

# **M.Sc. Zoology Syllabus**

For University, Constituent and Affiliated Colleges

**With effect from 2016 – 2017**



**Mahatma Gandhi University  
Nalgonda - 508254  
Telangana, India.**

**Mahatma Gandhi University, Department of Zoology,**  
**Two Year M.Sc. (Zoology) Programme w.e.f. 2016–2017**

**Proposed Scheme for Choice Based Credit System**

**Annexure - I**

I Semester					II Semester					III Semester					IV Semester				
Course	Tea. Hrs	Credits	Marks		Course	Tea. Hrs	Credits	Marks		Course	Tea. Hrs	Credits	Marks		Course	Tea. Hrs	Credits	Marks	
1	Core (SB)	4	4	100	1	Core (TTB)	4	4	100	1	Core (ED)	4	4	100	1	Core (AB)	4	4	100
2	Core (ECB)	4	4	100	2	Core (AP)	4	4	100	2	Paper – II (AZ)	4	4	100	2	Paper – II (FB)	4	4	100
3	Core (IMM)	4	4	100	3	Core (MGDB)	4	4	100	3	Elective –I	4	4	100	3	Elective –I	4	4	100
4	Core (TSFAI)	4	4	100	4	Core (EFAV)	4	4	100	4	Elective –II	4	4	100	4	Elective – II	4	4	100
5	Practical (SB)	4	2	50	5	Practical (TTB)	4	2	50	5	Practical (ED)	4	2	50	5	Practical (AB)	4	2	50
6	Practical (ECB)	4	2	50	6	Practical (AP)	4	2	50	6	Practical (AZ)	4	2	50	6	Practical (FB)	4	2	50
7	Practical (IMM)	4	2	50	7	Practical (MGDB)	4	2	50	7	Elective –I	4	2	50	7	Elective –I	4	2	50
8	Practical (TSFAI)	4	2	50	8	Practical (EFAV)	4	2	50	8	Elective –II	4	2	50	8	Elective –II	4	2	50
9	Communicative English & Soft Skill	2	2	50	9	Human Values & Ethics	2	2	50	9	ID Paper	4	4	100	9	ID Paper	4	4	100
10	Seminar	2	1	25	10	Seminar	2	1	25	10	Seminar	2	1	25	10	Seminar	2	1	25
<b>Total</b>		<b>36</b>	<b>27</b>	<b>675</b>	<b>Total</b>		<b>36</b>	<b>27</b>	<b>675</b>	<b>Total</b>		<b>38</b>	<b>29</b>	<b>725</b>	<b>Total</b>		<b>38</b>	<b>29</b>	<b>725</b>

**DEPARTMENT OF ZOOLOGY,  
MAHATMA GANDHI UNIVERSITY, NALGOND**

**Semester I  
CORE PAPER**

<b>Paper I</b>		<b>Zoo_101</b>
<b>Title</b>	<b>Structural Biology [SB]</b>	
<b>UNIT I–Basic concepts of Biomolecules and Structural Biology</b>		<b>15 Hrs</b>
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.	
<b>UNIT II–Enzymes and Metabolism</b>		<b>15 hrs</b>
3.1	Classification, nomenclature and properties of enzymes – catalysis and energy of activation; Enzyme kinetics, Michaelis–Menten Constant; (Km values) and LB plot; mechanism of enzyme action and regulation of enzyme activity	
3.2	Metabolism of carbohydrates – Glycolysis; TCA cycle; Gluconeogenesis; biological oxidation; role of respiratory chain in energy capture; ATP synthesis	
3.3	Catabolism of amino acids – Transamination, deamination and decarboxylation	
3.4	Oxidation and biosynthesis of fatty acids	
3.5	Metabolic disorders of different biomolecules (carbohydrates, proteins, lipids)	<b>15 Hrs</b>
<b>UNIT III–Cellular Organization</b>		
2.1	Molecular organization and functions of cell membranes	
2.2	Cell permeability – Transport across the cell membrane; transport of small molecules; Carrier proteins; Ion pumps; membrane bound enzymes	
2.3	Cell communications – Inter cellular communication and gap junctions; chemical signaling between the cells; strategies of chemical signaling	
2.4	Signaling mediated by intracellular receptors; signaling mediated cell surface receptors – second and third messengers; C–AMP, G–proteins, Ca <sup>++</sup> , Inositol Triphosphate (IP <sub>3</sub> ) and prostaglandins	
2.5	Cell cycle; molecular events in cell cycle; mitotic spindle	
<b>UNIT IV - Functional Biology of Nucleic Acids</b>		<b>15 Hrs</b>
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.	

## PRACTICAL

- 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, 8<sup>th</sup> ed.
- 7 Molecular Biology by Friefelder
- 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



**Semester I  
CORE PAPER**

Paper II

Code Zoo\_102

Title

Environmental and Conservation Biology [ECB]

**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<sub>2</sub>, NO<sub>2</sub>, 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

## PRACTICAL

- 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

**Semester I  
CORE PAPER**

Paper III

Code Zoo\_103

**Title Immunology [IM]**

<b>UNIT I – Introduction to Immune System</b>	<b>15 Hrs</b>
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	
<b>UNIT II – Antigen-Antibody Nature and Complement System</b>	<b>15 Hrs</b>
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	
<b>UNIT III – Hypersensitivity Reactions and Autoimmune Diseases</b>	<b>15 Hrs</b>
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 <i>diabetes mellitus</i> (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.	
<b>UNIT IV – Transplantation and Tumour Immunology</b>	<b>15 Hrs</b>
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 Agglutination test
- 2 Precipitation
- 3 Demonstration of Immunolectrophoresis
- 4 Neutralization and complement fixation
- 5 Separation of lymphocytes
- 6 Collection of macrophages and their characterization
- 7 Immunization schedules and rising of antibodies
- 8 Identification of histological slides of lymphoid tissue - Spleen, thymus, lymphnode and bone marrow
- 9 Demonstration of lymphocyte transformation test with nitrogen and an antigen

**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 Text by Basiro Davey
- 5 An introduction to immunology, by Ian R. Tizard





**Semester I**  
**CORE PAPER**

Paper IV

Code Zoo\_104

**Title Taxonomy, Systematics and Functional Anatomy of Invertebrates [TSFAI]**

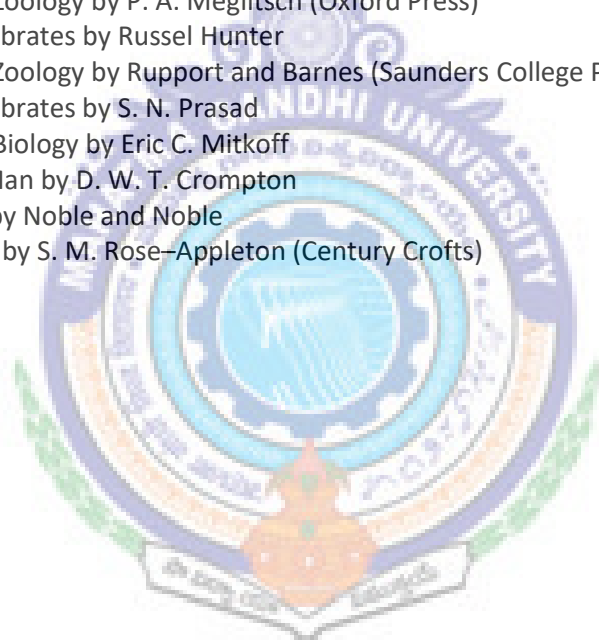
<b>UNIT I - Biosystematics and Taxonomy</b>	15 Hrs
1.1 Basic concepts of biosystematics, taxonomy and classification	
1.2 Recent trends in biosystematics -- molecular taxonomy	
1.3 Taxonomic hierarchies, species concepts.	
1.4 International Code for Zoological Nomenclature (ICZN) – operative principles, 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	
<b>UNIT II– Protozoa to Platyhelminthes</b>	15 Hrs
2.1 Structure and functions of Locomotory organs in protozoans, reproduction in protozoa, conjugation in verticella	
2.2 Porifera :-scoinc canal system, life cycle	
2.3 Platyhelminthes:- Polyembryons	
2.4 Life cycles and modes of transmission, <i>Paragonimus westermani</i> , <i>Diphyllobothrium latum</i> .	
2.5 Overview of reproduction and development in Protozoa, Proifera, Cnidaria, Ctenophora and Platyhelminthes	
<b>UNIT III - Annelida to Echinodermata</b>	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	
<b>UNIT IV - Minor and Other Phyla</b>	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
- 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)



**Semester II  
CORE PAPER**

Paper I

Zoo\_201

Title

Tools, Techniques and Biostatistics [TTB]

**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)

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- 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

#### **PRACTICAL**

- 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-phosovanillin 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

**Semester II  
CORE PAPER**

**Paper II  
Title**

**Code Zoo\_202**

**Animal Physiology [AP]**

**UNIT I – Digestion-Respiration- Circulation** 15 Hrs

- 1.1 Cellulose digestion –Ruminant and non-ruminant digestion; absorption 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<sub>2</sub> and O<sub>2</sub> 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, Bioluminescence & 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 .



**Semester II  
CORE PAPER**

Paper III

Code Zoo\_203

Title

**Molecular Genetics and Developmental Biology [MGDB]**

<b>UNIT I - Introduction to Genetics</b>	<b>15 Hrs</b>
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.	
<b>UNIT II – Molecular Genetics</b>	<b>15 Hrs</b>
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, <i>In-situ</i> hybridization	
<b>UNIT III – Overview of Developmental Biology</b>	<b>15 Hrs</b>
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	
<b>UNIT IV – Organogenesis</b>	<b>15 Hrs</b>
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 Berry



**Semester II  
CORE PAPER**

Paper IV

Code Zoo\_204

Title

**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 – Lepspondyli 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
- 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/ Tilapia
  2. Major – a) a) Cranial nerves of Labeo (V, VII, IX & X cranial nerves, b) Cornea and pecten of chick

## 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 & 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 Rupport 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 Regeneration by S. M. Rose–Appleton (Century Crofts).
- 12 Parasitology by Noble & Noble.



**Mahatma Gandhi University**

**Dept. of Zoology, M.Sc. Semester III & IV Elective papers**

**w.e.f. 2016–2017**

**Annexure - II**

**SEMESTER III**

**Paper III-**

Comparative Animal Physiology – I [CAP]

Applied Toxicology –I (AT)

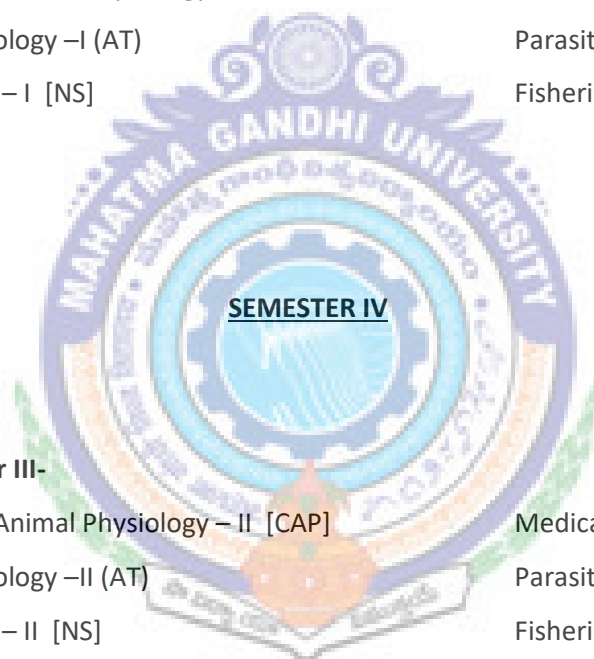
Neuroscience – I [NS]

**Paper IV-**

Medical Entomology – I [ME]

Parasitology – I [PA]

Fisheries – I [FS]



**Paper III-**

Comparative Animal Physiology – II [CAP]

Applied Toxicology –II (AT)

Neuroscience – II [NS]

**Paper IV-**

Medical Entomology – II [ME]

Parasitology – II [PA]

Fisheries – II [FS]

**\* Under CBCS,**

The candidate has to choose one out of three elective streams offered in paper – III and paper-IV in the beginning of III Semester, which also continue as paper III & IV in IV semester offered at college.

\* No semester end practical exam to be conducted if college fails to complete atleast 2/3 of practicals.

**M.Sc. Zoology Semester – III  
Core Paper**

**Paper I - Endocrinology**

**UNIT –I: Chemical and Neural Integration 15 Hrs**

- 1.1 Scope and position of endocrinology role in health disease.
- 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 – negative and positive and feedback mechanisms.
- 1.5 Concept of internal environment and homeostasis- regulatory mechanisms.

**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.

**PRACTICAL:**

- 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).



**M.Sc. Zoology SEMESTER – III**

**Core Paper**

**Paper – II: Applied Zoology**

**UNIT –I: Animal as Bioresources**

**15 periods**

- 1.1. Bioresources, Bioconversion Efficiency and transgenic animals as bioreactors (Honeybee, Silkworm)
- 1.2. Basic concepts of models and modeling, model behavior, Networks in system biology and their applications
- 1.3. Animal tools – insects, fish, amphibian, birds and mammals and their use in applied biology.
- 1.4. Biomonitoring and bioassay; biopesticide (Bt, Bv) uses and demerits in sustainable live hoods.
- 1.5. Pests of agricultural and veterinary importance, biology and management.

**UNIT-II: Vector Biology**

**15 periods**

- 2.1. Vectors – insect vectors, mosquito, housefly, bedbug, headlouse
- 2.2. Biology of Anopheles, Culex and Aedes
- 2.3. Vectorborne diseases – human diseases and their control measures
- 2.4. Vectorborne viral disease – Dengue, chickengunya and Japanese encephalitis
- 2.5. Vector control –Biological, chemical and physical methods

**UNIT-III: Apiculture & Lac Culture**

**15 periods**

- 3.1. Honey bees – types; biology of *Apis indica*
- 3.2. Honey bee culture – Methods & strategies
- 3.3. Honey – chemical composition, Nutritional value and medicinal importance
- 3.4. Diseases associated with honey bee
- 3.5. Lac insects, biology; Lac production, chemistry and industrial applications

**UNIT-IV Sericulture and Fisheries**

**15 periods**

- 4.1. Silkworm biology – types, races and varieties
- 4.2. Life history of *Bombyx mori*, *Properties and chemistry of silk*. Internal morphology of silkworm
- 4.3. Insect pests of mulberry, silkworm diseases and pests, Reeling technology
- 4.4. Principles of fisheries and aquaculture, types of aquaculture
- 4.5. Techniques of capture fisheries and harvesting technology – fish by products

**PRACTICALS**

1. Identification of Dipteran vectors
2. Life history of Anopheles, Culex, Aedes and Housefly
3. Identification of Silkworms - Mulberry, Tasar, Eri and Muga
4. Life history of *Bombyx mori*

5. Practice of sericulture – demo
6. Identification of defective cocoons.
7. Anatomy of silk gland
8. Identification of Honey Bee
9. Collection and identification of 5 fishes.

### Reference Books

1. Text Book of Sericulture - A. Madanamohan B.S. Publish.
2. Medical Zoology by Sobti
3. An Introduction to Systems Biology: Design Principles of Biological Circuits By Uri Alon.
4. Systems biology: A Text Book by Edda Klipp.
5. Fish and Fisheries of India – Jhingran, V. G. Hindustan Publishing Corporation New Delhi.
6. Aquaculture development, processes and prospects – TVR Pillaay Fishing news books.
7. Aquaculture – John, E. Bardach, John H. Ryther, W.O. Mclamey, John Willey and Sons, New York.



**M.Sc. Zoology Semester III**  
**Elective I**  
**Paper III - Comparative Animal Physiology - I**

**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 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.

**PRACTICAL**

- 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.



**Semester III  
Elective II**

**Paper III  
Title**

**Code Zoo\_303d**

**Applied Toxicology – I [AT-I]**

- UNIT I – Principles of Toxicology** 15 Hrs
- 1.1 Definition, Scope and sub division of toxicology.
  - 1.2 Classification of toxic agents, animal toxins, plant toxins, food toxins, genetic poisons and chemical toxins.
  - 1.3 Dose, Dose effect and Dose response relationship – Acute toxicity and Chronic Toxicity.
  - 1.4 Factors affecting toxicity- species and strains, age, sex, nutritional status, Hormone, Environmental Factors.
  - 1.5 Absorption and Distribution of toxicants- Portals of entry – Skin, Gastrointestinal tract and Respiratory system.
- UNIT II – Biochemical toxicology** 15 Hrs
- 2.1 Mechanism of toxicity – Reaction of toxicants with target molecules – cellular dis repair and repair mechanisms.
  - 2.2 Lipid peroxidation– ROS and RNS, Superoxide, Hydrogen Peroxide and Hydroxyl radicals in toxicity of Xenobiotics.
  - 2.3 Oxidative Stress - Toxicological consequence of oxidative stress Protein damage and DNA damage
  - 2.4 Xenobiotic induced alterations in intracellular calcium distribution, disruption of cellular energy production.
  - 2.5 Introduction to Phase I and II reactions.
- 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, Axonopathy, Myelionopathy, ionchannel, neuro toxins, Lesions of specific neurons.
- UNIT IV – Systemic toxicology and Chemical Carcinogenesis** 15 Hrs
- 4.1 Reproductive Toxicology – Reproductive organs, Chemicals affecting reproduction and Teratogenicity.
  - 4.2 Endocrine toxicology - Toxicity of Adrenal, Thyroid and Pancreas.
  - 4.3 Bio-magnification, bio-transformation of xenobiotics
  - 4.4 Genotoxicity – DNA interaction, DNA adducts and Mutations; DNA repair
  - 4.5 Carcinogenesis, types of carcinogens – mechanisms of action.
- PRACTICAL: (All experiments involving line animals are for demonstration only)**
- 1 Determination of LC50/LD50 of selected toxicant (bioassay method)

- 2 Effect of selected toxicant on Phase I enzyme activity (Cyt P<sub>450</sub>) (enzymatic assay)
- 3 Determination of LPO activity by TBRAS method
- 4 Effect of toxicant on Glycogen, Glucose and Amino acids
- 5 Hepato-toxicant effect on Total Bilirubin Content (direct and indirect method)
- 6 Estimation of SGOT and SGPT as a marker enzyme for hepatotoxicity
- 7 Estimation of Serum Creatinine activity as a marker enzyme for Renal toxicity
- 8 Micronuclei test
- 9 Effect of toxicant on sperm morphology

### Suggested Books

- 1 Principles of ecotoxicology- 3<sup>rd</sup> edition 2006, C H Walker, S P Hopkin, R N Sibly and D B Peakall (Eds.), Taylor and Francis, NewYork, NY.
- 2 Introduction to Environmental toxicology -3<sup>rd</sup> edition 2003, W.G.Landis and M.H.Yu. Lewis publishers, Florida.
- 3 Text Book of Modern Toxicology 2000 edition, Ernst Hodgson and Patrica Levi, McGraw – Hill International edition. Singapore.
- 4 Principles of toxicology 2010 edition, Anju Agarwal and Krishna Gopal, ibdc publishers India.
- 5 Essentials of Toxicology 2011 edition, Vijay Kumar Matham, New India Publishing Agency, New Delhi, India.
- 6 Principles of Biochemical Toxicology- Jatimbrell; Taylor and Francis Ltd, London.
- 7 Basic Environmental Toxicology – LorrisG.Cockerham, Barbara S Shane; CRC Press, London.
- 8 Hand book of Toxicology – Thomos J Haley, Willan O Berndt; Hemisphere Publishing cooperation, Washington.
- 9 Modern Toxicology (3 Volumes) - P K Gupta and Salunkha; B V Gupta Metropolitan Book Co., Ptv Ltd, New Delhi.
- 10 Encyclopedia of Toxicology – O P Jasra.

**M.Sc. Zoology 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.

**PRACTICAL: (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.

- 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.



**M.Sc. Zoology Semester III**  
**Elective II**  
**Paper IV - Medical Entomology - I**

**Unit 1: Overview of Entomology. 15hrs**

- 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 2: Biology of medically important Insects 15hrs**

- 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 3: Insect Ecology & Behaviour 15hrs**

- 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 4: Arthropod-borne diseases 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.

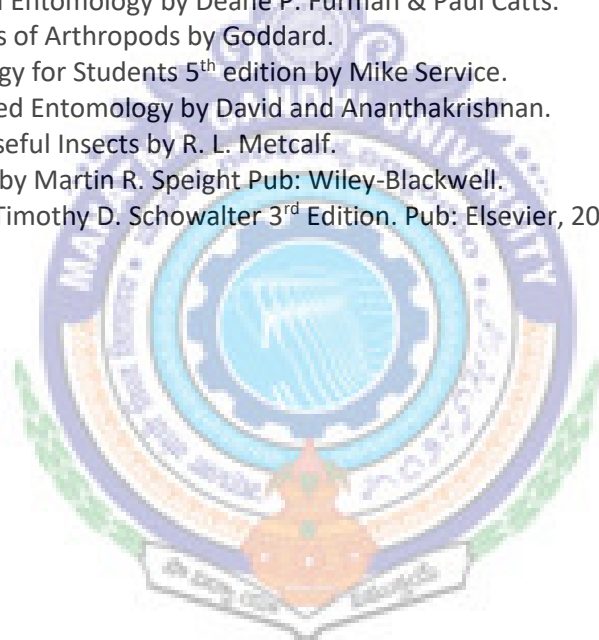
**Practicals:**

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.

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 5<sup>th</sup> edition by Mike Service.
8. General and Applied Entomology by David and Ananthakrishnan.
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 3<sup>rd</sup> Edition. Pub: Elsevier, 2011.



**M.Sc. Zoology Semester III**  
**Elective II**  
**Paper IV - PARASITOLOGY - I**

**UNIT-1: Morphology, Anatomy and Classification (15 hours)**

- 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-2: Reproduction, Ecology and Evolution (15 hours)**

- 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-3: Trematode and Cestode Diseases (15 hours)**

- 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 -4: Adult metabolism, Anthelmintics and Immunology (15 hours)**

- 4.1 Carbohydrate metabolism - Glycolysis (EMP-pathway), CO<sub>2</sub> 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  $\beta$  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, Aspidogastreaans and Cestode (Host Fishes, water snakes, birds, sheep, goat and cattle viscera).
2. *Fasciola* smear preparation, staining and study for eggs & concentration.



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 Publg. 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 Publg. 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) .



**M.Sc. Zoology Semester III**  
**Elective II**  
**Paper IV - Fisheries - I**

**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**

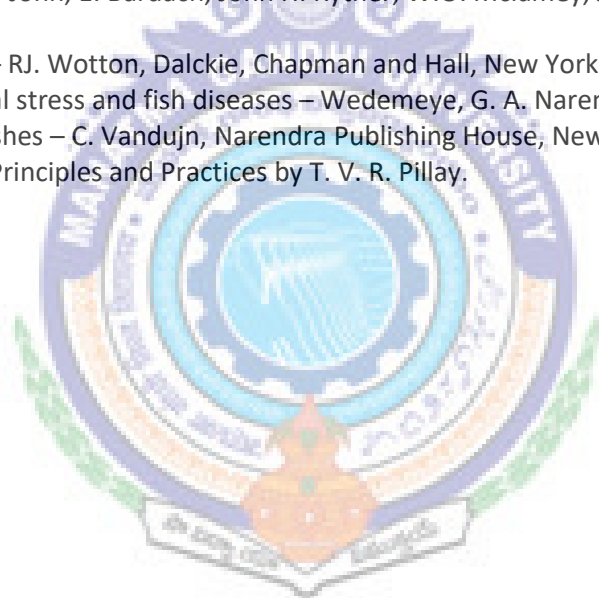
- 4.1 Fishing Crafts – Non-mechanized and mechanized vessels and maintenance of boats.
- 4.2 Fishing Gears – Gear material, gear making, accessories; types of gear and their preservation.
- 4.3 Cryopreservation; transgenic fish; fish genomics – chromosomal mapping, inbreeding genetic markers.
- 4.4 Sex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

**PRACTICAL**

- 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 IV**  
**Core Paper**  
**Paper - I: Animal Biotechnology**

**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.

**PRACTICAL**

- 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.



**M.Sc. Zoology Semester IV**  
**Core Paper**  
**Paper - II: FISH BIOLOGY**

**Unit – I: Introduction and Diversity of Fishes**

- 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**

- 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**

- 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**

- 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.

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



**M.Sc. Zoology Semester IV**  
**Elective I**  
**Paper - III: Comparative Animal Physiology - II**

**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.

**PRACTICAL: (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.



**M.Sc. Zoology Semester IV**  
**Elective I**  
**Paper - III: Applied Toxicology – II [AT-II]**

<b>UNIT I</b>	<b>Environmental toxicology</b>	15 Hrs
1.1	Environmental pollution- introduction, Sources and types of Pollution, important pollution events, scientific approach to ecotoxicology- entry, movement and fate of pollutants in ecosystems.	
1.2	Eco-toxicology of heavy metals – Mechanism of heavy metal toxicity, case studies of Arsenic, Mercury and Cadmium.	
1.3	Environmental persistence of pollutant – Abiotic degradation, Biotic degradation, non-degradative elimination process.	
1.4	Sources of toxicants to the environment and transport process – advection and diffusion.	
1.5	Bioaccumulation- factors influence on bioaccumulation.	
<b>UNIT II</b>	<b>Toxicity of Pesticides and Solvents</b>	15 Hrs
2.1	Pesticides, Classification and Bio-magnification of Pesticides.	
2.2	Pesticide toxicity – Haematotoxicity Reproductive and developmental effects, Carcinogenicity, Immunological effects.	
2.3	Environmental problems by organochlorine and organophosphate pesticides case studies of DDT, Endosulphan, Parathion and Malathion.	
2.4	Principles of Solvent toxicity - Nature of toxic effects, toxicity of Aliphatic solvents – Carbon tetra chloride : Chloroform; toxicity of alcohols.	
2.5	Toxicity of Food Additives- Polycyclic hydrocarbons, Hydrocyclic-amines, Nitroso amines and synthetic carcinogens.	
<b>UNIT III</b>	<b>Occupational and Industrial Toxicology</b>	15 Hrs
3.1	Occupational hazards- physical, chemical, biological and mechanical hazards.	
3.2	Occupational diseases: Pneumoconiosis, Silicosis, Asbestosis, Anthracosis. Prevention in different environments – Home, Workplace, Pollution of Air, Water and Land.	
3.3	Occupational Cancer – Skin cancer, Lung cancer, Bladder cancer and Leukemia; Prevention of Occupational diseases.	
3.4	Industrial toxicology – history and basic features, Industrial hygiene, Risk assessment and management of industrial chemicals.	
3.5	Introduction, Legislation and Regulation – Federal government, State government, Legislation and Regulation in other countries.	
<b>UNIT IV</b>	<b>Applied toxicology</b>	15 Hrs
4.1	Toxicology of chemical War fare agents – chemical weapons, classification of chemical Warfare agents. Management of warfare agents.	
4.2	Veterinary toxicology – common toxicity in Dog, Cat and Poultry by herbicides, house hold chemicals, heavy metals, mycotoxins etc.	
4.3	Wild life toxicology –Susceptibility of wild life to chemicals, acute ecological hazards, toxicology of chemicals inbirds and mammals, integrated approach to wild life toxicology.	
4.4	Cosmetic toxicology – toxicity of shampoos, conditioners, bleachers and Dyes,	

bioremediation and prevention of occupational diseases.

- 4.5 Laboratory animals – animal environment, animal husbandry, animal care and maintenance, CPCSEA

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

- 1 Pesticides reduces by TLC techniques.
- 2 Estimation of Hemoglobin and RBC in Lead exposed experimental animals.
- 3 Dermal sensitization test.
- 4 Estimation of Ache activity as a marker of pesticide poisoning.
- 5 Quantification of DNA damage by SCGE technique (COMET assay).
- 6 Effect of toxicants on chromosomal aberrations and sister chromatid exchanges.
- 7 Analysis of pesticide residues in different tissues of fish by TLC technique.

**Suggested Books**

- 1 Principles of ecotoxicology- 3<sup>rd</sup> edition 2006, C H Walker, S P Hopkin, R N Sibly and D B Peakall (Eds.), Taylor and Francis, NewYork, NY.
- 2 Introduction to Environmental toxicology -3<sup>rd</sup> edition 2003, W.G.Landis and M.H.Yu. Lewis publishers, Florida.
- 3 Text Book of Modern Toxicology 2000 edition, Ernst Hodgson and Patrica Levi, McGraw – Hill International edition. Singapore.
- 4 Principles of toxicology 2010 edition, Anju Agarwal and Krishna Gopal, ibdc publishers India.
- 5 Essentials of Toxicology 2011 edition, Vijay Kumar Matham, New India Publishing Agency, New Delhi, India.
- 6 Principles of Biochemical Toxicology- Jatimbrell; Taylor and Francis Ltd, London.
- 7 Basic Environmental Toxicology – LorrisG.Cockerham, Barbara S Shane; CRC Press, London.
- 8 Hand book of Toxicology – Thomos J Haley, Willan O Berndt; Hemisphere Publishing cooperation, Washington.
- 9 Modern Toxicology (3 Volumes)- P K Gupta and Salunkha; B V Gupta Metropolitan Book Co., Ptv Ltd, New Delhi.
- 10 Encyclopedia of Toxicology – O P Jasra.

**M.Sc. Zoology Semester IV**  
**Elective I**  
**Paper - III: Neuroscience - II**

<b>UNIT- I: Sensory System</b>	<b>15 Hrs</b>
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
<b>UNIT -II: Sensory and Motor System</b>	<b>15 Hrs</b>
2.1	Pain and it's 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.
<b>UNIT- III: Developmental neurobiology</b>	<b>15 Hrs</b>
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 circuitry
<b>UNIT - IV: Applied Neurobiology</b>	<b>15 Hrs</b>
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.
<b>PRACTICAL: (All experiments involving live animals are for demonstration only)</b>	
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.
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



**M.Sc. Zoology Semester IV**  
**Elective I**  
**Paper - III: Medical Entomology - II**

**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.

**Practical:**

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 5<sup>th</sup> edition by Mike Service.
9. Destructive and Useful Insects by R. L. Metcalf.



**M.Sc. Zoology Semester IV**  
**Elective II**  
**Paper - III: PARASITOLOGY - II**

**UNIT-I: Protozoology**

**15 Periods**

- 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 Periods**

- 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 Periods**

- 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. *Draunculus 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 Periods**

- 4.1 Medical Acanthocephalans - general account, morphology, life cycle, clinical symptom, pathogenecity, 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 Anthelmintic 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 *Palsmodium* 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.

**M.Sc. Zoology Semester IV**  
**Elective II**  
**Paper - III: Fisheries - II**

**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.

**PRACTICAL**

- 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.
- 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.

