Institute of Science and Technology

Master of Science in Zoology

M.Sc. Zoology

Curriculum

1999

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Master of Science in Zoology

M.Sc.Zoology

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Kathmandu, Nepal

Introduction

Three-year Bachelor level education has been introduced in Tribhuvan University in order to make the standard of education at par with the international standard. This has necessitated modifying and revising the present syllabus for Master's degree.

Objectives

The main objectives of the course are:

- to make the master degree program in zoology more relevant to the professional needs and to national development,
- to impart knowledge to the students on taxonomic status, general biology and evolutionary pattern of the non-chordates and chordates,
- to upgrade the quality of the master degree program in zoology so that the students would be able to compete with postgraduates of other universities,
- to provide to the students advanced knowledge in the area of their specialisation such as entomology, ecology, parasitology and fish and fisheries,
- to make the students capable of exploring fauna independently,
- to familiarise the students with various techniques applied in zoology research and
- to make the students aware of the various environment related problems on local and global scale.

Eligibility for Admission:

The candidates who have passed B.Sc. Degree with major in Zoology from Tribhuvan University or Equivalent Degree and major from Tribhuvan University or any other university recognized by Tribhuvan University shall be considered eligible to apply for Admission to M.Sc. Zoology

Admission Criteria:

An applicant seeking admission to M.Sc. Zoology must appear in an Entrance Examination of two hours' duration conducted by the Central Department of Zoology / Campus. An applicant who fails to appear in the Entrance Examination or fails to obtain a minimum qualifying score will not be allowed admission. A merit list of the qualified applicants will be prepared on the basis of the percentage of their B. Sc. Examination and the marks obtained by them in the Entrance Examination. Admission of the students will be based strictly on the merit list and on the enrollment capacity of the Central Department of Zoology / Campus.

Course Structure:

The entire M. Sc. course in Zoology is of two academic years. It carries seven theory papers, four practical papers and one dissertation work. The whole course is divided into two parts each of one year duration and 500 marks. The first year (Part I) comprises four theory papers, each of 100 marks and two practical papers each of 50 marks. The second year (Part II) consists of special

papers. There are four different specialization areas, each of 400 marks together with one compulsory dissertation work of 100 marks.
Students will choose any one of the following specialization areas:

a. Entomology
b. Fish and Fisheries
c. Ecology
d. Parasitology

Each specialization will have three theory papers carrying 80 marks each and two practical papers each of 80 marks. In each practical paper 25% marks shall be set apart for field work, collection, preservation, report writing and presentation.
The detailed structure of the course is as follows:

M. Sc. Part I

a. **Theory**: There are four Theory Papers which are compulsory for all the students.

Course no.	Courses Title	Full Marks	Pass Marks
Zoo. 511	Non-Chordata	100	40
Zoo. 512	Chordata	100	40
Zoo. 513	Cell and Molecular,Biology, Evolution, Distribution and Biostatistics.	100	40
Zoo. 514	Animal Physiology, Ecology and Animal Behaviour	100	40

b. **Practical**: There are two Two Practical Papers which are compulsory for all the students.

Course no.	Courses Title	Full Marks	Pass Marks
Zoo. 515	Non-Chordata (Invertebrata), Cell and Molecular Biology, Evolution, Distribution and Biostatistics.	50	20
Zoo. 516	Chordata, Animal Physiology, Ecology and Animal Behaviour.	50	20

M. Sc. Part II

There are Four Special Papers. Each special paper has Three Theory Papers and Two Practical Papers. Dissertation is compulsory in each special paper.

I. Entomology **II Fish and Fisheries**
III Ecology **and** **IV Parasitology**

I. Entomology.

Course no.	Courses Title	Full Marks	Pass Marks
Zoo. 611	General Entomology.	80	32
Zoo. 612	Applied Entomology.	80	32
Zoo. 613	Pest Management and	80	32

	Research Methodology.		
Zoo. 614	Practical (Zoo. 611)	80	32
Zoo. 615	Practical (Zoo. 612 and Zoo. 613)	80	32
Zoo. 616	Dissertation	100	40

II Fish and Fisheries.

Course no.	Courses Title	Full Marks	Pass Marks
Zoo. 621	Taxonomy, Anatomy, Physiology & Behaviour.	80	32
Zoo. 622	Applied Fisheries and Management.	80	32
Zoo. 623	Fresh water Ecology and Research Methodology.	80	32
Zoo. 624	Practical (Zoo. 621)	80	32
Zoo. 625	Practical (Zoo. 622 and Zoo. 623)	80	32
Zoo. 626	Dissertation	100	40

III Ecology.

Course no.	Courses Title	Full Marks	Pass Marks
Zoo. 631	Major habitats of Biosphere.	80	32
Zoo. 632	Principles and concepts pertaining. to organisation level and environmental pollution.	80	32
Zoo. 633	Conservation of natural resources and environmental impact assessment.	80	32
Zoo. 634	Practical (Zoo. 631 and Zoo. 632)	80	32
Zoo. 635	.Practical (Zoo. 632 and Zoo. 633)	80	32
Zoo. 636	Dissertation	100	40

IV. Parasitology.

Course no.	Courses Title	Full Marks	Pass Marks
Zoo. 641	General Parasitology, Protozoology & Entomology..	80	32
Zoo. 642	General Parasitology and Helminthology including Phytonematology.	80	32
Zoo. 643	Applied Parasitology & Research Methodology.	80	32
Zoo. 644	Practical (Zoo. 641 and Zoo. 643)	80	32
Zoo. 645	.Practical (Zoo. 642 and Zoo. 643)	80	32
Zoo. 646	Dissertation	100	40

Course Duration:
The entire course is spread over two academic years. There is a separate yearly examination after the end of each academic year.

Hours of Instruction:

a) Working days	:	150 days in an academic year.
b) Class hour	:	
i) Theory:		One theory paper of 100 marks will have 4 hours of lecture per week.
ii) Practical:		One practical paper of 50 marks will have 12 hours of practical per week and that of 80 marks will have 12 hours of practical per week.
iii) Dissertation:		Minimum 8 hours per week
c) Attendance	:	70 percent attendance in the class is compulsory.

Examination:
All students will appear in four hours examination for theoretical courses carrying 100 marks as well as 80 marks and six hours practical examination for 50 and 80 marks. The examination in each paper will be held at the end of the academic session

Evaluation :
Pass Marks: Theory - 40 % and Practical - 40 %

A student having passed his/her 2 years of study will be graded as follows.
Distinction - 75% and over (2 years' average)
1st division - 60% (2 years' average)
2nd division - 45% (2 years' average)
3rd division - 40% (2 years' average)
The student will have to pass separately in Theory and Practical Examinations.

M. Sc. Zoology
First year

Course Title: Non- Chordate Zoology — Full Mark - 100
Course No: Zoo. 511 — Pass Mark - 40
Nature of the Course: Theory — Year: I

Course Description: Theoretical aspects of non chordate fauna from protozoa echinodermata.

General Objectives:

- to make the M. Sc. in Zoology programme more practical and relevant to the professional needs for national development,
- to provide the students with advanced knowledge in the area of specialization and to upgrade the quality of the M. Sc. degree programme so that the post graduate students in zoology could compete academically with the post-graduates from other universities.

Specific Objectives:

- to identify the taxonomic status and discuss in evolutionary pattern of the non- chordates,
- to describe the general biology of the non-chordates,
- to make able to discuss on parasitic diseases,
- to make able to explore Nepalese non-chordate fauna,
- to know the method of collection, preservation and identification of non-chordate fauna and
- to know the different aspects of the arthropode pests management.

Course Contents:

Unit I Taxonomy: Significance and scope of taxonomy, Modern trends in taxonomy, Concept of species and speciation, Theories of biological classification, Taxonomic keys and their amendments. Central theme of international code of zoological nomenclature. **16 hrs.**

Unit II Diversity of Non - chordata: Diversity of form, structure, symmetry, habit and habitat, types of coelom, physiology and numerical strength in species and genera. **5 hrs.**

Unit III Protozoa: Classification, Protista and status of Protozoa. Parasitic protozoans and diseases with special reference to Kala-azar, Vaginitis and Babesiasis. Peculiarities of Radiolaria and Suctoria. Nutrition, locomotion, excretion, respiration, osmo regulation and reproduction in protozoan. Economic importance of protozoa. **16 hrs.**

Unit IV Porifera, Coelenterata, and Ctenophora: Classification, Affinites and economic importance of Porifera Polymorphism in Coelenterata. Theories of coral formation. Economic importance of Coelenterata, structure and affinities of Ctenophora. **10 hrs.**

Unit V Helminthes: Classification, Regeneration in Turbellaria, Parasitism and Parasitic adaptations in helminthes. Host parasite relationship. Adhesive organs and larval forms of Platy helminthes, Structure & life cycle,

distrtibution, epidemiology and clinical manifestation of *Ancylostoma duodenale* and *Enterobius vermicularis* Periodicity of microfilaria. **16 hrs.**

Unit VI Classification and General Survey of: Acanthocephala, Nemartinea, Nematomorpha, Rotifera, Gastrotricha, Bryozoa and Branchiopoda. **7 hrs.**

Unit VII Annelida: Classification and affinities of Annelida. Behavioral modification in annelids. Coelom and nephridial system in annelids. Role of annelids in agroecosystem with special reference to earthworm. Abberant Annelids - Structure and affinities of Archiannelida, Echiuroidea and Sipunculoidea. **10 hrs.**

Unit IX Arthropoda: Classification, Characteristics and affinities of Onychophora,Trilobita, Xiphosura, Arachnida and Myriapoda: Parasitism and larval forms in crustacea , Respiratory system in insects. Biology (Habit, habitat, distribution and general organisation) and control of *Pulex irritans* and *Nepholettix negropictus*. Principle of insect pest management. Insect adaptations to environmental changes. **22 hrs.**

Unit X Mollusca: Classification and affinities of Mollusca. Torsion and detorsion in Mollusca. Parasitic gastropoda. Molluscan pests of agricultural importance. Shell and foot in Mollusca. Biology of terrestrial slugs (Classification, digestive system , respiratory system, reproduction and locomotion) **11 hrs.**

Unit XI Echinodermata: Classification, Water vascular system in Echinodermata, Larval forms and symmetry in Echinodermata. Origin and Evolution of Echinodermata. **7 hrs.**

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Chordate Zoology

Course Title: Chordate Zoology
Course No: Zoo. 512
Nature of the Course: Theory

Full Mark - 100
Pass Mark - 40
Year: I

Course Description: Lower chordata, Ichthyology, Herpetology, Ornithology, Mammalogy, Comparative anatomy, Embryology and Endocrinology.

General Objectives :

- to make the M. Sc. in zoology programme more practical and relevant to the professional needs for National development,
- to upgrade the quality of the M. Sc. degree programme so that the post-graduate students in zoology could compete academically with the post-graduates from other universities.

Specific Objectives :

- to identify the taxonomic status of the chordates
- to acquaint the students with biology of the chordates,
- to acquire knowledge in the comparative anatomy and development system of chordates.
- to know the status of the Nepalese chordate fauna.
- to know the conservation and management strategies of the Nepalese fauna

Course Contents:

Unit I Lower-Chordata: Theories on origin of chordates, General organisation and affinities of Hemichordata, Urochordata, Cephalochordata & Cyclostomata. **7 hrs.**

Unit II Icthyology: Classification, General organisation and affinities of Holocephali and Dipnoi Origin and evolution of fishes, Colouration and mimicry, Parental care in fishes, Distribution, diversity and status of fishes with reference to Nepal, Biology (Habit, habitat, distribution and general organisation) of selected fishes (only one) Mahseer *(Tor Putitora)* or *Wallago attu,* Conservation and management of fishes. **15 hrs.**

Unit III Herpetology: a. **Amphibia**: Classification, Evolution and adaptive radiation, Extinct orders of Amphibia. Organisation and affinities of Gymnophiona, Reproduction, metamorphosis and neoteny , Defence mechanism, Distribution and diversity of amphibians in Nepal, Economic importance, Ecology (Habit, habitat and distribution) of Newt or Salamander (*Tylototriton Verrucosus),* Rhacophorus and Hyla. **15 hrs.**

Reptilia: Classification, Origin and evolution, Adaptive radiation, Extinct reptiles with emphasis on Dinosaurs, Distribution and diversity of reptiles with reference to Nepal, Threatened reptiles of Nepal, Ecology (Habit, habitat and distribution)of selected species of Reptiles: Gharial, Turtles, Python and Monitor lizard (*Varanus flavicens*). **15 hrs.**

Unit IV Ornithology: Classification, Origin and evolution, Flight and perching mechanism, Palate in birds, Breeding behaviour, Ecology (Habit,

habitat and distribution)of following species - Danphe, Spiny babbler, Swamp partridge, Sarus crane, Lesser Adjutant stork, Distribuion and diversity of birds with reference to Nepal, Threatened birds of Nepal, Economic importance.

20 hrs.

Unit V Mammology: Classification, Origin and evolution, Adaptive radiation, High altitude mammals and their adaptation, Distribution and diversity of mammals of Nepal, Stomach and dentition and their variation, Threatened mammals of Nepal, Ecology (Habit, habitat and distribution) of following species: Snow leopard, Blue sheep, Rhinoceros, Swamp deer and Dolphin, Red panda, and Assamese monkey. **20 hrs.**

Unit VI Comparative Anatomy: Brain, integument and it's derivatives, Respiratory system, Heart, Aortic arches, Digestive system and Urinogenital system. **12 hrs.**

Unit VII Embryology: Structure and chemical organisation of the eggs and it's significance in development. Nucleo cytoplasmic interactions during development. Cell interactions (Organizer mechanism of induction, chemical nature of evocaters), organogeny of brain, eye and heart. **8 hrs.**

Unit VIII Endocrinology: Major Invertebrate and Vertebrate endocrine tissues and their hormones, Chemical nature of hormones, Hypothalamo - Hypophysial system, Regulation of hormone via. feed back mechanism, Mechanism of hormone action. **8 hrs.**

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Cell and Molecular Biology, Evolutionary Biology, Animal Distribution and Biostat.

Course Title: Cell and Molecular Biology, Evolutionary Biology, Animal Distribution and Biostat. Full Mark - 100
Course No: Zoo. 513 Pass Mark - 40
Nature of the Course: Theory Year: I

Course Description: Cell and Molecular Biology, Evolutionary Biology, Animal Distribution and Biostat

General Objectives:

- to make this course in Zoology more relevant to meet the professional needs of the country,
- to upgrade the quality of Zoology course at par with the SAARC level and
- to enable the students to get fully acquainted with advanced topics in the related fields of Zoology.

Specific Objectives:

- to impart advanced knowledge in cell and molecular biology,
- to impart knowledge on use of biostatistics in the research fields in Zoology and
- to provide knowledge on animal distribution in the different regions and their evolution.

Course Contents:

Unit I Cell and Molecular Biology: The Cell and Ageing - Ultra - Structure and Functions of - Plasma membrane , Endomembrane system (Nuclear envelope, Endoplasmic reticulum and Golgi - complex) and Membrane organelles (Mitochondrion, Lysosome, Peroxisomes).Protein synthesis, Cells and organisms used in molecular biology, Tools used in molecular biology. Cell Differentiation - Characteristics (stable state, molecular and genetically controlled); Factors influencing in uni - and multicellualr organisms, Effects of environments, Level mechanisms, Cytoplasmic function in differentiation. Ageing - Ageing at cellular level, Theories of ageing (Changes in nucleic acids, Information content, Protein regulatory mechanisms, Free radical theory), Ageing of connective tissues, Differentiation and origin of elastin tissue, Mental aspect of ageing, Ageing and termination of synthesis programme. Cellular degeneration - Characteristics of cancer cells, Hypotheses about cancer, Genetic basis for cancer; Agents that cause cancer in animals. **20 hrs.**

Genetic Engineering and Biotechnology: Recombinant DNA and PCR (Cloning and amplification of DNA) - Restricted enzymes in cloning, Techniques used in recombinant DNA technology, Cloning vectors for recombinant DNA, Molecular probes, Gene Amplification, PCR and its applications. Restriction Maps and Molecular Genetic Maps - Restriction mapping, Markers for genetic maps, Linkage and recombination between molecular and phenotypic markers, Random amplified polymorphic DNA (RAPDS) using PCR, Isolation, Sequencing and synthesis of genes. Gene

transfer methods and transgenic animals. Molecular mechanism of recombination. Multiple alleles: Multiple - allelic blood group systems, Rh and ABO incompatabilities, Blood group inheritance in man. Artificial induction of genetic changes - Nature of high energy radiation, Measurement of radiation, Ionisation induced by radiation, Differential effects of radiation, Radiation hazards to man. Population Genetics - Gene pool, Gene frequency, Equilibrium of gene frequencies, Hardy - Weinberg Law (Two and more than two alleles, Loci - single, multiple), Genetic drift, Inbreeding, Depression and heterosis. **20 hrs.**

Unit II Evolutionary Biology & Animal Distribution:

Evolutionary Biology - Mechanism of Evolution - Natural selection at macro and micro levels, Variations (types and causes), Speciation (types and modes), Isolation (types) and Sexual selection (Characteristics, Theories and Drawbacks). Protective Resemblences Colouration (types and functions), Mimicry (types and functions). Palaentology - Fossils and kinds, its formation. **20 hrs.**

Animal Distribution: Geological distribution. Zoo-geographic Realms (horizontal or superficials) - Australian, Ethiopian, Palaearctic, Nearctic, Neotropical, Oriental: Physical and climatic nature, Important fauna, Sub-realm, Boundries, Extension and Recent. developments. Bathymetric distribution (aertical or altitudinal) - Introduction, Organic realms (Geobiotic Limnobiotic and Holobiotic), Inter- migration of animals. **20 hrs.**

Unit III Biostatistics: General - Introduction to bio-statistics, Sources of data, Classification, Tabulation and presentation techniques. Descriptive techniques - Measures of central tendency (arithmetic and geometric means, median, and mode), Dispersion (range and standard deviation), Elementary probability concepts - Properties and examples on Binomial, Poisson and Normal distribution. Sampling techniques - Experimental data, Sample survey; Sampling and non-sampling errors, Sampling methods (Simple random, Stratified and Systematic), Sampling with and without replacement, Standard errors associated with sample means. Correlation and regression - Techniques and applications, Making inferences about parameters, Modelling techiques - Linear, Exponential and Parabolic. Hypothesis testing - Nomenclature in hypothesis testing, T-test, Chi-square test, F-test and their applications. Analysis of variance - One way and two way analyses of variances, their applications, Confidence intervals and tests on means (Duncan multiple range test, least significant difference test), Experimental designs - Planning an experimental, Concept of experimentation, Controls, Precision of measurements, Replications, Randomization, Fixed and random effects models, Completely randomized design, Randomized block design, Latin square design. **40 hrs.**

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Animal Physiology, Ecology and Animal Behaviour

Course Title: Animal Physiology, Ecology and Animal Behaviour — Full Mark - 100
Course No: Zoo. 514 — Pass Mark - 40
Nature of the Course: Theory — Year: I

Course Description: Animal Physiology, Ecology and Animal Behaviour

General Objectives:

- to make the M. Sc. course more relevant to meet the professional needs of the country and
- to upgrade the quality of M. Sc. degree programme so that the post-graduate students in Zoology could compete academically with the post-graduates from other universities.

Specific Objectives:

- to acquaint the students at the post-graduate level with advanced theoretical knowledge of the working system of organs of animals, ecological principle and different types of animal behaviour in response to various conditions,
- to provide them with an understanding of currently established inter-disciplinary approach used to study animal physiology, ecology and animal behaviour.
- to make them familiar with the functions of their own organs of the body and
- to develop in them an understanding of the functional aspects of ecology.

Course Contents:

Unit I Animal Physiology: Nutrition: Basic requirements - Carbohydrate, Protein, Fat, Vitamins, Minerals, Overnutrition and Undernutrition and their effects, Physiology of Respiration: Structure, Properties and function of haemoglobin, Regulation of respiration , (Tidal volume, Vital capacity, Lung capacity, Dead space). Physiology of Circulation: Electrocardiography (ECG), Cardiac cycle, Stroke Volume and Cardiac output, Blood pressure and its regulation, Systolic and Diastolic, Regulation of arterial and venous flow, Immunological reaction of blood, Haemolysis, Mechanism of Coagualtion, Excretion and Osmoregulation: Homostatic funciton of vertebrate kidney, Mechanism of ionic regulation. Neurophysiology: Neural control of movement, Receptor neurons, Effector neurons, Gross functional evolution of brain, (Medulla oblongata, Cerebellum, mid brain, Diencephalon, Telencephalon, Reticulum), Physiology of vision, Thermoregulation: Temperature regulation, Thermal neutrality and Thermal comfort, Thermoreceptors, Acclimatization, Heat acclimatization, Cold acclimatization. Reproductive Physiology: Reproductive hormones, Cyclic changes in the uterus, Ovarian cycle. **50 hrs**

Unit II Ecology: Limiting factors of the Environment, Liebig's Law of Minimum. Shelford's Law of Tolerance. Population: Population density, indices of relative abundance, intrinsic Rate of Natural Increase, Population growth

form, concept of carring capacity. Community Analysis: Biotic Cummunity Concept, Cummunity Structure, Concept of Community Dominance, Community Analysis, Species Richness, Equitability, Heterogenety, Cummunity Classification, Stratification, Ecotypes, Ecotones and Concept of 'Edge' Effect, Ecological Indicators, Trophic Relations in Community. Ecological Productivity: Basic features of production, Primary and Secondary productivity of Terrestrial and aquatic Environment. Ecological regulations: Ecological Successions, Climax Concept, Positive and Negative Interactions, Evolution of ecosystem, Coevolution, Group Selection. Natural Resources: Renewable Natural Resources: Forest, Wildlife, Soil, Water, Sun and Air, Non - renewable Resources: Fossil fuel, Minerals. Major Human Impacts on Environment: Deforestation, Soil Erosion, Landslide, Ozone Layer Depletion.

50 hrs.

Unit III Animal Behaviour: Stereotyped and Acquird Animal Behaviour . Reproductive Behaviour - Courtship and Parental care. Agnostic Behaviour, Migratory Behaviour, Orientation in Fish and Birds. Social Behaviour, Pheromones in Reproduciton.

20 hrs.

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Non chordate, Cell and Molecular Biology, Evolutionary Biology, Animal Distribution and Biostat

Course Title: Non chordate, Cell and Molecular Biology, Evolutionary Biology, Animal Distribution and Biostat — Full Mark - 50
Course No: Zoo. 515 — Pass Mark - 20
Nature of the Course: Practical — Year: I

Course Description: Non-Chordate, Cell and Molecular biology, Evolution ,Distribution and Biostatics.

General Objective: The general objectives of this course is to upgrade the knowledge of the students about theoretical studies through experiments.

Specific Objectives :

to develop the knowledge of non- chordate diversity, culture techniques, cellular and molucular structure of different organelles, and to make students able to test theoretical principles and pests management.

Course Contents:

1. Culture of Protozoa. Paramecium, Euglena. etc. (Permanent slides and models)
2. Museum specimens of non-chordates (Protozoa to Echinodermata)
3. Study, identify and comment upon the permanent slides of non chordates.
4. Mounting of nephridium, parapodium, spermatophore (crab), Mounting of fresh water protozoan protozoan parasites of Earthworm, Fish, Frog. Other mounting materials from other non chordate Phyla.
5. Microtomy of some important tissues of non-chordate (Earthworm and cockroach).
6. Experiments to show regeneration in Hydra and Turbellarian.
7. Dissection of Squilla, Scropion, Unio to show the internal anatomy and nervous system.
8. Non chordate, faunal survey, collection, preservation, identification and report preparation.
9. Study of cytological slides.
10. Study of polytene chromosome of a) Drosophila b) Chironomous larva
11. Chromosomes of a) Grasshopper b) Cockroach
12. Survey of certain genetic traits in man and their mode of inheritance.
13. Graphical representation of data - frequency distribution table, histrogram, frequency curve, frequency polygon.
14. Measure of central tendency (mean, mode and median.)
15. Measurement of dispersion, mean deviation, standard deviation, coefficient of variation, standard error.
16. Linear correlation and regression.
17. Testing hypothesis - a) Student's T-test, b) F-test, c) Chi-square test

Chordate diversity, Dissection, Animal Physiology, Ecology and Animal Behaviour practicals

Course Title: Chordate diversity, Dissection, Animal Physiology, Ecology and Animal Behaviour, practicals.

Full Mark - 50
Pass Mark - 20
Year: I

Course No: Zoo. 516
Nature of the Course: Practical

Course Description: Chordate diversity, Dissection, Animal Physiology, Ecology and Animal Behaviour practicals.

General Objective: The general objective of this course is to upgrade the knowledge of theoretical studies through experiments.

Specific Objectives :

- to develop the knowledge of Chordate diversity, Physiology, Ecology and Animal Behaviour through experimental studies.
- to make able to test theoritical principles.

Course Contents :

1. Museum specimens of lower chordates, pisces, amphibia,reptiles, aves and mammalia.
2. Study of permanent slides of chordates.
3. Mounting of embryos and larvae, scales, internal ear, ampullae of lorenzini of fishes.
4. Microtomy of some tissues organ system of chordates.
5. Osteology (Preparation and study of bones).
6. Dissection of pisces so as to expose a) Cranial nerves b) Electric organ of Torpedo . c) Assessory respiratory organs.
7. Dissection of pigeon / Gallus so as to expose pecten, perching mechanism, flight muscles, air sacs.
8. Dissection of Rat or Rabbit to expose ear ossicles, neck nerves and endocrine glands,
9. Vertebrate faunal survey (Collection, preservation, identification and report preparation).

Physiology

1. Protein: Protein Precipitation, Ninhydrin reaction, Biuret reaction, Xanthoproteic reaction, Sakaguchi reation and Millon reaction.
2. Carbohydrate: Mollisch's test,Barfoed's test, Benedict's test, Cole's test, Fehling's test, Osazone formation, Iodine test,and acid hydrolysis of starch.
3. Lipids: Solubility test, Reaction with sudan IV, Saponification, Dunstans's test.
4. Hydrolysis of Polysaccharide in the presence of salivary amylase.
5. Hydrolysis of Polypeptides by protease.
6. Hydrolysis of complex lipides by lipase.

7. The influence of temperature on the rate of the hydrolysis of polysaccharide by enzymes.
8. The effect of enzyme concentration on the hydrolysis of polysaccharide.
9. The effects of hydrogen ion on the hydrolysis of polysaccharide by enzymes.
10. The effects of hydrogen ion on the hydrolysis of polypeptides by enzymes.
11. Chromatographic examination of the products of protein hydrolysis.
12. Chromatographic examination of the blood pigments.
13. Measurement of human arterial blood pressure.
14. Determination of the total number of human red and white (RBC & WBC)blood cells in cubic millimeter.
15. Measurement of the rate of muscle contraction and relaxation, heart beat etc. using kymograph.
16. Estimation of urea in urine.

Ecology

1. Measurement of primary productivity in aquatic ecosystem.
2. Determination of of biomass of terrestrial habitat.
3. Measurement of secondary productivity in aquatic ecosystem.
4. Measurement of population density of invertebrate animals of terrestrial habitat.
5. Measurement of population density of aquatic animals.
6. Measurement of Species Diversity Index of terrestrial plants.
7. Measurement of Species Diversity Index of aquatic plants.
8. Measurement of Species Diversity Index of aquatic invertebrates.
9. Study on Ecological Indicators in terrestrial ecosystem.
10. Study on Ecological Indicators in aquatic ecosystem.
11. Study of community dominance in terrestrial ecosystem.
12. Study of community dominance in aquatic ecosystem.
13. Study of community classification in terrestrial ecosystem.
14. Study of community classification in aquatic ecosystem.
15. Study on Natural Resources of Nepal. (Forest, Wildlife, Water, Minerals etc.) by using the available data.

Ecology
Second Year

Course Title: M. Sc. (Habitats of Biosphere) Full Marks: 80
Course No: Zoo. 611 Pass Marks: 32
Nature of the course: Theory Year: II.

Course Description: Major Habitats of Biosphere: Marine, Estuarine, Freshwater & Terrestrial.

General Objective: to provide an overview of broad basic approach of delimited areas of the earth's surface to achieve a detailed understanding of the world in which living organisms live.

Specific Objective: Specific objectives of this course are:

- to give the students an understanding of ecological principles of a particular habitat,
- to make them familiar with the role of climate in the distribution of living organisms,
- to acquaint the students with organisms and physico-chemical factors associated in a particular ecosystem,
- to provide knowledge of fundamental processes required for the investigation in the area of ecology and
- to develop an understanding of natural hazards of the earth's system.

Course Contents :

Unit -I Major Habitats of Biosphere: Marine, Estuarine, Freshwater and Terrestrial: Terrestrial Habitat: Structure of Earth, Soil formation, Factors affecting soil formation, soil profile development, Top soil and Subsoil. Physical and Chemical Properties of Soil: Soil texture, soil textural classes, major soil types of Nepal, soil structure, soil air, soil temperatue, soil moisture, soil water energy concept, Infiltration and percolation, Factors affecting amount and use of available soil moisture, soil pH, soil organic matter, formation of humus, macronutrient and micronutrient. Soil Organisms: Beneficial soil organisms - microorganisms and invertebrates. Soil and plant relation. Soil as a natural resource and it's management, Land use system - types and causes of soil erosion **23 hrs.**

Climate: Layered strucuture of atmosphere, Composition of air, World Climate Climatic factors: Temperature (Vertical and horizontal distribution, temperature inversion), Wind (Factors affecting wind motion, winds in tropical region, sub tropical wind, the westerlies, polar winds), Relative Humidity: (Evapotranspiration) Precipitation (Fog, clouds, types of precipitation, distriubution of precipitaion), Light, Singificance of climatic factors for the occurrence and distribution of living organisms. Topographic Factors (Altitude, direction of mountain chains, steepness and exposure of slopes). **20 hrs.**

Freshwater habitat: Types of freshwater habitats, Limiting factors: Temperature, transparency, current, biogenic salt, dissolved oxygen, carbondioxide, pH, ecological classification of fresh water organisms, Biotic

communities of lentic and lotic environment, (plankton, nekton, neuston). Concept of rapids zone, pool zone, littoral zone, limnetic zone, profundal zone, temperature zone pattern, stratification in tropics and temprate zone, geographical distribution and classification of lakes and ponds. **20 hrs.**

Unit II Research Methodology: Introduction, Identification of reserach problems, collection of data: Sampling methods in terrestrial environment, sampling methods in aquatic environment, Analysis of data: frequency distribution analysis, Chi square (χ^2)test, student t- test, contingency analysis - simple and multiple, correlation analysis, regression analysis, variance and covariance analysis, measurement of species diversity, measurement of community gradients, presentation of data, Interpretation of findings, conclusion, preparation and publication of findings . **23 hrs.**

Unit III Natural Hazards: Landslide: Causes of landslide and its prevention. Earthquake: Causes of earthquakes, magnitude of earthquakes, distribution of earthquake, protection from earthquake hazards, Flood: Causes of flooding and flood mitigation methods ,Volcanism: Causes of volcanism, volcanisms and climate. **10 hrs.**

Principles and Concepts Pertaining to Organisation Level and Environmental Pollution.

Course Title: Principles and Concepts Pertaining to Organisation Level and Environmental Pollution.
Course No: Zoo. 612
Nature of the course: Theory

Full Marks: 80
Pass Marks: 32
Year: II

Course Description: Principles and Concepts Pertaining to Organisation Level and Environmental Pollution

General Objective: General objectives of this course are :

- to provide an overview of principles and concepts applied to different levels of organisation, and
- to make the students familiar with the environmental problems both on a local and global scale.

Specific Objective: Specific objectives of this course are:

- to develop in the students an understanding of the functional aspects of ecology, to acquaint with advanced knowledge of principles and concept of organisation at the individual, the population and the community levels. and
- to provide them with an understanding of causes, prevention and control for particular pollution problems.

Course Contents :

Unit I Principles and Concepts Pertaining to Organisational level:

Population level: Species Interaction: Commensalism, cooperation and mutualism, Competition: factors for which plants compete for space, light, carbondioxide, nutrients and water. Inter specific competition, Lotka-Volterra model, competitive exclusion and coexistence principles, Ecological Niche: Fundamental Niche, Habitat Niche, Trophic Niche,Predater - prey systems, couple oscillation theory, Lotka-volterra model, stability of predater -prey system, **20 hrs.**

Population growth: Models of population growth, Population regulation - Concept of density dependent and independent action in population control, Concept of carrying capacity, Trends of human population growth, Population distribution, migration, nature and scopes with special reference to Nepal. Problems of rapid population growth, Food problems, environmental problems. **10 hrs.**

Community level organization, quantitative and qualitative study pattern in communities, biological diversity (The Convention on Biological Diversity, CBD), National Policy and Implementation Measures Toward CBD, community analysis, intracommunity classification, Ecological dominance, Ecotone, Ecological energetics: Energy flow in ecosystem, trophic dynamics, Food web. Production Biology: Gross primary productivity, net primary productivity, community productivity, secondary productivity, factors affecting

productivity, productivity of the major ecosystem of the world, methods of measuring productivites

Ecological succession: Primary and Secondary succession, climax concept. Biogeochemical cycles: Gaseous biogeochemical cycle, Sedimentary biogeochemical cycle. **33 hrs**

Distribution of Major Terrestrial Communities: Tundra, northern coniferous forest biomes, moist temperate coniferous forest biome, temperate deciduous forest biomes, broad -leaved evergreen subtropical forest biomes, temperate grassland biomes, tropical savanna biomes, desert biomes, chappral biomes, tropical rain forest, tropical deciduous forest. **10 hrs.**

Unit -II Environmental Pollution: Concept of pollution, kinds of pollution, air pollution - sources of air pollution, types of pollutants, mixing heights of pollutants, plume diffusion, effects of air pollution and prevention and control of air pollution, Water Pollution: Sources of water pollution, types of pollutants, effect of water pollution, prevention and control of water pollution, Solid waste Pollution: Introduction, Biodegradable and non-biodegradable pollutants, management of solid wastes, Radio active pollution: Waste from nuclear power plants and nuclear weapons, mutagenic effects, Noise (Sound) Pollution: Causes and effects of noise pollution. Prevention and control of noise pollution, National Policy and Implementation Measures Towards Pollution, Environmental problems - Photo chemical smog, Ozone layer depletion, greenhouse effect, acid rain etc. Environmental Health and Risk: Hazards - types and effects, biological hazards, hazardous waste, human and animal pathogens distribution and epidemiology of important human pathogens. **23 hrs**

Conservation of Natural Resources and Environmental Impact Assessment

Course Title: Conservation of Natural Resources and Environmental Impact Assessment
Full Marks: 80
Pass Marks: 32
Course No: Zoo. 613
Year: II
Nature of the course: Theory

Course Description: Conservation of Natural Resources and Environmental Impact Assessment.

Generai Objective: General objectives of this course are :

- to provide to the students a knowledge of principles of ecology applied for the conservation of natural resources. and
- to make them familiar with different methods used to study Environmental Impact Assessment (EIA).

Specific Objective: Specific objectives of this course are:

- to highlight the need and importance of conservation and sustainable use of natural resources,
- to provide an understanding of the methods used for the conservation of natural resources,
- to provide an understanding of standard techniques used in study of environmental impact assessment,
- to develop among the ability to evaluate impacts on physical environment and biotic community and
- to make the students familiar with management plan used to reduce impacts for the benefit of man.

Course Contents:

Unit I Conservation Of Natural Resources: Concept of Natural resources: Renewable and non renewable natural resources, Importance of natural resources. Forest resources of Nepal: (Tropical, temperate, subalpine, and alpine forest), Types of Forest (Governmental managed forest, protected forest, community forest, leasehold forest, religious forest) **7 hrs.**

Range land resources: Importance of National Parks and other conservation area, speciation and extinction, forest management and conservation, Wildlife - Concept of wildlife, habitat requirements - cover, food, water and undisturbed environment, Wildlife habitat - Habitat suitability Index (HSI) and Habitat Evaluation Procedures (HEP), Food-habit studies (Qualitative/Quanititative, direct and indirect methods), Breeding Habitats. **10 hrs.**

Wildlife Management and Conservation: Importance of wildlife, Endangered wildlife of Nepal, Convention on International Trade in Endangered species of Wild Fauna and flora (CITES), Main causes of wildlife depletion, Conflict between man and wildlife, Principles and practices of wildlife management, National Parks and wildlife reserves, Afforestation, community forest and pasture land development in Nepal, Wildlife Conservation projects of Nepal,

Man and Biosphere concept and programmes. Wildlife conservation act, Criteria and guidelines for selection of nature reserves, Ecology and behaviour of tiger, swamp deer, Wildlife as a pest and it's management. **20 hrs**

Mountain resources: Origin and evolution of mountains, Ecological classification of mountains, Mountain natural resources and it's management; Mountain soil, Climatic factors, Mountain biodiversity, Mountain wildlife, Human Impacts on mountains, Conservation of mountain environment. **10 hrs**

Water resources: Hydrological Cycle: Importance of water resources, water resources of Nepal, watershed management (Soil and Watershed Conservation Act), catchment ecosystem, Important Physico-chemical parameters of river, lakes and reservoirs, Biotic community of rapids and pool zones, Biotic community of littoral, limnetic and profundal zones. Impoundment of river, Impacts of river impoundment on water quality, riparian community, aquatic biotic community, Eutrophication and water pollution, monitoring, management and conservation of wetlands, Ramsar Convention , Aquatic Animals Protection Act, Primary and secondary productivities, measurement of primary and secondary productivity. **20 hrs**

Energy and Environment: Energy resources and their exploitation, conventional and non conventional energy sources: Fossil fuel, coal, oil and natural gas, hydroelectric power, wind energy, geothermal energy, biomass energy, nuclear energy, energy use pattern in different parts of the world and its impact **6 hrs**

Unit II - Environmental Impact Assessment (EIA): Basic concept of EIA, Historical development of EIA, Environmental quality guidelines. Environmental policy acts including environmental policy acts of Nepal. EIA Methodologies: Checklists, Identification of existing environmental condition, Identification of environmental modifications, Basic steps for predication and assessment, evaluating impacts on physical environment and biotic community, mitigition measures, Enviromental monitoring, EIA and quality of life, application of remote sensing, GIS, and GPS in ecological study. **23 hrs.**

Ecology Practical I

Course Title: Ecology Practical I
Course No Zoo. 614
Nature of the course: Practical

Full Marks: 80
Pass Marks: 32
Year: II

Course Description: General Habitat analysis, Substrate analysis of terrestrial habitats, biotic analysis of terrestrial habitats and climate analysis.

General Objectve: to provide practical knowledge of techniques used for the study of substrate and biotic community in the terrestrial habitats.

Specific Objective: Specific objectives of this course are:

- to acquaint the students with practical knowledge of ecological methods used to study biotic community in terrestrial habitats,
- to develop among the students an understanding of relationship between substrate and biotic community in the nature,
- to make the students familiar with standard techniques used in the study of climate,
- to develop in them an ability to work in the field and to evaluate the important ecological processes and
- to make them able to understand the need of conservation of soil and forest resources.

Course Contents:

Unit I General Habitat Analysis: Reading of Topo Maps, Reading of geological maps, Interpretation of Remotely sensed data.

Unit II Substrate Analysis of Terrestrial habitats: Sampling methods, soil profile, soil moisture content of different horizons, soil texture (clay, silt, and sand), measurement of soil temperature of different horizons, soil pH, measurement of soil acidity and alkalinity, measurement of soil organic matter.

Unit III Biotic Analysis of Terrestrial Habitats: Vegetation Analysis: Quadrate sampling methods, measurement of density, relative density, dominance, relative dominance, frequency, relative frequency and importance value of trees and grasses. measurement of distribution of trees. measurement of species diversity, analysis of species -area relation. measurement of primary productivity of grasses, measruement of community similarity. substrate preference analysis. measurement of interspecific association, correlation and regression analysis. measurement of litter production. Invertebrate Animals: measurement of population density by quadrate and capture-recapture method, measurement of population dispersion including frequency distribuion. substrate preference analysis, measurement of dominance. measurement of species diversity, measurement of interspecific association.

Unit IV Climate Analysis: Analysis of temperature by using the temperature data (at least 25 years), analysis of precipitation by using the precipitation data (at least 25 years), analysis of humidity by using the humidity data (at least 25 years). Analysis of day length pattern in different seasons.

Ecology Practical II

Course Title: Ecology Practical II
Course No: Zoo. 615
Nature of the course: Practical

Full Marks: 80
Pass Marks: 32
Year: II

Course Description: Substrate analysis of aquatic habitats, physico-chemical analysis of water, biotic analysis of aquatic habitat, analysis of pollution, analysis of faecal materials of wildlife and analysis of population parameter.

General Objectve: General objectives of this course are :

- to provide practical knowledge of techniques used for the study of abiotic and biotic components of aquatic habitats and
- to acquaint with the techniques in the study of pollution and population parameters.

Specific Objective: Specific objectives of this course are:

- to make the students familiar with ecological methods used for the study of aquatic habitats.
- to provide practical knowledge of measuring important abiotic and biotic components of fresh water habitats,
- to develop in them an understanding of the relation between abiotic and biotic components of the fresh water habitats,
- to make them able to understand the ecological processes of fresh water habitats
- to develop in them an ability to evaluate the existing conditions of fresh water environment,
- to provide knowledge of measuring the important population parameters and
- to acquaint them with techniques used for the study of air and water pollution.

Course Contents :

Unit I Substrate Analysis of Aquatic Habitats: Determination of physical structure of substrate, measurement of pH, conductivity, chloride, total alkalinity and organic matter.

Unit II Physico- chemical Analysis of water: Sampling methods for the collection of water samples from the different depths of lakes and rivers, measurement of temperature, pH, velocity, turbidity, light penetration, conductivity, total solids. total dissolved solids, total suspended solids, total alkalinity, acidity, carbondioxide, dissolved oxygen, biochemical oxygen demand, chloride, hardness, calcium, magnesium, nitrate and phosphate, measurement of vertical distribuiton of temperature, dissolved oxygen and carbondioxide, determination of relation between velocity and substrate structure.

Unit III Biotic Analysis of Aquatic Habitats: Vegetation Analysis: Sampling methods for the collection of macrophytes, measurement of density, relative density, frequency, dominance and importnce value, measurement of dispersion

pattern, measurement of species diversity and interspecific association, analysis of community, measurement of biomass, measurement of gross primary productivity, net primary porductivity and community respiration. Animals: Sampling methods, measurement of density, biomass, distribution pattern, species diversity, interspecific association and dominance, regression and correlation analysis, determination of relation between substrate structure and abundance of animals.

Unit IV Analysis of Pollution: Measurement of dust particles in the air and some gaseous pallutants (If possible, collect data from concerning office for the analysis), study of water quality indicators, Analysis of faecal materials of wildlife, study of wildlife protected area, Analysis of human population growth pattern of Nepal by using the population census data, life-table birth rate, survival rate, growth rate and mortality rate, fertility rate and total fertility rate.

Dissertation

Course Title: Dissertation
Course No: Zoo. 616
Nature of the course: Research projects

Full Marks: 100
Pass Marks: 40
Year: II

Course Description: Research projects in the area of ecology. Research projects and Thesis Submission: Research project areas will be decided during the second academic year. Students will be encouraged to contribute to the formation of projects, making use of their own experience, ideas and contacts. Project proposals should be discussed with comerned supervisor. Students will have to submit their research proposals during the registration for M. Sc. Zoology. Part II (Ecology). The progress of work will be reviewed internally from time to time and the final evaluation will be made of the thesis. The thesis should be presented for examination. Students will have to take an oral examination.

References :

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Entomology

Course Title: Entomology
Course No: Zoo. 621
Nature of the course: Theory

Full Marks: 80
Pass Marks: 32
Year: II

Course Description: Taxonomy and role of biosystematics in pest management , Morphology, Anatomy and Physiology, Embryology and Metamorphosis.

General Objectives :

- to make the students familiar with morphological, anatomical, physiological variations of insects as well as their developmental process and metamorphosis.
- to introduce to them the concept of insect taxonomy giving stress on biology and control measures of insects of human importance.

Specific Objectives :

- to provide overall knowledge on insect taxonomy.
- to help identify important family of each order and explain biology and control measures of economically important insects.
- to introduce the morphology and appendanges of insects.
- to impart knowledge on physiological process and hormones of insects.
- to help explain mechanism of light and sound production in insects.
- to help explain mechanism of insect development and metamorphosis. Also the types of larvae and pupae.

Course Contents :

Unit I Taxonomy: Classification and Phylogeny of insects: Apterygote insects, Exopterygote insects, Endopterygote insects. Systematics: Characteristics of the following orders and their economic importance: **Lepidoptera** (Rhopalocera: Lycaenidae, Pieridae, Papilionidae and Hesperiidae. Heterocera: Tineidae, Psychidae, Gracillariidae, Yponomeutidae, Gelechiidae, Cossidae, Limacodidae, Tortricidae, Pyralidae, Pterophoridae, Hespiriidae, Geometridae, Lasiocampidae, Bombicidae, Saturniidae), **Sphingidae**, Arctidae, Noctuidae, Lymantriidae, Sessidae and Zygaenidae. Coleoptera (Carabidae, Staphylinidae, Scarabaeidae, Buprestidae, Cantharidae, Elateridae, Lampyridae, Dermastidae, Bostrichidae, Anobiidae, Lyctidae, Trogossidae, Coccinellidae, Tenebrionidae, Meloidae, Cerambicidae, Bruchidae, Chrysomelidae, Attelabidae, Cucujidae, Apionidae and Curculionidae including Scolytinae and Platypodinae). **Diptera** (Psychodidae, Culicidae, Tipulidae, Simuliidae, Ceratopogonidae, Cecidomyidae, Tabanidae, Asilidae, Bombiliidae, Pipunculidae, Syrphidae, Drosophilidae, Sarcophagidae, Oesttrida, Calliphoridae, Tachinidae, Glossinidae, Hippoboscidae, Anthomyzidae, Agromyzidae, Chloropidae, Tephritidae and Muscidae). **Hymenoptera** (Siricidae, Cephidae, Tenthredinidae, Evanidae, Cynipidae, Ichneumonidae, Megachilidae,

Braconidae, Chalicididae, Perilampidae, Pteromalidae, Encyrtidae, Eulophidae, Trichogrammatidae, Mamoridae, Scelionidae, Dryinidae, Bethylidae, Formicidae, Vespidae, Eumenidae, Sphecidae, Xylocopidae, Apidae, Bombidae and Megachilidae). **Hemiptera** (Homoptera: Fulgoridae, Cercopidae, Cicadidae, Membracidae, Cicadellidae, Psyllidae, Aleyrodidae, Aphididae, Margarodidae, Lacciferidae, Pseudococcidae, Coccidae and Diaspididae; Heteroptera: Anthocoridae, Miridae, Lygaeidae, Pyrrhocoridae, Pentatomidae, Reduviida, Climicidae, Tingidae, Coreidae and Nabidae) **Orthoptera** (Tettigoniidae, Gryllidae, Gryllotalpidae, Acrididae and Tetrigidae). **Dictyoptera** (Blattidae and Mantidae). **Thysanoptera** (Thripidae and Phlaeothripidae). **Isoptera** (Termitidae, Kalotermitidae and Rhinotermitidae). **Sipunculata** (Pediculidae). Siphonoptera (Pulicidae and Tungidae). **Neuoptera** (Chrysopidae, Mantispidae, Hemerobiidae and Myrmeleontidae). Arachina (Mites: Acaridae, Eriophydae and Tetranychidae; Ticks: Ixodidae and Argasidae). **Araneidae** (Theraphoside, Tetragnathidae, Lysosidae and Oxyopidae). **36 hrs.**

(Emphasis should be given on groups that are likely to be commonly encountered with guides to their recognition through both morphology and life - histories).

Unit II: Role of biosystematics in pest management: **2 hrs.**

Unit III Morphology: Integuments and its derivatives. Insect colouration. Head segmentation and its appendages (Mouth parts their modification, Antennae and their modification). Thoracic segments and its appendages (Legs and their modifications, Wings and their venation, wing - coupling). Abdominal segments and its appendages. External genitalia. **20 hrs.**

Unit IV Anatomy and Physiology: Digestion, Respiration, Nervous system, Circulation, Excretion, Reproduction special reproductive devices (Paedogenesis, Polyembryony, Viviparity, Ovoviviparity and Parthenogenesis). Endocrine organs. Sound and light production. **20 hrs.**

Unit V Embryology and Metamorphosis: Mechanism of egg laying and egg structure with their variations, Development upto gastrulation. Blastokinesis, Larvae and pupae, Differences between nymph, naiad and larva. Metamorphosis (Types and role of hormones). **13 hrs.**

Unit VI Diapause: **2 hrs.**

Unit VII Introduction to insect behaviour: **3 hrs.**

Insect Ecology, Insect Pests and Useful Insects

Course Title: Insect Ecology, Insect Pests and Useful Insects
Full Marks: 80
Course No: Zoo. 622
Pass Marks: 32
Nature of the course: Theory
Year: II
Course Description: Insect Ecology, Insect Pests and Useful Insects.

General Objectves :

- to make the students familiar with insect ecology in the natural and induce environment.
- to introduce the survey of insect pests of agriculture, horticulture, forest with reference to Nepal, also the insects of public and animal health.

Specific Objectives :

- to provide knowledge on insect ecology, population dynamics, monitoring and pollination ecology.
- to give knowledge on insect pests of agriculture , forest and public health with reference to Nepal.
- to give knowledge on distribution, description, life-history, damage and control measures of some serious insect pests of Nepal.
- to introduce to the students a general overview of useful insects.
- to explain the method of insect collection, preservation and maintenance of reference insects.

Course Contents :

Unit I Insect Ecology: Population Dynamics: Population Structure. Life table: Age specific and Time specific. Population estimation: Common Sampling techniques (Marking technique and quadrate method of different habitats: agriculture land, grass land, forest and freshwater). Regulation factors (Concept of density dependent and density independent factors: Interspecific and Intraspecific). Predator-prey systems, couple oscillation theory, stability of predator-prey system. Insect and their environment: Niche (Fundamental niche, habitat niche and tropic niche). Insect population in induced environment. Ecological role of insect outbreak. Determinants of insect abundance. Insect Monitoring and forecasting Pollination Ecology. **36 hrs**

Unit II Inesect Pests: Important pest: Their description , life-cycle, host damage of those marked asterisk . Agricultural Pests: **Paddy** (*Spodoptera mauritia, Dicladispa armigera, Nilaparvata lungens, Orseolia oryzae, Nephotettix nigropictus, N. virescens, Leptocorisa chinensis, Cnaphalocrosis medinalis, Brevennia rehi, Heteronychus lioderes, *Sogatella furcifera, Chilo suppressalis, Baliothrips biformis, Scirpopaga incertulus* and *Sesamia inferens).* **Wheat** (*Mythimna separate, Bryobia sp., Taeniothrips flavidules, Anaphothrips flavicinctus, Schizaphis graminum* and *Rhizoperha dominica).* **Maize** (*Rhopalosiphum maidis, Atherigona variasoccata* and **Chilo partellus).* **Legumes** (*Aphis fabae, A . craccivora, Callosobruchus maculatus, C. chinensis, Acyrthosiphon pisum, Phytomyza horticola, Lampides boeticus, Ophiomyia phaseoli, Bruchus pisorum, Melanagromyza obtusa* and *Spilarctia*

casigneta). **Oilseed** (*Athalia lugens proxima* and **Lipaphis erisimi).* **Industrial crops** (Cotton: *Aphis gossypii, Amrasca biguttula biguttula,Pectinophora gossypiella, Erias vittella, Helicoverpa armigera, Disdercus cingulatus* and **Spodopter litura.* Tobacco: *Thrips tabaci, Bemisia tabaci* and *Lasioderma serricorne.* Sugarcane: **Pyrilla perpusilla, Saccharicocdus sacchari, Chilo infuscatellus, Tryporyza nivella* and *Odontotermus obesus).* **Stored grains and other stored material** (**Sitotroga cerealella, *Sitophilus oryzae, Trogoderma granarium, Tribolium castaneum, Agrotis ipsilon, A. segetum, Chaetecnuma minuta, Ephestia cautella, Anthrenus flavipes* and *Lepisma saccharius).* **Potato and other vegetables** (Potato: *Epilachna vigintioctopunctata, Myzus persicae, Epicauta hirtipes *Phthorimaea operculella, Dorylus orientalis* and *Phyllophaga* sp. Vegetables: *Aplosonyx chalybaeus, Brevicoryne brassicae, Pieris brassicae, *Plutella xylostella, Leucinodes orbonalis, Bactrocera cucurbita, Oligonychus* sp. and *Tetranychus* sp.) **Fruit trees** (Apple: *Drysthenes hugeli, Melacosoma indica, Eriosoma lanigerum* and *Quadraspidiotus periciosus.* **Banana**: *Pentalonia migronervos, Erionota thrax* and *Cosmopolites sordidus.* **Citrus**: *Toxoptera aurantii, T. citricidus, Phyllocnistis citrella, Diaphorina citri, *Aonidiella aurantii, Papilio demoleus* and *Apsylla cistellata.* Peach: **Bactrocera dorsalis* and *Brachycaudus helichrusi.*

20 hrs

Forest Pests: Leaf - eating (*Plecoptera reflexa , Ascotis imparata, Dasychira dalbergia, Dasychira grotei, Dichomeris eridantis, Ectropis deodarae, Apoderus sissu* and, *Hyblaea puera).* sap - sucking (*Urostylis punctigera, Aspidiotes orientalis, Toxoptera aurantii, Helopeltis antonii, Drosicha mangifera, Drosicha stebbingii* and *Lacifer lacca).* meristematic (*Tonica niviferana, Scolytus major, phylophaga sp. Agrotis ipsilon, Agrotis segetum* and *Dorylus orientalis).* Phloem (*Ips longifolia, Acmaeodera kerremansi, *Haploceramix spinicornis* and *Scolytus major).* phloem - wood (*Perissus dalburgiae* and *Cyclotermes obesus)* wood destroyers (**Xyleborus fornicatus).*

5 hrs

Insect and other Arthropods related to public and animal health: Mosquitoes (*Culex* spp., *Anopheles* spp., *Aedes* spp.,) *Sand flies (*Phlebotomus* spp.,) *Housefly (*Musca domestica.*,) Flies related to myiasis (*Chrysomyia* spp., *Callitroga* spp.,) Sucking lice (*Pediculus humanus capitis, P. h. humanus, Phthirius pubis)* beg bug (*Cimex lectularius, C. hemipterus.*) flea (*Xenopsylla cheopis.,)* eye gnat (*Siphunculina funicola.*,) Cockroaches (*Periplaneta anmericana, Blattella germanica, Blatta orientalis.*,) wasps/ Hornets (*Polites* spp., *Vespa* spp.) mites (*Sarcoptes scabies var hominis, Trombiculata* spp.).

15 hrs

Vector parsite relationship with special reference to malaria, filariasis, Japanese encephalitis and leihmaniasis.

20 hrs.

Unit III Useful Insects: Beneficial insects of nature: Insect Predators and Parasitiods. Productive insects: Honey bees, Silkworm, Shallac scale insects. Scavanger. Protein resource to poultry birds (Maggots, Grubs, Caterpillars). Insects as human food.

Unit IV Insect Collection, Preservation and Maintenace of Reference Insects:

Insect Pest Management and Research Methodology

Course Title: Insect Pest Management and Research Methodology
Full Marks: 80
Course No: Zoo. 623
Pass Marks: 32
Nature of the course: Theory
Year: II

Course Description: Insect Pest Management and Research Methodology

General Objectives :

- to acquaint the students with integrated pest management system.
- to make best use of insecticides for human welfare.
- to impart knowledge on research methodology especially on insects.

Specific Objectives :

- to impart knowledge on components of pest management.
- to provide knowledge on types of chemical, including botanical pesticides, their mode of action and results of their misuse.
- to help explain the mechanism of resistance against pesticides and its limitations.
- to enable the students to explain the research methodology on insects.

Course Contents :

Unit I Insect Pest Management: Pest Management (Concept of pest management and Decision making in pest control.) Integrated Pest Management Components: Cultural Management Practices (Field sanitation, Clean planting materials, Crop rotation, Adjusting in sowing and planting dates, Fertilizer management, Water management and Tillage). Use of resistant varieties (Mechanism of resistance: Ecological resistance, Genetic resistance, Antibiosis and Tolerance. Advantages of resistant varieties, Limitations of resistant varieties). Mechanical Approaches (Hand picking and destruction by dosers, rollers, etc. Exclusion: Use of barriers, Use of trapping devices and Banding of trees). Physical Approaches (Use of light, Temperature: cold and cooling storage, humidity and sound). Legislative Approach (Quarantine system). Biological Approaches (Balance of insect population in nature as control agents, Predators, Parasitoids and Pathogens. Practice of biological control: Augmantation, Inductive releases, Inoculative releases and Environmental manipulation, Conservation of natural enemies, Autocidal and genetic manipulation: Release of genetic incompaticle insect pests, Sterilization technique and field release). Chemical Approaches (Synthetic Chemicals: Advantages and disadvantages of chemical control, Types of pesticides, Classification of pesticides, Formulation of pesticides, Path of Pesticide entry, Toxicity - Acute and Chronic of pesticides, Insecticide calculation and Pesticide compatibilities, Result of Pesticide misuse, Equipment kinds and working mechanish for pesticides application, Handling of Pesticides and first aid measures, poisoning systems of pesticides, mechanism of chemical resistance, Common Pesticides used in Nepal. Natural Chemicals: Pyrethrum,

Nicotine, Rotenone, Crysanthemum and other local varieties: their extraction and testing. **66 hrs.**

Unit II Research Methodology: Introduction to research methodology. Problem (Title) Identification, Objectives of the research works, research planning and justification of the research. Literature review. Materials of research works (Various instruments used in insect related research works). Methodology (Taxonomic - Sampling, Preservation and Identification. Experimental Data Collection and its analysis using statistical tools and presentation). Discussion and comparision of the data. Conclusion / Abstract. Recommendation on the basis of research findings. Citation of literatures. Scientific paper writting. **30 hrs.**

Entomology Practical I Taxonomy

Course Title: Entomology Practical I Taxonomy — Full Marks: 80
Course No: Zoo. 624 — Pass Marks: 32
Nature of the course: Practical — Year: II

Course Description: Lab works, Taxonomy, Permanent mounting, Dissection, Microtomy and Pathogen tests of the vestors.

General Objectives: to provide practical knowledge of various techniques used in insect collection, identification and preservation , also examination of various tissues and anatomy of insects.

Specific Objectives:

- to develop among the students the skill and ability of identification of different insect species,
- to make the students able to expose the anatomy of insects and display the organs of digestion, excretion, respiration, reproduction (external and internal) as well as their nervous system;
- to make them able to prepare the mircotomical preparations of the alimentary canal and gonads.

Course Contents:

Unit I Taxonomy: Insect collection and identification upto order using a standard key, Study of head types based on their orientation with respect to body, nature of mouth- parts based on feeding habits, Identification of antenna types, Identification of leg types based on adaptive modifications, Study of wing structure of different groups (main orders), its venatious and coupling arrangements, Family, Identification of insects of the following orders upto family level: Lepidoptera, Coleoptera, Diptera, Hymenoptera and Hemiptera Study of collected specimens and sketching of typical types, Identification of mosquito (adult and larva) and sand fly using a standard key.

Unit II Permanent Mounting: Identification of different forms of immature insects , Mounting of -Whole mount of: Aphid, Thrips, White fly, Lice, Flea, Mosquitoes, Scales, Mites and Leaf-minor.

Mounting of: Mouth parts, Antennae and Leg types

Unit III Dissection :Dissection of typical insects so as to expose their genitalia, sting apparatus and their mounting, Dissection of common insects to expose: Alimentary canal, Nervous system, Reproductive organs, Trachael system and Circulatory system.

Unit IV Pathogen tests of vectors: Blood & saliva (DAT).

Unit V Microtomy preparation of the alimentary canal, gonads.

Entomology Practical II

Course Title: Entomology Practical II
Course No: Zoo. 625
Nature of the course: Practical

Full Marks: 80
Pass Marks: 32
The year: II

Course Description: Field works: Insect habit and habitat, Test of water and soil quality, Insect abundance, Equipment for the study of bee- culture and silkworm culture, Tests of insecticides residue, etc.

General Objective: to provide field knowledge of various techniques used for insect abundance analysis of water as well as knowledge on formulation of pesticides, bee-culture, silkworm culture and preparation of the field report.

Specific Objectives:

- to develop among the students the skill and ability for the analysis of water and soil,
- to make the students able to estimate insects in the field (cropland, grassland, water etc,
- to make them familiar with the insecticide application equipments,
- to make them able to mass-rearing of mosquito in the laboratory.
- to make them able to do the susceptibility test of vector species.

Course Contents :

Unit I Study of habit , habitat and general behaviour (Feeding, Mating, Courtship, etc.)of different insect species in the local area.

Unit II Test of water quality - pH, DO(Dissolve Oxygen), BOD(Biological Oxygen Demand) and free carbondioxide, Test of soil quality - acidity & alkalanity, Study of insect species as indicator of pollution (water and soil), Abundance of insects: Density, species diversity in different habitats, Population study of insects by capture and recapture method in the crop - land and grass - land, Estimation of aquatic insect population.

Unit III Callibration of sprayer and dilution of insecticide to the recommended concentration level, Study of different types of insecticide application equipments, Study of honey bee - hive structure, honey bee - members and related equipments.

Unit IV Study of different equipments used in silkworm rearing and silk reeling, Test of insecticidal residues in river water and vegetables.

Unit V Mass rearing of mosquitoes , Suscepsibility test of vector species , Field visit at least one day visit for three times in 2nd academic year including. collection, analysis and report preparation.

Unit VI Visiting different entomological laboratories and research fields.

Dissertation

Course Title: Dissertation
Course No: Zoo. 626
Nature of the course: Research projects

Full Marks: 100
Pass Marks: 40
The year: II

Course Description: Research projects in the area of Entomology.Research projects and Thesis Submission :Research project areas will be decided during the second academic year. Students will be encouraged to contribute to the formation of projects, making use of their own experience ideas and contacts. Project proposals should be discussed with possible supervisior. Students will have to submit their research proposals during the registration for M. Sc. Zoology. Part II (Parasitology). The progress of work will be be reviewed internally from time to time and final evaluation will be made of the thesis. The thesis should be presented for examination. Students will have to appear in an oral examination.

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Taxonomy, Anatomy, Physiology, and Behaviour
Fish and Fisheries

Course Title: Taxonomy, Anatomy, Physiology, and Behaviour
Full Marks: 80
Course No: Zoo. 631
Pass Marks: 32
Nature of the course: Theory
Year: II

Course Description: Taxonomy, Anatomy, Physiology, and Behaviour

General objective: to give thorough through knowledge of taxonomy, anatomy, physiology, behaviour and distribution of Fishes.

Specific Objectives :

- to introduce the subject of fisheries to the students,
- to familiarise the students with the subject of taxonomy, anatomy, physiology and behaviour of fishes.

Course Contents :

Unit I Classification and distribution of fresh water fishes of Nepal: **10 hrs**

Unit II Anatomy and physiology: Digestive system: Digestive organs, Food and feeding habit (herbivorous, carnivorous, omnivorous, planktivorous) structural differences in digestive organs, factors affecting food intake, physiology of digestion and associated glands. Respiratory system: Respiratory organs: Structure of gills, counter current system and gas exchange, relationship between water flow & lamellae surface, Accessory organs of respiraton. Blood vascular system: Heart, blood vessels, arterial & venous system, physiology of blood circulation. Excretory system and osmoregulation: The kidneys, urinary organs & their ducts, patterns of nitrogen excretion. Osmoregulation in fresh water & marine fishes. Nervous system: Structure of brain, central nervous system. peripheral nervous system, autonomic nervous system, Reproductive System: Reprodcutive organs, embryonic development (Pre and Post embryonic development). Air bladder and Weberian ossicles, Sense organs: lateral line system, olfactory organs, Taste buds, touch receptors, photoreceptors, Endocrine glands: Structure and functions of important endocirne glands and their functions. **66 hrs.**

Unit III Adaptive modification in fishes : **3 hrs.**

Unit IV Recent trends in fish genetics : **4 hrs.**

Unit V Specialised organs in fishes with special reference to - light and electric organs : **3 hrs.**

Unit VI Behaviour: Fish behaviour in relation to feeding, schooling,.courtship, mating, parental care, migration, spawning , swimming etc. **10 hrs**

Applied Fisheries and Management

Course Title: Applied Fisheries and Management
Course No: Zoology - 632
Nature of the course: Theory

Full Marks: 80
Pass Marks: 32
Year: II

Course Description: Applied Fisheries and Management.

General objective: to make the students able to understand overall knowledge of status of fish and aquaculture system.

Specific objectives :

- to introduce to the students different aquacultural practices,
- to familiarise students with the basic knowledge of fish pond construction and management to give practical knowledge of fish farm management.
- to introduce to the students the important diseases of farm fishes alongwith their treatment.
- to teach the student the principles of fish nutrition and
- to familiarise the students with the techniques of preservation and processing , the important aspects of fisheries technology.

Course Contents:

Unit I Applied Fisheries: Status of aquaculture in Nepal, Economic importance of fishes (Food value, medicinal value, ornamental value, sport value, trade value, larvivorous fishes, contribution in National GDP) **5 hrs**

Aquaculture system: Principle & concepts of fish culture, cultivable fishes,Classification of aquaculture practices: monoculture, polyculture, cage culture, pen - enclosure, shrimps culture, molluscan culture, frog culture , race-way culture **20 hrs**

Integrated fish culture: Animal husbandary (pig, cattle, duck, chickens etc.) with fish, Horticulture (vegetables, fruits) with fish **5 hrs**

Unit II Management: Pond Engineering and Management: Fish pond engineering: Survey of site, desgining, estimation, layout, Soil, Topography and water requirement, Repair and maintenance, Types of Ponds: Nursery pond, Rearing pond, Brood Pond, Production Pond, Race-way, Management of fish farm: Technical responsibility of fishery manager, Fish culture operation (stocking and manipulation of fish stock, growth check up etc.), Water quality improvement (cleaning, liming, protection aganist wild fishes, snakes etc.), weed control (mechanical, chemical and biological methods), fertilizing and manuring etc. Feeding of cultivated fishes, harvesting, record keeping, transport of fish fry, fingerlings, brood fish, table fish, Marketting, Hatcheary management: Maitenance of brood stock, Selection of brood stock, Artificial and semiartificial breeding (Kakabon hypophysation, incubation and hatching, larval rearing, nursery management), Estimation of fecundity, fertility , hatchelity, mortality. **40 hrs**

Unit III Fish Diseases: Concept of fish parasites and diseases, Classification of fish diseases (Parasitic, non parasitic, bacterial and viral) Common fish

disease, causes, symptoms, diagnosis and treatment. Public health importance of fish diseases. **5 hrs.**

Unit IV Fish Nutrition and Feeding managements: Nutritional requirement of fish (proteins, fats, carbohydrates, vitamins, minerals etc.), Feed and their formulations, Nutritional deficiency symptoms in fishes. **10 hrs.**

Unit V Fish Preservation and Processing: Fish as food: Biochemical composition and nutritive values of raw and preserved and processed fish, Fish Preservation: Principle of preservation, methods of prerservation, Chilling, refrigeration, Canning, sundrying, mechanical drying, dry salting, smoking, pickling, brining, Fish decomposition: Spoilage of fish, bacteria and bacterial spoilage, chemical spoilage, rancidity and autolysis, Utlization of fisheries: Products and by products. **11 hrs.**

Fresh Water Ecology and Research Methodology

Course Title: Fresh Water Ecology and Research Methodology. Full Marks: 80
Course No: Zoo. 633 Pass Marks: 32
Nature of the course: Theory Year: II

Course Description: Fresh Water Ecology and Research Methodology.

General objective: to give the student a through knowledge of water resources of Nepal and general technique of research methodology.

Specific Objectives :

- to give a broad spectrum knowledge of fresh water ecology to the students,
- to familiarise the students with the advance knowledge of limnology and aquatic pollution,
- to enable them to consider various fishery population and diversity,
- to give ideas of management and conservation of natural water and
- to introduce research methodology and biostatistics in fish and fishery research.

Course Contents :

Unit I Fresh Water Ecology: Aquatic resources: River system and its zonation, Lakes and their types, Ponds and reservoirs, Swamps and marshes, Irrigated paddy fields, Limnology and Aquatic pollution: Physiography of fresh water: stratification, buoyancy, temperature, turbidity, depth, colour, current velocity, specific conductivity etc. Limnochemistry: pH, hardness, dissolved Oxygen, free Carbondioxide, BOD, COD, alkalinity, acidity, Chloride, Ammonia, Orthophosphate , total phosphate, nitrate, nitrite, total Nitrogen, Silicates, etc., Biological Parameters: Primary productivity, Secondary Productivity, Chlorophyll, plankton's, periphyton, benthos, Carrying capacity, inter relationship between biotic and abiotic factors, Aquatic vegetation, Aquatic pollution: Concept of pollution, source of water pollution, major aquatic pollutants and their effects on fishes, causes of pollution and their control methods, Waste water recycling, Use of aquatic animals in monitoring pollution through bioassays. **38 hrs.**

Unit II Population and Diversity: Fish Population: population density, population structure (year classes), estimation of population, population fluctuation, abundance, casual factors, population dynamics, determination of age and growth rate, length-weight relationship, recruitment and mortality, Fish Diversity: Concept of diversity, species diversity, genetic diversity, species abundance and distribution pattern. **20 hrs**

Unit III Management and Conservation of natural water: Environmen impacts assessment (EIA), Effects of development activities on aquati environment and mitigation measures, Acts, regulation and implementation Fishing gear types and fishing exploitation, Management of natural population **15 hrs**

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Unit IV Research Methodology and Application of Biostatistics in Fish and Fisheries Research: Research Methodology: Introduction to research methodology, Identification of the problem, Objectives of the research works, research planning and justification, Literature review, Materials of methods of research works: Various instruments used in fish and fisheries related research works, Different methods used in - Sampling, Preservation and Identification, Analysis of collected data using statistical tools, Interpretation, description and comparison of the data, Conclusion / Abstract, Recommendation on the basis of research findings, Citation of literatures, Scientific paper writing..

Application of Biostatistics in fish and fisheries research: Statistics of dispersion and measurement, Samples and sampling techniques: Introduction, various techniques used in fish and fisheries, Data matrix - Introduction Application of following in fish and fisheries research: T- test, Chi square ($\chi 2$) test, Contingency table, Correlation and regression analysis, Analysis of variance. **23 hrs**

Fish and Fisheries, Practical I

Course Title: Fish and Fisheries, Practical I
Course No: Zoo. 634
Nature of the course: Practical

Full Marks: 80
Pass Marks: 32
Year: II

Course Description: Includes the practical knowledge of theory paper (Taxonomy, Anatomy, and Physiology)

General Objective: to provide practical knowledge of various techniques used in fish collection, identification, preservation, and examination of various organs and permanent slide preparation.

Specific Objectives:

- to develop a skill and ability on the identification of different species of fishes,
- to make able to expose, identify, flag label of particular organ system along with their function and able to show the relation with other organ system in the internal anatomy ,
- to make able to prepare the permanent slides of different organs, tissues and to have the knowledge of osteology.

Course Contents:

Unit I Taxonomy: Collection and identification of different species of fishes from natural habitat, Museum specimens.

Unit II Dissection of some fishes to study: General anatomy, Digestive organs, Respiratory and Accessory respiratory organs, Circulatory organs, Reproductive organs

Unit III Dissection of some siluroid and cyprinoid fishes (*Catla, Wallago*, Rohu, *Mystus* etc.) to study: Cranial nerves, Weberian ossicles, Internal ear

Unit IV Permanent mounting: Preparation of slides of scales, ampullae of lorenzini, respiratory membrane, eggs, hatchlings, fry and fingerlings

Unit V Preparation of fish skeleton and osteological study:

Unit -VI Microtomy preparation and study of gonads and different organs, tissues:

Unit VII Alizarine preparation:

Fish and Fisheries, Practical II

Course Title: Fish and Fisheries, Practical II
Course No: Zoo. 635
Nature of the course: Practical

Full Marks: 80
Pass Marks: 32
The year: II

Course Description: Includes the practical knowledge of theory (Limnology, Fishing gears, Fish Nutrition, Breeding techniques etc.)

General objective: to provide practical knowledge of various techniques used for the analysis of water as well as knowledge of feed composition/formulation, determination of age and preparation of report.

Specific Objectives:

- to develop among the students the skill and ability for the analysis of water,
- to familiarise them with different fishing gears,
- to make familiar with various breeding techniques and
- To make them familiar with various fish feed/feed composition/formation.

Course Contents:

Unit I Limnology: Measurement of temperature, pH, dissolved oxygen, free carbondioxide, biological oxygen demand (BOD), COD, alkalinity, acidity, hardness, minerals, specific conductivity, dissolved solids etc., sampling, preservation and identification of plankton's and macro invertebrates, methods for qualitative and quantitative estimation of plankton's and assessment of primary productivity by light and dark bottle methods.

Unit II Preparation **of benthymetric map of a water body:**

Unit III Introduction of different fishing gears using models:

Unit IV Study of fecundity of some fresh water fishes:

Unit V Determination of age and growth of fishes:

Unit VI Fish Nutrition: Feed composition / formulation

Unit VII Preparation of report on the basis of visit to different fish farm: (one day trip at least two times per one academic year), Breeding techniques (artificial and semi artificial), Types of ponds etc.

Fish and Fisheries Dissertation

Course Title: Fish and Fisheries Dissertation
Course No: Zoo. 636
Nature of the course: Research projects

Full Marks: 100
Pass Marks: 40
Year: II

Course Description: Research projects in the area of fish and fisheries. Research projects and Thesis Submission: Research project areas will be decided during the second academic year. Students will be encouraged to contribute to the formation of projects, making use of their own experience ideas and contacts. Project proposals should be discussed with concerned supervisor. Students will have to submit their research proposals during the registration for M. Sc. Zoology. Part II (Fish and Fisheries). The progress of work will be reviewed internally from time to time and the final evaluation will be made of the thesis. The thesis should be presented for examination. Students will have to take an oral examination.

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Parasitology

Course Title: General Parasitology, Protozoology And Entomology
Course No: Zoo. 641
Nature of the course: Theory

Full Marks: 80
Pass Marks: 32
Year: II

Course Description: General Parasitology, Protozoology and Entomology

General Objectives: to introduce general Parasitology and to impart advanced knowledge on various important protozoan parasites including some important microbial parasites and insects of medical, veterinary and agricultural importance.

Specific Objective: to apply the advanced knowledge on the subject in day to day life with special reference to Nepal.

Course Contents:

Unit I General Parasitology: Scope and historical land marks in Parasitology, Basic principles and nomenclature aspects of parasites, The parasites and their environment and the origin of parasitism and Kinds of parasites, effects of parasitism on parasites and host. **12 hrs**

Unit II Molecular Parasitology And Microbes: Characteristics of viruses (HIV, Flu. Virus (bird and pig); Bacteria (Vibrio *cholera*, *Salmonella typhi*, *Microbacterium leprae* And *Bacillus anthracis*). Spirochetes (*Treponema palladium*), and Rickettsia (*Rickettsia prowazekii*); mode of invasion (transmission and penetration) in host cell; Introduction to common and important parasitic diseases of medical, veterinary and agricultural importance. **20 hrs**

Unit III Protozoology: Introduction, life cycle (in brief), mode of infection, pathogenecity, control and prevention of diseases caused by following Protozoan parasites with special reference to Nepal. Parasitic (Amoebae of medical importance and protozoan encystment, Haemoflagellates of medical importance, Intestinal flagellates of medical importance and *Plasmodium*, *Toxoplasma*, *Babesia)*. **28 hrs.**

Unit IV Entomology: Structure, feeding habit and effect of bites of arthropod (vectors), method of pathogen transmission, casual organisms, remedies and prevention with reference to following forms: Hemiptera and Heteroptera (Bed Bug), Anoplura and Mallophaga (Lice), Siphonoptera (Fleas), Diptera (Mosquitoes), Blood sucking and disease carrying flies, Ticks and Mites **26 hrs.**

Unit V: Epidemiology of Typhus Fever, Relapsing Fever, Malarial Fever, Yellow Fever, Kalaazar, Encephalitis, and Filariasis, Insects causing vesication, urtication, and venenation in man, Insects of veterinary and medical importance with special reference to insects as vectors of diseases and Fly maggots and myiasis. **10 hrs.**

General Parasitology, Helminthology including Phytonematology

Course Title: General Parasitology, Helminthology including Phytonematology — Full Marks: 80
Course No: Zoo. 642 — Pass Marks: 32
Nature of the course: Theory — Year: II

Course Description: General Parasitology, Helminthology including Phytonematology

General Objectives: to introduce general Parasitology and to impart advanced knowledge on important helminth parasites including soil, plant and entomopathogenic nematodes.
Specific Objective: to improve immunity and resistance against the parasites and parasitic diseases.

Course Contents :

Unit I General Parasitology:.Host parasite relationship, Host specificity, Resistance and immunity, Parasitism and properties (behaviour) of parasites, and Adaptation in structure, life cycle, including infectiousness, establishment and transmission of parasites. **34 hrs**

Unit II Trematoda: Life cycle patterns in Trematoda, Physiology of Trematodes in general and General organization , pathology, control and prevention of diseases caused by the following forms: *Polystoma integerrimum, Clonorchis sinensis, Paragonimus westermani, Gastrothylax species and* Characteristics of Strigeidae, Diplostomatidae and Prohemistomidae. **15 hrs.**

Unit III Cestoda: Comparative studies of scolices in Cestod, Life cycle pattern on Cestoda, Physiology of Cestoda in general and General organization, pathology, control, and prevention of diseases caused by *Diphyllobothrium latum*, *Dipylidium caninum,* and *Moniezia expans* **15 hrs.**

Unit IV Acanthocephala:.General organization and life cycle. **4 hrs**

Unit V: Nematoda: General oganization , life cycle and economic importance of Nematodes with reference to following forms: **Human**: (*Strongyloides stercoralis, Trichuris trichura, Ancylostoma duodenale)* **Veterinary**: (*Trichostrongylus orientalis, Haemonchus contortus, Thelazia callipaeda)* **Plant:** Stem nematodes *(Anguina tritici*), Root gall nematodes (*Meloidogyne incognita*) Cyst nematodes (*Heterodera* and *Globodera*) Predatory (*Mononchus)* migratory (*Xiphinema)*and free living soil nematodes: *Tylenchus, Rhabditis,* and *Dorylaimus.*Insect: *Steinernama* and *Heterorhabditis*: **16 hrs.**

Unit VI: Role of plant parasitic Nematodes in agriculture with reference to Nematode diseases of potato, rice and citrus plants, effects of agricultural practices in Nematode population. **7 hrs.**

Unit VII Use of Nematodes for Human Benefits: Saprophagus, Mycophagus, Bacteriophagus, Entomopathogenic and Predatory. **5 hrs.**

Applied Parasitology and Research Methodology

Course Title: Applied Parasitology and Research Methodology
Course No: Zoo. 643
Nature of the course: Theory

Full Marks: 80
Pass Marks: 32
Year: II

Course Description: Applied Parasitology and Research Methodology

General Objectives:

- to share and impart the advanced knowledge of parasitology and apply it in research methodology of various parasites so as to obtain relevant findings and
- to apply the research findings in prevention and control of various parasites of medical, veterinary and agricultural importance.

Specific Objective: to improve the economy of nation and upgrade the quality of life with special reference to Nepal by the application of the research findings.

Course Contents :

Unit I Applied Parasitology: Parasitology as an academic and applied science, Parasite fauna , parastic burden, age of the host and season of the year, Parasite fauna, the food and mode of life and migration of the host, Epidemiology, Zoonoses and Zoogeography of parasites and Influence of human activity on the parasitic fauna of animals and man. **25 hrs**

Unit II: Socio-economic consequences and prospects for the control and prevention of parasitic diseases with special reference to Nepal, Ecological management and preventive measures of parasitic diseases with reference to Nepal, Biological control of parasites and Chemical control or use of Anthelmintics to prevent and control the parasites and parasitic diseases.**23 hrs.**

Unit III: Recent trends in control of vector and vector borne disease with special reference to household insect: Chemical, Biological, Environmental and Integrated **18 hrs.**

Unit IV: Introduction to biology of ageing (Gerontology) In Nematodes. **5 hrs.**

Unit V: Research Methodology: Introduction to research methodology, Selection and Formulation of problems, Extensive literature review, Objective of the research work, Experimentation application of various instruments, Careful observation, Collection and analysis of data, Interpretation, description & comparision, Discussion, Conclusion, Recommendation (on the basis of the research findings), Preparation of the report in a scientific way on the basis of international rules or thesis writing including abstract and references. **20 hrs.**

Unit VI: Publication of research findings in the international journals as far aspossible. **2 hrs.**

Unit VII: Types of research method: Taxonomic and Experimental: Histopathological, Serological, various diseases and life cycle of parasites. **3 hrs.**

Parasitology, Practical I

Course Title: Parasitology, Practical I
Course No: Zoo. 644
Nature of the course: Practical

Full Marks: 80
Pass Marks: 32
year: II.

Course Description: General Parasitology, Protozoology and Entomology.

General Objective: to provide practical knowledge of various techniques used in examination of living hosts, collection, preservation, permanent slides preparation and identification of various protozoan parasites and arthropod vectors.

Specific Objectives:

- to develop skill and ability on the study of protozoan culture,
- to acquaint the students with the practical knowledge of blood smears for various protozoan parasites,
- to make them familiar with the critical examination , isolation and identification of eggs (helminths) and cysts of parasites from faecal samples.
- to help them be familiar with the use of camera lucida, oculomicrometer, stage micrometer as well as microtomes.

Course Contents:

Unit I: Examination of different living animal hosts for collection , preservation, mounting and identification of protozoan parasites and arthropod vectors.

Unit II: Preparation and study of protozoan culture.

Unit III: Study of permanent slides of protozoan parasites and arthropod vectors, Microscopical Examination of Blood smears for protozoan parasites and Isolation and identification of protozoan cysts and eggs of Helminth parasites from faecal samples.

Unit IV: Use of Camera Lucida, Oculomicrometer and Stagemicrometer for measurement.

Unit V: Dissection of various arthropod vectors for the examination and collection of protozoan parasites, Microtomy of the infected tissues of the hosts and arthropod vectors and Study of permanent slides of different developmental stages of parasites and vectors.

Parasitology, Practical II

Course Title: Parasitology, Practical II
Course No: Zoo. 645
Nature of the course: Practical

Full Marks: 80
Pass Marks: 32
year: II

Course Description: General Parasitology, Helminthology including Phytonematology, Applied Parasitology and Research Methodology.

General Objective: to provide practical knowledge of various techniques used for the study of parasites from both invertebrate and vertebrate hosts as well as vectors of pathogenes with special reference to examination, observation, collection, Preservation, permanent slide preparation and identification of different parasites of both definitive and intermediate hosts and vectors.

Specific Objectives:

- to develop skill and ability on the Histopathological studies and the helminth culture techniques,
- to extract and prepare slides of nematode parasites from different habitats including in isolation of the entomopathogenic nematodes,
- to help be familiar the students with the sampling and estimation of population of nematodes from soil and plant tissues,
- to acquaint the students with the technique of producing *fasciola* metacercariae from eggs and
- to make them familiar with the methodology in the collection of larval trematodes form the infected snails and their permanent slide preparation.

Course Content :

Unit I: Examination of living animal hosts (Definitive and Intermediate) - Earthworm, Cockroach, Bony fish, Frog, Toad, Wall lizard, Garden lizard, Pigeon, Fowl, Rat etc. for collection, preservation, and identification of different helminth parasites.

Unit II: Studies of different sections (Transverse , Longitudinal , Sagittal) of parasites by using microtomy method. and Histopathological studies of different types of infected tissues of the host.

Unit III: Preparation of Helminth Culture.

Unit IV: Extraction and slide preparation of nematodes from different habitats including the isolation of the entomopathogenic nematodes and Sampling and estimation of population of nematodes from soil and plant tissues.

Unit V: Microscopical Examination of Blood smears for Microfilariae.

Unit VI: Production of *Fasciola* Metacercariae from egg. and Collection of larval Trematodes from infected snails and preparation of their mounts.

Unit VII: Identification of Helminth parasites of man.

Unit VIII: Methods of sketching, measuring and Microphotography of parasites.

Dissertation

Course Title: Dissertation
Course No: Zoo. 646
Nature of the course: Research projects

Full Marks: 100
Pass Marks: 40
year: II

Course Description: Research projects in the area of Parasitology: Research projects and Thesis Submission: Research project areas will be decided during the second academic year. Students will be encouraged to contribute to the formation of projects, making use of their own experience ideas and contacts. Project proposals should be discussed with possible supervisor. Students will have to submit their research proposals during the registration for M. Sc. Zoology. Part II (Parasitology). The progress of work will be reviewed internally from time to time and final evaluation will be the thesis. The thesis should be presented for examination. Students will have to take an oral examination.

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