Based on Undergraduate Curriculum Framework-2022

UNIVERSITY OF DELHI

UNDERGRADUATE PROGRAMMES OF STUDY

STRUCTURE, COURSES & SYLLABI OF SEMESTER –VII AND SEMESTER –VIII
B.Sc (P) Life Sciences

(4th Year of UG as per UGCF-2022 existing)

SEMESTER – VII

List of DSC Papers

Course Title	Nature of the Course	Total Credits	Components			Page No.
			Lectures	Tutorial	Practical	
Animal Models and Experimentation	DSC- 19	4	2	Nil	2	5

List of DSE Papers

Course Title	Nature of the Course	Total Credits	Components			Page No.
			Lectures	Tutorial	Practical	
Advanced Bio-techniques and Bioinstrumentation*	DSE- 18	4	3	Nil	1	10
Ichthyology	DSE- 19	4	3	Nil	1	13
Applied Entomology	DSE- 20	4	3	Nil	1	16

*Mandatory DSE to be offered in Semester-VII

SEMESTER – VIII

List of DSC Papers

Course Title	Nature of the Course	Total Credits	Components			Page No.
			Lectures	Tutorial	Practical	
Comparative Physiology of Vertebrates	DSC- 20	4	2	Nil	2	32

List of DSE Papers

Course Title	Nature of the Course	Total Credits	Components			Page No.
			Lectures	Tutorial	Practical	
Evolutionary Immunobiology of Animals*	DSE- 21	4	3	Nil	1	35
Faunal Conservation and Restoration	DSE- 22	4	3	Nil	1	38
Reproductive Endocrinology	DSE- 23	4	3	Nil	1	41

*Mandatory DSE to be offered in Semester-VIII

SEMESTER –VII

SEMESTER	DISCIPLINE SPECIFIC CORE COURSE (DSC)	DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE)
VII	ZOO-DSC-19: Animal Models and Experimentation	Zoo -DSE-18: Advanced Biotechniques and Bioinstrumentation*
		Zoo-DSE-19: Ichthyology
		Zoo-DSE-20: Applied Entomology

*Mandatory DSE to be offered in Semester-VII

DISCIPLINE SPECIFIC CORE COURSE -19

Animal Models and Experimentation

Zoo-DSC-19

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lectures	Tutorial	Practical /Practice		
Animal Models and Experimentation **Zoo-DSC-19**	04	02	Nil	02	Should have appeared in Semester VI	-

Learning Objectives

The learning objectives of this course are as follows:

- To acquire an in-depth knowledge of the importance and applications of animal models in scientific research.
- To understand theoretical concepts, ethical principles and legal frameworks governing animal experimentation to assist in comprehending the quick response to pandemics in the form of vaccines.
- To gain theoretical and practical knowledge of experimental techniques using animal models.
- To develop skills to design experiments involving animal models for studies related to diseases, drug testing, and toxicity assessments/ Biomedical research.
- To explore alternatives to animal experimentation and their role in modern research.

Learning Outcomes

By studying this course, students will be able to:

- Have a better understanding of the concepts of the selection criteria, types, and applications of animal models in research.
- Demonstrate competence in handling, restraining, and administering treatments to animals in a humane and ethical manner.
- Analyze and interpret data generated from animal experiments.
- Critically evaluate the ethical considerations in using animals for research and propose alternatives when feasible.

- Design small-scale experiments using appropriate animal models to investigate scientific hypotheses.

SYLLABUS OF DSC-19

THEORY **(30 hrs)**

UNIT 1: Introduction to Animal Models 6 hrs

Definition and Importance, Historical perspective and significance in biomedical research. Types of Animal Models: Inbred, outbred, transgenic, and knockout models. Criteria for Selecting an Animal Model: Relevance to human biology. Ethical considerations.

UNIT 2: Experimental Design and Techniques 10 hrs

Design of Experiments (DoE): Importance of hypothesis-driven research. Sample size estimation and randomization. Tissue collection and processing. Gene Editing in Animal Models: CRISPR-Cas9 and its applications. Creating knockout and knock-in models.

UNIT 3: Application of Animal Models 8 hrs

Disease Models: Oncology - Induced tumour models. Neurological disorders: Alzheimer's and Parkinson's models. Metabolic disorders: Diabetes and obesity models. Infectious diseases: Models for tuberculosis, malaria, and viral infections. Drug Discovery and Toxicology: Role of animal models in preclinical trials. Acute and chronic toxicity studies. Use of animals in stem cell research.

UNIT 4: Ethical and Regulatory Aspects of Animal Experimentation 6 hrs

Ethics in Animal Experimentation: Importance of humane treatment of animals. Principles of the 3Rs: Replacement, Reduction, and Refinement. Regulatory Frameworks: CPCSEA (India) and International Guidelines. Role of Institutional Animal Ethics Committees (IAECs). Good Laboratory Practices (GLP) for animal studies. Alternatives to Animal Testing: *In-vitro* models, organoids, and computational models. Advantages and limitations of alternatives.

PRACTICALS **(60 hrs)**

(Laboratory periods: 15 classes of 4 hours each)

1. Selection and Handling of Animal Models: Basic handling and restraint techniques. for mice, rats, and zebrafish. Observation of behavior and physiological parameters.
2. Techniques in Experimental Research: Induction of disease models, Behavioral testing: Maze and anxiety tests. Sample collection: Blood and tissue collection techniques.
3. Histology and Imaging: Preparation of tissues for histological studies. Basic imaging techniques (e.g., fluorescent microscopy).
4. Ethical Simulations: Case studies on ethical dilemmas. Mock IAEC proposal writing and review.
5. Presentation of Findings - Preparation of Scientific Posters - Oral Presentation Skills for sharing Research Outcomes

6. Project on any topic/ Project report on visit to any research institute/laboratory to for understanding some ongoing research studies using any animal model.

Essential/Recommended readings

1. Guide for the Care and Use of Laboratory Animals – National Research Council 8th Edition, 2011 9 Publisher: National Academies Press; ISBN: 978-0-309-15400-0.
2. Laboratory Animal Medicine 2nd Edition, 2002 Publisher: Academic Press; ISBN: 978-0-12-263951-7– James G. Fox, Bennett J. Cohen, Franklin M. Loew.
3. Principles of Laboratory Animal Science, Revised Edition, 2001, Publisher: Elsevier ISBN: 978-0-444-50612-2– L.F.M. van Zutphen, V. Baumans, A.C. Beynen.
4. Handbook of Laboratory Animal Management and Welfare, 4th Edition, 2013, Publisher: Wiley-Blackwell; ISBN: 978-0-470-65567-1– Sarah Wolfensohn, Maggie Lloyd.
5. Ethics of Animal Research: Exploring the Controversy, 2012, Publisher: MIT Press; ISBN: 978-0-262-01734-6– Jeremy R. Garrett.

Suggested Readings

1. Experimental Design and Data Analysis for Biologists 2002, Publisher: Cambridge University Press; ISBN: 978-0-521-00976-8– Gerry P. Quinn, Michael J. Keough.
2. Animal Models in Biomedical Research, 2010, Publisher: Humana Press; ISBN: 978-1-60761-670-2 – Timothy G. Geary, Aaron Maule (Editors).
3. Alternatives to Animal Testing: New Ways in the Biomedical Sciences, 2008, Publisher: Wiley-VCH; ISBN: 978-3-527-32090-2 – Christoph A. Reinhardt. Laboratory Manual for Animal Research, 1997, Publisher: Oxford University Press; ISBN: 978-0-19-511908-4– Tom L. Beauchamp *(A practical resource for students learning techniques in animal research and experimentation).*
4. CPCSEA Guidelines for Laboratory Animal Facility, 2003 – Committee for the Purpose of Control and Supervision of Experiments on Animals (India).
5. Zebrafish: Methods and Protocols. 2012, Publisher: Humana Press; ISBN: 978-1-61779-597-8 – Allan V. Kalueff, Adam C. Gould.
6. Behavioral Research and Animal Welfare, 2019 Publisher: Springer; ISBN: 978-3-030-13966-1 – Edward Narayan.

NOTE: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSE -18
Advanced Biotechniques and Bioinstrumentation
Zoo-DSE-18

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lectures	Tutorial	Practical/ Practice		
Advanced Bio-techniques and Bioinstrumentation **Zoo-DSE-18**	04	03	Nil	01	Should have appeared in Semester VI	-

Learning Objectives

The learning objectives of this course are as follows:

- To understand advanced techniques used for research, diagnostics, and industrial applications Biotechnology.
- To learn the principles, applications, and limitations of bioinstrumentation methods.
- To gain hands-on experience in the operation and maintenance of advanced instruments.
- To develop critical thinking to select and apply suitable techniques for solving specific biological problems.
- To learn to interpret experimental data and troubleshoot issues in instrumentation.

Learning Outcomes

By studying this course, students will be able to

- Have a better understanding of the diverse cellular processes and cellular interactions.
- To explain the principles and working mechanisms of advanced instruments in biotechnology.
- To demonstrate proficiency in operating instruments like spectrophotometers, chromatographs, and PCR machines.
- To design experiments using advanced techniques like chromatography, electrophoresis, and mass spectrophotometry.
- To analyze experimental data generated by advanced bioinstrumentation.
- To apply biotechnological tools to solve problems in diagnostics, genomics, proteomics, and drug discovery.

Syllabus of DSE-18

THEORY (45 hrs)

UNIT- 1: Spectroscopic Techniques 10 hrs

Principles and Applications: UV-Visible spectroscopy, Fluorescence spectroscopy, Circular Dichroism (CD). Advanced Techniques: Infrared (IR) spectroscopy, Atomic Absorption Spectroscopy (AAS), and Nuclear Magnetic Resonance (NMR).
Applications: Structure determination, protein folding studies, and biomolecular interactions.

UNIT-2: Chromatography and Electrophoresis 10 hrs

Chromatography: Principles and applications of HPLC, Gas Chromatography (GC), and Ion Exchange Chromatography.

Electrophoresis: Polyacrylamide Gel Electrophoresis (PAGE), Agarose Gel Electrophoresis, 2D Gel Electrophoresis. Applications in genomics and proteomics.

UNIT-3: Molecular Biology Techniques 9 hrs

Polymerase Chain Reaction (PCR): qPCR, RT-PCR, and digital PCR.
DNA Sequencing: Sanger sequencing and Next-Generation Sequencing (NGS).

UNIT 4: Imaging and Analytical Tools 16 hrs

Microscopy: Principles and applications of Confocal Microscopy, Electron Microscopy (SEM, TEM). Mass Spectrometry (MS): Principles, instrumentation, and applications in proteomics and metabolomics. Biosensors: Principles, components, and applications of Biosensors in diagnostics.

PRACTICALS (30 hrs)

(Laboratory periods: 15 classes of 2 hours each)

1. Chromatography Techniques: Separation of biomolecules using Chromatography.
2. Electrophoresis Techniques: SDS-PAGE for protein separation.
3. Amplification of DNA. Gel documentation and analysis of PCR products.
4. Imaging Techniques: Demonstration of SEM/TEM.
5. Biosensors: Demonstration of glucose biosensors and ELISA techniques.
   Project related to topics covered in Theory/ project report based on visit to labs/institutions/industry, etc.

Essential/recommended readings

1. 1. Principles and Techniques of Biochemistry and Molecular Biology by Keith Wilson and John Walker, 7th Edition (2010), Cambridge University Press.

2. Biophysical Chemistry: Principles and Techniques by Upadhyay, Upadhyay, and Nath, Revised Edition (2020), Himalaya Publishing.

3. Introduction to Spectroscopy by Donald L. Pavia et al., 5th Edition (2015), Cengage Learning.

4. Bioinstrumentation by John G. Webster, 1st Edition (2004), Wiley-Interscience.

Suggested readings

1. Fundamentals of Analytical Chemistry by Douglas A. Skoog et al., 9th Edition (2013), Cengage Learning.

2. Molecular Biology of the Gene by James D. Watson et al., 7th Edition (2013), Pearson.

3. Chromatography: Principles and Instrumentation by B.K. Sharma, Revised Edition (2007), Goel Publishing House.

NOTE: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSE -19
Ichthyology
Zoo-DSE-19

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lectures	Tutorial	Practical/ Practice		
Ichthyology **Zoo-DSE-19**	4	3	Nil	1	Should have appeared in Semester VI	-

Learning Objectives

The Learning Objectives of this course are as follows:
• To increase student familiarity with evolutionary history and taxonomic diversity of fishes.
• To improve understanding of the basic physiological and behavioural adaptations of fishes.
• To enhance students' skills in studying locally available fish species.
• To expose students to some of the issues surrounding the conservation of fish biodiversity in the environment.

The Learning Outcomes

After studying this course, students can:

- keep track of types of fishes and their morphology.
- get detailed knowledge about the physiology of fishes.
- attain knowledge of various feeding habits, adaptations, parental care, and reproduction of fishes.
- attain advanced knowledge about the fishes which would be helpful for designing experiments for research.

Syllabus- DSE-19:

THEORY **(45 hrs)**

Unit-1 Introduction to Fishes **16 hrs**

Introduction and types of fishes, Classification, General Characters, Fish Origin: The diversification and relationships of jawless and jawed fishes. Scales, Teeth, Muscles, Swim-bladder, Gills, Fins, Skull, Weberian ossicles, Lateral-line system.

Unit-2 Fish Physiology **15 hrs**

Gas exchange, Internal transport and Homeostasis- Aquatic and Aerial respiration, Cardiovascular physiology, Hematology, Lymphoid organs, osmoionic regulation, Acid-base balance, nitrogen excretion and metabolism, Sensory systems–photoreception, chemoreception, mechanoreception, electroreception.

Unit-3 Reproduction and Development **8 hrs**

Oviparity and ovoviviparity, Prolific breeders, Fecundity, Induced breeding, Fish larval stages, Parental care in fishes.

Unit-4 Food and Feeding habits of Fishes and their Adaptations **6 hrs**

Fish foods and feeding habits, Adaptations in hill stream and deep-sea fishes, Types of migration in fishes, Abiotic factors and their influence on fish.

PRACTICALS: **(30 hrs)**

(Laboratory periods: 15 classes of 2 hours each)

1. Identification of local fishes by physical key methods.
2. Study of different types of fish scales.
3. Study of chromatophores of fishes under microscope.
4. Analysis of water quality parameters viz. temperature, pH, dissolved oxygen.
5. Fish Morphometric measurements: Standard length, Total length, Fork length, Dorsal fin height, Pectoral fin length, Ventral fin length, Anal fin height.
6. Study of anatomy of digestive systems among different types of fishes.
7. Gonado-somatic index.
8. Study of Weberian ossicles and otoliths.
9. Visit to local fish market/farm and report preparation.

Essential/Recommended Readings:

- Biology of Fishes, Bone, Q. and Moore, R., Taylor and Francis Group, CRC Press, U.K.
- The Physiology of Fishes, Evans, D. H. and Claiborne, J. D., Taylor and Francis Group, CRC Press, UK
- The Senses of Fish Adaptations for the Reception of Natural Stimuli, von der Emde, R., Mogdans, J. and Kapoor, B. G., Narosa Publishing House, New Delhi, INDIA
- Ichthyology, Lagler, K.F., Bardach, J.E. and Miller, R.R. John Wiley and Sons Inc., New York, USA
- A textbook of fish biology and fisheries, Khanna S.S. and Singh H.R. Narendra publishing house, Delhi

Suggested readings:

- Ichthyology, Karl F. Lagler, John E. Bardach, Robert R. Miller, Dora R. May Passino, Wiley, New York, USA
- Ichthyology Handbook, Kapoor, B. G., Khanna, B. Springer Science & Business Media, 2004

NOTE: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSE -20
Applied Entomology
Zoo-DSE-20

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisites of the course (if any)
		Lectures	Tutorial	Practical/ Practice		
Applied Entomology **Zoo-DSE-20**	04	03	Nil	01	Should have appeared in Semester VI	

Learning Objectives:

The learning objectives of this course are as follows:

- To impart in-depth knowledge about various aspects of the insect world.
- To gain theoretical and practical knowledge of experimental techniques using insects as research models.
- To understand the immense role of insects as ecosystem providers.
- To gain theoretical and practical knowledge of insects as pests and their economic impact.
- To explore pest management measures which are effective, economical and eco-friendly.

Course Learning Outcome:

Upon completion of the course, students will be able to:

- Learn about the fascinating world of insects from a holistic perspective.
- Learn about the biology of insects.
- Understand the difference between various types of beneficial and destructive insects.
- Gain knowledge about important insect pests of crops, fruits, vegetables, stored grains, and of medical importance.
- Analyze the advantages and limitations of the various pest management measures and then design/ customize more effective measures by targeting the lacunae in the existing methods of pest management and by integrating the various aspects of Integrated Pest Management (IPM).

SYLLABUS OF DSE-20

THEORY (45 hrs)

Unit 1: Exploring the Fascinating World of Insects. 10 hrs

Overview of the economic importance of insects: Beneficial insects (Honey bees, Silkworm, Lac insect, ecosystem service providers: flesh flies, dung beetles, termites); Insect pests of agricultural crops, stored grains, medical and household; Insects as forensic agents: role of insects/arthropods in criminal investigation by predicting time and cause of death.

Unit 2: Co-evolution of insects and plants 5 hrs

Insect-plant relationships, Mechanisms of insect resistance in plants, Tri-trophic interactions (Plant-insect pest-natural enemies).

Unit 3: Bionomics of Insect Pests of Agricultural Crops and Stored grains 12 hrs

Pest, Economic threshold (ET), Economic injury level (EIL), classification of pests; Identification, seasonal history, nature of damage, life history and control of pests of rice: *Leptocorisa acuta;* pulses: *Helicoverpa armigera*; Sugarcane: *Scirpophaga nivella*; Cotton: *Earias vitella*; Vegetables: *Raphidopalpa foveicollis*; Fruits: *Papilio demoleus*, Stored grains: *Sitophilus oryzae*, *Corcyra cephalonica*, *Callosobruchus chinensis*.

Unit 4: Bionomics of Insect pests of Medical and Household importance and Pest Management Methods 18 hrs

Bionomics and management of mosquitoes, lice, fleas, house fly, cockroach, and termites. Physical, Cultural, Chemical, Biological, Microbial, Genetic (SIT, F_1 sterility, etc.), Biotechnological, and Bio-rational methods (using pheromones, JH mimics, MH agonists, etc.) in pest management. Integrated Pest Management (IPM) and Integrated Vector Management (IVM).

PRACTICALS: (30 hrs)

(Laboratory periods: 15 classes of 2 hours each)

1. **Study of morphology, growth and development of insect pests**
   (a) Rearing of a hemimetabolous [(e.g. Red cotton bug, *Dysdercus keonigii*)/ holometabolous (e.g. pulse beetle, *Callosobruchus chinensis*)] insect pest in the laboratory. Submission of life cycle stages and details on its biology, economic importance, and appropriate pest management method.
   (b) Study of life history stages of insect pests of medical and household importance – mosquitoes (*Anopheles, Culex*, *Aedes*), lice, sand fly, flea, house fly, cockroach (*any four*). Submission of life cycle stages and details on its biology, economic importance, and appropriate pest management method.

1. **Insect Toxicology:**
   (a) Estimation of LD_{50} and LC_{50} of insecticides using mosquito larvae/ given data.
   (b) Pesticide residue analysis of contaminated soil/vegetable/water samples using TLC.

Project work/ Field visits

1. Field survey of beneficial insects and insect pests. Submission of geo-tagged photographs captured in different locations, with details of field observations.

2. Visit to the institutional labs and/or fields. Submission of a lab. visit/field report.

Essential/recommended readings:

- Atwal, A.S. (1993) Agricultural Pests of India and South East Asia. Kalyani Publishers, New Delhi.
- Dennis, S. Hill (2005). Agricultural Insect Pests of the Tropics and Their Management, Cambridge University press.
- Metcalf, C. L., Flint, W.P. and R.L. Metcalf (1962). Destructive and Useful Insects: their habits and control, 4th Ed. Mc Graw-Hill.
- Pedigo, L. P. (2002). Entomology & Pest Management, Prentice Hall, New Jersey, USA.
- Service, M. (2012). Medical Entomology for students, Cambridge University Press, UK.

Suggested Readings:

- S. Pradhan (1998) (Reprint 2023). Insect Pest of Crops. National Book Trust, New Delhi.
- Schoonhoven, L. M., van Loon, J.A., & Dicke, M. Insect Plant Biology (2005). Oxford University Press, USA.
- Jolivet, P. (1998). Interrelationship between insects and Plants, CRC Press, USA.
- Norris, Caswell-Chen and Kogan, M. (2002). Concepts of IPM, Prentice-Hall, USA.

NOTE: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

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SEMESTER –VIII

SEMESTER	DISCIPLINE SPECIFIC CORE COURSE (DSC)	DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE)
VIII	ZOO-DSC-20: Comparative Physiology of Vertebrates	Zoo -DSE-21: Evolutionary Immunobiology of Animals*
		Zoo -DSE-22: Reproductive Endocrinology
		Zoo -DSE-23: Faunal Conservation and Restoration

***Mandatory DSE to be offered in Semester VIII**

DISCIPLINE SPECIFIC CORE COURSE -20

Comparative Physiology of Vertebrates

Zoo-DSC-20

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lectures	Tutorial	Practical/ Practice		
Comparative Physiology of Vertebrates **Zoo-DSC-20**	04	02	Nil	02	Should have appeared in Semester VII	

Learning objectives:

This course focuses on:

- understanding the physiological mechanisms that enable vertebrates to adapt and evolve over time.
- exploring how different vertebrates, from fish to mammals, have developed unique physiological adaptations to meet the demands of their environments.

Learning outcomes:

At the end of this course students should be able to:

- Learn the significance of variations in the digestive system based on different diets.
- Understand the mechanisms of extracting oxygen from the environment using different respiratory structures.
- Appreciate the design of the cardiovascular system in different vertebrates as an efficient gas transport mechanism.
- Appreciate the variations in the reproductive strategies in accordance with the environment.
- Understand the various strategies for maintaining a steady physiological state and respond to extreme environmental conditions.

SYLLABUS OF DSC-20

THEORY **(30 hrs)**

Unit 1: Physiological Processes **16 hrs**

Digestion: Monogastric, digastric and polygastric digestive systems**; Respiration:** Gills, swim bladder, skin and lungs as respiratory organs; **Circulation:** Single-circuit and double-circuit circulatory designs**; Reproduction:** Reproductive Cycles in seasonal and non- seasonal breeders.

Unit 2: Homeostasis **10 hrs**

Osmoregulation in freshwater, marine and terrestrial vertebrates. Thermoregulation in poikilotherms and homeotherms.

Unit 3: Adaptations **4 hrs**

Physiological responses to specific environmental challenges, like desert conditions, high altitude and starvation.

PRACTICALS **(60 hrs)**

(Laboratory periods: 15 classes of 4 hours each)

1. Physiological Response of *Drosophila*/fish/stored grain pests to environmental stressors like temperature extremes/starvation.
2. Comparison of Hemoglobin content of fish blood in fish kept in normal and low-oxygen water.
3. Comparison of blood cells in a blood smear of a fish and human.
4. Study of the Estrous cycle of rats through permanent slides of vaginal smears during different phases of the cycle.

PROJECT WORK

Project report (group activity) on effect of exercise/ yoga/meditation/adequate sleep/excessive mobile gaming on cardiovascular health (Heart rate, BP and SpO2 using pulse oximetry) to be submitted at the end of the semester.

Essential/Recommended Readings:

1. How Animals work by Knut Schmidt-Nielsen, Cambridge University Press
2. Animal Physiology: Adaptation and Environment by Knut Schmidt-Nielsen, Cambridge University Press

Suggested Readings:

1. Animal Physiology by Hill et al, Sinauer Associates Inc.
2. Environmental Physiology of Animals by Willmer et al, John Wiley (original)
3. Principles of General and comparative physiology by Carpenter, W B, Forgotten Books.
4. Experiments with *Drosophila* for Biology courses (ebook) by Lakhotia, SC, Indian National Academy of Sciences.
5. Manual of Experimental Ichthyology by Gahlawat, SK et al, Daya Publishing House.
6. Cardiopulmonary Exercise testing and cardiovascular health by Karlman Waserman, Wiley-Blackwell.

NOTE: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSE -21
Evolutionary Immunobiology of Animals
Zoo-DSE-21

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lectures	Tutorial	Practical/ Practice		
Evolutionary Immunobiology of Animals **ZOO-DSE-21**	4	3	Nil	1	Should have appeared in Semester VII	

Learning Objectives

The Learning Objectives of this course are as follows:

- To improve basic understanding about evolution of the immune system in different animals and group specific immunological adaptations.
- To increase student understanding about the evolution of complexity in the immune system as well as immunological repertoire among animals.
- To help students analyze immunological manifestations during experimentation and research.

The Learning Outcomes of this course are as follows:

After studying this course, learners can:

- Understand the basic organization of the immune system among different groups of animals.
- Gain knowledge about the evolution of primitive forms of the immune system and their functioning among invertebrates.
- Enhance student proficiency in understanding of immune system organization and their pathology in perturbation.

SYLLABUS OF DSC-21

THEORY **(45 hrs)**

Unit 1: Evolution of innate immunity **15 hrs**

Basics of unicellular to metazoan immunity, evolution of immunological armament across the animal phyla, hematopoiesis and functions of hemocytes in invertebrates (Insects, Crustaceans, Mollusks and Tunicates) humoral factors of tunicates. Evolution of Drosophila Toll-1 receptors and mammalian Toll-like receptors and antimicrobial host-defense of Drosophila.

Unit 2: Evolution of adaptive immunity 14 hrs

Origin and evolution of adaptive immunity in animals, a comparative account of lymphocyte development in vertebrates, humoral and cell mediated immunity in vertebrates, recognition of self/non-self, development of immunological memory. Major lymphoid organs and their distribution in fishes, nonspecific defense reaction of fishes. Peripheral lymphoid organs CALT, GALT, BALT, HALT and mural nodules in birds and other vertebrates.

Unit 3: Evolution of Cytokines in Vertebrates 08 hrs

Evolutionary Diversification of Cytokines. Pro-inflammatory, inflammatory and antimicrobial mediators of vertebrates and their functions.

Unit 4: Major Histocompatibility Complex 08 hrs

Genomic organization of MHC genes in vertebrates, evolution of Major Histocompatibility Complex in Teleosts.

PRACTICALS (30 hrs)

(Laboratory periods: 15 classes of 2 hours each)

1. Identification of organs of the immune system in Fishes, Amphibians, Aves and Mammals through slides/photographs.
2. Histological study of organs of the immune system of vertebrates.
3. Staining and identification of plasmatocytes of *Drosophila*.
4. Identification of different types of cells in the stained blood smears of Fish/Frog.
5. Study of techniques for the identification and quantification of cytokines and their expression.

Essential/Recommended readings

1. Evolutionary Concepts in Immunology by Robert Jack, Louis Du Pasquier. Publisher: Springer Nature Switzerland.
2. Evolution and Comparative Immunology of Immune Systems in Marine Organisms by Gyri T. Haugland, Sissel Jentoft, Monica Hongroe Solbakken. Publisher: Frontiers.

Suggested readings

1. The Evolution of the Immune System Conservation and Diversification by Davide Malagoli. Publisher: Academic Press.
2. Roitt's Essential Immunology by Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt. Publisher: Wiley.
3. Veterinary Immunology by Ian R. Tizard. Publisher: Elsevier.

NOTE: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSE- 22
Faunal Conservation and Restoration
Zoo-DSE-22

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lectures	Tutorial	Practical/ Practice		
Faunal Conservation and Restoration **Zoo-DSE-22**	4	3	Nil	1	Should have appeared in Semester VII	

Learning Objectives

The Learning Objectives of this course are as follows:

- To understand the faunal diversity in context to the Indian sub-continent, and recognise it as an integral part of global ecosystem.
- To understand theoretical concepts, ethical principles and legal frameworks governing animal conservation.
- To expose students to the various threats to biodiversity.
- To identify contemporary issues related to wildlife conservation such as habitat loss, poaching, climate change, or biodiversity decline.
- To have an in-depth exploration of different strategies used in faunal conservation, such as protected areas, captive breeding, rewilding, or community-based conservation.

Learning Outcomes

After studying this course, learner can:

- Understand the ethical, historical, and cross-cultural context of environmental issues related to fauna.
- Provide novel perspectives or solutions to conserve faunal species.
- Provide proposals for future research, policy changes, or conservation laws.

SYLLABUS OF DSC-22

THEORY (45 hrs)

Unit 1: Fundamentals of biodiversity 5 hrs

Species diversity, genetic diversity and ecosystem diversity. Faunal biodiversity hotspots of India: Himalayan region, western ghats and north-eastern region. Sentinel species/ environmental guardians.

Unit 2: Valuing biodiversity, Social issues and environment 11 hrs

Ecological economics, Ethical values, Evaluating development projects (any project of India). Global issues and sustainable development; Biodiversity crisis: how biodiversity is interconnected with ecosystem processes, and it's decline with emphasis on impact on human health. Release of GMOs in the environment.

Unit 3: Threats to biodiversity 14 hrs

Pollution Ecology: Air, water, soil and radioactive. Emerging contaminants. Habitat destruction, fragmentation and degradation; Overexploitation. Global climate change, acid rain; Invasion Ecology; Ecotoxicology. Wildlife forensics- forensic protocols for species identification from different parts of reptiles, birds and mammals; wildlife crime case studies.

Unit 4: Conservation Restoration 15 hrs

Sustainable utilization of natural resources; Bioprospecting; People biodiversity register; Role of indigenous knowledge system; Ecological footprinting; Protected areas; Policies and laws; Environmental impact assessment; GIS and remote sensing. Factors involved in implementing ecological restoration: Restoration of major communities; Bioremediation.

PRACTICALS (30 hrs)

(Laboratory periods: 15 classes of 2 hours each)

1. To study pollutants: phosphate, nitrates, sulphates in the water sample (control and polluted)
2. To analyze and compare phosphorus, nitrogen, organic matter, particle size of the soil samples.
3. To perform toxicological bioassay tests: LC50/ EC50 on organisms such as zooplankton, stored grain pests etc.
4. Study any eight endangered animal species of India with focus on their conservation efforts
5. To study principle of Global Positioning System (GPS) and Geographic Information System (GIS)

PROJECT WORK
Project Report on hypothesizing and designing experiment based on field or laboratory visit

Essential/Recommended Readings:

1. Richard, B. Primack, Essentials of Conservation Biology. (6th edition), Sinauer Associates.
2. Gabriel, M. Biodiversity and Conservation, Oxford and IBH Publishing.

3. Sharma, P.D., Ecology and Environment, Rastogi Publications.
4. Nair, S.M. Endangered Animals of India and their Conservation, National Book Trust of India.
5. Joseph, B., Environmental studies, Tata Mc Graw Hill.
6. Ghosh, S.K., Singh, R. 2003. Social Forestry and Forest Management. Global Vision Pub.
7. Sinha, S. 2010. Handbook on Wildlife Law Enforcement in India. TRAFFIC, India.

Suggested Readings:

1. Mohapatra Textbook of Environmental Biotechnology, IK Publication.
2. Thakur, I. S., Environmental Biotechnology, IK Publication.
3. Divan Rosencraz, Environmental Laws and Policies in India, Oxford Publication.
4. Allabay, M., Basics of Environmental Science, Routledge Press.
5. Rana SVS, Environmental pollution – Health and Toxicology, Narosa Publication.
6. Miller, G.T. 2002. Sustaining the Earth, an Integrated Approach. (5th edition) Books/Cole, Thompson Learning, Inc.
7. Chapman, J.L., Reiss, M.J. 1999. Ecology: Principles and Applications (2nd edition) Cambridge University Press.

NOTE: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSE- 23
Reproductive Endocrinology
Zoo-DSE-23

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lectures	Tutorial	Practical/ Practice		
Reproductive Endocrinology **Zoo-DSE-23**	4	3	Nil	1	Should have appeared in Semester VII	

Learning Objectives

The Learning Objectives of this course are as follows:

- To familiarize students with the reproductive anatomy, physiology and endocrinology of males and females.
- To introduce and discuss the interrelationships between reproductive hormones produced by the brain and reproductive glands and how they interact to control the reproductive processes like pregnancy, parturition and lactation.
- To introduce and discuss reproductive management practices and understand endocrine disorders.

Learning Outcomes

At the end of this course students should be able to:

- Appreciate the reproductive anatomy
- Learn the significance of physiology of the reproductive system, pregnancy and post pregnancy.
- Understand the various reproductive disorders

SYLLABUS OF DSC-23

THEORY **(45 hrs)**

Unit 1: Reproductive Anatomy- Male Reproductive System **10 hrs**

Primary and accessory sex organs and secondary sex characters. Histology of testis. Endocrine functions of testis. Spermatogenesis. Hypothalamic control of testicular functions.

Unit 2: Reproductive Anatomy- Female Reproductive System 15 hrs

Histology of ovary. Ovarian hormones and their functions. Oogenesis and ovulation. Formation and functions of corpus luteum. Hypothalamic control of ovarian functions. Menstrual cycle and its regulation. Abnormalities in menstrual cycle. Onset of menopause and postmenopausal changes.

Unit 3: Physiology of Pregnancy, parturition and lactation 10 hrs

Structure and functions of placenta. Maintenance of pregnancy and role of hormones. Development of mammary gland and lactation - role of hormones. Parturition. Pregnancy tests. Development of mammary glands, lactation and their hormonal control.

Unit 4: Reproductive Disorders 10 hrs

Sexual differentiation & developmental abnormalities – male & female Menstrual disorders – Precocious, delayed or absent puberty; Amenorrhea Fertility disorders – Sexual dysfunction; Infertility; Spontaneous pregnancy loss Pregnancy disorders – Pre-eclampsia, IUGR, Labour abnormalities Endocrine disorders – Hyperprolactinemia Autoimmune Disorders Genetic disorders (mutations and syndromes) Cancers and biomarkers – Testicular; Prostate; Ovarian; Endometrial; Cervical and Breast.

PRACTICALS (30 hrs)

(Laboratory periods: 15 classes of 2 hours each)

1. To study surgical techniques via videos 1. Ovariectomy 2. Castration.
2. Histological and histochemical techniques - Study of the different phases of the estrous cycle of rat using permanent slides of its vaginal smears during the different stages of the cycle.
3. To study sections of ovary, uterus, fallopian tube, testis, epididymis.
4. Study of Sperm count and motility and effect of some antifertility agents.
5. Study of modern contraceptive devices.

PROJECT WORK

Project report on survey of reproductive health in any small human community.

Essential/Recommended Readings:

1. Endocrinology, Mac E. Hadley, Pearson Education.
2. Vander's Human Physiology, E.P. Widmaier et al., McGraw-Hill, Higher Education.
3. Endocrinology. Vols. I, II and III by L.O. DeGroot. W.B. Saunders Co.

Suggested Readings:

1. Human Physiology: An Integrated Approach by D.U. Silverthorn, Pearson.
2. Medical Physiology, A.B. Singha Mahapatra, Current Books International.
3. "Pathways to Pregnancy and Parturition" (3rd Edition 2012, P. L. Senger)

NOTE: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

Bachelor of Science (Prog.) in Applied Life Sciences

Agrochemicals and Pest Management

SEMESTER-VII

ZOOLOGY

DISCIPLINE SPECIFIC CORE COURSE: **ALS-ZOO DSC 07**

INSECT BEHAVIOUR

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE- REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practicals/ Practice		
Insect Behaviour ALS ZOO DSC 07	4	2	Nil	2	Appeared in Sem-VI	NA

Learning Objectives:

- This syllabus provides a comprehensive overview of insect behavior, its underlying mechanisms, and its relevance to various fields.
- Insect behaviour is a scientific study of the behaviour of insects in their natural habitat and in relation to their interactions with other living organisms and the environment.
- Study of orientation, feeding and oviposition behaviour of insects has immense applications in pest management in an effective, economical and eco-friendly manner.
- Behavioural studies can be conducted easily by the undergraduate students in the laboratory and can later be extrapolated in the investigative field projects.

Course Outcomes:

Upon completion of the course, the students will be able to:

- Learn about the concept of insect behaviour and its applications
- Gain knowledge about importance of insect behaviour in natural habitat.
- Understand the complexities of insect behavior and its applications in the real world.
- Understand the difference between various types of pests and their host plants, extent of damage caused by them.

Theory **30h**

Unit 1: Introduction to insect behaviour **5 h**

Scope and importance of studying insect behavior. Types of behaviour: Innate, Learned, Fixed Action patterns (FAPs) and Complex behaviours (Altruism).

Unit 2: Mechanism of sensory perception and Orientation behaviour of insects **10 h**

Sensory perception in insects: mechanoreceptors, hygroreceptors, thermoreceptors, photoreceptors. Visual Communication, Acoustic communication, Tactile communication and Chemical communication, Neuronal and hormonal basis of Insect behaviour, Orientational responses: Kinesis and Taxis.

Unit 3: Feeding behavior of insects

Types of feeding habits with special emphasis on phytophagous insects, Insect-plant relationships, Foraging behaviour of Honey bees. **8 h**

Unit 4: Reproductive behavior

Locating mates, Courtship, Sexual differences in mating behavior, Mate selection and rejection, Genetic quality and mate choice, Aggregation signal, Sex pheromones. **7 h**

Practicals

(Laboratory periods 15 classes of 4 hrs each)

1. To study the various tools and techniques/methods used to study of the behaviour of insects in the laboratory and field conditions.
2. To observe the insects in the wild.
3. To distinguish between beneficial and destructive insects (pests).
4. To study the geotaxis behaviour of soil insects.
5. To study the phototaxis behaviour larvae of phytophagous insects.
6. To study the stridulation, swarming, habituation, courtship behaviour of insects (at least two videos for each behaviour).
7. Construction of ethogram by using suitable data to study insect behaviour.
8. Visit to forest, wildlife park, sanctuary, zoological park to study and record the behaviour of insects and prepare a short report.

Suggested Readings:

1. V.B. Awasthi. Principle of Insect Behaviour. Scientific Publication; 2nd Edition.
2. Mathews, W. Robert and Methews, R. Janice. Insect Behaviour. Springer, 2nd Edition.

3. Alcock, John. Animal Behaviour. Sinauer Associates. 11th Edition.

Additional Resources:

1. UGC INFONET / DU E-Resources & SciFinder Web Version registration
2. Viji, C. P., Phani Kumar, K. and Sudhavan Vani, V. Insect Ecology and Behaviour.

NOTE: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time

DISCIPLINE SCIENTFIC ELECTIVE COURSE: **ALS- ZOO DSE 06**

SOCIAL AND BENEFICIAL INSECTS

Credits distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practicals/ Practice		
Social and Beneficial Insects **ALS ZOO DSE 06**	4	2	Nil	2	Appeared in Sem-VI	NA

Learning Objectives:

The learning objectives of this course are as follows:

- to acquaint students of the social organization found in insects.
- to apprise them of beneficial aspects of insects.
- to impart knowledge about the techniques involved in culturing and rearing of bees, silkworms and lac insect.

Learning Outcomes:

By studying this course, students will be able to:

- identify different types of social and beneficial insects.
- differentiate the various castes and their role in the social life of insects.
- acquire skill for mass rearing of beneficial insects and their products.

Theory **30h**

Unit 1: Social Insects **7h**

Characteristics and systematic position. Social organization: caste determination, communication, social parasitism and symbioses, social insect pathogens. Life cycle, social organization and types of ants, bees, wasps and termites.

Unit 2: Apiculture **7h**

Habit and habitat of honey bee (Apis), bee keeping techniques, bee pasturage, artificial bee hives. Economic importance of bee. Bee enemies, bee diseases and their control.

Unit 3: Sericulture and Lac Culture **11 h**

Life cycle of silkworm Bombyx mori. Types of silkworm species and their salient features. Rearing techniques of mulberry, muga, eri and tassar silkworms. Enemies and diseases of silkworms and their management.

Habit, habitat and biology of *Laccifera lacca*. Host trees of lac insect, pruning, inoculation and lac harvesting. Enemies of lac insect and their control

Unit 4: Ecological aspects of beneficial insects **5h**

Ecological role of insects: pollination, weed control, improving soil fertility and as scavengers. Medicinal use of insects and insect products. Entomophagy.

PRACTICALS **60 h**

1. Study of life cycle of ants, bees, termites, silk worm and lac insect through museum specimens/photographs.
2. Study of different nests build by ants, bees and termites.
3. Construction and maintenance of artificial bee hives and study of equipments related to apiculture.
4. Rearing techniques of mulberry, muga, eri and tassar silkworms.
5. Study of different types of enemies and diseases of silkworms.
6. Study of lac culture technique: pruning, inoculation, cropping and harvesting.
7. Study of economically important insect products.

Essential/Recommended readings:

1. Watson, J. A. L., Okot-Kother, B. M. and Noiroh C. (1985) Caste differentiation in social insects. Pergamon Press.
2. Dunston AP. (2007) The Insects: Beneficial and Harmful Aspects.Kalyani Publishers., New Delhi.
3. Brian, M. V. (1983) Social insects: ecology and behavioural biology. Chapman and Hall, London, New York.
4. D. B. Tembhare (2017) Modern Entomology. Himalaya Publishing House.

5. Dokuhon, Z.S. (1998) Illustrated Textbook on Sericulture. Oxford & IBH publishing Co., Pvt. Ltd. Calcutta.
6. Shukla, G.S. and Upadhyay, V.B. (2014) Applied and Economic Zoology, Rastogi Publications.

Suggested Readings:

1. Maxwell F.G. and Jennings P.R. (Eds). (1980) Breeding Plants Resistant to Insects. John Wiley & Sons, New York.
2. Encyclopedia of Social Insects (2021) Springer International Publishing.

NOTE: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time

DISCIPLINE SCIENTFIC ELECTIVE COURSE: **ALS ZOO DSE-07**

BASICS OF CHRONOBIOLOGY

Credits distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practicals / Practice		
Basics of chronobiology ALS ZOO DSE 07	**4**	**2**	**Nil**	**2**	**Appeared in Sem-VI**	NA

Learning Objectives

The learning objectives of this course are as follows:

- to understand the cyclic physiological phenomena.
- to learn about the unique phenomena of seasonal migration and hibernation.
- to expose the students to clock dysfunctions.
- to make the students aware of the various aspects of chronobiology and its application in therapeutics and medicine
- to enable the students to learn about their own rhythms of sleep and body temperature
- Summarize the importance of various biological rhythm in nature.

Learning Outcomes

By studying this course, students will be able to

- Understand the concepts of biological significance of biological rhythms
- Acquaint with the patterns of animal behaviour and importance of circadian rhythms.
- Observe the adaptations in various animals.
- Develop an overview of the principles of chronobiology.
- Molecular mechanisms underlying the generation of circadian time
- study about the applications of chronobiology in medicine, pharmacology and therapeutics.

- **Theory** **30h**

UNIT- 1: Introduction to Chronobiology **12 h**

Milestone and scope of chronobiology; Types and properties of Rhythms – Ultradian rhythms, Circadian rhythms, Infradian rhythms; Lunar rhythm; Circannual rhythm. Characteristics of circadian rhythms, Temperature compensation; Masking and synchronization; Zeitgebers- Photic and non-photic Zeitgebers.

UNIT- 2: Biological clock system **8 h**

Characteristics, Input, time generation and output components; Central and peripheral clocks; Suprachiasmatic nucleus; Molecular mechanisms underlying the generation of circadian time in Drosophila.

UNIT- 3: Circannual rhythm and Photoperiodism **10 h**

Circannual rhythms; Photoperiodism and regulation of seasonal breeding animals in vertebrates; Pineal as photoreceptive structure in non-mammalian vertebrates. Seasonal Migration in birds; Role of melatonin and serotonin.

UNIT- 4: Circadian rhythms and human health. **10 h**

Circadian clock and sleep-wake cycle; Jet Lag, Shift work ; Sleep and Chronotypes; Consequence of clock dysfunction- Sleep Disorders, Depression, Anxiety, Stress, Cancer; Obesity, Immune Disorders; Chronopharmacology, Chronomedicine and Chronotherapy.

Practicals **60 h**

(Laboratory periods: 15 classes of 4 hours each)

1. Study of characteristics of circadian rhythms from a given dataset.
2. Ambulatory blood pressure monitoring and biological rhythm analysis.
3. Using periodically assembled data study of body temperature rhythm.
4. Study of circadian functions in humans (daily eating, sleep and temperature patterns).
5. Human chronotypes-MCTQ questionnaire and analysis.
6. Project related to topics covered in theory/ project report based on visit to labs/institutions/industry etc.

Essential/recommended readings

1. Binkley, S. (2020). Biological clocks: Your owner's manual. CRC Press.

2. Jay. C. Dunlap, Jennifer. J. Loros, Patricia J. DeCoursey (ed). 2004, Chronobiology Biological Timekeeping: J, Sinauer Associates, Inc. Publishers, Sunderland, MA, USA.
3. Koukkari, W. L., & Sothern, R. B. (2007). Introducing biological rhythms: A primer on the temporal organization of life, with implications for health, society, reproduction, and the natural environment. Springer Science & Business Media.

SUGGESTED readings

1. Palmer, J. D. (2002). The living clock: The orchestrator of biological rhythms. OxfordUniversity Press.
2. Dunlap J. C, Loros J. J, DeCoursey P. J. (2004) Chronobiology Biological Time keeping. Sinauer Associates, Inc. Publishers, Sunderland, MA, USA.
3. Saunders D. S. (2002). Insect Clocks. III Edition, Barens and Noble Inc. New York, USA

NOTE: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time

DISCIPLINE SPECIFIC ELECTIVE COURSE: **ALS ZOO DSE 08**

NON-INSECT PESTS AND THEIR CONTROL

Credits distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practicals / Practice		
Non-insect pests and their control ALS ZOO DSE 08	4	2	Nil	2	Appeared in Sem-VI	NA

Learning Objectives:

The learning objectives of this course are as follows:

- to introduce students with various types of non-insect pests in agriculture and household.
- to give an understanding of their behaviour and the damage they cause to crops
- to acquaint with various plant economic losses caused by non-insect pests.

Learning Outcomes:

By studying this course, the students will be able to:

- recognize major non-insect pests in Indian subcontinent.
- identify the specific life stage of the pest which causes significant loss to crop plants and adopt appropriate measures to control them.

Theory **30h**

Unit 1: Introduction to non-insect pests and their management **8 h**

Introduction, habit and habitat and economic importance of non-insect pests and their management. Major mite pests of cultivated and plantation crops, Economic importance along with their management strategies. Study of Red spider mite (*Tetranychus neocaledonicus*) and Cereal rust mite (*Abacarus hystrix*), its damage on different crops and control measures.

Unit 2: Damage to crops by Molluscs and and their control **7 h**

Important species of snails and slugs as pest in India. Description of their nature of damage on agricultural crops, fruits, vegetables and ornamental plants in coastal area. Study of *Helix* sp and Indian slug species (*Macrochlymus indica*)**.** Strategies for their management.

Unit 3: Nematodes as pests of crops and their control **7 h**

Habitat, general characteristics and management of major phyto-nematodes. Study of Root-knot nematode (*Meloidogyne incognita*) and cyst nematode (*Heterodera rostochiensis)*, its impact on crops and control measures.

Unit 4: Damage to crops by the pests and their management **8 h**

Study of important bird pests of agricultural crops and their control: Rose ringed parakeet (*Psittacula krameri*) and blue rock pigeon (*Columba livia*); damage caused by them and their management. Status of rodents as pest in India. Important species of rodents. Study of Indian mole-rat (*Bandicota bengalensis*), palm ***squirrel*** (*Funambulus palmarum*) and Indian fruit bat (*Pteropus giganteus*) with its nature of damage and control measure.

Practicals **60 h**

(Laboratory periods: 15 classes of 4 hours each)

1. Identification, life cycle and damage caused by following mites *with specimen/Photograph:*
Red spider mite (*Tetranychus neocaledonicus*), Cereal rust mite (*Abacarus hystrix),* Broad mite (*Polyphagotarsonemus latus*)

2. Identification and damage caused by of the following molluscan *with specimen/Photograph:*
Common snail, *Helix* spp and Indian slug (*Macrochlymus indica*)

3. Identification and damage caused by of the following nematode *with specimen/Photograph:*
Root-knot nematode (*Meloidogyne incognita*), cyst nematode (*Heterodera rostochiensis)* and Wheat-gall nematode (*Anguina tritici*)

4. Identification and damage caused by of the following Birds *with specimen/Photograph:*
Rose ringed parakeet (*Psittacula krameria*) and blue rock pigeon (*Columba livia*)

5.Identification and damage caused by of the following mammals *with specimen/Photograph:*
Indian mole-rat (*Bandicota bengalensis*), Commonrat (*Rattus rattus*), palm ***squirrel*** (*Funambulus palmarum*), Indian fruit bat (*Pteropus giganteus*) and common monkey (*Macaca mulatta*)

6. To visit any agriculture Institute and make a project report on main agriculture crops pest and its management.

Essential/recommended readings

1. Dhaliwal, G.S. (2009). *An Outline of Entomology* (2nd Ed.). Kalyani Publishers.
2. Atwal A.S. &Dhaliwal G.S. (2015) *Agricultural pests of south Asia and their management* (8th ed.). Kalyani Publishers.

Suggested readings

1. Devasahayam H.L (2011) *Practicals Manual of Entomology: Insects and Non-insect Pests*. New India Publishing Agency.

NOTE: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSE: **ALS ZOO DSE 09**

MODERN TOOLS AND TECHNIQUES FOR ENTOMOLOGICAL RESEARCH

Credits distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practicals/ Practice		
Modern tools and Techniques for Entomological research **ALS ZOO DSE 09**	4	2	Nil	2	Appeared in Sem-VI	

Learning Objectives:

The learning objectives of this course are as follows:

- To understand modern techniques used in biotechnology for research, diagnostics, and industrial applications.
- To learn the principles, applications, and limitations of bioinstrumentation methods.
- To gain hands-on experience in the operation and maintenance of advanced instruments.
- To develop critical thinking to select and apply suitable techniques for solving specific biological problems.
- To learn to interpret experimental data and troubleshoot issues in instrumentation.

Learning Outcomes:

By studying this course, students will be able to:

- Gain a better understanding of diverse cellular processes and cellular interactions.
- Explain the principles and working mechanisms of advanced instruments in biotechnology.
- Demonstrate proficiency in operating instruments such as spectrophotometers, chromatographs, and PCR machines.
- Design experiments using advanced techniques like chromatography, electrophoresis, and mass spectrometry.
- Analyze experimental data generated by advanced bioinstrumentation.

- to apply biotechnological tools to solve problems in diagnostics, genomics, proteomics, and drug discovery.

Theory: **30h**

UNIT-1: Overview of Basic instruments used in Entomology laboratory **4 h**

Microscopes: Principles and applications of various microscopes, Laminar-Flow Hood, Autoclave, Centrifuge, Hamocytometer, Incubator, Cryostorage Container, pH meter. 2 h

UNIT-2: Spectroscopic Techniques **8 h**

Principles and Applications: UV-Visible spectroscopy, Fluorescence spectroscopy, Advanced Techniques: Infrared (IR) spectroscopy, Atomic Absorption Spectroscopy (AAS), and Nuclear Magnetic Resonance (NMR). Applications: Structure determination, protein folding studies and biomolecular interactions.

UNIT-4: Chromatography and Electrophoresis 6 h

Chromatography: Principles, instrumentation, and applications of HPLC, Gas Chromatography (GC), and Ion Exchange Chromatography. Electrophoresis: Polyacrylamide Gel Electrophoresis (PAGE), Agarose Gel Electrophoresis, 2D Gel Electrophoresis. Applications in genomics and proteomics. Mass Spectrometry (MS): Principles, instrumentation, and applications.

UNIT-4: Molecular Biology Techniques **10 h**

Polymerase Chain Reaction (PCR): qPCR, RT-PCR, and digital PCR. DNA Sequencing: Sanger sequencing and Next-Generation Sequencing (NGS). CRISPR-Cas9 Technology: Gene editing and applications. Biosensors: Principles, components, and applications in diagnostics.

Practicals **60 h**

(Laboratory periods:15classes of 4 hours each)

1. Chromatography Techniques: Separation of biomolecules using Chromatography.
2. Electrophoresis techniques: SDS-PAGE for protein separation.
3. Amplification of DNA. Gel documentation and analysis of PCR products.
4, Imaging Techniques: Demonstration of SEM/TEM.
5. Biosensors: Demonstration of glucose biosensors and ELISA techniques.

Project related to topics covered in theory/ project report based on visit to labs/ institutions/industry.

Essential/recommended readings

1. Principles and Techniques of Biochemistry and Molecular Biologyby Keith Wilson and John Walker, 7th Edition (2010), Cambridge University Press.
2. Biophysical Chemistry: Principles and Techniques by Upadhyay, Upadhyay, and Nath, Revised Edition (2020), Himalaya Publishing.

3. IntroductiontoSpectroscopybyDonaldL.Paviaetal,5th Edition (2015), Cengage Learning.
4. Bioinstrumentation by John G. Webster,1st Edition (2004), Wiley-Interscience.

Suggested readings

1. Fundamentals of Analytical Chemistry by Douglas A. Skoog et al., 9th Edition (2013), Cengage Learning.
2. Molecular Biology of the Gene by James D. Watson etal., 7th Edition (2013), Pearson.
3. Chromatography: Principles and Instrumentation byB.K. Sharma, Revised Edition (2007), Goel Publishing House.

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Bachelor of Science (Prog.) in Applied Life Sciences

Agrochemicals and Pest Management

SEMESTER-VIII

ZOOLOGY COMPONENT

DISCIPLINE SPECIFIC CORE COURSE: **ALS ZOO DSC 08**

CONCEPT OF EVOLUTIONARY BIOLOGY

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE- REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practicals/ Practice		
Concept of Evolutionary Biology ALS ZOO DSC 08	4	2	Nil	2	Appeared in Sem-VII	NA

Learning Objectives:

- The learning objectives of this course are as follows:
- To understand evolutionary forces leading to the variations and diversification of species.
- To learn about deciphering evidences ranging from fossil records to molecular data and to establish phylogenetic relationships of species.
- To gain knowledge of the processes and patterns of biological evolution.
- To get acquainted with origin and evolution of man.
- To acquire problem solving and high order analytical skills by attempting numerical problems as well as performing simulation studies of various evolutionary forces in action.

Learning Outcomes:

By studying this course, students will be able to:

- To gain knowledge about the relationship of the evolution of various species and the environment they live in.

- To apply the knowledge gained on populations in real time, while studying speciation, behaviour and susceptibility to diseases.
- To have a better understanding of the variations and genetic drift to ensure that conservation efforts for small, threatened populations are focused in right direction.
- To predict the Practicals implications of various evolutionary forces acting on the insect population in the field of human health, agriculture and wildlife conservation.

Theory **30 h**

Unit- 1 Origin of life and Historical Review of Evolutionary Concepts. **8 h**

Lamarckism, Darwinism, Neo-Darwinism**,** Chemogeny, RNA world, biogeny, origin of photosynthesis, endo-symbiotic theory

Unit- 2: Evidences of Evolution **4 h**

Palaeontological Evidences: geological time scale, Origin and Evolution of Insects; Molecular Evidences: neutral theory of evolution, molecular clock

Unit-3: Causes and Mechanism of Organic Evolution **9 h**

Variations: Heritable variations and their role in evolution. Natural selection, types of natural selection, artificial selection, kin selection, adaptive resemblances, sexual selection, frequency dependent selection. Natural selection (concept of fitness, selection coefficient), genetic drift (founder's effect, bottleneck phenomenon), migration and mutation (genetic load).

Unit-4: Species, Speciation and Extinction **5 h**

Speciation micro-evolutionary changes (inter-population variations, clines, Ring species, races), species concept, isolating mechanisms. **4 h**

Mass extinctions (events, causes and effects), Detailed explanation of K-T extinction

Practicals **60 hrs**

(Laboratory periods: 15 classes of 4 hrs each)

1. Study of fossils (types, forms and dating) from models/pictures.
2. Study of homology, analogy and homoplasy from suitable specimens.
3. Study of different modes of speciation and adaptive radiation/macroevolution using suitable examples.

4. Study of variations in a sample human population: (a) Continuous variation: Height/Weight in relation to age and sex (b) Discontinuous variation: Ability/Inability to taste Phenylthiocarbamide (PTC).

5. Study of Hardy-Weinberg Equilibrium: statement, assumptions, derivation of the equation and its verification by chi square analysis.

6. Demonstration of role of natural selection and genetic drift in changing allelic frequencies using simulation studies.

Suggested Readings:

1. Roberts, A. (2018) Evolution: the human story, Dorling, Kindersley Ltd.
2. Hall, B.K. and Hallgrimson, B. (2013). Evolution. V Edition, Jones and Barlett Publishers.
3. Campbell, N.A. and Reece J.B. (2011). Biology. IX Edition. Pearson, Benjamin, Cummings. 4. Barton N.H., Briggs D.E.G., Eisen J.A., Goldstein D.B. and Patel N.H., (2007) 1st Ed. Evolution, Cold Spring Harbor Laboratory Press.

Additional Resources:

1. Futuyma, Douglas and Mark, Kirkpatrick (2017) 3rd Ed. Evolutionary Biology, Oxford University Press.
2. Zimmer C. and Emlen D. J., (2013) 1stEd. Evolution: Making Sense of Life, Roberts & Co.
3. Pevsner, J. (2009). Bioinformatics and Functional Genomics. II Edition, Wiley Blackwell.
4. Ridley, M. (2004). Evolution. III Edition, Blackwell publishing.
5. UGC INFONET / DU E-Resources & SciFinder Web Version registration

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DISCIPLINE SPECIFIC ELECTIVE COURSE: **ALS ZOO DSE 10**

MEDICAL AND VETERINARY PESTS

Credits distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practicals/ Practice		
Medical and Veterinary pests **ALS ZOO DSE 10**	**4**	**2**	**Nil**	**2**	**Appeared in Sem-VII**	**NA**

Learning Objectives:

The learning objectives of this course are as follows:

- This course offers an insight about the various types of human diseases.
- This course offers an insight about the various types of Farm Animal diseases
- The students will understand the concepts of pathogens and pathological basis of diseases including infectious diseases caused by viruses, prokaryotes, protozoans, helminthes, vector-borne and zoonotic diseases.
- Vector biology, medical importance and management of the medically important insects and Veterinary Insect Pests

Learning Outcomes

Upon completing this course, students will be able to:

- Identify and describe the importance of medical and veterinary pests: Recognize and describe the biology, ecology, and behavior of various pests, including insects, arachnids, and rodents.
- Understand the role of pests in disease transmission: Explain the role of pests in transmitting and maintaining diseases, and understand the impact of pest-borne diseases on human and animal health.
- Apply integrated pest management principles: Design and implement integrated pest management strategies that incorporate multiple control methods, including chemical, biological, physical, and cultural controls.

- Use surveillance data for pest management decision-making: Collect and analyze surveillance data to inform pest management decisions, and understand the importance of monitoring pest populations and activity.
- Select and apply appropriate pest control methods: Choose and apply effective pest control methods, including chemical, biological, physical, and cultural controls, and understand their advantages and limitations.
- Understand the importance of personal protective equipment (PPE) and other prevention methods: Recognize the importance of PPE and other prevention methods in preventing pest-borne diseases, and understand how to use them effectively.
- Communicate effectively about pest management: Communicate effectively with various stakeholders, including the public, healthcare professionals, and animal owners, about pest management strategies and risks.

Theory **30 h**

Unit-1: Introduction **4 h**

Definitive host, Intermediate host, Parasitism, Ecto- & Endoparasites of skin, Symbiosis, Commensalism, Reservoir, Zoonosis.

Unit- 2: Medically important insect pests **8 h**

Mosquitoes: Anopheles, Culex, Aedes. Rat Flea, Head and body louse, Bed bug, Sand fly Insect, Endoparasites (*Dermatobia hominis and Calliphoridae*)

Unit- 3: Transmission and control of various pathogens and insect vectors **12 h**

Plasmodium vivax, Trypanosoma gambiense; Wuchereria bancrofti, Dengue virus**.** Control of insect vectors of public health. Management of vector borne diseases by Integrated Vector Management.

Unit-4: Veterinary Insect Pests, their life cycle, transmission and control of diseases **6 h**

Flies, Mosquitoes, Ticks, Fleas, Lice and Mites

Practicals **60 hrs**

(Laboratory periods: 15 classes of 4 hours each)

1. Field collection of immature stages of mosquitoes and preparation of temporary slides.
2. Study of ~~few~~ available pathogens of arthropod-borne diseases. Malaria, Culex, Dengue
3. Study of different mosquitoes through photographs

4. Study of life history stages of medically important arthropods by using slides/ photographs: Flies, Ticks, Fleas, Lice and Mites
5. Visit any Vector borne disease lab or carry out a survey of breeding places of Vectors and make a report on your visit/ survey

Suggested Readings:

1. Mullen, Gary R. and Durden, Lance A. (2019). Medical and Veterinary Entomology. Elsevier ; 3rd Edition. ISBN 978-0-12-814043-7
2. Ramnik. Sood (2009) Medical Laboratory Technology Methods and Interpretations, 6th edition; Jaypee Brothers Medical Publishers, ISBN-13: 978-8184484496.
3. Robbins, Basic Pathology, 9th edition (2012), Kumar, Abbas, Fausto and Mitchell; Saunders Publication, ISBN-13: 978-1437717815

Additional Resources:

1. UGC INFONET / DU E-Resources & Sci Finder Web Version registration
2. Arora, D.R and Arora, B. (2001) Medical Parasitology. II Edition. CBS Publications

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DISCIPLINE SPECIFIC ELECTIVE COURSE: **ALS ZOO DSE 11**

LOCUSTS AND THEIR MANAGEMENT

Credits distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practicals/ Practice		
Locusts and their Management **ALS ZOO DSE 11**	**4**	**2**	**Nil**	**2**	Appeared in Sem-VII	**NA**

Learning Objectives:

The learning objectives of this course are as follows:

- The course aims to apprise the students of locust as one of the most dangerous pests of agricultural crops.
- To focus on identification of locust, reasons of their swarming and migratory nature which gives immense economic loss leading to national emergency of food and fodder.
- To provide knowledge about the control, monitoring and management strategies of locust.

Learning Outcomes:

By studying this course, students will be able to:

- learn about the importance of locust as serious pest that cause damage to the agro-ecosystems affecting the economy.
- learn about the habit, habitat, behaviour, morphology and different phases of locust.
- learn about the biology of locust and various methods of its control.

Theory: **30 h**

Unit 1: Introduction to Locusts **7 h**

Introduction, historical background, locust plague and upsurges, Systematic position of locusts and grasshoppers; habitat, behaviour and morphology of locusts. Difference between locusts and grasshoppers.

Unit 2: Distribution, life cycle of Locusts in India **6 h**

Locusts in India, distribution, life cycle of different species: *Schistocerca gregaria, Patanga succincta, Locusta migratoria;* damage caused by them.

Unit 3: Breeding of Locusts **5 h**

Breeding seasons and breeding areas, swarming. Biological phases: solitary, transient and gregarious. Changes in their behavior, color and structure. Biotic theory of periodicity.

Unit 4: Locust management **12h**

National and international organizations - LWO, SALO, CALO, FAO, NLCC, IRLCO-CSA (International Red Locust Control Organization for Central and Southern Africa), swarm monitoring. Control methods- Mechanical and traditional, regulatory practices,Chemical methods: ULV Sprays, dusting, baits, IGRs; advantages and disadvantages of different chemical control methods, biological practices: biopesticides, predators, parasitoids; Integrated Pest Management; Plant quarantine. Socio-Economic importance: Impact on the health of fauna and humans; on agriculture.

Practicals **60 h**

(Laboratory periods: 15 classes of 4 hours each)

1. Comparative study of different species of locusts through specimens /photographs.
2. Study of mouthparts, wings and legs of locust through specimens /photographs.
3. Study of sexual dimorphism in locust through specimens/photographs.
4. Study the life stages of the locust through specimens/slides/photographs.
5. Study of different tools used in the management of locust.
6. Study of different host plants of locust.
7. Visit to different institutes/stations/laboratories (submit a Report on visit/current status of locusts in India).

Essential/recommended readings

1. Ritchie, J. M., &Dobson, H. (1995).*Desert Locust, control operations and their environmental impact*. NRI bulletin 67, Hopps the printers Ltd.
2. Atwal, A. S.; &Dhaliwal, G. S. (2015). *Agricultural pest South Asia and their management* (8th Ed.). Kalyani publishers.
3. Pradhan, S. (2016). *Agricultural Entomology and Pest Control*. ICAR publication.
4. Pandey & Kumari R. (2021) *Locust in Indian Agriculture*. Notion press India.

Suggested readings

1. Rachadi, Tahar (2010). *Locust control handbook*. CTA publication, AJ Wagningen, The

Netherlands.
2. Krall, S; Peveling, R & Diallo, D. Ba. (1997).*New strategies in Locust Control*. Pirahauser Basel springer.

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DISCIPLINE SPECIFIC ELECTIVE COURSE: **ALS ZOO DSE 12**

PATHOGENS OF INSECTS IN PEST MANAGEMENT

Credits distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practicals / Practice		
Pathogens of Insects in Pest Management **ALS ZOO DSE 12**	**4**	**2**	**Nil**	**2**	**Appeared in Sem-VII**	NA

Learning Objectives:

The learning objectives of this course are as follows:

- to provide knowledge about the basic pathogens infecting insects.
- To understand Epizootiology, symptomatology and etiology of diseases caused by various agents.
- To promote use of environmentally friendly pest Control

Learning Outcomes:

By studying this course, students will be able to:

- Describe the nature and diversity of pathogens infecting insects, including viruses, bacteria, fungi, protozoa, and nematodes.
- Identify and classify different insect pathogens based on their biology, morphology, and mode of action.
- Assess the potential of entomopathogens as biological control agents in sustainable pest management.
- Advocate the use of insect pathogens as alternatives to chemical pesticides in promoting environmentally friendly pest control:

Theory **30 h**

Unit 1: Introduction to Insect Pathogens **6 h**

History of insect pathology, Classification of Insect Pathogens, infection of insects by bacteria, fungi, viruses, protozoa, rickettsia , spiroplasma and nematodes.

Unit 2: Etiology of Diseases and Defense systems **10 h**

Epizootiology, symptomatology and etiology of diseases caused by the Insect Pathogens and the controlling factors. Defense mechanisms in insects against pathogens.

Unit 3: Control of Pests **10 h**

Exploitation of Bacteria (Bacillus thuringiensis) and Viruses (Nuclear Polyhedrosis Viruses) for control of pests: Management and mass production techniques.

Unit 4: Sustainable Pest Control **4 h**

Safety and registration of microbial pesticides. Role of insect pathogens in Sustainable Pest Control.

Practicals **60 h**

(Laboratory periods: 15 classes of 4 hours each)

1. Equipments used in insect laboratory.
2. Identification of different groups of insect pathogens and symptoms of infection.
3. To study symptomatology and etiology of diseases caused by bacteria, fungi, viruses, protozoa, rickettsia, spiroplasma and nematodes with the help of photographs.
4. Isolation, culturing and testing pathogenicity of different groups of pathogens.
5. Testing Koch's postulates. Estimation of pathogen load.
6. Extraction of pathogens from live organisms and soil.

Essential/recommended readings

1. Boucias DG & Pendland JC. 1998. Principles of Insect Pathology. Kluwer Academic Publisher, Norwel.
2. Nitesh Kumar Maru, Ashwani Kumar, and Sunil Zachariah. Insect pathology: Text Book and Practicals Manual**.** Scientific Publisher, New Delhi.
3. Steinhaus EA. 1984. Principles of Insect Pathology. Academic Press, London.

Suggested readings

1. Yoshinori Tanada and Harry K. Kaya. **Insect Pathology** Academic Press.London.
2. Burges HD & Hussey NW. (Eds). 1971. Microbial Control of Insects and Mites. Academic Press, London.

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DISCIPLINE SPECIFIC ELECTIVE COURSE: **ALS ZOO DSE 13**

Insect Toxicology

Credits distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practicals/ Practice		
Toxicology of Pests **ALS ZOO DSE 13**	**4**	**2**	**nil**	**2**	**Appeared in Sem-VII**	NA

Learning Objectives:

Learning objectives of this course are as follows:

- To impart knowledge about the biological effects of toxic chemicals on insects.
- To emphasize on factors affecting toxicity of insecticides and synergistic substances which can be used to increase their efficacy.
- To enable students to understand the development of resistance in insects to insecticides.

Learning Outcomes:

By studying this course, students will be able to:

- learn about the principles of insecticide toxicity
- understand the safe use of toxic insecticides as well as treatments for insecticide poisoning.
- acquire Practicals skills of pest management in public buildings like termite proofing, rodent control.

Theory **30h**

Unit 1. Introduction to Toxicology **4h**

History of chemical control, Pesticides registration, Pesticide industries and markets.

Unit 2. Principles of Toxicology **10h**

Evaluation of insecticide toxicity: LC50/ LD50, ED50, LT50 etc, Tolerance limits, ADI value, Bioaccumulation; Joint action of insecticides: synergism, potentiation, antagonism, Insecticide compatibility, selectivity and Phytotoxicity, Factors affecting toxicity of insecticides.

Unit 3. Pesticide metabolism **8 h**

Mode of entry of pesticides: I, F, W Insecticides and their metabolism - phase I and phase II pathways, Pest resistance to insecticides; Mechanisms and types of resistance; Diagnosis and treatment of insecticide poisoning, Health hazards: carcinogenic, mutagenic and teratogenic effects.

Unit 4. Pest Management in Residential and Public Places **8 h**

Principles and methods of pest management in residential places and public buildings, Insecticides for domestic use and their safety, Pre and post-construction termite proofing of buildings, Appliances for domestic pest control; Organic methods of domestic pest management.

Practicals **60 h**

(Laboratory periods: 15 classes of 4 hours each)

1. To calculate LD50/ED50/LT50 of an insecticide from data provided.
2. To study the equipment used for spraying and dusting of insecticide**s.**
3. Metabolism of insecticides in insects using TLC
4. Pesticide residues analysis of soil samples by soxhlet extraction method
5. Video Demonstration of Gas chromatography/ HPLC.
6 Project Report on visit to IARI, IPFT, Hindustan Insecticides Ltd., FCI complex, etc.

Suggested Readings:

1. Ishaaya, I., & Degheele, (Eds.). (1998). *Insecticides with Novel Modes of Action.* Narosa Publication. House.
2. Matsumura, F. (1985). *Toxicology of Insecticides*. Plenum Press.
3. Perry, A.S., Yamamoto, I., Ishaaya, I., &Perry, R. (1998). *Insecticides in Agriculture and Environment.* Narosa Publication. House.
4. Prakash, A., & Rao, J. (1997). *Botanical Pesticides in Agriculture.* Lewis Publication.

Additional Readings:

1. Greim, H., & Snyder, R. (ed)., (2018). *Toxicology and Risk Assessment: A Comprehensive Introduction.* John Wiley and Sons.
2. Whitford, F. (2002). *The Complete Book of Pesticide Management.* Wiley Interscience, John Wiley and Sons.
3. Chattopadhyay, S.B. (1985). *Principles and Procedures of Plant Protection.* Oxford & IBH.
4. Gupta, H. C. L. (1999). *Insecticides: Toxicology and Uses.* Agrotech. Publication.

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DISCIPLINE SPECIFIC ELECTIVE COURSE: **ALS ZOO DSE 14**

Application of Biotechnology for Pest Management

Credits distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practicals / Practice		
Application of Biotechnology for Pests-Management **ALS ZOO DSE 14**	**2**	**1**	**Nil**	**1**	**Appeared in Sem-VII**	NA

Learning Objectives:

Learning objectives of this course are as follows:

- To provide knowledge about alternative measures to traditional pest management practices against insects.
- To learn about various tools and techniques of biotechnology used for controlling insect pests.

Learning Outcomes:

By studying this course, students will be able to:

- distinguish between various types of pests and the damage they cause to their host plants.
- acquire the skill to use important tools and techniques of biotechnology for management of pests.

Theory **30h**

Unit 1: Introduction to eukaryotic cell culture **4 h**

Introduction to eukaryotic cell culture; Historical background, Biology of animal cell and cell-cell interactions, good laboratory practices, Sterilization methods and techniques. Isolation of the tissue, Initiation of culture: Types of primary culture. Subculture and cell lines;

Unit 2: Media and Buffers **6 h**

Types of culture media, Physicochemical characteristics of medium-Osmolality, Temperature, Viscosity and Surface Tension. Importance of Serum and Serum-free media, Antibiotics and other supplements.

Unit 3: Advanced Cell culture techniques **15 h**

Principles of cryopreservation of cell lines. Methodology of production of chimeric DNA, I*n vitro* transfection of animal cells-chemical method, lipid mediated gene transfer (lipofection), Electroporation. Microbial contaminants (Bacteria, Yeast, Fungi, Mycoplasma and Virus) in cell line. Applications of Animal Cell Culture: Toxicology studies, Vaccine production, Gene therapy, Stem cell therapy, Production of recombinant proteins, Derived benefits from DNA barcode-based molecular taxonomy, Use of biotechnology for insect pest management

Unit 4: Challenges and Technologies for Pest management **5 h**

International project on barcode of life, Host–plant resistance: mechanism of resistance-antibiosis, antixenosis, tolerance, factors mediating resistance. Transgenic mosquito**,** Genetic control through sterile insect techniques.

Practicals **60 h**

(Laboratory periods: 15 classes of 4 hours each)

1. Packing and sterilization of glassware and plasticware for cell culture.
2. Preparation and sterilization of culture medium, buffers and solutions.
3. To study about cytotoxicity and cell viability.
4. Demonstration of Transfection in cell lines using Photographs/Videos.
5. Demonstration of working of the following instruments:

i) Laminar Flow Hood ii) Autoclave iii) Humidified CO_2 Incubator iv) pH Meter.

6. Project report on visit to animal cell culture labs

Essential/recommended readings

1. Freshney, R. IAN. (2021). Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications (8th Ed.).
2. Masters, John. R. W. (2000). Animal Cell Culture: A Practicals Approach (3rd Ed.).
3. Butler, M. (2003). Animal Cell Culture and Technology. (2nd Ed.).

Suggested readings

1. Davis, John. M. (2011). Animal Cell Culture: Essential Methods.
2. Bhatt, Sheelendra. M. (2011). Animal Cell Culture: Concept and Application.

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