





UNIVERSITY OF SARGODHA
OFFICE OF THE REGISTRAR
(ACAD BRANCH)

NOTIFICATION

On the recommendations of Academic Council made in its 21st (2/2024) meeting held on 07.06.2024, the Syndicate in its 67th (3/2024) meeting held on 12.07.2024 approved the following for implementation w.e.f. Fall 2024.

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| I. Curriculum of Post Graduate Diploma in Medial Entomology and Disease Vector Control (PGD-MEDVC) | Annex-'A' |
| II. Revised curriculum of M.Sc (Hons.) in Entomology. | Annex-'B' |
| III. Revised curriculum of Ph.D. in Entomology | Annex-'C' |


(WAQAR AHMAD)
Additional Registrar (General) 
Dated: 31.01.2025

No. SU/Acad/25/ 100

Distribution:

- Chairman, Department of Entomology
- Controller of Examinations
- Director Academics

C.C:

- Dean, Faculty of Agriculture
- Principal College of Agriculture
- Director, QEC
- Additional Registrar (Affiliation & Registration)
- Secretary to the Vice-Chancellor
- PA to Registrar
- Notification File

SCHEME OF STUDIES
FOR THE DEGREE OF M.Sc. (Hons.) Entomology



Implementation w.e.f. Fall 2024

DEPARTMENT OF ENTOMOLOGY
COLLEGE OF AGRICULTURE
UNIVERSITY OF SARGODHA
2024

Chairman
Chairman
Department of Entomology
College of Agriculture
University of Sargodha

1. Nomenclature of the Program:

M.Sc. (Hons.) Entomology

2. Department Brief:

Established in 2012, the Entomology Department at the University of Sargodha (UOS) has flourished from its 2007 beginnings as a major subject within the College of Agriculture. Today, it serves as a vital resource for UOS, developing a spirit of exploration and discovery in the fascinating world of insects and their profound impact on agriculture. The department offers a vigorous M.Sc.(Hons.) program in Entomology since 2009, equipping graduates with the expertise to tackle critical challenges in this field.

Our Mission:

Develop highly skilled professionals: We are dedicated to training the next generation of entomologists, equipping them with the technical expertise to tackle critical challenges in crop protection.

Promote academic excellence: Our faculty is providing exceptional teaching, research, and training opportunities for students pursuing undergraduate, postgraduate, and doctoral degrees.

Solve community problems: By promoting excellence in research, we aim to develop innovative solutions to address agricultural issues impacting our communities.

The Entomology Department, College of Agriculture, University of Sargodha, is committed to the continuous improvement of productivity and profitability in agriculture and related fields. We achieve this by:

Building capacity in entomology: We strive to develop a highly skilled workforce in the field of entomology.

Conducting research in entomology: Our research focuses on both fundamental and applied aspects of entomology. This research aims to develop novel, economically viable pest management strategies for crops, cereals, fruits, and vegetables.

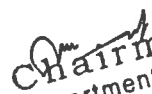
Integrating teaching, research, and extension: We visualize a continuous integration of teaching, research, and extension services to ensure food security.

Fostering research collaboration: We actively seek to develop research collaborations with public and private sector organizations at both national and international levels.

Offering IPM training courses: We provide training courses in Integrated Pest Management (IPM) to equip individuals with the necessary skills for effective pest control.

3. Program Learning Objectives:

The Program Learning Objectives for a M.Sc. (Hons.) Entomology encompasses a comprehensive set of goals designed to equip students with the knowledge, skills, and competencies necessary for success in the field. By the end of this program, students are expected to demonstrate a profound understanding of entomology principles, including Entomological research methods/techniques, insecticide toxicology, ecology, and pest management strategies. They should be adept at conducting scientific research, employing innovative techniques, and applying sustainable practices to address entomological challenges in agriculture. Furthermore, graduates should exhibit effective communication and collaboration skills, enabling them to work seamlessly within multidisciplinary teams and engage with diverse stakeholders in the agricultural sector. Overall, the program aims to produce graduates who are well-prepared to contribute significantly to sustainable agriculture, pest control, and food security.


Chairman
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University of Sargodha

4. Program Structure:

Duration	Minimum 1.5-Years (3-Semesters), Maximum 4-Years (8-Semesters)
Entry Requirements:	Candidates having Bachelor of Science (Hons.) degree in Agriculture with major in Entomology/Agricultural Entomology or BS Zoology* or a closely related field from HEC recognized Institutions with minimum CGPA 2.0/4.0 in B.Sc. (Hons.) or BS degree (16 years of education) in semester system *Subject to take deficiency courses as per requirement
Intra-disciplinary fields allowed for admission	1. Zoology* 2. Agricultural Sciences* (Any major in Agriculture) *Subject to take deficiency courses as per requirement
Degree Completion Requirements:	Total Credit Hours of Course Work: 24-33 Total Credit Hours of Thesis/Courses In Lieu of thesis: 06 Total Credit Hours of Program: 30-39 Completion of all coursework (core and elective) with satisfactory performance Successful completion of a research project and thesis defense
Program Mode (select one)	I. Thesis Track ✓ II. Coursework Track
Specialization (if any)	Students may tailor their studies to a specific area of entomology through elective courses and research project topic selection. However, formal specialization tracks may not be offered.

5. List of Deficiency Courses of Level-6: (for intra-disciplinary admissions only)

Sr. No.	Course Code	Course Title	Credit Hours	Prerequisite
1.	ENTO-6103	Insect Morphology	3(2-1)	Ento-5101 or equivalent
2.	ENTO-6105	Insect Ecology	3(2-1)	Ento-5101 or equivalent
3.	ENTO-6109	Insect Physiology	3(2-1)	Ento-5101 or equivalent
4.	ENTO-6110	Classification of Adult Insects	3(2-1)	Ento-5101 or equivalent
5.	ENTO-6111	Agricultural Pests and their Management	3(2-1)	Ento-5102 or equivalent
6.	ENTO-6112	Stored Product Pests and their Management	3(2-1)	Ento-5102 or equivalent
7.	ENTO-6116	Integrated Pest Management	3(2-1)	Ento-5102 or equivalent
8.	ENTO-6118	Insecticides and their Application	3(2-1)	Ento-5102 or equivalent

6. List of Mandatory/Compulsory/Core Courses:

Sr. No.	Course Code	Course Title	Credit Hours	Prerequisite
1.	ENTO-7101	Research Methods in Entomology	3(2-1)	B.Sc. (Hons) Agri. with Entomology or related degree
2.	ENTO-7102	Insects in Relation to Plant Diseases	3(2-1)	B.Sc. (Hons) Agri. with Entomology or related degree
3.	ENTO-7103	Special Problem	1(1-0)	Nil
4.	ENTO-7104	Seminar	1(1-0)	Nil
5.	ENTO-7105	Insecticide Toxicology	3(2-1)	B.Sc. (Hons) Agri. with Entomology or related degree
6.	STAT-7151	Statistical Methods for Agricultural Research-I	3(3-0)	Nil

Chairman
 Department of Entomology
 College of Agriculture
 University of Sargodha

7. List of Elective Courses:

Sr. No.	Course Code	Course Title	Credit Hours	Prerequisite
1.	ENTO-7106	Environmental Entomology	3(2-1)	B.Sc. (Hons) Agri. with Entomology or related degree
2.	ENTO-7107	Insecticide Resistance and Management	3(2-1)	Same as above
3.	ENTO-7108	Molecular Entomology	3(2-1)	Same as above
4.	ENTO-7109	Medical and Veterinary Entomology	3(2-1)	Same as above
5.	ENTO-7110	Acarology	3(2-1)	Same as above
6.	ENTO-7111	Insecticide and Public Health	3(2-1)	Same as above
7.	ENTO-7112	Insect Biochemistry	3(2-1)	Same as above
8.	ENTO-7113	Pesticides Application Equipments	3(2-1)	Same as above
9.	ENTO-7114	Forensic Entomology	3(2-1)	Same as above
10.	ENTO-7115	Insect Rearing Techniques	3(2-1)	Same as above
11.	ENTO-7116	Insect Biotechnology	3(2-1)	Same as above
12.	ENTO-7117	Chemical Ecology of Insects	3(2-1)	Same as above

8. Thesis:

1	Thesis	6
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College of Agriculture
University of Sargodha

Scheme of Studies

M.Sc. (Hons.) Entomology

Semester-I

Category	Course Code	Course Title	Credit Hours	Pre-Requisite
Deficiency-1*	ENTO-61xx	<i>To be selected from list</i>	3(2-1)/ 3(3-0)	
Compulsory-1	ENTO-71xx	<i>To be selected from list</i>	3(2-1)	
Compulsory-2	ENTO-71xx	<i>To be selected from list</i>	3(2-1)	
Elective-1	ENTO-71xx	<i>To be selected from list</i>	3(2-1)/ 3(3-0)	
Elective-2	ENTO-71xx	<i>To be selected from list</i>	3(2-1)/ 3(3-0)	

Semester Credit Hours: 12-15

Semester-II

Category	Course Code	Course Title	Credit Hours	Pre-Requisite
Deficiency-2*	ENTO-61xx	<i>To be selected from list</i>	3(2-1)/ 3(3-0)	
Compulsory-3	STAT-7151	Statistical Methods for Agricultural Research-I	3(3-0)	
Compulsory-4	ENTO-71xx	<i>To be selected from list</i>	3(2-1)	
Compulsory-5	ENTO-7103	Special Problem	1(1-0)	
Elective-3	ENTO-71xx	<i>To be selected from list</i>	3(2-1)/ 3(3-0)	

Semester Credit Hours: 10-

13

Semester-III


Category	Course Code	Course Title	Credit Hours	Pre-Requisite
Deficiency-3*	ENTO-61xx	<i>To be selected from list</i>	3(2-1)/ 3(3-0)	
Compulsory-6	ENTO-7104	Seminar	1(1-0)	
Elective-4	ENTO-71xx	<i>To be selected from list</i>	3(2-1)/ 3(3-0)	

* For Intra-disciplinary admitted candidates only

Semester credit hours: 04-7

Semester-IV

Category	Course Code	Course Title	Credit Hours	Pre-Requisite
Compulsory-7		Thesis	6(0-6)	Completion of course work



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College of Agriculture
University of Sargodha

Program Summary:

Category	Minimum No. of Courses	Minimum No. of Credit Hours
Deficiency Courses	3	9
Compulsory Courses	6	14
Elective Courses	4	12
Thesis or Courses in Lieu of Thesis	N/A	N/A

Note:

- I. The Regulations related to MS/M.Phil. /M.Sc. (Hons.) or equivalent approved by the Syndicate from time to time shall also be applicable.
- II. Deficiency Courses are to be decided by Graduate Program Committee in start of each session.
- III. Department can change the order of Core/Compulsory and Elective Courses as per availability of resources or demand.
- IV. Department can change the course offering as per available resources but shall be uniform for one session.


Chairman
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College of Agriculture
University of Sargodha

COURSE CONTENTS
M.Sc. (Hons.) Entomology
(List of Deficiency Courses)

ENTO-6103

Insect Morphology

3 (2-1)

This course aims to provide concepts of basic morphology of insects, particularly in reference to the Ak-grasshopper. Students will be familiar with the basic internal and external structural (anatomical) features of a model insect. The course includes a detailed description and demonstration of different external and internal morphological and anatomical features of a typical insect taking *Poekilocerus pictus* Ak grasshopper as model insect specimen. Students will be able to comparatively study these insect body features. Moreover, students will get familiarized with permanent and temporary mounts of different body structures and tissues of insects.

Contents (Theory)

- 1 Introduction of insect morphology
- 2 Integument and its layers with its derivatives in insects
- 3 Regions and segmentation of insect body
- 4 Comparison of morphology of insect head, thorax and abdomen
- 5 The appendages of insects in different insect orders
- 6 Morphology of endoskeleton in insects
- 7 Morphology of internal organ systems
- 8 The exocrine and endocrine organs in different insect orders

Contents (Practical)

- 1 Structure of insect integument and its derivatives
- 2 Comparative external and internal morphology of different insect orders
- 3 Preparation of temporary mounts of chewing and sponging type mouthparts
- 4 Preparation of temporary mounts of chewing and lapping type mouthparts
- 5 Preparation of temporary mounts of sucking and siphoning type mouthparts
- 6 Preparation of temporary mounts of types of antennae and wings in insects
- 7 Preparation of temporary mounts of male and female insect genitalia
- 8 External and internal body organs of different insect orders.


Recommended Texts

1. Richard, O.W. and R.G. Davies. (1984). *Imm's General Textbook of Entomology*, Vol. I (Structure, Physiology & Development) (10th ed.). New York: Chapman and Hall.
2. Snodgrass, R. (1935). *Principles of Insect Morphology*. U.S.A.: Cornell University Press.

Suggested Readings

1. Chapman, R. F. (2000). *The insects: Structure and Function* (4thed.). U.K.: Hodder and Stoughton Education Ltd.
2. Romoser, W.S. (2001). *The Science of Entomology* (3rd ed.). New York: WCB McGraw-Hill Inc.
3. Tonapi, G. T., 1994. *Experimental Entomology. An Aid to Laboratory and Field Studies*. CBS Publishers and Distributors, New Delhi, India.

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This course encompasses the basic concepts of insect ecology. It aims to familiarize the students about the key ecological parameters and factors interacting with insects such as natality, mortality, migration, dispersal and other key factors such as density dependent and density independent factors and inter and intra-specific interactions of insect species within a particular habitat, niche or natural and agro-ecosystem. Moreover, there is detailed information about the life table and diversity indices used to determine and understand the basics of an insect's ecology. The students should be well versed with the basic concepts of insect ecology, succession, population, and ecosystem and insect-ecosystem interactions.

Contents (Theory)

- 1 Overview of insect ecology, divisions of ecology
- 2 Habitat and niche
- 3 Intra and interspecific interactions
- 4 Natural and agro-ecosystems
- 5 Flow of energy in ecosystem, trophic relations
- 6 Food chain, food web and food mesh concepts
- 7 Ecological succession
- 8 Population and its characteristics like natality, mortality, migration, dispersal, key factors
- 9 Density dependent and density independent factors
- 10 Introduction to life tables and diversity indices

Contents (Practical)

- 1 Maintenance and measurement of abiotic factors (temperature, humidity, light, wind etc.) with different instruments
- 2 Population sampling, estimation and construction of life tables

Recommended Texts

1. Bourtzis, K. & Miller, T. (2003). *Insects Symbiosis*. Boca Raton, FL: CRC Press.
2. Huffaker, C.B. & Robert, L.R. (1984). *Ecological Entomology*. New York: Wiley Intersciences.

Suggested Readings

1. Odum, E. P. & Gary W.B. (2005). *Fundamentals of Ecology*. CA, USA: Thomson Brooks Inc.
2. Price, P. W., Denno, R. F., Eubanks, M. D., Finke D. L. & Kaplan I. (2011). *Insect Ecology: Behavior, Populations and Communities*. Cambridge, UK: Cambridge University Press.
3. Rockwood, L.L. (2006). *Introduction to Population Ecology*. New York: Wiley, John & Sons.

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University of Sargodha

This course is an undergraduate course for B.Sc. (Hons.) classes. This course aims to provide concepts of basic physiology, their functions in insects, particularly in reference to the Ak-grasshopper. The students will be able to understand the basic structural and functional principles of various insect body systems such as insect reproduction, respiratory, circulatory, nervous, muscular, digestive systems and functioning of different insect sense organs. Students will learn about the basics of physiological and chemical functioning of insect communication entities such as synthesis and functioning of insect pheromones and other chemical messenger molecules. Students will understand the thermoregulation process of insects.

Contents (Theory)

- 1 Introduction to insect physiology
- 2 Embryonic and post-embryonic development in insects
- 3 Physiology of integument
- 4 The structure and function of insect digestive system
- 5 The structure and function of insect circulatory, excretory and respiratory systems
- 6 The structure and function of insect reproductive, muscular and nervous systems;
- 7 The types of sense organs and perception in insects
- 8 The types of sound and light production organs in insects
- 9 The mechanism of Thermoregulation in insects
- 10 Mechanism of hormones and pheromones production and function in insects

Contents (Practical)

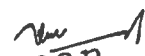
- 1 Analysis of insect chitin and cuticular proteins
- 2 Dissection of insect digestive and reproductive systems
- 3 Analysis of insect digestive enzymes
- 4 Measurement of respiration rate of insect and insect blood cells
- 5 Analysis of insect excretory products
- 6 Measuring response of insect hormones and pheromones

Recommended Texts

1. Berridge, M.J. & Treherne, J.E. (1982). *Advances in Insect Physiology*. London: Academic Press Inc.
2. Chapman, R.F. (1998). *The Insects; Structure and Function*(4thed.). New York: American Elsevier Publishing Co., Inc.

Suggested Readings

1. Howse, P. Stevens, I. & Jones, O. (1998). *Insect Pheromones and their Use in Pest Management*. London: Chapman and Hall.
2. Kerkut, G.A. & Gilbert, L.I. (1985). *Comprehensive Insect Physiology, Biochemistry and Pharmacology*. Oxford: Pergamon Press.
3. Rockstein, M. (ed.). (1974). *Advances in Insect Physiology* (2nd ed.), London: Academic Press.


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 University of Sargodha

Study of insect biodiversity and evolution are integral part of entomological sciences. Adult insect individuals represent the most astonishing biodiversity features as they manifest the distinct features of different species. This course aims to introduce the students about the basics of insect classification and biodiversity of different insect orders upto family level. Students will get familiarized with the concepts of insect classification, biodiversity and their different types. They will learn to study adaptation strategies of adult insects in different geographical areas and about their adaptive and phylogenetic affinities. They will study the available insect fauna diversity in Pakistan and their classification among different hierarchical categories i.e. orders, families, genera etc.

Contents (Theory)

- 1 Introduction to insect classification and biodiversity
- 2 Schemes of classification; types and components of biodiversity
- 3 History of insects, phylogenetic affinities of different orders
- 4 Insect adaptation in various geographical regions
speciation and biodiversity
- 5 Classification of insect orders up to family level with particular reference to insect fauna of Pakistan

Contents (Practical)


- 1 Collection, preservation, identification and classification of insects upto family level
- 2 Methods of studying biodiversity

Recommended Texts

1. Afzal, M. & Mufti, S.A. (1998). *Natural History Research*. Islamabad: Pakistan Scientific and Technological Information Center.
2. Collins, W. W & Quailset, C. O. (1998). *Biodiversity in Agroecosystems*. Boca Raton, New York: Lewis Publishers.

Suggested Readings

1. Triplehorn, C.A. & Jhonson, N.F. (2005). *Borror and DeLong's Introduction to the Study of Insects* (7th ed.). Belmont, CA: Brooks Cole.
2. Wheeler, W.M. (2006). *Insects: their Origin and Evolution*. New Delhi: Discovery Publishing House.
3. Suhail, A. (2008). *A Note Book of Classification of Adult Insects (Insect History, Biodiversity, Collection and Classification* (2nd ed.). Faisalabad: University of Agriculture.


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This graduate course, being taught to the students of B.Sc. (Hons.), includes comprehensive description and demonstration of biology and ecology of major agricultural pests of Indo-Pak region including agricultural insect pests, mite pests and vertebrate pests as well. Students will be able to learn about the biological and ecological behavior of major agricultural pests, their damage potential and damage symptoms and about different control strategies against these pests such as about different cultural, legislative, biological, chemical control tactics. At the end of course, students will be able to identify major agricultural pest species, their damage symptoms and will be able to find out the most effective control techniques against these pests.

Contents (Theory)

- 1 Introduction
- 2 Concepts of IPM technology
- 3 Identification
- 4 Distribution
- 5 Host plants, biology, damage and management of mites and insect pests of field crops, vegetables and orchards
- 6 Brief introduction to important vertebrate pests

Contents (Practical)


- 1 Collection
- 2 Identification
- 3 Distribution, host plants, biology
- 4 Nature of damage and management of insect and mite pests of field crops, vegetables and orchards
- 5 Other important vertebrate pests

Recommended Texts

1. Agarwal, S. (2009). *Insect Pests of Cereals and their Management*. India: Oxford Book Co.
2. Atwal, A.S. & Dhaliwal, G. S. (2005). *Agricultural Pests of South East Asia and their Management*. Ludhiana: Kalyani Publishers.

Suggested Readings

1. Awasthi, V.B. (2007). *Agricultural Insect Pests and their Control*. Jodhpur, India: Scientific Publishers.
2. Brooks, J.E., Ahmad, E., Hussain, I., Munir S. & Khan A. A. (1990). *A Training Manual on Vertebrate Pest Management*. Islamabad: Pan Graphics Publishers, Islamabad.
3. Fenemore, P.G. (2006). *Applied Entomology*. New Delhi: New Age International Pvt. Ltd.


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University of Sargodha

This course aims to clear the concepts of stored product pest management, food storage principles and storage losses incurred by different insect and mite pests. Students will learn about the basic sampling strategies being used for pest scouting in storage industry and about the biological and ecological aspects of each major stored grain insect or mite pests and will be able to understand different factors affecting grain and other stored food products in storage structures. They can collect, preserve and identify different stored grain insect pests and will also learn about how to rear some of these stored grain insect pests for different studies.

Contents (Theory)

- 1 Introduction
- 2 Identification
- 3 Biology and management of different stored product pests
- 4 Principles and types of storages
- 5 Factors affecting grain and other products in storages
- 6 Stored product losses and their prevention

Contents (Practical)

- 1 Visits to different godowns and demonstration of sampling methods
- 2 Collection, identification and management of different stored product pests
- 3 Culture of some stored products insect pests under different climatic conditions

Recommended Texts

1. Ashfaq, M. Saleem, M. A. & Ahmad, F. (2009) *Zari Ajnaski Mahfooz Zakhira Kari* (in Urdu). Lahore: Pak Book Empire, Lahore.
2. Hill, D.S. (2002). *Pests of Stored Food Stuffs and Their Control*. Berlin:Kluwer Academic Publishers.

Suggested Readings

1. Rees, D. (2009). *Insects of Stored Products*. New York: Manson Publishing Company.
2. Zaklandvoi, G. A. & Ratanova. V. F. (1987). *Stored Grain Pests and their control*. London: Oxonian Press Pvt. Ltd.

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College of Agriculture
University of Sargodha

Integrated pest management, or IPM, is a process you can use to solve pest problems while minimizing risks to people and the environment. IPM can be used to manage all kinds of pests anywhere—in urban, agricultural, and wildland or natural areas. This course provides comprehensive information related to the integrated pest management strategies being employed in plant protection sector. It provides students understanding of the basic concepts of insect pest population sampling and fluctuation factors in the field, population assessment, and about the principles, requirements and implementation of IPM. Students will be able to learn about the different strategies such as cultural, physical, mechanical, legislative, chemical, biological, microbial, biotechnological and genetic control measures to be used in an integrated manner to manage or control any insect pest species.

Contents (Theory)

- 1 Introduction
- 2 History, concept and principles of integrated pest management (IPM)
- 3 Organic farming, economics of pest management
- 4 Different methods of insect pest scouting and forecasting
- 5 Losses caused by insect pests to different crops
- 6 Methods of pest management: cultural, physical, mechanical, legislative, chemical, biological, microbial, biotechnological and genetic control measures
- 7 Feeding deterrents
- 8 Insect growth regulators (IGRs) and insect pheromones

Contents (Practical)


- 1 Demonstration of different methods of pest scouting and monitoring
- 2 Nature and extent of damage; assessment of crop losses by different methods
- 3 Estimation of economic threshold levels of different crop pests
- 4 Installation of light and pheromone traps
- 5 Designing of IPM modules of important selected crops

Recommended Texts

1. Atwal, A.S. & Bains, S.S. (2005). *Agricultural Pests of South East Asia and their Management*. Ludhiana: Kalyani Publishers.
2. Awasthi, V.B. (2007). *Agricultural Insect Pests and their Control*. Jodhpur, India: Scientific Publishers.

Suggested Readings

1. Binns, M.R. (2000). *Sampling and Monitoring in Crop Protection*. UK: CABI Publishing Co.
2. Dent, D. (2000). *Insect Pest Management* (2nd ed.). Ascot, UK: CABI Bioscience, UK Centre.
3. Dhaliwal, G.S. & Arora, R. (2006). *Integrated Pest Management*. Ludhiana, India: Kalyani Publishers.


Chairman
Department of Entomology
College of Agriculture
University of Sargodha

This course aims to provide information to students about concept of toxicity and insecticide formulations, mode of action, residues of insecticides and various types of spray equipment. Course includes the description about the classification of different insecticide formulations on basis of their mode of entry in to target insect body, on basis of their chemical nature, mode of action, toxicity level and formulation types. Moreover, basic structural and functioning principles of major insecticide application apparatus are discussed in this course.

Contents (Theory)

- 1 Introduction to insecticides and their application
- 2 Nomenclature of insecticides
- 3 Classification on the basis of mode of entry
- 4 Classification on the basis of chemical nature (natural and synthetic insecticides)
- 5 Classification on the basis of mode of action
- 6 Classification on the basis of toxicity
- 7 Classification on the basis of formulations
- 8 Compatibility, physico-chemical properties, residues of insecticides
- 9 Insecticide resistance and its management
- 10 Hazards and safety measures
- 11 Functioning of various types of hand and power operated equipment for insecticide application
- 12 Types of nozzles
- 13 Information about insecticide legislation.

Contents (Practical)

- 1 Computation, preparation and field application of different formulations of insecticides
- 2 Identification, classification, handling and maintenance of application equipment
- 3 Visit to pesticides industries/field visits.

Recommended Texts

1. Pedigo, L.P. & Marlin, E. R. (2009). *Entomology and Pest Management*(6th ed.).New Jersey: Person Education Inc.
2. Saleem, M.A. (2009). *Principles of Insect Toxicology*. Pakistan: Izhar sons Printers. Lahore.

Suggested Readings

1. Dodia, D.A. Petel, I.S. & Petal, G.M. (2008). *Botanical Pesticides for Pest Management*. Jodhpur, India: Scientific Publishers.
2. Ishaaya, I. & Degheele, D. (1998). *Insecticides with Novel Modes of Action: Mechanism and Application*. New Delhi: Norosa Publishing House.
3. Mathews G.A. (2002). *Pesticide Application Methods* (4th ed.). UK: Intercept Ltd.

(List of Mandatory/Compulsory/Core Courses)

ENTO-7101

Research Methods in Entomology

3 (2-1)

This course enables students to get familiarized with modern equipment used in Entomological Research and provide concept of software in data analysis. The course will aid in students' learning regarding use of state of the art equipment in their subject field and how these equipment work. Techniques and methods in entomological science are critical to understand the physiological and morphological aspects of insect system. The course will enable students to learn micrometry, preparation of permanent slides, and various software and data analysis. Preparations of permanent and temporary slides are important which would aid in learning outcomes of this course.

Contents (Theory)

- 1 Introduction to research methods in entomology
- 2 Techniques and apparatus employed in entomological research
- 3 Preparation of temporary and permanent mounts
- 4 Use of Microtomy, camera Lucida, ocular grid and scientific photography
- 5 Use of Bio-assay techniques, Use of Potter's tower
- 6 Use of Absorption Spectrophotometer and Use of Ultraviolet visual spectrophotometer
- 7 Use of Gas chromatography and High-performance liquid chromatography
- 8 Use of Amino acid analyzer, Electrophoresis, PCR and Recombinant DNA techniques
- 9 Ultra centrifugation
- 10 Scanning and Transmission Electron microscopy and Computer software in entomology

Contents (Practical)

- 1 Use of Methods of sampling, Analysis of data and report writing.
- 2 Insect sampling, collection and preservation techniques, rearing devices
- 3 Exercises in microtomy, preparation of permanent slides, software for data analysis
- 4 Scientific photography and electron microscopy
- 5 Maintenance and measurement of microclimate
- 6 Bioassay, Demonstration of insect DNA amplification through PCR methods.
- 7 Use of different equipment in entomological experiments, tabulation, analysis and interpretation of data.

Recommended Texts

1. Bancroft, J. D. and Stevens, A. (1990). *Theory and practice of histological techniques*. Chaschill Livingstone, London.
2. Binns, M.R. (2000). *Sampling and monitoring in crop protection*. CABI Publishing Company.

Suggested Readings

1. Smith, I. 1960. *Chromatographic and electrophoretic techniques*. William Heinemann Medical Books Ltd., London. Vol.I (4th ed.) XII.
2. Singh. P. and Moore. R. F. (1985). *Handbook of insect rearing* Vol. I & II. Elsevier. U.S.A.

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University of Sargodha

This course aims to provide the broad overview of insects in relation to plant diseases with special emphasis on their vector status. Insects in relation to plant diseases will focus on the status, needs, and the principles of insect and diseases in plants. This course will cover the key insects and diseases by these insects in major crops of global importance throughout the world with an emphasis on developing countries in Central and South America, Africa, Asia, and the Middle East. The objective of this course is to familiarize students with common insect and disease problems. Students will gain a basic understanding of the biology and ecology of these pests and the management of biotic and abiotic problems within a plant health care or integrated pest management context. In each class, several diseases or insect pests will be profiled. Course material will be distributed in class and will be used to increase student interaction.

Contents (Theory)

- 1 Introduction to insects in relation to plant diseases
- 2 Identification, biology of insect and mite vectors of plant diseases
- 3 Mode of transmission of plant pathogens by insects and mites
- 4 Insect adaptation for pathogen transmission, interrelationship of insect
- 5 Plant and microorganism, horizontal and vertical transmission
- 6 Beneficial microorganisms in insect control
- 7 Study of causing organisms
- 8 Etiology, symptoms and control of important fungal, bacterial and viral diseases of crop plants transmitted by insects and mites

Contents (Practical)

- 1 Identification of insect and mite vectors and pathogens
- 2 Rearing and handling of insect vectors for plant pathological studies
- 3 Study of mode of transmission of plant pathogens by insect and mite vectors

Recommended Texts

1. Boucias, D.G. (1998). *Principles of insect pathology*. Chapman Hall, London.
2. Jeppson, L.R. Keifer, H. H. and Baker, E. W. (1975). *Mites injurious to economic plants*. Univ. Calif. Press.

Suggested Books

1. Leach, J.B. (2007). *Insect transmission of plant diseases*. Biotech Books. Delhi, India.
2. Tanada, Y. (1992). *Insect pathology*. Academic Press.
3. Cater, W. (1973). *Insects in relation to plant disease*


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The special problem is intended to instruct students on proper techniques for scientific research and methodologies. The students are expected to prepare directed assignment and collect information and material related to current research interest. Special problem means an assignment that is expected to be temporary and is designated as a special assignment by the academic supervisor in its sole discretion. The main purpose of special problem is to increase the learning capabilities of students. The more we use our brains, the more they develop. Students learn a lot more when they read or practice something by themselves. Similarly, the purpose of assignments is to increase the practical skills of students. The main objectives of special problem assigned to students are: to enhance the knowledge of a subject helps to develop writing skills and to enhance time management and organizing skills. It enhances your planning and organizing skills: The special problem makes you do your work by prioritizing the needs and time frames. It helps you in completing all your tasks very peacefully instead of creating any panic. Scopes for improvement: Special problem writing work gives students a lot of scopes to improve themselves.


Chairman
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The seminar is intended to instruct students on proper techniques for presentation of scientific material. Each student is expected to prepare and present a scientific seminar and to submit written documentation supporting that seminar. A seminar is a form of academic instruction, either at an academic institution or offered by a commercial or professional organization. It has the function of bringing together small groups for recurring meetings, focusing each time on some particular subject, in which everyone is requested to participate. Seminars provide a chance to interact with experts from the specific field. Discussing about the relevant topics of the particular subject, students tend to learn about the latest information and new skills related to the concerned subject. Seminars are important and beneficial for those who have difficulty learning in a typical classroom setting where reading and writing are required. There is often a sense of friendship associated with seminar attendance, because everyone is attending with a like interest in learning about a subject important to them. Attending a seminar has numerous benefits, including improving communication skills, gaining expert knowledge, networking with others and renewing motivation and confidence.


Chairman
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The aim of this course is to impart knowledge about toxicity of important groups of insecticides in insects and higher animals with reference to their biochemical and genetic basis of mechanism of action. Insecticide toxicology deals with the nature, properties, effects and the detection of different insecticidal groups in insects, animals, plants, human and environment. This course will impart knowledge about toxicity of important groups of insecticides in insects and higher animals with reference to their biochemical and genetic basis of mechanism of action. The overall course objective is to increase the understanding of processes involved in the toxic response in insects to insecticides, insecticide classification, and consequences of insecticide use. At the end of the course the student is expected to: – Outline the history of insecticides – Recognize the major classes of insecticide and understand their mode of action – List and describe processes involved in toxico-dynamics of insecticides – Become aware of the limitations of insecticide use such as resistance and environmental contamination – Develop a basic understanding on performing insect bioassays

Contents (Theory)

- 1 Introduction and general concepts of insecticide toxicology
- 2 Theory and principles of bioassay
- 3 Chemistry and comparative toxicology of some common insecticides
- 4 Mechanism of action of major groups of insecticides
- 5 Mammalian and phyto-toxicity of insecticides
- 6 Enzyme activation and inhibition by insecticides at various levels
- 7 Detoxification mechanisms
- 8 Joint action of insecticides, (synergism and antagonism)
- 9 Handling and standardization of insects in insecticide tests
- 10 Methods for testing formulations of different insecticides under field and laboratory conditions.

Contents (Practical)

- 1 Laboratory equipment used in toxicology experiments; gross symptoms produced by representative insecticide groups
- 2 Relationship between dosages and responses
- 3 Use of time-mortality determination in comparing the relative toxicity of insecticides
- 4 Preparation of spectral transmittance and concentration transmittance curves
- 5 Bioassay of insecticides

Recommended Texts

1. Gupta, H.C.L. (2001). *Insecticides: toxicology and uses*. Agrotech Publishing Academy, Udaipur.
2. Hassal, K.A. (1990). *The Biochemistry and uses of pesticides: Structure, metabolism, mode of action and uses in crop protection*. ELBS/Macmillan, U.K.

Suggested Readings

1. Srivastava, R.P. (1989). *A text book of insect toxicology*. Himanshuw Publication.
2. Wilkinson, C.F. (1976). *Insecticides biochemistry and physiology*. Heyden, London, New York, Rheine

This course designed for MSc (Hons)/MPhil programs of agriculture sciences. This course provides the applied statistics background for survey and experimental work in Agriculture. Case studies and critical examples are used to work through commonly experienced research problems (from sampling designs to the ethical consideration) and to explain how they may be approached, solved or prevented with statistical means. The importance of statistical science in agriculture is obvious, where the collection, analysis and interpretation of numerical data are concerned. Statistical principles apply in all areas of experimental work and they have a very important role in agricultural experiments. Statistics plays an important role in experimentation. While many scientific problems could be solved by different statistical procedures. Furthermore, some statistical softwares knowledge will be provided to the students to improve their analytical skills. These activities are further supports the student's research.

Contents

- 1 Importance of Statistics in agriculture research.
- 2 Selection of statistical tools based on scale of measurements.
- 3 Analysis of Count and Frequency data.
- 4 Measures of central tendency and dispersion.
- 5 Some concepts of hypothesis testing. T, Z, Chi-square and F tests. Contingency Tables.
- 6 Diversity Indices.
- 7 Concept of ANOVA and its types.
- 8 Correlation Analysis: Simple correlation, multiple correlation, and Partial correlation.
- 9 Regression Analysis: Simple and multiple regression.
- 10 Generalized linear models: logistic regression, Poisson regression, Gamma regression, Inverse Gaussian regression.
- 11 Non-linear regression.
- 12 Dose Response Curves.

Recommended Texts

1. Montgomery, D. C. (2017). *Design and analysis of experiments* (9th ed.). New York: John Wiley & Sons.
2. Rao, G. N. (2007). *Statistics for agricultural sciences* (2nd ed.). BS Publication.

Suggested Readings

1. Lawal, B. (2014). *Applied statistical methods in agriculture, health and life sciences*. USA: Springer.
2. Sahu, P. K. (2016). *Applied statistics for agriculture, veterinary, fishery, dairy and allied fields*. USA: Springer.
3. Gbur, E. E., Stroup, W. W., McCarter, K. S., Durham, S., Young, L. J., Christman, M., West, M. & Kramer, M. (2012). *Analysis of generalized linear mixed models in the agricultural and natural resources sciences*. USA: Soil Science Society of America.

(List of Elective Courses)

ENTO-7106

Environmental Entomology

3 (2-1)

Aim of this course is to provide the basic concept of impact of environment on insects, and insects as indices of environmental changes. Exploration of diversity and roles of insects in natural and affected environments, impact of insects and pesticides on environmental quality, and discussion of environmental ethics in entomological science. Roles and effect of entomological venture to the environment. Entomological operations threatening to environmental deterioration. Their improvement and solution including entomology and other disciplines relating to conservation of the environment. This Integrated lecture and laboratory course will cover fundamental topics in environmental entomology. The course will also explore how insects influence humanity and their role as biological indicators of overall ecosystem health. Chemical, physical properties and their effect on insects will depict biological constituents of the environment. Upon completing of this course, students will have acquired basic knowledge and skills in identification and study of insects and their role in the environment.

Contents (Theory)

- 1 Introduction to Environmental Entomology
- 2 Diversity of insects in different ecosystems
- 3 Interactions of various groups of insects with biological constituents of the environment
- 4 Chemical and Physical constituents of the environment
- 5 Physical characterization of environmental contaminants
- 6 Chemical characterization of environmental contaminants
- 7 Impact of pollutants on insects and Non-target organisms at different levels

Contents (Practical)


- 1 Practical demonstration of biological responses to pollutants
- 2 Practical demonstration of biological responses to Biogeochemical cycles
- 3 Practical demonstration of insects as indicators of levels of pollution

Recommended Texts

1. *Annual Review of Entomology*, 1965 to date Palo Alto, California, Ann. Rev. Inc. U.S.A.
2. Anonymous (1983). *Agrochemical fate in food and environment*. Published by I.A.E.A., Vienna.

Suggested Readings

1. McEwen, F.L. and Stephenson, G. I. (1979). *The use and significance of pesticides in the environment*. John Wiley and Sons Inc., N.Y.
2. Perry, A.S. (1998). *Insecticides in agriculture and environment: retrospects and prospects*. Elsevier, New York.


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This course aims to provide the modern concepts of insecticide resistance in various insect populations. There are a number of ways insects can become resistant to insecticidal crop protection and public health products: Resistant insects may detoxify or destroy the toxin faster than susceptible insects, or quickly rid their bodies of the toxic molecules. Metabolic resistance is the most common mechanism and often presents the greatest challenge. Insects use their internal enzyme systems to break down insecticides. Resistant strains may possess higher levels or more efficient forms of these enzymes. In addition to being more efficient, these enzyme systems also may have a broad spectrum of activity (i.e., they can degrade many different insecticides). The target site where the insecticide acts in the insect may be genetically modified to prevent the insecticide binding or interacting at its site of action thereby reducing or eliminating the pesticide effect.

Contents (Theory)

- 1 Introduction to insecticide resistance and management
- 2 Development and types of resistance
- 3 Mechanism of resistance: physiological, behavioural, biochemical and genetic
- 4 Metabolism of insecticides; detoxification mechanism in insects
- 5 Phase-I reactions such as oxidation, hydrolysis, reduction and dehydrochlorination
- 6 Phase-II reaction such as conjugation; multiple pathways
- 7 Induction of detoxification enzymes
- 8 Management of resistance
- 9 Case histories of insecticide resistance management (IRM)

Contents (Practical)

- 1 Determination of resistance, monitoring
- 2 Development of resistant and susceptible strains
- 3 Collection of potentially resistant strains of insects from the insecticide sprayed fields
- 4 Biochemical basis of resistance
- 5 Demonstration of resistance breaking techniques

Recommended Texts

1. Onstand, D.W. (2007). *Insect resistance management*. Academic Press.
2. Pedigo, L.P. and Marlin, E. R. (2009). *Entomology and pest management*, 6th ed.. Pearson Education Inc., Upper Saddle River, New Jersey 07458, U.S.A.

Suggested Readings

1. Saleem, M. A. (2005). *Insecticides resistance and management*. B.Z. University Press, Multan.
2. Watson, D.L. and Brown, A.W. (1997). *Pesticide management and insecticide resistance*. Academic Press Inc. USA.
3. Onstad D. W. (2008). *Insect resistance management: Biology, Economics, and Prediction*. Academic Press, Elsevier Ltd. Jamestown Road, London UK.

This course aims to provide the modern concepts of molecular entomology and its applications in research and fields. This course provides a broad perspective on the molecular biology of insects and a specific focus on aspects relating to the transmission of insect-borne diseases. Provides background information on essential methodologies used in molecular entomological research and discusses the importance of molecular entomology for the development of disease control strategies. The basic developmental, genetic and genomic focused modules utilize the wealth of knowledge gained from studies in the model insect organism. Understand advanced concepts of medical molecular entomology. Evaluate molecular entomology-based strategies for vector-borne disease control. Design molecular entomology-based disease control strategies.

Contents (Theory)

- 1 Introduction to molecular entomology
- 2 Insects as a model for molecular study (*Drosophila*, Mosquitoes, Honeybee)
- 3 Insect genomes; nucleus, chromosomes, DNA and RNA;
- 4 Gene structure and function; gene transcription and translation
- 5 Concept of introns and exons; central dogma of molecular biology
- 6 Primer Design and polymerase chain reaction (PCR)
- 7 Gene cloning and sequencing; restriction analysis, gene libraries
- 8 Mitochondrial and genomic DNA for insect species identifications
- 9 Insect population diversity/biotyping; Use of molecular markers in insects
- 10 RAPD, RFLP, PCR-RFLP, microsatellites and SNPs
- 11 Linkage and chromosomal mapping, genes regulatory processes, mutagenesis
- 12 Molecular basis of insect functions (insect behavior, insecticidal resistance)
- 13 Gene knock-in and knock-out by RNA interference, barcoding
- 14 DNA and protein sequence alignments and use of bioinformatics tools.

Contents (Practical)

- 1 Demonstration of insect DNA extractions, PCR amplification
- 2 Gel electrophoresis, gene cloning and plasmid DNA extractions
- 3 DNA hybridization (Southern and northern blots); RAPD, RFLP analysis techniques
- 4 Use of Bio-Informatics software tools.

Recommended Texts

1. Hall, B.G. (2007). *Phylogenetic trees made easy: A how to manual*. 3rded. Sinauer Associates.
2. Handler, A. M. James, A.A. (Eds.). (2004). *Insect transgenesis: Methods and applications, Comprehensive review of insect gene transfer, its methodologies, applications and risk assessment and regulatory issues*. CRC Press.

Suggested Readings

1. Glick, B.R. Pasternak, J. J. and Patten, C. L. (2009). *Molecular biotechnology: Principles and applications of recombinant DNA*. ASM Press Publishers. 4th edition.
2. Gray, J. Richard, B. (2003). *Insect pheromone biochemistry and molecular biology*, Elsevier Academic Press

Chairman
Department of Entomology
College of Agriculture
University of Sargodha

This course aims to provide the knowledge of identification, biology, epidemiology of insects and other arthropods of medical importance. This course presents current information on the pests that have and continue to plague humans and animals. This course will explore the arthropods of importance in human health and those that impact livestock production, companion animals and wildlife through direct attack and disease transmission. It will include information on their biology, ecology, potential for disease transmission and management. Students will learn to identify the common pests and the principles of epidemiology and pest management. The factors involved in the epidemiology of vector-borne diseases, host, parasite, vector and reservoir, will be stressed, as this is the recurrent theme in medical entomology. Students will be encouraged to share their own experiences throughout the course. The course is useful in understanding primary vectors of medical and veterinary entomology that will help in explaining the reasons underlying the major diseases outbreaks in human history, and relate to why these outbreaks occasionally occur in today's modern world.

Contents (Theory)

- 1 Introduction to medical and veterinary entomology
- 2 Epidemiology; identification, biology and management of insects and other arthropods of medical and veterinary importance insect
- 3 Arthropods transmitting diseases
- 4 Symptoms and diagnosis; venoms, defense secretions and allergens due to arthropods
- 5 Economics of livestock and poultry pests with emphasis on different flies, midges, mosquitoes, ticks, mites, beetles and other important insects of medical and veterinary importance.

Contents (Practical)

- 1 Surveillance and collection of different insects
- 2 Identification and management of different insect- pests of medical and veterinary importance
- 3 Collection of insects in relation to diseases of man and domestic animals

Recommended Books

1. Aldridge, B. (2004). *Medical entomology: Text book of public health and veterinary*. Chapman and Hall, London.
2. Kettle, D.S. (1995). *Medical and veterinary entomology*. 2nd ed., CAB International, UK.

Suggested Books

1. William, R. E. (2009). *Veterinary entomology: livestock & companion animals*. CRC press
2. Tyagi. (2003). *Medical entomology: A hand book of medically Important insects & other arthropods* Scientific Publisher.
3. Eldridge F., Edman, E. (2003). *Medical entomology: A text book on public health and veterinary problems caused by arthropods*. Kluwer Academic Publishers.

This course aims to provide knowledge about the importance of mites and their impact on crops, vegetables, fruits and stored products. The Acarology course will make students proficient in the identification of a broad range of mite diversity. Additionally, the course will broaden graduates understanding of mite ecology, evolution, and biogeography. This course will review the mites associated with crops, ornamental plants and stored products. The major emphasis will be on identification and classification of acari associated with humans and domestic animals. The course will also concentrate on ticks (Ixodida), and will deal with all the other groups of vertebrate parasitic mites. In addition to the standard emphasis of identification, it will include extensive discussions of disease transmission. The discussions of various Mesostigmata (Dowling), Astigmata, including feather mites (Klimov), dust mites (Needham), Trombiculoidea (chiggers) (Welbourn), and miscellaneous Prostigmata (Klompen).

Contents (Theory)

- 1 Introduction to acarology
- 2 Methods of collection, rearing and preservation of different mites
- 3 Methods of collection, rearing and preservation of different mite related insects
- 4 External and internal morphology and physiology of mites
- 5 Reproduction and development of mites and classification of mites
- 6 Mites as pests of important crops, vegetables, fruit trees
- 7 Mites in stored products and their management
- 8 Losses caused by and management of mite pests
- 9 Ecology and dispersal of mites
- 10 Methods of estimation of mite population
- 11 Mites and plant diseases and resistance mechanism in mites

Contents (Practical)

- 1 Collection, preservation and sampling of mites
- 2 Rearing techniques and identification of phytophagous mites
- 3 Predatory, parasitic and stored grain mites
- 4 Preparation of permanent slides of mites
- 5 Estimation of mite population, losses in crops, vegetables, fruit plants and stored grains.

Recommended Texts

1. Chhillar, B.S. and Gulati, R. (2007). *Agricultural acarology*. Daya Publishing House.
2. Evans, G.O. (1992). *Principles of acarology*. C.A.B. International Cambridge University Press, Cambridge.

Suggested Readings

1. Krantz, G.W. and Walter, D.E. (2009). *A Manual of acarology*. Texas Tech. University Press.
2. Zhang, Z.Q. (2003). *Mites of green houses: Identification biology and control*. Elsevier, New York.
3. Sabelis, M. W. (2010). *Trends in acarology: Proceedings of the 12th International Congress*. Springer Dordrecht Heidelberg London IITK

The aim of this course is to provide advance concepts of insecticide poisoning, residual effects and their perception on safe use of insecticides. Pesticides are substances or mixtures of substances that are mainly used in agriculture or in public health protection programs in order to protect plants from pests, weeds or diseases, and humans from vector-borne diseases, such as malaria, dengue fever, and schistosomiasis. Exposure to pesticides can be through contact with the skin, ingestion, or inhalation. The type of pesticide, the duration and route of exposure, and the individual health status (e.g., nutritional deficiencies and healthy/damaged skin) are determining factors in the possible health outcome. Within a human or animal body, pesticides may be metabolized, excreted, stored, or bio-accumulated in body fat. Pesticide use as part of a public health program may lead to increased exposure for large segments of the population, including exposure to sensitive subpopulations. This course carefully evaluates human and ecological risks from exposure to pesticides, including bystander and occupational exposure with an emphasis on applicator's health in making decisions about all pesticides, including pesticides with public health, uses.

Contents (Theory)

- 1 Insecticides poisoning and its importance to public health
- 2 Toxic effects of insecticides on indoor inhabitants, farmers, field workers and their domesticated animals
- 3 Distribution of pesticide residues in soil, ground water, drinking wells and air
- 4 Insecticide residues poisoning in blood, fat bodies. and the acute diseases they cause
- 5 Public health and environmental consideration
- 6 Farmers perception of acute poisoning and safe measures
- 7 First aid procedures; laboratory verification
- 8 Treatment of insecticide poisoning
- 9 Insecticides monitoring; safe use of insecticides and knowledge of antidotes;
- 10 Transport, storage and disposal of insecticides
- 11 Insecticide labeling

Contents (Practical)

- 1 Determination of pesticide residues in soil, water, vegetables fruits, milk, cereals, human blood, fat bodies and vital organs
- 2 Survey for finding farmers/public perception about pesticide poisoning.

Recommended Texts

1. Dhaliwal, G. S. and Singh, B. (2000). Pesticides and environment. Commonwealth Publishers. New Delhi. India.
2. Gupta, H. C. L. (2001). Insecticides: toxicology and uses. Agrotech Publishing Academy, Udaipur

Suggested Readings

1. Oudejans J. H. (1991). *Agropesticides and functions in integrated crop protection*. ESCAP. United Nations. Bangkok, Thailand.
2. Ashfaq, M. and Saleem. M.A. (2010). *Environmental pollution and agriculture*. Pak Book Empire, Lahore Pakistan

This course aims to provide concepts of biochemistry of insect energy pathways in different life stages. This will help to understand the insect biochemical cycles necessary for their life. Insect physiology and biochemistry is discussed in the following categories: Nutrient flow through insects including nutrient capture, digestion, absorption, circulation, intermediary metabolism, energy metabolism, detoxification, excretion and electrolyte homeostasis. Embryologic, developmental, reproductive, and neurophysiologic systems are covered, as well as respiration and diapause, including the basic molecular mechanisms. Communication systems including mechanical (tactile, acoustic, visual) and chemical (hormones, pheromones, allomones, kairomones, necromones) in terms of signal characteristics, sending and receiving mechanisms. Selected topics are further explored in laboratory exercises. Students will get basic knowledge of insect communication including mechanical (tactile, acoustic, visual) and chemical (hormones, pheromones, allomones, kairomones, necromones) systems in terms of signal characteristics, sending and receiving mechanisms.

Contents (Theory)

- 1 Introduction to insect biochemistry
- 2 Energy metabolism and production in insects
- 3 Biochemistry of cuticle, muscles, flight, synaptic transmission, light production, biochromes, hormones and kairomones
- 4 Biochemical mechanism of Insect growth regulators and diapause in insects
- 5 Metabolism and role of carbohydrates, proteins and lipids in insects
- 6 Chemical control of insect behaviour
- 7 Biochemical defenses in insects

Contents (Practical)

- 1 Chemical identification of insect species and biotypes
- 2 Pheromone extraction, its identification and control in insects
- 3 Hormonal control of insect growth and development.
- 4 Quantitative analysis of Amino acids, proteins, uric acids in haemolymph; amylase etc.

Recommended Texts

1. Chapman, R.F., (1998). *Insects: Structure and function*. 4th ed. American Elsevier. Publ. Co. Inc., New York.
2. Candy, D. J. and Kilby, B. A. (1978). *Insect biochemistry and function* (2nd ed.) Chapman and Hall London.

Suggested Readings

1. Gilmour, D., (1961). *The Biochemistry of insects*. Academic Press London.
2. Morgan, E.D. (2004). *Biosynthesis in insects*. T.J. Intl. USA.
3. Rockstein, M., (1978). *Biochemistry of insects*. Academic Press, New York, U.S.A.
4. Turner, R. B. (1977). *Analytical biochemistry of insects*. Elsevier Scientific Publishing Company New York.

This course aims to provide concepts of insecticide application equipments in the field. This course is developed primarily for graduates that are intended to work in turf and landscape, but can be helpful to anyone who applies pesticides. Learners will be able to describe why calibration is important and be able to list the materials and tools needed in order to calibrate equipment. They will see various examples of pesticide application equipment for liquid, granular, and soil drenching and soil injection applications. The course includes many examples of calculations needed to calibrate equipment. Learners will be able to describe why calibration is important and be able to list the materials and tools needed in order to calibrate equipment. Various examples of pesticide application equipment for liquid, granular, and soil drenching and soil injection applications as well as examples of calculations needed to calibrate equipment, are presented throughout the course.

Contents (Theory)

- 1 Introduction to insecticide application equipment
- 2 History of development of application equipment
- 3 Different systems of insecticide application
- 4 Type of dusting equipment
- 5 The maintenance and operation of hand dusters, bellow type dusters, rotary hand and power dusters;
- 6 Types of spraying equipment
- 7 Components of a spray machine
- 8 Maintenance and operation of compression and pump systems, hand, power sprayers
- 9 Maintenance and operation of hand, power and granular applicators
- 10 Comparative study of ground and aerial application equipment
- 11 Calibration methods and measurement of droplet size.

Contents (Practical)

- 1 Study of different parts and assembling of sprayers, dusters and granule applicators
- 2 Assembling and working of different application equipment
- 3 Study of different types of spray guns, lances, hoses and nozzles
- 4 Aerosols and aerosol bombs
- 5 Calibration and measurement of droplet size.

Recommended Texts

1. Mathews, G.A. (1992). *Pesticides application methods*, 4th ed. Longman Inc., N.Y.
2. Mathews, G.A. (1984). *Pest management*. 1st ed. Longman Inc., N.Y.

Suggested Readings

1. Nastec. (2005). *Technology of application of pesticides*. CRC Press.
2. Pedigo, L.P. (2002). *Entomology and pest management*, 4th ed., Prentice. Hall of India Pvt. Ltd., New Delhi-110001.
3. Pfadt, E. R., (1985). *Fundamentals of applied entomology*, 4th ed. The Macmillan Co., N.Y

This M.Sc. level course aims to impart knowledge about various insect groups to solve medico-legal cases and different puzzling crimes. This course will examine the roles that insects play in the field of Forensic Science. Specifically, we will be focusing on the entomological contributions that have served to further our understanding of how both human and animal remains decompose. It will aid to identify forensically important insects, in partnership with proper collection and rearing techniques, and how to properly read and analyze scientific papers. The overall goal is to gain an understanding of how forensic entomology is utilized and to understand how forensic entomology techniques used to identify forensically important insects and how insects are used in neglect, abuse, and food contamination cases. They will be able to properly collect and rear forensically important insects and will learn the proper way to prepare and write a case report.

Contents (Theory)

- 1 History and scope of Forensic Entomology
- 2 Study of various insect groups and other arthropods related to medico-legal investigations
- 3 Involvement of arthropod in puzzling events of murder, suicide, rape, physical abuse, control
- 4 Review and survey of insect life histories, life cycle and faunal succession of arthropods related to medico-legal cases and survey of the following insects as indicators
- 5 Hister beetles (Histeridae), Carrion beetles (Silphidae), Ham beetles (Cleridae), Skin hide beetles (Dermestidae), Blow flies (Calliphoridae)
- 6 Flesh flies (Sarcophagidae), Lesser corpse flies (Sphaeroceridae), Sun flies (Heleomyzidae), Black soldier flies (Stratiomyidae), Rove beetles (Staphylinidae), House flies (Muscidae), Cheese flies (Piophilidae), Coffin flies (Phoridae), Scarabs beetles (Scarabaeidae)
- 7 Macrocheles mites as feeder in early stages of decomposition, Tyroglyphids as feeder on dry skin
Review of classification of ages in decomposition of human and animal remains
- 8 Uses of insect and arthropods in investigation of the causes of death and the duration of PMI

Contents (Practical)

- 1 Sampling, rearing, and preservation techniques in forensic entomology
- 2 Survey, identification and biology of insects and arthropods of forensic importance
- 3 Study and analysis of court room proceedings regarding medico-legal cases
- 4 Visit to forensic laboratories/hospitals.

Recommended Texts

1. Byrd, J. H. and Costner, J. L. (2001). *Forensic entomology*. CRC Press.
2. Catts, E. P. and Haskell N. H. (1990). *Entomology and death. A procedural guide*. Joyce's Print Inc. Clemson, SC.

Suggested Readings

1. Greenberg, B. and Kunich, J. C. (2002). *Entomology and the law: Flies as forensic indicators*, Cambridge University Press, Cambridge.
2. Smith, K. G. V. (1986). *A manual of forensic entomology*, Comstock's Publishing Associates, Cornell University Press Ithaca NY

Aim of this course is to provide knowledge about insect rearing techniques for natural predators, parasites and other insects of economic importance. These courses are dedicated to advancing insect rearing through formal science and technology education with up-to-date rearing practices, data driven research, quality and process control in rearing systems, quantitative diagnostic techniques and insectary problem solving through a multidisciplinary approach. This course is rich in information on all aspects of insect rearing, so everyone who rears insects would benefit from this course. The course is aimed at helping people who rear insects understand the complexities of the entire range of rearing organization (insects' biology, feeding habits in relationship to rearing quality, basic physiological ecology in a rearing framework, diet chemistry and physics, microbial interactions in the rearing system, quality and process control in rearing systems, and many other subjects that clearly need understanding and attention in order to rear quality insects).

Contents (Theory)

- 1 Introduction to Insect Rearing Techniques
- 2 General principles of rearing
- 3 Basics of insect feeding and reproductive biology of different insect pests, parasitoids and predators in relation to rearing
- 4 Insect diets (development of diets, components of diets, diet assessment and quality control and microbiology of insect diet)
- 5 Insectary environments
- 6 Packaging technology
- 7 Quality control in mass-rearing systems

Contents (Practical)

- 1 Operation of standard rearing equipment (balances, volumetric equipment, pH meters, microscopes, spectrophotometers, various kinds of diet processing equipment)
- 2 Diet-making methodology
- 3 Practical instructions in the rearing of different important insect pests, parasitoids and predators
- 4 Visit to different insect rearing laboratories

Recommended Texts

1. Cohen, A. C. (2005). *Insect diets, science and technology*, CRC Press Boca Raton London, New York, Washington, D.C.
2. Brewer, F. D. and Lindig, O. (1984). *Ingredients for insect diets. Quality assurance, sources, and storage and handling*, in *Advances and Challenges in Insect Rearing*, E.G. King and N.C. Leppla, Eds. USDA, ARS, New Orleans.

Suggested Readings

1. Bernays, E.A. and Chapman, R. F. (1994). *Host-Plant selection by phytophagous insects*. Chapman & Hall, New York.
2. King, E. G., and Leppla, N. C. Eds. USDA, ARS, New Orleans, LA, 2-8.

This course provides an introduction to the field of insect biotechnology, exploring the diverse applications and potential of using insects in various areas of scientific research and industrial applications. Students will gain a fundamental understanding of the theoretical principles and practical techniques involved in insect biotechnology.

Course Contents (Theory):

1. Introduction to Insect Biotechnology
 - Overview of the field and its significance
 - Historical developments and current trends
2. Insect Physiology and Anatomy
 - Understanding insect morphology and life cycles
 - Important physiological processes and their relevance to biotechnology
3. Genetic Manipulation Techniques
 - Introduction to genetic engineering methods applicable to insects
 - Transgenesis and gene editing technologies
4. Insect as Bioreactors
 - Utilizing insects for the production of valuable substances
 - Insect-based systems for protein expression and industrial processes
5. Insect Models in Biomedical Research
 - Exploring the use of insects as model organisms
 - Advantages and limitations of insect models in studying human diseases

Course Contents (Practical):

1. Insect Rearing and Handling
 - Techniques for rearing and maintaining insect colonies
 - Proper handling and care of insects in a laboratory setting
2. Genetic Manipulation Experiments
 - Hands-on experience with genetic engineering techniques in insects
 - Gene delivery methods and transgenic insect generation
3. Insect Bioreactor Setup and Operation
 - Design and construction of insect-based bioreactors
 - Monitoring and optimizing conditions for efficient production
4. Insect-based Assays and Screening Methods
 - Practical approaches to using insects for bioassays and screening
 - Assessing insect responses to various stimuli or compounds

Recommended Books:

1. Vilcinskas, Andreas, ed. Insect biotechnology. Vol. 2. Springer Science & Business Media, 2010.
2. Kumar, D., & Gong, C. (Eds.). (2018). Trends in insect molecular biology and biotechnology. Springer.
3. Kumar, D., & Shukla, S. (Eds.). (2023). Introduction to Insect Biotechnology. Springer Nature.

Suggested Readings:

1. Rahul, K., Makwana, P., Ghosh, S., & Pappachan, A. (2023). Why Biotechnology Needed in Insects? In Introduction to Insect Biotechnology (pp. 17-44). Cham: Springer International Publishing.
2. Rechcigl, J. E., & Rechcigl, N. A. (Eds.). (1999). Biological and biotechnological control of insect pests. CRC Press.

The basic objective of this course is to provide knowledge in the area of insect behavioral chemical and physical interaction, host selection and sexual communication. The course deals with the chemical ecology of insects to explain the role of semiochemicals in plant-herbivore, herbivore-carnivore and plant-carnivore interactions. The semiochemicals, mediating tritrophic interactions may be produced by plants, herbivores or their natural enemies. Some semiochemicals attract the herbivores and carnivores and mediate interaction among them, while on the other hand some repel them. The semiochemicals are used by herbivores, parasites and predators as cues to locate food, host or prey. All the organisms in an ecosystem are linked biochemically and their relationship is obvious in food chains and food webs. Another important feature of tritrophic interaction is that the alternate trophic levels in food chain usually have symbiotic relationship. The natural enemies of herbivores favor plant by reducing the herbivore and plants favor the natural enemies by making herbivores more vulnerable to them.

Contents (Theory)

- 1 Introduction to chemical ecology of insects
- 2 Odor dispersion in still air and wind
- 3 Effect of wind speed and air temperature
- 4 Chemo- orientation in walking and flying insects
- 5 Insect-plant interactions
- 6 Pollinators ecology
- 7 Chemical and physical interactions
- 8 Warning coloration and mimicry
- 9 Warning coloration and predator learning
- 10 Sexual communication with pheromones and uses of insect pheromones in plant protection

Contents (Practical)

- 1 Practical demonstration of parasitoids performance and their host relationship
- 2 Determination of sources of parasitoid behavioral chemicals
- 3 Calculation and measurement of modes of mimetic resemblance

Recommended Texts

1. Barbosa, P. and Letourneau, D. (1989). *Novel aspects of insect plant interactions*. John Wiley & Sons. New York.
2. Bell. W.J and Carde, R. T. (1994). *Chemical ecology of insects*. Chapman and Hall London.

Suggested Readings

1. Jutsum, A.R. and Gorgen, R.F.S. (1989). *Insect Pheromones in plant protection*. John Wiley & Sons. UK.
2. Harbone, J.A. (1998). *Introduction to ecological biochemistry*. Academic Press. London.