

Tribhuvan University
Institute of Science and Technology
M. Sc. Zoology (Semester System)
SEMESTER II
ENTOMOLOGY

Course title: General Entomology
Course No.: Zoo 560
Nature of the course: Theory

Credits: 3
Lecture hrs: 48
Full Marks: 75
Pass Marks: 37.5

Course Objectives

- To acquaint students with insect structures, life processes and life cycle.
- To make students able to understand insect biochemistry.
- To acquaint students with molecular and developmental entomology.
- To acquaint students with entomological research methods.

Course Contents

1. **Comparative Insect Structures and Functions:** Insect Morphology - Integument: structure, cuticular modifications, moulting, sclerotization, colouration. Body segmentation: head (head segmentation, antennae, mouthparts, compound eyes), thorax (legs & wings) and abdomen. Comparative study of organ-systems and functions of Apterygotes, Exopterygotes and Endopterygotes: alimentary canal, salivary glands, circulatory system, organs of excretion, osmoregulation, heat production, respiration, reproduction, brain, sense organs, mechanism of image formation, sound and light producing organs. **24 hrs**
2. **Insect Biochemistry, Molecular and Developmental Entomology:** Chitin metabolism in insects: structure, function and regulation. Signaling and molecular basis of Neuropeptides in insects. Insect hormones & pheromones: types, structure & biosynthesis. TGF- β (Transforming Growth Factor- β) and its role in insect development. Molecular approaches for controlling vector borne diseases, Molecular, microbial and environmental basis of sex determination in insects. Molecular basis of circadian rhythms in insects. Insecticide resistance-associated genes in insects. Viviparity, polyembryony and parthenogenesis in insects. Metamorphosis: Hormonal regulation and theories of metamorphosis. Programmed cell death (PCD) in Metamorphosis and its inducing gene. Developmental stages in insects. Types of larvae and pupae. Diapause and overwintering in insects. **16 hrs**
3. **Research Methodology:** Tools and techniques of insect collection & preservation. Research design (lab & field). Insect collection & sampling techniques. General techniques for insects rearing. Format for proposal, thesis, report & scientific paper in entomological research. **8 hrs**

Tribhuvan University
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M. Sc. Zoology (Semester System)
SEMESTER II
ENTOMOLOGY

Course title: Taxonomy & Insect Pests
Course No.: Zoo 561
Nature of the course: Theory

Credits: 3
Lecture hrs: 48
Full Marks: 75
Pass Marks: 37.5

Course Objectives

- To make students able to understand origin and evolution of insects.
- To acquaint students with taxonomic characters of insect orders and their classification.
- To familiarize students with beneficial and harmful insects and other arthropods particularly pests of major field crops, vegetables, fruits, other plants and stored grain pests, and their management tools.
- To provide fundamental knowledge of morphology, biology, damage patterns and control measures of selected major insect pests.

Course Contents

- 1. Insect Evolution & Taxonomy:** Origin of and evolution of insects. Fossil insects. Phylogeny of insect orders. Naming and describing insects. Classification and identifying characters of Apterygota (Protura, Diplura, Collembola* and Thysanura*), Exopterygota (Ephemeroptera*, Odonata*, Blattodea, Mantodea, Isoptera, Dermaptera, Plecoptera*, Orthoptera,* Phasmatodea, Psocoptera, Hemiptera*, Thysanoptera), Endopterygota (Megaloptera, Neuroptera, Mecoptera, Siphonaptera, Coleoptera*, Diptera*, Lepidoptera*, Trichoptera*, Hymenoptera*) **24 hrs**
**Emphasis should be given particularly to these orders and their ecologically and economically important families significantly related to agriculture, forestry, water body, medical, biological control and productive resource reported from oriental region.*
- 2. Insect Pests of Field and Horticulture (Vegetables and Fruits) Crops:** Taxonomic position, morphology, marks of identification, crop damage symptoms, biology and management of insect pests of field crop (rice, maize, wheat, pulses, oil seed crops and cash crops). Taxonomic position, morphology, marks of identification, crop damage symptoms, biology and management of insect pests of vegetables (crucifer crops, cucurbit crops, potato, and tomato) and fruits (mango, litchi, guava, citrus, peach, pear, banana and apples), *Tuta absoluta* invasion in Nepal. **14 hrs**
- 3. Forest Insects:** Taxonomic position, morphology, marks of identification, crop damage symptoms, biology and management of Insect pests of natural and planted forests (Defoliating lepidopterans, saw flies, beetles, flies; Sap suckers- scale insects, aphids, psyllids and bugs). Galls and gall insects. Gall insect of invasive plant species (*Ageratina adenophora*) of Nepal. Insect pests of timber. **4 hrs**
- 4. Stored Grain Pests:** Taxonomic position, morphology, marks of identification, crop damage symptoms, biology and management of store grain pest insects. Assessment of post-harvest crop loss and grain storage structures. **2 hrs**
- 5. Pests of Ornamental and Medicinal Plants:** Taxonomic position, morphology, marks of identification, crop damage symptoms, biology and management of major insect pests in ornamental

and medicinal plants. An overview of important insect pests of medicinal plants in Hindu Kush Himalayan region. **2 hrs**

6. **Acarology:** Systematics, morphology, biology and ecology of ticks and mites. Management of acarine pests of humans, animals and plants. Role of parasitic species in causation and transmission of diseases. **2 hrs**
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M. Sc. Zoology (Semester System)
SEMESTER II
ENTOMOLOGY

Course title: General Entomology, Taxonomy & Pests
Course No.: Zoo 562
Nature of the course: Practical

Credits: 2
Lecture hrs: 90
Full Marks: 50
Pass Marks: 25

Course Objectives

- To acquaint the students practically with morphology, anatomy, physiology and embryology of insects.
- To provide students with practical knowledge of handling and studying insects.
- To give practical knowledge to the students regarding collection, preservation, and identification variety of insect fauna.

Course Contents

1. **Insect morphology:** Morphology of major insect orders mentioned in Zoo 561. Modifications in mouthparts, wings and legs.
2. **Internal anatomy:** Dissection of commonly available insects to study their digestive system, nervous system, reproductive organs, tracheal system.
3. **Embryology & development:** Types of metamorphosis. Types of larvae and pupae.
4. **Insect collection and preservation:** Tools & techniques of insect collection, Collection of insects (pest and non-pest) from diverse habitats like forest, agricultural lands, grassland, lakes, pond, river and streams by standard techniques. Insect preservation techniques and reference storage.
5. **Identification of different insects** including pests, predators, vectors, pollinators by using standard identification keys. Keying out families of major insect orders
6. **Survey of immature insects** and identification of their orders, families and genera.
7. **Permanent mounting/slide preparation** (Insect structures like antenna, wings, legs, genitalia or whole mount whenever necessary and different ecologically and economically important insects)
8. **Identification report:** Students need to present their identification report.
9. **Review of scientific papers:** A report preparation relevant to the studied topics.

10. **Data analysis:** Scientific field designing, samples coding, data management techniques in excel program and analysis practices (descriptive statistics, and multivariate) for insect data in suitable statistical software(e.g. R-statistical software)
11. **Report preparation and specimen deposition:** The students prepare a scientific report based on their collected specimens. The collected specimens will be registered permanently in the Department with reference ID code.

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SEMESTER III
ENTOMOLOGY

Course title: Pest Management
Course No.: Zoo 607
Nature of the course: Theory

Credits: 3
Lecture hrs: 48
Full Marks: 75
Pass Marks: 37.5

Course Objectives

- To orient the students with classification and mode of action of insecticides, their applications, hazards and safety measures.
- To develop an understanding of Integrated Pest Management (IPM).
- To develop fundamental knowledge on biocontrol agents in pest management.
- To acquaint students with current regulatory provisions on insecticide application.

Course Contents

1. **Concept of Pest Management:** Pest management strategies and tactics. Kinds of pests. History of pest control and development of pest management. Ecological background of pest control. Economic decision level for pest population. **4 hrs**
2. **Insect Toxicology:** Historical background of insecticide use. General concepts of insecticide toxicology. Classification of pesticides (based on mode of entry, mode of action, toxicity, and chemical nature). Mode of action of pesticides. Pesticide act and regulations. Insecticide toxicity. Insecticide formulations and synergism. Bioassay techniques. Insecticide resistant insects and resistant insect management. Semiochemicals. Insecticide calculation. Pesticide application equipments. Spray calibration. Health hazards and safety measures of pesticide application. Pesticides and environmental consequences. Use of insecticides in Nepal. Pesticide act and pesticide regulations in Nepal. **20 hrs**
3. **Integrated Pest Management:** IPM Concept. Overview of IPM in Nepal. Techniques of IPM (chemical, cultural, mechanical & physical, biological, botanical, genetic, biotechnological and legislative approaches). Ethics in pest management. Insect pest management through resistance of plants. Plant quarantine program in Nepal. National pest inventory, Pest Risk Assessment (PRA) and World Trade Organization (WTO). Prediction of insect pest (degree day method). Latest technologies in pest monitoring (remote-sensing, telemetric and computer-based techniques). Vertebrate Pest Management. **24 hrs**

Tribhuvan University
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M. Sc. Zoology (Semester System)
SEMESTER III
ENTOMOLOGY

Course title: Medical, Veterinary and Industrial Entomology
Course No.: Zoo 608
Nature of the course: Theory

Credits: 3
Lecture hrs: 48
Full Marks: 75
Pass Marks: 37.5

Course Objectives

- To provide fundamental knowledge to students regarding major insects of medical, veterinary, and industrial importance.
- To develop practical knowledge on research tools and techniques to study insects and impart scientific writing skills.

Course Contents

1. **Medical and Veterinary Entomology:** Arthropods and pathogen – an introduction. Morphology, life history, pathology and importance of mosquitoes, sandflies, houseflies, fleas, eye gnats, cockroaches, black flies, horse flies, bed bugs, sucking lice, ticks and mites. Overview of vectors and vector borne diseases humans and animals in Nepal. Medically important arthropods and insect groups. Vector ecology (global distribution and response with environmental and climatic factors). Vector biology, larval habitats of the vectors of malaria, Japanese encephalitis, Lymphatic filariasis, Dengue/dengue haemorrhagic fever, Chikungunya, Zika, Scrub typhus and Leishmaniasis. Vector pathogen interaction, types and mechanisms of transmission of vector borne diseases, vector competence and vectorial capacity, entomological indices. Insecticide resistance in vectors, insecticide susceptibility test for larval and adult mosquitoes. Climate change and vector distribution. Integrated vector management (IVM): elements & strategies. An introduction to forensic entomology, general terms & background history of forensic entomology, insects associated with forensic science. **24 hrs**

Industrial Entomology

24 hrs

2. **Apiculture:** Overview of beekeeping in global and Nepalese perspectives. Scope of apiculture industry. Bee species and their biology, morphology, behavior and products. Social organization of honey bee. Apiary management (beekeeping equipment, seasonal management, uniting, dividing and preparation for shifting colonies, queen rearing and swarming, honey extraction, factors affecting honey yield). Importance of bees in pollination. Pest and diseases of bees and their management. Colony collapse disorder (CCD) in Bees. Beekeeping as an enterprise. Honey bees, natural ecosystem and crop pollination. Inter-specific interaction in Honey bees. Biology of Nesting. Honey bees and wild bees as environmental indicators. Climate change and bee industry, conservation and promotion of native honey bee species in Nepal. **12 hrs**
3. **Sericulture:** Overview of sericulture in global and Nepalese perspectives. Mulberry varieties & their cultivation. Silkworm biology, rearing & egg production. Technical aspects of sericulture: cocoon production, silk reeling and management. Diseases and pests of mulberry & silkworm and their

management. Non-mulberry sericulture. Sericulture economics & extension. Sericulture as an enterprise. Silkworm biotechnology. **10 hrs**

4. **Lac culture:** Lac, lac hosts, strains of lac & lac crops, life history of lac insect, scientific method of lac cultivation, enemies of lac insects. Prospects and possibilities of lac culture in Nepal. **2 hrs**
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Tribhuvan University
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SEMESTER III
ENTOMOLOGY

Course title: Insect Ecology and Behavior
Course No.: Zoo 609
Nature of the course: Theory

Credits: 3
Lecture hrs: 48
Full Marks: 75
Pass Marks: 37.5

Course Objectives

- To make the students understand concepts of ecology with emphasis on insect systems.
- To acquaint students with insect behavior.

Course Contents

1. **Insect Ecology:** Dynamics of insect life systems (determinants of insect abundance, population change, birth and death rate), Insect life tables and its application. Effects of environment in insect development (Predicting biological events- the degree-day method, degree-day programmes in insect pest management). Regulation of insect populations, insect as ecological indicator: insect outbreak, insect monitoring and forecasting. Insect communities in aquatic and terrestrial systems. Patterns of insect distribution, Global patterns of insects richness, body weight, range size, species richness, sex ratio and abundance (habitat, altitude latitude), biogeography of insect, Effect of global change in insects distribution and range shift. Global change and insect diversity. Urban insects: Introduction, ecology and conservation. Ethno-entomology: An overview of insects fauna based on local knowledge and entomo-therapy. **24 hrs**
2. **Insect Adaptation:** Morphological, physiological, anatomical and reproductive adaptation of insects (life histories and mating strategies: r and k strategies, polyphenism, polymorphism, photoperiodism, osmoregulation and thermoregulation in insects). **6 hrs**
3. **Insect Diseases:** Bacterial, fungal, viral, mites and nematodes as pathogens of insects. *Wolbachia* and *Nosema* in insects. Acarine tracheal mites. **2 hrs**
4. **Insect Behavior:** Overview: Basic responses and patterns of behavior, nervous system and behavior, hormones and behavior, genetic control of behavior, behavioral periodicity and clocks, oriental navigation and homing. Host selection and feeding behavior, defence behavior, foraging behavior, resting behavior, communication behavior (bioluminescence, chemical, acoustic, visual and tactile), epigamic behavior, mating and reproductive behavior, parental care, presocial behavior, eusocial behavior, leadership behavior. **16 hrs**

Tribhuvan University
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SEMESTER III
ENTOMOLOGY

Course title: Agro-ecosystem and Environment

Course No.: Zoo 610

Nature of the course: Theory

Credits: 3

Lecture hrs: 48

Full Marks: 75

Pass Marks: 37.5

Course Objectives

- To make students able to understand importance of agro-biodiversity and its conservation.
- To acquaint students with biotic interaction in agro-ecosystem and their management practices.
- To acquaint students with soil ecosystem in agriculture lands.

Course Contents

1. **Agro-ecosystem:** Introduction, importance of agro-biodiversity. Natural ecosystem and agro-ecosystem. Ecosystem services and management. **2 hrs**
 2. **Agro-biodiversity and Conservation:** Introduction. Conservation of agro-biodiversity and food security. Agro-biodiversity and global change. Insect pests in a changing agro-ecosystem. Invasive insects in agro-ecosystem, Green revolution and agro-biodiversity conservation. Food sovereignty, biotechnology and the loss of agro-biodiversity. Conservation of indigenous agro-biodiversity versus modern trends in agro-biodiversity. Concept of sustainable agro-ecosystem and scenario in Nepal. **14 hrs**
 3. **Biotic Interaction in Agro-ecosystem:** Insect-plant interactions. Insect, herbivores relationship in agro-ecosystem. Rhizosphere ecosystem and role of mycorrhiza. Concept of above-ground & below-ground dynamics. Competition between crops and weeds. Insect pollinators, Plant-pollinator network concept. Threats for pollinators, Conservation of pollinating insects, National and global initiatives for pollinator conservation, pollinators and transgenic crops. **16 hrs**
 4. **Soil Ecosystem in Agriculture Lands:** Structure of soil communities in agroecosystem. Soil ecological indicators (Insects and Nematodes), Nematodes soil indices, Soil biodiversity in conventional and organic farming system, transgenic crops and soil ecosystem. Nutrient cycle: carbon, nitrogen, phosphorus and sulphur cycle for soil mineralization and plant growth. Microbes and fungi inhibiting in soil and their role. Decomposition of cellulose, hemicelluloses, pectin and lignin. Biofertilizer: types and their role in crop yields. **12 hrs**
 5. **Agro-ecosystem Management:** Ecosystem based Adaptation for agro-ecosystem management. Managing insect pests in a changing agro-ecosystem. Principles and strategies for designing sustainable farming systems. Invasive alien insects and their management on agro-ecosystem. Agro-ecosystem of Nepal and initiatives for management. **4 hrs**
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SEMESTER III
ENTOMOLOGY

Course title: Pest Management, Medical & Industrial Entomology
Course No.: Zoo 611
Nature of the course: Practical

Credits: 2
Lecture hrs: 90
Full Marks: 50
Pass Marks: 25

Course Objectives

- To acquaint the students practically with insect pest management and industrial insects.
- To provide students with practical knowledge of economically and medically important insect rearing.
- To give practical knowledge to the students regarding insect parasites isolation.
- To enable the students about the determination of physiochemical parameters.

Course Contents

1. **Degree day calculation:** Degree day calculation of pest insect and prediction of life history events.
2. **Excursion:** Collection of insect pest of crop, fruits, store grain and medically important insects from different parts of Nepal
3. **Field experiment:** Experimental plot demonstration for IPM
4. **Pesticides residue analysis:** Quantification of pesticide residue of important vegetable from different agro-farms and market vegetables
5. **Insect parasites isolation:** Isolation bacteria and other organisms (e.g. nematodes, fungi) from insects.
6. **Rearing of insects:** Rearing of insects of industrial, medical, veterinary and agricultural importance. Insect parasitoids and predators (*Tricogramma* spp, larval parasitoids, green lace wing, lady beetles), diseased insects for pathogens (Bt, NPV, green/white muscardins), silk worms, mosquitoes, green leafhoppers in rice, potato aphids in potato.
7. **Assessment of pest status and yield loss in crop:** Pest damage patterns (defoliator, leaf minor, borers, gall insects etc). Crop loss assessment.
8. **Sprayer handling and spray calibration:** Pesticide calculations for recommended concentration. Handling pesticide application equipments. Spray calibration for a crop of different phonological stages (germinated stage, vegetative stage, reproductive stage).
9. Evaluation of commercially available domestic insect pest control products through bioassays.
10. Indigenous pest control techniques in rural areas of Nepal.

11. **Apiculture:** Identification of honey bee species, bee castes and special adaptations, identification and handling of bee-keeping equipment. Handling of honey bees-hive and frame inspection. Honey extraction and processing methods of hive products extraction. Visit to bee nursery and commercial apiaries.
12. **Silkworm rearing and management.** Lac processing, products and by-products of lac.
13. **Collection, mounting and identification** of insects of medical and veterinary importance. Vector sampling techniques.
14. **Report preparation:** A field and lab based report on insect pest, pest management and insect vectors

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SEMESTER III
ENTOMOLOGY

Course title: Insect Ecology & Agro-ecosystem
Course No.: Zoo 612
Nature of the course: Practical

Credits: 2
Lecture hrs: 90
Full Marks: 50
Pass Marks: 25

Course Objectives

- To acquaint the students practically with insect ecology, ethno-entomology, insect Behavior and agro-ecosystem
- To provide students with practical knowledge of soil fauna extraction and determination of soil nutrients.
- To give practical knowledge to the students regarding life history study, degree day calculation
- To enable the students about the determination of physiochemical parameters.

Course Contents

1. **Ethno-entomology:** Assessment of insects fauna based on local knowledge and Entomo-therapy in Nepal
2. **Field observation:** Observation of insect pollinators in local gardens
3. **Life history study:** Life table calculation of insects
4. **Soil fauna extraction:** Extraction of soil insects, nematodes (free living, phyto-parasites), soil fungi, Protista, and bacteria.
5. **Determination of physiochemical parameters:** Water (Hardness, DO, CO, temperature, BOD, turbidity), Soil (organic carbon, NPK, soil moisture, soil temperature)
6. **Measurement of ecological indices of insects:** (a) population, (b) density and relative density, (c) frequency and relative frequency, (f) abundance and distribution, (g) Shannon- Wiener index,

simpson's index, evenness index , Nematode indices for soil monitoring (Maturity index, Channel index, enrichment index, Structural index)

- 7. Report preparation:** (Report on agro-ecosystem management, agro-biodiversity, soil biodiversity; Report on insect ecology and conservation)

Suggested Readings

- Adams, B.M., et al. "Population dynamics models in plant–insect herbivore–pesticide interactions." *Mathematical biosciences* 196.1 (2005): 39-64.
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- Gillott, C. 1995. Entomology .2nd Edition. Plenum Press, New York.
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- Gliessman, Stephen R., ed. 2000. *Agroecosystem Sustainability: developing practical strategies*. CRC Press
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