

Tribhuvan University
Institute of Science and Technology
4 Years Bachelor of Science (B.Sc.) Programme
B.Sc. 4th Year Zoology

Course Title : Entomology and Parasitology
Course No. : Zool.401
Nature of Course : Theory
Instruction Lectures : 150

Full Marks: 100
Pass Marks: 35
Year: IV

Objectives of the Course:

At the end of course students will be able to:

- Understand value of virus, bacteria, protozoan and helminth parasites and insects.
- Explain and demonstrate general anatomy of insects and host-parasite relationship.
- Understand the epidemiology of diseases caused by parasites/environment and concept of pharmacology.
- Identify some common pests and parasites of agriculture and understand their control measures.
- Create understanding of economic and commercial insects, vectors and vector-borne diseases.

Teaching materials required to fulfill the objectives are boards, charts, flex prints, overhead projector (OHP), power-point projector and other basic teaching materials prepared by teachers and as provided by the campuses.

Group A: Entomology (75 lec.)

General Entomology				
Unit	Sub-unit	Description of content of the sub-unit (depth)	Lectures	Text/Ref. for the topics (for detail see the list of text & references)
Diversity and Importance of Insects (7 Lectures)	Introduction, insect diversity	What are insects & entomology? The biological success of insects, possible reasons for insect success.	2	Fenemore & Prakash; Gullan & Cranston.
	The importance of insects	Man & insects, harmful insect activities, beneficial insect activities: natural enemies of pest species, pollinators of cultivated plants, producers of useful materials.	2	
	Naming and classification of insects	Basis of insect classification, the insect orders, insect nomenclature, means of identifying insects: uses of keys, field identification and comparison of specimens.	3	
Insect Morphology (11 Lectures)	General body plan, Head, Head appendages: antennae and mouthparts	General body plan of insects, Head: general structure, Head appendages- antennae: structure, functions and types of antennae; mouthparts: typical chewing mouthparts, mouthparts modifications in selected insect orders (Coleoptera, Hymenoptera, Lepidoptera & Diptera).	4	Chapman; Gillot; Snodgrass.
	Thorax, Thoracic appendages: legs and wings	Thorax: structure, Thoracic appendages- Legs: basic structure, leg modifications; Wings: basic structure, veins and venation, modifications, wing coupling.	4	
	Abdomen, Abdominal	Segmentation: number & structure of abdominal	3	

	appendages: external genitalia and other appendages	segments, abdominal appendages and outgrowths: External genitalia, other appendages (cerci, styli, cornicles, prolegs, gills).		
Insect Anatomy and Physiology (20 Lectures)	Digestive system	Alimentary canal, salivary glands, physiology of digestion.	3	Chapman; Gillot; Snodgrass.
	Circulatory system	Structure, physiology (circulation & heartbeat), haemolymph.	2	
	Excretory system & nitrogenous excretion	Excretory systems: Malpighian tubules, other excretory structures (rectum, integument, nephrocytes), Nitrogenous excretion: nature of nitrogenous wastes & physiology of nitrogenous excretion).	4	
	Nervous & chemical integration	Nervous system: central and visceral nervous system; pheromones: sex pheromones, aggregation pheromones, alarm pheromones, caste regulating pheromones.	3	
	Sense organs	Sensory hairs, Johnston's organ, tympanal organs, compound and simple eyes.	2	
	Respiratory system	Respiratory system: integument as a respiratory organ, blood gills, tracheal system (tracheae, tracheoles, spiracles), tracheal air sacs & tracheal gills, movement of gases within tracheal system (diffusion, passive and active ventilation).	4	
	Reproductive system	Structure and function of male and female reproductive systems.	2	
Applied Entomology				
Pest Management	Pest damage	Pest damage- direct effects of insect feeding, indirect effects of insects on crops	1	Hill; Pedigo.

(21 Lectures)	Economic decision levels for pest populations	Concepts of economic levels, Economic injury level, economic threshold.	1	
	Methods of pest control	Methods of pest control: legislative, physical, cultural, biological (parasites and parasitoids, predators, pathogenic microorganisms like bacteria, viruses, fungi), crop plant resistance to pest attack and chemical control. Classification of pesticides: according to the site of encounter (stomach poison, systemic poison, contact poison and fumigants), insecticide mode of action (nerve poisons and muscle poisons), based on chemicals (chlorinated hydrocarbons, organophosphates, carbamates and pyrethroids), concept of pesticide formulations: liquid formulations (emulsifiable concentrates, solutions, aerosols and liquefied gas) and dry formulations (dusts, granules, wettable powders, soluble powder, slow-release formulations), effects of pesticides, pesticide use in Nepal, safe use of pesticides.	12	
	Integrated Pest Management	Concept of Integrated Pest Management, IPM strategies and tactics, goals of IPM, key steps in IPM program.	2	
	Descriptions, biology and control of selected crop pests (<i>Quadraspidiotus perniciosus</i>, <i>Aphis gossypii</i>, <i>Leptocorisa acuta</i>, <i>Phthorimaea operculella</i>, <i>Spodoptera litura</i>, <i>Sitophylus zeamais</i>)	Hosts, damage, pest status, life history and control of <i>Quadraspidiotus perniciosus</i> , <i>Aphis gossypii</i> , <i>Leptocorisa acuta</i> , <i>Phthorimaea operculella</i> , <i>Spodoptera litura</i> , <i>Sitophylus zeamais</i> .	5	Hill.

Industrial Entomology (16 Lectures)	Apiculture: Society organization of honey bee, species, morphology, life cycle of honey bee, bee keeping, prospects of beekeeping in Nepal	Society organization of honey bee, honey bee species in Nepal, morphology of honey bee, Life history of honey bee: development (egg, larva, pupa and adults) and caste determination, bee keeping, types of bee hives, diseases and enemies of bee, prospects of beekeeping in Nepal.	6	Fenemore & Prakash.
	Sericulture: Introduction, Life cycle of silk moth, strains of silkworm, rearing of silkworms, cocoons, mulberry cultivation, composition & uses of silk, prospects of sericulture in Nepal.	Introduction, Life cycle of silk moth (eggs, larvae, pupae and adults), strains of silkworm and silk production, rearing of silkworms, diseases of silkworm, treatment and disposal of cocoons, mulberry cultivation, varieties of mulberry in Nepal, composition & uses of silk, utility of byproducts, prospects of sericulture in Nepal.	6	Aruga, Fenemore & Prakash
	Lac culture: Introduction, Life cycle of the lac insect, strains of lac, host plants for lac insects, lac cultivation, composition and uses of lac	Introduction, Life cycle of the lac insect, strains of lac, host plants for lac insects, lac cultivation (pruning, coupe system, inoculation, preservation of brood lac, parasites & predators of lac insect, harvesting & yield, refining), composition and uses of lac	2	Fenemore & Prakash.
	Yarsa Gumba (Parasitic fungus & Ghost moth caterpillar): Introduction, economic importance & conservation.	Yarsa Gumba: Introduction. Fungus (<i>Ophiocordyceps sinensis</i>). Ghost moth (<i>Thitarodes</i> spp.). Fungus-insect interactions. Economic importance. Conservation and indigenous management.	2	Cannon et al.; Childs and Choedup.

Group B: Parasitology (75 lec.)

Unit	Sub-unit	Description of content of the sub-unit (depth)	Lectures	Text/Ref. for the topics (for detail see the list of text & references)
General Parasitology (5 Lectures)	Introduction, scope and historical landmarks.	A brief introduction and definition of parasites and parasitism. Scope of parasitology: Academic, health-sector, animal-husbandry, agriculture & medical. History: Early views, views of Redi, Goldfuss, Leeuwenhoek & Rudolphi.	1	Chandler & Read; Cheng; Sharma & Ratnu
	Host parasite inter-relationship.	Effects of parasites on hosts: Consumption of non-nutritional materials, Competition for nutrients, Change in the growth patterns, Tissue damage, Effects of secretions and excretions, Mechanical interference and Castration and sex reversal of the host. Effects of hosts on parasites: Effect of diet, Crowding effect, Temperature, Sex, Age, Host's immunity, Host's specificity.	2	Cheng; Sharma & Ratnu; Chandler & Read.
	Types of host and parasites. Properties of parasites.	Types of parasites: ectoparasites, endoparasites, obligatory, facultative, accidental, permanent, temporary, pathogenic, non pathogenic. Types of hosts: definitive, intermediate, paratenic (transfer), reservoir, accidental. Properties of parasites: depending upon infectiousness, establishment and transmission.	2	Chandler & Read; Cheng; Read.

<p>Epidemiology (7 Lectures)</p>	<p>Uses, tools and measurements (mortality, morbidity, incidence and prevalence).</p>	<p>A brief history and definition of epidemiology. John M. Last 1988: “The study of the distribution and determinants of health-related states or events in specified populations, and the application of this study to the control of health problems”</p> <p>Uses: 1. To study historically the rise and fall of disease in the population. 2. Community diagnosis. 3. Planning and evaluation. 4. Evaluation of individual’s risks and chances. 5. Syndrome identification 6. Completing the natural history of disease 7. Searching for causes and risk factors.</p> <p>Tools: Rates, Ratios, & Proportions.</p> <p>Measurements: Mortality: Crude death rate, specific death rate, Case fatality rate, Proportional mortality rate, survival rate. Morbidity: Morbidity rates or ratio for frequency, duration and severity. Incidence:= No. of new cases of specific disease during a given time period x 1000 ----- Population at risk during that time Prevalence= No. of existing cases(old and new) of a specified disease during a given period of time interval x100 ----- Estimated mid-interval pop. at risk</p>	<p>5</p>	<p>Park;</p>
	<p>Dynamics of disease transmission.</p>	<p>Three links of chain of transmission: the source/reservoir, modes of transmission and the susceptible host.</p>	<p>2</p>	<p>Park</p>

Bacteriology and Virology (13 Lectures)	Bacteria- Molecular characteristics. Entry and colonization in human host. Bacterial toxin. and human diseases. Modes of transmission, pathogenicity and control measures of bacterial diseases (Tetanus, Syphilis and Leprosy).	Bacteria: Definition, history, salient features, molecular characters (bacterial spores, capsules, virulent factors/antigenic variation, bacterial conjugation, transformation and transduction, mechanism of bacterial resistance to antibiotics). Sources of bacterial infection in human through animals, insects, soil, contact and water. Bacterial toxin and human disease: introduction, exotoxin and endotoxin. Bacterial diseases: Introduction, causative agent, mode of transmission, clinical features, treatment and prevention of tetanus, syphilis and leprosy.	7	Arora; Ananthanarayan & Paniker; Chakraborty; Dubey & Maheshwari; Gupta.
	Virus- Molecular characteristics. Modes of transmission, pathogenicity and control measures of viral diseases (Hepatitis B, Dengue, Avian influenza, Ebola and Swine flu).	Virus: definition, history, salient features, classification (DNA and RNA viruses), general structure and molecular characters (antigenic variation, viral replication, retrovirus and reverse transcription). Viral Diseases: Introduction, causative agent, source of infection, mode of infection, clinical features, treatment and prevention of hepatitis B, dengue, avian influenza, Ebola and Swine flu).	6	Ananthanarayan & Paniker; Chakraborty; Arora.
Protozoology and Helminthology (10 Lectures)	Epidemiology of Protozoan diseases (Malaria, Leishmaniasis, Giardiasis, Amoebiasis) and	Brief knowledge about medically important protozoans. Protozoan diseases: Introduction, causative agent, geographical distribution, status in Nepal, habitat, reservoir of infection, mode of transmission, factors that facilitate the spread of disease, clinical features, control and prevention of malaria, leishmaniasis, giardiasis, amoebiasis.	3	Chandler; Cheng; Park; Jordan & Verma.

	helminthic diseases (Fasciolopsis, Echinococcosis, Schistosomiasis, Ancylostomiasis, Enterobiasis and Filariasis).	Brief knowledge about medically important helminthes. Introduction, causative agent, geographical distribution, status in Nepal, habitat, reservoir of infection, mode of transmission, factors that facilitate the spread of disease, clinical features, control and prevention of fasciolopsis, echinococcosis, schistosomiasis, ancylostomiasis, enterobiasis and filariasis.	4	
	Parasitic nematodes in citrus plant. Agricultural practices in phytonematode control.	Brief introduction and definition of phytonematodes. Brief account of citrus plants. Introduction and pathogenicity of major nematode pests of citrus: (<i>Tylenchulus semipenetrans</i> (Citrus nematode), <i>Pratylenchus coffeae</i> (Root-lesion nematode), <i>Hoplolaimus indicus</i> (Lance nematode), <i>Meloidogyne</i> spp (Root-knot nematode). Control of phyto-nematode: cropping, manuring, soil disinfection, heat, fallowing, flooding, solarization and biological control.	3	Jenkins & Taylor; Chitwood & Chitwood.
Zoonotic Diseases (7 Lectures)	Epidemiology of viral (Japanese encephalitis), bacterial (Brucellosis), protozoan (Theilariosis) and helminthic (Trichinelliosis).	Brief introduction and definition of zoonoses. Introduction, causative agent, geographical distribution, status in Nepal, habitat, reservoir of infection, mode of transmission, factors that facilitate the spread of disease, clinical features, control and prevention of japanese encephalitis, brucellosis, theilariosis and trichinelliosis.	7	Chandler & Read; Cheng; Park.
Vector and Vector Borne Diseases (7 Lectures)	Diseases transmitted by sandflies, mosquitoes, ticks and mites. Control of vector and	Introduction of arthropod vectors and vector borne disease.	2	Chandler & Read; Cheng; Park.
		Brief account of diseases and their control measures transmitted by sandfly (sandfly-fever,	5	

	vector borne diseases.	leishmaniasis), Mosquitoes (malaria, yellow-fever, dengue, filariasis), Ticks (relapsing-fever, spotted-fever, babesiosis), Mites (scabies).		
Environmental Health (7 Lectures)	Problems, planning and management in Nepal.	Brief information of environment and health. Causes of environmental problems. Environmental threats in Nepal. Introduction to health care system. Health care system in Nepal (Allopathic, Ayurvedic, Homeopathic, Unani). Problems, planning and management of health care system in Nepal.	2	Dahal; Gartoulla; Mathur.
	Excreta disposal and public health importance.	Human excreta disposal and hazards (soil pollution, water pollution, contamination of food). Method of excreta disposal (pit latrin, ventilated improved latrine, aqua privy, chemical closet, water seal latrine).	2	Gartoulla; Mathur; Dahal.
	Food, milk and water borne diseases.	Brief information about importance of food, milk and water borne diseases. Classification of foodborne diseases: as foodborne intoxications (natural toxins, bacteria toxin, fungi toxin, chemical poisoning) and foodborne infections (bacterial, viral and parasites). Classification of milk borne diseases. Classification (biological) of water borne diseases.	2	Park; Gartoulla; Mathur; Dahal.
	Occupational diseases due to biological agents (Anthrax & Hydatidosis)	Definition and meaning of occupational diseases. Brief information about the occupational diseases-anthrax and hydatidosis.	1	Park; Mathur.
Immunology (8 Lectures)	Immunity.	Definition, Types of immunity (active and passive).	2	Park; Mathur.
	Immunizing agents. Types	Brief information about immunizing agents:	6	

	of vaccines. The Cold chain. Current immunization practices.	vaccines, immunoglobins (IgG,IgM,IgA,IgD and IgE) and antisera. Types of vaccines. Definition of the cold chain. The cold chain equipments. National immunization Schedule.		
Pharmacology (11 Lectures)	Introduction.	Definitions and Introduction of pharmacology and drugs.	1	Tripathi; Pathak.
	Nomenclature of drugs.	Chemical, non-proprietary {United States Adopted Name (USAN)} and proprietary (brand) name.	1	
	Routes of drug administration.	Local routes: Topical, deeper tissues and arterial supply. Systemic routes: Oral, sublingual or buccal, rectal, cutaneous, inhalation, nasal, parenteral: subcutaneous, intramuscular, intravenous and intradermal injection.	2	
	Pharmacokinetics and pharmacodynamics.	Definition and general introduction.	2	
	Antibiotics, its classification and application in medical sciences.	Introduction of antibiotics. Classification based on 'mechanism of action' and 'types of organisms against which primarily active'. Application of antibiotics in medical science.	3	
	Anthelmintic and antiprotozoan medicines.	Anthelmintics: First choice drugs and alternatives for round worm, hook worm, thread worm, whip worm, filarial and tape worms. Its uses, administration and adverse effects. Antiprotozoan : Drugs for amoebiasis, giardiasis, trichomoniasis.	2	

Suggested Readings:

Entomology (latest editions)

- Aruga, H. Principles of Sericulture. Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi.
- Cannon, P.F., Nigel, L H, Maczey, N., Lungten, N., Tshitila, Tashi, S.and Phurba L. (2009). Steps towards sustainable harvest of *Ophiocordyceps sinensis* in Bhutan. Biodivers Conserv **18**: 2263–2281.
- Chapman, R.F. The Insects: Structure and Function. 4th edition. Cambridge University Press.
- Childs, G. and Choedup, N. (2014) Indigenous Management Strategies and Socioeconomic Impacts of Yartsa Gunbu (*Ophiocordyceps sinensis*) Harvesting in Nubri and Tsum, Nepal, Himalaya **34**(1): 7-22.
- Delong, J. Borror and Delong, Dwight M. An Introduction to the Study of Insects.
- Fenimore, P.G. and Prakash, A. Applied Entomology. New Age International Publishers.
- Gillot, C. Entomology. Plenum Press, New York.
- Gullan, P.J. & Cramston, P.S. The insects: An outline of Entomology, Wiley Publishers.
- Hill, D.S. 1993. Agricultural Insect Pests of the Tropics and their Control. Special edition for sale in Asia only. Cambridge University Press..
- Metcalf, R.L. and Flint, W.P. Useful and Destructive Insects, their Habitats and Control. McGraw- Hill, New York.
- Metcalf, R.L. and Luckmann, W.H. Introduction to Insect Pest Management.. John Wiley & Sons, New York
- Pedigo, L.P. Entomology and Pest Management. Prentice Hall of India Private Limited, New Delhi.
- Richards, O.W. and Davies, R.G. IMMS' General Textbook of Entomology. vol. 1. BI Publications Pvt. Ltd., New Delhi.
- Snodgrass, R.E. Principles of Insect Morphology. CBS Publishers & Distributors.
- Verma, L.R. (eds) Honeybees in mountain agriculture, Oxford & IBH publishing Co. Pvt. Ltd. New Delhi, India

Parasitology (latest editions)

- Ananthanarayan and Paniker. A Text Book of Microbiology. Orient Blackswan, Telangana, India.
- Arora, D.R. and Arora B. Medical Parasitology. CBS Publishers and Distributors, New Delhi.
- Arora, D.R. Text Book of Microbiology. CBS Publishers and Distributor, New Delhi.
- Bhattacharya, S. Epidemiology: Principles and Practice. Jaypee Brothers Medical Pub.(P) Ltd. Mumbai, St Louis (USA), etc.
- Chakraborty, P. A Text Book of Microbiology. New Central Book Agency, Delhi.
- Chatterji, K.D. Parasitology (Protozoology and Helminthology). Medical Publishers, Calcutta, India.
- Chandler, A.C. and Read, C.P. Introduction to Parasitology. John, Wiley and Sons, inc.
- Cheng, T.C. The Biology of Animal Parasites. Saunders Co. Philadelphia and London.
- Chitwood, B.G. & Chitwood, M.B. Introduction to Nematology, University Park Press, Baltimore, London, Tokyo.
- Dahal, A. R. A Text Book of Health management. Vidyarthi Pustak Bhandar, Pub. & Distri., Bhotahity, Kathmandu.
- Dubey, R.C. & Maheshwari, D.K. A Text Book of Microbiology. S. Chand & Company P. Ltd.

Gartoulla, P. A Text Book of Environmental Health. Vidyarthi Pustak Bhandar, Pub. & Distri., Bhotahity, Kathmandu.
Gupta, S. The Short Text Book of Medical Microbiology (Including Parasitology). Jaypee Pub.
Jenkins, W.R. & Taylor, D.P. 1967. Plant Nematology. Reinhold Publishing Corporation, New York.
Mathur, J.S. Preventive and Social Medicine, A comprehensive Text book with special focus on Nepal. CBS Publication and Distributor, Delhi.
Park, K. Text book of Preventive and Social Medicine. Banarsidas Bhanot Publishers Jabalpur, India.
Parija, S.C. Review of Parasitic Zoonoses. A.I.T.B.S. Publishers and Distributors, Delhi.
Pathak, T.B. (2011). Medical Pharmacology and Pharmacy. Vidharthy Prakashan Pvt. Ltd., Kamalpokhari
Read, Clark P. 1977. Animal Parasitism. Prentice Hall of India PTL. New Delhi.
Sharma, P.N. & Ratnu L.S. 1984. An Introduction to Parasitology. S. Chand & Company Ltd., New Delhi.
Tripathi, K.D. Essentials of Medical Pharmacology. Jaypee Brothers, Medical Publishers P. Ltd., New Delhi.

Course Title: Entomology and Parasitology

Course No. : B. Sc. Zool.402

Nature of Course : Practical

Objective of the Course: For better understanding of the topics of Zool.401.

Full Marks:50

Pass Marks:20

Year : IV

Entomology

1. Study of museum specimens/permanent slides of pest species and vectors covering important orders.
2. Identification of collected insects up to orders using keys to orders, identification of major crop pest species and their wet and dry preservation (liquid preservatives, insect pinning, labeling and storing).
3. Preparation of permanent slides: Antennae (3-5 types), Wings (3-5 types), Mouth parts (2-3 types) and Whole mount of fleas, lice, apterygotes, thrips, aphids, ticks and mites (2-5 types).
4. Dissection of common insects such as honey bees (sting), grasshoppers (nervous system).
5. Survey of varieties of synthetic chemical pesticides available in the market and write note on i) trade name, common name and chemical name composition, ii) Nature of action and target species iii) Note whether recommended to use in Nepal, and iv) note their formulations with their characteristics nature.
6. Study different kinds of sprayers and their parts with respective functions in operation.
7. Study of caste system of honey bees and different instars of silkworm.

Parasitology

1. Study of museum specimens of helminthes and permanent slides of bacteria, protozoans, platyhelminthes and nematodes.
2. Collection, preservation/slide preparation and identification of parasites.
3. Examination of faecal samples for identification of intestinal parasites and eggs.
4. Preparation of thick and thin blood smears on a slide.
5. Preparation and study of protozoan culture.
6. Microphotography of parasites. Identification of photos of different stages of parasites.
7. Principle and use of *in vitro* diagnostic tools: Immunochromatographic Test (ICT) / Rapid Diagnostic Test (RDT) for different human diseases (malaria, filariasis, dengue etc).

Practical note book preparation as regular study.

Report writing: Survey of any locality regarding any topic of Zool. 401 and write a report of about 5 -10 pages. Conduct **seminar** on the report and submit the final report accommodating suggestions made in the seminar.

Examples:

- Study of damage patterns of stored grains, field crops and vegetables caused by the insects and nematodes.
- Visit to the hospitals for the survey (general survey, status or case report) of any studied disease, immunization programs, etc
- Visit of farmer plots, apiculture / sericulture/ fish/ poultry /animal husbandry in local area.
- Prepare market survey report on pesticide use on vegetables or fruit trees.

Suggested Readings:

Entomology (latest editions)

Delong, J. Borror and Delong, Dwight M. An Introduction to the Study of Insects.

Fenimore, P.G. and Prakash, A. Applied Entomology. New Age International Publishers.

Hill, D.S. Agricultural Insect Pests of the Tropics and their Control. Special edition for sale in Asia only. Cambridge University Press.

Neupane FP Balibiruwaka Satruharu Ra Tinko Roktham (In Nepali), Sajha Prakasan

Raghavaiah G (eds) Practical Manual for Insect Ecology and Integrated Pest Management, Acharya N G Ranga Agricultural University, Rajendranagar, Hyderabad

Schauff M. E. (eds) Collecting and Preserving Insects and Mites: Techniques and tools Systematic Entomology Laboratory, USDA, National Museum of Natural History, NHB 168, Washington, D.C.

Parasitology

Chatterji, K.D. Parasitology (Protozoology and Helminthology). Medical Publishers, Calcutta, India.(for Para-3&4).

Verma, P.S. Invertebrate Zoology, Latest Ed., S. Chand & Co. Pub., 857 pp. (for Para. 5)

WHO. Basic Laboratory Methods in Medical Parasitology. Pub. World Health Organization, Geneva.
