Osmania University

Department of Zoology

M.Sc. Zoology

Syllabus for Semester I, II, III & IV

w.e.f AY 2022-23

Department of Zoology, Osmania University
Two Year M.Sc. (Zoology) Programme w.e.f. AY 2022–2023 onwards

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 (ATIB) (Zoo_101T)	3	3	100	1	Core (EVB) (Zoo_201T)	3	3	100	1	Core (SMB) (Zoo_301T)	3	3	100	1	Core (ABT) (Zoo_401T)	3	3	100
2	Core (ECB) (Zoo_102T)	3	3	100	2	Core (IMM) (Zoo_202T)	3	3	100	2	Paper – II (RM) (Zoo_302T)	3	3	100	2	Paper – II (AZ) (Zoo_402T)	3	3	100
3	Core (SB) (Zoo_103T)	3	3	100	3	Core (AP) (Zoo_203T)	3	3	100	3	Elective –I (Zoo_303T)	3	3	100	3	Elective –III (Zoo_403T)	3	3	100
4	Core (BIT) (Zoo_104T)	3	3	100	4	Core (GDB) (Zoo_204T)	3	3	100	4	Elective –II (Zoo_304T)	3	3	100					
5	Practical (ATIB) (Zoo_101P)	4	2	50	5	Practical (EVB) (Zoo_201P)	4	2	50	5	Practical (SMB) (Zoo_301P)	4	2	50	4	Practical (ABT) (Zoo_401P)	4	2	50
6	Practical (ECB) (Zoo_102P)	4	2	50	6	Practical (IMM) (Zoo_202P)	4	2	50	6	Practical (RM) (Zoo_302P)	4	2	50	5	Practical (AZ) (Zoo_402P)	4	2	50
7	Practical (SB) (Zoo_103P)	4	2	50	7	Practical (AP) (Zoo_203P)	4	2	50	7	Elective –I (Zoo_303P)	4	2	50	6	Elective –III (Zoo_403P)	4	2	50
8	Practical (BIT) (Zoo_104P)	4	2	50	8	Practical (GDB) (Zoo_204P)	4	2	50	8	Elective –II (Zoo_304P)	4	2	50	7	Project (Pr) (Zoo_404Pr)	10	5	150
9	Seminar	2			9	Seminar	2			9	Seminar	2			9	Seminar	2		
	Total	**30**	**20**	**600**		**Total**	**30**	**20**	**600**		**Total**	**30**	**20**	**600**		**Total**	**33**	**20**	**600**

Titles of the papers offered in each semester

Semester/Paper	Semester I	Semester II	Semester III	Semester IV
Paper I	Core Paper	Core Paper	Core Paper	Core Paper
	Advances in Taxonomy and Invertebrate Biology (ATIB)	Evolution and Vertebrate Biology (EVB)	Systems Biology (SMB)	Animal Biotechnology (ABT)
Paper II	Core Paper	Core Paper	Core Paper	Core Paper
	Environmental & Conservation Biology (ECB)	Immunology (IMM)	Research Methodology (RM)	Applied Zoology (AZ)
Paper III	Core Paper	Core Paper	Elective I	Elective III
	Structural Biology (SB)	Animal Physiology (AP)	Refer to the Elective Bucket	Refer to the Elective Bucket
Paper IV	Core Paper	Core Paper	Elective II	Project
	Biological Instrumentation and Techniques (BIT)	Genetics & Developmental Biology (GDB)	Refer to the Elective Bucket	

New CBCS Syllabus for 2022-23 onwards

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COURSES OFFERED DURING SEMESTER III and SEMESTER IV

[includes the bucket list of courses offered as Electives]

SemesterIII	SemesterIV
CoreCourse – I	CoreCourse – I
SystemsBiology(SMB)	Animal Biotechnology(ABT)
CoreCourse – II	CoreCourse – II
ResearchMethodology(RM)	AppliedZoology(AZ)
ElectiveCourse – I	Elective Course –III
Neuroscience – I (NS - I) Medical Entomology – I (ME - I) Toxicology – I (TOX - I) Parasitology – I (PRS - I) Comparative Animal Physiology – I (CAP - I) Principles of Fisheries – I (PF - I) Agricultural Entomology – I (AE - I)	Neuroscience – II (NS - II) Medical Entomology – II (ME - II) Toxicology – II (TOX - II) Parasitology – II (PRS - II) Comparative Animal Physiology – II (CAP - II) Principles of Fisheries – II (PF - II) Agricultural Entomology – II (AE - II)
ElectiveCourse – II	Project
*Principles of Toxicology (PT) Endocrinology (EN) Phytonematology (PN) Sericulture (SER) Zoonotic Diseases (ZD) Bioremediation (BR) Wildlife Techniques (WT) Cancer Biology and Therapeutics (CBT)	

Note: Student must choose at least **one Course**(earlier known as Paper) from the **bucket of Electives** being offered at the department (courses offered are based on the availability of the subject experts at the department) at the commencement of the Semester III and Semester IV.

* Students choosing Toxicology – I (Tox - I) as Elective Course – I, are **not eligible** to select Principles of Toxicology (PT) as Elective – II.

Project offered in the IV Semester carries credits and grades will be awarded to the same.

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Semester - I

M.Sc. Zoology

Code Zoo_101

Semester – I

CORE PAPER

Paper IV: Advances in Taxonomy & Invertebrate Biology [ATIB]

COURSE OUTCOMES

By the end of this course, students will be able to:

- Understand the fundamental concepts of systematics, taxonomy, and classification, including the branches of taxonomy such as cytotaxonomy and chemotaxonomy, numerical taxonomy and cladistics, as well as recent trends in biosystematics like molecular taxonomy and integrative approaches.
- Explore the taxonomic hierarchy of ranks and various species concepts, including biological, evolutionary, phylogenetic, and ecological concepts.
- Gain proficiency in the International Code for Zoological Nomenclature (ICZN), including its operative principles, interpretation, and application of essential rules.
- Learn about zoological types and understand the basis of scientific names.
- Study the respiratory and excretory systems in Annelida, Arthropoda, and Mollusca, and explore the unique features of each.
- Understand the reproduction and development in Cnidaria, including the concept of metagenesis and its significance in the life cycle.
- Differentiate between Prokarya and Eukarya, as well as Radiata and Bilateria, and recognize the biological and medical importance of sponges.
- Examine feeding and digestion mechanisms in various invertebrate groups, including Protozoa, Porifera, Helminthes, Mollusca, and Echinodermata.
- Explore specialized feeding mechanisms like filter feeding in Polychaeta and the evolutionary origin of nerves and cnidarian nerve nets.
- Learn about the different types of circulatory mechanisms, both open and closed, in Annelids and Arthropods.
- Investigate the types of helminthic parasites and their parasitic adaptations.
- Understand the evolutionary and phylogenetic significance of larval forms in crustaceans and echinoderms.
- Examine the systematic position, general organization, and affinities of various invertebrate groups, including Rotifera, Rhynchocoela, Ectoprocta, and Entoprocta.
- Explore intriguing concepts such as eusociality in insects, autotomy, and regeneration in echinoderms, and the significance of connecting links in the evolution of invertebrates.

15 Hrs

UNIT I – Advances in Taxonomy

1.1 Basic concepts of systematics, taxonomy and classification; Branches of taxonomy – Cytotaxonomy and Chemotaxonomy; Numerical Taxonomy and Cladistics.

1.2 Recent trends in biosystematics – Molecular taxonomy and Integrative approaches.

1.3 Taxonomic hierarchy of ranks; Species concepts – Biological, Evolutionary, Phylogenetic, and Ecological.

1.4 International Code for Zoological Nomenclature (ICZN) – Operative principles, interpretation and application of important rules.

1.5 Zoological Types – Holotype, Paratype, Syntype, Allotype; Scientific names and their basis – Eponym, Toponym, Taxonym, Bionym, Morphonym.

15 Hrs

UNIT II – Invertebrate Biology – I

2.1 Concepts of Prokarya & Eukarya and Radiata & Bilateria; Concept of Ecdysozoa & Lophothrochozoa; Biological and medical importance of sponges.

2.2 Feeding and digestion in invertebrates - Protozoa, Porifera, Helminthes, Mollusca, and Echinodermata

2.3 Filter feeding in invertebrates - Polychaeta; Origin of nerves and cnidarian nerve nets; Open and closed type of circulatory mechanisms in Annelids and Arthropods

2.4 Respiration and excretory system in in Annelida, Arthropoda, and Mollusca

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2.5 Reproduction and development in Cnidaria; Metagenesis and its significance.

15 Hrs

UNIT III – Invertebrate Biology – II

3.1 Types of helminthic parasites; Parasitic adaptations in helminthes
3.2 Crustacean larval forms: Evolutionary and phylogenetic significance
3.3 Echinoderm larval forms: Evolutionary and phylogenetic significance
3.4 Systematic position, general organization and affinities of a) Rotifera; b) Rhynchocoela; c) Ectoprocta and Entoprocta
3.5 Eusociality in insects; Autotomy and regeneration in echinoderms; Concept and significance of connecting links in invertebrates

PRACTICALS

1. Identification, classification and salient feature of selected protozoans (three to five examples) of medical importance
2. Identification, classification and salient features of selected helminths (two to four examples) of medical importance
3. Study of section of certain representatives of Cnidaria, Platyhelminthes and Annelida to understand coelom evolution and their types
4. Study of larval forms of Platyhelminthes
5. Study of larval forms of crustaceans
6. Study of larval forms of Echinodermata
7. Mounting and study of different types of mouth parts in house fly (piercing and sponging), butterfly (siphoning), and mosquito (piercing and sucking).
8. Study of *Peripatus* and *Balanoglossus* for their evolutionary significance
9. Study of respiratory organs in arthropods– book lungs, trachea, spiracles (models / virtual).
10. Excretory organs in platyhelmiths, annelids and arthropods – Flame cells, Malphigian tubules and Nephridia (models / virtual).
11. Preparation of permanent slides of zooplanktons (minimum three different types of species).
12. Culture of *Paramecium/Vorticella/Dorsophila* to study their morphological features.
13. Collection and identification of parasites from cockroach.
14. Demonstration and practice of virtual dissection of digestive, circulatory, respiratory, nervous and reproductive systems in cockroach/prawn.
15. Visit to Freshwater Biology Research Station, Zoological Survey of India, Hyderabad and submit a report.

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 and ant; 7) Life history of silk moth and lac insect; 8) Diagrams of larvae of Crustacea; 9) Diagrams of larval forms in Echinoderms; 10) Morphology of Vorticella, Ostracoda, Copepoda, Tubifex, and Chaetognatha.
[To be submitted at the time of Practical Examination – 5 Marks]

Assignments

1. Theory Assignment will be three detailed essays on any one topic each from Units I, II & III. The theory assignment shall be submitted to the concerned teacher handling the course by the submission date decided by him/her.

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2. Practical Assignment shall be submitted at the Semester end Practical Examination. The practical assignment shall be submitted to the concerned teacher handling the course by the submission date decided by him/her.

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 L. Margulis & M.J. Chapman
3 Animal Taxonomy: Principles & Practices by D.N. Pandit
4 A Textbook of Zoology Vol. I by Parker and Haswell (Revised)
5 The Invertebrates Vol. I to Vol. VI by L. H. Hyman
6 Invertebrate structure and function by E. J. W. Barrington
7 Invertebrate Zoology by P. A. Meglitsch
8 Life of Invertebrates by Russel Hunter
9 Invertebrate Zoology by Rupport and Barnes
10 Life of Invertebrates by S. N. Prasad
11 Evolutionary Biology by Eric C. Mitkoff
12 Worms and Man by D. W. T. Crompton
13 Parasitology by Noble and Noble
14 Regeneration by S. M. Rose-Appleton

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M.Sc. Zoology

Code Zoo_102

Semester – I
CORE PAPER
Paper II – Environmental and Conservation Biology [ECB]

COURSE OUTCOMES

By the end of this course, students will be able to:

- Understand the fundamental concepts of ecosystems, including the different types of ecosystems such as aquatic (freshwater and marine) and terrestrial ecosystems.
- Explore key ecological principles, including the laws of limiting factors, minimum, tolerance, and the tragedy of the commons, and understand their relevance to ecosystem dynamics and management.
- Examine the concepts of ecosystem stability and complexity, including the role of micronutrients and macronutrients in ecosystem functioning.
- Study population characteristics and dynamics, including growth curves (sigmoid curve, J curve, and hyperbola), the logistic equation, and concepts related to population growth.
- Investigate the concept of climate change and its impacts on ecosystems, as well as avenues for mitigating climate change.
- Analyze community structure and species diversity, including diversity indices (Simpson Diversity, Shannon Diversity, Evenness Index), and the interactions between abiotic and biotic factors.
- Understand concepts related to biota, habitat, and biome, as well as the ecotone concept, edge effect, ecological niche, niche overlap, and productivity in ecosystems.
- Examine trophodynamics and the eutrophication of lakes, as well as concepts of solid waste management, reduction, reuse, and recycling.
- Learn about biological indicators of water quality and how to assess and manage water quality.
- Explore biological waste management, the impact of plastic pollution and ocean acidification, and their implications for achieving Sustainable Development Goals (Goals 13, 14, and 15).
- Understand the principles, scope, and purpose of Environmental Impact Assessment, as well as the concept of carbon footprint and the transition to a zero-carbon economy.
- Examine the concepts of natural resources, including renewable and non-renewable resources, and the consequences of resource overexploitation, including deforestation, water table depletion, and land degradation.
- Learn about the role of ecological restoration in conservation efforts and the challenges associated with the displacement and settlement of local communities.
- Explore major conservation movements in India, the role of non-governmental organizations (NGOs) in conservation efforts, and initiatives like Project Tiger.
- Understand the national legislation for protecting biological resources in India, including the Biodiversity Act, 2002, and Biodiversity Rules, 2004. Gain insights into the historical perspective on conservation in India.

15 Hrs

UNIT I – Basic Concepts of Ecology

1.1 Concepts of ecosystems; Types of ecosystems – Aquatic (freshwater and marine) and Terrestrial;

1.2 Concepts of laws of limiting factor, minimum, tolerance and tragedy of commons; Ecosystem dynamics and management; Stability and complexity of the ecosystem

1.3 Micronutrients and macronutrients; Role in aquatic and terrestrial ecosystems.

1.4 Population characteristics and dynamics; Growth curves and pyramids; sigmoid curve, J curve and hyperbola; Logistic equation and concepts relating to growth

1.5 Concept of climate change; Impacts of climate change on ecosystems; Mitigation of climate change.

15 Hrs

UNIT II – Community Organization and Structure

2.1 Community analysis, species diversity; Ecotone concept and edge effect; Interaction between abiotic and biotic factors.

2.2 Concepts of biota, habitat and biome; ecological niche and niche overlap; Concepts of productivity; Trophodynamics and Eutrophication of lakes.

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2.3 Solid waste management; Biological indicators of water quality; Water quality assessment and management.

2.4 Acid rain sources and its impact on the biological system; Greenhouse effect, global warming, and ozone depletion; Impact of plastic pollution and ocean acidification.

2.5 Environmental Impact Assessment – principle, scope and purpose; Concept of carbon footprint and zero carbon economy.

15 Hrs

UNIT III – Natural Resource Management and Conservation

3.1 Concepts of natural resources – renewable and non-renewable resources.

3.2 Overexploitation of resources – deforestation, water table depletion and land degradation.

3.3 Role of ecological restoration in conservation; Displacement and settlement of local communities.

3.4 Major conservation movements in India; NGOs in conservation efforts; Conservation in India - Project Tiger.

3.5 National legislation for protecting biological resources – Biodiversity Act, 2002 and Biodiversity Rules, 2004; Historical perspective on conservation in India.

PRACTICALS

1. Enumeration and identification of benthos and pelagic zooplanktons.
2. Identification of the freshwater faunal diversity (snails, fishes, amphibians and waterbirds) of the local habitat.
3. Identification of the terrestrial faunal diversity (butterflies, reptiles, birds and mammals) of the local habitat.
4. Estimation of particulate matter in the air.
5. Estimation of nitrates and nitrites in the water sample.
6. Estimation of total alkalinity in the water sample.
7. Estimation of phosphates in the water sample.
8. Estimation of magnesium in the water sample.
9. Estimation of calcium in the water sample.
10. Estimation of dissolved oxygen in the water sample.
11. Determination of water quality index.
12. Calculation of species diversity indices – Simpsons index, Shannon Wieners index, and Evenness index
13. Estimation of land use change using Google Earth imagery.
14. Visit to Solid Waste Management or Treatment Plant and submission of a report.
15. Visit to Nehru Zoological Park, Hyderabad or other biodiversity rich area in and around Hyderabad and submission of a report.

Submission of assignment on: 1) Growth curves 2) Ecological Pyramids 3) Eutrophication; 4) Biogeographical regions of India; 5) Population dynamics; 6) Biogeochemical cycles; 7) Status of lake in the surrounding area; 8) Renewable and Non-renewable resources; 9) Overexploitation of natural resources; 10) Green audit – Concepts and process; 11) Major conservation movements in India; 12) Role of NGOs in conservation; 13) Sustainable Development Goals.
[To be submitted at the time of Examination – 5 Marks]

Assignments

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2. Practical Assignment shall be submitted at the Semester end Practical Examination. The practical assignment shall be submitted to the concerned teacher handling the course by the submission date decided by him/her.

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. Doak2002. 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. Caughley2006. 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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Semester – I
CORE PAPER
Paper III – Structural Biology [SB]

COURSE OUTCOMES

By the end of this course, students will be able to:

- Understand the composition, structure, and functions of biomolecules, including carbohydrates, lipids, proteins, and nucleic acids.
- Explore the principles of bioenergetics, including the ATP cycle, and the biosynthesis of carbohydrates through processes like glycogenesis.
- Investigate the biosynthesis of fatty acids and amino acids, as well as the biochemical aspects of hormone action.
- Learn about the classification, nomenclature, and properties of enzymes, including concepts like Michaelis-Menten constant (Km) and the mechanism of enzyme action. Explore the regulation of enzyme activity.
- Examine the catabolism of amino acids through processes like transamination, deamination, and decarboxylation. Understand the role of heat shock proteins (HSPs) and molecular chaperones in protein binding.
- Study macromolecules and their role in the origin of cells. Explore the molecular organization and functions of cell membranes, including cell permeability and transport mechanisms.
- Learn about cell communication, both intercellular and chemical signalling between cells, and the strategies of chemical signalling.
- Explore signalling mediated by intracellular receptors and cell surface receptors, including second and third messengers like cAMP, G-proteins, Ca++, Inositol Triphosphate (IP3), and prostaglandins.
- Understand the cell cycle, including the molecular events that occur during the cell cycle and the formation of the mitotic spindle.
- Explore DNA replication, including semi-conservative replication, the enzymology of DNA replication, initiation, elongation, and termination of the replication process. Understand the proofreading function of DNA polymerases.
- Study protein synthesis, including the regulation of the genetic code (Wobble's concept) and the events of protein synthesis. Compare transcription in prokaryotes and eukaryotes.
- Examine post-transcriptional processing, enzymatic synthesis of RNA, and translation in prokaryotes and eukaryotes.
- Learn about DNA repair mechanisms, including high fidelity of DNA sequence and the alteration of DNA molecules. Explore biological indicators of repair and eukaryotic repair systems like Nucleotide Excision Repair, Base Excision Repair, and Mismatch Repair.
- Understand the molecular genesis of cancer, including the molecular interactions between cancer and healthy cells. Explore therapeutic interventions for cancer.

15 Hrs

UNIT I – Biomolecules, Enzymes and Metabolism

1.1 Composition, structure and function of biomolecules (Carbohydrates, proteins, and nucleic acids).
1.2 Bioenergetics principles; ATP cycle; Biosynthesis of carbohydrates – gluconeogenesis and glycogenesis.
1.3 Biosynthesis of fatty acids; Biosynthesis of amino acids; Biochemical aspects of hormone action.
1.4 Classification, nomenclature and properties of enzymes; Michaelis–Menton constant; Km values; Mechanism of enzyme action and regulation of enzyme activity.
1.5 Catabolism of amino acids – Transamination, deamination and decarboxylation; HSP's and molecular chaperons and protein binding.

15 Hrs

UNIT II – Cellular Organization

2.1 Macromolecules and origin of cells; Molecular organization and functions of cell membranes.
2.2 Cell permeability – Transport across the cell membrane; transport of small molecules; carrier proteins, ion pumps, membrane bound enzymes.
2.3 Cell communications – Intercellular communication and gap junctions; Chemical signaling between the cells; Strategies of chemical signaling.
2.4 Signaling mediated by intracellular receptors; Signaling mediated by cell surface receptors –

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second and third messengers; C–AMP, G proteins, Ca^{++}, inositol triphosphate (IP_3) and prostaglandins.

2.5 Cell cycle; Molecular events in the cell cycle, Mitotic spindle.

15 Hrs

UNIT III – Molecular Biology

3.1 DNA replication – Semiconservative, enzymology of DNA replication, replication of circular DNA, initiation, elongation and termination of replication process; proof reading function of DNA polymerases.

3.2 Protein synthesis – Regulation of genetic code – Wobble's concept, Events of protein synthesis; Transcription in prokaryotes and eukaryotes.

3.3 Transcriptional processing; Enzymatic synthesis of RNA; Translation in prokaryotes and eukaryotes.

3.4 DNA repair mechanism: High fidelity of DNA sequence and alteration of DNA biomolecules; biological indicators of repair; Eukaryotes repair system (nucleotide excision repair, base excision repair, mismatch repair).

3.5 Cancer: Molecular genesis of cancer; Molecular interaction of cancer and healthy cells; Therapeutic interventions to cancer.

PRACTICALS

1. Introduction to Good Laboratory Practices..
2. Preparation of standard graph using carbohydrate/protein.
3. Quantitation of DNA by UV-visible Spectrophotometer and/or Colorimetry.
4. Quantitation of protein by UV-visible Spectrophotometer and/or Colorimetry.
5. Quantitation of total carbohydrates by UV-visible and/or Colorimetry.
6. Quantitation of lipids by UV-visible and/or Colorimetry.
7. Determination of enzyme activity of SDH in cultured fish.
8. Determination of enzyme activities of LDH in cultured fish.
9. Effect of substrate concentration on SDH activity in cultured fish.
10. Effect of pH on SDH activity in cultured fish.
11. Protein fractionation using sodium sulphate.
12. Virtual demonstration of cell permeability.
13. Virtual demonstration of cell communication.
14. Virtual demonstration of cell signaling.
15. Virtual demonstration of cell cycle.

Submission of assignment on: Structure of Biomolecules – Carbohydrates, Amino acids, Proteins, Lipids, Nucleic acids; Mechanism of enzyme action; Metabolic cycles – Glycogenesis, Kreb's Cycle, Electron Transport System; DNA synthesis, RNA synthesis, protein synthesis; Molecular basis and interactions of cancer and healthy cells

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

Assignments

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2. Practical Assignment shall be submitted at the Semester end Practical Examination. The practical assignment shall be submitted to the concerned teacher handling the course by the

submission date decided by him/her.

Suggested Books

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

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Code Zoo_104

Semester – I

CORE PAPER

Paper IV – Biological Instrumentation and Techniques [BIT]

COURSE OUTCOMES

By the end of this course, students will be able to:

- Understand the principles and applications of various microscopic techniques.
- Learn about microtomy and staining procedures, including the types of microtomes, tissue fixation, embedding, and various staining and mounting procedures for biological materials.
- Explore the basic principles of centrifugation, including the types of centrifugations and their principles.
- Understand the basic principles of chromatography and their applications.
- Explore the principles and applications of electrophoresis techniques.
- Learn about various spectroscopy techniques and their applications.
- Understand the principles and applications of X-ray diffraction and MALDI-TOF spectrometry.
- Explore techniques for single neuron recording, patch-clamp recording, and ECG recording.
- Learn about PCR techniques and hybridization techniques, and their applications.
- Understand RT-PCR techniques for qualitative and quantitative analysis of DNA, RNA, and proteins, as well as their practical applications.
- Explore various imaging techniques, including PET, MRI, fMRI, CAT, ultrasound, radiography, mammography, and their uses in medical diagnosis.
- Learn about Microarray Technology, its principles, and applications.
- Study molecular diagnostics for communicable disease detection and their relevance in public health.
- Explore molecular diagnostics in non-communicable disease detection and their importance in personalized medicine.
- Understand point-of-care diagnostic techniques and their role in rapid diagnosis and treatment.
- Learn about zoonotic diagnostic techniques for both animals and humans, emphasizing the importance of One Health approaches.

UNIT I – Tools and Separation Techniques — 15 Hrs

1.1 Principles and Applications of Microscopic Techniques: Bright and Dark Filed 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 Basic Principles of Centrifugation: Types of centrifugations & their principles, Refrigerative; Principles of Sedimentation, Svedberg Co-efficient; Cell separation by density gradient centrifugation; Cell separation by Affinity adsorption; Cell separation by anchorage-based techniques.

1.4 Separation Techniques: Basic principles of chromatography concept and applications; Concept and application of Ion Exchange Chromatography and Gel Chromatography; Concept and application of HPLC and Affinity Chromatography.

1.5 Electrophoretic Techniques: Principles and applications of Agarose and SDS-polyacrylamide gel electrophoresis; Principles and applications of Zone and Moving Boundary electrophoresis; Principles and applications of Isotachophoresis and Isoelectrophoresis.

UNIT II – Separation and Imaging Techniques — 15 Hrs

2.1 Spectroscopic Techniques-I: Principles and applications of UV, Visible, IR and Fluorescence spectroscopy; Principles and applications of Atomic Absorption spectroscopy; Principles and applications of NMR and ESR spectroscopy.

2.2 Spectroscopic Techniques-II: Principles and applications of Mass spectrometry (LC-MS, GC-MS); Principles and applications of X-ray diffraction; Principles and applications of MALDI-TOF.

2.3 Electrophysiological Techniques: Principles and applications of single neuron recording; Principles and applications of patch-clamp recording; Principles and applications of ECG Recording.

2.4 PCR Techniques: Hybridization techniques - A) Southern, B) Northern, C) Western, Principles and applications; RT-PCR Techniques for Qualitative and Quantitative Analysis of DNA, RNA and Proteins; Applications of PCR and RT-PCR techniques.

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2.5 Imaging techniques: PET, MRI, fMRI and CAT; Ultrasonography, Radiography, Mammography.

UNIT III – Diagnostic Techniques **15 Hrs**

3.1 Radioisotope Techniques: Principles and applications of tracer techniques in biology and autoradiography; Radioactive isotopes and half-life periods of isotopes; Principles and application of Geiger-Muller and Scintillation Counter.
3.2 Microarray technology: Principles and applications of microarray technology.
3.3 Molecular diagnostics for communicable disease detection.
3.4 Molecular diagnostics for non-communicable disease detection.
3.5 Point of care diagnostic techniques; Zoonotic diagnostic techniques for animals and humans.

PRACTICAL

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 by TLC.
4. To prepare a paraffin block of tissue for microtomy for making sections of tissue for histological studies.
5. Quantitative detection of total carbohydrates using Anthrone method.
6. Quantitative detection of total lipids using Sulphur phospho vanillin technique.
7. Quantitative detection of total proteins using Lowry et al. or Biurett method.
8. Demonstration of the gel electrophoresis for separation of DNA.
9. Virtual demonstration of SEM and TEM.
10. Virtual demonstration of FISH and GISH techniques.
11. Virtual / Live demonstration of GCMS.
12. Virtual our live demonstration of FTIR.
13. Virtual demonstration of ELISA/EIA REI for detecting microbial diseases.
14. Virtual demonstration of RT-PCR for detecting viral diseases.
15. Visit to Central Facilities for Research and Development, Osmania University and submission of report.

Submission of assignment on: Microscopy and its application in biology; Principles and applications of centrifugation; Chromatographic techniques; Microtomy Electrophoresis techniques and its application; Spectroscopic techniques; Radioisotope techniques; Electrophysiological techniques Microarray techniques.
[To be submitted at the time of Examination –5 Marks]

Assignments

1. Theory Assignment will be three detailed essays on any one topic each from Units I, II & III. The theory assignment shall be submitted to the concerned teacher handling the course by the submission date decided by him/her.
2. Practical Assignment shall be submitted at the Semester end Practical Examination. The practical assignment shall be submitted to the concerned teacher handling the course by the submission date decided by him/her.

Suggested Books

1 Techniques in life sciences – by Tembhare
2 Principles and techniques of Practical Biochemistry Ed. B.L. Williams &K. Wilson, Arnold Publishers.
3 Practical Biochemistry by Plummer
4 Immunology – Roit

5 Cell and Molecular Biology – DeRoberties
6 Cell and Molecular Biology – Ladish et al.

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Semester - II

M.Sc. Zoology

Code Zoo_201

Semester – II

CORE PAPER

Paper I – Evolution and Vertebrate Biology (EVB)

COURSE OUTCOMES

By the end of this course, students will be able to:

- Trace the evolutionary history of vertebrates from agnathans to amniotes, highlighting key transitional stages.
- Identify and describe the major extinct and living agnathan groups, gnathostomes, and teleostomi.
- Analyze the characteristics and significance of placoderms, chondrichthyes, acanthodii, and osteichthyes in vertebrate evolution.
- Understand the evolution of tetrapods and their diverse groups, including labyrinthodonts, lepospondyls, and lissamphibia.
- Examine the evolutionary paths of amniotes, including reptiles, birds, and mammals, with a focus on prototheria and theriiformes.
- Explore the integumentary system and its derivatives in vertebrates.
- Investigate the cranial and post-cranial skeletal systems, including jaw suspension types and joint variations.
- Describe the components and functions of the digestive system in Aves and Mammals, including dentition in mammals.
- Evaluate the respiratory system across vertebrates, from gills in fishes to lungs in mammals.
- Examine the excretory system, focusing on kidney structure and modes of excretion in vertebrates.
- Understand the nervous system, including the brain, spinal cord, and peripheral nerves, in various vertebrate classes.
- Analyze the structure and function of the eye in Aves and Mammals and the evolutionary significance of the amniotic egg, internal fertilization, and different types of placentas.

UNIT I – Evolution of Vertebrates — 15 Hrs

1.1 Evolution of Agnathans – a) Extinct Agnathans (Conodonts, Ostracoderms & Pteraspidomorphi) and b) Living Agnathans (Myxinoidea & Petromyzontiformes).

1.2 Evolution of Gnathostomes – a) Placodermi and b) Chondrichthyes (including Elasmobranchii & Holocephali).

1.3 Evolution of Teleostomi – a) Acanthodii and b) Osteichthyes (Actinopterygii & Sarcopterygii).

1.4 Evolution Tetrapods – a) Labryinthodonts, b) Lepospondyls, and c) Lissamphibia (Urodela, Anura & Apoda).

1.5 Evolution of Amniotes – a) Reptilia (Mesozoic and living reptiles), b) Aves (Palaeognathae & Neognathae), and c) Mammalia (Prototheria & Theriiformes).

UNIT II – Functional Anatomy of Vertebrate– I — 15 Hrs

2.1 Integumentary system – Integument and its derivatives.

2.2 Cranial skeletal system – a) Basic plan of skull; b) Temporal fossae – its function; c) Jaw suspension and its types.

2.3 Post-cranial skeletal system – a) Axial skeleton; b) Appendicular skeleton; and c) Joints (both axial & appendicular and their types).

2.4 Digestive system in Aves and Mammals – Components and function; Dentition in mammals.

2.5 Respiratory system in vertebrates (Fishes to Mammals) – Gills, lungs, and other respiratory structures.

UNIT III – Functional Anatomy Vertebrates – II — 15 Hrs

3.1 Excretory system in vertebrates (Fishes to Mammals) – Kidney and its structure; Modes of excretion.

3.2 Nervous system in vertebrates (Fishes to Mammals) – Brain, spinal cord, and peripheral nerves.

3.3 Eye in vertebrates (Aves and Mammals) – Structure and function in different classes.

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3.4 Amniotic egg – Its structure and evolutionary significance.
3.5 Evolutionary significance of internal fertilization; Placenta - its types and functions

PRACTICALS

1. Specimen study: Unique representatives of
   1) Elasomobranchii – Shark, Ray fish
   2) Actinopterygii – *Labeo, Exocetus*
   3) Dipnoi – *Protopterus*, *Neoceratodus* and *Lepidosiren*
   4) Amphibia – one representative of each Anura, Apoda, Urodela.
2. Specimen study of
   1) Reptilia: Marsh Crocodile, Star tortoise, Gecko, Russell's Viper, and Rat Snake.
3. Specimen study of
   1) Aves: Ostrich, Kiwi, Penguin, Vulture, and Duck;
   2) Mammalian: *Echidna*, *Platypus*, *Macropus*, Tiger, Spotted Deer.
4. Collection and preparation of slides of scales of fishes.
5. Comparative study of alimentary canals of vertebrates.
6. Comparative study of Reproductive system of vertebrates.
7. Comparative studies of (Axial skeleton) – Skull of vertebrates.
8. Comparative studies of (Axial skeleton) – Vertebrae of vertebrates.
9. Comparative studies of (Apendicular skeleton) Girdles – pelvic and pectoral.
10. Comparative studies of (Apendicular skeleton) Limb bone – Fore limbs and hind limbs.
11. Study of skin and derivates of integument – Nail, claw, horn, and hoof.
12. Study of different types of feathers, hairs, and scales
13. a. Dissection (Demonstration / virtual) of Weberian ossicles of *Labeo*
    b. Dissection (Demonstration / virtual) of Respiratory trees of *Clarius*
14. Dissection (Demonstration / virtual) of Cranial nerves of *Labeo* (V, VII, IX & X cranial nerves)
15. Visit to National Park in Hyderabad.

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]

Assignments

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2. Practical Assignment shall be submitted at the Semester end Practical Examination. The practical assignment shall be submitted to the concerned teacher handling the course by the submission date decided by him/her.

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 by E.L. Jordan & P.S. Verma
14 Vertebrate Zoology & Evolution by Yadav B. N. & D. Kumar

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M.Sc. Zoology

Code Zoo_202

Semester – II
CORE PAPER
Paper II – Immunology [IMM]

COURSE OUTCOMES

By the end of this course, students will be able to:

- Understand the evolution of the immune system in invertebrates and vertebrates and differentiate between innate and adaptive immunity.
- Explore the physiology of the immune system, including physical and chemical barriers, primary and secondary lymphoid organs, and lymphatic tissues and traffic.
- Describe the structure and functions of key immunoreactive cells such as Macrophages, Granulocytes, Natural Killer Cells, T cells, B cells, Dendritic cells, and Mast cells.
- Analyze the humoral and cell-mediated immune responses, including the roles of cytokines, lymphokines, interleukins, and interferons in the immune system.
- Examine the lymphoid tissues, both primary and secondary lymphoid organs, and their relevance in the immune response.
- Explore the nature and types of antigens, epitopes, haptens, antigenicity, and adjuvants in immunology.
- Describe the structure, function, and classification of antibodies (immunoglobulins) and understand antigen-antibody reactions.
- Investigate the production and application of monoclonal and polyclonal antibodies.
- Analyze the components and activation pathways (Classical and Alternative) of the complement system, as well as its biological consequences.
- Understand the structure and function of the Major Histocompatibility Complex (MHC) and Human Leukocyte Antigens (HLA) system, and their roles in immune phagocytosis, inflammation, and anaphylaxis.
- Examine the concepts and challenges of transplantation, including solid organ transplantation, graft rejection, and Graft-versus-host disease (GvHD).
- Investigate immunity against diseases and the mechanisms by which pathogens evade the immune response, as well as the field of tumor immunology, including tumor-specific antigens (TSA), immune surveillance, and immune suppression.
- Explore immune disorders, including the mechanisms of hypersensitivity and autoimmunity, and the concept of organ-specific autoimmune diseases.

UNIT I – Introduction to Immunology — 15 Hrs

1.1 Introduction and evolution of immune system in invertebrates and vertebrates; Immunity types – Innate and adaptive immunity.

1.2 Physiology of immune system – Physical and chemical barriers; Primary and secondary lymphoid organs; Lymphatic tissues and lymphatic traffic.

1.3 Immunoreactive cells – Structure and function of Macrophages, Granulocytes, Natural Killer Cells, T cells, B cells, Dendritic cells, and Mast cells.

1.4 Immune response – Humoral and Cell mediated immune response; Role of cytokines, lymphokines, interleukins, and interferons in immune system.

1.5 The Lymphoid tissues – Primary and secondary lymphoid organs; Lymphatic traffic.

UNIT II – Immunoglobulins and Complement system — 15 Hrs

2.1 Antigens – Nature and Types; Epitope, Haptens, Antigenecity, and Adjuvants.

2.2 Immunoglobulins – Structure, function, and classification of antibodies; Antigen and Antibody reactions.

2.3 Monoclonal and polyclonal antibodies; Production of monoclonal antibodies and their application.

2.4 Complement system – Components of the complement system; Pathways – Classical and Alternative; Biological consequences of complement activation and complement significance.

2.5 Major Histocompatibility Complex (MHC); Human Leukocyte Antigens (HLA) system: Structure and function; Immune phagocytosis; Inflammation, and Anaphylaxis.

15 Hrs

UNIT III – Transplantation, Tumor Immunology and immune disorders

3.1 Toxicity of chemicals on immune system functions; Immunomodulators and immunostimulators; Immune compromised states.

3.2 Transplantation – Concepts and challenges in Transplantation; Solid organ transplantation; Barriers to transplantation, graft rejection, and Graft-versus-host disease (GvHD).

3.3 Immunity against diseases and evasion of immune response by bacteria, virus, fungi, and parasites.

3.4 Tumour immunology – Immunity to tumours; TSA (tumour-specific antigens); Immunosurveillance; Immune suppression; Oncogene and cancer induction, and anti-tumor drug resistance.

3.5 Immune disorders; Mechanisms of hypersensitivity and autoimmunity; Organ-specific autoimmune diseases.

PRACTICALS

1. Blood grouping – Forward and Reverse, RH typing.
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. Identification of various immune cells (Lymphocytes) by morphology – Leishman stain/Giemsa stain.
7. Identification of histological slides of lymphoid tissues - Spleen, Thymus, Lymph Node and Bone marrow.
8. Total count/Differential count of leucocytes
9. Agglutination reaction – Latex agglutination reaction – Rheumatoid factor
10. Haemagglutination
11. Serum electrophoresis/ PAGE of serum proteins
12. Precipitation reactions- Single Radial immunodiffusion, double diffusion, Rocket electrophoresis counter current immune electrophoresis
13. Preparation of lymphocytes from peripheral blood by density gradient centrifugation/ficoll method.
14. Separation of IgG by chromatography using DEAE cellulose or sephadex.
15. Demonstration of Western blotting technique.

Submission of assignment on: structure of immune cells, antibodies, antigen-antibody reactions, Immunological techniques (ELISA, RIA, Immunoprecipitation- FISH and GISH) Monoclonal antibodies, MHC, Autoimmunity Hypersensitivity types, transplantation and tumour immunology primary and secondary diseases.

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

Assignments

1. Theory Assignment will be three detailed essays on any one topic each from Units I, II & III. The theory assignment shall be submitted to the concerned teacher handling the course by the submission date decided by him/her.
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practical assignment shall be submitted to the concerned teacher handling the course by the submission date decided by him/her.

Suggested Books

1 Immunology, Kuby, W.F. Freeman, U.S.A.
2 Fundamentals of Immunology, W. Paul.
3 Essentials of Immunology, I.M. Roitt.
4 Immunology A Foundation Test by Basiro Davey.
5 An introduction to immunology, by Ian R. Tizard.
6 The Experimental Foundations of Modern Immunology by W. Clark John Wiley and Sons, New York.
7 Cellular and Molecular Immunology by Abbas, Lichtman and Pober, W.B. Saunders Company , Philadelphia.

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M.Sc. Zoology

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Semester – II
CORE PAPER
Paper III – Animal Physiology [AP]

COURSE OUTCOMES

By the end of this course, students will be able to:

- Understand the processes of cellulose digestion, including differences between ruminant and non-ruminant digestion, as well as absorption in mammals. Explore events in absorptive and post-absorptive states and their regulation, both endocrine and neural.
- Examine the complex cascade of oxygen transport to tissues at high altitudes and adaptations to diving. Analyze the responses to CO_2 and O_2-rich environments, including oxygen toxicity and the regulation of respiration.
- Investigate buffering mechanisms by body fluids, including their role in maintaining pH balance.
- Explore the principles of haemodynamics, blood pressure regulation, blood coagulation, and the cardiac cycle. Understand the basics of electrocardiography (ECG).
- Analyze osmoregulation in different environments, including aquatic organisms in brackish water, fresh water, and marine environments, as well as in terrestrial animals. Study the hormonal control of osmoregulation.
- Examine urine formation, the counter-current mechanism, and the role of the juxtaglomerular apparatus in excretion.
- Understand hormonal regulation, including the Renin-Angiotensin System (RAS), Anti-Diuretic Hormone (ADH), and aldosterone.
- Explore the detoxification of nitrogen products, including the purine cycle and other detoxification pathways.
- Understand temperature regulation in poikilotherms, homeotherms, and heterotherms, along with the mechanisms these animals employ for survival.
- Analyze the central control of homeothermy and concepts like cold death, cold resistance, and heat death. Study torpor, hibernation, and aestivation.
- Examine the comparative molecular structure and function of skeletal, smooth, and cardiac muscles. Investigate energy metabolism in skeletal muscles and the phenomenon of muscle fatigue.
- Explore the basis and significance of membrane potentials, including action potentials, sodium-potassium currents, neurotransmitters, and types of neurons and glial cells.
- Study different types of synapses, synaptic transmission, and synaptic inhibition.
- Investigate receptors and sensory coding, including mechanoreceptors, photochemical aspects of vision, and phonoreception in mammals.
- Understand the mechanisms of hormone action, including peptide and steroid hormones.
- Explore the hormones of vertebrates, including those of the hypothalamus, pituitary, thyroid, parathyroid, adrenal glands, pancreas, testis, ovaries, and biological clocks.

15 Hrs

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 CO_2 and O_2 rich environment; Oxygen toxicity; Hypercapnea, regulation of respiration.
1.4 Buffering mechanisms by body fluids.
1.5 Circulation – Principles of hemodynamics; Blood pressure and its regulation; Blood coagulation; Cardiac cycle and Electrocradiograph

15 Hrs

UNIT II – Osmoregulation, Excretion & Thermoregulation

2.1 Osmoregulation in aquatic organisms (brackish water, fresh water, and marine organisms) and in terrestrial animals; Hormonal control of osmoregulation.
2.2 Excretion – Urine formation, counter-current mechanism; Juxtaglomerular apparatus; Hormonal regulation: Renin-Angiotensin System (RAS), Anti Diuretic Hormone (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,

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and their mechanisms of survival; Central control of homeothermy.

2.5 Cold death, cold resistance, and heat death; Torpor, hibernation, and aestivation.

UNIT III – Muscle Physiology, Neurophysiology and Hormones **15 Hrs**

3.1 Comparative molecular structure and function of skeletal, smooth, and cardiac muscles; Energy metabolism in skeletal muscle; Muscle fatigue.

3.2 Basis and significance of membrane potentials; Action potential – Sodium potassium currents, and neurotransmitters; Types of neurons and glial cells; Types of synapses, synaptic transmission, and synaptic inhibition.

3.3 Receptors – Receptor mechanisms, sensory coding; Mechanoreceptors, photochemical aspects of vision, and phonoreception in mammals.

3.4 Mechanism of hormone action – Peptide and steroid hormones; Hormones of vertebrates: Hormones of hypothalamus, pituitary, thyroid, and parathyroid.

3.5 Hormones of adrenal glands, pancreas, testis, and ovaries; Biological clocks.

PRACTICALS

1. Preparation of Buffer of known pH – Buffering capacity.
2. Isolation of casein protein from milk and estimating iso electric pH of casein.
3. Estimation of blood chlorides under hetero osmotic media.
4. Cold and heat stress on metabolic rate in tilapia fish/crab.
5. Effect of heat stress on glycogen levels in tilapia fish/crab.
6. Estimation of Acetylcholinesterase activity.
7. Estimation of Phosphorylase activity.
8. Adrenalin induced changes in blood glucose levels in rat/mice.
9. Insulin induced changes in blood glucose levels in rat/mice.
10. Kymographic recordings of twitch, tetanus and fatigue.
11. Estimation of Hb, ESR and blood clotting time.
12. Demonstration of cell fragility.
13. Estimation of serum creatinine by Jaffe's et al method.
14. Effect of drugs and hormone on contraction of smooth muscles.
15. Preparation of models of amnio acid, peptides, DNA, and RNA.

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. Social communication and social dominance **[To be submitted at the time of Examination – 5 Marks]**

Assignments

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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 K. 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.
10 Principles of Animal Physiology by Eckert and Randall

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M.Sc. Zoology

Code Zoo_204

Semester – II

CORE PAPER

Paper IV – Genetics and Developmental Biology [GDB]

COURSE OUTCOMES

By the end of this course, students will be able to:

- Understand the extension of Mendelian inheritance and explore concepts related to gene interaction, including pleiotropy, expressivity, penetrance, and genomic imprinting.
- Examine the molecular anatomy of eukaryotic chromosomes, including heterochromatin, euchromatin, polytene, and lampbrush chromosomes.
- Analyze different types of mutations, such as lethal, conditional, and biochemical mutations.
- Explore the concepts of loss-of-function and gain-of-function mutations, as well as germinal and somatic mutants, and understand dosage compensation in C. elegans, Drosophila, and humans.
- Investigate molecular markers used in genome analysis, and comprehend the linkage of molecular markers to disease resistance genes.
- Explore the nature of genes and their functions, including the fine structure of genes, and study methods of gene mapping, such as the 3-point test cross in Drosophila and gene mapping in humans through linkage analysis in pedigrees.
- Trace the origin, migration, and fate of primordial germ cells. Examine the factors controlling spermatogenesis and oogenesis.
- Understand the processes of fertilization, including egg-sperm interactions, prevention of polyspermy, and chemical changes during cleavage.
- Explore gastrulation and the formation of primary organ rudiments, along with general metabolism during gastrulation.
- Understand the concept of a primary organizer, as introduced by Hans Spemann and Hilde Mangold, and explore induction processes, including mesoderm development and the role of growth factors. Study neural tube induction.
- Investigate cell differentiation, including the equivalence of nuclei and genome constancy, and examine the chemical basis of differentiation and the role of hormones in the process.
- Explore the concept of stem cells, including embryonic stem cells and adult stem cells, and their medical applications.
- Understand techniques like Embryo Transfer (ET) and In Vitro Fertilization (IVF) in humans and livestock, as well as superovulation and embryo culture.
- Analyze the genetics of axis formation, including dorso-ventral and anterior-posterior axis determination and axis specification in Drosophila, and study the role of maternal genes, segmentation genes, and homeotic genes.
- Examine organogenesis in various systems, including limb development, central nervous system development, and heart development.
- Understand the role of HOX genes and other pattern-forming genes in vertebrate limb development.
- Explore the determination of polarity in developing organisms and the causes of teratogenesis, both genetic and environmental. Investigate the teratological effects of xenobiotics and the developmental mechanisms of teratogenesis.

UNIT I – Genetics — 15 Hrs

1.1 Extension of Mendelian inheritance; Gene interaction – Pleiotropy Expressivity, Penetrance, Genomic Imprinting.

1.2 Molecular anatomy of eukaryotic chromosomes – Heterochromatin, Euchromatic, Polytene, and Lampbrush chromosomes.

1.3 Mutations – Types: Lethal, Conditional, Biochemical; Loss of functions and Gain of functions; Germinal and somatic mutants; Dosage compensation in *C. elegans*, *Drosophila*, and Human.

1.4 Molecular markers in genome analysis: RFLP, RAPD, AFLP analysis; Molecular markers linked to disease resistance genes.

1.5 Nature of gene and its functions; Fine structure of gene (rll locus); Methods of gene mapping: 3-point test cross in *Drosophila*; Gene mapping in humans by linkage analysis in pedigree.

UNIT II – Gametogenesis, Fertilization and Early Development — 15 Hrs

2.1 Origin, migration, and fate of primordial germ cell; Gametogenesis – Factors controlling spermatogenesis and oogenesis.

2.2 Fertilization – Egg-sperm interactions; Post fertilization cortical reactions and prevention of

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polyspermy; Cleavage – Mechanism and influence of yolk; Chemical changes during cleavage.

2.3 Gastrulation and formation of primary organ rudiments in *Amphioxus*; General metabolism during gastrulation; Concept of primary organizer (concept of Hans Spemann & Hilde Mangold).

2.4 Induction – Mesoderm development, Growth factors; Embryonic induction and competence; Neural tube induction.

2.5 Cell differentiation – Equivalence of nuclei and genome constancy; Chemical basis of differentiation; Hormones and differentiation.

UNIT III – Stem cells & Organogenesis **15 Hrs**

3.1 Stem cells – Embryonic stem cells and adult stem cells, and their medical applications; Embryo Transfer (ET) and In Vitro Fertilization (IVF) in Humans and Livestock; Superovulation and embryo culture.

3.2 Genetics of axis formation – Determination of dorso-ventral and anterior-posterior axis and axis specification in *Drosophila*; Role of maternal genes, segmentation genes, and homeotic genes.

3.3 Organogenesis – Limb, central nervous system, and heart; Role of HOX genes and other pattern forming genes in vertebrate limb development.

3.4 Determination of polarity.

3.5 Teratogenesis – Genetic and environmental causes; Teratological effects of xenobiotics; Developmental mechanisms of teratogenesis.

PRACTICAL

1. Isolation and estimation of DNA in chick embryo – 24hrs/48hrs/72hrs/96 hrs.
2. Isolation and estimation of RNA in chick embryo – 24hrs/48hrs/72hrs/96 hrs.
3. Estimation of structural proteins in chick embryo – 24hrs/48hrs/72hrs/96 hrs.
4. Estimation of soluble proteins in chick embryo – 24hrs/48hrs/72hrs/96 hrs.
5. Estimation of SDH & LDH activity in chick embryo – 24hrs/48hrs/72hrs/96 hrs.
6. Estimation of calcium in eggshell by EDTA method – 24hrs/48hrs/72hrs/96 hrs.
7. Identification of chick embryo developmental stages – 24hrs/48hrs/72hrs/96 hrs.
8. Study of cleavage patterns in *Lymnaea*.
9. Observational study of development of eye in *Lymnaea*.
10. Observational study of foot development in *Lymnaea*.
11. Observation of early development of frog – 2-, 4-, 8-, and 16-celled stage, blastula, gastrula and yolk plug stage (Virtual Demonstration).
12. Vital staining experiments on chick embryos employing window method and tracing the development of stained parts (Virtual Demonstration).
13. Handling of *Drosophila* and study of its life cycle.
14. Examination of wild type (males and females) and mutants of *Drosophila.*
15. Study Life cycle and development of *Caenorhabditis elegans* (Virtual Demonstration).

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]**

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Assignments

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2. Practical Assignment shall be submitted at the Semester end Practical Examination. The practical assignment shall be submitted to the concerned teacher handling the course by the submission date decided by him/her.

Suggested Books

1 Balinsky, B. I. (1981). An introduction to Embryology 5th Ed. Holt SaundersPubl., Philadelphia.
2 Browder, L. W., Erickson, C. A. and Jeffery, R. W. (1991). Developmental Biology 3rd Ed. Saunders College Publ., Philadelphia.
3 Jenkin, P. M. (1970). Control of growth and metamorphosis, 1st Ed. Pergamon Press, Oxford.
4 Melissa A Gibbs (2003). A Practical guide to Developmental Biology Oxford University Press 118 pages, B/w illus, figs
5 Lodish et al; Molecular cell Biology, Latest edition, W.H. Freeman & Company, 2000.
6 Developmental Biology by Berryl
7 Cell and Molecular Biology – Concepts and Experiments by Gerald Karp. John Wiley and Sons Inc. Latest edition.
8 Waston et al. Molecular Biology of the gene, Latest Edition, Pearson Prentice Hall, USA.
9 Alberts et al: Molecular Biology of the Cell (4th ed 2002, Garland)
10 Gilbert: Developmental Biology (8th ed 2006, Sinauers)
11 Kalthoff: Analysis of Biological development (1996, McGraw)
12 Watson et al.: Molecular Biology of gene by Watson et al. Vol I & II
13 Cell and molecular biology by De Robertis and De Robertis, 8th ed.
14 Developmental Biology - Patterns, problems and principles by W. Saunders Jr.

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Semester - III

M.Sc. Zoology

Code Zoo_301

Semester – III
Core Paper
Paper I – Systems Biology [SMB]

COURSE OUTCOMES

By the end of this course, students will be able to:

- Understand the foundational concepts of systems biology and its applications in various biological systems.
- Demonstrate knowledge of the principles of systems thinking and modeling as applied to biological processes.
- Analyze and interpret quantitative and qualitative models related to sustainable pest and disease management, molecular modeling, and biochemical networks.
- Apply predictive modeling techniques to study population dynamics and ecological interactions, including predator-prey relationships.
- Explore the practical aspects of systems biology through laboratory experiments and computational simulations.
- Investigate the integration of biological networks, especially in the nervous system, and their role in neural function and neurotoxicity.
- Explore the field of evolutionary systems biology and its application in molecular phylogeny.
- Gain insights into the characterization and applications of nanoparticles in biological systems.

15 Hrs

UNIT I – Systems Biology - Introduction

1.1 History, concept, prospects and applications of systems biology and systems approach.
1.2 Basic concepts of systems approach to biology; Mammalian biological clocks
1.3 Basic concepts of models and modelling, model behaviour, classification.
1.4 Quantitative and qualitative models for Sustainable pest and disease management; Molecular modelling - Apoptosis.
1.5 Basic concepts of networks; types of networks neuronal and humeral network mechanism - Biochemical networks and metabolic cycles – Kreb's cycle, Electron Transport System.

15 Hrs

UNIT II – Predictive Modeling

2.1 Continuous population models for single species.
2.2 Insect outbreak model – A periodic Dynamics.
2.3 Predictive ecology, game theory population models, predator-prey model.
2.4 Kinetic models of the biochemical system – Metabolic control analysis.
2.5 Data formats, simulation techniques, modelling tools.

15 Hrs

UNIT III – Systems Biology - Applications

3.1 Networks in the nervous system: Integrative synaptic mechanism of the neural networks.
3.2 *Caenorhabditis elegans* model system for neurotoxicity.
3.3 Endobiogeny: An approach to systems biology, host-parasite interaction.
3.4 Evolutionary systems biology; approach to molecular phylogeny.
3.5 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.

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7 Bioassay of neurotoxicity.
8 Estimation of population growth under different environmental conditions.
9 Protein expression profiling using 2D electrophoresis.
10 Synthesis of nanoparticles of plant extracts.
11 Characterization of Nanoparticles by UV/FTIR
12 Study of any three softwares used in System Biology Modelling.
13 Integrating and interpreting datasets with network models and dynamic models
14 Construct a relationship tree using molecular phylogeny of any animal of study
15 **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 – 6 Marks]

Assignments

1. Theory Assignment will be three detailed essays on any one topic each from Units I, II & III. The theory assignment shall be submitted to the concerned teacher handling the course by the submission date decided by him/her.
2. Practical Assignment shall be submitted at the Semester end Practical Examination. The practical assignment shall be submitted to the concerned teacher handling the course by the submission date decided by him/her.

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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M.Sc. Zoology

Code Zoo_302

Semester – III
Core Paper
Paper II – Research Methodology [RM]

COURSE OUTCOMES

By the end of this course, students will be able to:

- Define research and explain its importance and applications, distinguishing between basic and applied research.
- Identify and describe the essential steps in the research process.
- Understand and apply general methods in biological research, including natural observation, field studies, and experimentation.
- Formulate clear research hypotheses and differentiate between various types of experimental designs.
- Conduct literature collection effectively, including the review process and proper citation methods.
- Demonstrate proficiency in writing dissertations, project proposals, project reports, and research papers.
- Understand the concepts of intellectual property rights, including biopiracy, copyrights, patents, traditional knowledge, and plagiarism.
- Utilize computer applications (MS Word and MS Excel) for word processing, data processing, and data analysis in biological research.
- Comprehend sampling methods, population vs. sample, and the types of variables involved in research.
- Explain probability distribution, including Normal, Binomial, and Poisson distributions, and their applications.
- Apply inferential statistical tools such as hypothesis testing, t-tests, ANOVA, and chi-square tests in research.
- Interpret and draw conclusions from statistical results, including correlation and regression analysis.
- Apply practical skills in data analysis and presentation, including creating charts, calculating descriptive statistics, and conducting hypothesis tests using MS Excel.
- Conduct literature reviews using online resources and prepare research publications and dissertations.
- Develop effective communication skills through the preparation of MS PowerPoint presentations and the analysis of epidemiological data.

15 Hrs

UNIT I – Research Design and Method

1.1 Research – definition, importance and application; Types - basic and applied research; Essential steps in research. General methods in biological research – 1) Natural observation, 2) Field study, and 3) experimentations; Purpose Statement – definition and significance.

1.2 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.

1.3 Literature collection – Need, review process, consulting source material, literature citation; Components of research report – Text, tables, figures, bibliography.

1.4 Writing of dissertations, project proposals, project reports, research papers.

1.5 Intellectual Property Rights – Biopiracy, copyrights, patent and traditional knowledge and plagiarism.

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 Sampling method – Concept of population and sample; Sampling (random sampling and non-random sampling); Variables (random, independent and intervening variables).

2.4 Data collections – Methods for primary data (observation, interview, questionnaire methods, and experiments) & secondary data (scientific journals, books, reports, databases).

2.5 Probability distribution – Definition & Types; Properties and applications of 1) Normal distribution, 2) Binomial distribution, and 3) Poisson distribution.

15Hrs

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UNIT III – Inferential Statistical Tools in Research

3.1 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.

3.2 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.

3.3 Single sample tests – Z test, Standard error of the mean, One-tailed and Two-tailed Z test and interpretation. Student's 't' test basic concepts; 1) Paired two sample for means, 2) Two-Sample assuming equal variances, & 3) Two-Sample assuming unequal variances.

3.4 ANOVA – 1) One-way and 2) Two-way ANOVA; 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.

PRACTICALS

1 Preparation of charts (Frequency graphs, Scatter plots, Pie charts) using MS Excel.
2 Calculation and preparation of the graphs 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 t-test for unpaired two samples for means using MS Excel.
6 Calculation of correlation and 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 Calculation of Chi -square using MS Excel.
10 Estimation of Population means and variance in simple random sampling.
11 Literature review using online resources.
12 Preparation and documentation of research publication/dissertation.
13 Preparation of MS PowerPoint presentation on a topic of your choice.
14 Analysis and inference of Epidemiological data.
15 **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 – 6 Marks]

Assignments

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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

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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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M.Sc. Zoology

Code Zoo_303

Semester – III
Elective - I
Paper III – Neuroscience - I [NS–I]

COURSE OUTCOMES

By the end of this course, students will be able to:

- Describe the cellular and molecular basis of the nervous system, including its organization and the uniqueness of the central and peripheral nervous systems, as well as the blood-brain barrier.
- Explain the ultrastructure of neurons, axonal transport, and its underlying mechanisms.
- Identify and differentiate between various types of neuronal and glial cells and understand their roles in brain development, migration, and axon guidance.
- Analyze the organization and functions of the cerebral cortex and limbic system in relation to behavior.
- Define and discuss the types of biopotentials, mechanisms, and action potentials, along with cable conduction.
- Describe various synaptic receptors (nicotinic, muscarinic, Ach receptor), ion channels, voltage-gated channels, and ion pumps, and their roles in synaptic transmission.
- Explain the molecular and physiological mechanisms of synaptic transmission, and recognize disorders associated with synaptic transmission.
- Understand the principles and methods of electrophysiological techniques, including voltage and patch clamp, as well as neuroanatomical and neuroimaging techniques.
- Explore neurotransmitters, neurotransmitter receptors, and neuromodulators, along with their metabolism and functional significance.
- Discuss G-protein coupled receptor mechanisms and their role in neural signaling.
- Examine neuroendocrine and neuroimmune circuits and their relevance to the nervous system.
- Analyze the molecular basis of learning and memory, with a focus on the role of the hippocampus and LTP/LTD, as well as the involvement of calcium ions.
- Demonstrate practical skills related to neurobiology through experiments involving live animals for demonstration purposes, including brain anatomy, biochemical assays, electrophysiology, and behavioral studies.

UNIT I – Cellular Neurobiology — 15 Hrs

1.1 Cellular and molecular basis of nervous system and its uniqueness (organization, functional anatomy of CNS, PNS) ; Blood brain barrier.
1.2 Ultra structure of a neuron, axonal transport and its mechanism.
1.3 Types of neuronal and glial cells, organization of neurons in the brain; glial guided neuronal migration, path finding and axon guidance.
1.4 Cerebral cortex, organization and behavior.
1.5 Limbic system – structure and functions.

UNIT II – Neurophysiology — 15 Hrs

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

UNIT III – Molecular and cognitive Neurobiology — 15 Hrs

3.1 Neurotransmitters, Neurotransmitter receptors and neuromodulators.
3.2 Metabolism and functional significance of neurotransmitters, specific transmitter defined system. (SNARE hypothesis of vesicle fusion)
3.3 G-protein coupled receptor mechanisms.
3.4 Neuroendocrine circuits and Neuroimmune circuits.

3.5 Molecular basis of learning and memory; the role of hippocampus and LTP and LTD in memory; Role calcium ions in LTP and LDP.

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

1 Demonstration of gross anatomical regions of the brain in mice/rat.
2 Demonstration of hippocampus, preparation of AchE, staining.
3 Identification of different types of neural and glial cells.
4 Estimation of acetylcholine in different regions of the brain of mice/rat.
5 Estimation of acetylcholinesterase, sodium and potassium ATPase activity in an animal model.
6 Electrophysiological demonstration of biopotentials and conduction velocity.
7 Determination of maze learning in mice.
8 Estimation of proteins in the hippocampus of mice/rat.
9 Biochemical differentiation of fast and slow muscles – SDH & LDH activities in mice.
10 Induction of stress and estimation of glycogen in mice/rat.
11 Induction of stress and estimation of lactate in mice/rat.
12 Induction of stress and estimation of AChE and Na-K ATPase activities in mice/rat.
13 Study of neuron /myelin by Nissl, Giemsa or Luxol fast blue staining.
14 Behaviour changes in depression in animal model.
15 **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; Neuroendocrine/Neuroimmune circuits; Diagram of the neuronal mechanism of sleep awake; LTP mechanism; Organization cerebral cortex.
[To be submitted at the time of Examination – 6 Marks]

Assignments

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Suggested Books

1 Physiology and biophysics – Ruch and Patten.
2 A textbook of muscle physiology – D. A. Jones and J. M. Round.
3 Neurobiology – Gorden 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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M.Sc. Zoology

Code Zoo_303

M.Sc. Zoology Semester – III
Elective – I
Paper III – Toxicology I (TOX- I)

COURSE OUTCOMES

By the end of this course, students will be able to:

- Define toxicology, its scope, and subdivisions, and understand the concepts of dose, dose-effect, and dose-response relationships.
- Classify toxic agents and identify factors affecting toxicity, including species, age, sex, and environmental factors.
- Explain the processes of absorption, distribution, translocation, binding, repair, storage, and elimination of toxicants.
- Understand biomagnification and the biotransformation of xenobiotics through Phase I and Phase II reactions.
- Explore the principles of toxicokinetics, toxicodynamics, toxicogenomics, toxicoproteomics, and metabolomics.
- Describe the generation and classification of free radicals, oxidative stress, and its consequences on biomolecules.
- Examine oxidative defense mechanisms, both enzymatic and non-enzymatic, in response to oxidative stress.
- Analyze the effects of toxicants on oxidative phosphorylation and their role in oxidative stress-related diseases, including carcinogenesis.
- Identify various occupational hazards and diseases, including pneumoconiosis, occupational cancers, and toxic exposures.
- Discuss the toxicity of chemical warfare agents, cosmetic products, mycotoxins, and the use of antidotes in poisoning.
- Explore preventive toxicology, including bioremediation, toxic site reclamation, and the role of biomarkers in molecular epidemiology.
- Investigate occupational health hazards due to radiation, emissions, particulate matter, gaseous and corrosive substances, using case-control and cohort studies.

UNIT I – Fundamental Toxicology

15 Hrs

1.1 Introduction, Definition, scope and sub division of toxicology; Dose - Dose *effect* - dose response relationship; Types of toxic effects –toxicity testing.

1.2 Classification of toxic agents (Natural, animal, plant, food toxins, genetic poisons, chemical/synthetic toxins); Factors affecting toxicity – species, strain, age, sex, nutritional, hormones, environmental, circadian rhythms.

1.3 Absorption and distribution of toxicants, portals of entry, translocation of xenobiotics; membrane barriers; Binding of xenobiotics to target molecules; Repair mechanism; Storage depots; Elimination of xenobiotics.

1.4 Biomagnification; Biotransformation of xenobiotics -Phase I & Phase II reactions.

1.5 Concepts of toxicokinetics; toxicodynmaics; toxicogenomics; toxicoproteomics; metabolonomics.

UNIT II – Free Radical Biology

15 Hrs

2.1 Free radical – generation, classification, Haber-wise reaction, Fenton reaction, lipid peroxidation- initiation, factors influencing LPO; key role of super oxide ion radical, H_2O_2, hydroxyl radicals and nitric oxides in toxicity of xenobiotics.

2.2 Oxidative stress: Definition, Toxicological consequences of oxidative stress, oxidative damage to biomolecules (Proteins, DNA, RNA & lipids.)

2.3 Oxidative defense mechanisms – Enzymatic:- role of glutathione, superoxide dismutase, peroxidase, calatase and Non enzymatic – metallothionin, α-tocopheral, selenium as antioxidants.

2.4 Effect of toxicant on oxidative phosphorylation - change in mitochondrial membrane permeability inhibition of ETS and NADH production.

2.5 Oxidative stress related disease: Carcinogenesis, types of carcinogens, mechanism of chemical carcinogenesis – inorganic, organic carcinogens; oncogenes; mechanism of necrotic and apoptotic cell death; Ames test, micronucleus test, salmonella test

UNIT III – Occupation toxicology

15 Hrs

3.1 Occupational hazards – physical, chemical, biological, mechanical, psychosocial hazards, ergonomics

3.2 Occupational diseases – pneumoconiosis silicosis, asbestosis, anthracosis, byssinosis; occupational cancer-skin, lung, bladder cancers; leukemia.

3.3 Toxicity of chemical warfare agents; cosmetic products; mycotoxins, and use of antidotes in poisoning.

3.4 Preventive toxicology – Bioremediation, toxic site reclamation, prevention of occupational diseases: Bio

markers in molecular epidemiology and toxicology.

3.5 Occupational health and hazards due to radiation, emission, particulate matter, gaseous, toxic chemicals, corrosives; Case-control studies and cohort studies – QSAR and toxicity.

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

1 Determination of LC_{50}/LD_{50} of selected toxicant using bioassay method on Paramecium/ Zebrafish/ Crustacea.
2 Effect of selected toxicant on phase I enzyme activity cytochrome P_{450} enzymatic assay in liver, Muscle, Kidney of mice.
3 Determination of LPO activity by TBRAS method in mice/fish.
4 Effect of toxicant on tissue glycogen in mice/fish by Anthrone Method.
5 Effect of toxicant on tissue glucose in mice/fish by Nelson-Somogyi Method.
6 Effect of toxicant on tissue amino acids in mice/fish Ninhydrin Method by Moore and Stein.
7 Effect of toxicant on total proteins in fish muscle/gills/liver by Folin's Method.
8 To study the effect of toxicant on haematological indices.
9 Study on nuclear aberrations in paramecium under pesticidal stress.
10 Estimation of SOD and Catalase activity in fish muscle exposed to toxicant.
11 Cytotoxicity test using Comet assay.
12 Effect of heavy metal toxicant on the behavior pattern of earthworm/*Daphnia*/*Lymnea*.
13 Effect of pesticide on the swimming behaviour/ciliary movement in Paramecium.
14 Conduct and writing a report on epidemiological survey due to occupational hazards event
15 **Submission of assignment on:** Dose effect and dose-response relationship; Oxidative stress; Occupational diseases – pneumoconiosis, silicosis, asbestosis; Detoxification Mechanisms /Biotransformation of xenobiotic; Drug metabolizing enzyme system (DMES), Biomagnification, antagonism, synergism. Xenobiotic induced intercellular and cellular alterations; ROS, RNS, Health effects of air pollution; marine pollution, ground water pollution; Biological radioactive pollutants and their impact on biomolecules; farmer's lung; Ames test, mechanism of oncogenes, activation by retroviruses **[To be submitted at the time of Examination – 6 Marks]**

Assignments

1. Theory Assignment will be three detailed essays on any one topic each from Units I, II & III. The theory assignment shall be submitted to the concerned teacher handling the course by the submission date decided by him/her.
2. Practical Assignment shall be submitted at the Semester end Practical Examination. The practical assignment shall be submitted to the concerned teacher handling the course by the submission date decided by him/her.

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 Patrica 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., Pvt. Ltd.
10 Encyclopedia of Toxicology – O P Jasra.

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Code Zoo_303

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

COURSE OUTCOME

By the end of this course, students will be able to:

- Understand the scope and significance of insects and their success in the ecosystem, including the classification of insects, arachnids, and medically important arthropods.
- Describe the morphology of insects, focusing on the exoskeleton and the structure of the head, thorax, and abdomen.
- Explain the physiology of insects, including their digestive, excretory, respiratory, circulatory, nervous, endocrine, and reproductive systems, as well as the processes of growth, development, and metamorphosis.
- Analyze the impact of climate change on insect distribution and its ecological consequences, including community ecology, interactions, factors influencing interactions, and their effects on community structure and species diversity.
- Explore insect behavior, including the factors influencing dispersal, mating, reproductive, and social behaviors.
- Investigate the biology and life cycles of medically important insects, ticks, and mites.
- Examine the biology and life cycles of pathogens and parasites.
- Understand the characteristics of venomous arthropods, including bees, wasps, ants, spiders, and scorpions, and their potential impact on human health.

UNIT I – Insects, their ecosystem and behaviour — 15hrs

1.1 Scope and Significance of Insects - Reasons for Insects success: Classification of Insects, Arachnids and other medically important Arthropods.
1.2 Insect Morphology: exoskeleton, head, thorax, and abdomen.
1.3 Insects Physiology: digestive system, excretory system, respiratory system, circulatory system, nervous system, endocrine system, and reproductive system, Insect growth, development and metamorphosis.
1.4 Impact of climate change on insect distribution and its ecological implications, Community ecology, including classes of interaction, factors influencing interactions, and their consequences on community structure and species diversity
1.5 Insect Behaviour – Factors affecting Dispersal Behaviour, Mating Behaviour, Reproductive and social Behaviour

UNIT II – Medically Important Insects, Ticks and Mites — 15hrs

2.1 Biology and life cycles of Culicidae: Anophelinae (*Anopheles*) and Culicinae (*Aedes* and *Culex*)
2.2 Biology and life cycles of Phlebotamidae (Sandflies) and Simuliidae (Blackfly)
2.3 Biology and life cycle of Glossinidae (Tsetse fly)
2.4 Biology and life cycle of Pulicidae (Fleas)
2.5 Biology and life cycle of Acari (Ticks and Mites)

UNIT III – Vector-borne Pathogens and Venomous Arthropods — 15hrs

3.1 Pathogenicity of Bacteria – *Yersinia pestis*, *Rickettsia* sp.
3.2 Pathogenicity of Arboviruses – *Flavivirus* (DENV, JEV, TBEV) and *Alphavirus* (CHIKV).
3.3 Pathogenicity of Protozoans – *Plasmodium*, *Leishmania* and *Trypanosoma*.
3.4 Pathogenicity of Helminthes – *Wuchereria bancrofti* and *Onchocerca volvulus*.
3.5 Venomous arthropods: Bees, Wasps, Ants, Spiders, Scorpions.

PRACTICALS

1 Insect collection and preservation of medically important insects.
2 Study essential aspects of insect morphology, including the exoskeleton, head, thorax, and abdomen.

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3 Collection and identification of medically important insects, ticks, mites - up to genus level.
4 Collection and identification of venomous arthropods - up to genus level.
5 Identification of different mosquito breeding habitats.
6 Investigate the various stages of insect development, including growth, development, and metamorphosis.
7 Preparation of permanent mounts of mosquito larval mouth parts and respiratory siphon.
8 Preparation of permanent mounts of Insect leg and antennae.
9 Preparation of permanent mounts of wings of mosquito.
10 Preparation of permanent mounts of adult mosquito mouthparts.
11 Dissection of Mosquito salivary glands and Reproductive system.
12 Study of species diversity indices: Simpson's index, Shannon-Weiner index.
13 Study of permanent slides/specimens - Plasmodium, Leishmania, Trypanosoma and Wuchereria.
14 Maintenance of Insect / venomous arthropod collection box. Note: (**Submission of Insect / venomous arthropod collection box is must during the practical examination)
15 **Submission of assignment on:** Draw a well labelled external morphology of *Anopheles* mosquito; Draw a well labelled external morphology of *Aedes* mosquito; Draw a well labelled external morphology of *Culex* mosquito; Draw a well labelled life cycle of *Anopheles* mosquito; Draw a well labelled life cycle of *Aedes* mosquito; Draw a well labelled life cycle of *Culex* mosquito; Draw a well labelled life cycle of Sandfly; Draw a well labelled life cycle of Blackfly; Draw a well labelled life cycle of Tsetse fly; Draw a well labelled life cycle of Flea; Draw a well labelled life cycle 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 – 6 Marks]**

Assignments

1. Theory Assignment will be three detailed essays on any one topic each from Units I, II & III. The theory assignment shall be submitted to the concerned teacher handling the course by the submission date decided by him/her.
2. Practical Assignment shall be submitted at the Semester end Practical Examination. The practical assignment shall be submitted to the concerned teacher handling the course by the submission date decided by him/her.

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]

COURSE OUTCOMES

By the end of this course, students will be able to:

- Classify and provide an overview of Monogenea, Aspidogastrea, Digenea, and Cestoda, with an understanding of their taxonomy and diversity.
- Describe the ultrastructure and functions of the tegument in trematodes and cestodes.
- Explain the anatomy and functions of the digestive system in these helminths, including feeding mechanisms.
- Understand the excretory system, specifically the paranephridial system and lymphatic system, in these parasitic organisms.
- Comprehend the nervous system and its mechanisms, including the functions of sense organs in trematodes and cestodes.
- Analyze the reproductive systems, eggshell formation, types of eggs, and larval morphology in these parasites.
- Investigate the ecology of trematode and cestode parasites in wild animals, emphasizing their life cycles.
- Explore the interactions between hosts and parasites, with an emphasis on the role of helminths as vectors of microbial infections.
- Describe the morphology, life cycles, pathogenicity, diagnosis, treatment, and control measures of major helminths.
- Examine the metabolic processes in adult helminths, including carbohydrate metabolism (glycolysis, CO_2 fixation, etc.), protein metabolism (amino acid catabolism, transamination), and lipid metabolism (fatty acid metabolism and β-oxidation).
- Discuss the immunity to Schistosomiasis and Fascioliasis, including immune evasion and molecular mimicry mechanisms.
- Understand the role of arthropods and molluscs in the spread of helminth diseases, including their significance in transmission dynamics.

UNIT I – Morphology, Anatomy and Classification — 15 Hrs

1.1 An overview and classification of Monogenea, Aspidogastrea, Digenea and Cestoda.
1.2 Ultrastructure and functions of the tegument – Trematodes, Cestodes.
1.3 Digestive system, feeding and mechanism of digestion.
1.4 Excretory system, paranephridial system and lymphatic system.
1.5 Nervous system and its mechanism; sense organs and its functions.

UNIT II – Reproduction, Ecology and Evolution — 15 Hrs

2.1 Reproductive system, eggshell formation, types of eggs, and morphology of larval forms.
2.2 General account of Trematode and Cestode parasites of wild animals with emphasis on their life cycles.
2.3 Host-parasite interactions and their significance; the role of helminths as vectors of microbial infection
2.4 Trematode and Cestode parasites of humans; Morphology, life cycle, pathogenicity, diagnosis, treatment, and control measures of *Clonorchis sinensis, Dactylogyrus* spp. and *Gyrodactylus* spp.
2.5 Life cycle and pathogenicity *of* Cestode parasites - *Moniezia* spp., *Dicrocoelium dendriucum* and *Echinococcus multilocularis*

UNIT III – Adult Metabolism, Anthelminthics — 15 Hrs

3.1 Carbohydrate metabolism - Glycolysis (FMP-pathway), $C0_2$ fixation, PK/PEPCK branch point, malate dismutation; role of TCA cycle, Electron Transport chain - oxidation.
3.2 Protein composition and metabolism; Amino acid catabolism, transamination.
3.3 Lipid composition and metabolism-fatty acid metabolism and the role of β oxidation.
3.4 Immunity to Schistosomiasis and Fascioliasis; evasion of immunity and molecular mimicry.
3.5 Role of Arthropods and Molluscs in spreading of helminth diseases.

PRACTICALS

1 Collection, fixation, and staining techniques of permanent whole-mount preparations and identification

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of Monogeneans(Host cultivated fish, poultry, sheep, goat, and cattle viscera).

2 Collection, fixation, and staining techniques of permanent whole-mount preparations and identification of Digeneans (Host cultivated fish, poultry, sheep, goat, and cattle viscera).

3 Collection, fixation, and staining techniques of permanent whole-mount preparations and identification of Aspidogastreans (Host cultivated fish, poultry, sheep, goat, and cattle viscera).

4 Collection, fixation, and staining techniques of permanent whole-mount preparations and identification of Cestode (Host cultivated fish, poultry, sheep, goat, and cattle viscera).

5 *Fasciola* smear preparation, staining and study for eggs & concentration.

6 Collection and examination of infective larvae from intermediate hosts, snails, microcrustaceans (*Cyclops, Gammarus*, fishes).

7 Effect of light, and temperature on the emergence of cercaria.

8 Estimation of total carbohydrates in helminth infected and normal tissue.

9 Estimation of total proteins in helminth infected and normal tissue.

10 Estimation of total lipids in helminth infected and normal tissue.

11 Estimation of glycogen levels in helminth infected and normal tissue

12 Measurement of infection: Prevalence, density, intensity and index of helminth parasites.

13 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 – 6 Marks]

Assignments

1. Theory Assignment will be three detailed essays on any one topic each from Units I, II & III. The theory assignment shall be submitted to the concerned teacher handling the course by the submission date decided by him/her.
2. Practical Assignment shall be submitted at the Semester end Practical Examination. The practical assignment shall be submitted to the concerned teacher handling the course by the submission date decided by him/her.

Suggested Books

1 Animal parasitology – J. D. Smyth (Cambridge Univ. Press., 1976).

2 Foundations of parasitology 6 ed. – L. S. Roberts & J. Janovy Jr (McGraw Hill Publ., 2000).

3 Parasitism – A. O. Bush, J.C. Fernandez & J. R. Seed (Cambridge Univ. Press, 2000).

4 Helminthology – Eds. N. Chaudhury & I. Tada (Narosa Publg. House, 1994).

5 Helminthes, Arthropods, & Protozoa of domesticated animals 6 ed. – EJL Soulsby (ELBS, 1976).

6 Introduction to parasitology – B.E. Matthews (Cambridge Univ. Press. 1998).

7 The physiology of Trematodes – JD. 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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Semester – III
Elective - I
Paper III – Comparative Animal Physiology - I [CAP-I]

COURSE OUTCOMES

By the end of this course, students will be able to:

- Understand the scope, principles, and significance of a comparative approach to physiology in studying digestion and respiration.
- Examine the origin of nutritive types, dietary requirements, and the role of amino acids and vitamins in different animals, including feed and feeding mechanisms.
- Compare the physiology of digestive enzymes and the carbohydrate pathways (glycolysis and gluconeogenesis) across different animal species, while understanding the neural and hormonal regulation of digestion.
- Analyze oxygen availability, uptake, and the factors influencing oxygen uptake in various animals, along with oxygen consumption by intact organisms. Also, study the comparative aspects of oxygen and carbon dioxide transport.
- Explore the presence of respiratory pigments in different phylogenetic groups and the genetic aspects related to hemoglobin, as well as the regulation of respiration.
- Investigate the challenges and solutions related to osmoregulation in different environments and among different animal groups.
- Understand the excretory organs and general mechanisms of excretion in various animal groups.
- Examine adaptations related to freezing, winter hardening, lethal limits, resistance, and thermoregulation in response to environmental conditions, including the neural mechanisms of thermoregulation.
- Analyze various metabolic disorders, including their causes, effects, and management, such as colonic bacterial flora, liver cirrhosis, pulmonary diseases (asthma, sleep apnea), electrolyte imbalances (acidosis, alkalosis), and conditions like heatstroke and thirst.

UNIT I – Comparative Aspects of Digestion and Respiration **15 Hrs**

1.1 Scope, principles and validity of comparative approach to physiology.
1.2 Origin of nutritive types - dietary requirements of some animals, amino acid and vitamins; feed and feeding mechanisms.
1.3 Comparative physiology of digestive enzymes, Comparative aspects of carbohydrate pathways - Glycolysis and gluconeogenesis regulatory mechanism of digestion – Neural and hormonal.
1.4 Oxygen availability, uptake and factors influencing uptake; Oxygen consumption by an intact animal, Comparative aspects of the transport of oxygen and carbon dioxide.
1.5 Respiratory pigments in different phylogenic groups, genes with reference to haemoglobin; regulation of respiration.

UNIT II – Osmoregulation, Excretion and Thermoregulation **15 Hrs**

2.1 Problem of osmoregulation and biological responses in different environments.
2.2 Comparative aspect of osmoregulation in different animal groups.
2.3 Excretory organs and general mechanisms of excretion in various animal groups.
2.4 Freezing, winter hardening, lethal limits and resistance adaptation; Behavioral and locomotory adaptations; Heat regulation - physical and chemical.
2.5 Temperature regulation in homeotherms; neural mechanism of thermoregulation.

UNIT III – Metabolic Disorders **15 Hrs**

3.1 Effects of colonic bacterial flora (beneficial and harmful effect); lactose intolerance, GERD.
3.2 Liver cirrhosis and its causative agents; fatty liver.
3.3 Chronic obstructive pulmonary disease – Asthma, sleep apnea, and snoring.
3.4 Electrolyte imbalance - Acidosis, alkalosis; Dialysis.
3.5 Heatstroke; thirst and its physiological mechanism.

PRACTICALS

1 Estimation of levels of lactic acid in tissues of *Labeo/Catla/Tilapia.*
2 Estimation of levels of free amino acids in tissues of *Labeo/Catla/Tilapia.*

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3 Effect of Heterosmotic media on blood chlorides in *Labeo/Catla/Tilapia.*
4 Effect of acclimatization to hetero osmotic media on SDH activity in *Labeo/Catla/Tilapia.*
5 Effect of acclimatization to hetero osmotic media on LDH activity in gills and muscle tissue of *Labeo/Catla/Tilapia.*
6 Effect of starvation on glycogen levels in *Labeo/Catla/Tilapia.*
7 Effect of starvation on free amino acids in the liver and muscles of *Labeo/Catla/Tilapia.*
8 Starvation induced changes in aminotransferases in *Labeo/Catla/Tilapia.*
9 Starvation induced changes in excretory products in *Labeo/Catla/Tilapia.*
10 Acclimatization to cold and high temperature in *Labeo/Catla/Tilapia* and its effect on oxygen consumption.
11 Effect of the thyroid and antithyroid agents on oxygen consumption in *Labeo/Catla/Tilapia.*
12 Estimation of enzyme – trypsin, amylase.
13 Estimation of Urea and Uric acid in *Labeo/Catla/Tilapia.*
14 Observation of decreasing PO_2 of water on lactic acid in muscle of *Labeo/Catla/Tilapia.*
15 Observation of decreasing PO_2 of water on respiratory rate of *Labeo/Catla/Tilapia.*
16 **Submission of assignment on:** Comparative aspects of carbohydrate pathways; Comparative aspects of metabolic pathways; Respiratory pigments in different phylogenic groups; Nitrogen excretion pattern as in different animal groups; Freezing; Winter hardening; GERD
[To be submitted at the time of Examination – 6 Marks]

Assignments

1. Theory Assignment will be three detailed essays on any one topic each from Units I, II & III. The theory assignment shall be submitted to the concerned teacher handling the course by the submission date decided by him/her.
2. Practical Assignment shall be submitted at the Semester end Practical Examination. The practical assignment shall be submitted to the concerned teacher handling the course by the submission date decided by him/her.

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]

COURSE OUTCOMES

By the end of this course, students will be able to:

- Trace the history of fisheries and comprehend the current state of the fisheries sector in India, including an awareness of fisheries institutes and their roles in enhancing fish production.
- Classify fisheries and assess their significance in the economic development of the nation, while understanding the diverse fisheries resources in India.
- Analyze the ecology of lentic and lotic ecosystems, and recognize the impact of aquatic pollution on fisheries.
- Evaluate water quality by considering physico-chemical parameters in different aquatic environments and understand the ideal conditions for fish culture.
- Explore the management of reservoir, riverine, and estuarine fisheries.
- Compare and contrast various culture systems, including open, closed, semi-intensive, and intensive culture systems, and assess their cost-benefit ratios.
- Investigate the concept of poultry-cum-fish culture and paddy/horticulture-cum-fish culture, analyzing their economic feasibility.
- Examine the opportunities and challenges associated with sewage-fed fish culture and understand the principles of composite fish culture and prawn-cum-fish culture.
- Identify the types of fishing crafts (non-mechanized and mechanized) and fishing gears, including their materials and accessories.
- Understand methods for preserving fish gears and maintaining fishing crafts.
- Explore fish biotechnology, including cryopreservation of gametes, fish genomics, chromosomal mapping, and the application of fish transgenics in therapeutics and vaccine development for fish diseases.

UNIT I – Fisheries and Ecology of Water Bodies — 15 Hrs

1.1 History of fisheries; Present scenario of the fisheries sector in India; Fisheries institutes in India and their role in the augmentation of fish production.

1.2 Classification of fisheries; Resources of fisheries in India; Role of fisheries in the economic development of the nation.

1.3 Ecology of lentic and lotic ecosystems; Aquatic pollution and its impact on fisheries.

1.4 Water quality: Physico-chemical parameters of freshwater, brackish water and marine; Ideal conditions of soil and water for fish culture.

1.5 Reservoir, riverine and estuarine fisheries and their management

UNIT II – Culture Systems — 15 Hrs

2.1 Culture systems: open, closed, semi-intensive and intensive culture systems.

2.2 Poultry-cum-fish culture; Analysis of cost-benefit ratio.

2.3 Paddy and Horticulture-cum-fish culture; Analysis of cost-benefit ratio.

2.4 Sewage-fed fish culture - Opportunities and challenges.

2.5 Composite fish culture; Prawn-cum-fish culture.

UNIT III – Fish Harvesting Technology and Fish Biotechnology — 15 Hrs

3.1 Types of Fishing Crafts: Non-mechanized and mechanized crafts.

3.2 Types Fishing Gears: Gear material, gear making, accessories.

3.3 Fish gear preservation methods and maintenance of crafts.

3.4 Cryopreservation of gametes; Fish genomics; Chromosomal mapping.

3.5 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 Soli analysis and its relation with Aquaculture – nitrogen, carbon, minerals.
3 Collection and identification of planktons.
4 Collection and identification of benthos.
5 Identification of Fishing gear models.
6 Identification of Fishing craft models.
7 Identification of important fish parasites.
8 Determination of food & feeding habits of fishes through Gonado-Somatic Index.
9 Determination of absolute and relative fecundity in fishes.
10 Use of limnological equipment: Secchi disc, Elman's grab, water sampling bottle, plankton net, Sedgwick-Rafter counting cell
11 Demonstration of fish breeding techniques.
12 Karyotyping of chromosomes in fishes.
13 Visit to major and minor reservoirs in Telangana for sample collection to determine water quality and submit report.
14 Visit to fish ponds, fish processing unit/fish seed farm/aquaculture farms and submit a report of your study.
15 **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 – 6 Marks]

Assignments

1. Theory Assignment will be three detailed essays on any one topic each from Units I, II & III. The theory assignment shall be submitted to the concerned teacher handling the course by the submission date decided by him/her.
2. Practical Assignment shall be submitted at the Semester end Practical Examination. The practical assignment shall be submitted to the concerned teacher handling the course by the submission date decided by him/her.

Suggested Books

1 Water quality criteria for freshwater fish. Albastor, J. S. and Lloyd, R. Buttorvorth 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. 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 – 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]

COURSE OUTCOMES

By the end of this course, students will be able to:

- Understand the scope and importance of Agricultural Entomology, and identify and classify phytophagous insects.
- Examine the external morphology of insects, including mouthparts, antennae, legs, wings, and genitalia, and comprehend insect development, growth, and metamorphosis.
- Analyze the relationship between insects and their environment, considering habitat and geographical distribution.
- Study the life history, hosts, nature of damage, and control measures for oilseed pests.
- Study the life history, hosts, nature of damage, and control measures for commercial crop pests.
- Study the life history, hosts, nature of damage, and control measures for vegetable and stored grains pests.
- Identify and study the major stored grain pests and minor stored grain pests.

UNIT I – Oilseed pest **15 Hrs**

1.1 Scope and importance of Agricultural Entomology; Insect – outline classification and emphasis on identification of phytophagous insects.

1.2 General Insect Plan - External Morphology, different types of mouthparts, antenna, legs, wings and external genitalia; Insect development: growth, development and metamorphosis.

1.3 Insects and their environment, habitat & geographical distribution.

1.4 Life history, hosts, nature of damage and control measures of oil seed pest: *Aphis craccivora, Stomopteryx nertaria, Agrotis segetum, Bemesia tabaci.*

1.5 Life history, hosts, nature of damage and control measures of oil seed pest: *Athalia lugens, Lipaphis erysimi, Asphondylia sesami, Eysarcoris ventralis, Dichocrocis punctiferalis, Euproctis lunata.*

UNIT II – Commercial crop pests **15 Hrs**

2.1 Life history, hosts, nature of damage and control measures of commercial crop pest: *Nilaparvata lugens, Nephotettix nigropictus.*

2.2 Life history, hosts, nature of damage and control measures of commercial crop pest: *Chrotogonus trachypterus, Atherigona naqvii.*

2.3 Life history, hosts, nature of damage and control measures of commercial crop pest: *Chilo partellus, Spodoptera frugiperda.*

2.4 Life history, hosts, nature of damage and control measures of commercial crop pest: *Sesamia inferens, Pyrilla perpusilla.*

2.5 Life history, hosts, nature of damage and control measures of commercial crop pest: *Helicoverpa armigera, Spodoptera litura.*

UNIT III – Vegetable & Stored Grains pests **15 Hrs**

3.1 Life history, hosts, nature of damage and control measures for: *Urentius sentis, Plusia orichalcea, Dysdercus koenigii, Plutella xylostella.*

3.2 Life history, hosts, nature of damage and control measures for: *Scirtothrips dorsalis, Euzophera perticella, Earias vittella.*

3.3 Life history, hosts, nature of damage and control measures for: *Tanymecus indicus, Exelastis atmosa, Amsacta moorei.*

3.4 Major Stored Grain Pests - Khapra beetle, Rice weevil, Rice moth, Pulse beetle.

3.5 Minor Stored Grain Pests - Lesser grain borer, Indian meal moth, Saw-toothed beetle.

PRACTICALS

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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 Study of morphological changes in larva nymph during and after moulting.
10 Study of orders of insects and their identification using taxonomic keys.
11 Estimation of insect haemocytes.
12 Visit to granaries and submit report.
13 Visit to pest control unit and submit report.
14 Case study of any one crop damage and control measures adopted and submit report.
15 **Submission of assignment on:** General body plan of a typical insect; types of phytophagous insect; mouthparts, antennae, legs, wings, external genitalia of phytophagous insects; Stored grain pests of paddy, wheat, sorghum, maize, and pulses.
[To be submitted at the time of Examination – 6 Marks]

Assignments

1. Theory Assignment will be three detailed essays on any one topic each from Units I, II & III. The theory assignment shall be submitted to the concerned teacher handling the course by the submission date decided by him/her.
2. Practical Assignment shall be submitted at the Semester end Practical Examination. The practical assignment shall be submitted to the concerned teacher handling the course by the submission date decided by him/her.

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

Code Zoo_304

Semester – III
Elective – II
Paper IV – Endocrinology [EN]

COURSE OUTCOMES

By the end of this course, students will be able to:

- Understand the scope and significance of endocrinology as a field of study and its relevance in physiological regulation.
- Comprehend the concept of neurohumors and neurotransmitters, and recognize the characteristics of neural and hormonal integration, including neuro-endocrine mechanisms.
- Explore hormones as chemical messengers and their regulation, with a focus on the concept of the internal environment and homeostasis.
- Examine the endocrine systems in invertebrates, including their hormones and functions in Cnidaria, Annelida, Arthropoda, and Echinodermata.
- Investigate the structure, hormones, and functions of vertebrate endocrine glands, including the pituitary, hypothalamus, thyroid, parathyroid, thymus, adrenal glands, pancreas, pineal gland, gastrointestinal tract, and gonads, with an understanding of feedback mechanisms.
- Classify hormones and understand the biosynthesis, release, and transport of amino acid derivatives, peptide hormones, and steroid hormones.
- Analyze the mechanisms of hormone action, including membrane-bound and intracellular receptors, for amino acid derivatives, peptide hormones, and steroid hormones.
- Explore the clinical and applied aspects of endocrinology, including its relevance in understanding obesity, metabolic complications, and the role of adipokines, insulin resistance, and dyslipidemia.
- Learn about the use of hormones in IVF, pregnancy testing, and amniocentesis, and delve into the pathophysiology of endocrine glands, clinical disorders of male and female gonads, pheromones.
- Application of endocrinology in Pisciculture, Sericulture, and Apiculture.

UNIT I – Endocrine systems

15Hrs

1.1 Scope of endocrinology.

1.2 Concept of neurohumors and neurotransmitters; Characteristics of neural and hormonal integration, neuro-endocrine mechanism.

1.3 Hormones as chemical messengers; Regulation of hormone secretions; Concept of internal environment and homeostasis.

1.4 Invertebrate endocrine system; Hormones and their functions (Cnidaria, Annelida, Arthropoda and Echinodermata).

1.5 Vertebrate endocrine glands – Structure, hormones and functions of pituitary, Hypothalamus, thyroid, parathyroid, thymus, adrenal, pancreas, pineal, gastro-intestinal tract and gonads; Feedback mechanisms.

UNIT II – Chemistry of Hormones and Mechanism of Hormone Action

15Hrs

2.1 Classification of hormones.

2.2 Biosynthesis of release and transport of amino acid derivatives.

2.3 Biosynthesis and transport of peptide and steroid hormones.

2.4 Membrane-bound and intracellular receptors.

2.5 Mechanism of action of amino acid derivatives, peptide and steroid hormones.

UNIT III - Clinical and Applied Endocrinology

15Hrs

3.1 Obesity – Role of hormones and its metabolic complications – The role of Adipokines Insulin Resistance and Dyslipidemia.

3.2 Hormones in IVF, Pregnancy testing, and Amniocentesis.

3.3 Pathophysiology of endocrine glands; Clinical disorders of male and female gonads.

3.4 Pheromones – Definition, types, and their functions.

3.5 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.
8 Paper chromatographic separation of corticoids
9 Estimation of adrenal ascorbic acid in mice/rat.
10 Estimation of cholesterol in mice/rat.
11 Hypophysectomy in fish.
12 Effect of epinephrine on blood glucose levels in rat/fish.
13 Effect of epinephrine on liver glycogen in rat/fish.
14 Effect of corticoids on liver glycogen deposition in rat.
15 **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 – 6 Marks]

Assignments

1. Theory Assignment will be three detailed essays on any one topic each from Units I, II & III. The theory assignment shall be submitted to the concerned teacher handling the course by the submission date decided by him/her.
2. Practical Assignment shall be submitted at the Semester end Practical Examination. The practical assignment shall be submitted to the concerned teacher handling the course by the submission date decided by him/her.

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 Clarendan 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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Code Zoo_304

Semester – III
Elective – II
Paper IV – Phytonematology [PN]

COURSE OUTCOMES

By the end of this course, students will be able to:

- Understand the importance and historical perspective of plant-parasitic nematodes, recognizing their significance in agriculture and the development of phytonematology in India.
- Describe the general characteristics of plant-parasitic nematodes and classify them up to the family level with representative examples.
- Master the techniques for collecting nematodes from various habitats, including soil, roots, shoots, leaves, seeds, and galls. Learn how to count, fix, stain, mount, perform micrometry, and calculate deMan's ratio.
- Explore the world of predatory nematodes and their roles in biological control measures.
- Examine the general morphology of plant-parasitic nematodes and understand their life cycles. Study the structure of the cuticle, cuticular modifications, body wall structure, and musculature.
- Investigate the digestive system of nematodes, including types of oesophageal modifications and associated digestive glands. Explore the diversity of stylets and feeding mechanisms, and understand the host-nematode parasite relationship.
- Recognize field symptoms caused by nematode infestations, both general and specific, including symptoms above ground and below ground. Understand the concept of nematode associations and the formation of disease complexes.
- Study the habits, habitats, life histories, and pathologies of specific nematodes.
- Learn about various nematode control measures, including physical methods like tilling, fallowing, sun drying, hot water treatment, and fumigation, as well as cultural practices such as crop rotation and trap crops.
- Assess the use of chemical and biological control methods for nematodes and their ecological consequences.
- Understand the concept of Integrated Nematode Management (INM) for sustainable nematode control.

UNIT I – Taxonomy and Collection Methods — 15 Hrs

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

UNIT II – Morphology of Phtyonematodes, Feeding, Symptoms and Pathology — 15 Hrs

2.1 General account of nematodes, morphology and pattern of life cycles.
2.2 Structure of cuticle, cuticular modifications, structure of body wall and musculature.
2.3 Digestive system –Types of oesophageal modifications and associated digestive glands.
2.4 Types of stylet and feeding mechanisms. Host and nematode parasite relationship
2.5 Field symptoms - General and specific (above ground and below ground). Nematode associations and formation of disease complexes.

UNIT III – Life Cycles and Nematode Control measures — 15 Hrs

3.1 Habit, habitat, life history and pathology of Rice nematode (*Hirschmaniella*) and Lance nematode (*Hoplolaimus*).
3.2 Habit, habitat, life history and pathology of Cyst nematode (*Heterodera*) and Root-knot nematode (*Meloidogyne*).
3.3 Physical methods – Tilling, fallowing, sun drying, hot water treatment, fumigation; Cultural practices - Crop rotation, trap crops.
3.4 Chemical control of nematodes and its consequences in the ecosystem; Biological control of nematodes and its field application.
3.5 Integrated Nematode Management (INM).

PRACTICALS

1 Collection of soil plant-parasitic nematodes by Baermann technique.
2 Collection of soil plant-parasitic nematodes by Pie-pan method or the Cobb sieving method .
3 Collection of soil plant-parasitic nematodes by Tray method.
4 Collection of plant-parasitic nematodes from plant parts – roots, stems (squeezing method).
5 Nematode counting and frequency calculations.
6 Nematode fixing, staining and mounting methods.
7 Application of deMan's ratio for identification of phytonematodes.
8 Rice root nematode collection from the rice fields to isolate and permanent preparation of *Hirschmaniella species.*
9 Lance nematode collection from the tomato and potato fields to isolate and permanent preparation of *Hoplolaimus species.*
10 Root knot nematode collection from the brinjal and tomato fields to isolate and permanent preparation of *Meloidogyne species.*
11 Cyst nematode collection from the brinjal and tomato fields to isolate and permanent preparation of *Heterodera species*
12 Identification of predominant plant-parasitic nematodes of Paddy and Groundnut crops.
13 Identification of predominant plant-parasitic nematodes of the Vegetables crops.
14 Visiting of Directorate of Rice Research Centre, Rajendernagar and submit report.
15 **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.
[To be submitted at the time of Examination – 6 Marks]

Assignments

1. Theory Assignment will be three detailed essays on any one topic each from Units I, II & III. The theory assignment shall be submitted to the concerned teacher handling the course by the submission date decided by him/her.
2. Practical Assignment shall be submitted at the Semester end Practical Examination. The practical assignment shall be submitted to the concerned teacher handling the course by the submission date decided by him/her.

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 Phytonematology – 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 Nematodes –Wallace H.R.
13 Plant nematology – Edited by Southy J.F.
14 Biological Control – Shamim Jairajpuri et al.
15 Plant Pathogens – Nematodes – R.S. Singh and J. Sita Ramaiah.
16 Phytonematology – Mrinal K. and Dasgupta.

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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.

M.Sc. Zoology

Semester – III **Code Zoo_304**

Elective – II

Paper IV – Sericulture [SER]

COURSE OUTCOMES

By the end of this course, students will be able to:

- Understand the cultivation of mulberry, including the varieties of mulberry and non-mulberry food plants.
- Gain knowledge of the agroclimatic conditions required for Moriculture and learn agricultural practices, harvesting techniques, and leaf preservation methods.
- Identify and manage diseases of mulberry, including bacterial, viral, and fungal diseases, as well as insect pests affecting mulberry plants.
- Analyze the external morphology of *Bombyx mori*, including the egg, larva, pupa, and adult stages.
- Distinguish between races of mulberry and non-mulberry silkworms.
- Explore the internal morphology of *Bombyx mori*, including the digestive, respiratory, nervous, excretory, and reproductive systems, as well as the morphology and anatomy of silk glands.
- Gain practical knowledge of silkworm rearing, including the setup of rearing houses and appliances, the required environmental conditions, and the rearing of both early and late stages of silkworms.
- Learn about the processes of mounting and harvesting silkworm cocoons and become familiar with common silkworm diseases and pests.
- Comprehend the techniques for cocoon harvesting, leaf-cocoon ratio, and the transportation of cocoons to cocoon markets.
- Evaluate the commercial characteristics of cocoons and learn about defective cocoons and price determination.
- Understand reeling technology for both mulberry and Vanya silk rearing.
- Explore seed technology, including grainage and DFLs.
- Learn about the by-products of sericulture, their types, and uses, as well as the properties and composition of silk.
- Recognize the role of biotechnology in sericulture and its applications in improving silk production and quality.

UNIT I – Moriculture and Morphology of *Bombyx mori* **15Hrs**

1.1 Mulberry cultivation - Varieties of mulberry and non-mulberry food plants; Agroclimatic conditions for Moriculture; Agricultural practices; Harvesting and Preservation of leaves; Sericulture as an agro-industry

1.2 Diseases of Mulberry and their management - Bacterial diseases, Viral diseases, Fungal diseases; Insect Pests of Mulberry and their management.

1.3 Mineral deficiency diseases and their management.

1.4 External morphology of *Bombyx mori* - Egg, larva, pupa & adult; Races of mulberry and non-mulberry silkworms.

1.5 Internal morphology of *Bombyx mori* - Digestive, respiratory, nervous, excretory and reproductive systems, Morphology and anatomy of silk glands.

UNIT II – Silkworm Rearing **15Hrs**

2.1 Rearing house and rearing appliances.

2.2 Environmental conditions for silkworm rearing.

2.3 Rearing of early stages (Chawki rearing) and late stages of silkworms.

2.4 Mounting and harvesting of silkworm cocoons.

2.5 Silkworm diseases and pests.

UNIT III – Harvesting Technology **15Hrs**

3.1 Cocoon harvesting; Leaf cocoon ratio; Transport of cocoons to cocoon markets.

3.2 Commercial characters of cocoons; Defective cocoons and price fixation.

3.3 Reeling technology – Mulberry and Vanya silk rearing.

3.4 Seed technology – Grainage & DFLs; By-Products - Types and uses; Properties and composition of silk.

3.5 Role of biotechnology in sericulture.

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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 system and nervous system in the larva.
9. Dissection of reproductive organs in the adult moths.
10. Calculation of Shell Ratio.
11. Diseases of silkworm.
12. Cultivation of mulberry plantation/row and pit system.
13. Visit to the Cocoon market and submission of a report.
14. Visit to the Reeling Centre and Grainage Units and submission of a report.
15. **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 – 6 Marks]

Assignments

1. Theory Assignment will be three detailed essays on any one topic each from Units I, II & III. The theory assignment shall be submitted to the concerned teacher handling the course by the submission date decided by him/her.
2. Practical Assignment shall be submitted at the Semester end Practical Examination. The practical assignment shall be submitted to the concerned teacher handling the course by the submission date decided by him/her.

Suggested Books

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

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M.Sc. Zoology Semester – III
Elective – II
Paper IV – Principles of Toxicology [PT]

COURSE OUTCOMES

By the end of this course, students will be able to:

- Define and understand the scope and significance of toxicology.
- Explain the classification of toxic agents and the concepts of dose, dose-effect, and dose-response relationships, including acute and chronic toxicity.
- Identify the factors that affect toxicity and describe the processes of absorption and distribution of toxicants.
- Recognize the different portals of entry for toxicants, including the skin, gastrointestinal tract, and respiratory system.
- Explain the concepts of bio-accumulation, bio-magnification, biotransformation, and elimination of xenobiotics in the body.
- Describe the mechanisms and reactions of toxicants, including covalent and non-covalent bonding, as well as enzymatic reactions.
- Understand the role of lipid peroxidation, Reactive Oxygen Species (ROS), and Reactive Nitrogen Species (RNS) in xenobiotic toxicity.
- Discuss oxidative stress, its consequences, and the damage it causes to proteins and DNA.
- Explore the antioxidant defense mechanisms, including the roles of glutathione, superoxide dismutase, and metallothionein.
- Examine the basics of organ toxicity, including hepatotoxicity, pulmonary toxicity, renal toxicity, and neurotoxicity.
- Understand the susceptibility of these organs to toxicants and the biochemical mechanisms involved in injury.
- Analyze the eco-toxicology of heavy metals, focusing on mechanisms of heavy metal toxicity and case studies of arsenic, mercury, and cadmium.
- Evaluate the environmental problems caused by organochlorine and organophosphate pesticides.
- Understand occupational hazards, including physical, chemical, biological, and mechanical hazards, and the prevention of occupational diseases.
- Explore carcinogenesis, including the types of carcinogens and mechanisms of carcinogenesis, with a focus on skin cancer, lung cancer, and leukemia.
- Understand legislation and regulation related to toxicology, including federal and state government regulations and international legislation and regulation in other countries.

15 Hrs

UNIT I – Principles and Biochemical toxicology

1.1 Definition, scope and importance of toxicology; classification of toxic agents; Dose, dose-effect and dose-response relationship – Acute toxicity, chronic toxicity.

1.2 Factors affecting toxicity ; Absorption and distribution of toxicants, portals of entry– Skin, gastrointestinal tract and respiratory system.

1.3 Bio-accumulation, bio-magnification, biotransformation and elimination of xenobiotics.

1.4 Mechanism and reactions of toxicants - Covalent bonding, non-covalent bonding and enzymatic reactions.

1.5 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.

15 Hrs

UNIT II – Systemic toxicology

2.1 Oxidative Stress – Consequences of oxidative stress; protein and DNA damage; Antioxidant defense mechanism – Role of glutathione, superoxide dismutase, metallothionine.

2.2 Basics of organ toxicity; Hepatotoxicity - susceptibility of the liver; Types of liver injury and biochemical mechanism.

2.3 Pulmonary toxicity – Lung injury, systematic lung toxins, lung pathology.

2.4 Renal toxicity – susceptibility of the kidney to toxicants; Chemical induced renal injury.

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

15 Hrs

UNIT III – Environmental and Occupational Toxicology

3.1 Eco-toxicology of heavy metals – Mechanism of heavy metal toxicity; Case studies of Arsenic, Mercury and Cadmium.

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3.2 Environmental problems by organochlorine and organophosphate pesticides; case studies of DDT, endosulfan, parathion and malathion.

3.3 Occupational hazards - physical, chemical, biological and mechanical hazards. Occupational diseases: Pneumoconiosis, silicosis, asbestosis; Prevention of occupational diseases.

3.4 Carcinogenesis – Carcinogen types, mechanisms of carcinogenesis; Skin cancer, lung cancer and leukaemia.

3.5 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)on gambusia fish/paramecium.
2 Determination of LPO activity by TBRAS method in tissue
3 Effect of toxicant on glycogen in mice/fish by Anthrone Method.
4 Effect of toxicant on glucose in mice/fish by Nelson-Somogyi Method.
5 Effect of toxicant on amino acids in mice/fish.
6 Hepato-toxicant effect on Total Bilirubin Content (direct and indirect method) in mice/fish.
7 Estimation of SGOT and SGPT as a marker enzyme for hepatotoxicity.
8 Estimation of serum creatinine activity as a marker enzyme for Renal toxicity in mice.
9 Micronuclei test.
10 Effect of toxicant on sperm morphology in mice.
11 Estimation of Hemoglobin and RBC in Lead exposed experimental animals.
12 Estimation of AchE activity as a marker of pesticide poisoning in model animals fish/mice.
13 Effect of selected toxicant on phase I enzyme activity cytochrome P_{450} enzymatic assay.
14 Effect of heavy metal toxicant on the behavior pattern of earthworm/Daphnia/Paramecium.
15 **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 – 6 Marks]

Assignments

1. Theory Assignment will be three detailed essays on any one topic each from Units I, II & III. The theory assignment shall be submitted to the concerned teacher handling the course by the submission date decided by him/her.
2. Practical Assignment shall be submitted at the Semester end Practical Examination. The practical assignment shall be submitted to the concerned teacher handling the course by the submission date decided by him/her.

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 Frantis, 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 Patrica 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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M.Sc. Zoology

Code Zoo_304

Semester – III
Elective – II
Paper IV – Zoonotic Diseases [ZD]

COURSE OUTCOMES

By the end of this course, students will be able to:

- Understand the concept of zoonoses and their classification.
- Analyze the factors influencing the prevalence of zoonotic diseases, including causes, signs, symptoms, and the importance of diseases of One Health significance.
- Describe the general concept of vectors and their role in the transmission of zoonotic diseases.
- Explore biology, importance, and control of vectors, as well as intermediate host arthropod diseases.
- Examine the characteristics, classification, morphology, life cycles, pathogenicity, symptoms, prognosis, diagnosis, prophylaxis, and treatment of protozoan zoonotic diseases.
- Investigate the aetiology, epidemiology, transmission, symptoms, prognosis, diagnosis, prophylaxis, and treatment of bacterial zoonotic diseases.
- Analyze the aetiology, epidemiology, transmission, symptoms, prognosis, diagnosis, prophylaxis, and treatment of rickettsial diseases and fungal zoonotic diseases.
- Explore zoonoses associated with meat, fish, and milk, and understand prevention and control measures, public health issues, and government policies related to zoonoses.
- Evaluate the challenges of controlling zoonotic diseases in India.
- Understand the concepts of viral classification and overview viral zoonotic diseases, including their pathogenicity and pathology.
- Analyze outbreaks and impacts of viral zoonoses.

UNIT I – Parasitic zoonoses **15 Hrs**

1.1 Introduction to zoonosis, classification – Zoonosis; factors influencing prevalence of zoonosis; (causes, signs, symptoms and importance of zoonotic and vector borne disease of ONE health significance

1.2 General concept of vector and mode of transmission of zoonotic disease biology, importance and control of vectors intermediate host arthropod diseases myasis, scabies, tick paralysis zoonosis as occupational hazard

1.3 General account, characteristics and classification, morphology life cycle, pathogenicity, symptoms, prognosis, diagnosis, prophylaxis and treatment of protozoan zoonotic diseases – Amebiasis, Trypanosomiasis, Leishmaniasis, Malaria, Giardiasis, Toxoplasmosis

1.4 General account, characteristics and classification, morphology life cycle, pathogenicity, symptoms, prognosis, diagnosis, prophylaxis and treatment of helminthic zoonotic diseases – Trichinosis, Echinococcosis, Fasciolosis, and Schistosomiasis

1.5 General account, characteristics and classification, morphology life cycle, pathogenicity, symptoms, prognosis, diagnosis, prophylaxis and treatment of helminthic zoonotic diseases –Clonorchiasis, Paragonimiasis, Filariasis, and Dracunculiasis

15 Hrs

UNIT II – Bacterial & fungal zoonoses

2.1 Genera account on aetiology, epidemiology, transmission, symptoms, prognosis, diagnosis, prophylaxis of bacterial zoonotic diseases – Leptospirosis, Gastritis (due to Helicobacter pylori), Borreliosis, Vibriosis, Tuberculosis.

2.2 Genera account on aetiology, epidemiology, transmission, symptoms, prognosis, diagnosis, prophylaxis of rickettsial diseases – Typhus (scrub and murine), Tick typhus, Relapsing fever.

2.3 Genera account on aetiology, epidemiology, transmission, symptoms, prognosis, diagnosis, prophylaxis of fungal zoonotic diseases – Aspergillosis, Candidiasis, Histoplasmosis, Blastomycosis, Coccidomycosis.

2.4 Zoonoses associated with meat, fish, and milk; Prevention and control measures, public health issues & government policies for zoonoses; Challenges to control in India.

2.5 Impact, analysis of zoonotic disaster and outbreaks of pandemics and epidemics like anthrax, plague, and brucellosis.

15 Hrs

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UNIT III – Viral zoonoses

3.1 Concepts of viral classification and overview of viral zoonotic diseases – Pathogenicity and pathology of Chikungunya, Japanese Encephalitis, Dengue, Yellow Fever, Rabies.

3.2 Pathogenicity, pathology of viral zoonotic diseases – Out breaks of KFD virus, Covid-19, SARS-CoV, Ebola virus, Swine flu (H5N1, H1N1, H7N7) and herpes virus.

3.3 Molecular diagnosis of zoonotic diseases – Modern Techniques: advantages and disadvantages; Diagnostic Techniques: Serological, molecular, electron microscopy, Next generation sequencing.

3.4 Immunization against viral disease; Challenges and future prospects of vaccine development; Approaches, formulation and delivery.

3.5 Emerging and re-emerging zoonotic diseases; Case studies of zoonotic disease in India: Covid-19, Plague, Swine flu.

PRACTICALS

1 Study of vertebrate vectors for transmission of zoonotic disease.
2 Isolation and identification of important bacterial zoonotic pathogens.
3 Identification of fungi in wet smears and stained smears of blood and urine.
4 Identification of protozoan parasites and stages prepare smears, staining and observation.
5 Identification of adult and larval helminths – preparation of temporary and permanent whole mount preparation.
6 Collection of medically important arthropod vector and intermediate host.
7 VDRL Test.
8 Study the haemological indices of normal/infected person.
9 ELISA antibody test for viral infection.
10 Perform dengue IgG/IgM Test by kit method.
11 Vaccination schedule.
12 Visit to Institute of Preventive Medicine and submit report.
13 Submission of project report on the outbreak of any three zoonotic diseases – case study.
14 **Submission of assignment on:** Factors influencing prevalence of zoonosis, malarial vaccination and recrudescence of malaria; *Brugia malayi*, clonorchasis, paragonimiasis, KFD, Dengue, Covid-19, SARS–CoV, MERS; viral pathogenesis; immune response to viruses, bacteria, and parasites; Next Generation Sequencing; Obstacles to viral immunization; Bioterrorism.

Assignments

1. Theory Assignment will be three detailed essays on any one topic each from Units I, II & III. The theory assignment shall be submitted to the concerned teacher handling the course by the submission date decided by him/her.
2. Practical Assignment shall be submitted at the Semester end Practical Examination. The practical assignment shall be submitted to the concerned teacher handling the course by the submission date decided by him/her.

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]

COURSE OUTCOMES

By the end of this course, students will be able to:

- Understand the fundamental concepts of bioremediation, including its definition, scope, principles, applications, types, and mechanisms.
- Explore the production of bioremediation metabolites and intermediates, growth kinetics of organisms, microenvironments, and biofilms.
- Analyze the various factors that affect bioremediation, including biological and environmental factors, as well as scientific, non-scientific, and regulatory factors.
- Learn about acclimatization, detoxification, transformation, degradation, metabolism, biostimulation, bioaugmentation, and the use of bioindicators and biomarkers.
- Examine different types of pollutants, their nature, bioavailability, and the methods used for bioremediation in various contexts, such as wastewater treatment, contaminated soil remediation, and addressing other common contaminants.
- Explore the techniques for detecting microbial communities and understanding biodiversity (alpha, beta, and gamma biodiversity).
- Learn about metagenomics and Next Generation Sequencing technologies for exploring the structure and function of microbial communities.
- Investigate the role of enzymes and metabolites in the degradation of pollutants.
- Understand in-situ and ex-situ bioremediation technologies, including bioventing, biospurging, and their applications in restoring freshwater bodies, groundwater, and addressing oil spills.
- Examine the practical aspects of bioremediation, including the commercialization of bioremediation technology and the use of various microorganisms (bacteria, fungi, zooplankton, crustaceans, chironomid larvae, and micro-invertebrates).
- Learn about biosensors, biosurfactants, electrokinetic remediation, and electron beam irradiation.
- Focus on the degradation and detoxification of metals through bioleaching, biomining, biosorption, and bioaccumulation from solid and liquid waste.
- Explore the biodegradation and biotransformation of xenobiotics, including pesticides, chlorinated and nitrated aromatic compounds, phenolic compounds, and polycyclic aromatic compounds.
- Understand the enzymes and metabolic pathways involved in the degradation of xenobiotic compounds.
- Learn about advanced techniques such as in silico analysis, metatranscriptomics, metaproteomics, and metabolomics in the context of bioremediation research and innovation.

UNIT I – General Concepts of Bioremediation — 15 Hrs

1.1 Introduction to bioremediation; Definition and scope; Principle, applications, types and mechanism of bioremediation

1.2 Production of bioremediation metabolites and intermediates; Growth kinetics of organisms; Microenvironments and biofilms.

1.3 Factors affecting bioremediation: Biological and environmental factors; Scientific, non-scientific and regulatory factors.

1.4 Acclimatization, detoxification, transformation, degradation and metabolism; Biostimulation and bioaugmentation; Bioindicators and biomarkers.

1.5 Pollutants – Nature and bioavailability; Emerging hazardous pollutants; Methods of treatment – Wastewater, contaminated soil, and other common contaminants.

UNIT II – *In situ* and *Ex-situ* Bioremediation Technology — 15 Hrs

2.1 Detection of the microbial community; Alpha, beta and gamma biodiversity.

2.2 Metagenomics – Next Generation Sequencing technologies to explore the structure and function of microbial communities.

2.3 Role of enzymes and metabolites in the degradation of pollutants; Bioventing and Biospurging; Restoration of freshwater water bodies, groundwater, and oil spills.

2.4 Bioremediation in practice – Commercialization of bioremediation technology; Use of microbes (bacteria, fungi, zooplankton, crustaceans, chironomid larvae, and micro invertebrates).

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2.5 Biosensors – Principle and mechanism; Application of biosurfactants; Electrokinetic remediation and Electron beam irradiation.

UNIT III – Degradation and Detoxification of Metals and Pesticides **15 Hrs**

3.1 Bioremediation of metals; Bioleaching, biomining, biosorption and bioaccumulation of metals from solid and liquid waste.

3.2 Biodegradation and biotransformation of xenobiotics including pesticides, chlorinated and nitrated aromatic compounds, phenolic compounds, polycyclic aromatic compounds.

3.3 Enzymes and metabolic pathways of degradation of xenobiotic compounds.

3.4 *In silico* analysis as a valuable tool; Metatranscriptomics, Metaproteomics, Metabolomics.

3.5 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 cultures.

5 Storage / Preservation of microorganisms. Microbial growth measurement, Standard plate count, Haemocytometry.

6 Measure of the bacterial population by turbidometry .

7 Studying the effect of temperature, pH, carbon and nitrogen on populations of microorganisms.

8 Separation of biomass – Wet and Dry mass.

9 Immobilization of cells and enzymes.

10 Isolation of bacterial Genomic DNA, quantification and quality analysis by gel electrophoresis.

11 Preparation and Incubation of microcosm from soil or water and data analysis.

12 Estimation of sludge volume index in activated sludge.

13 Removal of heavy metal by using bacteria/ciliates/crustaceans.

14 Filed Visit to any Waste Water Treatment Plant/ STP and Field Study Report.

15 **Submission of assignment on:** Biostimulation and bioaugmentation; Bioindicators and Biomarkers; Bioavailability of pollutants, metabolites and intermediates; Growth kinetics of organisms; Microenvironments and biofilms; Metagenomics, Phytoremediation, Bioventing and Biosparging; Commercialization of bioremediation technology; Biosensors, application of biosurfactants; Electrokinetic remediation and Electron beam irradiation; *In silico* analysis; Metatranscriptomics; Metaproteomics; Metabolomics.

[To be submitted at the time of Examination – 6 Marks]

Assignments

1. Theory Assignment will be three detailed essays on any one topic each from Units I, II & III. The theory assignment shall be submitted to the concerned teacher handling the course by the submission date decided by him/her.
2. Practical Assignment shall be submitted at the Semester end Practical Examination. The practical assignment shall be submitted to the concerned teacher handling the course by the submission date decided by him/her.

Suggested Books

1 Nicolas P Cherewsinott: Handbook of water and waste water Treatment Technology Boston Oxford Auckland Johannesburg Melbourne, New Delhi

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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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Semester – III
Elective – II
Paper IV – Wildlife Techniques [WT]

COURSE OUTCOMES

By the end of this course, students will be able to:

- Understand the concept of wildlife, its classic and contemporary definitions, and the various methods used in the study of different wildlife groups such as Ichthyology, Herpetology, Ornithology, and Mammalogy.
- Learn how to measure wildlife diversity, including species richness, alpha-diversity, beta-diversity, and the use of diversity indices.
- Explore the principles and aspects of conservation biology, its history, and the Protected Area Network in India.
- Understand community conservation efforts outside the Protected Area Network.
- Comprehend the causes, processes, and prevention of extinction, including the demographic and genetic problems associated with small populations.
- Learn about extinction vortex, risk prediction in small populations, and population viability analysis.
- Identify deterministic factors affecting wildlife populations, such as habitat loss, habitat fragmentation, introduced and invasive species, pollution, overharvest, and global climate change.
- Gain proficiency in survey design, including survey extent, experimental units, sample units, and sampling intensity.
- Learn about various census techniques and population estimation methods, including point counts, strip counts, drive counts, aerial photography, and plot-based methods.
- Explore advanced population estimation techniques, such as detection probability methods, removal methods, and the mark-resight method, along with their associated estimators.
- Understand the principles of conservation genetics, including molecular genetic techniques, taxonomy, and the conservation of genetic diversity.
- Learn about population genetics, molecular ecology, and their applications in wildlife conservation.

UNIT I – Wildlife

15Hrs

1.1 Wildlife: Definition (Classic and contemporary); Taxonomy & diversity; Study methods: Field, Museum & Systematic methods of Ichthyology, Herpetology, Ornithology, Mammalogy.

1.2 Measuring diversity: Species richness, α-Diversity, β-Diversity, diversity indices.

1.3 Conservation biology: History, principles & aspects of conservation biology; Protected Area Network in India; Community conservation outside Protected Area Network.

1.4 Extinction: Causes, process and prevention; Risk of extinction – Demographic problems, genetic problems, effective population size (genetic & demographic); Extinction vortex – Predicting risk in small population; Population viability analysis – Quantitative methods for analyzing viability.

1.5 Deterministic factors affecting wildlife: Habitat loss, habitat fragmentation, introduced and invasive species, pollution, overharvest, global climate change.

UNIT II – Estimating Abundance

15Hrs

2.1 Survey design: Survey extent, experimental units, sample units, survey design, sampling intensity.

2.2 Census techniques: Point counts, strip counts, drive counts, aerial photography, spot mapping, total mapping.

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 Method, 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 Genetics

15Hrs

3.1 Molecular genetic techniques: Nuclear vs mitochondrial genome, genetic variation, analysis of gene

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products and fragments, SNPs, genetic sampling.

3.2 Taxonomy: Species and subspecies identification, hybridization, evolutionary significant units (ESUs), Molecular Operational Taxonomic Units (MOTUs).

3.3 Conservation of genetic diversity: Mutation, gene flow, sex-specific dispersal, population structure and fragmentation, detecting bottlenecks and drifts.

3.4 Population genetics: Effective vs census population size, selection, genetic diversity & population viability

3.5 Molecular ecology: Dietary analysis, gender identification in mammals and birds.

PRACTICAL

1 Identification of major features of wildlife based on museum specimens.
2 Estimation of density of herpetofauna using the quadrate 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 one of the above-listed experiments.
11 Calculations of diversity indices – Simpson's, Shannon-Weiner, and Evenness.
12 *In silico* phylogenetic analysis of any one model animal using online tools.
13 Report writing on any one case study on conservation movement in India.
14 Preparation of ethograms – time activity budgets & social interaction matrices.
15 **Submission of assignment on:** Identification characters of five species of fishes, herpetofauna, birds, and mammals of Telangana; Species richness, α-Diversity, β-Diversity; Diversity indices; Strip counts and Point counts; Hahn method, King method & Hayne method; Removal methods (catch per unit effort & change in the ratio); Lincoln-Petersen estimator, Schnabel estimator, Schumacher–Eschmeyer estimator, Jolly–Seber estimator; Extinction – Causes, process and prevention; Population Viability Analysis; Habitat loss & fragmentation; Introduced and Invasive species; Global Climate Change; PA network in India; Conservation of genetic diversity; Molecular ecology.
[**To be submitted at the time of Examination – 6 Marks**]

Assignments

1. Theory Assignment will be three detailed essays on any one topic each from Units I, II & III. The theory assignment shall be submitted to the concerned teacher handling the course by the submission date decided by him/her.
2. Practical Assignment shall be submitted at the Semester end Practical Examination. The practical assignment shall be submitted to the concerned teacher handling the course by the submission date decided by him/her.

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.

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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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Semester – III
Elective – II
Paper IV – Cancer Biology and Therapeutics [CBT]

COURSE OUTCOMES

By the end of this course, students will be able to:

- Understand the fundamental concepts of cancer, including the growth characteristics of cancer cells, morphological properties, and nomenclature of neoplasms. Differentiate between benign and malignant tumors.
- Explore the mechanisms of carcinogenesis, including radiation and chemical carcinogenesis, the role of free radicals, and environmental carcinogens.
- Examine viral carcinogenesis and its association with DNA and RNA viruses.
- Comprehend the aberrant metabolism during cancer development, paraneoplastic syndromes, and epidemiology of specific cancers such as breast, cervical, oral, and lung cancers.
- Learn about growth factors in signal transduction and cell cycle regulation in cancer, including tumor suppressor genes.
- Investigate signaling mechanisms in cancer, including VEGF signaling and angiogenesis, epigenetic regulation through DNA methylation, epigenetic silencing of tumor suppressor genes, and apoptosis in cancer cells.
- Explore death signalling pathways, both mitochondrial and death receptor pathways.
- Gain knowledge of cancer diagnosis and therapeutics, including clinical examination, radiological examination, and the use of computational tools in cancer prediction.
- Understand the strategies of anticancer drug therapy, including chemotherapy, gene therapy, immunotherapy, and radiotherapy.
- Explore the role of interleukins and interferons in cancer treatment, their biological effects, mechanisms, and clinical applications.
- Learn about FDA-approved anti-cancer immunotherapeutic drugs, tumor-specific and tumor-associated antigens, as well as human leukocyte antigen (HLA).
- Understand emerging therapies such as stem cell and peptide therapies for cancer treatment and their potential in cancer therapeutics.

UNIT I – Overview of Cancers and Carcinogenesis — 15Hrs

1.1 Introduction: Growth characteristics of cancer cells; hyperplasia, dysplasia, anaplasia and neoplasia Morphological and ultrastructural properties of cancer cells; Nomenclature of neoplasms; benign and malignant tumours

1.2 Carcinogenesis – Radiation and chemical carcinogenesis; Free radicals, antioxidants in cancer; Environmental carcinogens.

1.3 Viral carcinogenesis – DNA and RNA Viruses and human cancers

1.4 Aberrant metabolism during cancer development; Paraneoplastic syndromes; Epidemiology of breast, cervical, oral, and lung cancers.

1.5 Growth factors in signal transduction; cell cycle regulation in cancers; Tumour suppressor genes and their mechanisms

UNIT II – Signaling Mechanisms — 15Hrs

2.1 VEGF signalling; angiogenesis.

2.2 Epigenetics – Role of DNA methylation in gene silencing.

2.3 Epigenetic silencing of tumour-suppressor genes.

2.4 Apoptosis in cancer cells; Role of caspases.

2.5 Death signalling pathways - Mitochondrial and death receptor pathways.

UNIT III – Diagnosis and Therapeutics — 15Hrs

3.1 Clinical examination: Blood tests, Biochemical tests and Biopsy; Radiological examination: X-rays, CT scan and MRI; Applications of computational tools in cancer prediction.

3.2 Strategies of anticancer drug therapy – Chemotherapy, gene therapy, immunotherapy, and radiotherapy.

3.3 Interleukins and Interferons: Biological effects of interferons; Oncologic applications of interferons; Interleukin-2: Biological effects, mechanism, and clinical application.

3.4 FDA approved anti-cancer immunotherapeutic drugs; Interferon-α2a; Interferon-α2b; Tumour-specific

Antigens (TSA); Tumour-associated Antigens (TAAs); Human Leukocyte Antigen (HLA).

3.5 Stem cell and Peptide therapies for cancer treatment.

PRACTICAL

1 Histological observation of cancer vs normal tissues using permanent slides.
2 Peripheral blood lymphocyte culture.
3 Cell 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.
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 Micronucleus test.
13 To study eye mutation in zebra fish.
14 Visit to the cancer hospital and submission of report.
15 **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 – 6 Marks]

Assignments

1. Theory Assignment will be three detailed essays on any one topic each from Units I, II & III. The theory assignment shall be submitted to the concerned teacher handling the course by the submission date decided by him/her.
2. Practical Assignment shall be submitted at the Semester end Practical Examination. The practical assignment shall be submitted to the concerned teacher handling the course by the submission date decided by him/her.

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, Momna Hejmadi, Ventus Publishers. Molecular Biology of Human Cancers, Wolfgang Arthur Schulz, Springer Science, Business Media, Inc.

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Semester - IV

M.Sc. Zoology

Code Zoo_401

Semester – IV
Core Paper
Paper I – Animal Biotechnology [ABT]

COURSE OUTCOMES

By the end of this course, students will be able to:

- Understand the fundamentals of biotechnology, its scope, importance, and various applications in the improvement of livestock herds and selective breeding of traits.
- Explore advanced reproductive technologies in animal breeding.
- Learn about superovulation and the applications of stem cells.
- Comprehend the principles of cell culture, including animal cell, tissue, organ, and embryo culture.
- Gain insights into the merits and demerits of cell culture, as well as sterile techniques and cell propagation.
- Learn in vitro cell culture techniques, disaggregation of tissues, primary, secondary, and suspension cultures, and the maintenance of mammalian cell lines.
- Understand the differences between primary and established cell line cultures.
- Explore the scaling-up of animal cell culture, cell synchronization, cell separation, cell cloning, micromanipulation, and cell transformation techniques.
- Gain knowledge about the cloning of mammals, including cloning from embryonic and adult cells.
- Understand the processes involved in creating transgenic animals, and their applications.
- Study the production of transgenic animals, and their utility as models for human diseases.
- Learn about large-scale culture and production from genetically engineered animal cell cultures, as well as downstream processing from recombinant microorganisms.
- Explore the applications of biotechnology in various fields, including medical biotechnology, environmental biotechnology, insecticide development, in aquaculture, and the use of animals as bioreactors.
- Understand the utility of knock-out and knock-in model systems and the CRISPR technology.

UNIT I – Biotechnology and Animal Improvement — 15Hrs

1.1 Introduction to biotechnology- scope, importance, and its applications; Role of Biotechnology in the improvement of livestock herds and breeding selected traits.

1.2 *In vitro* fertilization and embryo transfer; ICSI, sperm sexing; Cryopreservation, cryoprotection and gamete banking; Super ovulation; Stem cells – their applications.

1.3 Cell culture - Basic requirement of cell culture; Animal cell, tissue, organ, and embryo culture ; merits and demerits; Principle of sterile techniques and cell propagation.

1.4 *In vitro* cell culture techniques; disaggregating of tissue; Primary, secondary and suspension culture; cell lines; mammalian cell lines, characteristics and their maintenance; Primary and established cell line cultures.

1.5 Scaling-up of animal cell culture, cell synchronization, cell separation, cell cloning, micromanipulation, cell transformation.

UNIT II – Production of Recombinant Organisms and Transgenic Animals — 15Hrs

2.1 Cloning of mammals; cloning from embryonic cells and adult cells.

2.2 Transgenic animals; creation of transgenic mice, retroviral vector method, Microinjection, embryonic stem cell method – short gun, electroporation, lipofection, microinjection.

2.3 Production of transgenic animals – cattle, sheep, pigs and fish; transgenic animals as model for human disease or disorders.

2.4 Large scale culture and production from genetically engineered animal cell culture.

2.5 Large scale culture and production from recombinant microorganisms – Downstream processing.

UNIT III – Application of Biotechnology — 15Hrs

3.1 Medical biotechnology – Application of RFLP in forensic science, DNA finger printing, hybridoma

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technology and production monoclonal antibodies.

3.2 Environmental Biotechnology - Bioassay, biosensors in ecotoxicological screening; Bioleaching of metals by microorganisms; Bioabsorption of metals by bacteria.

3.3 Insecticide development – biopesticides; *Bacillus thuringiensis* – mode of action of toxin, toxin gene isolation and engineering of *B. thuringiensis.*

3.4 Biotechnology of aquaculture - sex reversal in fish and sterile fish culture.

3.5 Use of animals as bioreactors; Knock out and knock in model systems and their utility; CRISPR technology

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.

6 Antibiotic sensitivity test.

7 Yield estimation in fermentations products:
a) *Aspergillus niger*-citric acid; b) *Lactobacillus* – Lactic acid from curd; and
c) *Saccharomyces cervisiae* (Yeast) Alcohol

8 Microbial evaluation of stored foods from plant/animal origin for contaminants/toxins.

9 Detection of food borne pathogenic organism in vegetables, fruit using PCR

10 Demonstration of DNA finger printing for identification of animal species.

11 Isolation and detection of plasmid DNA from given bacterial strain / plasmid DNA by using mini preparation method and using UV spectrophotometer

12 Determination of viable cell count in the given culture of bacteria by dilution and spreading technique

13 Preparation of single cell suspension from chicken liver(primary culture)

14 Visit to Quality Control Labs and submission of report.

15 **Submission of assignment on:** Male and female reproductive system and gametogenesis; *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 *Bacillus thuringiensis*; Use of animals as bioreactors.
[To be submitted at the time of Examination – 6 Marks]

Assignments

1. Theory Assignment will be three detailed essays on any one topic each from Units I, II & III. The theory assignment shall be submitted to the concerned teacher handling the course by the submission date decided by him/her.
2. Practical Assignment shall be submitted at the Semester end Practical Examination. The practical assignment shall be submitted to the concerned teacher handling the course by the submission date decided by him/her.

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.

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5 Gene manipulation – Old & Primrose.
6 Biotechnology – S. Mitra.

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M.Sc. Zoology

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SEMESTER – IV
Core Paper
Paper – II: Applied Zoology

COURSE OUTCOMES

By the end of this course, students will be able to:

- Understand the scope and present status of aquaculture in India, including different types of fisheries (freshwater, marine, brackish water, and reservoir fisheries).
- Gain knowledge of induced breeding techniques, the design and management of hatcheries, and the importance of hatchery operations in aquaculture.
- Learn about fish diseases and control measures, as well as the by-products derived from fish processing.
- Explore vermiculture and earthworm rearing management, including the role of earthworms in waste management and soil fertility improvement for sustainable agriculture.
- Comprehend the scope and present status of apiculture, including the species of honey bees in India, their life cycle, colony organization, division of labor, and communication.
- Familiarize themselves with beekeeping as an agro-based industry, methods, equipment, and tools used in apiculture, and effective apiary management.
- Acquire knowledge about honey and wax extraction methods, processing, and uses, as well as bee venom, bee diseases, enemies, and their management.
- Gain insights into lac culture, its production in India, the life cycle of lac insects, lac cultivation practices, and the processing and uses of lac products.
- Understand poultry farming, including the classification of fowls (broilers and commercial layers), their rearing methods, breeding, and management of breeding stock.
- Learn about feed formulation for chicks, the nutritive value of eggs, meat management in modern poultry farms, and the control and management of poultry diseases.
- Explore animal husbandry, including the preservation of semen, artificial insemination of cattle, and the induction of early puberty and synchronization of estrus in cattle.
- Comprehend dairy farming, its advantages and disadvantages, integrated livestock farming, establishment management, cattle diseases, and the economic importance of livestock.

Unit I – Aquaculture and Vermiculture — 15Hrs

1.1 Aquaculture in India: An overview, scope and present status. Types of fisheries – freshwater, marine and brackish water, Reservoir fisheries.
1.2 Hatchery - Induced breeding; Techniques, design, construction, and management of hatcheries.
1.3 Fish diseases & control measures; by products of fishes.
1.4 Introduction to vermiculture earthworm rearing management.
1.5 Vermi technology and sustainable agriculture: Role of earth worms in waste management, soil fertility in land improvement.

Unit II – Apiculture and Lac culture — 15Hrs

2.1 Introduction, scope and present status of apiculture; species of honey bees in India, life cycle, colony organization division of labour & communication.
2.2 Bee keeping as on agro-based industry; Methods and equipment and other standard tools used in apiculture; Apiary management.
2.3 Methods of extraction of honey and wax, royal jelly (indigenous and modern); Processing and uses of honey and wax; Bee venom, bee diseases, and enemies, and their management.
2.4 History of lac and its applications; Lac production in India; life cycle, host plants and strains of lac insect.
2.5 Lac cultivation – Local practice, propagation of lac insect, inoculation period, harvesting of lac, lac composition processing , products, uses and their pests.

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Unit III – Poultry farming & Animal husbandry **15Hrs**

3.1 Classification of Fowls: Broilers and Commercial layers, their rearing methods, and breeding; Management of breeding stock; Processing of broiler and preservation of eggs.

3.2 Feed formulation for chicks; nutritive value of egg; Meat management in modern poultry farm.

3.3 Poultry diseases and their control & management; Progressive plans to promote poultry as a self-employment venture; Poultry diseases: Viral, Bacterial, Fungal, Protozoan.

3.4 Animal Husbandry - Introduction, preservation of semen, artificial insemination of cattle, induction of early puberty and synchronization of estrus in cattle.

3.5 Dairy farming: advantages & disadvantages of dairy farming; Integrated live stock farming, establishment management; cattle diseases; Economic importance of live stock.

PRACTICALS

1. Identification and study of important cultivable and edible fishes.
2. Identification and study of important cultivable and edible crustaceans.
3. Estimation of quality of milk from different dairy farm units – specific gravity, fat content, pH, viscosity.
4. Identification of purity of honey in different samples.
5. Study of morphology of honey bee and caste system.
6. Mounting of mouth parts, stinging apparatus of honey bee.
7. Study of structure of the honey comb.
8. Study of physico-chemical parameters of fresh water bodies.
9. Preparation of vermibeds and their maintenance.
10. Vermicompost characterization.
11. Estimation and comparison of protein and lipid content in poultry and country chicken using standard methods.
12. Setting up of an aquarium and maintenance.
13. Study of Common Freshwater Ornamental Fishes
14. Field visits to a vermiculture / sericulture / fisheries / apiculture / poultry / dairy farm and submission of visit report.
15. **Submission of assignment on:** Scope of vermiculture; types of earthworms; collection and preservation of earthworm advantages of vermin composting; diseases and pests of earthworm; nutritional status of vermicompost; Worm casts; Economic importance of vermiculture; Freshwater fishing gears & crafts; Management of hatcheries, nurseries, rearing ponds and stocking ponds; Maintenance of aquarium; Division of labour in honey bees; Pearl culture; Chemical composition of honey and its medicinal importance; Morphology of honey bees; Species and races of honey bees; Rearing of queen bee; Lac composition, processing, by-products and uses; Modern fish farming techniques – awaponics, RAS, biofloc, aqua scaping; Poultry as self-employment; Duck farming; Piggery development in India; Health management of live stock.

Assignments

1. Theory Assignment will be three detailed essays on any one topic each from Units I, II & III. The theory assignment shall be submitted to the concerned teacher handling the course by the submission date decided by him/her.
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Suggested Books

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1 Text Book Of Applied Zoology, Vermiculture, Apiculture, Sericulture, Lac-Culture, Agricultural Pests And Their Controls by P.V. Jabde

2 Applied And Economic Zoology by Shukla, G. S. and Upadhyay, V. B

3 Applied Zoology by Murlidhar Hyalij and Sanjay Kumbhar

4 Applied Zoology by Nagendra S. Pawar

5 Applied and Economic Zoology by A.K. Rathoure, D. Kumar, N.Z. Deshmukh and Rachna Goswami

6 Applied Entomology by Metcalf, C. L. and Luckmann, W. P.

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Semester – IV
Elective – III
Paper III – Neuroscience - II [NS-II]

COURSE OUTCOMES

By the end of this course, students will be able to:

- Understand the different types of sensory receptors and the basic mechanisms of sensory transduction, including the functioning of sensory circuits and pathways.
- Explore the neurobiology of chemoreception, including taste, smell, and somatic senses, and gain insights into the neurophysiology of hearing and vision.
- Comprehend the mechanisms of pain perception, both physiological and neurohumoral, and the sensory aspects of muscle function, including receptors, muscle spindles, and Golgi tendon organs (GTO).
- Investigate the processes involved in the development of the nervous system, including induction, patterning, and the generation and survival of nerve cells, with a focus on neurotrophic factors.
- Learn about axon guidance to their targets, synaptogenesis, developmental plasticity, and the formation of neural connections, along with their reactions to injury and the concepts of regeneration, reinnervation, and sprouting.
- Gain insights into neural specificity and the remodeling of neural circuitry, understanding how neural connections evolve and adapt.
- Explore the neurobiology of autonomic function and motor hierarchies, as well as the mechanisms of reflexes, reflex pathways, and the coordination of reflex actions.
- Understand the complex mechanisms underlying locomotion and movement and delve into the neurobiology of various neuronal disorders.

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, smell and somatic sense.
1.3 Neurophysiology of hearing & vision
1.4 Pain and its mechanism - Physiological and neurohumoral.
1.5 Muscle sense – receptors, muscle spindle and GTO.

UNIT II – Developmental Neurobiology **15Hrs**

2.1 Induction and patterning of nervous system.
2.2 Generation and survival of nerve cells, neurotrophic factors.
2.3 Guidance of axons to their targets, synaptogenesis and developmental plasticity.
2.4 Neural connection and their reactions to injury.
2.5 Regeneration, reinnervation, sprouting; neural specificity; Remodeling of neural circuitry.

UNIT III – Applied Neurobiology **15Hrs**

3.1 Neurobiology of Autonomic function; Motor hierarchies.
3.2 Reflex, reflex pathways and coordination of reflexes.
3.3 Mechanism of locomotion and movement.
3.4 Neuronal disorders – Parkinson's, Alzheimer's, psychosomatic disorders.
3.5 Behavioral disorders, drug abuse and dependence.

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

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

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7 Determination of conduction velocity in nerve.
8 Induction of stress and estimation of on glycogen, lactate, AChE and Na-K ATPase activities.
9 Experimental studies on atrophy, hypertrophy of muscles and nerve degeneration as well as regeneration.
10 Rotarod test for motor coordination.
11 Demonstration of patch clamp techniques
12 Testing learning and memory in mice by using Intellicage maze.
13 Functional physiology using biopac-EEG.
14 Behavioral assay using *C. elegans*/zebra fish/snail/earthworm.
15 Extraction of DNA/RNA from brain /neural cell cultures.
16 **Submission of assignment on:** Basic mechanism of sensory transduction – Molecular and physiological; Sensory circuit; Sensory pathway; Taste transduction; Smell; Vision; Pain – neurohumoral mechanism; 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 – 6 Marks]

Assignments

3. Theory Assignment will be three detailed essays on any one topic each from Units I, II & III. The theory assignment shall be submitted to the concerned teacher handling the course by the submission date decided by him/her.
4. Practical Assignment shall be submitted at the Semester end Practical Examination. The practical assignment shall be submitted to the concerned teacher handling the course by the submission date decided by him/her.

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 – Gorden 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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Semester – IV
Elective – III
Paper III: Medical Entomology - II [ME-II]

COURSE OUTCOMES

By the end of this course, students will be able to:

- Understand the scope and importance of Medical Entomology, recognizing the crucial role of organizations like WHO and CDC in preventing vector-borne diseases.
- Gain insights into national-level vector control programs, with a specific focus on the National Center for Vector-Borne Diseases Control (NCVBDC), and appreciate the significance of these programs in public health.
- Learn about personal protective measures against vectors, including insect-proof housing and shelters, insecticide-treated screening and curtains, impregnated protective clothing, and the use of Long-lasting Insecticidal Nets (LLINs) for disease prevention.
- Recognize the importance of community involvement in vector control, including community awareness campaigns and mass initiatives aimed at source reduction.
- Explore solid waste management and environmental modification techniques for preventing vector-breeding habitats, understanding their role in reducing disease transmission.
- Investigate bio-pesticides and growth regulators used in vector control, and the synthesis of plant-mediated silver nanoparticles.
- Examine innovative vector control strategies such as Sterile Insect Technology (SIT) and the use of Genetically Modified Organisms (GMOs).
- Comprehend the history of insecticide discovery, the classification of insecticides, and the mode of action of different classes of synthetic insecticides.
- Gain awareness of insecticide application methods, safety precautions, and the bioassay of insecticides, while also understanding the concept of pesticide resistance, its types, and underlying mechanisms.

Unit I – Vector Control Strategies

15 Hrs

1.1 Scope and importance of Medical Entomology, including the role of WHO and CDC in preventing vector-borne diseases.

1.2 Overview of national-level vector control programs, with a focus on the National Center for Vector-Borne Diseases Control (NCVBDC).

1.3 Personal protective measures; Insect-proof houses and shelters, insecticide-treated screening and curtains, impregnation of protective clothing and fabrics with insecticides, and Long-lasting Insecticidal Nets (LLINs).

1.4 Community awareness and mass campaign programs on source reduction, emphasis on the importance of community involvement.

1.5 Solid waste management and environmental modification and manipulation for preventing vector-breeding habitats.

UNIT II – Bio-pesticides and Growth Regulators

15Hrs

2.1 *Bacillus thuringiensis*, *Lagenidium giganteum*, and *Romanomermis iyengari* as vector control bio agents.

2.2 Plant extracts as potential mosquito larvicides.

2.3 Nanoparticles: Synthesis of plant-mediated silver nanoparticles for vector control.

2.4 Sterile Insect Technology (SIT).

2.5 Genetically Modified Organisms (GMO); Releasing of Insects carrying a Dominant Lethal gene (RIDL).

UNIT III – Chemical Control and Insecticide Resistance

15Hrs

3.1 History of insecticide discovery, classification of Insecticides.

3.2 Synthetic insecticides and their mode of action: Organochlorides, Organophosphates, and Carbamates.

3.3 Pyrethrins and Pyrethroids, classification of pyrethroids and mode of action.

3.4 Pesticide application methods and safety precautions.

3.5 Insecticide bioassay, Pesticide resistance - types and mechanisms

PRACTICALS

1 Collection of Indoor/Outdoor Resting Mosquitoes and Voucher Specimen Preparation, and assessment of Mosquito Larval Density in Breeding Habitats.
2 Estimation of Mosquito Man-Hour Density.
3 Estimation of the Gonotrophic Cycle Duration.
4 Determination of Larval Susceptibility to Different Insecticides.
5 Extraction of Plant Materials for Vector Control.
6 Analysis of Secondary Metabolites in Plant Extracts.
7 Synthesis of Silver Nanoparticles and Their Efficacy as Larvicides.
8 Assessment of Repellent Activity of natural and commercially available products.
9 Field Application of Bio-Pesticides (*Bacillus thuringiensis*) (*Vecto-Bac*).
10 Insecticide Bioassays for Susceptibility and Resistance.
11 Community Awareness Programs and Impact Assessment.
12 Surveillance and Report Writing on Mosquito Breeding Habitats.
13 Submission of report on various control strategies.
14 Field study techniques and strategies related to environmental modification and manipulation in vector control.
15 **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 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 – 6 Marks]

Assignments

1. Theory Assignment will be three detailed essays on any one topic each from Units I, II & III. The theory assignment shall be submitted to the concerned teacher handling the course by the submission date decided by him/her.
2. Practical Assignment shall be submitted at the Semester end Practical Examination. The practical assignment shall be submitted to the concerned teacher handling the course by the submission date decided by him/her.

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).

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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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Code Zoo_403

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

COURSE OUTCOMES

By the end of this course, students will be able to:

- Understand the fundamentals of organ toxicity, including the concept of target organs, organ selectivity, and specificity, enabling them to identify and analyze toxic effects on specific organs.
- Comprehend pulmonary toxicity, its underlying mechanisms of lung injury, and recognize agents that can cause lung injury. Gain knowledge of various lung pathologies associated with toxicity.
- Explore hepatotoxicity, focusing on the mechanisms of liver injury related to substances like carbon tetrachloride and acetaminophen.
- Distinguish between different types of liver injuries and their implications.
- Examine renal toxicity, with a specific focus on nephrotoxins such as heavy metals and halogenated carbons.
- Understand the mechanisms of renal injury and the development of nephropathy.
- Analyze neurotoxicity, including the effects of various neurotoxins on the nervous system.
- Learn about specific toxic neuropathies caused by substances like methyl mercury, carbon disulphide, lead, nicotine, cocaine, and amphetamines.
- Investigate environmental toxicology, including the entry, fate, and movement of pollutants in ecosystems.
- Understand the scientific approach to ecotoxicology and delve into the mechanisms of heavy metal toxicity, considering factors like metallothionein, Heat Shock Proteins, and lipid peroxidation.
- Learn about the toxicity of organic solvents and dyes and gain insights into their effects on health and the environment.
- Gain knowledge of regulatory toxicology, risk assessment for industrial chemicals, and concepts of industrial hygiene.
- Understand the Environmental Impact Assessment (EIA) methodology, prediction, and assessment, along with its implications for the environment.
- Explore international regulatory agencies and guidelines, including FDA, EPA, WHO, IARC, OSHA, and UNEP.
- Analyze the issues and challenges related to environmental protection and sustainable development.

UNIT I – Organ Toxicity — 15 Hrs

1.1 Basics of organ toxicity - Target organs, organ selectivity and specificity.

1.2 Pulmonary toxicity: Mechanism of lung injury, agents causing lung injury and lung pathology.

1.3 Hepatotoxicity: Mechanism of liver injury pertaining to carbon tetrachloride and acetaminophen, types of liver injury.

1.4 Renal toxicity: Nephrotoxins - heavy metals, halogenated carbons, therapeutic agents; Mechanism of renal injury: Nephropathy.

1.5 Neurotoxicity: Neurotoxins; neuropathy by methyl mercury; axonopathy by carbon disulphide, myelonopathy by lead; Ion channel neurotoxicity by nicotine, cocaine and amphetamines; Lesions of specific neurons.

UNIT II – Environmental toxicology — 15 Hrs

2.1 Ecotoxicological episode, entry, fate, movement of pollutants in ecosystem, scientific approach to ecotoxicology.

2.2 Eco-toxicology of heavy metals: Mechanism of heavy metal toxicity, induction of metallothionein, Heat Shock Proteins, Haemoporphyrin metabolism, lipid peroxidation, metal protein interaction, metal nucleic and metal ligand interactions.

2.3 Case studies of heavy metal – arsenic, mercury cadmium and lead.

2.4 Environmental problems by organochlorine pesticides and organophosphate pesticides and carbamates (Mode of action); case studies of DDT, endosulfan, benzene hexa chloride parathion and malathion.

2.5 Toxicity of organic solvents and dyes: Carbon tetrachloride, chloroform, benzene, toluene, alcohols, food additives, azodyes, and fluorescent dyes.

UNIT III – Regulatory toxicology — 15 Hrs

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3.1 Risk assessment for industrial chemicals and concepts of Industrial hygiene
3.2 Overview of EIA, its methodology, prediction and assessment; Impact on environment.
3.3 Toxicology - Legislation and Regulation: In India and in other countries; Environmental Regulatory agencies: FDA, EPA, WHO, IARC, OSHA, UNEP; Environmental protection: Issues and problems, sustainable development
3.4 Industrial SOPs and GLPs guide lines of OCED and CPCSEA in animal care and maintenance.
3.5 Regulatory toxicology: Regulation of industrial chemicals, pesticides, food additives; biological monitoring of environmental pollutants.

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

1 Hepato-toxicant effect on Total Bilirubin Content (direct and indirect method) in mice/rat
2 Estimation of SGOT and SGPT as a marker enzyme for hepatotoxicity in mice
3 Estimation of serum creatinine activity as a marker enzyme for Renal toxicity in mice
4 Effect of toxicant on heartbeat of Daphnia.
5 Cytotoxicity determination by MTT, LDH and neutral red uptake assay
6 Determination of heavy metals from waste water/ sludge/ sewage/polluted water by spectrophotometric methods.
7 Water analysis for detecting the pesticides by TLC
8 Study of phagocytosis in paramecium on exposure to pesticides.
9 Removal of heavy metal by Zeolite/activated carbon by adsorption
10 To determine the rate of oxygen consumption in fish pre exposed to a metal for 24hrs
11 Effect of temperature on the ciliary activity in the normal and pesticide/metal exposed *Paramecium/Oxytricha/Vorticella*.
12 To study the effect of toxicant on enzyme on Ach & AcHE enzymes in mice.
13 Toxicant sensitivity testing on *Drosophila*
14 Visit to pollution control board/waste water treatment plant/ waste dumping yards or quality control labs and submission of the visit report.
15 **Submission of assignment on:** Dose effect and dose-response relationship; Oxidative stress; Effect of toxic agents on neurons, lesions of neural tissue; Occupational disease – pneumoconiosis, silicosis, asbestosis; Legislation & Regulation involved in environmental toxicology; Detoxification Mechanisms /Biotransformation of xenobiotic; Drug metabolizing enzyme system (DMES), Biomagnification, antagonism, synergism; Xenobiotic-induced cellular alterations; Health effects of air pollution; Ground water pollution; Biological radioactive pollutants and their impact on biomolecules; Ames test mechanism of oncogene activation by retroviruses; Effect of toxic agents on neurons; Lesions of neural tissue; Legislation and regulation involved in environmental toxicology; Cardiotoxins, cardiotoxicity; Endocrine toxins and their general mechanisms; Kyoto Protocol 1997; UN Convention to Combat Desertification 1994; Biomonitoring, BHC poisoning; Handiagodu syndrome meal – ligand metal protein, metal ion interaction; Lipid peroxidation
[To be submitted at the time of Examination – 6 Marks]

Assignments

1. Theory Assignment will be three detailed essays on any one topic each from Units I, II & III. The theory assignment shall be submitted to the concerned teacher handling the course by the submission date decided by him/her.
2. Practical Assignment shall be submitted at the Semester end Practical Examination. The practical assignment shall be submitted to the concerned teacher handling the course by the submission date decided by him/her.

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 Patrica 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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M.Sc. Zoology

Code Zoo_403

Semester – IV
Elective – III
Paper III – Parasitology - II [PS-II]

COURSE OUTCOMES

By the end of this course, students will be able to:

- Understand the general characteristics, historical significance, scope, and importance of nematodes in various ecosystems.
- Identify and classify nematodes up to the family level, using examples to illustrate the diversity within this group of organisms.
- Examine the functional anatomy of nematodes, including the structure of the cuticle, cuticular modifications, body wall, musculature, and pseudocoelom, allowing for a detailed understanding of their morphology.
- Explore the digestive system of nematodes with a focus on oesophageal modifications and associated glands, providing insights into their feeding mechanisms.
- Investigate the excretory system, nervous system, and sense organs of nematodes, shedding light on their sensory and physiological processes.
- Analyze the reproductive system of nematodes, including the types of eggs produced and their embryology and development.
- Examine the life cycles, pathology, epidemiology, treatment options, and geographical distributions of gastrointestinal nematodes and tissue nematodes.
- Understand specific conditions and diseases caused by nematode parasites, such as visceral larva migrans, dermatitis, and pulmonary bronchitis, along with their diagnosis and control measures.
- Explore the origin and evolution of animal nematode parasites, emphasizing host-parasite interactions in various ecosystems.
- Study medical acanthocephalans, focusing on their general characteristics, morphology, life cycles, clinical symptoms, pathogenicity, diagnosis, prophylaxis, and treatment.
- Gain knowledge of the metabolic pathways in helminth parasites, including carbohydrate, protein, and lipid metabolism.
- Understand enzyme secretions, anthelminthic drug action, and the concept of drug resistance.
- Explore the prospects and applications of biotechnology and nanotechnology in parasitology, highlighting their potential contributions to research and treatment.
- Recognize the importance of biosafety, precautions, bioethics, and ethical principles in parasitology research and practice.

15Hrs

UNIT I – General Account, Taxonomy and Morphology of Nematodes

1.1 General characteristics, history, scope and significance of nematodes.
1.2 Classification of nematodes up to family level with examples.
1.3 Functional anatomy – Structure of cuticle and cuticular modifications, Body wall, musculature and pseudocoelom.
1.4 Digestive system with special reference to oesophageal modifications and associated glands.
1.5 Excretory system, nervous system and sense organs of nematodes.

15Hrs

UNIT II – Cestodes and Nematodes (Morphology, life cycles and pathology)

2.1 Reproductive system, types of eggs, embryology and development.
2.2 Life cycles, pathology, epidemiology, treatment and geographical distributions of the gastrointestinal nematodes: i) *Strongyloides stercoralis*, ii) *Ancylostoma duodenale*, iii) *Dracunculus medinensis*
2.3 Life cycles, pathology, epidemiology, treatment and geographical distributions of the tissue nematodes: i) *Wuchereria bancrofti, ii) Brugia malayi* and iii) *Trichinella spiralis*
2.4 Visceral larva migrans; Dermatitis and pulmonary bronchitis: diagnosis and control measure.
2.5 Origin and evolution of animal nematode parasites; Host–parasite interactions.

15Hrs

UNIT III – Acanthocephala and Metabolic Pathways in Parasites

3.1 Medical Acanthocephalans - General account, morphology, life cycle, clinical symptom, pathogenicity, diagnosis, prophylaxis and treatment of the diseases caused by *Macracanthorhynchus hirudinaceous* and *Moniliformis*.
3.2 Metabolic pathways of helminth parasites: Carbohydrates, proteins, and lipids.
3.3 Enzyme secretions and activity; Anthelminthic drug action and drug resistance.

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3.4 Biotechnology and Nanotechnology in parasitology – prospects and its applications.
3.5 Biosafety and precautions; Bioethics and principles in parasitology.

PRACTICALS

1 Collection, fixation, preparation of permanent slides and identification of nematode parasites from cockroaches.
2 Collection, fixation, preparation of permanent slides and identification of nematode parasites from chicken viscera.
3 Collection, fixation, preparation of permanent slides and identification of nematode parasites from sheep viscera.
4 Collection, fixation, preparation of permanent slides and identification of nematode parasites from goat viscera.
5 Collection, fixation, preparation of permanent slides and identification of nematode parasites from carp fish.
6 Collection, fixation, preparation of permanent slides and identification of nematode parasites from catfishes.
7 To study the general morphology and differences between female and male nematode parasites and *Acanthocephala* spp.
8 Identification of nematode eggs and larval stages.
9 Blood smear preparation for the identification of *Wuchereria* spp. / *Plasmodium* spp.
10 Qualitative and quantitative estimation of carbohydrates in normal, infected tissues and parasites.
11 Qualitative and quantitative estimation of proteins in normal, infected tissues and parasites.
12 Qualitative and quantitative estimation of lipids in normal, infected tissues and parasites.
13 Ecology of parasites and biostatistical calculations of incidence, intensity, density and index of infection of nematode parasites.
14 Fields studies and observations – visiting of slaughter houses in and around Hyderabad and submit report.
15 **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; Anthelminthic drug action and resistance.
[To be submitted at the time of Examination – 6 Marks]

Assignments

1. Theory Assignment will be three detailed essays on any one topic each from Units I, II & III. The theory assignment shall be submitted to the concerned teacher handling the course by the submission date decided by him/her.
2. Practical Assignment shall be submitted at the Semester end Practical Examination. The practical assignment shall be submitted to the concerned teacher handling the course by the submission date decided by him/her.

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.

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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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M.Sc. Zoology

Code Zoo_403

Semester – IV
Elective – III
Paper III – Comparative Animal Physiology - II [CAP-II]

COURSE OUTCOMES

By the end of this course, students will be able to:

- Understand the general characteristics of receptors, receptor potentials, and sensory coding, and their significance in animal physiology.
- Compare the central nervous systems of insects and vertebrates, highlighting similarities and differences.
- Explain the concept of integration for effective behavior, including spinal reflexes, learning, memory, and their genetic basis.
- Analyze adaptations in organ systems for sensory reception, covering chemo-, thermo-, mechano-, and electro-receptors.
- Investigate the influence of environmental factors on chromatophore systems and understand biological rhythms, including circadian, circumlunar, and circannual rhythms.
- Examine the mechanisms of target tissue activation and secretion in gland effectors, along with the types of muscle fibers (slow, fast, and asynchronous) and the chemistry of muscle fiber contraction.
- Explore accessory movements, such as skeletal levers and elastic movements, as well as various effector mechanisms for movement, including cyclosis, amoeboid, ciliary, flagellar movements, and their control.
- Study stress biology and related disorders, gaining insights into the physiological responses of animals to stressors.
- Classify major types of body fluids, understand fluid compartments, and examine the regulation of circulatory systems in vertebrates.
- Investigate the types of vertebrate hearts, heart rate regulation, cardiac output, and the chemical and nervous control of heart rate.
- Analyze the characteristics of invertebrate hearts in annelids, scorpions, insects, crustaceans, mollusks, and tunicates.
- Understand the concepts of r-selected and k-selected reproductive patterns, timing with respect to environmental variables, and the role of photoperiods in reproduction.
- Examine the role of hormones in development and their control of insect growth and reproduction, as well as the mechanisms governing sexual behavior, pregnancy, and parental care in vertebrates.

UNIT I – Responses & Adaptations of Animals to Environment — 15Hrs

1.1 General receptor characteristics, receptor potentials and sensory coding.
1.2 Central nervous system – Insect to vertebrate comparison.
1.3 Integration for effective behavior - spinal reflex; Learning and memory and its genetic basis.
1.4 Adaptations in organ systems for reception: Chemo-, thermo-, mechano-, and electro- receptors.
1.5 Influence of environmental factors on chromatophore systems. Biological rhythms circadian - circumlunar and circannual rhythm.

UNIT II – Physiology of Movements and Stress Biology — 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; Mechanism and chemistry of muscle fiber contraction.
2.3 Accessory movements – skeletal levers, elastic movements.
2.4 Effectors for movement – Cyclosis, amoeboid, ciliary, flagellar movements, and control of movement.
2.5 Stress biology and related disorders.

UNIT III – Circulation & Control of Reproduction — 15Hrs

3.1 Major types of body fluids – fluid compartments; classification and regulation of vertebrates circulatory systems.
3.2 Types of vertebrate hearts; Heart rate, regulation and cardiac output; Chemical and nervous control of heart rate.
3.3 Invertebrate hearts – annelids, scorpion, insect, crustacean, molluscan, and tunicate hearts.
3.4 *r* -selected and *k*- selected reproductive patterns; timing with respect to environmental variables; photoperiods.
3.5 Hormones & developments; hormonal control of insect growth and reproduction; Sexual behavior,

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pregnancy, and parental care in vertebrates.

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

1 Maze behaviour studies in rat.
2 Metabolic distinction of slow and fast muscles in mice.
3 Kymographic studies of muscle properties in mice.
4 Effect of temperature on heart beat of prawn.
5 Effect of AchE and adrenaline on heartbeat in prawn.
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 prawn, and their comparison.
9 Dissection of male and female reproductive systems of cockroach and prawn, and their comparison.
10 Effect of drugs/hormones on contraction of smooth muscle in mice.
11 Concentration/dispersal of pigment in isolated scales of dark/light adapted fish.
12 To determine the median threshold concentration of sucrose for housefly population.
13 To examine the relative activity of enzymes in fore, mid & hindgut of a typical insect/cockroach and correlate the enzyme activity with gut regions.
14 To study orientation responses of larvae/earth worm to visual stimuli.
15 **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 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 – 6 Marks]

Assignments

3. Theory Assignment will be three detailed essays on any one topic each from Units I, II & III. The theory assignment shall be submitted to the concerned teacher handling the course by the submission date decided by him/her.
4. Practical Assignment shall be submitted at the Semester end Practical Examination. The practical assignment shall be submitted to the concerned teacher handling the course by the submission date decided by him/her.

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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M.Sc. Zoology

Code Zoo_403

Semester – IV
Elective – III
Paper III – Principles of Fisheries [PF-II]

COURSE OUTCOMES

By the end of this course, students will be able to:

- Define fisheries and discuss its historical development, present status, and potential future prospects.
- Identify the criteria for selecting fish species suitable for aquaculture and understand the importance of species selection in fisheries.
- Explain advanced techniques in seed production, including induced breeding methods for fishes and prawns.
- Describe the types of hatcheries used in aquaculture, their construction, management, and methods for seed transportation.
- Analyze the structures and functions of fishermen cooperative societies in the context of fisheries management.
- Understand the biology of major cultivable fishes, prawns, and crabs, including Indian major carps, exotic major carps, air-breathing fishes, and selected prawn and crab species.
- Demonstrate knowledge of pond management, including site selection, fish farm design, and construction.
- Learn about pre-stocking and nursery pond management, stocking, rearing pond management, disease prevention and control measures, and post-harvest management techniques in fisheries (including processing, preservation, and value-added product development).

UNIT I – Introduction to fisheries **15Hrs**

1.1 Definition, history, present status and future prospects of fisheries.
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 – Cultivable Fishes, Prawns and Crabs **15Hrs**

2.1 Biology of Indian major carps – *Catla catla*, *Labeo rohita* and *Cirrhinus mrigala*.
2.2 Biology of exotic major carps – *Hypophthalmichthys molitrix*, *Ctenopharyngodon idella* and *Cyprinus carpio*.
2.3 Biology of air-breathing fishes – *Channa punctatus, Channa marulius, Clariaus magur*.
2.4 Biology of cultivable prawns – *Macrobrachium rosenbergii, Macrobrachium malcolmsonii*.
2.5 Biology of cultivable crabs – *Barytelphusa cunicularis.*

UNIT III – Pond, Disease and Post harvest Management **15Hrs**

3.1 Site selection, design and construction of fish farms.
3.2 Pre-stocking and Nursery pond management:- Aquatic weeds predatory insects and their control, pond fertilization.
3.3 Stocking and Rearing pond Management, Natural fish food organisms, supplementary feeding and Brood pond Management – Monosex culture
3.4 Infectious diseases of fishes and prawn - prevention and control measures.
3.5 Processing and preservation of fishes and prawns; By-products and value-added products 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 phytoplanktons and zooplanktons.

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6 Study of physico-chemical parameters of water.
7 Identification of benthos as fish feed.
8 Separation of pituitary gland from fish.
9 Demonstration of induced breeding technology in common carp.
10 Museum study of fishes, prawns, and crabs.
11 Demonstration of accessory respiratory organ in air-breathing fish.
12 Dissection/demonstration digestive system of *Labeo/Catla/Tilapia*.
13 Identification of bacterial and viral diseases of fish and prawn.
14 Visits to local fish markets/seed producing units/ processing and preservation units and submit a report.
15 **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 byproducts and value-added products.
[To be submitted at the time of Examination – 6 Marks]

Assignments

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Suggested Books

1 Water quality criteria for freshwater fish. Albastor, J. S. and Lloyd, R. Buttorvorth 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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M.Sc. Zoology

Code Zoo_403

Semester – IV
Elective – III
Paper III – Agricultural Entomology - II [AE - II]

COURSE OUTCOMES

By the end of this course, students will be able to:

- Understand the historical context of insect pest problems and the reasons behind insects becoming pests, including factors leading to pest outbreaks.
- Define and apply concepts such as Economic Injury Level (EIL) and Economic Threshold Level (ETL) in pest management.
- Analyze the influence of climatic factors and natural barriers in pest control, and utilize pest monitoring and survey methods.
- Comprehend the necessity of Integrated Pest Management (IPM), including its tools and the relationship between ecology and IPM.
- Explore various insect pest control methods, including cultural, physical, mechanical, biological, and genetic approaches.
- Evaluate the use of chemical control methods, including inorganic and organic pesticides, synthetic pyrethroids, and pesticide formulations, and understand their applications in pest management.
- Discuss the importance of pesticide resistance, its types, mechanisms, and genetic basis, as well as regulatory methods and their role in pest control.
- Examine modern trends in pesticide research, biotechnological advances in IPM, and the adverse consequences of pesticide applications on the environment, including the concepts of organic farming.

15 Hrs

UNIT I – Insect Pest Control Method – I

1.1 Introduction – Antiquity of pest problem.
1.2 Reasons for insects turning into pest, reasons for pest outbreaks. Economic injury level; Economic threshold level.
1.3 Climatic factors and natural barriers; Pest monitoring and methods of survey.
1.4 IPM - Definition, necessity of IPM; Tools of IPM; Ecology versus IPM.
1.5 Insect pest control method – Cultural, Physical, Mechanical, Biological, Genetic

15 Hrs

UNIT II – Insect Pest Control Methods – II

2.1 Chemical control – Inorganic pesticides, Organic pesticides, Organochlorides, Organophosphates, Carbamates.
2.2 Synthetic pyrethroids – Classification and their applications; Biological control of agricultural pests
2.3 Pesticide formulations – Dust, Sprays, Emulsions, Aerosols, Fumigants, Seed dressers or Seed treatment chemicals.
2.4 Synergists, Repellents, Baits, Toxicants, Antifeedants, Attractants, Chemosterilants.
2.5 Pesticide application methods and Safety parameters in pesticides application.

15 Hrs

UNIT III – Pesticide Resistance and Advances in IPM

3.1 Chitin Synthesis Inhibitors; Insect growth regulators; Pheromones.
3.2 Pesticide resistance – Definition and types of resistance; Mechanism of resistance; Genetics of resistance.
3.3 Regulatory methods – Insecticides and Plant Quarantine Acts.
3.4 Modern trends in pesticide research; Biotechnological advances in IPM.
3.5 Pesticide applications and their adverse consequences on environment; Concepts of organic farming.

PRACTICALS

1 Collection, identification, and preservation of insect pests of agricultural 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 Field collection of parasitoids and predators
10 Evaluation of different traps against fruit flies with respect to signals
11 Report on insect pest outbreak – A case study.
12 Visit to ICRISAT, Hyderabad, Telangana State and submit a report
13 Visit to PJSTAU Biocontrol Laboratory, Rajendernagar and submit a report.
14 Visit to organic farming sites and submit a report.
15 **Submission of assignment on:** IPM definition; necessity of IPM; Ecology versus IPM; Reasons for insects 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 – 6 Marks]

Assignments

1. Theory Assignment will be three detailed essays on any one topic each from Units I, II & III. The theory assignment shall be submitted to the concerned teacher handling the course by the submission date decided by him/her.
2. Practical Assignment shall be submitted at the Semester end Practical Examination. The practical assignment shall be submitted to the concerned teacher handling the course by the submission date decided by him/her.

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_404)

	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	2	75
Total	**5**	**150**

Note:
The project offered in Semester IV carries 5 credits worth 150 marks.

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