physiographic zones: Himalayas, Indo-Gangetic plains and Deccan Plateau; Biogeographic Zones and their characteristics
- 1.2 Forest types of India and associated wildlife: Evergreen forests, Deciduous forests, Littoral and Swamp forest (Mangrove forest), Thorn forest, Tropical forests, Temperate forests, Sub Alpine forest, and their sub types
- 1.3 Biodiversity hotspots; Protected Area Network of India: Wildlife Sanctuaries, National Parks, Biosphere Reserves, and Community Conservation Areas
- 1.4 Threatened wildlife of India; Laws and legislations: Wildlife Protection Act, Biodiversity Act
- 1.5 International treaties for wildlife conservation: Convention on Biological Diversity (CBD); Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES); Convention on Migratory Species (CMS)

UNIT II- Herpetology 15 Hrs

- 2.1 Systematics of amphibians and reptiles; amphibian diversity in India; reptilian diversity in India
- 2.2 Herpetofaunastudy techniques: signs (visual, acoustics and indirect evidence); capture techniques – pitfall traps, drift fencing, noose, hooks and tongs, handling, measuring, sexing and aging herpetofauna; Survey techniques – quadrat (random and clustered), transect, visual encounter survey
- 2.3 Inventorying and monitoring techniques: time and area constraint searches, active sampling (dipnetting, kick sampling, stove piping, egg mass and nest counts, basking surveys)
- 2.4 Capturing, handling, measuring, sexing and aging amphibians, turtles and tortoises, lizards and non-venomous snakes; photography and photo-vouchering
- 2.5 Effects of climate change on herpetofauna; amphibian extinctions, chytrid infection; range shifts among reptiles

UNIT III - Ornithology 15 Hrs

- 3.1 Systematics of birds; bird diversity in India; observational techniques for aquatic and terrestrial birds
- 3.2 Breeding biology: mating systems, courtship, nest building, types of nests; foraging behaviour, food (trophic status), territoriality; social systems - solitary, communal, flocks (single species and mixed species)
- 3.3 Bird communities - guilds, stratification, resource partitioning; economic importance of birds; effects of anthropogenic activities on birds
- 3.4 Bird study techniques: bird signs (visual and acoustics); capture techniques - nets and traps, handling, measuring, sexing and aging birds; Survey techniques - transects (point and line), nest monitoring, capture and marking
- 3.5 Birds as environmental indicators – habitat quality, pollution, biodiversity and disease outbreaks

UNIT IV - Mammalogy

- 4.1 Systematics of mammals; mammalian diversity in India; observational techniques for non-volant and volant mammals
- 4.2 Capturing mammals: Capture devices, baits, trap arrays and interval for small terrestrial and volant mammals; sexing and aging mammals
- 4.3 Mammalian study techniques: Visual, olfactory and acoustic signs; remote trip cameras and GPS tags; data handling, analysis and interpretation
- 4.4 Estimation of mammal abundance, species richness, population size and density
- 4.5 Human health concerns in wildlife surveys; ethics in wildlife research – legal and cultural considerations; trapping, processing and handling animals

Practicals

- 1 Mapping the biogeographic zones of India using free open source online resources
- 2 Determination of herpetofaunal diversity through visual encounter surveys
- 3 External morphological measurements and sexing of amphibians
- 4 External morphological measurements, pholidosis and sexing of gecko
- 5 External morphological measurements a bird
- 6 External morphological measurements, sexing and aging of a rat
- 7 Craniodental measurements and analyses of relationships between parameters using mammalian skull
- 8 Estimation of density of birds using strip transect method
- 9 Inventorying bird species richness and calculating diversity indices
- 10 Calculation of diversity and evenness indices between two habitats using birds as example
- 11 Preparation of species distribution map using DIVA GIS
- 12 Acoustic surveys of bats and analysis of call data
- 13 Visit to Nehru Zoological Park / any protected area for field study

List of Books

1. Fundamentals of Wildlife Management. By Rajesh Gopal
2. Ecological Census Techniques: A Handbook. By Sutherland, W.J.
3. Wildlife Biology. By Raymond F. Dasmann
4. A Field Guide to Birds of the Indian Subcontinent. By Krys Kazmierczak
5. The Book of Indian Animals. By S.H. Prater
6. The Book of Indian Reptiles and Amphibians. By J.C. Daniel
7. Snakes of India: The Field Guide. By Romulus Whitaker & Ashok Captain
8. Amphibians of Peninsular India. By R.J. Ranjit Daniels
9. South Asian Mammals: Their Diversity, Distribution, and Status. By Chelmala Srinivasulu and Bhargavi Srinivasulu

UNIT I - Introduction and Animal Improvement 15 Hrs

- 1.1 Introduction to biotechnology- scope, importance and its applications.
- 1.2 Mammalian reproductive systems and gametogenesis.
- 1.3 In vitro fertilization and embryo transfer; ICSI, sperm sexing.
- 1.4 Cryopreservation, cryoprotection and gamete banking.
- 1.5 Biotechnology in improvement of live stock herds and breeding selected traits.

UNIT II - In vitro culture of cells and tissues 15 Hrs

- 2.1 Cell culture - Equipment and materials for cell culture technology, principle of sterile techniques and cell propagation, primary and established cell line cultures.
- 2.2 Mammalian cell lines & their characteristics.
- 2.3 Basic techniques of mammalian cell culture in vitro, disaggregating of tissue and primary culture, maintenance of cell culture, cell separation.
- 2.4 Tissue culture system – cell tissue fragment, organ and embryo cultures, merits and demerits.
- 2.5 Scaling-up of animal cell culture, cell synchronization, cell cloning, micromanipulation, cell transformation.

UNIT III - Production of recombinant organisms and transgenic animals 15 Hrs

- 3.1 Cloning of mammals.
- 3.2 Transgenic animals; creation of transgenic mice, retroviral vector method, Microinjection, embryonic stem cell method – short gun, electroporation, lipofection, microinjection.
- 3.3 Production of other transgenic animals – cattle, sheep, pigs and fish.
- 3.4 Large scale culture and production from genetically engineered animal cell culture
- 3.5 Large scale culture and production from recombinant microorganisms –Downstream processing.

UNIT IV - Application of Biotechnology 15 Hrs

- 4.1 Medical biotechnology – Application of RFLP in forensic science, hybridoma technology and production monoclonal antibodies.
- 4.2 Environmental Biotechnology - Bioassay, biosensors in ecotoxicological screening; Bioleaching of metals by microorganisms; Bioabsorption of metals by bacteria.
- 4.3 Insecticide development – biopesticides; Bacillus thuringiensis – mode of action of toxin, toxin gene isolation and engineering of B. thuringiensis.
- 4.4 Biotechnology of aquaculture - sex reversal in fish and sterile fish culture.
- 4.5 Use of animals as bioreactors; Knock out model systems and their utility.

PRACTICALS

- 1 Preparation of culture media:
a) Bacteria; b) Fungi
- 2 Methods of cultivating Bacteria and Fungi
- 3 Isolation and characterization of microbes useful in fermentation.
- 4 Staining Techniques for microbes:
a) Gram's staining; b) Spore & Capsule staining;
c) Acid-fast stain; d) Fungal stains
- 5 Determination of microbial Growth Curve.
- 6 Antibiotic sensitivity test.
- 7 Yield estimation in fermentations products:
a) *Aspergillus niger*-citric acid; b) *Lactobacillus* – Lactic acid from curd; and
c) *Saccharomyces cerevisiae* (Yeast) Alcohol
- 8 Microbial evaluation of stored foods from plant/animal origin for contaminants/toxins.
- 9 Visit to Quality Control Labs.

Suggested Books

- 1 Culture of Animal cells. R. Ian Freshney, Wiley Liss.
- 2 Animal Cell culture – Practical Approach – Ed. John R W Masters, Oxford.
- 3 Animal Cell Biotechnology, 1990 – Speir, RE and Griffith, JB, Academic Press.
- 4 Molecular Biotechnology – Glick & Pasternock.
- 5 Gene manipulation – Old & Primrose.
- 6 Biotechnology – S. Mitra.

Semester- IV
Core Paper
Paper - II: Fish Biology

UNIT I - Introduction and Diversity of Fishes 15 Hrs

- 1.1. Introduction, general characteristics, evolutionary succession and fossil history of fishes.
- 1.2. The early evolution of fishes; Chondrichthian fishes - Sharks, Skates and Rays.
- 1.3. Characterization and classification of: Ostracoderms, placoderms, acanthodians, holocephali, and elasmobranchs.
- 1.4. Characterization and classification of cyclostomes, sarcopterygii, dipnoi, and actinopterygii.
- 1.5. Integumentary system - basic structure of skin, dermal and epidermal pigments, fins, and scales.

UNIT II - Fishes habits and habitats 15 Hrs

- 2.1. Buoyancy – Dynamic lift and static lift; swim bladder- structure and function.
- 2.2. Locomotion – Myotomal muscles and caudal fin oscillation mechanisms
- 2.3. Feeding mechanisms – Food habits and feeding, fish as predators and prey; Food chains and food webs.
- 2.4. Osmoregulation and ion balance – Freshwater, brackish water and marine teleosts; kidney and salt balance
- 2.5. Fish migration, migratory mechanisms, mating, and parental care.

UNIT III - Fish Biology 15 Hrs

- 3.1. Skeletal system - skull, splanchnocranium, jaw suspension and vertebral column.
- 3.2. Digestive system – Digestive tract, enzymes and digestion.
- 3.3. Respiratory mechanism – Respiratory gills and lungs.
- 3.4. Circulatory system – Heart and accessory pumps.
- 3.5. Excretory system – Excretory organs and excretion.

UNIT IV - Fish biology and Embryogenesis 15 Hrs

- 4.1. Nervous system- Central nervous system, brain and peripheral nervous system.
- 4.2. Sense organs – Olfactory, taste buds, touch receptors, photoreceptors, lateral line and internal ear.
- 4.3. Endocrine system – Pituitary gland, urohypophysis, adrenal gland, gonads, and thyroid gland.
- 4.4. Reproductive system- Male and female reproductive organs; role of hormones.
- 4.5. Embryogenesis - Early development and post embryonic development.

PRACTICALS:

1. Morphometric identification of fishes.
2. Meristic characters of fishes.
3. Dissection and preparation of permanent slides of scales.
4. Isolation of pituitary gland.
5. Identification of fish developmental stages - egg, spawn, fry fingerling and adult.
6. Dissection of Weberian ossicles.

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7. Dissection of digestive system.
8. Dissection of reproductive system.
9. Sexual differentiation of fishes.
10. Determination of chlorides in heterosmotic media.

Books:

1. Textbook Of Fish Biology & Indian Fisheries Rahul P Parihar
2. A Text Book of Fish Biology and Fisheries by S S Khanna and H R Singh,
3. Handbook of Fish Biology and Fisheries,(Vol I & II) by Paul J. B. Hart and John D. Reynolds
4. Fish Biology by, C B L Srivastava.
5. Fauna of British India, including Ceylon & Burma – by Francis Day.
6. Indian Fishes and Fisheries – Jhingran.
7. Introduction to Fish Physiology – Dr. Lynwood S. Smith
8. An Introduction to fishes – S. S. Khanna
9. Ichthyology – K.F. Lagler, John F., Bardach, R. R. Miller and D. R. May Passino

UNIT I - Sensory System 15 Hrs

- 1.1 Types of receptors, basic mechanisms of sensory transduction; sensory circuit and sensory pathways
- 1.2 Neurobiology of chemoreception – taste and smell
- 1.3 Neurobiology of somatic sense
- 1.4 Neurophysiology of hearing
- 1.5 Neurophysiology of vision

UNIT II - Sensory and Motor System 15 Hrs

- 2.1 Pain and its mechanism - physiological and neurohumoral.
- 2.2 Muscle sense – receptors, muscle spindle and GTO.
- 2.3 Neurobiology of Autonomic function; Motor hierarchies.
- 2.4 Reflex, reflex pathways and coordination of reflexes.
- 2.5 Mechanism of locomotion and movement.

UNIT III- Developmental neurobiology 15 Hrs

- 3.1 Induction and patterning of nervous system
- 3.2 Generation and survival of nerve cells, neurotrophic factors
- 3.3 Guidance of axons to their targets, synaptogenesis and developmental plasticity
- 3.4 Neural connection and their reactions to injury
- 3.5 Regeneration, reinnervation, sprouting; neural specificity; Remodeling of neural circuitary

UNIT IV - Applied Neurobiology 15 Hrs

- 4.1 Concept of stress; physiological basis of stress and its disorders.
- 4.2 Role of muscles in sports, slow and fast muscles in exercise and its metabolism.
- 4.3 Diseases of motor units - neuropathies and myopathies.
- 4.4 Neuronal disorders – Parkinson's, Alzheimer's, psychosomatic disorders.
- 4.5 Behavioral disorders, drug abuse and dependence.

PRACTICALS: (All experiments involving live animals are for demonstration only)

- 1 Tail flick test for measurement of pain.
- 2 Spinal reflexes in decerebrated animal.
- 3 Preparation of neuromuscular system for electrophysiological recording.
- 4 Biochemical differentiation of fast and slow muscles – SDH, LDH activities, glycogen and lactate content in altered neurobiological conditions.
- 5 Effect of ankle sprain on muscle metabolism.
- 6 Determination of contractile properties of muscle in pathological condition.

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- 7 Determination of conduction velocity in nerve.
- 8 Induction of stress and estimation of on glycogen, lactate, AChE and Na-K ATPase activities.
- 9 Experimental studies on atrophy, hypertrophy of muscles and nerve degeneration as well as regeneration.
- 10 Moto rod test for motor coordination.

Suggested Books

- 1 Physiology and biophysics – Ruch and Patten
- 2 A text book of muscle physiology – D. A. Jones and J. M. Round
- 3 Neurobiology – Gordon M Sheperd
- 4 Principles of neural science – E. Kandel and others
- 5 Essentials of neural science and behaviour – E. Kandel and others
- 6 Behavioral neuroscience – Cottman
- 7 From Neuron to Brain – Nichollas, J. G. others
- 8 Neuroscience – A. Longstaff
- 9 Elements of molecular Neurobiology – C U M Smith
- 10 Physiology of excitable cells – D. J. Aidley
- 11 Text book of medical physiology – Guyton

UNIT I - Source Reduction and Environmental Methods for Vector Control 15 Hrs

- 1.1. Habitat management; Improvement of water supply and storage; solid waste management.
- 1.2. Prevention of breeding sites and removal or destruction of breeding sites.
- 1.3. Improvement of environmental sanitation and hygiene.
- 1.4. Protection of food, eating utensils and people from contact with flies.
- 1.5. Environmental modification and manipulation.

UNIT II - Physical, Mechanical, and Personal Protective Control measures. 15 Hrs

- 2.1. Baits and traps, avoidance and diversion of biting Diptera.
- 2.2. Making houses and shelters insect-proof; Insecticide-treated screening and curtains.
- 2.3. Impregnation - treated clothing, treating fabrics with an insecticide; protective clothing.
- 2.4. Insecticide vaporizers, electric liquid vaporizer, pressurized spray cans, spray gun.
- 2.5. Netting materials, mosquito net models and problems with mosquito nets, Insecticide-treated mosquito nets and outdoor supports.

UNIT III - Biological Control 15 Hrs

- 3.1. Biological control of vectors through predators and pathogens.
- 3.2. Extraction of plant materials for vector control.
- 3.3. Synthesis of plant medicated Silver nanoparticles and applications.
- 3.4. Genetic control of vectors: Sterile Insect Technology (SIT)
- 3.5. Insect Growth Regulators (IGR): Chitin synthesis inhibitors and juvenile hormones.

UNIT IV - Chemical Control 15 Hrs

- 4.1. Classification of Insecticides and their mode of action; Antiquity of insecticides.
- 4.2. Synthetic insecticides: Organochlorides, Organophosphates, Carbamates, Pyrethroids.
- 4.3. Toxicity of pesticides, Insecticide appliances and safety precautions.
- 4.4. Repellents & attractants: DEET, Semiochemicals.
- 4.5. Methods of insecticide applications, and development of a Module for Integrated Vector Management.

PRACTICALS:

1. Surveillance and writing a report on breeding habitat of cockroach / housefly / mosquito breeding habitats.
2. Collection of indoor / outdoor resting mosquitoes / housefly/ Cockroach and preparing an voucher specimen.
3. Preparation of plant extracts for larvicidal activity.
4. Estimation of man hour landing of mosquitoes and assessment of man-vector contact.
5. Bioassay of vectors through biological and chemical agents.

6. Study of species diversity indices - Species Richness, Simpson's Index, Shannon-Weiner Index, and Pileou's Evenness Index.
7. Estimation of gonotrophic cycle duration.

References:

1. Biology of Disease Vectors, 2nd Ed., William C. Marquardt, 2004, Elsevier Academic Press.
2. Medical and Veterinary Entomology, 2nd Ed., Gary Mullen and Lance Durden.
3. Medical Entomology: A Textbook on Public Health and Veterinary Problems Caused by Arthropods, Revised Edition, Edited by Bruce Eldridge and John Edman.
4. Medical Toxicology by Richard C. Dart. Pub: Lippincott Williams & Wilkin.
5. Manual of Medical Entomology by Deane P. Furman & Paul Catts.
6. Infectious Diseases of Arthropods by Goddard.
7. Hand Book of Medical Entomology by [K N Panicker](#), [Geme Urge Dori](#).
8. Medical Entomology for Students 5th edition by Mike Service.
9. Destructive and Useful Insects by R. L. Metcalf.

UNIT I - Protozoology 15 Hrs

- 1.1 Protozoan ecology, nutrition; population structure and kinetics.
- 1.2 Metabolic pathways in protozoa – carbohydrate, protein and lipids.
- 1.3 Antimetabolites analogs, inhibitors and transport phenomenon in protozoa.
- 1.4 Enzyme secretions and activity; nucleic acids composition and its synthesis.
- 1.5 Respiration in protozoa; nutritional requirements and nitrogen excretion.

UNIT II - General account and Taxonomy of Nematodes. 15 Hrs

- 2.1 History, scope and significance of nematodes.
- 2.2 Classification of nematodes upto family level with examples.
- 2.3 Functional anatomy – Structure of cuticle and cuticular modifications, Body wall, musculature and pseudocoelom.
- 2.4 Digestive system with special reference to oesophageal modifications and associated glands.
- 2.5 Excretory system, nervous system and sense organs of nematodes.

UNIT III - Morphology, Development, Life cycles and Pathology 15 Hrs

- 3.1 Reproductive system, types of eggs, embryology and development.
- 3.2 Life cycles, pathology, treatment of the gastrointestinal nematodes; tissue nematodes, epidemiology and geographical distributions of
 - a. *Strongyloides stercoralis*
 - b. *Ancylostoma duodenale*
 - c. Visceral larva migrans, dermatitis and pulmonary bronchitis.
 - d. *Dracunculus medinensis*, *Wuchereria bancrofti*, *Brugia malayi* and *Trichinella spiralis*.
- 3.3 Origin and evolution of animal nematode parasites and host interaction.
- 3.4 General account of entomophilic Nematodes – characteristics and classification.
- 3.5 Nematicides and their action, Nematode drug resistance.

UNIT IV - Acanthocephala 15 Hrs

- 4.1 Medical Acanthocephalans - general account, morphology, life cycle, clinical symptom, pathogenicity, diagnosis, prophylaxis and treatment of the diseases caused by *Macracanthorhynchus hirudinaceus* and *Moniliformis moniliformis*.
- 4.2 The role of vectors in spreading of diseases in humans.
- 4.3 Host -parasite relationships and their immunological reactions.
- 4.4 Innate and acquired immune resistance.
- 4.5 Antihelminthic drug action and drug resistance.

PRACTICALS:

1. Collection of nematode parasites and acanthocephalan parasites, fixation, preparation of permanent slides and their identification.
2. Hosts – cockroaches (invertebrate), fish (carps & catfishes), birds (fowl), and mammals (sheep and cattle).
3. Identification of nematode eggs and larval stages.
4. Blood smear preparation for the identification of *Plasmodium* spp.
5. Qualitative and quantitative estimation of carbohydrates, proteins and lipids in normal, infected tissues and parasites.
6. Ecology of parasites and biostatistical calculations of incidence, intensity, density and index of infection of nematode parasites.

List of books:

1. Principles of nematology – by Chitwood B.G. and Chitwood M.B.
2. Nematode parasites of domestic animals and of man – by Levine Norman D Burgess publishing Co. Minneapolis.
3. The natural history of Nematodes by Pionar G.O., Prentice Hall, New Jersey.
4. The organization of nematodes by Croll N.A., Academic press.
5. The physiology of nematodes by Lee D. L. & At. Kinson, Columbia University Press, New York.
6. Agricultural Helminthology – Filipjev I. N.
7. General Parasitology by Cheng T.C.
8. Introduction to animal parasitology by J. D. Smith.
9. Entomophilic nematodes and their role as biological control of pest insects by George Poiner, Pub. INC Engle wood cliffs, New Jersey.
10. Parasitology by Noble & Noble.
11. Parasitology by K. D. Chatterjee.
12. Parasitology by Chandler.
13. Human Helminthology - by Faust.
14. Medical Zoology by Sobti.

- UNIT I - Responses of animals to their environment 15 Hrs
- 1.1 General receptor characteristics, receptor potentials and sensory coding.
 - 1.2 Adaptations in organ systems for reception – chemo-, thermo-, mechano-, and electro-receptors.
 - 1.3 Central nervous system - Insect to vertebrate comparison.
 - 1.4 Integration for effective behavior - spinal reflex; Learning and memory and its genetic basis.
 - 1.5 Stress biology and related disorders.
- UNIT II - Effectors and responses 15 Hrs
- 2.1 Gland effectors for secretion - mechanism of target tissue activation and mechanism of secretion.
 - 2.2 Types of muscle fibers slow, fast and asynchronous flight muscle.
 - 2.3 Mechanism and chemistry of muscle fiber contraction.
 - 2.4 Accessory movements – skeletal levers, elastic movements.
 - 2.5 Effectors for movement – cyclosis, amoeboid, ciliary, flagellar movements, and control of movement.
- UNIT III - Circulation of body fluids 15 Hrs
- 3.1 Major types of body fluids – fluid compartments.
 - 3.2 Classification of circulatory mechanisms.
 - 3.3 Types of vertebrate hearts, heart rate, regulation and cardiac output, chemical and nervous control of heart rate.
 - 3.4 Invertebrate hearts – annelids, scorpion, insect, crustacean, molluscan, and tunicate hearts.
 - 3.5 Regulation of vertebrate circulatory systems.
- UNIT IV - Control of reproduction –adaptations to environment 15 Hrs
- 4.1 r -selected and k- selected reproductive patterns; timing with respect to environmental variables, photo periods.
 - 4.2 Hormonal control of insect growth and reproduction.
 - 4.3 Hormones and development; sexual behaviour in vertebrates; pregnancy and parental care.
 - 4.4 Influence of environmental factors on chromatophore systems.
 - 4.5 Biological rhythms circadian - circumlunar and circannual rhythm.

PRACTICALS: (All experiments involving live animals are for demonstration only)

- 1 Maze behaviour studies in rat.
- 2 Metabolic distinction of slow and fast muscles.
- 3 Kymographic studies of muscle properties.
- 4 Effect of temperature on heart beat of crab
- 5 Effect of AchE and adrenaline on heart beat in crab.
- 6 Effect of estrogen on serum calcium levels of rat
- 7 Pregnancy testing by using HCG kit.
- 8 Dissection of nervous system of cockroach and crab.
- 9 Dissection of Male and Female reproductive systems of cockroach and crab.

Suggested Books

- 1 Comp. Animal Physiology by Ladd Prosser (Publ. W. B. Samders, Philadelphia).
- 2 Comp. Animal Physiology by William Hoar, (Pub. E.E.E. IBH).
- 3 Animal Physiology – Adaptation and function., By F. Reed Hainsworth (Publ. by Addison-Wesley Publ. company, Calofornia).
- 4 Animal Physiology by Kent Schmidt Nielson (Publ. E.E.E. IBH).
- 5 Animal Physiology and adaptation by David Gordon.
- 6 Animal Physiology by Wilson.

UNIT I - Seed Production Technology 15 Hrs

- 1.1 Fish and prawn seed resources in India.
- 1.2 Collection of seeds from natural resources and transportation of seeds.
- 1.3 Advanced techniques in seed production - Induced breeding methods in fishes and prawns.
- 1.4 Bundh breeding, brood stock management.
- 1.5 Hatcheries – Types, construction and management of hatcheries.

UNIT II - Pond and Reservoir Management 15 Hrs

- 2.1 Site selection, design and construction of aquafarms.
- 2.2 Pre-stocking pond management – Aquatic weeds, insects and their control.
- 2.3 Farm Management - Nursery, rearing and stocking ponds.
- 2.4 Reservoir ecosystem.
- 2.5 Reservoir fisheries and their management.

UNIT III - Feed and Health Management 15 Hrs

- 3.1 Feed management – Feeding habits of cultivable fishes; nutritional requirements, supplementary feeding.
- 3.2 Live feed – Fish food organisms, culture of plankton; significance of plankton in aquaculture.
- 3.3 Health management of fishes – Parasitic and non-parasitic diseases and their control.
- 3.4 Health management of prawns – Parasitic and non-parasitic diseases and their control.
- 3.5 Disease diagnosis and therapeutic methods.

UNIT IV - Cultures and Integrated Farming 15 Hrs

- 4.1 Composite fish culture; Sewage-fed, cage and pen cultures.
- 4.2 Air-breathing and ornamental fish culture.
- 4.3 Integrated fish cum agriculture – Paddy, Horticulture and Azolla.
- 4.4 Integrated fish cum livestock – Poultry, Piggery and Dairy.
- 4.5 Utilization of renewable energy resources and bio-gas slurry in aquaculture.

PRACTICALS

- 1 Identification of freshwater fishes.
- 2 Identification of Freshwater fish developmental stages.
- 3 Identification of freshwater prawns.
- 4 Identification of scampi developmental stages.
- 5 Identification of diseased fishes and prawns.
- 6 Analysis and identification of phyto- and zoo-planktons and benthos.
- 7 Culture of phyto- and zoo-planktons.
- 8 Separation of pituitary gland from fish

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- 9 Demonstration of induced breeding technology.
- 10 Field trips to seed and rearing farms and submit an observation report (weightage of 10 marks to be given to each candidate).

Suggested Books

- 1 Water quality criteria for fresh water fish. Albastor, J. S. and Lloyd, R. Butterworth Scientific.
- 2 Fish and Fisheries of India – Jhingran, V. G. Hindustan Publishing Corporation New Delhi.
- 3 The fishes of India – Francis. Day. Vol. I &II, New Delhi – CSIR.
- 4 The freshwater fishes of Indian Region – Jayaram, KC. Narendra Publishing house, New Delhi.
- 5 Prawns and prawn fisheries – Kurian, C.V. and Sebastian, V. O. Hindustan Publishing Corporation, New Delhi.
- 6 A manual of freshwater aquaculture – Santhanam, R. Sukllnaran. N. Natarajan Oxford and IBHPublishing Company, New Delhi.
- 7 Freshwater aquaculture – Rath, R. K. Scientific Publishers, Jodhpur.
- 8 Text book of fish culture, breeding and cultivation of fish – MareelHuet, Fishing News books.
- 9 Aquaculture development, processes and prospects – TVR Pillaay Fishing news books.
- 10 Aquaculture – John, E. Bardach, John H. Ryther, W.O. Mclamey, John Willey and Sons, New York.
- 11 Fish Ecology – RJ. Wotton, Dalckie, Chapman and Hall, New York.
- 12 Environmental stress and fish diseases – Wedemeye, G. A. Narendra. Publishing House.
- 13 Diseases of fishes – C. Vandujn, Narendra Publishing House, New Delhi.
- 14 Aquaculture Principles and Practices by T. V. R. Pillay.

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M.Sc. Zoology Semester IV

Paper - IV: PROJECT WORK

Credits 6

	Credits	Marks
Research Design	1	25
Research work	1	25
Completion seminar	1	25
Dissertation, Final presentation & Viva	3	75