

CBCS SYLLABUS
(w.e.f. ACADEMIC YEAR 2020-21)

FOR
POST-GRADUATE DEGREE PROGRAMME

Master of Science
in Zoology

I to IV Semester

OF
OSMANIA UNIVERSITY



Head,
Department of Zoology

Chairperson,
BoS in Zoology

Osmania University
Hyderabad - 500 007
Telangana State

Department of Zoology, Osmania University
Two Year M.Sc. (Zoology) Programme w.e.f. AY 2020-2021 onwards

Proposed Scheme for Choice Based Credit System

	Semester I				Semester II				Semester III				Semester IV			
	Course	Hrs /Wk	Credits	Marks	Course	Hrs /Wk	Credits	Marks	Course	Hrs /Wk	Credits	Marks	Course	Hrs /Wk	Credits	Marks
1	Core (SB) (Zoo_101T)	4	4	100	1 Core (TTB) (Zoo_201T)	4	4	100	1 Core (SMB) (Zoo_301T)	4	4	100	1 Core (AB) (Zoo_401T)	4	4	100
2	Core (ECB) (Zoo_102T)	4	4	100	2 Core (AP) (Zoo_202T)	4	4	100	2 Paper - II (RM) (Zoo_302T)	4	4	100	2 Paper - II (FB) (Zoo_402T)	4	4	100
3	Core (IMM) (Zoo_103T)	4	4	100	3 Core (MGDB) (Zoo_203T)	4	4	100	3 Elective - I (Zoo_303T)	4	4	100	3 Elective - I (Zoo_403T)	4	4	100
4	Core (ATFAI) (Zoo_104T)	4	4	100	4 Core (EFAV) (Zoo_204T)	4	4	100	4 Elective - II (Zoo_304T)	4	4	100				
5	Practical (SB) (Zoo_101P)	4	2	50	5 Practical (TTB) (Zoo_201P)	4	2	50	5 Practical (SMB) (Zoo_301P)	4	2	50	4 Practical (AB) (Zoo_401P)	4	2	50
6	Practical (ECB) (Zoo_102P)	4	2	50	6 Practical (AP) (Zoo_202P)	4	2	50	6 Practical (RM) (Zoo_302P)	4	2	50	5 Practical (FB) (Zoo_402P)	4	2	50
7	Practical (IMM) (Zoo_103P)	4	2	50	7 Practical (MGDB) (Zoo_203P)	4	2	50	7 Elective - I (Zoo_303P)	4	2	50	6 Elective - I (Zoo_403P)	4	2	50
8	Practical (ATFAI) (Zoo_104P)	4	2	50	8 Practical (EFAV) (Zoo_204P)	4	2	50	8 Elective - II (Zoo_304P)	4	2	50	7 Project (Pr) (Zoo_404Pr)	8	6	150
Total		32	24	600	Total	32	24	600	Total	32	24	600	Total	32	24	600

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Two Year M.Sc. (Zoology) Programme w.e.f. AY 2020-2021 onwards

List of Elective Papers (Semester III & IV) for Choice Based Credit System

SEMESTER III		SEMESTER IV	
Elective - I	Elective - II	Elective - I	Project
Neuroscience – I (NS – I) Medical Entomology – I (ME – I) Parasitology – I (PS – I) Comparative Animal Physiology – I (CAP – I) Principle of Fisheries – I (PF – I) Agricultural Entomology – I (AE – I)	Applied Toxicology (AT) Sericulture (SER) Phytonematology (PN) Zoonotic Viral Diseases (ZVD) Wildlife Techniques & Conservation (WTC) Bioremediation (BR) Endocrinology (EN) Cancer Biology and Therapeutics (CBT)	Neuroscience – II (NS – II) Medical Entomology – II (ME – II) Parasitology – II (PS – II) Comparative Animal Physiology – II (CAP – II) Principle of Fisheries – II (PF – II) Agricultural Entomology – II (AE – II)	Project (Pr)

NOTE:

A college can offer any course from the available courses listed under the Elective – II for the Semester III based on the availability of infrastructure and faculty expertise. The course will be offered only when a minimum of 15 students opt for the said course.



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DEPARTMENT OF ZOOLOGY, OSMANIA UNIVERSITY

Scheme of Examination

Semester – I

S.N.	Subject Code	Subject (Title)	Instruction Hrs/week	Duration of (hrs) Exam.	Max. Marks		Total Marks	Credits
					Internal Assessment	Semester Exam.		
	THEORY							
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	Advances in Taxonomy and Functional Anatomy of Invertebrates	4	3	20	80	100	4
	PRACTICALS							
5.	Zoo_101P	Structural Biology	4	3	-	50	50	2
6.	Zoo_102P	Environmental and Conservation Biology	4	3	-	50	50	2
7.	Zoo_103P	Immunology	4	3	-	50	50	2
8.	Zoo_104P	Advances in Taxonomy 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.	Subject Code	Subject (Title)	Instruction Hrs/week	Duration of (hrs) Exam.	Max. Marks		Total Marks	Credits
					Internal Assessment	Semester Exam.		
	THEORY							
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							
5.	Zoo_201P	Tools, Techniques and Biostatistics	4	3	-	50	50	2
6.	Zoo_202P	Animal Physiology	4	3	-	50	50	2
7.	Zoo_203P	Molecular Genetics and Developmental Biology	4	3	-	50	50	2
8.	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.	Subject Code	Subject (Title)	Instruction Hrs/week	Duration of (hrs) Exam.	Max. Marks		Total Marks	Credits
					Internal Assessment	Semester Exam.		
	THEORY							
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							
5.	Zoo_301P	Systems Biology	4	3	-	50	50	2
6.	Zoo_302P	Research Methodology	4	3	-	50	50	2
7.	Zoo_303P	Elective - I	4	3	-	50	50	2
8.	Zoo_304P	Elective - II	4	3	-	50	50	2
Total:			32		80	520	600	24

Note:

A college can offer any course from the available courses listed under the Elective - II for the Semester III based on the availability of infrastructure and faculty expertise. The course will be offered only when a minimum of 15 students opt for the said course.

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Scheme of Examination

Semester – IV

S.N.	Subject Code	Subject (Title)	Instruction Hrs/week	Duration of (hrs) Exam.	Max. Marks		Total Marks	Credits
					Internal Assessment	Semester Exam.		
	THEORY							
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
	PRACTICALS							
4.	Zoo_401P	Animal Biotechnology	4	3	-	50	50	2
5.	Zoo_402P	Fish Biology	4	3	-	50	50	2
6.	Zoo_403P	Elective - I	4	3	-	50	50	2
7.	Zoo_404Pr	Project	8	3	50	100	150	6
Total:			32		110	490	600	24

Credits and marks distribution for Project (Zoo_404pr)

	Credits	Marks
Internal Assessment		
Research Design	1	25
Completion Seminar	1	25
Semester-end Assessment		
Research work (Semester end test)	1	25
Dissertation, Final presentation & Viva	3	75
Total	6	150

Note:

The project offered in Semester IV carries 6 credits worth 150 marks.

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; Deoxy sugars, amino sugars 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, cerebroside, 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; the role of the 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 – Intercellular communication and gap junctions; chemical signalling between the cells; strategies of chemical signalling.
- 3.4 Signalling mediated by intracellular receptors; signalling 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 the cell cycle; mitotic spindle.

UNIT IV – Synthetic Biology

15 Hrs

- 4.1 DNA replication – Semi conservative, enzymology of DNA replication, replication of circular DNA, initiation, elongation and termination of replication process; Proofreading function of DNA polymerases.
- 4.2 Enzymatic synthesis of RNA; Regulation of genetic code – Wobble's concept, translation in prokaryotes and eukaryotes.
- 4.3 Protein synthesis – Events of protein synthesis; transcription in prokaryotes and eukaryotes; post-transcriptional processing.
- 4.4 DNA repair mechanism – High fidelity of DNA sequence – Repair of damage caused by UV light, Eukaryotes repair systems.
- 4.5 Synthetic genomics – Basics theoretical and computational modelling of the replicating system.

PRACTICALS

- 1 Determination of proteins by Biuret method/ Folin Phenol method.
- 2 Determination of glucose by Somogyi / Anthrone method.

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- 3 Determination of lipids by Vanillin 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 Extraction of DNA and RNA.
- 10 Electrophoretic analysis of proteins/DNA.
- 11 Feulgen reaction method for DNA localization.
- 12 Preparation and characterization of a synthetic molecule.
- 13 Submission of assignment on: Structure of Biomolecules – Carbohydrates, Amino acids, Proteins, Lipids, Nucleic acids; Mechanism of enzyme action; Metabolic cycles; DNA synthesis, RNA synthesis, protein synthesis.

[To be submitted at the time of Examination – 5 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 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.
- 13 Synthetic Biology – Tools and Application by Humin Zhao


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Code Zoo_102

Semester – I
CORE PAPER

Paper II: Environmental and Conservation Biology [ECB]


- UNIT I – Basic Concepts of Ecology** 15 Hrs
- 1.1 Types of ecosystems – Freshwater, marine and terrestrial.
 - 1.2 Laws of limiting factor, Laws of Minimum, Laws of Tolerance and Tragedy of Commons.
 - 1.3 Micronutrients and macronutrients.
 - 1.4 Population characteristics and dynamics – A 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; the interaction between environment and biota Habitat and ecological niche and niche overlap; the 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 the ecosystem.
 - 2.4 Biogeochemical cycles; inorganic pollutants and their impact SO₂, NO₂, CO, Phosphates, heavy metals (Arsenic, Lead and Mercury); radioactive nucleotides and their impact on the biological system.
 - 2.5 Acid rain sources and its impact on the biological system; greenhouse 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 legislation for protecting biological resources – Biodiversity Act, 2002 and Biodiversity Rules, 2004.
- PRACTICALS**
- 1 Draw the biogeographical regions of India and provide in brief the salient features of each biogeographical zone.
 - 2 Estimation of total alkalinity of water and soil.
 - 3 Estimation of phosphates in the water sample.
 - 4 Estimation of nitrates and nitrites in the water sample.
 - 5 Estimation of magnesium in the water sample.
 - 6 Estimation of calcium in the water sample.
 - 7 Biological indicators of water quality and their population dynamics – Collection of the water sample.
 - 8 Identification of zooplanktons, and their ecological significance.
 - 9 Enumeration and identification of the freshwater biodiversity of the local habitats.

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- 10 Enumeration and identification of the terrestrial biodiversity of the local habitats.
- 11 Estimation of particulate matter in the air.
- 12 Submission of assignment on: Growth curves- Pyramids; Productivity – eutrophication; Biogeographical regions; Legislation; Population dynamics; Biogeochemical cycles: Lake status in the surrounding area; Overexploitation of resources – any resources study on any one-Biogeographical regions of India; Major conservation movements in India NGO in conservation.
[To be submitted at the time of Examination – 5 Marks]

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.
- 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.


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UNIT I – Introduction to Immunology

- 1.1 Evolution of Immune system - Invertebrates and Vertebrates.
- 1.2 Immune system – Innate and adaptive immunity.
- 1.3 Humoral mediated immunity and cell-mediated immunity.
- 1.4 Cells involved in the immune system, the role of macrophages in immunity, Major histocompatibility complex (MHC).
- 1.5 The Lymphoid tissues – primary and secondary lymphoid organs, lymphatic traffic.

15 Hrs

UNIT II – Immunoglobulins and Complement system

- 2.1 Antigens nature, epitope, haptens, antigen-presenting cells, adjuvants.
- 2.2 Immunoglobulins structure, function and classification of antibodies.
- 2.3 Monoclonal antibodies and their application.
- 2.4 Immunological techniques ELISA, FISH and GISH.
- 2.5 Complement system – Components of the complement system, pathways - classical and alternative, biological consequences of complement activation and complement significance.

15 Hrs

UNIT III – Hypersensitivity Reactions and Autoimmune Diseases

- 3.1 Hypersensitivity – Classification of hypersensitivity reactions; Type – I – Anaphylactic hypersensitivity; Type – II – Antibody-mediated cytotoxic hypersensitivity.
- 3.2 Type – III – Immunocomplex mediated hypersensitivity.
- 3.3 Type – IV – Cell-mediated (Delayed) hypersensitivity.
- 3.4 Autoimmune diseases – Organ-specific autoimmune diseases – Grave's disease, insulin-dependent *diabetes mellitus* (type-I diabetes).
- 3.5 Autoimmune diseases – Systemic autoimmune diseases – Systemic Lupus Erythematosus (SLE), Rheumatoid arthritis.

15 Hrs

UNIT IV – Transplantation and Tumour Immunology

- 4.1 Transplantation – Barriers to transplantation.
- 4.2 Genetic predisposition for graft rejection, prevention of rejection.
- 4.3 Immunity to infection 1 – Viruses, bacteria, fungi - nature of interaction; immunopathological considerations.
- 4.4 Immunity to infection 2 – Parasites - nature of interaction; immunopathological considerations.
- 4.5 Tumour immunology – Immunity to tumours, tumour-specific antigens; Immunosurveillance.

PRACTICALS

- 1 Slide agglutination test – A, B, O blood groups.
- 2 HIV test (Tridot method).
- 3 RDT Kit for Malaria / Dengue (Source for kit – NVBDCP).
- 4 RPR Test for Syphilis.
- 5 Widal test for diagnosis of enteric fever.
- 6 Blood smear preparation and identification of lymphocytes.
- 7 Identification of histological slides of lymphoid tissues - Spleen, thymus, lymph node and bone marrow.
- 8 Single Radial immunodiffusion for estimating the concentration of antibodies and antigens.

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- 9 Immunization schedules and rising of antibodies.
 - 10 Demonstration of Immuno-electrophoresis.
 - 11 Submission of assignment on: structure of immune cells, antibodies, antigen-antibody reactions, Immunological techniques (ELISA, RIA, Immunoprecipitation- FISH and GISH) Monoclonal antibodies, MHC, Hypersensitivity types, transplantation and tumour immunology.
- [To be submitted at the time of Examination – 5 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 Text by Basiro Davey.
- 5 An introduction to immunology, by Ian R. Tizard.


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M.Sc. Zoology

Code Zoo_104

Semester – I

CORE PAPER

Paper IV: Advances in Taxonomy & Functional Anatomy of Invertebrates [ATFAI]

15 Hrs

UNIT I – Advances in Taxonomy

- 1.1 Basic concepts of biosystematics, taxonomy and classification; Branches of taxonomy – Cytotaxonomy, Chemotaxonomy, Numerical Taxonomy, and Cladistics Taxonomy.
- 1.2 Taxonomic hierarchy of ranks; Species concepts – Biological, Evolutionary, and Phylogenetic.
- 1.3 Recent trends in biosystematics – Molecular taxonomy and Integrative approaches.
- 1.4 International Code for Zoological Nomenclature (ICZN) – Operative principles, interpretation and application of important rules.
- 1.5 Zoological Types; Scientific names and their basis.

15 Hrs

UNIT II – Lower Invertebrates

- 2.1 Concepts of Prokarya and Eukarya; Concepts of Protostomia and Deuterostomia.
- 2.2 Reproduction and development in Cnidaria.
- 2.3 Reproduction, development and larval forms of Platyhelminthes.
- 2.4 Host-parasite relationship and their interaction.
- 2.5 Filter feeding in invertebrates – Porifera, Polychaeta and Mollusca.

15 Hrs

UNIT III – Higher Invertebrates

- 3.1 Respiration in Annelida and Mollusca.
- 3.2 Shell and foot & their functions in Mollusca.
- 3.3 Evolutionary and phylogenetic significance of crustacean larval forms.
- 3.4 Evolutionary and phylogenetic significance of echinoderm larval forms.
- 3.5 Eusociality in insects; Autotomy and regeneration in echinoderms.

15 Hrs

UNIT IV – Minor Phyla

- 4.1 Systematic position, general organization and affinities of Ctenophora.
- 4.2 Systematic position, general organization and affinities of Nemertea.
- 4.3 Systematic position, general organization and affinities of Rotifera and Acanthocephala.
- 4.4 Systematic position, general organization and affinities of Bryozoa and Entoprocta.
- 4.5 Systematic position, general organization and affinities of Chaetognatha.

PRACTICALS

- 1 Specimen studies - Salient characteristics, identification and classification of representative types of invertebrate groups from Protozoa, Porifera, Cnidaria, Ctenophora, Annelida, Mollusca, Arthropoda, Echinodermata, and Hemichordata.
- 2 Collection and identification of invertebrates in pond water.
- 3 Preparation of permanent slides of zooplanktons (minimum three different types of species).
- 4 Collection and identification of parasites from the cockroach.
- 5 Dissections -
 1. Minor – a) Reproductive system of cockroach, b) Mouthparts of cockroach
 2. Major – a) Nervous system of prawn
- 6 Submission of assignment on: 1) International Code for Zoological Nomenclature; 2) Molecular taxonomy; 3) Life cycle of *Paragonimus westermani*; 4) Foot in Mollusca; 5) Shell in Mollusca; 6) Social life of the bee, silk moth, and lac insect; 7) Diagrams of larvae of Crustacea; 8) Diagrams of larval forms in Echinoderms;

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New CBCS Syllabus for 2020-21 onwards


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9) Morphology of Ctenophora, Nemertea, Bryozoa, Entoprocta, Chaetognatha.

[To be submitted at the time of Practical Examination – 5 Marks]

Suggested Books

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


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UNIT I – Tools and Separation Techniques

15 Hrs

- 1.1 Principles and Applications of Microscopic Techniques: Bright and Dark Field Microscopy; Fluorescent Microscopy; Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM).
- 1.2 Microtomy and staining procedures– Types of microtomes, Tissue Fixation, Embedding, types of stains, staining and mounting procedures of biological materials.
- 1.3 Centrifugation – Basic Principle of Centrifugation, Types of Centrifugation, Preparative and Analytical, Principles of Sedimentation, Svedberg Co-efficient; Cell separation by density gradient centrifugation; Cell separation by Affinity adsorption; Cell separation by anchorage-based techniques; principles and applications of Preparative, analytical and ultra-centrifugation.
- 1.4 Separation & Identification of Materials - Concept of Chromatography; Adsorption Chromatography, Ion Exchange Chromatography, Gel Chromatography, HPLC, Affinity Chromatography.
- 1.5 Electrophoresis Techniques - Principles and applications of agarose and polyacrylamide gel electrophoresis.

15 Hrs

UNIT II – Separation and Imaging Techniques

- 2.1 Spectroscopy: Fluorescence, UV, Visible, Infrared, Atomic absorption spectroscopy, NMR and ESR spectroscopy.
- 2.2 Mass spectrometry (LC-MS, GC-MS), X-ray diffraction, MALDI-TOF.
- 2.3 Electrophysiological Techniques: Single neuron recording, patch-clamp recording, ECG Recording.
- 2.4 PCR; Types of PCR; Primer Design; Applications of PCR.
- 2.5 SDS-PAGE, 2D- Gel Electrophoresis.

15 Hrs

UNIT III – Diagnostic Techniques:

- 3.1 Radioisotope Techniques: Principles and applications of tracer techniques in biology; radioactive isotopes and half-life periods of isotopes; autoradiography. Principles and application of Geiger-Muller and scintillation counter.
- 3.2 Imaging Techniques: PET, MRI, fMRI and CAT.
- 3.3 RT-PCR Techniques for Qualitative and Quantitative Analysis of DNA; RNA and Proteins
- 3.4 Micro Array Technology: Principles and Applications of Micro Array Technology.
- 3.5 Gene Editing Technologies; CRISPER/CAS9 Technology and Applications

15 Hrs

UNIT IV – Biostatistics– Descriptive Statistics

- 4.1 Introduction to biostatistics; Statistical data & its taxonomy; Organization and tabulation of data.
- 4.2 Frequency distribution; Concept of population & sample.
- 4.3 Measures of central tendency – Mathematical average (Mean – Arithmetic, Geometric & Harmonic Mean) and Positional Averages (Median and Mode); Measures of dispersion (or variability) – types, range, quartile deviation, mean deviation, variance, standard deviation, coefficient of variance.
- 4.4 Sampling distribution of mean, standard error; Random variable – Concept, expectation and variance of the random variable.
- 4.5 Basics of Probability – Concept of probability, addition and multiplication laws of probability and application to the problems of biology.

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PRACTICALS

- 1 To fix a tissue with Bouin's fixative and stain using hematoxylin-eosin stain for histochemical studies
- 2 Separation of biological compounds by paper chromatography
- 3 Separation of biological compounds of by TLC
- 4 To prepare a paraffin block of tissue for microtomy for making sections of tissue for histochemical studies
- 5 Quantitative detection of total carbohydrates using Anthrone technique
- 6 Quantitative detection of total lipids using sulpho-phosphovanillin technique
- 7 Quantitative detection of total proteins using Lowry et al's Biuret technique
- 8 Graphic presentation of data – bar diagram, histogram, frequency polygon and pie chart
- 9 Calculation of measures of central tendencies – mean, median and mode
- 10 Calculation of measures of dispersions – range, mean deviation, standard deviation, variance and coefficient of variance
- 11 Submission of assignment on Principles & applications of centrifugation; Chromatographic techniques; microtomy; Microscopy and its applications in biology; Electrophoresis techniques and its applications; Spectroscopic techniques; Radioisotope techniques; Electrophysiological techniques; Microarray techniques; Statistical data & its taxonomy; Frequency distribution; Concept of population & sample; Measures of central tendency; Measures of dispersion; Sampling distribution of mean; standard error; Random variable; Concept of probability; Addition and multiplication laws of probability.
[To be submitted at the time of Examination – 5 Marks]

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 – DeRobertis
- 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


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UNIT I – Digestion, Respiration & Circulation

- 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 CO₂ and O₂ 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.

15 Hrs

UNIT II – Osmoregulation, Excretion & Thermoregulation

- 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.

15 Hrs

UNIT III – Muscle Physiology, Neurophysiology & Receptors

- 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 the stimulus, Na, K currents in the 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.

15 Hrs

UNIT IV – Endocrinology, Bioluminescence & Stress Physiology

- 4.1 Detailed overview of invertebrate hormones.
- 4.2 Hormones in vertebrates - Biochemistry and physiological functions.
- 4.3 Mechanism of hormone action - Peptide and steroid hormones.
- 4.4 Bioluminescence - Luminescent organisms - Neural control; Biochemistry and significance of luminescence.
- 4.5 Stress - Coping mechanisms to stress; Role of hormones and sympathetic nervous system in stress.

PRACTICALS

- 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.


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- 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.
- 10 Submission of assignment on Ruminant and non-ruminant digestion. Absorption and post absorptive states and their regulation in mammals. Respiration – Cascade of oxygen transport to tissues at high altitude. Hemodynamics. Osmoregulatory problems in aquatic and terrestrial animals. Rennin-angiotensin system and hormonal regulation – ADH and aldosterone, purine cycle, torpor hibernation and aestivation. Types of neurons and glial cells. Synaptic transmission and Neurotransmitters. Receptor mechanism, photoreception and phonoreception in mammals. Endocrine glands of invertebrates. Biochemistry & significance of luminescence. Stress – hormones and the sympathetic nervous system in stress. **[To be submitted at the time of Examination – 5 Marks]**

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.


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Semester II
CORE PAPER

Paper III: Molecular Genetics and Developmental Biology [MGDB]

15 Hrs

UNIT I – Introduction to Genetics

- 1.1 Mendelism; Mendelian inheritance; modification of mendelian inheritance.
- 1.2 Linkage studies, crossing over and extrachromosomal inheritance, multiple alleles, blood group antigens.
- 1.3 Chromosome structure (Prokaryote and Eukaryote); identification, karyotype.
- 1.4 Genetic disorders – Chromosomal disorders; polygenic disorders; environmental disorders.
- 1.5 Bacterial genetics – Transformation, transduction, conjugation, viral lytic and lysogenic cycle.

15 Hrs

UNIT II – Molecular Genetics

- 2.1 Introduction of DNA technology – Restriction endonucleases, methods of ligation – DNA ligases, ligation of the 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 concerning 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.

15 Hrs

UNIT III – Overview of Developmental Biology

- 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.

15 Hrs

UNIT IV – Organogenesis

- 4.1 Gastrulation, metabolic events during gastrulation and rudimentary organs formation.
- 4.2 Concept of organisers and inducers; Neural tubule formation.
- 4.3 Organogenesis: limb, central nervous system, heart, kidney and eye.
- 4.4 Role of hormones in the 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; senescence.

PRACTICALS

- 1 Identification of blood groups: A, B, O.
- 2 Karyotyping of human chromosomes.
- 3 Isolation and estimation of DNA in tissue.
- 4 Isolation and estimation of RNA in tissue.
- 5 Estimation of soluble and structural proteins in chick embryo (any two durations) – 24hrs, 48hrs, 72hrs, & 96hrs.
- 6 Estimation of SDH activity in chick embryo (any two durations) – 24hrs, 48hrs, 72hrs, & 96hrs.
- 7 Estimation of LDH activity in chick embryo (any two durations) – 24hrs, 48hrs, 72hrs, & 96hrs.

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- 8 Estimation of calcium in eggshell by EDTA method (any two durations) – 24hrs, 48hrs, 72hrs, & 96hrs.
- 9 Identification of chick embryo developmental stages (any two durations) – 24hrs, 48hrs, 72hrs, & 96hrs.
- 10 Study of cleavage patterns in *Lymnaea*.
- 11 Submission of assignment on: Linkage; Crossing over; Multiple alleles; Blood group antigens; Bacterial transformation, transduction, conjugation (only diagrams); Hybridization techniques – Southern blot, Northern blot and Western blot; Features of vectors – cosmids, plasmids and shuttle vector; DNA fingerprinting and its application; Gametogenesis (spermatogenesis & oogenesis); Fertilization and its significance; Parthenogenesis and its significance; Cleavage types; Presumptive areas and fate maps; Concept of organisers and inducers; Role of hormones in the metamorphosis of frog; Regeneration in Amphibia (limb and tail regeneration).

[To be submitted at the time of Examination –5 Marks]

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 (OU Press)
- 14 Textbook 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 Berryl


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Semester – II
CORE PAPER

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

15 Hrs

UNIT I – Evolution of Life

- 1.1 Evolution of evolutionary biology – Pre-Darwinian concepts, Darwinism, Neo-Darwinism.
- 1.2 Natural Selection and adaptation; Mutation – Its types, mutation rates; Variation – gene mixing mechanisms.
- 1.3 Genetic drift; Speciation – Reproductive isolation (Pre-zygotic & Post-zygotic), modes of speciation (Allopatric, Sympatric & Parapatric).
- 1.4 Patterns of evolution – Sequential, divergent, convergent, gradual, punctuated, monophyletic, polyphyletic & paraphyletic.
- 1.5 Origin and evolution of primates and human; Evolutionary significance of bipedalism in non-human and human primates.

15 Hrs

UNIT II – Evolution of Vertebrates

- 2.1 Evolution of Agnathans – a) Extinct (Conodonts, Ostracoderms & Pteraspodomorphi) and b) Living (Myxinoidea & Petromyzontiformes).
- 2.2 Evolution of Gnathostomes – a) Placodermi and b) Chondrichthyes (including Elasmobranchii & Holocephali).
- 2.3 Evolution of Teleostomi – a) Acanthodii and b) Osteichthyes (Actinopterygii & Sarcopterygii).
- 2.4 Evolution Tetrapods – a) Labrynthodonts, b) Lepospondyls and c) Lissamphibia (Urodela, Anura & Apoda).
- 2.5 Evolution of Amniotes – a) Reptilia (Mesozoic and living reptiles), b) Aves (Palaeognathae & Neognathae) and c) Mammalia (Prototheria & Theriiformes).

15 Hrs

UNIT III – Functional Anatomy – I

- 3.1 Integumentary system – Integument and its derivatives.
- 3.2 Cranial skeletal system – a) Basic plan of skull; b) Temporal fossae – its function; c) Jaw suspension and its types.
- 3.3 Post-cranial skeletal system – a) Axial skeleton; b) Appendicular skeleton; c) Joints (both axial & appendicular and their types).
- 3.4 Digestive system in Aves and Mammals – Components and function; Dentition in mammals.
- 3.5 Respiratory system in vertebrates (Fishes to Mammals) – Gills, lungs and other respiratory structures.

15 Hrs

UNIT IV – Functional Anatomy – II

- 4.1 Excretory system in vertebrates (Fishes to Mammals) – Kidney and its structure; Modes of excretion.
- 4.2 Nervous system in vertebrates (Fishes to Mammals) – Brain, spinal cord and peripheral nerves.
- 4.3 Eye in vertebrates (Aves and Mammals) – Structure and function in different classes.
- 4.4 Amniotic egg – Its structure and evolutionary significance.
- 4.5 Evolutionary significance of internal fertilization; Placenta and its types.

PRACTICALS

- 1 Specimen studies - Salient characteristics, identification and classification of representative types of vertebrate groups - Pisces, Amphibia, Reptilia, Aves, and Mammalia.
- 2 Collection and preparation of slides of scales of fishes.
- 3 Dissections:
 1. Minor – a) Weberian ossicles of *Labeo*, and b) Respiratory trees of *Clarius*

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2. Major – a) Cranial nerves of *Labeo* (V, VII, IX & X cranial nerves)
- 4 Submission of assignment on: Diagrammatic representation with labelling of 1) Theories of evolution; 2) Types of speciation; 3) Evolution of primates; 4) Evolution of human; 5) Adaptive radiation in amphibians, reptiles, birds, and mammals; 6) Integument and its derivatives; 7) Types of axial and appendicular joints; 8) Senses organs – a) Eye in vertebrates; b) Ear in tetrapods; 9) Structure of brain, nervous system, respiratory system, digestive, and excretory systems in fishes to mammals; 10) Different types of skulls basing on temporal fossae; 11) Structure of Amniotic egg; 12) Placenta and different types of the placenta.
- [To be submitted at the time of Practical Examination – 5 Marks]**

Suggested Books

- 1 Evolution of Vertebrates by E.H. Colbert
- 2 Evolutionary Biology by Mitkoff
- 3 Organic Evolution by Veer Bala Rastogi
- 4 Vertebrates – Comparative Anatomy, Function & Evolution (8th Ed.) by K.V. Kardong
- 5 Life of Vertebrates by J.Z. Young
- 6 A Textbook of Zoology Vol. II by Parker and Haswell (revised by Marshall)
- 7 Vertebrate Body by A.S. Romer
- 8 Chordates by Alexander
- 9 Comparative Vertebrate Anatomy by Hyman
- 10 Vertebrate Structure and Function by Waterman
- 11 Comparative Anatomy by Kent
- 12 Vertebrates by R.L. Kotpal
- 13 Chordate Zoology E. L. Jordan & P. S. Verma
- 14 Vertebrate Zoology & Evolution – Yadav B. N. & D. Kumar


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Semester – III

Core Paper

Paper I - Systems Biology [SMB]

15 Hrs

UNIT I – Introduction to Systems Biology

- 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 modelling, model behaviour, classification.
- 1.5 Basic concepts of networks; types of networks.

15 Hrs

UNIT II – Systems Approach

- 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 modelling.
- 2.5 Bioremediation - Hydrocarbon bioremediation, radionuclide biotransformation, metals bioimmobilization.

15 Hrs

UNIT III – Predictive Modeling

- 3.1 Continuous population models for single species.
- 3.2 Insect outbreak model - Aperiodic Dynamics.
- 3.3 Predictive ecology, game theory population models, predator-prey model.
- 3.4 Kinetic models of the biochemical system – Metabolic control analysis.
- 3.5 Data formats, simulation techniques, modelling tools.

15 Hrs

UNIT IV – Systems Biology Applications

- 4.1 Networks in the 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 – Characterization and applications.

PRACTICALS

- 1 Live-cell imaging through a fluorescent microscope.
- 2 Estimation of predator-prey relationship using larvivorous fish.
- 3 Temperature-dependent enzymatic activity in metabolites.
- 4 *In silico* phylogenetic analysis.
- 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.
- 10 Submission of assignment on: Types of networks in systems biology; Biochemical networks and metabolism (Kreb's cycle & electron transport) cycles; Mechanism of apoptosis; Insect outbreak, Bioremediation techniques; Predictive ecology – predator, prey model; *Caenorhabditis elegans* model system for neurotoxicity; Nanoparticles in biological systems & their applications.


[To be submitted at the time of Examination – 5 Marks]

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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 Kunihiko.
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.
10. A Model of Development of a Spontaneous Outbreak of an Insect with Aperiodic Dynamics.
-by A. Yu. Perevaryukha. Entomological Review, 2015, Vol. 95, No. 3, pp. 397–405


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UNIT I – Research Design and Method

- 1.1 Research – definition, importance and application; Types - basic and applied research; Essential steps in research.
- 1.2 General methods in biological research – 1) Natural observation, 2) Field study, and 3) experimentations; Purpose Statement – definition and significance.
- 1.3 Experimental design – Basic principles & research hypotheses; Types of experimental design – 1) One-group & Two-group design, 2) Matched pair data analysis, 3) Factorial design, & 4) Randomized block design.
- 1.4 Sampling method – Concept of population and sample; Sampling (random sampling and non-random sampling); Variables (random, independent and intervening variables).
- 1.5 Data collections: Methods for primary data (observation, interview, questionnaire methods, and experiments) & secondary data (scientific journals, books, reports, databases).

15 Hrs

UNIT II – Computers in Research & Concepts of Probability and Hypothesis

- 2.1 Computers and their applications in biology; Word Processing – Introduction to MSWord, typesetting, formatting, creating tables, inserting resources, and managing references.
- 2.2 Data Processing – Introduction to MS Excel, formatting, data management, and understanding formulas and data analysis tool.
- 2.3 Probability distribution – Definition & Types; Properties and applications of 1) Normal distribution, 2) Binomial distribution, and 3) Poisson distribution.
- 2.4 Statistical Inference, Statistical Model & Estimation; Hypothesis – types (null hypothesis, alternate hypothesis); Basic approach to hypothesis testing; Hypothesis testing (one-tailed & two-tailed hypothesis tests); Test of significance.
- 2.5 Type I & Type II errors in hypothesis testing; Level of significance; Sample size estimation; Use of different statistical estimations depending on the type of data.

15Hrs

UNIT III – Inferential Statistical Tools in Research

- 3.1 Single sample tests – Z test, Standard error of the mean, One-tailed and Two-tailed Z test and interpretation.
- 3.2 Student's 't' test basic concepts; 1) Paired two sample for means, 2) Two-Sample assuming equal variances, & 3) Two-Sample assuming unequal variances.
- 3.3 ANOVA 1) One-way, and 2) Two-way ANOVA.
- 3.4 Chi-square test – Concept and application of 1) Goodness of Fit and 2) Test for independence.
- 3.5 Correlation and regression – Concepts and their applications.

15 Hrs

UNIT IV – Reporting Research

- 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; Good Laboratory Practices.
- 4.5 Animal model systems; animal ethics- animal welfare guidelines for care and use of animals.

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PRACTICALS

- 1 Preparation of charts (Frequency graphs, Scatter plots, Pie charts) using MS Excel.
- 2 Calculation of Mean and Standard Deviation, and preparation of the graph depicting mean and standard deviation using MS Excel.
- 3 Calculation of descriptive statistics of data in MS Excel.
- 4 Calculation of t-test for paired two samples for means using MS Excel.
- 5 Calculation of correlation for bivariate data using MS Excel.
- 6 Calculation of regression for bivariate data using MS Excel.
- 7 Calculation of one-factor ANOVA using MS Excel.
- 8 Calculation of two-factor ANOVA using MS Excel.
- 9 Literature review using online resources.
- 10 Preparation and documentation of research publication/dissertation.
- 11 Preparation of MS PowerPoint presentation on a topic of your choice.
- 12 Submission of assignment on: 1) Experimental design – Basic principles, hypotheses; 2) Random and non-random sampling; 3) Data collection – primary & secondary data; 4) Graphical representation of data – Column or Bar chart, Line chart, Scatter chart, & Pie chart; 5) Probability distribution – Definition & Types; Properties and applications of 1) Normal distribution, 2) Binomial distribution, and 3) Poisson distribution; 7) Statistical hypothesis – null hypothesis & alternate hypothesis; 8) Student T-test; 9) Chi-square test; 10) One way & Two way ANOVA; 11) Literature collection – sources; 12) Paper Dissertation writing – Steps; 13) Plagiarism tools; 14) Ethical considerations in Animal & human experimentation; 15) Good Laboratory Practices.

[To be submitted at the time of Examination – 5 Marks]

Suggested Books

- 1 Biostatistics by N. Gurumani
- 2 Research Methodology by N. Gurumani
- 3 Research Methodology by R C Kothari
- 4 Research Methodology – A Step by Step Guide by Ranjith Kumar
- 5 Practical Statistics using Microsoft Excel by Dibyojyoti Bhattacharjee
- 6 Next-generation Excel by I D Gottlieb
- 7 Research design: Qualitative, quantitative, and mixed methods approaches (4th ed.) by John W. Creswell.
- 8 Fundamental of Research Methodology and Statistics by Yogesh Kumar Singh
- 9 Introduction to Research Methods by Catherine Dawson
- 10 Research Methods and Statistics by Sherri L Jackson


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Semester – III

Elective - I

Paper III - Neuroscience - I [NS-I]

UNIT I – Cellular Neurobiology

15 Hrs

- 1.1 Ultrastructure of a neuron, axonal transport and its mechanism.
- 1.2 Types of neuronal and glial cells, organization of neurons in the brain.
- 1.3 Organization of CNS and PNS.
- 1.4 Overview of the functional anatomy of the 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 muscarinic 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 Biorhythm – Sleep and awake; neuronal – humoral mechanisms.
- 4.2 Types of learning and memory; cellular and molecular basis of learning and memory; the 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 behaviour.

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

- 1 Demonstration of gross anatomical regions of the brain.
- 2 Isolation of hippocampus, preparation of AchE, staining, the protocol of hippocampal cell culture.
- 3 Identification of different types of neural and glial cells.
- 4 Estimation of acetylcholine in different regions of the brain.
- 5 Estimation of acetylcholinesterase sodium and potassium ATPase activity.
- 6 Electrophysiological demonstration of biopotentials and conduction velocity.
- 7 Determination of maze learning and estimation of proteins in the 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.
- 10 Submission of assignment on: Ultrastructure of neuron axoplasm transport; Types of neuronal and glial cells; Functional anatomy of the brain, spinal cord; Circuits of voltage and patch-clamp technique; Types of biopotentials; Structure of Ach receptor, ion channels, ion pumps; Structure of neurotransmitter; Mechanism of G-protein receptor mechanisms;


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Neuroendocrine/Neuroimmune circuits; Diagram of the neuronal mechanism of sleep awake; LTP mechanism; Organization cerebral cortex.

[To be submitted at the time of Examination – 5 Marks]

Suggested Books

- 1 Physiology and biophysics – Ruch and Patten.
- 2 A textbook of muscle physiology – D. A. Jones and J. M. Round.
- 3 Neurobiology – Gordon M Shepperd.
- 4 Principles of neural science – E. Kandel and others.
- 5 Essentials of neural science and behaviour – E. Kandel and others.
- 6 Behavioural 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 Textbook of medical physiology – Guyton.


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Semester – III

Elective - I

Paper III - Medical Entomology – I [ME-I]

- UNIT I – Overview of Entomology** 15hrs
- 1.1 Significance of Insects to human importance: Reasons why insects are so successful.
 - 1.2 Classification of Insects, Arachnids and other medically important Arthropods.
 - 1.3 Insect Morphology: exoskeleton, head, thorax, and abdomen.
 - 1.4 Insects Physiology: digestive system, excretory system, respiratory system, circulatory system, nervous system, reproductive system, and endocrine system.
 - 1.5 Insect development: growth, development and metamorphosis.
- UNIT II – Biology and Life Cycles of Medically Important Insects, Ticks and Mites** 15hrs
- 2.1 Culicidae: Anophelinae (*Anopheles*), Culicinae (*Aedes* and *Culex*)
 - 2.2 Phlebotomidae: (Sandflies), Simuliidae: (Blackfly)
 - 2.3 Glossinidae: Tsetse fly
 - 2.4 Pulicidae: Fleas
 - 2.5 Acari: Ticks and Mites
- UNIT III – Insect Ecology & Behaviour** 15hrs
- 3.1 Scope of Insect ecology, ecological hierarchy, and influence of climate change on vector distribution.
 - 3.2 Insect population dynamics: Population fluctuations, and factors affecting population size.
 - 3.3 Community ecology: Classes of interaction, factors affecting interaction and consequences of interaction.
 - 3.4 Community structure - Species diversity, Species interaction.
 - 3.5 Insect behaviour – factors affecting dispersal behaviour, mating behaviour, reproductive and social behaviour.
- UNIT IV – Pathogens and Parasites Transmitted by Vectors, Venomous Arthropods** 15hrs
- 4.1 Bacteria- *Yersinia pestis*, Rickettsiae.
 - 4.2 Arboviruses – Flavivirus (DENV), (JEV), (TBEV) and Alphavirus (CHIKV).
 - 4.3 Protozoans – Plasmodium, Leishmania and Trypanosoma.
 - 4.4 Helminthes – *Wuchereria bancrofti* and *Onchocerca volvulus*.
 - 4.5 Venomous arthropods: Bees, Wasps, Ants, Spiders, Scorpions, Annoying insects, and Scabies.
- PRACTICALS**
- 1 Insect collection and preservation of medically important insects.
 - 2 Collection and identification of medically important insects, ticks, mites - up to genus level.
 - 3 Collection and identification of venomous arthropods - up to genus level.
 - 4 Identification of different mosquito breeding habitats.
 - 5 Maintenance and study the stages of the life cycle of the mosquito.
 - 6 Preparation of permanent mounts of mosquito larval mouthparts and respiratory siphon.
 - 7 Preparation of permanent mounts of Insect leg and antennae.
 - 8 Preparation of permanent mounts of wings of mosquito.
 - 9 Preparation of permanent mounts of adult mosquito mouthparts.
 - 10 Dissection of Mosquito salivary glands and Reproductive system.
 - 11 Study of species diversity indices: Simpson's index, Shannon-Weiner index.
 - 12 Study of permanent slides/specimens - *Plasmodium*, *Leishmania*, *Trypanosoma* and *Wuchereria*.

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- 13 Maintenance of Insect / venomous arthropod collection box. Note: (**Submission of Insect / venomous arthropod collection box is must during the practical examination)
- 14 Submission of assignment on: Draw a well labeled external morphology of Anopheles mosquito; Draw a well labeled external morphology of Aedes mosquito; Draw a well labeled external morphology of Culex mosquito; Draw a well labeled lifecycle of Anopheles mosquito; Draw a well labeled lifecycle of Aedes mosquito; Draw a well labeled lifecycle of Culex mosquito; Draw a well labeled lifecycle of Sandfly; Draw a well-labelled lifecycle of Blackfly; Draw a well-labelled lifecycle of Tsetse fly; Draw a well-labelled lifecycle of Flea. Draw a well-labelled lifecycle of Ticks and Mites. Life cycle of Plasmodium, Life cycle of *Wuchereria bancrofti*. Life cycle of *Leishmania*.

[To be submitted at the time of Examination – 5 Marks]

Suggested Books

- 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 - 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 Ananthakrishnan.
- 9 Destructive and Useful Insects by R. L. Metcalf.
- 10 Ecology of Insects by Martin R. Speight Pub: Wiley-Blackwell.
- 11 Insect Ecology: An Ecosystem Approach - by Timothy D. Schowalter 3rd Edition. Pub: Elsevier, 2011.
- 12 Mosquito ecology field sampling methods 3rd edition by John B. Silver Pub: Springer.


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Semester – III

Elective - I

Paper III - Parasitology – I [PS-I]

15 Hrs

UNIT I – Morphology, Anatomy and Classification

- 1.1 An overview and classification of Monogenea, Aspidogastrea, Digenea and Cestoda.
- 1.2 Ultrastructure and function of the 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.

15 Hrs

UNIT II – Reproduction, Ecology and Evolution

- 2.1 Reproductive system, eggshell 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 Helminth's host specificity and its breakdown.
- 2.5 Host-parasite interactions and their significance; the role of helminths as vectors of microbial infection

15 Hrs

UNIT III – Trematode and Cestode Diseases

- 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*.

15 Hrs

UNIT IV – Adult Metabolism, Anthelmintics and Immunology

- 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 the 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, Aspidogastreans 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 helminths.
- 6 Measurement of infection: Prevalence, density, intensity and index of helminth parasites.

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- 7 Submission of assignment on: Classification of Monogenea, Aspidogastrea and Digenea; Classification of cestoda and trematode; Types of eggs and morphology of larval forms of cestode and trematode; Morphology and larval forms of cestode and trematode; Morphology and life cycle of *Fasciola hepatica*; Morphology and life cycle of *Echinococcus multiloculus*; Carbohydrate metabolism in helminths; Protein metabolism in helminths.

[To be submitted at the time of Examination – 5 Marks]

Suggested Books

- 1 Animal parasitology – J. D. Smyth (Cambridge Univ. Press., 1976).
- 2 Foundations of parasitology 6 ed. – L. S. Roberts & J. Janový 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 Handbook 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 (Bombay popular Prakshan, 1993).


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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 gastrointestinal 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 an intact animal, modifying agents.
- 2.3 Adaptations to diving and high altitudes.
- 2.4 Comparative aspects of the transport of oxygen and carbon dioxide; regulation of respiration.
- 2.5 Respiratory pigments in different phylogenetic groups, genes with reference to haemoglobin.

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 Heatstroke; 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 the 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 the thyroid and antithyroid agents on oxygen consumption in fish.
- 10 Submission of assignment on: Comparative aspects of carbohydrate pathways; Comparative aspects of metabolic pathways; Respiratory pigments in different phylogenetic groups; Nitrogen excretion pattern as in

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different animal groups; Freezing; Winter hardening; GERD

[To be submitted at the time of Examination – 5 Marks]

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 – Adaptation and function By F. Reed Hainswoth (Publ. by Addison – Wesley Publ. Company, California).
- 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 Medical physiology by Sujit K. Chaudari.
- 8 Textbook of medical physiology by Arthur Guyton


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Semester – III

Elective - I

Paper III - Principles of Fisheries –I [PF-I]

- UNIT I – Introduction to Fisheries** 15 Hrs
- 1.1 History of fisheries; Present scenario of the fisheries sector in India; Blue revolution & food security.
 - 1.2 Classification of fisheries; Resources of fisheries in India and Telangana in particular.
 - 1.3 Fisheries institutes in India and their role in the augmentation of fish production.
 - 1.4 Role of fisheries in the economic development of the nation.
 - 1.5 Fishery economics - Basic concepts in economics; micro versus macro-economics.
- UNIT II – Ecology of Water Bodies** 15 Hrs
- 2.1 Ecology of lentic and lotic ecosystems. Aquatic pollution and its impact on fisheries.
 - 2.2 Ecosystem and productivity – Energy flow, Trophodynamics, Ecological pyramids, Ecological productivity.
 - 2.3 Water quality: Physico-chemical parameters of freshwater, brackish water and marine; Ideal conditions of soil and water for fish culture.
 - 2.4 Population dynamics – Population characteristics, Dynamics of the fish population.
 - 2.5 Reservoir, riverine and estuarine fisheries and their management.
- UNIT III – Culture Systems** 15 Hrs
- 3.1 Culture systems: open, closed, semi-intensive and intensive culture systems.
 - 3.2 Poultry-cum-fish culture - Analysis of cost-benefit ratio.
 - 3.3 Paddy and Horticulture-cum-fish culture - Analysis of cost-benefit ratio.
 - 3.4 Sewage-fed fish culture - Opportunities and challenges.
 - 3.5 Composite fish culture - Prawn-cum-fish culture.
- UNIT IV – Fish Harvesting Technology and Fish Biotechnology** 15 Hrs
- 4.1 Types of Fishing Crafts – Non-mechanized and mechanized crafts.
 - 4.2 Types Fishing Gears – Gear material, gear making, accessories.
 - 4.3 Fish gear preservation methods and maintenance of crafts.
 - 4.4 Cryopreservation of gametes; Fish genomics – chromosomal mapping.
 - 4.5 Fish transgenics for therapeutics; Vaccine development for fish diseases.
- PRACTICALS**
- 1 Water analysis and its relation with Aquaculture – pH, Dissolved oxygen, Total alkalinity, Salinity, Calcium, Magnesium, Nitrates, Phosphates, total dissolved solids, Turbidity.
 - 2 Collection and identification of planktons.
 - 3 Collection and identification of benthos.
 - 4 Identification of Fishing gear and craft models.
 - 4 Karyotyping of chromosomes in fishes.
 - 5 Submission of assignment on: Classification of fisheries; Culture system of fishes; Integrated fish culture; types of fishing crafts; types of fishing gears. Cryopreservation of gametes; Fish transgenics for therapeutics. Vaccine development for fish diseases.
- [To be submitted at the time of Examination – 5 Marks]

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Suggested Books

- 1 Water quality criteria for freshwater fish. Albastor, J. S. and Lloyd, R. Butterworth Scientific Pub.
- 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.
- 6 A manual of freshwater aquaculture – Santhanam, R. Suklllnaran. N. Natarajan Oxford and IBH Pub. comp.
- 7 Freshwater aquaculture – Rath, R. K. Scientific Publishers, Jodhpur.
- 8 Textbook of fish culture, breeding and cultivation of fish – MareelHuet, Fishing News Books.
- 9 Aquaculture development, processes and prospects – TVR Pillay 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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SEMESTER – III

Elective - I

Paper III: Agricultural Entomology - I [AE -I]

UNIT I – Introduction

15 Hrs

- 1.1 Scope and Importance of Agricultural Entomology.
- 1.2 Insect – outline classification and emphasis on identification of phytophagous insects.
- 1.3 General Insect Plan - External Morphology, different types of mouthparts, Antenna Legs, Wings and External genitalia.
- 1.4 Insect development: growth, development and metamorphosis.
- 1.5 Insects and their environment. Habitat & Geographical distribution.

UNIT II – Oilseed pest: Life history, hosts, nature of damage and control measures – I

15 Hrs

- 2.1 *Aphis craccivora*, *Stomopteryx nertaria*.
- 2.2 *Agrotis segetum*, *Bemesia tabaci*.
- 2.3 *Athalia lugens*, *Lipaphis erysimi*.
- 2.4 *Asphondylia sesami*, *Eysarcoris ventralis*.
- 2.5 *Dichocrocis punctiferalis*, *Euproctis lunata*.

UNIT III – Commercial crop pests: Life history, hosts, nature of damage and control measures – II

15 Hrs

- 3.1 *Nilaparvata lugens*; *Nephotettix nigropictus*.
- 3.2 *Chrotogonus trachypterus*, *Atherigona naqvii*.
- 3.3 *Chilo partellus*, *Spodoptera frugiperda*.
- 3.4 *Sesamia inferens*, *Pyrilla perpusilla*.
- 3.5 *Helicoverpa armigera*, *Spodoptera litura*.

UNIT IV – Vegetable & Stored Grains pests: Life history, hosts, nature of damage and control measures – III

15 Hrs

- 4.1 *Urentius sentis*, *Plusia orichalcea*, *Dysdercus koenigii*, *Plutella xylostella*.
- 4.2 *Scirtothrips dorsalis*, *Euzophera perticella*, *Earias vittella*.
- 4.3 *Tanymecus indicus*, *Exelastis atmosa*, *Amsacta moorei*.
- 4.4 Major Stored Grain Pests - Khapra beetle, Rice weevil, Rice moth, Pulse beetle.
- 4.5 Minor Stored Grain Pests - Lesser grain borer, Indian meal moth, Saw-toothed beetle.

PRACTICALS

- 1 Collection, Preservation and identifications of insect pests of agricultural and stored products importance.
- 2 Study of permanent slides of different parts of insects.
- 3 Preparation of permanent slides of different parts of insects and their stages of the lifecycle.
- 4 Study of museum specimens of agricultural importance.
- 5 Rearing of pests of agricultural importance in the laboratory.
- 6 Dissection of the digestive system of Grasshopper or any suitable pest.
- 7 Dissection of the reproductive system of Grasshopper or any suitable pest.
- 8 Dissection of nervous systems of Grasshopper or any suitable pest.
- 9 Submission of assignment on: General body plan of a typical insect, types of phytophagous insect mouthparts, antennae, legs, wings, external genitalia, types of phytophagous insects, Pests of paddy, wheat, sorghum, maize, pulses, Stored grain pests. [To be submitted at the time of Examination – 5


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Marks]

Suggested Books

- 1 Metcalf, C. L. & Flint, W.P: Destructive and useful insects. Their habits and control, 4th Edition, McGraw Hill, New York.
- 2 Pradhan. S. Insect pests of Crops. National Book Trust, New Delhi.
- 3 K. P. Srivastava: A Text Book of Applied Entomology Vol. I & II. Kalyani Publishers, New Delhi.
- 4 H. S. Pruthi: Text Book of Agricultural Entomology. ICAR Publication ., New Delhi.
- 5 Alwal, A. S. Agricultural Pests of India and South East Asia, Kalyani Publishers, New Delhi.
- 6 B. V. David & Kumara Swamy: Elements of Economic Entomology
- 7 Pedigo, L.P. Entomology and Pest Management. Prentice-Hall, New Delhi.


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

15 Hrs

UNIT I – Principles of Toxicology

- 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, biotransformation and elimination of xenobiotics.

15 Hrs

UNIT II – Biochemical toxicology

- 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, metallothioneine.
- 2.5 Xenobiotic induced intracellular and cellular alterations.

15 Hrs

UNIT III – Systemic toxicology

- 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 Neurotoxicity – Effect of toxic agents on neurons, ion channel neurotoxins; Lesions of neural tissue.

15 Hrs

UNIT IV – Environmental and Occupational Toxicology

- 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, endosulfan, 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 leukaemia.
- 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.

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- 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.
- 10 Industrial visit
- 11 Submission of assignment on: Dose effect and dose-response relationship; Oxidative stress; Effect of toxic agents on neurons, lesions of neural tissue; Occupation disease – pneumoconiosis, silicosis, asbestosis; Legislation & Regulation involved in environmental toxicology; Detoxification Mechanisms /Biotransformation of xenobiotic.

[To be submitted at the time of Examination – 5 Marks]

Suggested Books

- 1 Principles of ecotoxicology- 3rd edition 2006, C H Walker, S P Hopkin, R N Sibly and D B Peakall (Eds.), Taylor and Francis, New York, NY.
- 2 Introduction to Environmental toxicology -3rd edition 2003, W.G. Landis and M.H. Yu. Lewis publishers.
- 3 Text Book of Modern Toxicology 2000 edition, Ernst Hodgson and Patricia Levi, McGraw – Hill Int. ed.
- 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 – Lorris G. Cockerham, Barbara S Shane; CRC Press, London.
- 8 Handbook of Toxicology – Thomas J Haley, Willan O Berndt; Hemisphere Publishing cooperation.
- 9 Modern Toxicology (3 Volumes) - P K Gupta and Salunkha; B V Gupta Metropolitan Book Co., Ptv Ltd.
- 10 Encyclopedia of Toxicology – O P Jasra.


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Semester – III

Elective - II

Paper IV – Endocrinology [EN]

UNIT I – Chemical and Neural Integration

15Hrs

- 1.1 Scope 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

15Hrs

- 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

15Hrs

- 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 intracellular 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 – Definition, types and their functions.
- 4.5 Application of endocrinology in Pisciculture, Sericulture and Apiculture.

PRACTICALS

- 1 *In situ* demonstration of endocrine glands of the 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 the Rat.

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- 8 Submission of assignment on: Diagram of endocrine glands; flow chart of HCG; Classification of hormones; Hormones as chemical messengers; Flow chart diagram of steroid, peptide hormonal biosynthesis.
[To be submitted at the time of Examination – 5 Marks]

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 Joen Laycock and Peter Loise Oxford Univ. Press.
- 10 A Text Book of Medical Physiology by Arthruma C. Guyton.
- 11 Text Book of Endocrinology by R.H. Williams (W.B. Saunders).


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Semester – III

Elective - II

Paper IV - Phytonematology [PN]

15 Hrs

UNIT I – Introduction, Taxonomy and Collection Methods

- 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 up to 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.

15 Hrs

UNIT II – Morphology and Life Cycles

- 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.

15 Hrs

UNIT III – Feeding, Pathology and Symptoms

- 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.

15 Hrs

UNIT IV – Nematode Control

- 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).

PRACTICALS

- 1 Collection of soil and plant-parasitic nematodes by various techniques (Baermann technique, the pie-pan method, or the Whitehead tray method etc.)
- 2 Nematode counting and frequency calculations.
- 3 Nematode fixing, staining and mounting methods.
- 4 Identification of phytonematodes by deMan's ratio.
- 5 Identification of predominant plant-parasitic nematodes of the crops of Paddy, Groundnut, & Vegetables.
- 6 Field trip – Observation Book.
- 7 Submission of assignment on: Taxonomy up to family level with representative examples; Morphology and pattern of life cycles of phytonematodes; Types of stylet; Field symptoms - General and specific (above ground and below ground); Physical methods: Tilling, fallowing, sun drying, hot water treatment, fumigation; Cultural practices - Crop rotation, trap crops.


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Suggested 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 nematology – 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.


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Semester – III
Elective - II
Paper IV – Sericulture [SER]

UNIT I – Introduction

15Hrs

- 1.1 Introduction - Sericulture as an agro-industry.
- 1.2 Mulberry cultivation - Varieties of mulberry and non-mulberry food plants; Agroclimatic conditions for Moriculture; Agricultural practices; 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

15Hrs

- 2.1 Races of mulberry and non-mulberry silkworms.
- 2.2 External morphology of *Bombyx mori* - Egg, larva, pupa & adult.
- 2.3 Internal morphology of *Bombyx mori* - 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

15Hrs

- 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 silkworms.
- 3.4 Mounting and harvesting of silkworm cocoons.
- 3.5 Silkworm diseases and pests.

UNIT IV – Harvesting Technology

15Hrs

- 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; By-Products: Types and uses.
- 4.5 Role of biotechnology in sericulture.

PRACTICALS

- 1 Rearing appliances.
- 2 Study of the life history of silkworm by rearing.
- 3 Identification of different types of silkworms - 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 mouth parts, spiracles and appendages of the larva.
- 7 Dissection of silk glands of the silkworm 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.


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- 13 Submission of assignment on: Sericulture as an agro-industry; Agroclimatic conditions for Moriculture; inter cultivation; Mineral deficiency diseases and their management; Insect Pests of Mulberry and their management; External morphology of silkworm; Internal morphology of silkworm; Morphology and anatomy of silk glands; Mounting and harvesting of silkworm cocoons; Silkworm diseases and pests; Commercial characters of cocoons; Grainage; Role of biotechnology in sericulture.
[To be submitted at the time of Examination – 5 Marks]

Suggested Books

1. FAO Manuals
2. Ullal and Nārasimhanna: 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


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UNIT I – Principles of Zoonoses & Viral Diversity

15 Hrs

- 1.1 Concepts of virus classification; Principles of zoonosis and its significance; Emerging and reemerging viral diseases.
- 1.2 Overview of zoonotic viral diseases; Alphaviral Zoonosis - Pathogenesis and pathology of Chikungunya.
- 1.3 Flaviviruses Zoonosis - Complexes of the Flaviviridae with clinical importance; Pathogenesis and pathology of Japanese Encephalitis and Kyasanur Forest Disease.
- 1.4 Bunyavirus Zoonosis - Complexes of the Bunyaviridae with clinical importance; Pathogenesis and pathology of some important haemorrhagic fever caused by Hantavirus.
- 1.5 Filovirus Zoonosis - Pathogenesis and pathology of Marburg Hemorrhagic Fever (MHF) and Ebola Hemorrhagic Fever (EHF).

15 Hrs

UNIT II – Zoonoses of caused by major viruses

- 2.1 Coronavirus Zoonosis - Pathogenesis and pathology of SARS-CoV-1, SARS-CoV-2 (COVID-19), MERS and other Coronaviruses.
- 2.2 Retrovirus Zoonosis - Pathogenesis and pathology of SIV, HIV 1 and HIV 2.
- 2.3 Herpesvirus Zoonosis - Pathogenesis and pathology of Herpesvirus hominis type 1 & 2 (HSV-1 and HSV-2) and Varicella-zoster virus.
- 2.4 Rhabdovirus Zoonosis - Paramyxoviruses, Poxviruses, Hendra Virus, Nipah Virus Encephalitis, Picornaviruses, Hepatitis.
- 2.5 Orthomyxoviruses Zoonosis - Influenza Viruses (H5N1, H1N1, H5N1, H7N7, H7N9, and H9N2).

15 Hrs

UNIT III – Pathogenesis of Viral Infection

- 3.1 Epidemics and pandemics; Virus databases.
- 3.2 Viral Pathogenesis - Definitions and concepts; Antigen presentation; Antigenic variation.
- 3.3 Immune Response to Viruses: Antibody-Mediated Immunity and Cell-Mediated Immunity.
- 3.4 Determinants of cell, organ, and tissue; Tropism, Cytokines and Chemokines.
- 3.5 Fate of the infected cell, tissue, and host.

15 Hrs

UNIT IV – Virus Diagnostics, Vaccines and Treatment

- 4.1 Diagnostic Virology - History, specimens for diagnosis; Viral detection methods and their significance.
- 4.2 Virus detection and discovery; Diagnostic Techniques: Serological and molecular approaches, Electron Microscopy, Next Generation Sequencing.
- 4.3 Immunization Against Viral Diseases - Antigenicity and immunogenicity of viral proteins; Viral antigens recognized by the immune system; Vaccine-induced immunity - Obstacles to immunization in early life and the elderly, goals of Immunization against viral diseases.
- 4.4 Viral Vaccine Development - History & future prospects; Virus vaccines – Active/Live, Inactivated, Virus-like particle; Other Vaccine Approaches, Vaccine Formulation and Delivery.
- 4.5 Antiviral Agents - Overview, mechanisms of specific antiviral drugs; Principles of antiviral therapy; Monoclonal antibody therapy.

PRACTICALS

- 1 Standard Operational Procedures and biosafety (BSL-2, BSL-3, BSL-4) precautions in Viral Lab.

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- 2 Glassware decontamination, washing, sterilization, packing and sterile handling.
- 3 Operational procedures of Laminar Flow.
- 4 Sample collection and preservation for virus detection.
- 5 Extraction & isolation of DNA & RNA of a virus.
- 6 PCR amplification and testing of amplicons through electrophoretic techniques.
- 7 In silico phylogenetic analysis.
- 8 ELISA antibody test for viral infections.
- 9 Lymphocyte separation.
- 10 Submission of assignment on: Evolution of viruses; Virus-Like Particle Vaccines; Monoclonal Antibody Therapy; Next Generation Sequencing; Antigenic Variation; Virus Discovery; Influenza Viruses; Hemorrhagic fevers; flaviviruses; Kyasnur Forest Disease; SARS-CoV; SARS-CoVII; MERS.

Suggested Books

- 1 Handbook of Zoonoses: Identification and Prevention by J. L. Colville and D. L. Berryhill. 2007
- 2 Human-Animal Medicine: Clinical Approaches to Zoonoses, Toxicants and Other Shared Health Risks by Rabinowitz and Conti. 2009
- 3 Fields Virology Volume 1 & 2 by David M. Knipe
- 4 Rolf Bauerfeind et al. Zoonoses Infectious Diseases Transmissible from Animals to Humans. 2016
- 5 Encyclopedia of VIROLOGY 3rd Edition by Dr. Brian J Mahy, Dr Marc H V Van Regenmortel, 2008
- 6 Basic Immunology: With Student Consult Access. Abul K. K. Abbas, Andrew H. Lichtman, 2004.
- 7 Immunology. David A. Goldsby, Janis Kuby, Thomas J. Kindt, Barbara A. Osborne Latest edition / Pub. Date: December 2002
- 8 Immunology. Ivan Roitt, Jonathan Brostoff, David Male, David K. Male (Editor), 2001.
- 9 Cellular Interactions and Immunobiology (Biotol S.) 1993
- 10 Defence Mechanisms, Biotol Series, Butterworth/Heinemann, Oxford, UK.
- 11 Antiviral Agents, Vaccines, and Immunotherapies. Stephen K. Tyring. 2004.
- 12 Antiviral Drug Discovery for Emerging Diseases and Bioterrorism Threats. Paul F. Torrence (Editor). 2005.
- 13 Chimeric Virus like Particles as Vaccines. Wolfram H. Gerlich, Detlev H. Krueger & Rainer Ulrich , 1996.
- 14 Vaccines. Stanley A. Plotkin, Walter A. Orenstein. 2003.
- 15 CRC Handbook of Viral and Rickettsial Hemorrhagic Fever by James H. S. Gear.
- 16 Viral Haemorrhagic Fevers. By C.R. Howard. Elsevier. Perspectives In Medical Virology. Series Editor: Arie J. Zuckerman, Uk Isa K. Mushahwar. 2004.
- 17 Dengue and Dengue Hemorrhagic Fever, D. J. Gubler & G. Kuno (Editor), 1998.
- 18 Bioterrorism Hemorrhagic Viruses Manual: For Healthcare Workers and Public. 2004.
- 19 Viral Encephalitis in Humans. John Booss, Margaret M. Esin, Margaret Esiri (Editor), 2003:
- 20 Encephalitis Protection. Qingshan Liang, 2004.
- 21 Viral Infections of Respiratory Tract by Raphael Dolin and Peter Wright.
- 22 Clinical Virology Manual Ed: Specter, RL Hodinka, SA Young.
- 23 Influenza. Edited by C.W. Potter. Elsevier Perspectives In Medical Virology. Series, Editor: Arie J. Zuckerman, Uk Isa K. Mushahwar. 2002.

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Semester – III

Elective - II

Paper IV – Bioremediation [BR]

UNIT I – General Concepts of Bioremediation

15 Hrs

- 1.1 Introduction to bioremediation; Definition and scope.
- 1.2 Principle of bioremediation and its applications.
- 1.3 Types of Bioremediation; Process and mechanism of bioremediation.
- 1.4 Acclimatization, detoxification, transformation, degradation and metabolism.
- 1.5 Biostimulation and bioaugmentation; Bioindicators and biomarkers.

UNIT II – Factors Affecting bioremediation

15 Hrs

- 2.1 Factors affecting bioremediation – Biological and environmental factors; Scientific, non-scientific and regulatory factors.
- 2.2 Pollutants – Nature and bioavailability; Emerging hazardous pollutants.
- 2.3 Production of bioremediation metabolites and intermediates.
- 2.4 Growth kinetics of organisms; Microenvironments and biofilms.
- 2.5 Methods of treatment – Wastewater, contaminated soil and other common contaminants.

UNIT III – *In situ* and *Ex-situ* Bioremediation Technology

15 Hrs

- 3.1 Detection of the microbial community; Alpha, beta and gamma biodiversity.
- 3.2 Metagenomics – Next-generation sequencing technologies to explore the structure and function of microbial communities.
- 3.3 Role of plant enzymes and metabolites in the degradation of pollutants; Bioventing and Biosparging; Restoration of freshwater water bodies, groundwater, and oil spills.
- 3.4 Bioremediation in practice – Commercialization of bioremediation technology; Use of microbes (bacteria, fungi, crustaceans, chironomid larvae and micro invertebrates and zooplankton) and plants in biodegradation.
- 3.5 Biosensors – Principle and mechanism; Application of biosurfactants; Electrokinetic remediation and Electron beam irradiation.

UNIT IV – Degradation and Detoxification of Metals and Pesticides

15 Hrs

- 4.1 Bioremediation of metals; Bioleaching, biomining, biosorption and bioaccumulation of metals from solid and liquid waste.
- 4.2 Biodegradation and biotransformation of Xenobiotics including pesticides, chlorinated and nitrated aromatic compounds, phenolic compounds, polycyclic aromatic compounds.
- 4.3 Enzymes and metabolic pathways of degradation of xenobiotic compounds.
- 4.4 In silico analysis as a valuable tool. Metatranscriptomics, Metaproteomics, Metabolomics.
- 4.5 Bioremediation – Advances in research and innovation; Its limitations and future prospective.

PRACTICALS

- 1 Sterilization, disinfection, safety in an environmental biotechnology laboratory.
- 2 Collection, isolation and screening of certain industrially important Bacteria, Protozoa, crustaceans, larvae and micro invertebrates from polluted soil and wastewater.
- 3 Preparation of media for growth of various microorganisms.
- 4 Isolation and maintenance of organisms by plating, streaking and serial dilution methods - slants and stab

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- cultures.
- 5 Storage / Preservation of microorganisms. Microbial growth measurement, Standard plate count, Haemocytometry.
 - 6 Measure of the bacterial population by turbidometry and studying the effect of temperature, pH, carbon and nitrogen.
 - 7 Separation of biomass – Wet and Dry mass
 - 8 Immobilization of cells and enzymes
 - 9 Isolation, bacterial Genomic DNA Quantification and Quality Analysis by Gel Electrophoresis
 - 10 Preparation and Incubation of Microcosm from soil or water and data analysis
 - 11 Filed Visit to any Waste Water Treatment Plant/ STP and Field Study Report.
 - 12 Submission of assignment on: 1. Biostimulation and bioaugmentation, Bioindicators and Biomarkers. 2 Bioavailability of pollutants, metabolites and intermediates.3. Growth kinetics of organisms, Microenvironments and biofilms. 4. Metagenomics, Phytoremediation, Bioventing and Biosparging. 5. Commercialization of bioremediation technology, Biosensors, application of biosurfactants, Electrokinetic remediation and Electron beam irradiation. 6. In silico analysis, Metatranscriptomics, Metaproteomics, Metabolomics.
- [To be submitted at the time of Examination – 5 Marks]**

Suggested Books

- 1 Nicolas P Chereusinott: Handbook of water and waste water Treatment Technology Boston Oxford Auckland Johannesburg Melbourne, New Delhi
- 2 Frederick W Pontius: Water Quality and Treatment. American water works Association, Mc Graw Hill Inc.
- 3 S K Agarwal: Water Pollution, APH Publishing Corporation.
- 4 Ronald L Dooste: Theory and Practical of water and wastewater treatment.
- 5 S. K. Agarwal: Environmental Biotechnology
- 6 Martin Alexander: Biodegradation & Bioremediation (1999), Academic press.
- 7 Stanier R. Y., Ingram J.L., Wheelis M.L., Painter R.R: General Microbiology, McMillan Publications, 1989.
- 8 Foster C.F., John Ware D.A: Environmental Biotechnology, Ellis Horwood Ltd., 1987.
- 9 Karrely D., Chakrabarty K., Omen G.S: Biotechnology and Biodegradation, Advances in Applied Biotechnology Series, Vol.4, Gulf Publications Co. London, 1989.
- 10 John. T. Cookson: Bioremediation engineering; design and application 1995 Jr. Mc Graw Hill, Inc.
- 11 Norris et al, Robert S. Kerr: Handbook of Bioremediation, Publisher: Environmental Research Laboratory.
- 12 Ewies, Ergas, Chang and Schroeder: Bioremediation Principles
- 13 David S. Bioremediation Protocols. Publisher: Humana Press, New Jersey.
- 14 Environmental Biotechnology by A.K. Chatterjee
- 15 Environmental Biotechnology by S.N.Jogdand Himalaya Publishing


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Paper IV – Wildlife Techniques & Conservation [WTC]

UNIT I – Wildlife, Diversity & Study Techniques

15Hrs

- 1.1 Wildlife – Classic and contemporary definition; Ichthyology – Taxonomy & diversity; Study methods – Field, Laboratory, Museum & Systematic methods.
- 1.2 Herpetology – Taxonomy & diversity; Study methods – Field, Laboratory, Museum & Systematic methods.
- 1.3 Ornithology – Taxonomy & diversity; Study methods – Field, Laboratory, Museum & Systematic methods.
- 1.4 Mammalogy – Taxonomy & diversity; Study methods – Field, Laboratory, Museum & Systematic methods.
- 1.5 Measuring diversity – Species richness, α -Diversity, β -Diversity, diversity indices.

UNIT II – Estimating Abundance

15Hrs

- 2.1 Survey design – Survey extent, experimental units, sample units, survey design, sampling intensity.
- 2.2 Census techniques – Drive count, aerial photography, spot mapping, total mapping, strip counts, point counts.
- 2.3 Population estimation through counts on sample plots 1) with estimating area (Hahn method, King method, Hayne method) and 2) plotless methods (Point-to-Target and Target-to-Nearest-Neighbor Methods & Point quarter method).
- 2.4 Population estimation through 1) detection probability method (double sampling, double [independent and dependent] observer sampling, marked sample & modern distance sampling) and 2) removal methods (catch per unit effort & change in the ratio).
- 2.5 Mark resight method – Lincoln-Petersen estimator, Schnabel estimator, Schumacher–Eschmeyer estimator & Jolly–Seber estimator.

UNIT III – Conservation in Theory and Practice

15Hrs

- 3.1 Conservation biology – A brief history; Guiding principles and aspects of conservation biology.
- 3.2 Extinction – Causes, process and prevention; Risk of extinction – Demographic problems, genetic problems, effective population size (genetic & demographic).
- 3.3 Extinction vortex – Predicting risk in small population; Population viability analysis – Quantitative methods for analyzing viability.
- 3.4 Deterministic factors affecting wildlife – Habitat loss, fragmentation, Introduced and invasive species, pollution, overharvest, global climate change.
- 3.5 Conservation – PA network in India; Community conservation outside PA network; International conservation.

UNIT IV – Conservation Genetics

15Hrs

- 4.1 Molecular genetic techniques – Nuclear vs mitochondrial genome, genetic variation, analysis of gene products and fragments, SNP, genetic sampling.
- 4.2 Taxonomy – Species and subspecies identification, hybridization, evolutionary significant units, management units.
- 4.3 Conservation of genetic diversity – mutation, gene flow, sex-specific dispersal, population structure and fragmentation, detecting bottlenecks and drifts.
- 4.4 Population genetics – Effective vs census population size, selection, genetic diversity & population viability
- 4.5 Molecular ecology – Dietary analysis, gender identification in mammals and birds.

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PRACTICAL

- 1 Identification of major features of wildlife based on museum specimens.
 - 2 Estimation of density of herpetofauna using the quadrat method.
 - 3 Estimation of abundance, frequency and density of avifauna using strip transect method.
 - 4 Mensural and morphometric studies of select herpetofauna.
 - 5 Morphometric and cranial studies of rodents and bats.
 - 6 Comparative morphology of dentition and skull of mammals.
 - 7 Mapping distribution of selected species of mammals using open source GIS software.
 - 8 Analysis of species richness indices using online tools.
 - 9 Species identification using molecular phylogenetics.
 - 10 Preparation of research report based on any of the above-listed experiments.
 - 11 Submission of assignment on:
 - 1) Checklist of any one group of wildlife: fishes/herpetofauna/birds/mammals of Telangana; 2) Species richness, α -Diversity, β -Diversity, diversity indices; 3) Strip counts and Point counts; 4) Hahn method, King method & Hayne method; 5) Removal methods (catch per unit effort & change in the ratio); 6) Lincoln-Petersen estimator, Schnabel estimator, Schumacher-Eschmeyer estimator, Jolly-Seber estimator; 7) Extinction – Causes, process and prevention; 8) Population Viability Analysis; 9) Habitat loss & fragmentation; 10) Introduced and Invasive species; 11) Global Climate Change; 12) PA network in India; 13) Conservation of genetic diversity; 14) Molecular ecology
- [To be submitted at the time of Examination – 5 Marks]

Suggested Books

- 1 Biodiversity: Measurement and Estimation by D.L. Hawksworth.
- 2 Conservation and Biodiversity by A.P. Dobson.
- 3 Wildlife ecology, conservation, and management (2nd ed.) by Anthony R.E. et al.
- 4 Bird Populations and Studies for Conservation by Perrins CM et al.
- 5 Principles of Systematic Zoology by Mayr, E. and P.D. Ashlock.
- 6 Ecology of a Changing Planet by M.B. Bush.
- 7 Conservation of wildlife populations(2nd ed) by L. Scott Mills.
- 8 Reptiles and Amphibians of India by J.C. Daniels.
- 9 Reptiles of South India by Ranjit Daniels.
- 10 Birds of India by Salim Ali.
- 11 Mammals of India by Vivek Menon.
- 12 Principles of Conservation Biology (3rd ed.) by Martha J. Groom et al.
- 13 Wildlife in Danger by Martin King.
- 14 Wildlife Study Techniques by Berwick and V. B. Saharia.


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Paper IV – Cancer Biology and Therapeutics

UNIT I – Overview of Cancers and Carcinogenesis

15Hrs

- 1.1 Introduction – Growth characteristics of cancer cells; Morphological and ultrastructural properties of cancer cells.
- 1.2 Types of growth-hyperplasia, dysplasia, anaplasia and neoplasia; Nomenclature of neoplasms; Differences between benign and malignant tumours; Warburg effect.
- 1.3 Epidemiology of breast, cervical, oral, and lung cancers.
- 1.4 Carcinogenesis – Radiation and chemical carcinogenesis; Stages in chemical carcinogenesis - Initiation, promotion and progression; Free radicals, antioxidants in cancer; Environmental carcinogens.
- 1.5 Viral carcinogenesis – DNA and RNA Viruses and human cancers.

UNIT II – Molecular Genetics of Cancer

15Hrs

- 2.1 Aberrant metabolism during cancer development; Paraneoplastic syndromes.
- 2.2 Growth factors – EGF, TNF- α and TGF- β and growth factor receptors in signal transduction.
- 2.3 Role of transcription factors in cell cycle regulation in cancers.
- 2.4 Tumour suppressor genes p53, p21, Rb, BRACA1, BRACA2 and their mechanisms.
- 2.5 Telomeres, telomerase, and immortality.

UNIT III – Signaling Mechanisms

15Hrs

- 3.1 VEGF signalling; angiogenesis.
- 3.2 Epigenetics – Role of DNA methylation in gene silencing.
- 3.3 Epigenetic silencing of tumour-suppressor genes.
- 3.4 Apoptosis in cancer cells; Role of caspases.
- 3.5 Death signalling pathways - Mitochondrial and death receptor pathways.

UNIT IV – Diagnosis and Therapeutics

15Hrs

- 4.1 Clinical examination - Blood tests, Biochemical tests and Biopsy; Radiological examination - X-rays, CT scan and MRI; Applications of computational tools in cancer prediction.
- 4.2 Strategies of anticancer drug therapy – Chemotherapy, gene therapy, immunotherapy, and radiotherapy.
- 4.3 Interleukins and Interferons – Biologic effects of interferons; Oncologic applications of interferons; Interleukin-2: Biologic effects, mechanism, and clinical application.
- 4.4 FDA approved anti-cancer immunotherapeutic drugs; Interferon- α 2a; Interferon- α 2b; Tumour-specific Antigens (TSA); Tumour-associated Antigens (TAAs); Human Leukocyte Antigen (HLA).
- 4.5 Stem cell and Peptide therapies for cancer treatment.

PRACTICAL

- 1 Histological observation of preparation of cancer vs normal tissues.
- 2 Peripheral blood lymphocyte culture.
- 3 Proliferation assay (MTT).
- 4 DNA damage by COMET assay.
- 5 Cell Survival Assays - Trypan Blue method.
- 6 Preparation and comments on micronuclei induced by carcinogens.
- 7 Study of cancer databases - Computational approach.

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- 8 Identification of cancers by using molecular markers.
- 9 Diagnosis of cancer using PCR Method.
- 10 Quantification of cancers by using RT-PCR.
- 11 2D-Gel analysis of cancer cells.
- 12 Visit to the cancer hospital
- 13 Submission of Assignment: Types of Cancer; Cancer Therapy Methods; Signalling mechanisms in cancer cells; Apoptotic Pathways in cancer; FDA-approved immunotherapeutic drugs in cancer treatment; Diagnostic tools in cancer; Epigenetics and role of DNA methylation in gene silencing in cancers; Interleukins and interferons in cancer treatment; Tumor suppressor genes and their mechanisms.
[To be submitted at the time of Examination – 5 Marks]

Suggested Books

- 1 The Biological Basis of Cancer: R. G. McKinnell, R. E. Parchment, A. O. Perantoni, G. Barry Pierce, I. Damjanov. 2nd Edition, Cambridge University Press, 2006.
- 2 The Biology of Cancer: R. A. Weinberg. Garland Science. 2006.
- 3 The Molecular Biology of Cancer: S. Pelengaris, M. Khan. Blackwell Publication. 2002
- 4 The Cancer Hand Book: Malcolm R. Alison. Nature Publishing Group.
- 5 Molecular Pathology and Diagnostics of Cancer (Cancer Growth and Progression), Domenico Coppola, Springer.
- 6 An Introduction to Cellular and Molecular Biology of Cancer, Oxford Medical publications. 3. The Biology of Cancer, Janice Gabriel, John Wiley & Sons Ltd., 2nd Ed.
- 7 Cancer Biology by Raymond W. Ruddon, Oxford University Press, Inc., 4th Ed.
- 8 Introduction to Cancer Biology, Momina Hejmadi, Ventus Publishers. Molecular Biology of Human Cancers, Wolfgang Arthur Schulz, Springer Science, Business Media, Inc.


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Semester – IV

Core Paper

Paper I: Animal Biotechnology [AB]

UNIT I – Introduction and Animal Improvement

15Hrs

- 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 the improvement of livestock herds and breeding selected traits.

UNIT II – *In vitro* Culture of Cells and Tissues

15Hrs

- 2.1 Cell culture - Equipment and materials for cell culture technology, the 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.

15Hrs

UNIT III –Production of Recombinant Organisms and Transgenic Animals

- 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.

15Hrs

UNIT IV – Application of Biotechnology

- 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 and/or b) animal cells.
- 2 Methods of cultivating a) Bacteria and/or b) animal cells.
- 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.

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- 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.
- 10 Submission of assignment on: *In vitro* fertilization and embryo transfer; ICSI, sperm sexing. Cryopreservation, cryoprotection. Primary and established cell line cultures. Scaling-up of animal cell culture, cell synchronization, cell transformation. Transgenesis – methods involved transgenic animals; shot gun, electroporation, lipofection, microinjection and embryonic stem cell method. Production of transgenic animals, cattle, sheep, pig and fish. Application of RFLP in forensic science. Hybridoma technology. Bioleaching of metals by bacteria. Biopesticides – *Bacillus thuringiensis*, mode of action of toxin, toxin gene. Sex reversal in fish – isolation of engineering of Bt. Use of animals as bioreactors.

[To be submitted at the time of Examination – 5 Marks]

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.


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Semester – IV

Core Paper

Paper II: Fish Biology [FB]

15Hrs

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; Chondrichthyans 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 the skin, dermal and epidermal pigments, fins, and scales.

15Hrs

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.

15Hrs

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.

15Hrs

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, neurohypophysis, 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 the digestive system.
- 8 Dissection of the reproductive system.
- 9 Sexual differentiation of fishes.
- 10 Determination of chlorides in heterosmotic media.
- 11 Submission of assignment on: Digestive system; Respiratory system; Circulatory system; Excretory system;

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Nervous system; Endocrine system; Reproductive system; Osmoregulation system
[To be submitted at the time of Examination – 5 Marks]

Suggested 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


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Semester – IV

Elective - I

Paper III: Neuroscience - II [NS-II]

UNIT I – Sensory System

15Hrs

- 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

15Hrs

- 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

15Hrs

- 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.

UNIT IV – Applied Neurobiology

15Hrs

- 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.
- 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 Rotarod test for motor coordination.
- 11 Submission of assignment on: Basic mechanism of sensory transduction – Molecular and physiological; Sensory circuit; Sensory pathway; Taste transduction; Smell; Vision; Pain – neurohumoral mechanism;

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Muscle spindle; Motor hierarchies; Reflex pathway; Patterning mechanism; Growth of axons synaptosomes; Reinnervation; Physiological basis of stress; Slow and fast muscles; Diseases of motor unit; Parkinson's/ Alzheimer's disorder mechanism.

[To be submitted at the time of Examination – 5 Marks]

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 Shepperd
- 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 Textbook of Medical Physiology – Guyton


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- UNIT I – Introduction to Vector Control** 15Hrs
- 1.1 Scope and importance of Medical entomology.
 - 1.2 Role of research organizations in medical entomology – CDC, WHO, VCRC, CRME, NIMR, NCDC.
 - 1.3 Trajectory of National level vector control programmes - NMCP, NMEP, NFCP and NVBDCP.
 - 1.4 Source reduction, environmental modification and manipulation and solid waste management.
 - 1.5 Community awareness programmes for vector control.
- UNIT II – Physical, Mechanical & Personal Protective Measures** 15Hrs
- 2.1 Making houses and shelters insect-proof, insecticide-treated screening and curtains.
 - 2.2 Impregnation, protective clothing, treating fabrics with an insecticide, LLINs.
 - 2.3 Repellents - Vaporizers, Dispensers, Coils, DEET, etc.
 - 2.4 Avoidance and diversion of biting Dipterans.
 - 2.5 Recent advances in vector management, GIS and remote sensing in vector control.
- UNIT III – Bio-pesticides and Growth Regulators** 15Hrs
- 3.1 *Bacillus thuringiensis*, *Lagenidium giganteum*, *Romanomermis iyengari* as vector control bio agents.
 - 3.2 Plant extracts as potential mosquito larvicides.
 - 3.3 Nanoparticles: Synthesis of plant-mediated silver nanoparticles for vector control.
 - 3.4 Sterile Insect Technology (SIT).
 - 3.5 Genetically Modified Organisms (GMO); Releasing of Insects carrying a Dominant Lethal gene (RIDL).
- UNIT IV – Chemical Control and Insecticide Resistance** 15Hrs
- 4.1 History of insecticide discovery, classification of Insecticides.
 - 4.2 Synthetic insecticides and their mode of action: Organochlorides, Organophosphates, Carbamates.
 - 4.3 Pyrethrins and Pyrethroids, classification of pyrethroids and mode of action.
 - 4.4 Pesticide application methods and safety precautions.
 - 4.5 Insecticide bioassay, Pesticide resistance - types and mechanisms.
- PRACTICALS**
- 1 Collection of indoor / outdoor resting mosquitoes and preparing a voucher specimen.
 - 2 Assessment mosquito larval density in breeding habitat.
 - 3 Estimation of predatory efficiency against mosquito larvae.
 - 4 Extraction of phytochemicals for larvicidal activity- Alkaloid test.
 - 5 Estimation of mosquito man-hour density.
 - 6 Estimation of gonotrophic cycle duration.
 - 7 Assessment of repellent activity.
 - 8 Determination of larval susceptibility to different insecticides.
 - 9 Synthesis of silver nanoparticles and their efficacy as larvicides.
 - 10 Surveillance and report writing on the breeding habitat of mosquitoes.
 - 11 Submission of assignments on: Prevention of breeding sites and removal and/or destruction of breeding sites. Environmental modification and manipulation. Baits and traps, avoidance and diversion of biting Diptera. Insecticide vaporizers, electric liquid vaporizer, pressurized spray cans, spray gun. Extraction of

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plant materials for vector control. Classification of Insecticides and their mode of action; History of insecticide discovery. Toxicity of pesticides, Insecticide appliances and safety precautions. Methods of insecticide applications, and development of a Module for Integrated Vector Management.

[To be submitted at the time of Examination – 5 Marks]

Suggested Books

- 1 Handbook for integrated vector management, WHO/HTM/NTD/VEM/2012.3
- 2 Biology of Disease Vectors, 2nd Ed., William C. Marquardt, 2004, Elsevier Academic Press.
- 3 Medical Toxicology by Richard C. Dart. Pub: Lippincott Williams & Wilkin.
- 4 Manual of Medical Entomology by Deane P. Furman & Paul Catts.
- 5 Hand Book of Medical Entomology by K N Panicker, Geme Urge Dori
- 6 Medical Entomology for the Students 5th edition by Mike Service.
- 7 Destructive and Useful Insects by R. L. Metcalf.
- 8 Mosquitoes and their control 2nd edition by Norbert Becker pub: Springer.
- 9 Mosquito ecology field sampling methods 3rd edition by John B. Silver Pub: Springer.
- 10 Vector Control Methods for use by individuals and communities by Jan A. Rozendaal Pub: WHO 1997.
- 11 Global strategic framework for integrated vector management. Geneva: World Health Organization; 2004 (WHO/CDS/CPE/PVC/2004.10).
- 12 Phytochemical Reference standard of selected medicinal plants, ICMR -2012
- 13 Chemical pesticides, mode of action and toxicology by CRC, Press, London. By Jorgen Stenersen (2004).
- 14 Pesticides preparation and mode of action. John Wiley and Sons, Ltd., New York. By Cremlyn R. (1979).
- 15 Pesticides application: Principles and practices. Clarendon Press. Oxford. - Haskell P. T. (1985).
- 16 The standard pesticides user's guide. 5th edition, Prentice Hall Inc. By Bert L. Bolimont. (2000).
- 17 The chemistry of pesticides. The Macmiller Press Ltd., Hong Kong by Kenneth A. Hassall (1982).
- 18 Integrated Vector Management: Controlling Vectors of Malaria and Other Insect Vector Borne Diseases By Graham Matthews Pub: Wiley-Blackwell 2011.


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Semester – IV

Elective - I

Paper III: Parasitology – II [PS-II]

15Hrs

UNIT I – Protozoology

- 1.1 Protozoan ecology, nutrition; population structure and kinetics.
- 1.2 Metabolic pathways in protozoa – carbohydrate, protein and lipids.
- 1.3 Antimetabolites analogues, 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.

15Hrs

UNIT II – General Account and Taxonomy of Nematodes

- 2.1 History, scope and significance of nematodes.
- 2.2 Classification of nematodes up to 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.

15Hrs

UNIT III – Morphology, Development, Life Cycles and Pathology

- 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 i) *Strongyloides stercoralis*, ii) *Ancylostoma duodenale*, iii) *Dracunculus medinensis*, iv) *Wuchereria bancrofti*, v) *Brugia malayi* and vi) *Trichinella spiralis*; Visceral larva migrans, dermatitis and pulmonary bronchitis.
- 3.3 Origin and evolution of animal nematode parasites and host interaction.
- 3.4 General account of entomophilic Nematodes – characteristics and classification.
- 3.5 General account of phytonematodes; Life history and pathology of *Hirschmanniella* and *Meloidogyne*.

15Hrs

UNIT IV – Acanthocephala

- 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*.
- 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 *Plasmodium* spp.
- 5 Qualitative and quantitative estimation of carbohydrates, proteins and lipids in normal, infected tissues and parasites.

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- 6 Ecology of parasites and biostatistical calculations of incidence, intensity, density and index of infection of nematode parasites.
- 7 Submission of assignment on: Classification of nematodes upto family level with examples. General account of entomophilic nematodes – characteristics and classification. The role of vectors in spreading of diseases in humans. Metabolic pathways in protozoa – carbohydrate, protein and lipids. The oesophageal modifications and associated glands. Host – parasite relationships and their immunological reactions. Antihelminthic drug action and resistance.

[To be submitted at the time of Examination – 5 Marks]

Suggested 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.
- 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.


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Semester – IV

Elective - I

Paper III: Comparative Animal Physiology - II [CAP-II]

UNIT I – Responses of Animals to Their Environment

15Hrs

- 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

15Hrs

- 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

15Hrs

- 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

15Hrs

- 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 heartbeat 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, and their comparison.
- 9 Dissection of male and female reproductive systems of cockroach and crab, and their comparison.
- 10 Submission of assignment on: General receptor characteristics, receptor potentials and sensory coding. Adaptations in organ systems for reception – chemo-, thermo-, mechano-, and electro- receptors. Central

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nervous system - Insect to vertebrate comparison – diagrams. Stress biology and related disorders. Types of muscle fibers slow, fast and asynchronous flight muscle. Invertebrate hearts – annelids, scorpion, insect, crustacean, molluscan, and tunicate hearts – diagrams. r-selected and k-selected reproductive patterns; timing with respect to environmental variables, photoperiods. Hormonal control of insect growth and reproduction. Biological rhythms with examples.

[To be submitted at the time of Examination – 5 Marks]

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 – Adaptation and function., By F. Reed Hainsworth (Publ. by Addison-Wesley Publ. company, California).
- 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.


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UNIT I – Introduction to Aquaculture

15Hrs

- 1.1 Definition, history, present status and future prospects of aquaculture.
- 1.2 Criteria for selection of fish species for culture.
- 1.3 Advanced techniques in seed production - Induced breeding methods in Fishes and Prawns.
- 1.4 Types of hatcheries: construction and management of hatcheries, and seed transportation methods.
- 1.5 Fishermen Cooperative societies – structures and functions.

UNIT II – Biology of Cultivable Fishes, Prawns and Crabs

15Hrs

- 2.1 India Major carps – *Catla catla*, *Labeo rohita* and *Cirrhinus mrigala*.
- 2.2 Exotic Major carps – *Hypophthalmichthys molitrix*, *Ctenopharyngodon idella* and *Cyprinus carpio*.
- 2.3 Air-breathing fishes - *Channa punctatus*, *Channa marulius*, *Clarias batrachus*.
- 2.4 Cultivable prawns – *Macrobrachium rosenbergii*, *Macrobrachium malcolmsonii*.
- 2.5 Cultivable crabs - *Barytelphusa cunicularis*.

UNIT III – Fish Pond Management

15Hrs

- 3.1 Site selection, design and construction of Aquafarms.
- 3.2 Pre-stocking pond management – Aquatic weeds, predatory insects and their control.
- 3.3 Nursery pond management – pond fertilization.
- 3.4 Stocking and Rearing pond Management, Natural fish food organisms, supplementary feeding.
- 3.5 Brood pond Management – Monosex culture.

UNIT IV – Disease Management & Post-harvest Technology

15Hrs

- 4.1 Infectious diseases of fishes, their prevention and control measures.
- 4.2 Infectious diseases of prawns, their prevention and control measures.
- 4.3 Non-infectious diseases of fishes and their preventive measures.
- 4.4 Processing and preservation of fishes and prawns.
- 4.5 By-products and value added-byproducts of fishes and prawns.

PRACTICAL

- 1 Identification of fishes through general characters and morphometry and meristic characters.
- 2 Identification of prawns through general characters and morphometry.
- 3 Identification of fish and prawn through developmental stages.
- 4 Symptomatic identification of diseased fishes and prawns.
- 5 Analysis and identification of planktons – Phytoplanktons and Zooplanktons.
- 6 Identification of benthos as fish feed.
- 7 Separation of pituitary gland from fish.
- 8 Demonstration of induced breeding technology in common carp.
- 9 Submission of assignment on: Resources of aquaculture; Blue revolution; Fisherman co-operative societies; Criterion for selection of species for culture; Nutrition and feeding habits; Pond management; Induced breeding method in Prawns; Integrated fish farming, fish-cum-poultry; Ornamental fish culture and aquarium management; Fish and prawn value added-byproducts.

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[To be submitted at the time of Examination – 5 Marks]

Suggested Books

- 1 Water quality criteria for freshwater fish. Albastor, J. S. and Lloyd, R. Butterworth Scientific. London.
- 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.
- 6 A manual of freshwater aquaculture – Santhanam, R. Sukllnaran. N. Natarajan Oxford and IBH Pub. Comp.
- 7 Freshwater aquaculture – Rath, R. K. Scientific Publishers, Jodhpur.
- 8 Textbook of fish culture, breeding and cultivation of fish – Mareel Huet, Fishing News Books.
- 9 Aquaculture – John, E. Bardach, John H. Ryther, W.O. Mclamey, John Willey and Sons, New York.
- 10 Fish Ecology – RJ. Wotton, Dalckie, Chapman and Hall, New York.
- 11 Prevention and control of fish & prawn diseases, 2nd edition. By K. P. Biswas
- 12 Diseases of fishes – C. Vandujn, Narendra Publishing House, New Delhi.
- 13 Aquaculture Principles and Practices by T. V. R. Pillay
- 14 A textbook of fish, fisheries and technology by K. P. Biswas.
- 15 Fisheries and Aquaculture by Ravishankar Piska.


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Semester – IV

Elective - I

Paper III – Agricultural Entomology – II [AE – II]

UNIT I – Introduction

15 Hrs

- 1.1 Introduction – Antiquity of pest problem.
- 1.2 Reasons for insects turning into pest, reasons for pest outbreaks.
- 1.3 Economic injury level; Economic threshold level.
- 1.4 Climatic factors and natural barriers.
- 1.5 Pest monitoring and methods of survey.

UNIT II – Insect Pest Control Methods – I

15 Hrs

- 2.1 IPM - Definition, necessity of IPM; Tools of IPM, Ecology versus IPM.
- 2.2 Cultural control methods.
- 2.3 Physical control and Mechanical control methods.
- 2.4 Biological control methods.
- 2.5 Genetic control methods.

UNIT III – Insect Pest Control Methods – II

15 Hrs

- 3.1 Chemical control – Inorganic pesticides, Organic pesticides, Organochlorides, Organophosphates, Carbamates.
- 3.2 Synthetic pyrethroids – Classification and their applications.
- 3.3 Pesticide formulations – Dust, Sprays, Emulsions, Aerosols, Fumigants, Seed dressers or Seed treatment chemicals etc.
- 3.4 Synergists, Repellents, Baits, Toxicants, Antifeedants, Attractants, Chemosterilants.
- 3.5 Pesticide application methods and Safety parameters in pesticides application.

UNIT IV – Pesticide Resistance and Advances in IPM

15 Hrs

- 4.1 Chitin Synthesis Inhibitors; Insect growth regulators; Pheromones.
- 4.2 Pesticide resistance – Definition and types of resistance; Mechanism of resistance, Genetics of resistance.
- 4.3 Regulatory methods – Insecticides and Plant Quarantine Acts.
- 4.4 Modern trends in pesticide research; Biotechnological advances in IPM.
- 4.5 Pesticide applications and their adverse consequences on environment; Concepts of organic farming.

PRACTICALS

- 1 Collection, Identification and Preservation of insect pests of agricultural, medical and veterinary importance.
- 2 Usage of light traps for insect collection.
- 3 Usage of pheromone traps for insect collection.
- 4 Bird perches and their utility.
- 5 Bioassay of insecticides using different methods of exposure.
- 6 Calculation of LD50 using probit analysis.
- 7 Study of antifeedant activity in *Spodoptera* or any suitable pest.
- 8 Culturing of NPV.
- 9 Visit to ICRISAT Hyderabad Telangana State.
- 10 Submission of assignment on: IPM definition, necessity of IPM, Ecology versus IPM; Reasons for insects

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turning into pests, Economic threshold level, Pest monitoring and Methods of Survey, Types of pest control, Pesticide Resistance and Regulatory methods, Biotechnological advances in IPM, Safety parameters in pesticides application

[To be submitted at the time of Examination – 5 Marks]

Suggested Books

- 1 Introduction to General and Applied Entomology by V.B. Awasthi.
- 2 Integrated pest management principles and practices by Abrol D.P, CABI publications.
- 3 Integrated pest management principles and applications vol. 1 by Singh, CBS publication.
- 4 Applied Entomology by P.G. Fenemore and Alka Prakash.
- 5 Biodiversity and insect pests management S. Ignacimuthu, S. Jayaraj.
- 6 Integrated pest management principles and applications Amerika Singh, O.P. Sharma, D.K. Garg.
- 7 Handbook of Integrated pest management by ICAR.
- 8 Pest management principles and practices by Rajesh Ravi.
- 9 Theory and practices of Integrated pest management by A.K. Dhawan & Ramesh Arora.
- 10 A textbook of Applied Entomology, Vol. I & II. by K.P. Srivastava.


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Semester – IV
Project

Each student has to execute independent project work under the guidance of the teacher in their respective college.

The process of execution of the project will be supervised by the concerned teacher from initiation to final submission.

Credits and marks distribution for Project (Zoo_404pr)

	Credits	Marks
Internal Assessment		
Research Design	1	25
Completion Seminar	1	25
Semester-end Assessment		
Research work (Semester-end test)	1	25
Dissertation, Final presentation & Viva	3	75
Total	6	150

Note:

The project offered in Semester IV carries 6 credits worth 150 marks.